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WANDA BIELECKA, OLGA STYK *

# SOME STRATIGRAPHICALLY IMPORTANT KUIAVIAN AND BATHONIAN FORMINIFERA OF POLISH LOWLANDS

(Pl. XCIX—CII and 2 Figs.)

## *Niektóre ważniejsze stratygraficznie otwornice kujawu i batonu Polski niżowej*

*(Tabl. XCIX—CII i 2 fig.)*

Abstract. The Kuiavian [1] and Bathonian deposits of Polish Lowlands have been lithologically characterized. A vertical distribution of stratigraphically important Kuiavian and Bathonian species of Foraminifera is graphically shown in Table 1. Characteristics of following Foraminifera have been given among them two new species: *Ammopalmula infrajurensis* (Terquem), *Lenticulina* (*Lenticulina*) *daphne* n. sp., *Lenticulina* (*Astacolus*) *polymorpha polymorpha* (Terquem), *L.* (*A.*) *volubilis* Dain, *L.* (*A.*) *interrumpa* Blank, *Paalzowella pazdroae* n. sp.

## INTRODUCTION

Foraminifers from the Dogger deposits of Poland have so far been described by not very many authors. O. Terquem's work, published in 1886, is one of the most extensive monographs devoted to the Dogger microfauna but at present it is mostly of an historical importance. It concerns the Dogger foraminifers and ostracods of the Cracow-Częstochowa Jura which, however, now require a considerable revision. Valuable is also T. Wiśniowski's monograph (1890, 1891) which deals with the foraminifers from *ornatus* clays of the environs of Cracow. The rest of these works are mostly devoted to certain particular problems and describe only individual genera and species of foraminifers.

A new genus *Flabellamminopsis*, together with several of its new species were described by J. Małecki in 1953. In 1958—1959, Kuiavian and Bathonian miliolids of the environs of Częstochowa were elaborated by O. Pazdrowa and in 1961 the species *Trocholina conica* (Schlumberger) was studied by W. Bielecka and E. Dudziak.

As regards the stratigraphical value of the Dogger foraminifers of Poland, this subject was first studied in 1954 by O. Pazdrowa who presented a model diagram of the distribution of foraminifers in the Dogger ore-bearing sediments of the Częstochowa region. Later on, these studies were continued by W. Bielecka and J. Kopik. In 1956,

* Dr. Wanda Bielecka and Dr. Olga Styk, Geological Institute, Warszawa, ul. Rakowiecka 4, Poland.

[1] A stratigraphical concept of the Kuiavian has been introduced to the Polish geology; its range is shown in Table 1.

J. Kopik published the results of his stratigraphical studies on the Aalenian and Bajocian microfauna of the Borucice bore-hole in Central Poland. In 1960, O. Pazdrowa presented the first schema of a vertical distribution of the species of the Kuiavian and Bathonian foraminifers of the Polish Lowlands and J.. Kopik — of those of the Liassic and Lower Dogger. In 1967, as part of the materials prepared for the Tenth European Micropaleontological Colloquium, convened in Poland, J. Kopik and O. Pazdrowa, as well as W. Bielecka and O. Styk published some data on more important Middle Jurassic microfaunistic sections of the Cracow-Częstochowa Jura. In 1959, 1965 (in J. Błaszyk & H. Malz 1965) and 1967, J. Błaszyk's papers were published, devoted to the Kuiavian and Bathonian ostracods of the Cracow-Częstochowa Jura.

Microfaunistic analyses of boring materials from the Middle Jurassic of the entire Polish Lowlands were made by W. Bielecka, J. Kopik and O. Styk at the Geological Institute in Warsaw and, partly, by A. Siewniak at the Upper Silesian Field Station in Sosnowiec. Most of these works remained, however, unpublished.

The Dogger subfamily Epistomininae has recently been studied in detail by O. Pazdrowa whose results are issued in 1969. Now, B. Jędryka is preparing a work on the species of the genus Lenticulina from the Liassic to the Cretaceous ones.

The aim of the present paper is to present brief characteristics of some stratigraphically more important Kuiavian and Bathonian foraminifers, together with a few palaeontological descriptions. The distribution of more important Kuiavian and Bathonian species of foraminifers in the Polish Lowlands is shown in Table 1.

The Plates have been photographed by Mrs. Janina Modrzejewska and Figures have been drawn by Mrs. Ewa Gadomska.

## BRIEF CHARACTERISTICS OF THE KUIAVIAN AND BATHONIAN FORAMINIFERA OF THE POLISH LOWLAND

The Kuiavian and Bathonian sediments of the Polish Lowlands are mostly developed in the muddy-clayey-sandy facies. Their distribution and facial development have been recently given by K. Dayczak-Calikowska (1964) in the Geological Atlas of Poland.

The Lower Kuiavian sediments are frequently reduced and developed in the arenaceous facies. Usually, these are sands and sandstones or sandy mudstones with siderite concretions. Clayey-mudstone intercalations occur in the central part of the basin. The sandy character of the Lower Kuiavian sedimentation caused a scarcity and frequently even a lack of fauna in these layers.

Agglutinated foraminifers of the genera *Trochammina, Rhabdammina, Haplophragmoides, Recurvoides, Glomospira, Reophax, Proteonina, Ammobaculites, Ammodiscus,* etc. predominate in the Lower Kuiavian. Foraminifers with calcareous tests are relatively few and they primarily belong to the genera *Lenticulina, Eoguttulina* and *Epistomina.*

The species of foraminifers which also occur in the Bajocian such as, for instance, *Recurvoides trochamminiforme* Höglund, *Trochammina inflata* (Montagu), *T. canningensis* Tappan, *Haplophragmoides concavus* (Chapman), *Ammodiscus orbis* Lalicker, *Verneuilinoides mauritii* (Terq.) and very rarely, *Ammopalmula infrajurensis*

(T e r q.), are found in the Lower Kuiavian sediments. Few calcereous foraminifers such as, *Lenticulina* (*Astacolus*) *varians recta* F r a n k e, *Lenticulina* (*A.*) *interrumpa* B l a n k, *Ophthalmidium carinatum agglutinans* P a z d r o, *Garantella ornata* (H o f k e r), *G. rudia* K a p t.-C h e r n., *Paalzowella pazdroae* n. sp. and few *Epistomina nuda* T e r q., *E. regularis* T e r q., as well as — in the top parts of the Lower Kuiavian — the first specimens of *Lenticulina* (*Planularia*) *eugenii* (T e r q.), *Epistomina costifera* T e r q., *Ophthalmidium carinatum terquemi* P a z d r o, *Lenticulina* (*A.*) *polymorpha polymorpha* (T e r q.) and *Lenticulina* (*A.*) *volubilis* D a i n are also met with in these layers. Not all of the species of foraminifers mentioned above occur, however, simultaneously and in many areas their occurrence is recorded during later periods.

The lithofacial development of the Middle Kuiavian deposits of the Polish Lowlands is marked by a general occurrence of claystones, clayey shales and mudstones and, in the upper part, sandy mudstones and sandstones. An abundant microfauna of foraminifers is recorded in Middle Kuiavian deposits, particularly in its middle part. In addition to the species, already known from the Lower Kuiavian, new species of foraminifers appear assigned primarily to the families Nodosariidae, Spirillinidae, and Involutinidae, as well as to the subfamily Epistomininae. The predominance of agglutinated foraminifers over those with calcareous tests disappears and, vice versa, the latter start to predominate conspicuously. *Ammopalmula infrajurensis* (T e r q.), *Flabellamminopsis variabilis* M a ł e c k i, *Lenticulina* (*A.*) *polymorpha polymorpha* (T e r q.), *Lenticulina* (*A.*) *volubilis* D a i n, *Lenticulina* (*A.*) *interrumpa* B l a n k, *Lenticulina* (*Lenticulina*) *daphne* n. sp., *Lenticulina* (*P.*) *eugenii* (T e r q.), *Ophthalmidium carinatum terquemi* P a z d r o, *Garantella ornata* (H o f k e r), *G. rudia* K a p t. - C h e r n., *Reinholdella media* (K a p t. - C h e r n.) and *Epistomina costifera* T e r q. should be considered as typical Middle Kuiavian species. *Verneuilinoides mauritii* (T e r q.), *Ophthalmidium carinatum agglutinans* P a z d r o, *Paalzowella pazdroae* n. sp., as well as the species assigned to the genera *Spirillina* and *Epistomina* also occur in these sediments. Most species of the Middle Kuiavian foraminiferal assemblage pass to the Upper Kuiavian but usually they are less abundant.

A particularly abundant microfauna of foraminifers has been recorded in a complex of dark clayey shales of the *Parkinsonia subarietis* and *P. parkinsoni* zones. A higher mudstone-clayey part of the Middle Kuiavian, that is, *Parkinsonia schloenbachi* zone, is characterized by a considerable impoverishment of microfauna.

The Upper Kuiavian deposits consist primarily of clayey shales and clayey mudstones with siderites and with local intercalations of sandstones. Species with a slightly wider stratigraphic range of occurrence, i.e., Middle Kuiavian-Upper Kuiavian, are most often met with in the Upper Kuiavian assemblage of the foraminiferal microfauna. Besides a few index species of agglutinated foraminifers, they are not on the whole stratigraphically significant.

Foraminifers with calcareous tests continue to occur abundantly. Of more important species, the following are recorded: *Ophthalmidium carinatum agglutinans* P a z d r o, *Epistomina nuda* T e r q., *E. regularis* T e r q., *Paalzowella pazdroae* n. sp., *Reinholdella media* (K a p t.-C h e r n.), *Lenticulina* (*A.*) *polymorpha polymorpha* (T e r q.), as well as the species which do not pass to the Bathonian sediments as, *Garan-*

*tella ornata* (H o f k e r), *Lenticulina* (*Pl.*) *eugenii* (T e r q.), *Epistomina costifera* T e r q., *Ophthalmidium carinatum terquemi* P a z d r o, *Lenticulina* (*A.*) *volubilis* (D a i n) and *Lenticulina* (*L.*) *daphne* n. sp. *Ophthalmidium carinatum porai* P a z d r o and *Palaeomiliolina rawiensis* (P a z d r o) should be considered as index species for the Upper Kuiavian. The first specimens of *Palaeomiliolina czestochowiensis* (P a z d r o) and *Trocholina conica* (S c h l u m b e r g e r), along with *Verneuilinoides favus* (B a r t.) are met with in the top parts of the Upper Kuiavian.

In the area of the Polish Lowlands, the Bathonian sediments are mostly developed in the mudstone-sandy facies. In these sediments, microfauna is not on the whole very abundant. It occurs more abundantly in shaly--clayey rocks. The foraminiferal assemblage consists primarily of species with calcareous tests, whereas agglutinated foraminifers occur less abundantly. In the Bathonian, the most important role is played by Epistominae and foraminifers assigned to the families Nodosariidae and Miliolidae, the latter being particularly abundant in the upper parts of the Bathonian.

*Palaeomiliolina czestochowiensis* (P a z d r o) and *Trocholina conica* (S c h l u m b.) should be mentioned as the species of foraminifers characteristic of the Bathonian deposits. Likewise, many specimens of *Paalzowella pazdroae* n. sp. and species of the genera *Epistomina* and *Lenticulina* occur in these deposits.

In the Lower Bathonian, the assemblage of foraminifers has still many characters in common with that occurring in the Upper Kuiavian. Agglutinated foraminifers and rather numerous specimens of *Ophthalmidium carinatum agglutinans* P a z d r o, *Paalzowella pazdroae* n. sp., and *Reinholdella media* (K a p t. - C h e r n.) are still recorded in these deposits, together with sporadically occurring *Ophthalmidium carinatum porai* P a z d r o, *O. carinatum terquemi* P a z d r o and *Lenticulina* (*A.*) *polymorpha polymorpha* (T e r q.). *Epistomina nuda* T e r q., *E. regularis* T e r q. and *Verneuilinoides favus* (B a r t.) also occur here, whereas *Palaeomiliolina czestochowiensis* (P a z d r o) and *Trocholina conica* (S c h l u m b.) even become abundant.

Specimens of *Trocholina conica* (S c h l u m b.), *Reinholdella media* (K a p t. - C h e r n.), *Verneuilinoides favus* (B a r t.) and different species of *Epistomina* continue to occur in the Middle Bathonian. *Reinholdella* aff. *dreheri* (B a r t.) appears in these sediments, whereas *Ophthalmidium carinatum agglutinans* P a z d r o displays a predominance in the number of individuals over *Palaeomiliolina czestochowiensis* (P a z d r o).

*Palaeomiliolina czestochowiensis* (P a z d r o) and *Trocholina conica* (S c h l u m b.) are on the whole numerously recorded in the Upper Bathonian, in which *Paalzowella pazdroae* n. sp. and few specimens of *Ophthalmidium carinatum agglutinans* P a z d r o, *Epistomina nuda* T e r q. and *E. regularis* T e r q. are continuously met with. Likewise, *Epistomina mosquensis* U h l i g, *E. parastelligera* (H o f k e r) and, sometimes, *E. callovica* (K a p t. - C h e r n.) are recorded in these deposits. The latter three species pass to the Callovian.

To conclude, it should be mentioned that the outline of the stratigraphic distribution of the Kuiavian and Bathonian foraminifers of the Polish Lowland presented above concerns primarily the areas which once occupied the central parts of the sedimentation basin (clayey-mudstone facies). Lithofacial changes in the Kuiavian and Bathonian sediments are markedly reflected in the composition of a microfaunal assemblage.

They are observed, for instance, in either disappearance or exuberant development of miliolids, in a larger or smaller part of agglutinated forms or, finally, in the specific differentiation of the entire assemblage of foraminifers.

## PALAEONTOLOGICAL DESCRIPTIONS OF FORAMINIFERA

Family Lituolidae de Blainville, 1825
Subfamily Lituolinae de Blainville, 1825
Genus *Ammopalmula* Lindenberg, 1966

### *Ammopalmula infrajurensis* (Terquem 1870)

(Pl. XCIX, Figs. 1a, b; 2a, b; Pl. C, Figs. 1a, b; 2a, b)

1870 *Haplophragmium infrajurense* Terq.; Terquem O.: p. 337, Pl. 24, Fig. 27, 28.
1924 *Haplophragmium infrajurense* Terq.; Klähn H.: p. 459, Pl. 22, Fig. 6.
1937 *Ammomarginulina infrajurensis* (Terq.); Bartenstein H., Brand E.: p. 187, Pl. 6, Fig. 42, Pl. 8, Fig. 39, Pl. 12-A, Fig. 23, Pl. 13, Fig. 24.
1941 *Ammomarginulina infrajurensis* (Terq.); Frentzen K.: p. 365, Pl. 7, Fig. 10, 11.
non 1951 *Ammomarginulina infrajurensis* (Terq.); Bartenstein H., Brand E.: p. 269, Pl. 1, Fig. 26.
non 1954 *Ammobaculites infrajurensis* (Terq.); Bielecka W., Pożaryski W.: p. 26, Pl. 2, Fig. 4.
1959 *Ammobaculites infrajurensis* (Terq.); Ziegler J.H.: p. 67, 99.
1962 *Ammomarginulina infrajurensis* (Terq.); Brand E., Fahrion H. in Leitfossilien der Mikropaläontologie, p. 154, Pl. 20, Fig. 12.
non 1962 *Frankeina* sp. Brand E., Fahrion H. in Leitfossilien der Mikropaläontologie, p. 154, Pl. 20, Fig. 41.
non 1965 *Ammomarginulina baryntica* Loeblich., Tappan.; Hanzlíková E.: Pl. 10, Fig. 5.
non 1965 *Ammobaculites infrajurensis* (Terq.); Hanzlíková E.: p. 58, Pl. 3, Fig. 2, 3.
1966 *Ammopalmula infrajurensis* (Terq.); Lindenberg H.G.: p. 465—469, Pl. 51, Fig. 4a, b, c, Abh. 3—5, non Pl. 51, Fig. 1—3.
1967 *Flabellammina infrajurensis* (Terquem); Stroemer N., Wienholz E.: Pl. VII, Fig. 63.

Material. Twenty-five rather poorly preserved specimens, many of them broken. Coll. No. I.G. Nr. 5,400—5,403/68/F.

Dimensions of three tests in mm:

| | (1) | (2) | (3) |
|---|---|---|---|
| Length | 1.6 | 1.15 | 0.9 |
| Width | 0.63 | 0.59 | 0.57 |
| Thickness | 0.18 | 0.18 | 0.19 |

Description. Test elongate, uniformly bilaterally flattened, mostly thin, consisting of a spiral portion and rectilinear portion. Initial portion planispiral, fairly large, slightly projecting laterally, consisting of 2 1/2 whorls. In the spiral portion 7—9 chambers are visible in the last formed whorl. Size of chambers increases regularly. Initial chamber round, in the first whorl chambers are not very distinct. Rectilinear portion consists

of 1—7 chambers, which are low and wide, chevron-shaped and situated one above another, forming a wide, inverted V. Spiral portion is wider than rectilinear one. Sutures between chambers slightly depressed, in some cases poorly visible. A siliceous test is formed by quartz grains bound together with cement. Test wall has not a labyrinthic structure. An internal, chitinous layer of test on the whole well preserved; aperture oval, terminal, situated in the middle on top of the last formed chamber.

In this species, sexual dimorphism is expressed in wide macrospherical (Pl. XCIX, Fig. 2; Pl. C, Fig. 2) and long and narrow microspherical (Pl. XCIX, Fig. 1; Pl. C, Fig. 1) forms. These characters are particularly visible in thin slides of foraminifers and after immersing the specimens in toluene.

Variability is expressed in a different size of the rectilinear portion of test, in a different degree of the development of chambers and in their variable number.

Remarks. As compared with O. Terquem's (1870) holotype from the Dogger of Paris Basin the specimens described do not display any differences. In relation to the specimens described by G. H. Lindenberg (1966) from the south-western Germany, our specimens are in conformity with flat forms of *Ammopalmula infrajurensis* (Terq.) considered by G. H. Lindenberg to be macrospherical forms. Our specimens are also very similar to *Ammopalmula infrajurensis* — forma *opalina* in which two generations have been distinguished by G. H. Lindenberg.

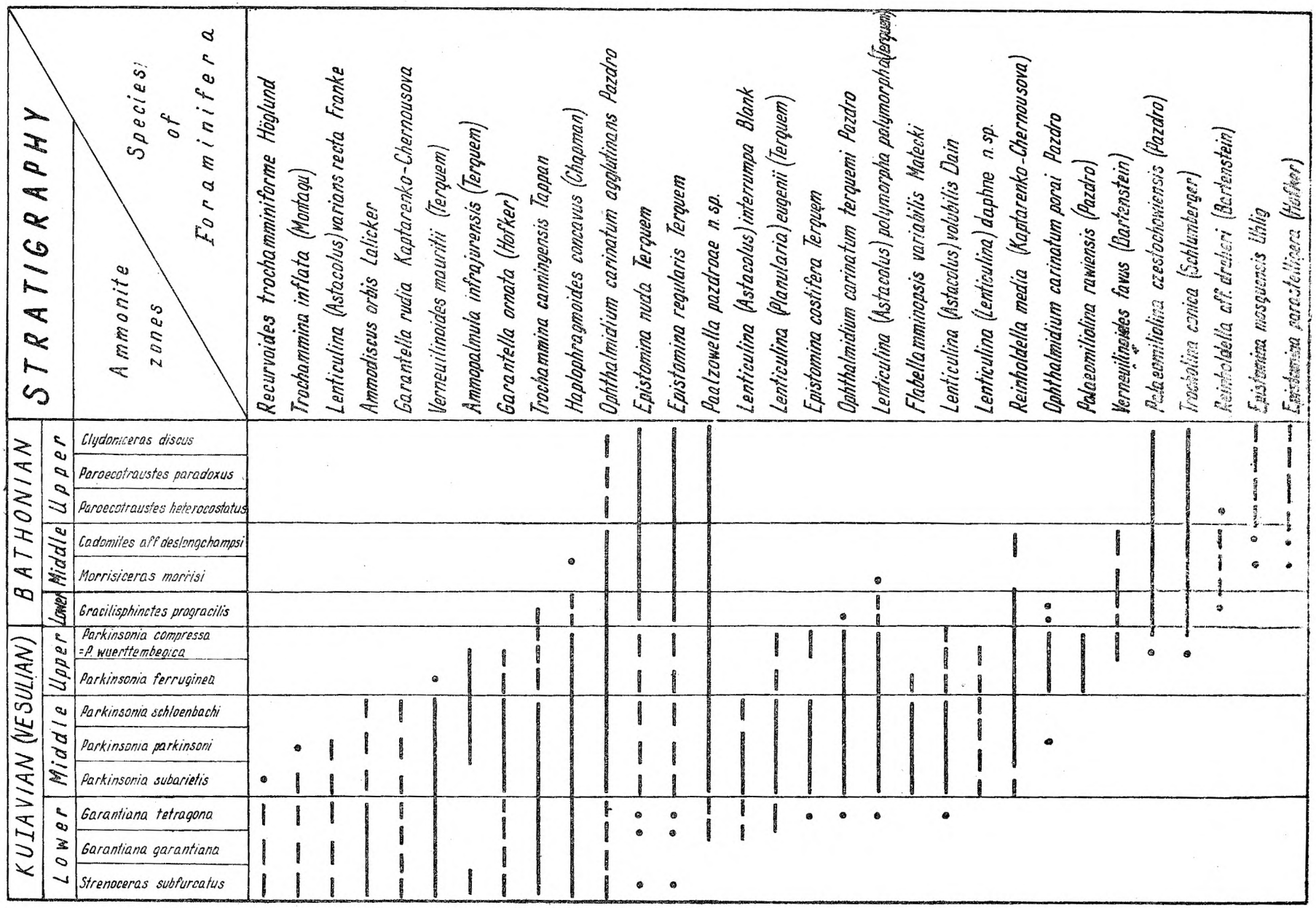
Tri- and quadrilateral tests, that is, according to G. H. Lindenberg, a microspherical form of the species *Ammopalmula infrajurensis* (Terq.) probably belong to the genus *Flabellamminopsis* Małecki. H. G. Lindenberg (1966) emphasizes that such tests are rarely met with and that both in the spiral and retilinear portion they have more chambers than flat forms. In the transverse section through angular tests the initial chamber is very small and hardly discernible. According to H. G. Lindenberg, angular tests occur in the Dogger of north-western Germany only in parkinsonia horizons, whereas in the Liassic Zeta and Dogger Alpha only flat tests are found. Within the range of the last-named tests, H. G. Lindenberg distinguishes only two generations and assigns them to *Ammopalmula infrajurensis* forma *opalina*. The fact that in older layers two generations may be distinguished among flat specimens of a species, whereas in younger layers the tests of one generation are tri- or quadrilateral and those of another generation — flat, seems to be strange.

In the Dogger of Poland, in parkinsonia zones, in addition to flat tests with rectilinear walls, flat specimens are also found which slightly differ in shape, as well as tri- and quadrilateral ones. These specimens have a labyrinthine wall and round aperture. J. Małecki (1953) distinguished, among the forms named above, several species of a new genus *Flabellamminopsis* erected by him. In this work, he presented a review of tests depicting a complete evolutional row of this genus. He determined forms transitional between flat and trilateral and between tri- and quadrilateral ones. He distinguished two generations: microspherical, wider and macrospherical, narrow forms.

In the material from the Kuiavian of the Polish Lowlands, which we studied, there were flat specimens whose test wall was not labyrinthine. Among the specimens which we assigned to *Ammopalmula infrajurensis*

Distribution of the more important species of Foraminifera from the Kuiavian and Bathonian in the Polish Lowland

TABLE 1



(T e r q.) we might distinguish micro- and macrospherical forms. In addition to the tests, referred to above, flat specimens are also rarely met with, together with slightly more abundant tri- and quadrilateral ones having a labyrinthine structure of wall which induced us to assign the latter to the genus *Flabellamminopsis*. After preparing thin slides, macro- and microspherical forms were found in these specimens.
Occurrence: The species *Ammopalmula infrajurensis* (T e r q.) is known from parkinsonia zones of France, as well as from the Liassic Zeta and Dogger of Germany. In Poland, this species occurs in the Aalenian and Kuiavian.

Family Lagenidae S c h u l t z e, 1854
Subfamily Lenticulininae S i g a l, 1952
Genus Lenticulina L a m a r c k, 1804

*Lenticulina* (*Lenticulina*) *daphne* n. sp.
(Pl. CI, Figs. 1—10)

H o l o t y p u s: Specimen shown in Pl. CI, Fig. 1a, b, c.
S t r a t u m t y p i c u m: the Kuiavian.
L o c u s t y p i c u s: Krośniewice bore-hole.
D e r i v a t i o n o m i n s: after a mythological character called Daphne.

M a t e r i a l. A dozen or so on the whole well-preserved specimens. Coll. No. I.G. Nr. 5,404—5.413/68/F.

D i m e n s i o n s of three tests in mm:

| | (1) Holotype | (2) | (3) |
|---|---|---|---|
| Length | 0.63 | 0.68 | 0.55 |
| Width | 0.48 | 0.45 | 0.36 |
| Thickness | 0.18 | 0.21 | 0.18 |
| Length-width ratio | 1.3 | 1.5 | 1.5 |
| Width-thickness ratio | 2.6 | 2 | 2 |

D i a g n o s i s: Test planispiral, involute. The last formed whorl has 8—12 chambers. Five to eight fine secondary costae run on the surface of the test parallel to the outer margin of the test.
D e s c r i p t i o n: Test planispiral, involute, slightly convex on lateral surfaces. The last formed whorl has 8—12 chambers. A distinct, fairly sharp keel runs along the periphery. Sutures between chambers flat or slightly depressed, provided with fine costae running from the middle of the test just above sutures. The last formed chamber and in some cases the last but one is separated from the remaining chambers by a distinct, concave suture. Additional, fine costae occur on the surface of test, running almost parallel to the outer margin of test nearer the ventral side. These costae are most strongly developed in the umbilical portion where they are irregular and more or less discontinuous. Number of costae varies in particular chambers from 5 to 8. Costae pass through a few chambers, beginning at various levels and usually do not reach the last formed chamber. Apertural face fairly narrow, slightly convex and forming a rounded, fine edge at the place of contact with lateral surfaces of the test. Aperture round, radiate, situated on a slightly extended top of the last formed chamber. Wall calcareous, somewhat transparent, porous.

Variability consists primarily in a different degree of the conspicuousness and varying number of secondary costae. Usually, on the one side of the test, there are more costae than on the other. In some specimens, the system of secondary ribs is poorly developed, two or three costae only being visible. Likewise, with the same number of chambers, variable is the size of test. Some specimens display the tendency to break away one or two youngest chambers from a whorl and to displace the slightly to one side( Pl. CI, Figs. 9 and 10).

Remarks. A middle-sized specimen with a test 0.63 mm long, 0.48 mm wide and 0.18 mm thick has been accepted as a holotype. *Lenticulina* (*L.*) *daphne* n. sp. displays a certain similarity to stratigraphically older species: *Lenticulina* (*L.*) *bicostata* (Deecke) and *Lenticulina* (*L.*) *d'orbignyi* (Roemer) from which it probably derives. *Lenticulina* (*L.*) *daphne* n. sp. differs from *Lenticulina* (*L.*) *bicostata* (Deecke) in the presence of much finer and discontinuous costae, as well as in a different arrangement of these costae on the surface of the test. In addition, *Lenticulina* (*L.*) *daphne* n. sp. was found in the *parkinsonia* zone, whereas *Lenticulina* (*L.*) *bicostata* (Deecke) was described from older layers from the *Sonninia sowerbyi* zone. *Lenticulina* (*L.*) *daphne* n. sp. slightly resembles *Lenticulina* (*L.*) *d'orbignyi* (Roemer), known from the Liassic Zeta and Dogger Alpha. It differs from the latter species in a greater number of chambers (3—4), larger dimensions, different arrangement of costae and presence of conspicuous keel.

Occurrence. *Lenticulina* (*L.*) *daphne* n. sp. occurs in the Middle and in the lower part of the Upper Kuiavian of Polish Lowlands.

*Lenticulina* (*Astacolus*) *polymorpha polymorpha* (Terquem)
(Pl. CII, Figs. 1a, b-4)

1870 *Cristellaria polymorpha* Terquem; Terquem O.: p. 454, Pl. 19, Fig. 1—3, 7—9, 13, 15 (?), 17, 18 (?), Pl. 20, Fig. 3—6, 13, 16, 17, 19—20, 27—29.

1886 *Cristellaria polymorpha* Terquem; Terquem O.: p. 40, Pl. 4, Fig. 22—25.

non 1956 *Lenticulina* (*Lenticulina*) *polymorpha* (Terquem) Ziegler J. H.: p. 102, Pl. 4, Fig. 32—35.

non 1961 *Lenticulina* (*Astacolus*) *polymorpha* (Terq.); Kaptarenko-Chernousova O. K.: p. 38, Pl. VII, Fig. 2a, b; 3a, b; 4a, b.

1961 *Lenticulina polymorpha* (Terquem); Kusnetzova K. I.: p. 97—98, Pl. I, Fig. 2a, b.

Material. More than 50, on the whole well-preserved specimens. Some of them damaged. Coll. No. IG. Nr 5,414—5,417/68/F.

Dimensions of three tests in mm:

| | (1) | (2) | (3) |
|---|---|---|---|
| Length | 0.70 | 0.45 | 0.37 |
| Width | 0.36 | 0.27 | 0.23 |
| Thickness | 0.19 | 0.12 | 0.10 |
| Length-width ratio | 1.9 | 1.5 | 1.5 |
| Width-thickness ratio | 1.8 | 2.2 | 2.3 |

Description: Test planispiral, involute, laterally flattened. Six to eleven chambers; 7—8 in the last formed whorl on the whole do not deviate from the whorl. In the older parts, chambers triangular, in the younger trapezoidal. A conspicuous, sharp keel running along the peri-

phery, sometimes disappears in the last formed chamber. Sutures between chambers slightly depressed, arcuate in the older, less so in the younger part. Surface of test covered with distinct, mostly rounded costae, situated almost exactly on the sutures .In some cases costae join each other forming a sort of an additional keel near the peripheral margin of the surface of test. Three to four fine costae radially diverging from the aperture (Pl. CII, Fig. 1—4) are visible in some cases on the lateral surface of the last formed chamber and, sometimes, on the surface of two preceding chambers. Apertural face narrow, flat, slightly arcuate posteriorly, bordered with slats which separate is from the lateral surfaces of the test. Aperture round, radiate, situated on the top of the last formed chamber slightly extended upwards and near peripheral margin. Well calcareous.

Variability of this species consists primarily in a slightly different development of costae, rounded or somewhat sharpened, sometimes discontinuous, connected with each other by secondary costae (or not connected) near the peripheral margin and in degree of conspicuousness of the peripheral keel.

Remarks: The specimens described display certain differences as compared with some of O. Terquem's specimens. As emphasized by L. G. Dain (1958) and K. I. Kusnetzova (1961), some of O. Terquem's specimens should be assigned to different subgenera of the genus *Lenticulina*. O. Terquem's specimens, shown in Pl. 19, Figs. 21 and 29 and in Pl. 20, Figs. 1, 2 and 21, were assigned by L. G. Dain (1958) to her new species *Lenticulina* (*A.*) *volubilis*. According to K. I. Kusnetzova (1961), O. Terquem's specimens, shown in Pl. 20, Figs. 7—12, belong to the species *Planularia tricarinella* (Reuss). In view of the fact that O. Terquem (1870) did not distinguish a holotype from many specimens he described and figured, K. I. Kusnetzova (1961) considers O. Terquem's specimen, shown by him in Pl. 19, Figs. 2a, b, to be a lectotype. Our specimens of *Lenticulina* (*A.*) *polymorpha polymorpha* (Terq.) correspond to the specimens of *Lenticulina* (*A.*) *polymorpha* as understood by K. I. Kusnetzova (1961). Specimens, figured by J. H. Ziegler (1959) in his Pl. 4, Figs. 32—35, display certain differences as compared with typical specimens of the species *Lenticulina* (*A.*) *polymorpha polymorpha*. J. Kopik (1969) includes them in the synonymy of *Lenticulina* (*A.*) *polymorpha arachne* Kopik. As compared with the lectotype of *Lenticulina* (*A.*) *polymorpha* (Terq.) (in Kusn., 1961), specimens of *Lenticulina (A.) polymorpha* (Terq.), presented by O. K. Kaptarenko-Chernousova (1961) in Pl. VII, Figs. 2a, b; 3a, b; 4a, b, are more convex and have a different sculpture of their tests. *Lenticulina* (*A.*) *volubilis* Dain and *Lenticulina* (*A.*) *argonauta* Kopik (1969) are species closely related, in the Kuiavian, to *Lenticulina (A.) polymorpha* (Terq.). According to K. I. Kuznetsova (1961), in the phylogenetic development, the next link in the Callovian are, *Lenticulina (L.) sculpta* (Mitjanina), *Lenticulina (L.) polonica* (Wiśn.), *Lenticulina (L.) subgaleata* (Wiśn.), *Lenticulina (L.) decipiens* (Wiśn.) and, in the Oxfordian, *Lenticulina (L.) quenstedti* (Gümbel) and *Lenticulina* (*L.*) *brückmanni* (Miatluk).

Occurrence. *Lenticulina (A.) polymorpha* (Terq.) is cited in literature from the Bathonian and Upper Bajocian (Kuiavian) of France and Germany. It is also mentioned from the Upper Bajocian (Kuiavian) of the Ukraine. In Poland, it occurs in the Kuiavian and Bathonian.

*Lenticulina (Astacolus) volubilis* Dain
(Pl. CII, figs. 5a, b—8)

1870 *Cristellaria polymorpha* Terquem; O. Terquem: p. 454, Pl. 19, Fig. 16, 21, 29; Pl. 20, Fig. 1, 2, 21.

1958 *Lenticulina (Astacolus) volubilis* Dain; Dain L. G.: p. 37—38, Pl. VI, Fig. 7—12.

1961 *Lenticulina (Astacolus) volubilis* (Dain); Kaptarenko-Chernousova O. K.: p. 39, Pl. VII, Fig. 5a, b; non Pl. VII, Fig. 6a, b.

1961 *Lenticulina volubilis* Dain; Kusnetzova K. I.: p. 97—98, Pl. I, Fig. 1, 3, 4, 5; Pl. III, Fig. 1, 2.

Material. Some scores of specimens, on the whole well-preserved, some of them damaged. Coll. No. I.G. Nr. 5,418—5,421 (68)F.

Dimensions of three tests in mm:

| | (1) | (2) | (3) |
|---|---|---|---|
| Length | 0.72 | 0.62 | 0.42 |
| Width | 0.48 | 0.41 | 0.34 |
| Thickness | 0.21 | 0.19 | 0.19 |
| Length-width ratio | 1.5 | 1.5 | 1.3 |
| Width-thickness ratio | 2.2 | 2.2 | 1.8 |

Description. Test planispiral, involute, somewhat elongate, slightly convex, with lateral surfaces slightly flattened, consisting of 1.5—2 whorls. The last formed whorl has 7—9 chambers increasing with growth. Sometimes one or, less frequently, two chambers do not contact the whorl. A keel, more strongly outlined, on earlier formed chambers, runs along the periphery of the test. Sutures between chambers slightly depressed, arcuate, with their curvature directed posteriorly. They are provided with costae which, in the form of an arc, run from the middle of the test towards keel. On younger chambers, these costae are somewhat withdrawn from sutures. Converging in the middle of the test, costae usually form an incipient ring, which may be either continuous or discontinuous. The presence of more or less distinct depressions or pits on costae is a characteristic feature of these costae. They also have short, delicate, transverse, secondary costae which branch off upwards. Apertural face of the narrow, flat, slightly arcuate, bent posteriorly and bordered with slats which separate it from lateral surfaces of the test. Aperture round, radiate, situated on the top of the last formed chamber which is slightly extended upwards. Wall calcareous.

A considerable variability consists primarily in a larger or smaller degree of convexity of the test and in a variable number of chambers which break off from the whorl. Costae and additional elements of the sculpture (pits and secondary costae) are more or less distinct.

Remarks: As compared with L. G. Dain's holotype, the specimens described do not display fundamental differences. In general, they are smaller than Kusnetzova's specimens. *Lenticulina (A.) volubilis* Dain is most closely related to *Lenticulina (A.) polymorpha polymorpha* (Terq.), from which it differs, however, in a slightly larger convexity of the test, in the presence of additional elements of sculpture in the form of pits and secondary costae and, mostly, in the presence of a ring formed by costae in the umbilical portion.

Occurrence: *Lenticulina (A.) volubilis* Dain is cited from the *Garantiana garantiana, Strenoceras subfurcatus* and *Pseudomonotis do-*

*neziana* zone of the Dneper-Donets basin in the U.S.S.R. In Polish Lowlands, this species was recorded in the Upper and Middle Kuiavian.

*Lenticulina (Astacolus) interrumpa* Blank, 1961
(Pl. CII, Figs. 9—10)

1961 *Lenticulina interrumpa* Blank; Blank M. I. pp. 214—215, Pl. II, Figs. 5a, b, w.

Material. Some scores of well-preserved specimens. Coll. No. IG. Nr. 5,422—5,423 (68)F.

Dimensions of three tests in mm:

| | (1) | (2) | (3) |
|---|---|---|---|
| Length | 0.72 | 0.50 | 0.43 |
| Width | 0.37 | 0.32 | 0.34 |
| Thickness | 0.24 | 0.18 | 0.18 |
| Length-width ratio | 1.9 | 1.5 | 1.2 |
| Width-thickness ratio | 1.5 | 1.8 | 1.8 |

Description: Test planispiral, slightly elongate and convex with lateral surfaces somewhat flattened, consisting of 6—9 and mostly 7—8 chambers. In some cases, one or two chambers break off from the whorl. Initial chamber situated nearer the peripheral margin. Further chambers triangular, increasing with growth. A sharp keel, more strongly outlined in the middle of the test and disappearing on the 8th and 9th chambers, runs along the periphery of the test. Sutures between chambers strongly depressed, particularly so in the central part, arcuate, bent posteriorly. A fairly sharp costa, with its height decreasing towards the peripheral margin of the test, runs above the suture. The depression of the suture in the central part of the test, together with the rib situated above it give the impression as if a given chamber was undercut and mounted on the preceding chamber. On older chambers, sutures and costae are somewhat less distinct. Sometimes, on older chambers, small bosses are visible in the umbilical portion. Apertural face of the test narrow, flat, posteriorly slightly arcuate, bordered by two not very high slats separating it from the lateral surfaces of the test. Aperture round, radiate, situated on the top of the last formed chamber which is tubelike and extended upwards. Wall calcareous, lack-luster, smooth.

Variability consists in a more or less strongly outlined bosses and even in their presence or absence on older chambers, as well as in the presence or absence of two, very delicate slats running on both sides of the keel in the central part of the dorsal surface of the test.

Remarks. The specimens of the species *Lenticulina (A.) interrumpa* Blank, here described, do not display fundamental differences as compared with the holotype. In our specimens, bosses on the surface of older chambers are less distinct or even absent. M. I. Blank (1961) emphasizes that the keel, running on the dorsal side of the test, bifurcates in the central sector, then once again becomes single and disappears on the 8th chamber. In our specimens, the keel is continuous, but, in some cases, two delicate slats are observed on its both sides in the central part of the test. The species *Lenticulina (A.) interrumpa* Blank is slightly similar to *Lenticulina (A.) lithuanica* Brückmann from which it differs, however, in a smaller number of chambers and in the fact that the sutures on older chambers are markedly depressed whereas

in *Lenticulina (A.) lithuanica* they are almost completely flat and no bosses occur on older chambers.

Occurrence: *Lenticulina (A.) interrumpa* Blank was described from the Bajocian (Lower Kuiavian) *Strenoceras niortense* and *Garantiana garantiana* zone of the Dneper-Donets Coalfield. In Polish Lowlands it occurs in the upper part of the Lower Kuiavian and in the Middle Kuiavian.

Family Involutinidae Bütschli, 1880
Genus *Paalzowella* Cushman, 1933

*Paalzowella pazdroae* n.sp.
(Pl. CII, Figs. 11a, b, c, 12a, b,c; Figs. 1a, b, c, 2)

Holotypus: Specimen shown in Fig. 1.
Stratum typicum: Bathonian.
Locus typicus: Wągrowiec bore-hole.
Derivatio nominis: After the name of Professor Olga Pazdro, a Polish micropalaeontologist.

Material. More than 300 specimens, on the whole well-preserved, some of them filled with pyrite or slightly damaged. Coll. I.G. No. 5,424—5,427 (68) F.

Dimensions of three tests in mm:

| | (1) Holotype | (2) | (3) |
|---|---|---|---|
| Diameter of the base of test | 0.16 | 0.18 | 0.21 |
| Height of the cone | 0.10 | 0.09 | 0.10 |
| Length of the side of test | 0.12 | 0.10 | 0.14 |

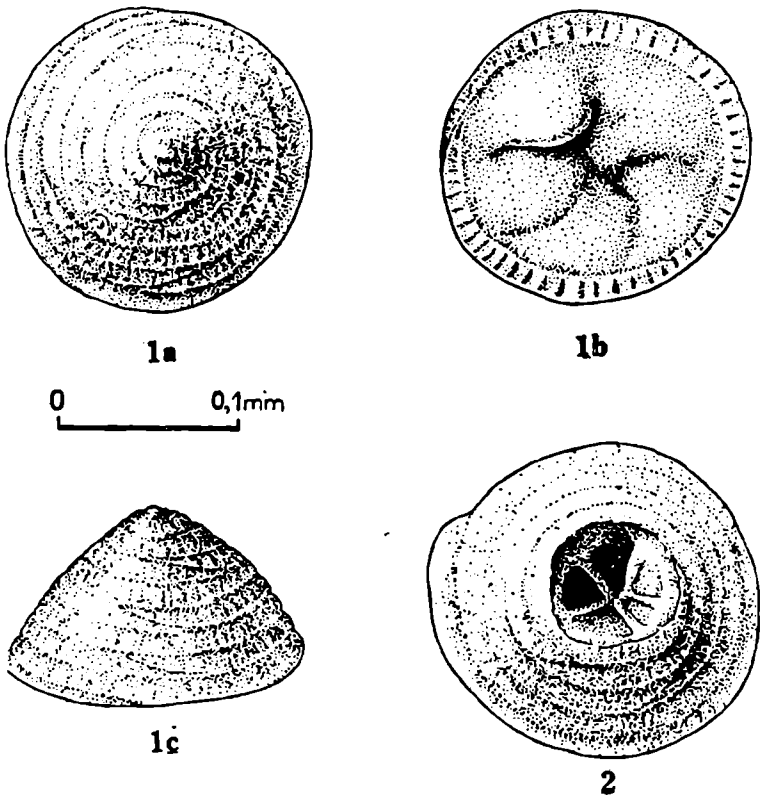
Diagnosis: Test trochospiral, shaped like a low cone. Initial chamber small, round. Test consisting of 5—7 stairlike whorls with 5 chambers in each of them.

Description: Test trochospiral, shaped like a low cone, very slightly rounded. Initial chamber small, round, situated on the top of test which consists of 5—7 whorls arranged in a stairlike manner. In some cases, oblique inter-chamber septa are marked on the dorsal side of the surface of test. Their number does not exceed five. Many, tiny costae are frequently observed on the surface of each of the whorls. Only the last whorl of the spire is visible on the ventral side. The ventral side almost completely flat, in the umbilical area depressed. Five, very delicate inter-chamber septa are visible on the surface of the ventral side. Out of some scores of the specimens examined, the presence of five chambers in the first two whorls was clearly visible in one specimen only (Fig. 2). A similar phenomenon was recorded by E. Seibold and I. Seibold (1955) who found four chambers in each of the whorls of the species *Paalzowella turbinella* (Güm b.) they examined. The dorsal side of the test is separated from the ventral side by a sharp marginal edge in the form of a keel. Aperture, in the form of a fairly narrow, bent fissure, is situated on the ventral side and runs from the peripheral margin of the test almost as far as the middle of the ventral surface. The diameter of the base of test is twice as large as the height of test. Test calcareous, transparent, porous, with very thin walls.

Variability small, consisting only in not very large differences in the

height of the cone, in a more or less distinct shape of whorls and in additional ornamentation.

Remarks: Specimens of the new species here described are most similar to Paalzowella jurassica Kaptarenko-Chernousova (1959) and even they have been determined so far by Polish palaeontologists as *Paalzowella* aff. *jurassica* Kapt.-Chern. (O. Pazdro 1960). *Paalzowella pazdroae* n.sp. is, however, a new species which differs from *Paalzowella jurassica* Kapt.-Chern. in a smaller height of the cone, smaller number of whorls, slightly different exterior of the test and a different stratigraphic range of occurrence. *Paalzowella jurassica* Kapt.-Chern. was described from the Oxfordian of the Dneper-Donets Depression and it might be one of the subspecies of *Paalzowella feifeli* (Paalz.). Our specimens occur mostly in the Bathonian and Kuiavian clayey-muddy sediments, few of them being recorded in Callo-




Figs. 1—2. *Paalzowella pazdroae* n. sp. 1 — holotype, a — dorsal view, b — ventral view; c — lateral view; 2 — another specimen; dorsal view; five chambers visible in the whorl

vian. *Paalzowella pazdroae* n.sp. differs from *P. feifeli seiboldi* Lutze (1960) in a different general outline of the test, considerably lower cone, smaller number of whorls (5—7 as compared with 8—10) and a more acute angle at which the lateral surface of the test contacts the plane of the ventral side. *Paalzowella pazdroae* n.sp. differs from *P. feifeli elevata* (Paalz.) in smaller dimensions, smaller number of whorls and in a different ratio of the height of the test to its base. An angle at which the lateral surface of the test contacts the plane of the ventral side is in *Paalzowella pazdroae* n.sp. more acute than in *Paalzowella feifeli elevata* (Paalz.), in the last-named form the place of contact of both these surfaces being rounded.

Occurrence: *Paalzowella pazdroae* n.sp. occurs mostly in the Bathonian sediments and, somewhat less numerously, in the Kuiavian and Callovian of Polish Lowlands.

*Micropalaeontological Laboratory*
*of the Department of Stratygraphy,*
*Geological Institute,*
*Warsaw.*

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## STRESZCZENIE

Podano krótką charakterystykę niektórych gatunków otwornic kujawu i batonu Polski niżowej. Na tabeli 1 przedstawiono rozprzestrzenienie pionowe ważniejszych stratygraficznie gatunków otwornic.

Osady kujawu Polski niżowej wykształcone są przeważnie w facji ilasto-mułowcowo-piaszczystej. Osady dolnego kujawu są często zredukowane i wykształcone w facji piaszczystej. Występuje w nich na ogół nieliczny zespół otwornic. Przeważają formy aglutynujące z rodzajów. *Trochammina, Rhabdammina, Haplophragmoides, Recurvoides, Reophax, Glomospira, Proteonina, Ammodiscus.* Otwornic o skorupkach wapiennych jest niewiele i należą one głównie do rodzajów *Epistomina* i *Lenticulina.*

W środkowym kujawie przeważa facja ilasto-mułowcowa, a w górnej jego partii — mułowcowo-piaszczysta. Zespół otwornic jest szczególnie liczny w poziomach *Parkinsonia subarietis* i *P. parkinsoni.* Zanika przewaga otwornic aglutynujących nad otwornicami o skorupkach wapiennych, a nawet te ostatnie nieraz dominują. Jako gatunki charakterystyczne można wymienić: *Ammopalmula infrajurensis* (T e r q.), *Lenticulina* (*Astacolus*) *volubilis* D a i n, *Lenticulina* (*L.*) *daphne* n. sp., *Lenticulina* (*Planularia*) *eugenii* (T e r q.), *Epistomina costifera* T e r q., *Ophthalmidium carinatum terquemi* P a z d r o. Poziom *Parkinsonia schloenbachi* charakteryzuje zubożenie mikrofauny.

W osadach górnego kujawu występują łupki i mułowce ilaste z syderytami, lokalnie z piaskowcami. W zespole otwornic przeważają gatunki o zasięgu występowania kujaw środkowy — kujaw górny. Gatunkami przewodnimi są: *Ophthalmidium carinatum porai* P a z d r o i *Palaeomiliolina rawiensis* (P a z d r o).

Osady batonu na obszarze Polski niżowej wykształcone są najczęściej w facji mułowcowo-piaszczystej. Mikrofauna nie jest zbyt liczna, obficiej znajdywana jest w skałach łupkowo-ilastych. Zespół mikrofauny składa się głównie z otwornic o skorupkach wapiennych. Na pierwsze miejsce wysuwają się gatunki z rodziny Nodosariidae i Miliolidae oraz z podrodziny Epistomininae. Ogólnie osady batonu charakteryzuje obecność *Palaeomiliolina czestochowiensis* (P a z d r o) i *Trocholina conica* (S c h l u m b.). Występują tu także *Paalzowella pazdroae* n. sp. oraz gatunki z rodzaju *Epistomina* i *Lenticulina.* W dolnym batonie spotyka się jeszcze dość liczne okazy *Ophthalmidium carinatum agglutinans* P a z d r o oraz *Reinholdella media* (K a p t. - C h e r n.). W batonie środkowym pojawia się *Reinholdella* aff. *dreheri* (B a r t.), a niekiedy *Ophthalmidium carinatum agglutinans* P a z d r o posiada przewagę ilościową okazów nad *Palaeomiliolina czestochowiensis* (P a z d r o). W górnym batonie stosunek ilościowy tych dwóch gatunków jest odwrotny. Opisano dwa nowe gatunki otwornic: *Lenticulina* (*L.*) *daphne* n. sp. i *Paalzowella pazdroae* n. sp.

## EXPLANATIONS OF PLATES

### Plate XCIX

Fig. 1. *Ammopalmula infrajurensis* (T e r q.), ×70, microspherical form. a — lateral view; b — the same specimen viewed in the transmitted light after immersion in toluene

Fig. 2. *Ammopalmula infrajurensis* (T e r q.), ×70, macrospherical form. a — lateral view; b — the same specimen viewed in the transmitted light after immersion in toluene

Plate C

Fig. 1. *Ammopalmula infrajurensis* (T e r q.), ×60, microspherical form. a — lateral view; b — the same specimen viewed in the transmitted light after immersion in toluene

Fig. 2. *Ammopalmula infrajurensis* (T e r q.), ×60, macrospherical form. a — lateral view; b — the same specimen viewed in the transmitted light after immersion in toluene

Plate CI

Figs. 1—8. *Lenticulina* (*Lenticulina*) *daphne* n. sp., ×54. 1 a, b, c — holotype; a, b — lateral view; c — frontal view from the apertural face

Figs. 9—10. *Lenticulina* (*Lenticulina*) *daphne* n. sp., ×45, extended, asymetric forms

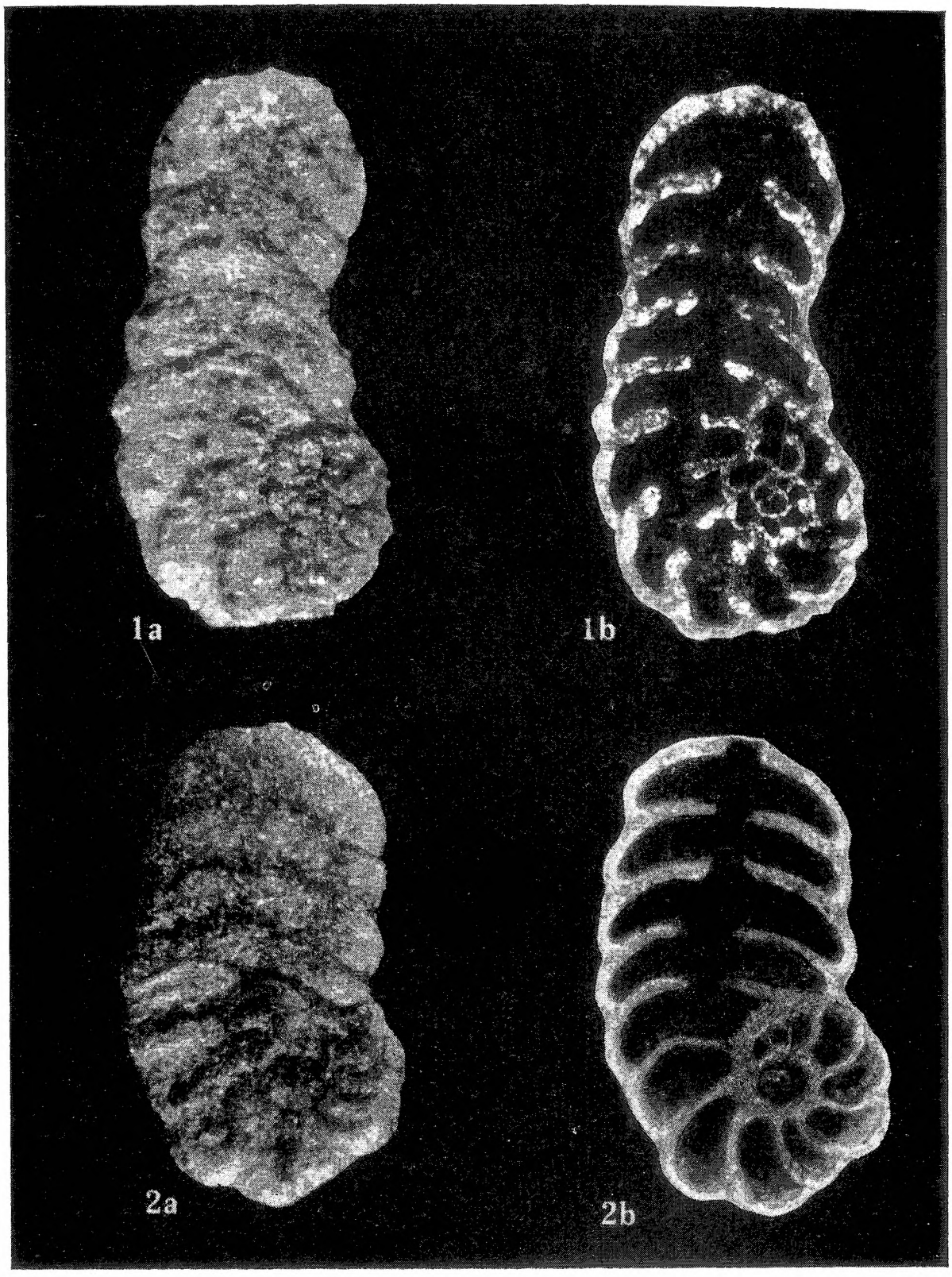
Plate CII

Figs. 1—4. *Lenticulina* (*Astacolus*) *polymorpha polymorpha* (T e r q.), ×57. a — lateral view; b — frontal view from the apertural face

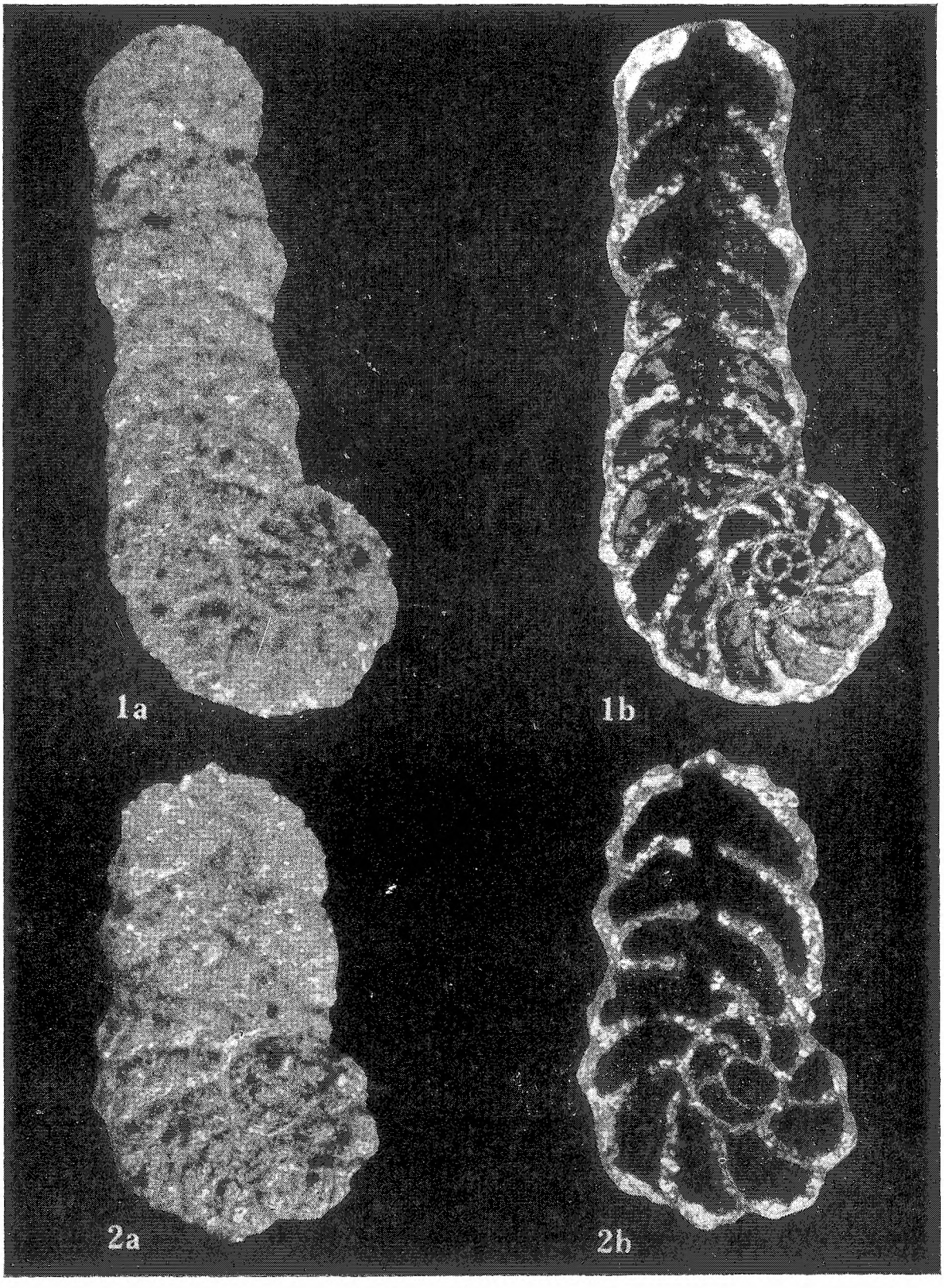
Figs. 5—8. *Lenticulina* (*Astacolus*) *volubilis* D a i n, ×54. a — lateral view; b — frontal view from the apertural face

Figs. 9—10. *Lenticulina* (*Astacolus*) *interrumpa* B l a n k, ×40

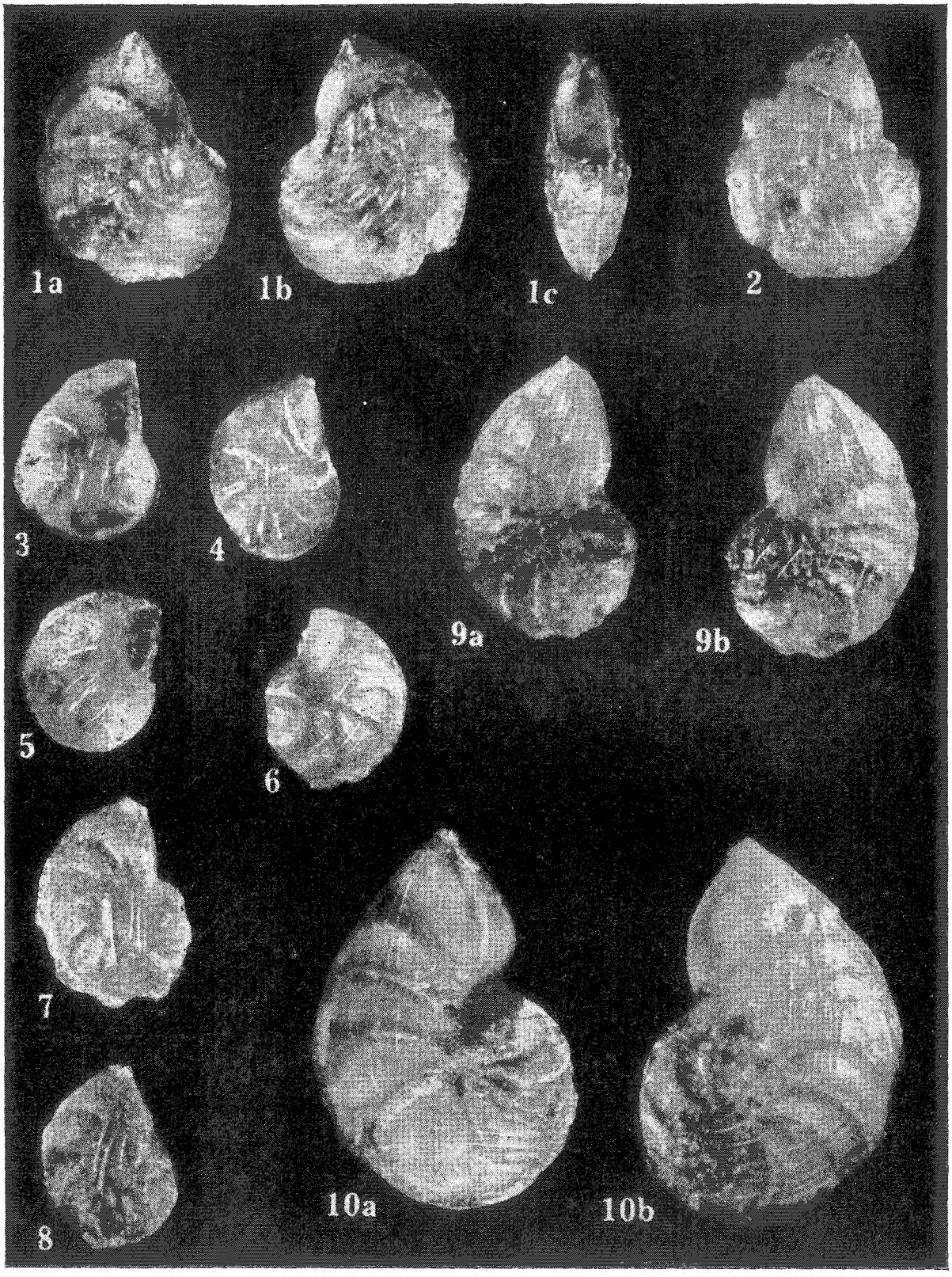
Figs. 11—12. *Paalzowella pazdroae* n. sp., ×100. a — dorsal view; b — ventral view; c — lateral view




*W. Bielecka, O. Styk*




*W. Bielecka, O. Styk*

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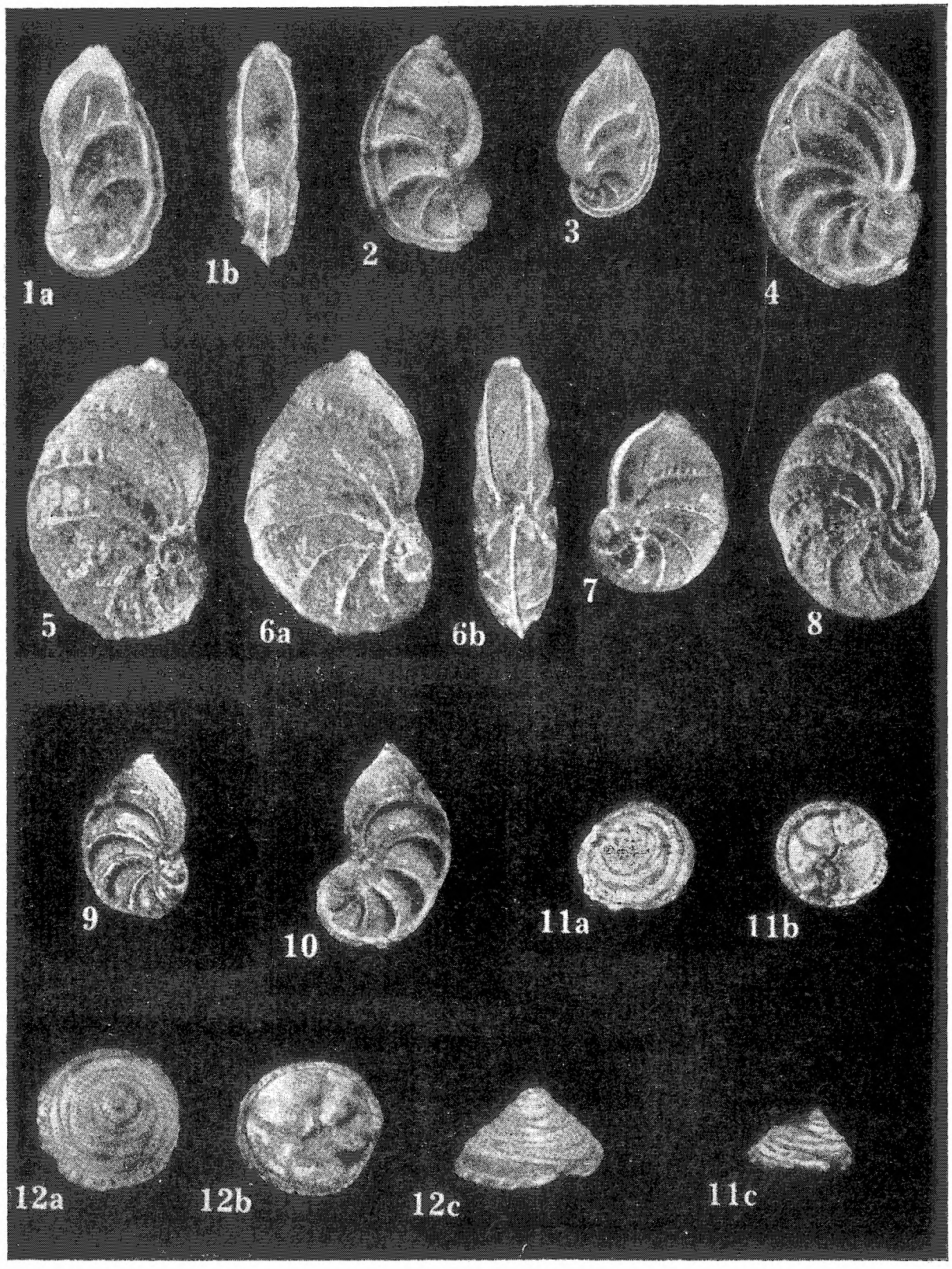


*W. Bielecka, O. Styk*