Annales Societatis Geologorum Poloniae (1992), vol. 62: 269 - 287
PL ISSN 0208-9068

ARENACEOUS FORAMINIFERA FROM LOWER-MIDDLE DEVONIAN BOUNDARY BEDS OF WESTERN PART OF THE GÓRY ŚWIĘTOKRZYSKIE MTS

Jan Malec

Oddział Świętokrzyski Państwowego Instytutu Geologicznego, Zgoda 21, 25-953 Kielce

Malec, J., 1992. Arenaceous foraminifera from Lower-Middle Devonian boundary beds of western part of the Świętokrzyskie Mts. *Ann. Soc. Geol. Polon.*, 62: 269 – 287.

Abstract: The paper concerns assemblages of arenaceous foraminifera from the borehole Dąbrowa D-5 (northern part of Kielce). Nine species are described, including the following five new ones: *Amphitremoida kielcensis* sp. nov., *A. pajchlowae* sp. nov., *Lagenammina silnica* sp. nov., *Saccammina scutella* sp. nov. and *S. guerichi* sp. nov. Five successive assemblages have been distinguished. The indirect biostratigraphical data indicate that the foraminifera bearing deposits from Dąbrova represent the boundary beds of the *patulus/partitus* conodont zones. It is possible, basing on the foraminiferal fauna, to correlate precisely the Lower-Middle Devonian boundary beds in the western part of the Góry Świętokrzyskie Mts.

Key words: Arenaceous foraminifera, Lower-Middle Devonian, stratigraphy, central Poland.

Manuscript received 14 March 1991, accepted 12 March 1992.

INTRODUCTION

In Poland, Devonian foraminifera have been recorded nearly exclusively from the Góry Świętokrzyskie Mts. The earliest record is that of the Upper Emsian foraminifera from Wydryszów and Upper Eifelian ones from the Grzegorzowice-Skały section (Duszyńska, 1956, 1959). Later, Ozonkowa (1961, 1978), and Olkowicz-Paprocka & Ozonkowa (1970) described foraminifera in thin sections from Givetian and Frasnian carbonates of the eastern part of the Góry Świętokrzyskie Mts, and Neumann *et al.* (1975) described those from the Upper Devonian of the Lublin region. In the 80-ties, foraminifera from the Lower-Middle Devonian boundary beds from northern and southern parts of the Góry Świętokrzyskie Mts. were studied by Malec (1979, 1982, 1984 a, b), Żakowa *et. al.* (1986) and Malec & Studencki (1988). Famennian foraminifera from Kowala and Jabłonna in the southern region of the Góry Świętokrzyskie Mts were also studied (Olempska, 1983; Jurkiewicz & Żakowa, 1983; Żakowa *et al.*, 1985).

The foraminiferal assemblages concerned in this paper are derived mainly from the Lower-Middle Devonian boundary beds from the borehole Dąbrowa D-5 drilled in the northern part of Kielce (Fig. 1). The deposits which yielded these assemblages are underlain by sandstones and overlain by dolostones. They were named by Czarnocki (1951) the Dąbrowa Beds. The limestone complex at their top was named by Gürich (1896) the Dąbrowa Horizon. The brachiopods *Chimaerothyris dombrowiensis* (Gürich) ocurring in this limestone indicate that these deposits belong to the local biozone *Ch. dombrowiensis* distinguished in the Eifelian deposits of the Góry Świętokrzyskie Mts. (Studencka, 1983).

Assemblages of arenaceous foraminifera from the Lower-Middle Devonian boundary beds have been also reported from the western part of the southern region of the Góry Świętokrzyskie Mts, from Szydłówek and Porzecze (Malec, 1984a; Malec & Studencki, 1988). Similarly as the present assemblages, those from Szydłówek and Porzecze are dominated by *Webbinelloidea similis* Stewart & Lampe. Stratigraphically important are the species belonging to *Amphitremoida, Lagenammina* and *Saccammina* because of their short vertical ranges.

The foraminiferal assemblages from Dąbrowa D-5 include 6 genera and 9 species, 5 of them new. Five different successive assemblages have been distinguished in the upper Emsian and lower Eifelian deposits of this borehole.

The described late Emsian assemblages containing species belonging to *Amphitremoida, Lagenammina* and *Saccammina* are quite unique because these genera have not been recorded before from deposits of this age (see Conkin & Conkin, 1977; Pojarkow, 1979). The remaining species (except *Hyperammina couviniana*) are recorded from the Lower Devonian deposits of Europe also for the first time. The arenaceous Lower Devonian (Emsian) foraminiferal assemblages have been, so far, described from Europe only from the *Rheinisches Schiefergebirge* and from the Góry Świętokrzyskie Mts.

DESCRIPTION OF SECTIONS

The generalised lithological columns of the described sections are shown in Fig. 2.

Borehole Dąbrowa D-5

The borehole Dąbrowa-5 was drilled perpendicularly to the steep (75-80), northern limb of the Niewachlów anticline, within the premises of the abandoned iron-ore mine Włodzimierz, now situated within the northern part of Kielce (Fig. 1).

The Devonian part of this profile has been described recently by Tarnowska & Malec (1987), and Malec (1989). The lithological sequence (from the base) is as follows: quartz sandstone; pale-green mudstone about, 7.5 m thick; claystone complex, about 20 m thick, ocurring at depth 71,5 - 103.5 m. In the lower part (86,2 - 103,5 m) of this complex the claystone is black and it contains pyrite, foraminifera and single remnants of bryozoans. Higher up (71.5 - 86.2 m) there are gray-yellow

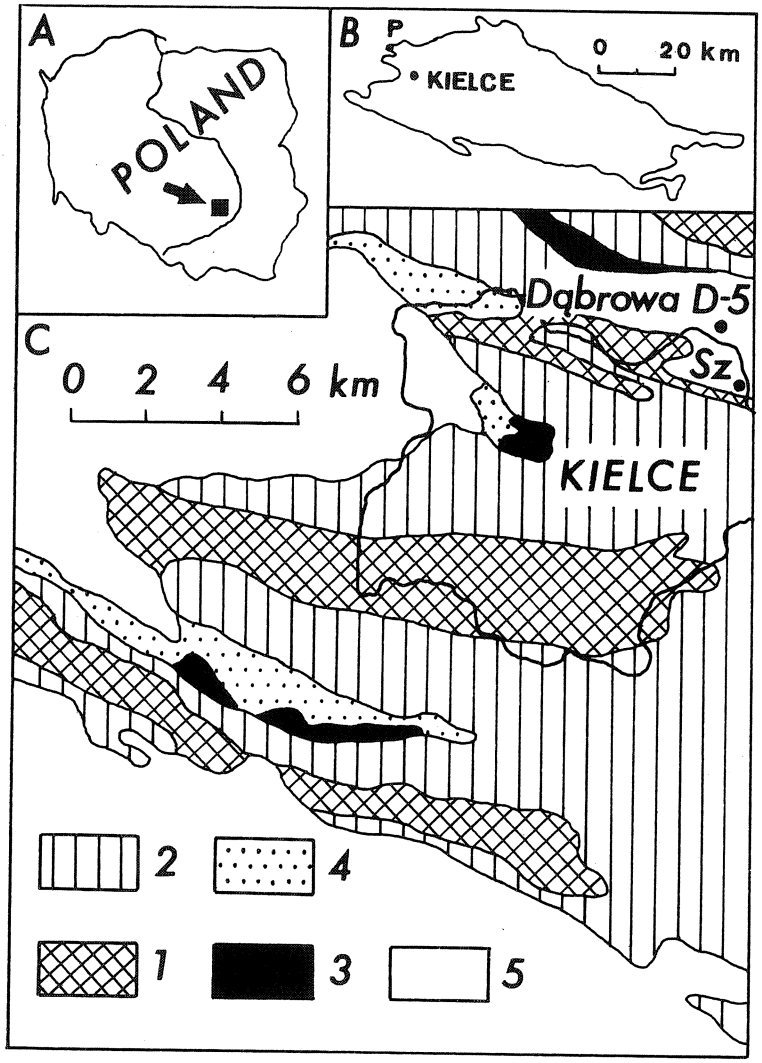


Fig. 1 Location of sections mentioned in text: A – within Poland, B – within outcrop area of Palaeozoic deposits in the Góry Świętokrzyskie Mts, C – against geological map of western part of Góry Świętokrzyskie Mts. *1* – Cambrian, Ordovician, Silurian; *2* – Devonian; *3* – Carboniferous; *4* – Permian; *5* – Mesozoic; *P* – borehole Porzecze IG-5A; *Sz* – Szydłówek

claystones containing iron ore (syderite). They yielded scarce brachiopods, crinoids, bryozoans and ophiocystoids. Higher up, at depth 66,0 - 71,5 m, there is a limestone complex (micrites and biomicrites) containing gyrogonites of charophytes, and abundant marine fauna including conodonts, tentaculitids, brachiopods, trilobites, gastropods, bivalves, crinoids and echinoids, sclerites of ophiuroids and skeletal plates of ophiocystoids. Arenaceous foraminifera are relatively abundant. There occur also abundant ostracods represented by 25 taxons which have recently been described by Malec (1989).

Szydłówek

The profile of the Lower-Middle Devonian boundary beds at Szydłówek (Fig. 1) was studied mainly in the road cut of the new road to Warszawa, and in the neighbouring shallow wells (Malec & Studencki, 1988).

In the section at Szydłówek, which is situated about 2 km to SE from the borehole Dąbrowa D-5, the Upper Emsian quartzitic sandstones are overlain by gray-celadon and light pink mudstones of varying thickness (2 - 5 m). Higher up, there occur 5 to 10 m thick, black and gray claystones containing pyrite. The claystones yielded arenaceous foraminifera which were especially abundant in black claystones. These deposits are followed by yellow-brown claystones about 16 m thick, containing syderite concretions. They contain scanty crinoids and some other indeterminable organic remains. Higher up, there are marly dolomites. Within the lower portion of this complex, there occur poorly preserved brachiopods, conodonts *Icriodus werneri* Weddige, scolecodonts, crinoids and agglutinated foraminifera.

Borehole Porzecze IG-5A

This borehole is situated in the NW part of the Góry Świętokrzyskie Mountins (Fig. 1). The Lower-Middle Devonian boundary beds are in this profile in an upturned position and they dip at 40-60°. The oldest deposits ocurring at depth 7.0 to 12.9 m are yellow-brown mudstones and claystones. They once overlied quartz sandsone which has been pierced in the close neighbourhood of this borehole. The mudstones and claystones are overlain at the depth 12.9-39.5 m by dark gray marly dolomite. Within its lower part, at depth 19.2-23.5 m, there are claystone intercalations which yielded ostracod assemblages described by Malec (1979). The dolomite contains also crinoids, coraloids and agglutinated foraminifera. At the depth 39.5-116.5 m there occur gray and black marly micritic limestones. These deposits contain rich and diverse fauna including coraloids, stromatoporoids, brachiopods, crinoids, ophiocystoids, ophiuroids, sponges, bryozoans, bivalves, gastropods, tentaculitids, scolecodonts, conodonts, fish remnants and gyrogonites of charophytes. A few successive agglutinated foraminiferal assemblages have been distinguished in the limestones by Malec (1984a).

SUCCESSION OF FORAMINIFERAL ASSEMBLAGES

Foraminifera have been recovered from the Dąbrowa D-5 borehole from all principal constituents of the sequence above the sandstone (Fig. 2). Some specimens of *Webbinelloidea* have been recovered from limestones collected near the shaft named Agricola by which the borehole is situated (see Malec, 1989). The collection of foraminifera from this borehole consists of more than 3000 specimens belonging to the families Astrorhizidae and Saccaminidae, to the genera *Amphitremoida, Hyperammina, Lagenammina, Saccammina, Tolypammina* and *Webbinelloidea.*

Most abundant are foraminifera of *Webbinelloidea*, of the species *W. similis* (Fig. 3). Several morphotypes of this species have been distinguished according to the scheme proposed by Conkin & Conkin (1970). The principal feature on which the division is based is test convexity. Convex (A) and flat (B) morphotypes have been distinguished. These include unilocular (I), bilocular (II) and multilocular (III) specimens.

Five successive foraminiferal assemblages have been distinguished in the section Dąbrowa D-5. Two of them have analogs in the sections Porzecze IG-5A and Szydłówek which permits biostratigraphical correlation (Fig. 2).

Assemblage a - occurs in the higher part of mudstones, at the depth 98.0-

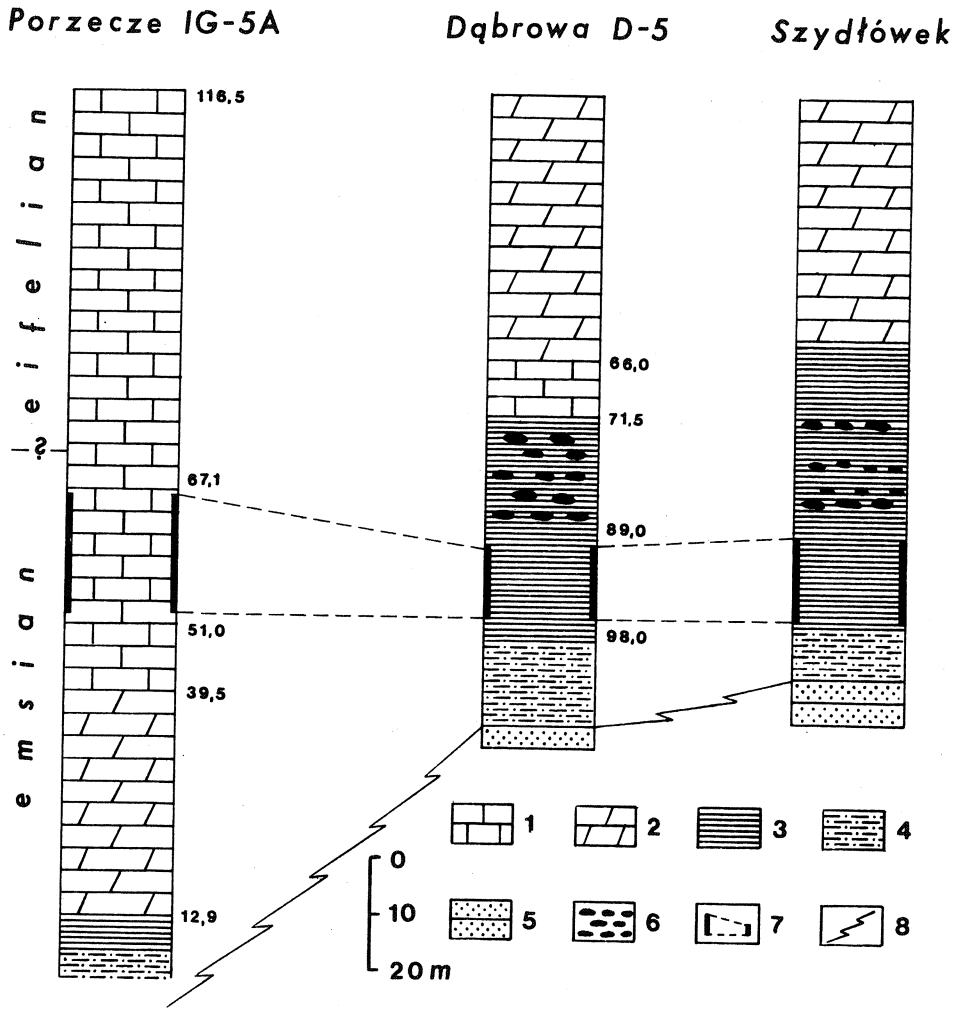


Fig. 2 Occurrence of foraminiferal assemblage B in sections discussed in text. Note the upturned position of deposits in the Porzecze IG-5A borehole. *1* – limestones; *2* – dolostones; *3* – claystones; *4* – mudstones; *5* – sandstones; *6* – syderite; *7* – stratigraphical range of genera Amphitremoida, Lagenammina and Saccammina; *8* – lithostratigraphical correlation

106.0 m. It has been subdivided into two sub-assemblages. In the lower sub-assemblage, the morphotype IB of *W. similis* is relatively abundant, and there occurs *Hyperammina couviniana* and single specimens of *Tolypammina* sp. In the upper sub-assemblage, there occur *H. couviniana* and *W. similis* - morphotypes IA, IB and IIB.

Assemblage b - occurs in black and brownish claystones with pyrite at the depth 89.0-98.0 m. This assemblage was distinguished basing on the whole stratigraphic range of the genera *Amphitremoida, Lagenammina* and *Saccammina*. In the lower part of this range, the representatives of these genera are

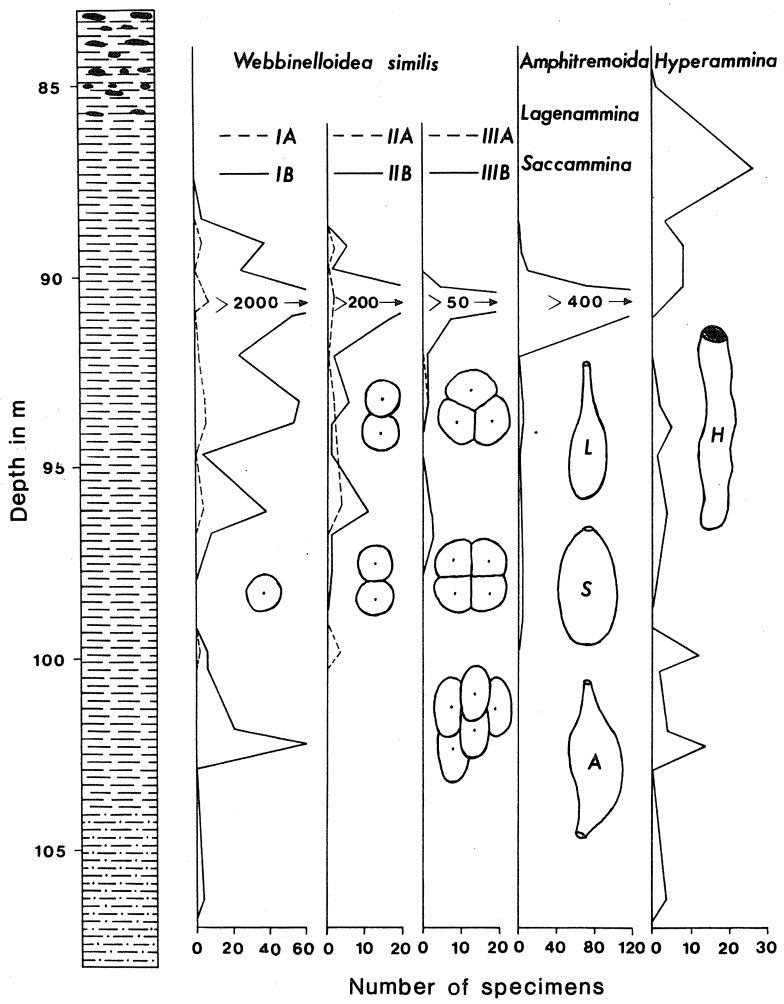


Fig. 3 Proportions of foraminiferal taxa in late Emsian dark claystones in section Dąbrowa D-5. Morphotypes of *Webbinelloidea similis* Stewart & Lampe after Conkin & Conkin (1970). *IA - IIIA* – convex, uni- bi- and multilocular specimens; *IB - IIIB* – flat, uni-, bi- and multilocular specimens; *A* – *Amphitremoida*; *L* – *Lagenammina*; *S* – *Saccammina*; *H* – *Hyperammina*

rare, and they are accompanied by *Hyperammina couviniana* and numerous specimens of *W. similis* - morphotypes IA, IB, IIA, IIB, IIIA, and IIIB. In the upper part of the range of the assemblage b, at the depth 89.2-92.0 m, there is an acme of occurrence of *Amphitremoida, Lagenammina and Saccammina.* In this interval specimens belonging to these genera constitute about 20% of specimens (Fig. 3). Most numerous is *W. similis* - morphotype IB, less numerous are morphotypes IA, IIA, IIB and IIIB of this species, *Hyperammina* sp. A and H. sp. B.

A foraminiferal assemblage of identical composition has been found in the

borehole Porzecze IG-5A, at the depth 51.0-67.1 and in Szydłówek within the black claystones with pyrite (Fig. 2).

Assemblage c - occurring in the lower part of the claystones with syderite at the depth 85.0-89.0 m is characterised by the dominance of *Hyperammina* sp. A, which constitutes 84% of specimens. It is accompanied by *W. similis* - morphotypes IA and IB.

Assemblage d - occurs in the limestone complex at the depth 66.0-71.5 m. In this assemblage, the dominant species is *W. similis* - morphotype IA which constitutes 74% of specimens of this species.

An assemblage of similar composition was found in the Porzecze IG-5A borehole, at the depth 79.4-115.5 m (Malec 1984a)

Assemblage e - occurs in the dolomite complex above the depth 66.0 m. *W similis* - morphotype IB constitutes about 60% of the foraminiferal assemblage, contribution of the morphotype IA of this species is 36%, and that of morphotype IIB is 4%.

BIOSTRATIGRAPHY

Biostratigraphy and age assignement of the deposits from the borehole Dąbrowa D-5 is based on ostracods and foraminifera. In the limestone complex, there occur ostracod assemblages identical as those from the complex VIII (according to the lithostratigraphical division by Pajchlowa, 1957) of the section in Grzegorzowice in the Łysogóry region of the Góry Świętokrzyskie Mts. This indicates an early Eifelian age (Malec, 1989) of the limestone complex.

The stratigraphic position of the black claystones with piryte containing foraminiferal assemblage b is established on correlation with the well dated section Porzecze IG-5A in which the corresponding assemblage occurs in late Emsian deposits (Malec, 1982) (Fig. 2).

The biostratigraphy of the Porzecze IG-5A section is based on ostracods, coraloids, brachiopods and conodonts (Malec, 1979; Sarnecka, 1979; Studencka, 1983; Malec & Studencki, 1988). The diversified assemblage of ostracods from the lower part of the dolomite complex, from the depth 19.2-23.5 m, indicates a late Emsian age. This assemblage includes among other species *Bairdia cultrijugati* Krommelbein, *Bairdiocypris lamellaris* Adamczak, *Evlanella mitis* Adamczak, *Guerichiella septentrionensis* Adamczak, *Kummerowillina prima* Adamczak, *Microcheilinella clava* (Kegel), *Poniclacella abnormis* Adamczak, *Pseudorayella lambda* Adamczak, *Ropolonellus robustus* Adamczak and *Sulcella (Sulcella) kloedenellides* Adamczak (Malec, 1979). The same ostracod association is known from lower parts of the sections from Grzegorzowice and Wydryszów (Adamczak, 1968, 1976) from the Łysogóry region of the Góry Świętokrzyskie Mts dated on conodonts as late Emsian (Malec, 1986).

The late Emsian age of the lower part of the limestone complex from Porzecze, from the depth 27.0-71.3 m is indicated by the occurrence of coraloids *Alveolites praelimniscus* Le Maitre, *Favosites goldfussi eifeliensis* (Penecke), *Thamnopora micropora* Lecompte and *Heliolites porosus* (Goldfuss) (Sarnecka, 1979). Brachiopods *Chimaerothyris dombrowiensis* (Gürich) ocurring in the higher part of the limestone complex, at the depth 74.5-105.0 m, indicate an early Eifelian age of these rocks (Studencka, 1983). Conodont species from Porzecze are *Icriodus werneri* Weddige found at the depth 62.7 m, and *Icriodus retrodepressus* Bultynck found at the depth 66.5 m.

In the section at Porzecze, the Lower-Middle Devonian boundary occurs presumably within the interval between the top of the range of the foraminiferal assemblage corresponding to the assemblage b from Dąbrowa D-5 and the level of the first appearance of brachiopods *Chimaerothyris dombrowiensis*, i. e. between 67.1 and 74.5 m (Fig. 2). This is suggested by the biostratigraphic data from Grzegorzowice and from the northern part of Kielce where *Ch. dombrowiensis* appears above the level of the first appearance of *I. retrodepressus* (Malec, 1992).

The succession of foraminiferal assemblages in the sections Dąbrowa D-5 and Porzecze IG-5A is similar. Out of the five assemblages distinguished at Dąbrowa (see previous section) two are also recorded from Porzecze. The foraminifera based correlation between the two sections suggests that the Lower-Middle Devonian boundary occurs in the Dąbrowa section somewhere within the lower part of the gray-yellow claystones containing syderite.

REMARKS ON NATURE OF TEST WALL OF STUDIED FORAMINIFERA

The study of foraminiferal test wall under SEM revealed considerable variability of grain size and distribution and of the character of matrix. Specimens of *Amphitremoida*, *Lagenammina*, *Saccammina* and *Webbinelloidea* have been studied, and several basic types of wall have been distinguished. These are as follows.

A. Wall composed of large (40-70 μm) siliceous crystals of trigonal trapezoedral or, less commonly, hexagonal trapezoedral shape. The large crystals occur between smaller crystals and grains. Surface rough (Pl. I: 1).

B. Wall composed of small siliceous crystals and irregular grains (commonly 10-20 μm). Between these elements there are holes so that the wall appears porous (Pl. I: 2).

C. Wall composed of flat or slightly flattened, irregularly shaped siliceous grains of various size (up to 30 μm). Basic or large elements are tightly packed or cemented by small siliceous grains (Pl. I: 3).

D. Wall composed of small and very small, irregularly distributed siliceous grains (1-8 μm in size) with rounded corners. The grains are commonly

cemented together. The wall has a porous appearance due to the presence of holes between the grains. At the wall surface, there occur sporadically larger elements representing fragments of invertebrate skeletons (sponge spicules?) or indeterminable objects of flattened shape (Pl. I: 4).

E. Wall composed of siliceous crystals of medium size (up to 20 μm. They are irregularly distributed between minute siliceous fragments cemented together and forming siliceous mass. The crystals have an appearance of raisins in dough. The wall is not porous (Pl. I: 5).

F. Wall not porous, composed of very small (1-5 μm) siliceous fragments of rounded, almost isometric shape, in siliceous cement (Pl. I: 6).

In *Amphitremoida*, there occur two types of wall. *A. kielcensis* sp. nov. has the type A wall while *A. pajchlowae* sp. nov. has the type C wall.

In *Lagenammina*, there are three types of wall. Most common is wall type A observed in 50 percent of specimens of this genus. It occurs most commonly in elongated morphotypes of *L. silnica* sp. nov. Wall type D was observed mostly in convex morphotypes of *L. silnica*, and less commonly in elongated morphotypes of this species. Less common is the type B wall occurring in both, convex and elongated morphotypes of *L. silnica*.

Wall of most variable structure has been observed in *Saccammina*. The most common is wall type B ocurring in 50 percent of specimens. It is the dominating wall type in *S. guerichi* sp. nov., and it is also common in *S. scutella* sp. nov. Some specimens of *S. guerichi* have wall type A and some representatives of *S. scutella* have wall of types C, D, or E.

In flat tests of *Webbinelloidea similis* occurring in the clay complex containing pyrite, two types of wall have been observed. Type A is sporadic and type B is common. The specimens of *W. similis* from limestone have thin, type F wall.

The above observations suggest that there is no relation between the wall type and the taxonomic position of specimens at the generic level. This observation is partly in agreement with that by Ebner (1973) on arenaceous foraminifera from the Silurian and Upper Devonian of the Carnic Alps. Even in single species of the present material, or more, even in single morphotypes, the occurrence of various wall types has been observed. This concerns tests from single samples, and also tests (like those of Webbinelloidea similis) from samples from different lithologies, thus, representing different environment.

SYSTEMATIC PART

The described material is deposited in the Laboratory of Stratigraphy of the Świętokorzyski Branch of the State Geological Institute in Kielce. The collection number is PIG-OS FI/1-90.

The taxonomical system used is that after Loeblich & Tappan (1964) and Conkin & Conkin (1977, 1979).

The explanation of the symbols used is as follows:
L = test length; D = test diameter (max. = maximum, min. = minimum); S = diameter of test opening; H = test height.

Order Foraminiferida Eichwald, 1830
Family Astrorhizidae Brady, 1881
Genus *Hyperammina* Brady, 1878
Hyperammina cuviniana Duszyńska, 1959
Pl. III: 3, 4

1959 *Hyperammina cuviniana* Duszyńska, p. 73, 74, fig. 1.
Material. 8 tests.
Size (in mm):

L	D max.	D min.
0.500	0.150	0.125
0.550	0.130	0.100
0.600	0.100	0.050
0.675	0.150	0.125

Description. Test tube-shaped, straight, curved or meandering, commonly flattened. Initial chamber not distinctive. Second chamber straight sided along the whole length, tapering sharply near the terminus. Aperture circular or oval. Wall thick, composed of siliceous crystals and grains of various sizes in siliceous cement. Colour light gray.
Remarks. Specimens of *H. couviniana* from Dąbrowa are similar in shape and the test length/width ratio to the holotype described from Wydryszów (Duszyńska, 1959), but they differ in being slightly smaller.
Occurrence. Poland (Góry Świętokrzyskie): Wydryszów, and borehole Dąbrowa D-5, upper Emsian.

Hyperammina sp. A
Pl. III: 2

1988 *Hyperammina* sp.; Malec & Studencki, p. 81, pl. 1: 8-12.
Material. More than 20 specimens.
Size (in mm):

L	D max.	D min.
0.575	0.225	0.200
0.600	0.350	0.325
0.725	0.275	0.200
0.750	0.385	0.320

Description. The megalosphaerical test (Pl. III: 2) has sphaerical initial chamber and straight or slightly curved, straight sided second chamber. The microsphaerical test has the second chamber of slightly conical shape, i.e. it tapers slightly towards the aperture. Some tests are more or less flattened. Aperture wide, circular. Wall composed of siliceous crystals of medium size in siliceous cement. Colour light gray.
Remarks. In the studied material, dominant are megalosphaeric, not completely preserved forms.

Hyperammina sp. A is similar in generall shape and size to *Hyperammina casteri* Conkin from the lower Mississippian of the USA (Conkin *et al.*, 1963). It differs from that species in having more convex second chamber and nearly sphaerical initial chamber. *H.* sp. A is also similar to H.? *rudis* Parr from Silurian of the United States (Browne and Schott, 1963) but is smaller.
Occurrence. Poland (Góry Świętokrzyskie Mts): Szydłówek, and borehole Dąbrowa D-5, upper Emsian - lower Eifelian ?

Hyperammina sp. B
Pl. III: 1

Material. 2 tests.
Size (in mm):

L	D max.	D min.
1.300	0.225	0.200

Description. Test almost straight, tubular, probably flattened. Initial chamber not preserved. Wall straight sided along the whole length. Aperture wide, elliptical. Wall very light gray, composed of medium sized siliceous crystals and grains in quartz cement.
Remarks. *Hyperammina* sp. B from Dąbrowa is very similar to *Hyperammina constricta* Gutschick & Treckman from the Palaeozoic of the United States. It differs from the specimens of this species described by McClellan (1966) from Silurian in being longer, and from those from Lower Devonian (McClellan, 1973) in being longer and in having diameter of almost double length.
Occurrence. Poland (Góry Świętokrzyskie Mts): borehole Dąbrowa D-5, upper Emsian.

Family Saccamminidae Brady, 1884
Genus *Amphitremoida* Eisenack, 1937
Amphitremoida pajchlowae sp. nov.
Pl. I: 3; Pl. III: 10

Holotype. PIG-OS FI/10; Pl. III: 10.
Type horizon. Upper Emsian.
Type locality. Dąbrowa, Góry Świętokrzyskie Mts, Poland.
Derivation of the name. In honour of Doc. Maria Pajchlowa who contributed considerably to our knowledge on geology of the Devonian from the Góry Świętokrzyskie Mts.
Diagnosis. An *Amphitremoida* of crescentic shape, widest within the middle part. One of the two apertures situated at the end of a short, wide neck.
Material. 7 tests
Size (in mm):

	L	D	S1	S2
	0.410	0.230	0.075	0.075
	0.425	0.220	0.075	0.050
	0.465	0.260	0.065	0.050
holotype	0.575	0.270	0.110	0.100
	0.725	0.300	0115	0.100

Description. Test bulbous, widest within the central part. Single apertures are present at both test ends. Wall composed of fine, irregular, commonly flat siliceous grains in siliceous cement. Colour of test dark gray or light brown.
Remarks. The described species is similar in test shape to *Amphitremoida? asymmetrica* Eisenack from the Silurian of the Baltic region (Eisenack, 1954; pl. 4: 5), but is slightly larger.

Occurrence. Poland (Góry Świętokrzyskie Mts): borehole Dąbrowa D-5, upper Emsian.

Amphitremoida kielcensis sp. nov.
Pl. III: 11

1988 *Amphitremoida* sp. B; Malec & Studencki, p. 82, pl. 1: 5.
Holotype: PIG-OS FI/15; Pl. III: 11.
Type horizon: Upper Emsian.
Type locality. Dąbrowa, Góry Świętokrzyskie Mts, Poland.
Derivation of the name. From the town Kielce.
Diagnosis. Test straight, spindle-shaped, widest within central part. Appertures situated at the opposite ends.
Material. 6 tests.
Size (in mm):

	L	D	S1	S2
	0.335	0.170	0.075	0.070
	0.560	0.240	0.085	0.075
holotype	0.585	0.250	0.100	0.075

Description. An *Amphitremoida* having elongated, spindle-shaped tests widest within central part. At both ends, there are circular appertures differing in size from one another. Wall of rough surface, composed of large siliceous grains in siliceous cement. Colour gray or light brown.
Remarks. *Amphitremoida kielcensis* sp. nov. is similar in shape and length/width ratio to *A. hauffmani* Conkin & Conkin from the Upper Devonian and Lower Carboniferous of the United States (Conkin & Conkin, 1981) but is larger and seems to have larger appertures.
Occurrence. Poland (Góry Świętokrzyskie Mts): Szydłówek and borehole Dąbrowa D-5, upper Emsian.

Genus *Lagenammina* Rhumbler, 1911
Lagenammina silnica sp. nov.
Pl. I: 1, 4; Pl. II: 1-3; Pl. III: 5, 8

1988 *Lagenammina* sp.; Malec & Studencki, p. 82, pl. 1: 6.
Holotype: PIG-OS FI/34; Pl. II: 1.
Type locality. Dąbrowa, Góry Świętokrzyskie Mts, Poland.
Derivation of the name. From Silnica River flowing across Kielce.
Diagnosis. A *Lagenammina* of elongate, straight or slightly bent, bottle-shaped tests. Test widest at 1/3-1/2 of the length, tapering gradually towards aperture. Aperture circular, situated at the end of gradually tapering neck.
Material. More than 90 tests.
Size (in mm):

L	D	S
0.225	0.150	0.035
0.350	0.150	0.035
0.450	0.235	0.042
0.475	0.250	0.070
0.575	0.250	0.070

Description. *Lagenammina* having elongate, straight or slightly bent, bottle-shaped tests. Test widest at 1/3-1/2 of the length. At the initial end, test is widely rounded. It tapers gradually passing into a narrow neck terminated by a circular aperture. Wall composed of commonly large (Pl. I: 1), sporadically fine (Pl. I: 4) siliceous crystals and grains in siliceous cement. Colour gray or brown.
Remarks. Variability in the species *L. silnica* concerns the size of tests, their shape (they are more or less bulbous), and the development of the neck. *L. silnica* is somehow similar to Lagenammina sp. from the Silurian of England (Mabillard & Aldridge, 1982, pl. 1: 12), but is distinctly larger and has constricted neck. Some morphotypes of *L. silnica* are similar in shape to *L. stilla* Moreman from the Silurian of the United States (Moreman, 1930; Dunn, 1942; Browne & Schott, 1963; Mound, 1968), but are slimmer and have wider neck.
Occurrence. Poland (Góry Świętokrzyskie Mts): Szydłówek and borehole Dąbrowa D-5, upper Emsian.

Genus *Saccammina* Sars, 1969
Saccammina scutella sp. nov.
Pl. I:5; Pl. II:4, 5, 8, 9

Holotype: PIG-OS FI/55; Pl. II:4.
Type horizon. Upper Emsian.
Type locality. Dąbrowa, Góry Świętokrzyskie Mts, Poland.
Derivation of the name. From scutella (latin) = cylinder.
Diagnosis. A *Saccammina* of elongated, convexly cylindrical shape, widest at the initial test part. Aperture circular, situated at the narrowed test end.
Material. More than 70 tests.
Size (in mm):

L	D	S
0.300	0.130	0.040
0.425	0.125	0.060
0.475	0.200	0.070
0.525	0.150	0.100
0.750	0.300	0.110

Description. *Saccammina* of elongated, convexly cylindrical shape, widely rounded at the initial test end. Test nearly straight sided, widest at the initial end, straight or slightly bent, tapering towards aperture. Aperture circular, situated at the narrow test end which is generally devoid of a distinctly delimited neck. Wall composed of fine siliceous crystals, or, not commonly, from irregular silicious grains in silicious cement (Pl. I: 5). Colour dark gray or light brown.
Remarks. Variability in *S. scutella* concerns the length/diameter ratio and diameter of aperture. Some morphotypes of this species are somewhat similar to *Lagenammina cumberlandiae* (Conkin) from the Silurian of the United States (McClellan, 1966), but are longer and have less rounded initial test part.
Occurrence. Poland (Góry Świętokrzyskie Mts): borehole Dąbrowa D-5, upper Emsian.

Saccammina guerichi sp. nov.
Pl. I: 2; Pl. II: 7

Holotype. PIG-OS FI/43; Pl. II: 7.
Type horizon. Upper Emsian.
Type locality. Dąbrowa, Góry Świętokrzyskie Mts, Poland.

Derivation of the name. In honour of George Gürich, German palaeontologist, who studied Palaeozoic faunas of the Góry Świętokrzyskie Mts.
Diagnosis. A *Saccammina* of the shape of a bulbous or partly straight-sided sack. Aperture circular, situated at the end of a weakly demarcated, short and slightly bent neck.
Material. More than 45 tests.
Size (in mm):

	L	D	S
holotype	0.430	0.260	0.085
	0.340	0.250	0.060
	0.400	0.250	0.060
	0.445	0.200	0.045
	0.525	0.240	0.120
	0.650	0.255	0.120

Description. *Saccammina* of elongated, sack-like shape; initial part widely rounded. Test straight sided along c. 2/3 of length, widest at central part. From 2/3 of the length, the test tapers gradually. Aperture wide, circular, situated at the end of a weakly demarcated, short and wide neck. Wall composed commonly of fine siliceous crystals and irregular grains, sporadically of large crystals in siliceous cement (Pl. I: 2). Wall gray or light brown.
Remarks. Variability in *S. guerichi* concerns test size, convexity, and diameter of aperture. This species differs from *S. scutella* sp. nov. in being more convex and widest at half of the length. *S. guerichi* is most similar to *Protecnina jolietensis* Dunn from the Silurian of the United States (Dunn, 1942) but it differs in being larger and in having a weakly demarcated neck.
Occurrence. Poland (Góry Świętokrzyskie Mts): borehole Dąbrowa D-5, upper Emsian.

Genus *Webbinelloidea* Stewart & Lampe, 1947 emend Conkin & Conkin, 1970
Webbinelloidea similis Stewart & Lampe, 1947
Pl. I: 6; Pl. II: 6, 10; Pl.III: 6, 9; Pl. IV: 1-9

1947 *Webbinelloidea similis* Stewart & Lampe; p. 535, pl. 78: 8.
1970 *Webbinelloidea similis* Stewart & Lampe; Conkin & Conkin, p. 4-14, pl. 1: 1-31; pl. 2: 1-27; pl. 3: 1-16; pl. 3: 1-35.
1984b *Webbinelloidea similis* Stewart & Lampe; Malec, p. 560-561, pl. 1: 1-20; pl. 2: 1-12.
1988 *Webbinelloidea similis* Stewart & Lampe; Malec & Studencki, p. 84, 85, pl. 1: 13, 15-18; pl. 2: 1-4; pl. 3: 1-5.
For further synonyms see Conkin & Conkin (1970, 1981).
Material. More than 2000 tests.
Size (in mm):

L	D min.	D max.	H	morphotype
–	0.450	0.525	0.200	
–	0.425	0.475	0.230	IA
–	0.550	0.575	0.200	
0.775	0.450	0.525	0.300	
0.766	0.385	0.435	0.240	IIA
0.900	0.400	0.450	0.200	

L	D min.	D max.	H	morphotype
0.583	0.465	0.470	0.245	
0.775	0.425	0.450	0.220	
0.725	0.325	0.400	0.250	IIIA
0.660	0.250	0.365	0.225	
–	0.450	0.525	0.160	IB
0.725	0.425	0.450	0.115	
1.035	0.400	0.415	0.135	IIB
0.635	0.335	0.385	0.125	
0.600	0.335	0.365	0.125	
1.400	0.375	0.425	0.110	
0.825	0.375	0.470	0.120	IIIB
1.150	0.350	0.375	0.120	

Remarks. *Webbinelloidea similis*, the most abundant foraminiferal species in Dąbrowa D-5, has been recorded before from Poland only from the Lower and Middle Devonian deposits of the Góry Świętokrzyskie Mts (Malec, 1984 a, b; Malec & Studencki, 1988). Outside Poland, it was recorded from deposits of similar age from the United States (only sigle specimens are recorded from the Lower Carboniferous of that region). The same morphotypes as in Poland are recorded from the United States, from the Columbus and Dalaware formations (Stewart & Lampe, 1947; Summerson, 1958; Conkin & Conkin, 1970). The Columbus Formation belongs to the *patulus* to *costatus* conodont zones (Lower and Middle Devonian boundary deposits) while the Delaware Formation corresponds to the *kockelianus* Zone (higher part of Eifelian) (Sparling, 1983).

In the populations of *W. similis* from Dąbrowa, most numerous individuals are unilocular and flat (morphotype IB), without the basal wall. They are the basic elements of the associations from the claystones with pyrite (Fig. 2). Flattened, multilocular specimens (morphotypes IIB, IIIB) (pl. III: 9; Pl. IV: 2, 7, 8, 9) are less common, and uni- and multilocular convex specimens (morphotypes IA, IIA, IIIA), with distinct basal wall (Pl. II: 6, 10: Pl. IV: 1, 4) are rare.

In the wall of some specimens there are small holes - apertures. Usually they are healed. The flattened specimens of *W. similis* from claystones with pyrite have thick wall of the type A composed of medium and large siliceous crystals and grains, but more common are individuals having thin wall of the type B. The convex specimens have walls type F, composed of finer material. The most flattened specimens were probably attached to some sedimentary particles and skeletons of dead fauna (see Malec & Studencki, 1988; pl. 2: 3; pl. 3: 3).

The unilocular, convex specimens, less commonly multilocular, convex ones, are dominant element of assemblages from limestones (Pl. III: 6; Pl. IV: 3, 5, 6). They posses one (Pl. I: 6) or a few (Pl. IV: 5) small apertures situated in the convex part of test. The basal wall is commonly flat and much thinner than the wall of the convex part. It may also be uneven, wavy, concave or convex, being the cast of elements to which it was attached. These elements were probably fragments of charophyte tissue because gyrogonites and vegetative parts of these algae occur together with the foraminifera (see Malec, 1984a). The meandering sinusoidally charophyte tissues were the cause of deformation even of the upper part of some tests (Pl. IV: 6). Out of the numerous specimens of *W. similis* from the limestone complex none have been found bearing prints of benthic fauna skeletons on the basal wall.

ACKNOWLEDGEMENTS

I want to thank Professor Halina Żakowa from the State Geological Institute from Kielce for critically reading the manuscript, and Doc. dr hab. Janina Szczachura for useful comments on the manuscript, and especially on its palaeontological section. I am also grateful for useful comments to Professor Elżbieta Turnau, and Dr. Ewa Olempska. Thanks are extended to Alicja Skrzypczyk for making the SEM micrographs, and Małgorzata Skuza for printing them.

REFERENCES

Adamczak, F., 1968. *Palaeocopa* and *Platycopa* (Ostracoda) from Middle Devonian rocks in the Holy Cross Mountains, Poland. *Stockholm Contr. Geol.*, 17: 1 – 109.

Adamczak, F., 1976. Middle Devonian Podocopida (Ostracoda) from Poland; their morphology, systematics and occurence. *Senck. leth.*, 57(4/6): 265 – 465.

Beckmann, H., 1952. Foraminiferen aus dem Unterdevon des Rheinland. *Neues Jb. Geol. Paläont. Mh.*, 8: 364 – 370.

Browne, R. G. & Schott, V. J., 1963. Arenaceous Foraminifera from the Osgood Formation at Osgood, Indiana. *Bull. Amer. Paleont.*, 46 (209): 191 – 242.

Conkin, J. E. & Conkin, B. M., 1970. Middle Devonian arenaceous Foraminifera of central Ohio. Part 1 - Revision of the genus *Webbinelloidea* Stewart & Lampe, 1947. *Micropaleontology*, 16 (1): 1 – 14.

Conkin, J. E. & Conkin, B. M., 1977. Paleozoic smaller foraminifera of the North American Atlantic borderlands. In: Swain, F.M. (ed.) *Stratigraphic micropaleontology of Atlantic basin and borderlands*. Elsevier, Amsterdam, pp. 49 – 59.

Conkin, J. E. & Conkin, B. M., 1979. Illustrated key to genera of Paleozoic smaller Foraminifera of the United States. *Univ. of Louisville Stud. in Paleont. and Stratigr.*, 11: 1 – 21.

Conkin, J. E. & Conkin, B. M., 1981. Early Mississippian (Kinderhookian) limestone of Missouri and Illinois. *Univ. of Louisville Stud. in Paleont. and Stratigr.*, 15: 1 – 39.

Conkin, J. E., Conkin, B. M. & McDonald, D., 1963. Mississippian smaller foraminifera from the southern peninsula of Michigan. *Micropaleontology*, 9 (2): 215 – 227.

Czarnocki, J., 1951. Iron ore deposit in Dąbrowa near Kielce in connection with problem of Devonian ores in Góry Świętokrzyskie Mts.(In Polish, English summary). *Prace Państw. Inst. Geol.*, 7: 95 – 114.

Dunn, P. H., 1942. Silurian foraminifera of the Mississippi Basin. *J. Paleont.*, 16 (3): 317 – 342.

Duszyńska, S., 1956. Foraminiferes from the Middle Devonian of the Holy Cross Mountains. *Acta Palaeont. Polon.*, 1 (1): 23 – 34.

Duszyńska, S., 1959. Devonian foraminiferes from Wydryszów (Holy Cross Mountains). *Acta Palaeont. Polon.*, 4 (1): 71 – 90.

Ebner, F., 1973. Foraminiferen aus dem Paläozoikum der Karnischen Alpen. *Mitt. Abt. Geol. Paläont. Bergb. Landesmus. Joanneum*, 34: 1 – 55.

Eisenack, A., 1954. Foraminiferen aus dem baltischen Silur. *Senck. leth.*, 35 (1/2): 51 – 72.

Gürich, G., 1896. Das Palaeozoicum im Polonischen Mittelgebirge. Verh Russ. - *Kaiserl. Miner. Ges.*, 32: 1 – 539.

Jurkiewicz, H. & Żakowa, H., 1983. Arenaceous foraminifers from the Famennian and Carboniferous deposits of Jabłonna, Góry Świętokrzyskie Mts, Poland (In Polish, English summary). *Biul. Inst. Geol.*, 345: 155 – 175.

Loeblich, A. R. & Tappan, H., 1964. Sarcodina, chiefly "thecamebians" and Foraminiferida. In: R. C. Moore (ed.), *Treatise on Invertebrate Paleontology, part C. Protista* 2; 900. *Geological Society of America and Kansas University Press, Lawrence.*

Mabillard, J. E. & Aldridge, R. J., 1982. Arenaceous foraminifera from the Llandovery/Wenlock boundary beds of the Wenlock edge area, Shropsire. *J. Micropaleontology*, 11: 129 – 136.

Malec, J., 1979. Ostracods and foraminifera of Middle Devonian from borehole Porzecza 5A (In Polish). *Kwart. Geol.*, 23 (4): 939 – 940.

Malec, J., 1982. Foraminifera and algae (Charophyta) from lower Eifelian of borehole Porzecze 5 A (In Polish). *Kwart. Geol.*, 26 (3/4): 722 – 723.

Malec, J., 1984a. Preliminary data on lower Eifelian (Middle Devonian) foraminifera from western part of the Góry Świętokrzyskie Mts, (In Polish, English summary). *Kwart. Geol.*, 28 (1): 79 – 92.

Malec, J., 1984b. *Webbinelloidea similis* Stewart & Lampe (Foraminiferida) from Eifelian of Łagów syncline (In Polish, English summary). *Kwart.Geol.*, 28 (3/4): 555 – 568.

Malec, J., 1986. Conodonts and ostracods from Grzegorzowice Formation of Bodzentyn syncline in Góry Świętokrzyskie Mts, (In Polish). *Kwart. Geol.*, 30 (1): 143 – 144.

Malec, J., 1989. Lower Eifelian ostracods from the West Świętokrzyskie Mountains (Poland). *Acta Palaeont. Polon.*, 34 (3): 233 – 270.

Malec, J., 1991. Remarks on startigraphy of Lower-Middle Devonian boundary beds of western part of Góry Świętokrzyskie Mts, (In Polish). *Kwart. Geol.*, 35 (4): 525 – 526.

Malec, J. & Studencki, M., 1988. Lower Eifelian at Szydłówek in Kielce (In Polish, English summary). *Biul. Inst. Geol.*, 358: 73 – 92.

McClellan, W. A., 1966. Arenaceous foraminifera from the Waldren shale (Niagaran) of southeast Indiana. *Bull. Amer. Paleont.*, 50 (230): 245 – 518.

McClellan, W. A., 1973. Siluro-Devonian microfaunal biostratigraphy in Nevada. *Bull. Amer. Paleont.*, 62 (274) 231 – 375.

Moreman, W. L., 1930. Arenaceous foraminifera from Ordovician and Silurian limestones of Oklahoma. *J. Paleont.*, 4 (1): 42 – 59.

Mound, M. C., 1968. Arenaceous Foraminiferida and zonation of the Silurian rocks of Northern Indiana. *Bull. Indiana Geol. Surv.*, 38: 1 – 126.

Neumann, M., Pożaryska, K. & Vachard, D., 1975. Remarques sur les microfacies du Devonien de Lublin (Pologne). *Rev. Micropal.*, 18 (1): 38 – 52.

Olempska, E., 1983. The uppermost Devonian foraminiferes of the Świętokrzyskie (Holy Cross) Mts., Poland. *Acta Palaeont. Polon.*, 28 (3 – 4): 393 – 416.

Olkowicz-Paprocka, J. & Ozonkowa, H., 1970. Lithologic development of Devonian Formation in the Eastern part of the Świętokrzyskie Mountains (In Polish). *Kwart. Geol.*, 14 (4): 664 – 677.

Ozonkowa, H., 1961. On presence of foraminifera in Devonian limestones of eastern part of Góry Świętokrzyskie Mts (In Polish). *Biul. Geol. Wydz. Geol. Univ. Warsz.*, 1 (2): 140 – 147

Ozonkowa, H., 1978. Characteristic of Upper Devonian calcareous foraminifera from selected areas of Poland (In Polish, English summary). *III Naukowa Konferencja Paleontologów poświęcona badaniom regionu górnośląskiego oraz karbonu GZW i LZW w ostatnim trzydziestoleciu*. Sosnowiec, 12-14 września 1978., 38 – 40.

Pajchlowa, M., 1957. The Devonian in the Grzegorzowice - Skały Section (In Polish, English summary). *Biul. Inst. Geol.*, 122: 145 – 254.

Pojarkow, B. W., 1979. Development and distribution of Devonian foraminifera. *AN USSR, Nauka*, Moskwa. 1 – 172 p.

Sarnecka, E., 1979. In: Wyjaśnienie perspektyw rudonośności osadów dewonu, permu i triasu w północno-zachodniej części Gór Świętokrzyskich. Dokumentacja wynikowa wiercenia Porzecze IG-5A. *Archiwum Państw. Inst. Geol.*

Sparling, D. R., 1983. Conodont biostratigraphy and biofacies of Lower Middle Devonian limestones, north-central Ohio. *J. Paleont.*, 57 (4): 825 – 864.

Studencka, J., 1983. *Chimaerothyris dombrowiensis* (Gürich) from lower Eifelian of Góry Świętokrzyskie Mts (In Polish, English summary). *Kwart. Geol.*, 27 (3): 471 – 490.

Stewart, G. A. & Lampe, L., 1947. Foraminifera from the Middle Devonian Bone Beds of Ohio. *J. Paleont.*, 21 (6): 529 – 536.

Summerson, H., 1958. Arenaceous Foraminifera from the Middle Devonian limestone of Ohio. *J.*

Paleont., 32 (3): 544 – 558.
Tarnowska, M. & Malec, J., 1987. Deposits of Emsian-Eifelian boundary in borehole Dąbrowa D-5 near Kielce (In Polish). *Kwart. Geol.*, 31 (2/3): 510 – 511.
Żakowa, H., Nehring-Lefeld, M. & Malec, J., 1985. Devonian-Carboniferous Boundary in the borehole Kowala 1 (Southern Holy Cross Mts, Poland). Macro- and Microfauna. *Bull. Acad. Polon. Sci., Ser. Sci. de la Terre*, 33 (1-2): 87 – 95.
Żakowa, H., Radlicz, K. & Malec, J., 1986. Basement of the Permian in the vicinities of Szydłowiec (In Polish, English summary). *Kwart. Geol.*, 30 (1): 23 – 48.

Streszczenie

OTWORNICE Z POGRANICZA DEWONU DOLNEGO I ŚRODKOWEGO ZACHODNIEJ CZĘŚCI GÓR ŚWIĘTOKRZYSKICH

Jan Malec

Z utworów pogranicza dewonu dolnego i środkowego zachodniej części Gór Świętokrzyskich, nawierconych w otworze Dąbrowa D-5 (Fig. 1), opracowano zespół otwornic zlepieńcowatych. Osady występujące w profilu Dąbrowy pomiędzy piaskowcami i dolomitami (Fig. 2) (ciemne iłowce z pirytem, iłowce z syderytem i wapienie) – określane były przez Czarnockiego (1951) jako warstwy dąbrowskie, zaś występujący w ich stropie kompleks wapieni z bogatą fauną - to poziom dąbrowski według Güricha (1896). Otwornice występują w górnej części serii piaskowcowo-mułowcowej, w iłowcach z pirytem (nieliczne w iłowcach z syderytem), w wapieniach i dolomitach. Najliczniejszy i najbardziej zróżnicowany taksonomicznie zespół otwornic występuje w iłowcach z pirytem. Zmiany frekwencji gatunków w profilu tych iłowców przedstawiono na Fig. 3. W dewonie Dąbrowy wyróżniono 6 rodzajów otwornic: *Amphitremoida*, *Hyperammina*, *Lagenammina*, *Saccammina*, *Tolypammina* i *Webbinelloidea*, a w profilu pionowym – pięć charakterystycznych zespołów otwornicowych (zespoły a-e). Opisano 9 gatunków otwornic, w tym 5 nowych: *Amphitremoida pajchlowae* sp. n., *A. kielcensis* sp. n., *Lagenammina silnica* sp. n., *Saccammina scutella* sp. n. i *S. guerchi* sp. n. Opisane gatunki zilustrowano na Planszach II-IV.

Otwornice z Dąbrowy porównano z analogicznymi zespołami otwornicowymi występującymi w udokumentowanych stratygraficznie profilach dewonu Gór Świętokrzyskich oraz z podobnym zespołem otwornicowym występującym w dewonie środkowym USA. Wiek skał zawierających badane otwornice określono na górny ems i dolny eifel.

Omówiono i zilustrowano (Plansza I) zróżnicowanie w budowie ścianki 4 rodzajów opracowywanych otwornic.

EXPLANATION OF PLATES

Plate I

Details of foraminiferal wall (x 1200) of specimens from Dąbrowa D-5

1 — *Lagenammina silnica* sp. nov., wall type A, depth 90.8-91.2 m, PIG-OS FI/35.
2 — *Saccammina guerichi* sp. nov., wall type B, depth 82.3-82.8 m, PIG-OS FI/37.
3 — *Amphitremoida pajchlowae* sp. nov., wall type C, depth 90.0-90.4 m, PIG-OS FI/10.
4 — *Lagenammina silnica* sp. nov., wall type D, depth 89.6-90.0 m, PIG-OS FI/32.
5 — *Saccammina scutella* sp. nov., wall type E, depth 90.8-91.2 m, PIG-OS FI/55.
6 — *Webbinelloidea similis* Stewart & Lampe, wall type F, aperture in central part of photo, limestone complex, PIG-OS FI/78.

Plate II

Foraminifera from Dąbrowa D-5; all photographs x 120, except when indicated otherwise

1-3 — *Lagenammina silnica* sp. nov.; 1 - holotype, depth 90.0-90.4 m., PIG-OS FI/34; 2 - depth 90.0-90.4, PIG-OS FI/27; 3 - depth 90.0-90.4 m, PIG-OS FI/18.
4, 5, 8, 9 — *Saccammina scutella* sp. nov.; 4 - holotype, depth 90.8-91.2 m, PIG-OS FI/55; 5 - depth 88.9-89.3 m, PIG-OS FI/67, x 70; 8 - depth 90.0-90.4, PIG-OS FI/60; 9 - depth 90.0-90.4, PIG-OS FI/81.
6, 10 — *Webbinelloidea similis* Stewart & Lampe; 6 - depth 93.0-93.5 m, PIG-OS FI/82, x 60; 10 - depth 90.8-91.2 m, PIG-OS FI/81, x 60.
7 — *Saccammina guerichi* sp. nov., holotype, depth 90.0-90.4, PIG-OS FI/43.

Plate III

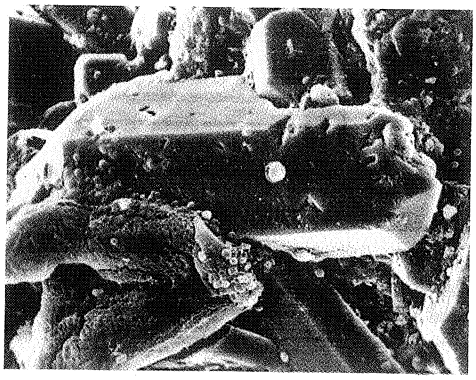
Foraminifera from Dąbrowa D-5; all photographs x 120, except when indicated otherwise

1 — *Hyperammina* sp. B; depth 86.8-87.4 m, PIG-OS FI/9, x 60.
2 — *Hyperammina* sp. A; depth 86.8-87.4 m, PIG-OS FI/5, x 60.
3, 4 — *Hyperammina* cuviniana Duszyńska; 3 - depth 89.6-90.0 m, PIG-OS FI/2, x 70; 4 - depth 89.6-90.0 m, PIG-OS FI/1, x 70.
5, 8 — *Lagenammina silnica* sp. nov.; 5 - depth 90.0-90.4 m, PIG-OS FI/30; 8 - depth 89.6-90.0 m, PIG-OSFI/31
6, 9 — *Webbinelloidea similis* Stewart & Lampe; 6 limestone complex,- PIG-OS FI/79, x 70; 9 - depth 93.0-93.5 m, PIG-OS FI/89, x 60
7 — *Saccammina scutella* sp. nov.; depth 90.8-91.2 m, PIG-OS FI/63.
10 — *Amphitremoida pajchlowae* sp. nov.; holotype, depth 90.0 - 90.4 m, PIG-OS FI/10.
11 — *Amphitremoida kielcensis* sp. nov.; holotype, depth 90.0-90.4 m, PIG-OS FI/15.

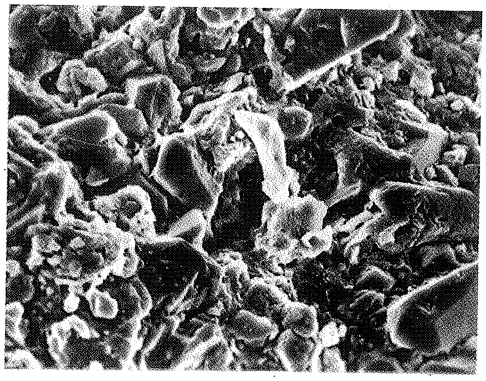
Plate IV

Foraminifera from Dąbrowa D-5; all photographs x 60, except when indicated otherwise

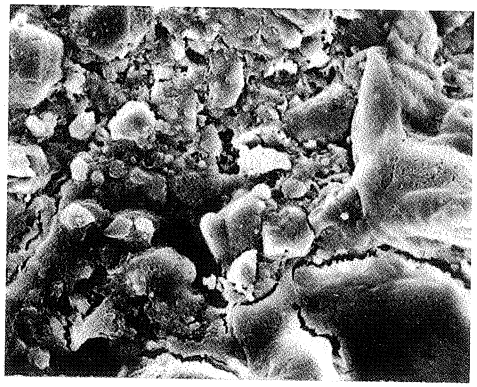
1-9 — *Webbinelloidea similis* stewart & Lampe. 1 - depth 95.9-96.3 m, PIG-OS FI/76; 2 - depth 91.2 m, PIG-OS FI/85, x 75; 3 - limestone complex, PIG-OS FI/78; 4 - depth 94.4-94.9 m, PIG-OS FI/80; 5 - limestone complex, PIG-OS FI/75; 6 - limestone complex, PIG-OS FI/77, x 70;7 - depth 93.0-93.5 m, PIG-OS FI/89; 8 - depth 95.8-96.3, PIG-OS FI/86; 9 - depth 90.8-91.2 m, PIG-OS FI/84.



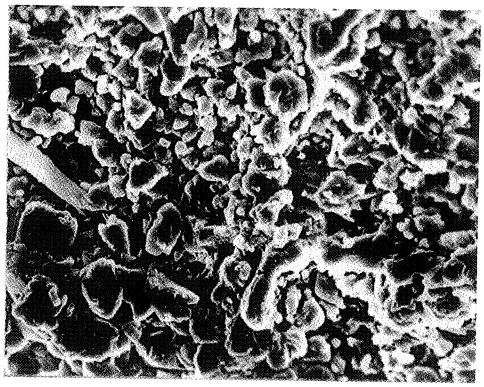
1



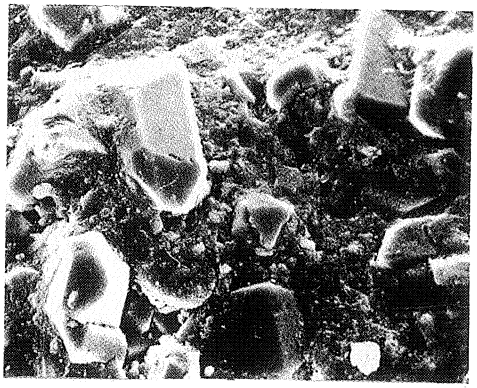
2



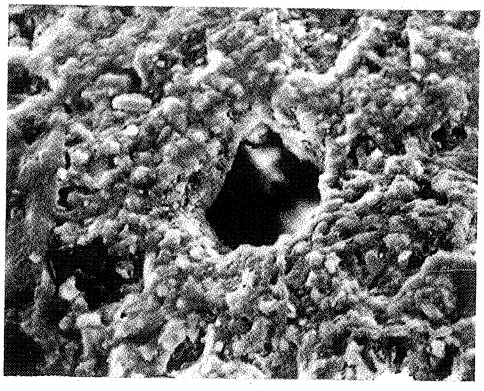
3



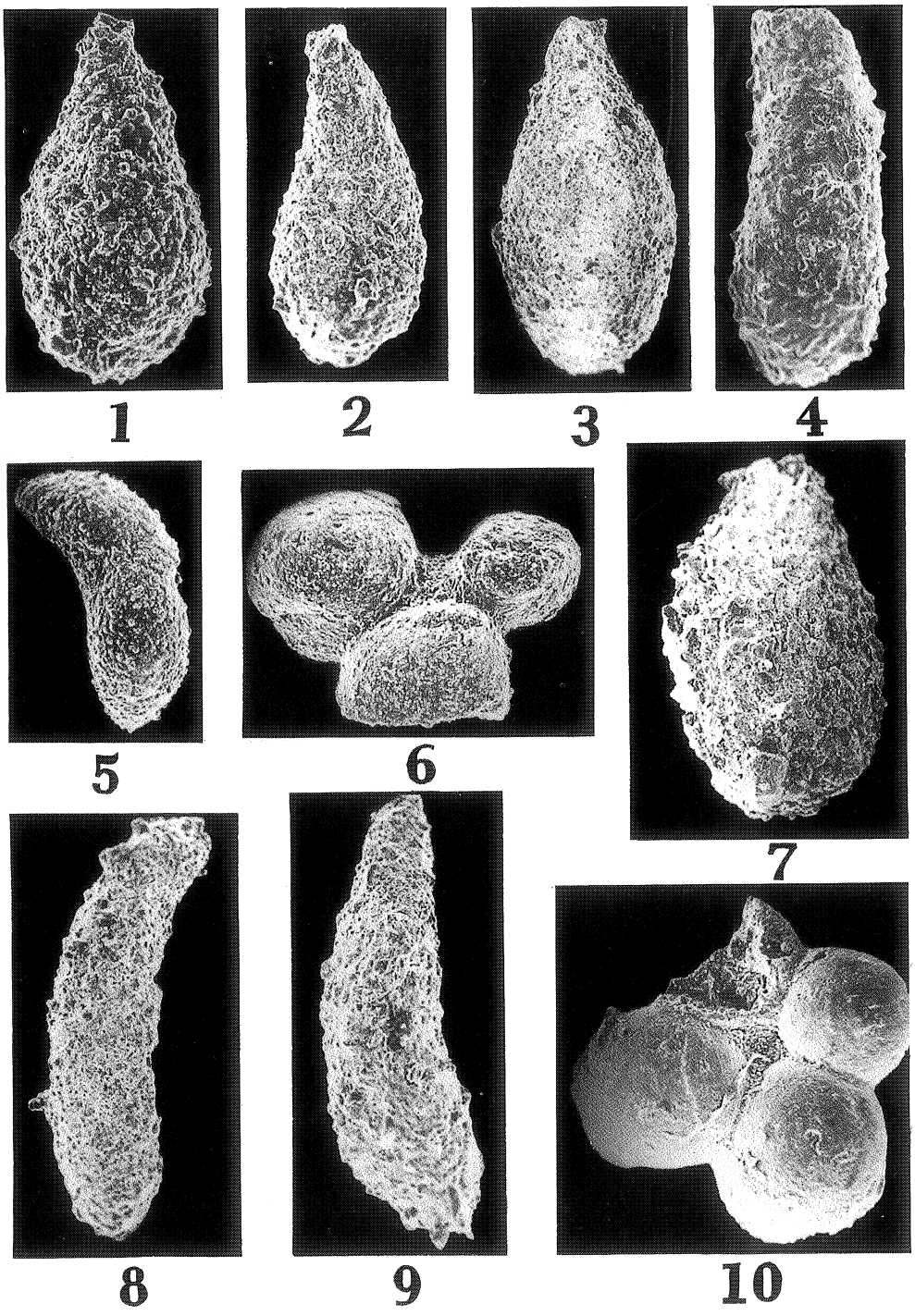
4

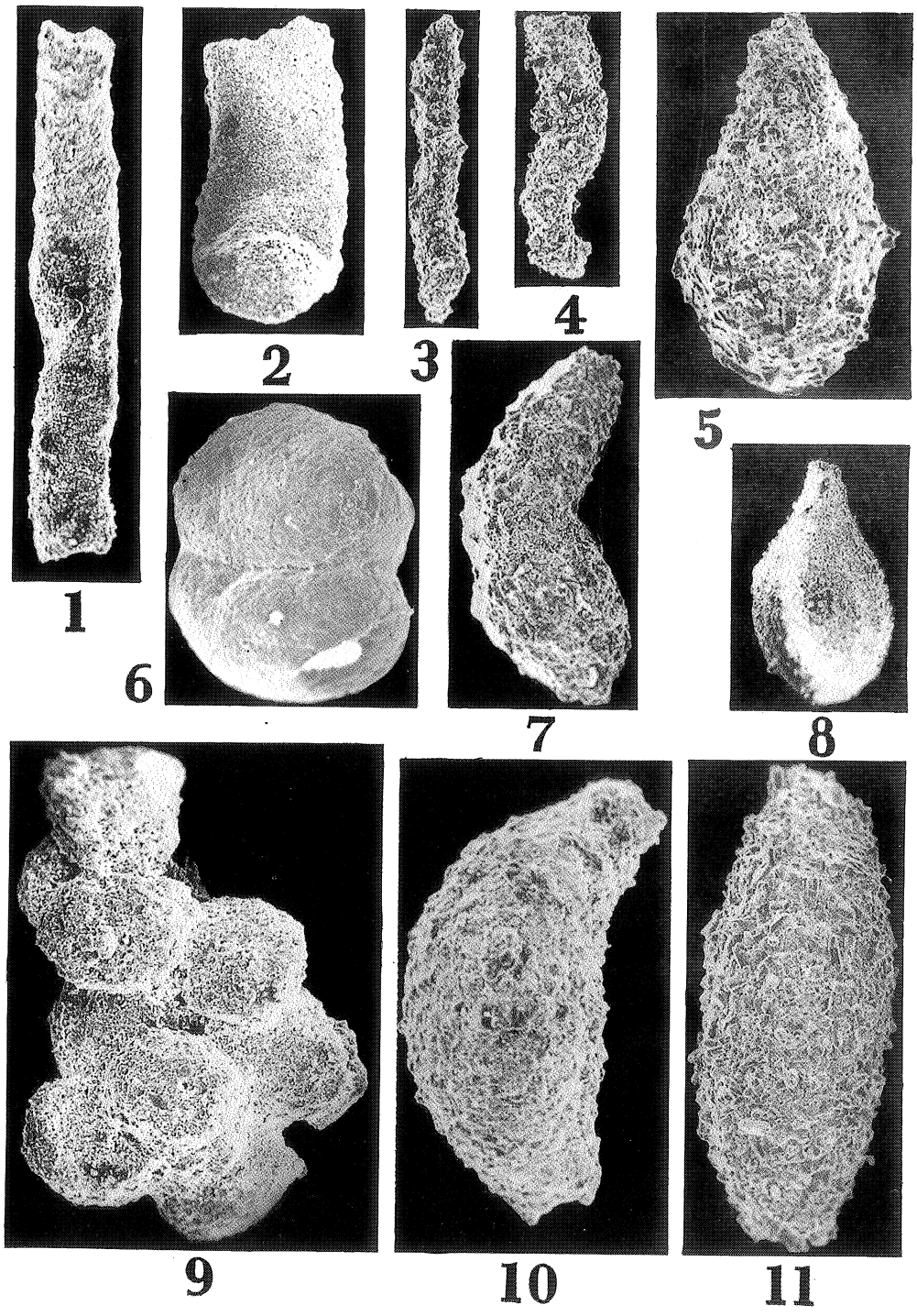


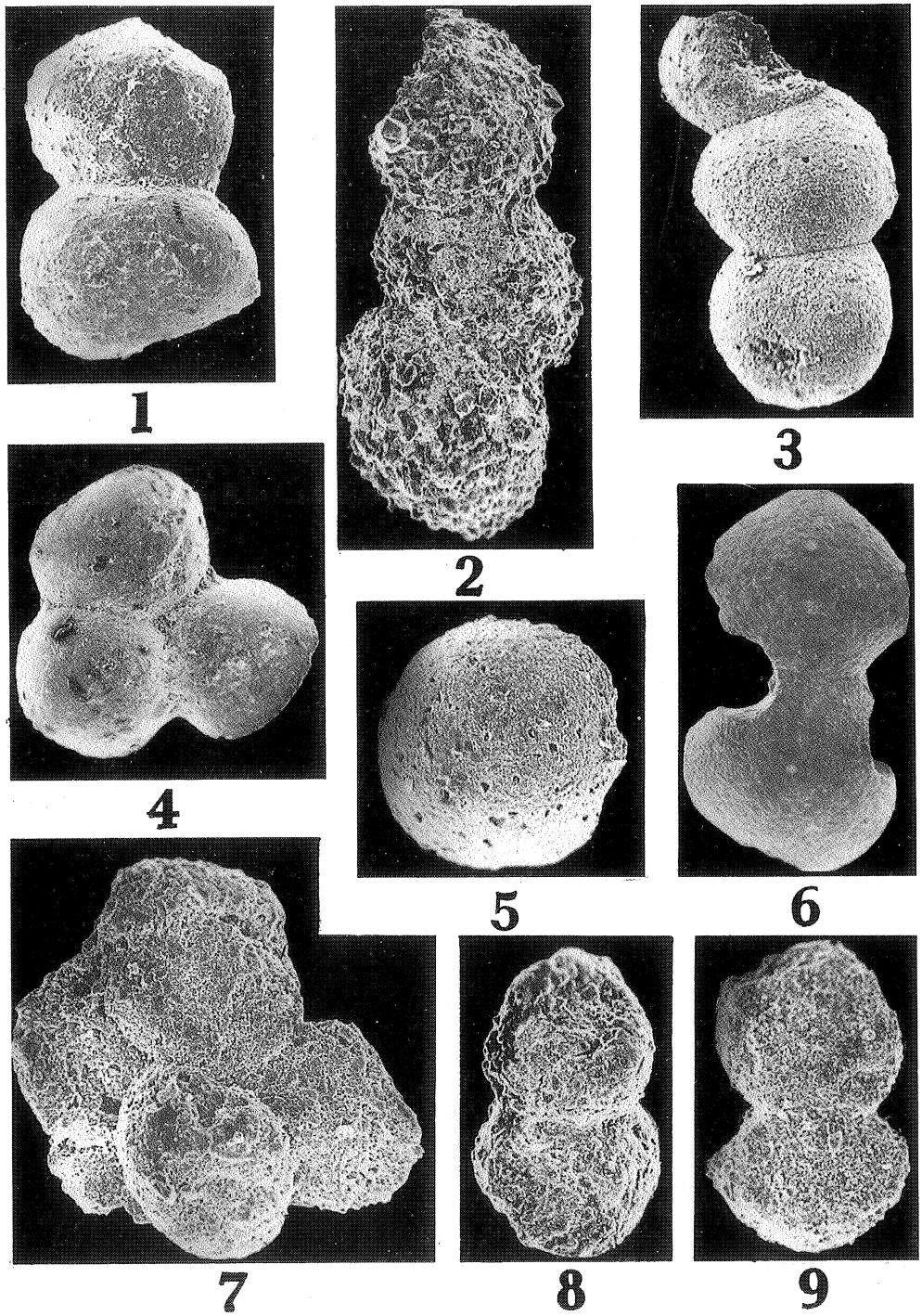
5



6


1
2
3
4
5
6
7
8
9
10


1
2
3
4
5
6
7
8
9
10
11


1
2
3
4
5
6
7
8
9