

## *Trochammina quadriloba* (Grzybowski) sensu Geroch, 1960 in the Polish Outer Carpathians

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### Abstract

An agglutinated foraminifera corresponding to *Trochammina quadriloba* (Grzybowski) sensu Geroch (1960) has been found in the foraminiferal assemblages of the Middle Eocene variegated marls and shales of the Fore-Magura Thrust Sheet. The characteristic features of this species is a very rough surface of the test and low, trochospiral coiling with three chambers visible on the umbilical side. Examination of numerous specimens of this taxon and comparison with some specimens from original collections confirm the opinion that Geroch's taxon differs from Grzybowski's type species of *Haplophragmium* (*Reussina*) *quadrilobum*.

### INTRODUCTION

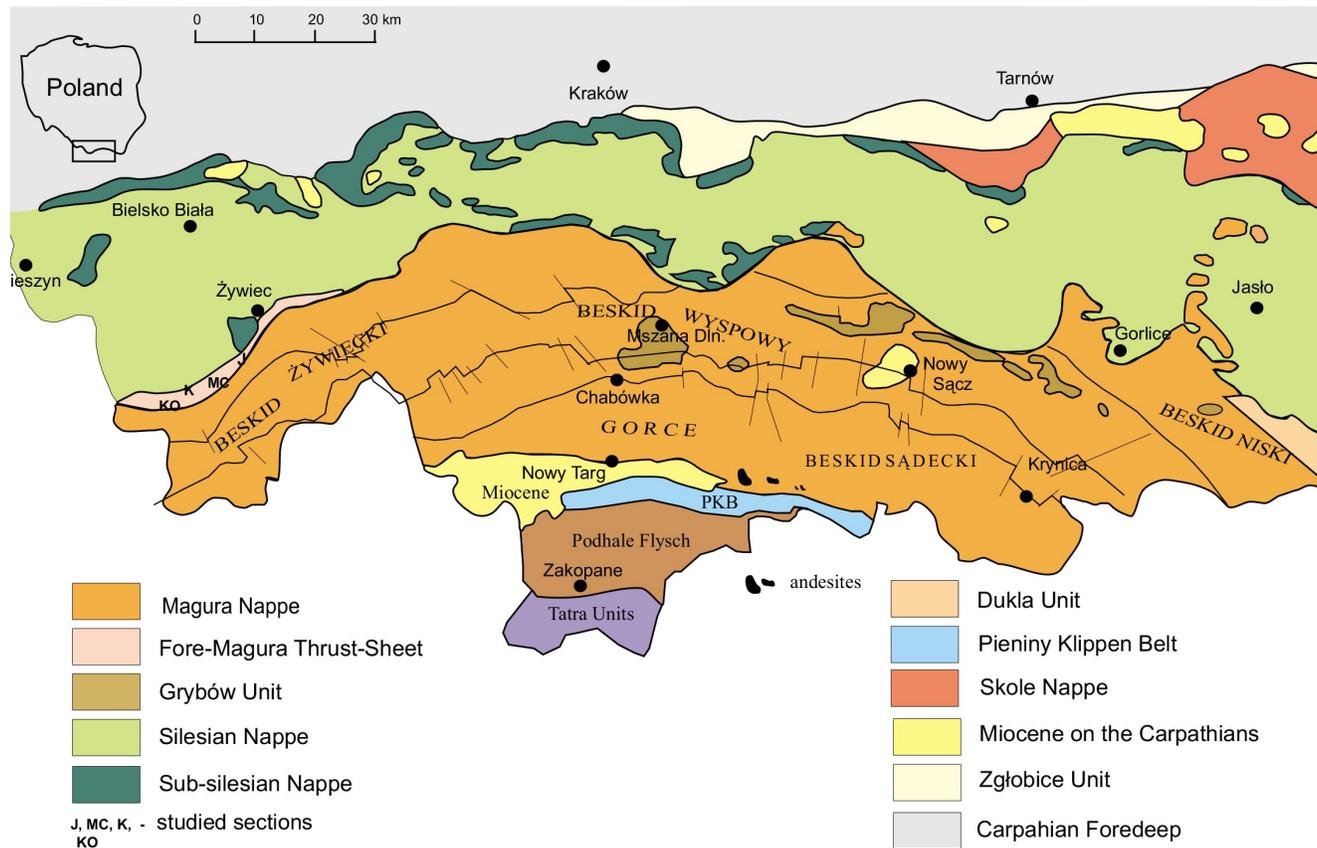
Józef Grzybowski and his successors described more than hundred species of agglutinated deep-water foraminifera from the Polish part of the Outer Carpathians. Most of these taxa are cosmopolitan and have been recognized in various settings around the world (see Slaczka & Kaminski, 1998; Kaminski & Gradstein, 2005).

In 1896, Grzybowski described several species of agglutinated foraminifera along with calcareous taxa from the red and green shales and marls from the area of Wadowice, one of the new agglutinated species described in this paper was *Haplophragmium* (*Reussina*) *quadrilobum* (see Grzybowski, 1986; p. 278, Pl. VIII, fig. 31). The original description states: "Test with a rough surface, comprised of four spherical chambers arranged in a pyramid. Three chambers lie in one plane, the fourth lies more or less symmetrically upon them. The aperture is a simple opening at the lower edge of the final chamber. Size 1.0 mm. Very rare in red clays" (after Kaminski *et al.*, 1993). Another new species of agglutinated foraminifera, introduced in the same paper, was *Haplophragmium* (*Reussina*) *bulloidiforme* n.sp. var. . (see Grzybowski, 1986; p. 278; Pl. VIII, fig. 32) with the following specification: "Chambers with a rough surface, arranged as in *Globigerina bulloides* d'Orbigny. From one side, four chambers are visible, lying more or less in a single plane, with a depression in the centre.

From the other side a fifth chamber is visible in the centre resting upon the other chambers. It is slightly smaller than the others. Aperture as is in the preceding species [*Haplophragmium* (*Reussina*) *quadrilobum*]. Size 1.0 mm. Common in red clays" (after Kaminski *et al.*, 1993). The

quoted descriptions and Grzybowski's drawings show similarities of these two new species. Geroch (1960) included Grzybowski's *Haplophragmium* (*Reussina*) *quadrilobum* in the synonymes of *Trochammina quadriloba* (Grzybowski) from the Middle Eocene assemblages of the Silesian Unit giving the following description: "Test with rough surface seemingly four-chambered. When illuminated in immersion fluid more chambers are discernible but probably their number is not more than ten. Test low, trochoid; chambers successively and rapidly increasing in size. Last coil consisting of 3 chambers embraces about  $\frac{3}{4}$  of the test. Specimens are 0.5 to 0.6 mm in size". Geroch (1960) based his description on nine specimens. Geroch's description and drawings of *T. quadriloba* differ from those of both new species of Grzybowski's genera *Haplophragmium*. Huss (1966), presenting the agglutinated foraminifera from the Upper Cretaceous deposits of the Subsilesian Unit, included all above mentioned taxa in the synonyms of *Trochammina bulloidiformis* (Grzybowski). *Trochammina quadriloba* (Grzybowski) was also described by Jurkiewicz (1967) from the middle part of the Polish Flysch Carpathians as well as by Samuel (1977) from the Slovakian West Carpathians. Both authors listed *H. quadrilobum* Grzybowski and *T. quadriloba* (Grzybowski) of Geroch (1960 in the synonyms of this taxon but mentioned that their specimens corresponded well with the forms described by Geroch (1960).

Liszka & Liszkowa (1981) revised Grzybowski's (1896) collection from Wadowice area which appeared to be incomplete, with poorly preserved foraminifera and in many cases represented by single specimens. They did not find a



**Figure 1.** Tectonic map of the western part of the Polish Outer Carpathians (Malata, 2001; unpublished material).

specimen matching the holotype of *Haplophragmium (Resussina) quadrilobum*. After examination of only one specimen from the Grzybowski's original collection, and basing on their own observations from the Cretaceous red shales of the Subsilesian Unit, they corrected Grzybowski's determination and ascribed this taxon to *Trochammina bulloidiformis* (Grzybowski).

During my studies on the biostratigraphy of the Fore-Magura Thrust Sheet deposits, southwest of the Żywiec area, I have noticed in several samples the taxon identical to *Trochammina quadriloba* (Grzybowski) presented by Geroch (1960). Considerable number of specimens allowed to observe the taxon morphology and its variety. Some specimens from Geroch's material and the form revised by Liszka & Liszkowa (1981) from Grzybowski's collection have been examined for comparison. This paper is an attempt to clarify taxonomic position and biostratigraphy of the species *Trochammina quadriloba sensu* Geroch, 1960 with respect to previous studies.

### Geological Settings

The outer Carpathian sedimentary domain, consisted of several longitudinal troughs and ridges. The following sedi-

mentary basins existed: the Magura, Fore-Magura set of sub-basins, Silesian, Subsilesian, and the Skole basin. In the present-day configuration they represent individual structural units distinguished in the Polish sector of the Outer Carpathians (Fig. 1). In the troughs mainly flysch-type sediments were deposited while on the slopes and submarine rises hemipelagic and pelagic sediments developed. The entire sedimentation spanned the time between the Late Jurassic and the Late Miocene (see Slaczka & Kaminski, 1998; Oszczytko, 2004). The sedimentary area of the Fore-Magura Thrust Sheet (FMTS) was situated between the Magura and Silesian basins and the majority of its deposits are represented by hemipelagic and pelagic marls and shales deposited above local CCD. They are strongly compressed, imbricated, tectonically deformed and reduced.

### MATERIALS

An agglutinated taxon corresponding to *Trochammina quadriloba* (Grzybowski) *sensu* Geroch (1960) has been noticed in 24 foraminiferal assemblages of the Middle Eocene variegated marls and shales sampled in a few sections of the Fore-Magura Thrust Sheet outcropping SW of Żywiec (Fig. 1).

The foraminiferal assemblages from the variegated marls are generally very rich and taxonomically diverse. They are dominated by planktonic foraminifera (about 80%), agglutinated taxa account for 11-16%, and calcareous benthic 9-4%. The exclusively agglutinated assemblage has been recovered from the variegated shales. *Reticulophragmium amplexens* (Grzybowski) is the most characteristic agglutinated species along with *Spiroplectammina spectabilis* (Grzybowski), *Reophax pilulifer* Brady and *Haplophragmoides walteri* (Grzybowski).

The amount of *Trochammina quadriloba* in the studied assemblages varies from single to about 40 specimens per sample. Altogether, more than 300 specimens could have been examined, displaying various state of preservation. The best preserved specimens have been selected and photographed using Sony (A330) digital camera mounted on a Nikon SMZ1500 stereomicroscope. SEM images of some specimens were made using the Hitachi S-4700 Scanning Microscope at the Institute of Geological Sciences of the Jagiellonian University.

## SYSTEMATICS

*Trochammina quadriloba* Geroch, 1960 [non Grzybowski, 1896]

Plate 1, figs. 6-19; Plate 2, figs. 1-10

*Trochammina quadriloba* (Grzybowski, 1896) – Geroch, 1960, p. 64, pl. 8, fig. 31. – Jurkiewicz, 1967, p. 92, pl. 6, fig. 14. – Salaj, 1977, p. 51, pl. 27, fig. 1. – Waskowska-Oliwa, 2008, p. 252.

*Rhumblerella quadriloba* (Grzybowski, 1896) - Neagu *et al.*, 2011, p. 153, pl. 13, fig. 9; pl. 15, figs. 13-16.

*Pseudotrochammina* sp. – Poag, 2012, p. 87, pl. 2, figs. 11, 12.

**Material.** About 350 specimens in 24 samples.

**Description.** Compact test with a very rough surface, more or less spherical, displaying low, trochospiral coiling with three chambers visible on the umbilical side. Spiral side seems to consist of four chambers however, in some specimens, particularly with higher coiling, more chambers can be observed particularly when observed in immersion fluid (see Plate 2, figs. 10, 16, 17). Aperture slightly arched opening at the base of last chamber; in some juvenile specimens apertural lip is preserved (see Plate 2, figs. 6, 18).

**Remarks.** Despite of the robust test and coarse-grained wall the majority of specimens are deformed. Well defined aperture is also rarely preserved. The most common forms display dimensions of 0.6 x 0.5 mm, the smallest, juvenile forms are 0.4 x 0.3.5 mm in size, and the biggest about 1.15 x 0.9 mm. The sideview parameters depend on the height of the spire and usually are only slightly smaller than the

smaller diameter of a particular specimen.

**Occurrence.** Middle Eocene variegated marls and shales of the Fore-Magura Thrust Sheet.

## DISCUSSION

*Trochammina quadriloba* from the Fore-Magura Thrust Sheet deposits, discussed in this paper, corresponds well with Geroch's (1960) description and illustrations. The specimens studied show also the same features as the original forms from Geroch's collection (see Plate 1, figs. 1-5). It considerably differs in the general outline of the test, size, shape and number of individual chambers and the stratigraphic distribution from Grzybowski's *H. quadrilobum* and from Huss (1966) description and drawings of *Trochammina bulloidiformis* (Grzybowski).

Liszka & Liszkowa (1981) in their revision mentioned Geroch's (1960) description of *T. quadriloba* as: "unconformable with the preserved specimens and Grzybowski's figure, as well as with specimens from Wozniki". Grzybowski (1896) suggested Oligocene age of the foraminiferal assemblages from the Wadowice area. Liszka & Liszkowa (1981) changed the age of Grzybowski's material. The red shales (marls) appeared to be Campanian and green shales and marls Paleocene. Grzybowski (1986) reported *H. quadrilobum* from the red clays, thus its age is Late Cretaceous. In the Atlas of index and characteristic fossils, Gawor-Biedowa *et al.*, (1984) considered synonymous both *H. quadrilobum* Grzybowski and *H. bulloidiforme* var. Grzybowski with *Trochammina bulloidiformis* (Grzybowski, 1986). My observations are in agreement with those two opinions.

## Stratigraphic Distribution

Geroch (1960) reported *Trochammina quadriloba* as a rare element in the Middle Eocene assemblages of the Reticulophragmium amplexens zone of the Silesian Unit/Nappe in the Beskid Slaski Range. Jurkiewicz (1967) found this taxon in the Paleocene deposits of the Magura, Silesian and Skole nappes in the middle part of the Polish Outer Carpathians. It has been found in the Paleocene deposits of the Subsilesian Unit occurring in a few tectonic windows in the western part of the Polish Outer Carpathians. In the Fore-Magura Thrust Sheet *Trochammina quadriloba* occurs in the Middle Eocene assemblages. In the Magura Nappe, I have found a few specimens of this taxon only in the Upper Eocene marly deposits of the Krynica Subunit in the area of Leluchów. According to Salaj (1977) it is very rare in the Middle Eocene of the Dukla and Magura units in the Slovakian Western Carpathians. Neagu *et al.*, 2011

described this species under different generic name from the Upper Eocene deposits of the Vacaroiia Formation of the Romanian Carpathians. Based on so far published data from the Outer Carpathians *Trochammina quadriloba* Geroch, 1960 seems to be Paleocene-Eocene taxon.

## CONCLUSIONS

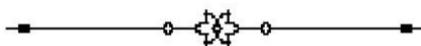
*Trochammina quadriloba* Geroch, 1960 is a distinct, though generally rare component of the flysch-type deep-water agglutinated assemblages. It seems to be more numerous in the slope-biofacies of the Outer Carpathians such as represented in the Fore-Magura Thrust and Subsilesian

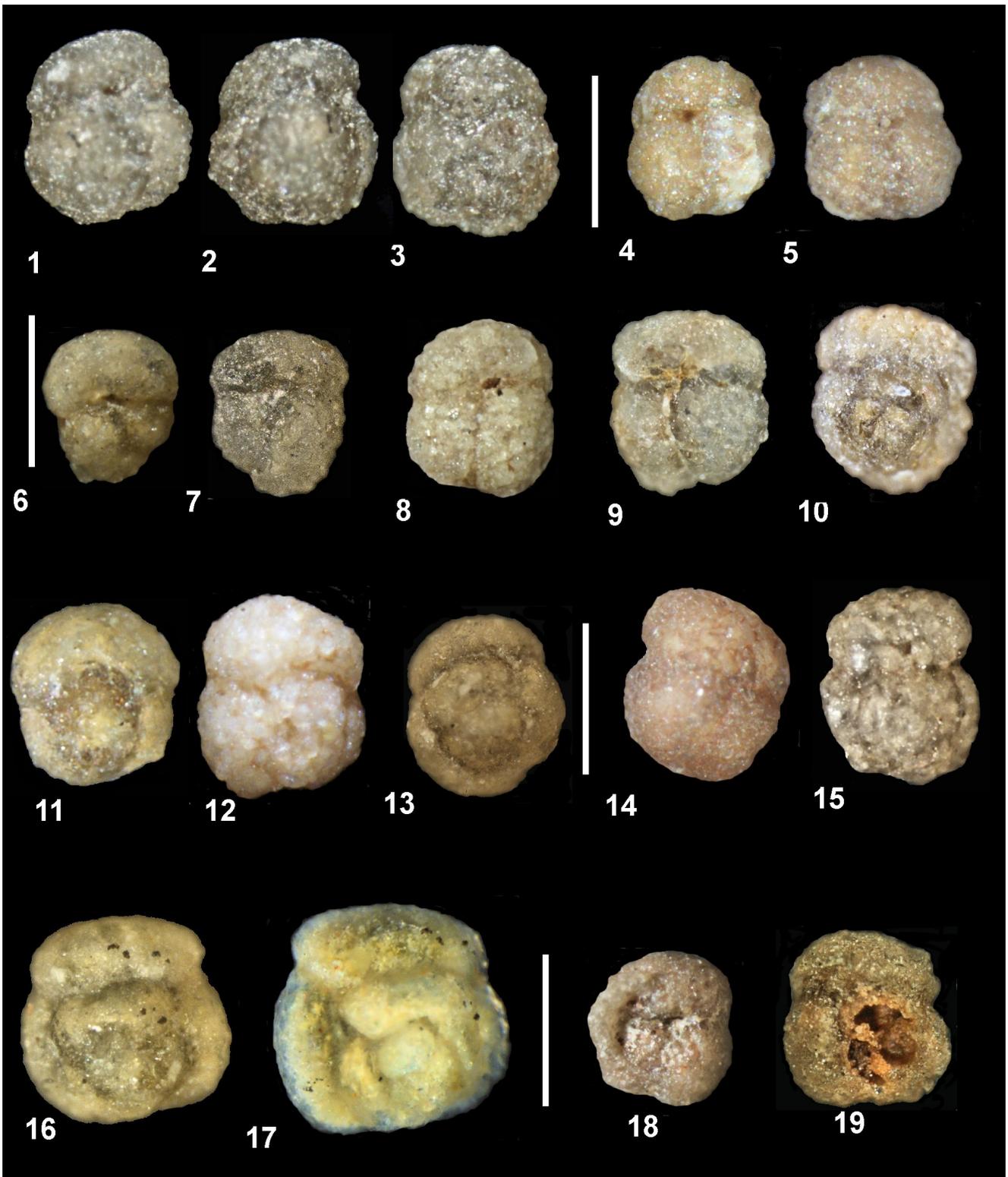
Unit. Its stratigraphic range, according to available data, is Paleocene-Eocene, preferably occurring in the Reticulophragmium ampletens zone.

An identical form has been described by Neagu *et al.*, 2011, under the generic name *Rhumlerella* and by Poag (2012) as *Pseudotrochammina* sp. Thus, its generic affiliation needs farther studies. *H. quadrilobum* Grzybowski and *H. bulloidiforme* var. Grzybowski are synonymous with *Trochammina bulloidiformis* (Grzybowski). This form displays different morphological features and represents another taxon of Late Cretaceous - ? Paleocene age.

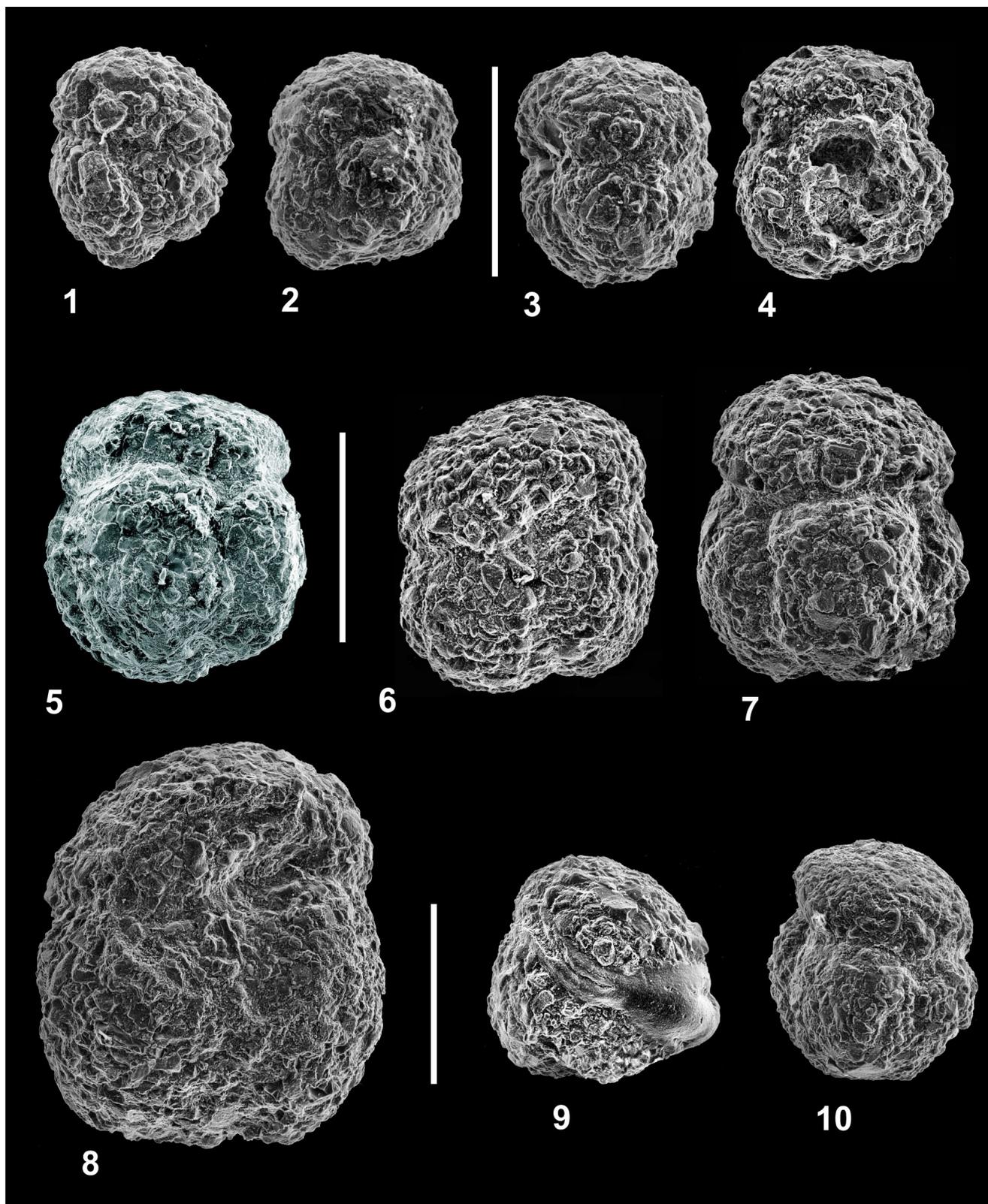
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**Plate 1.** Stereomicroscope photographs of *Trochammina quadriloba* sensu Geroch, 1960; 1-5: two specimens from Geroch's collection: Upper Hieroglyphic Beds, Silesian Unit; sample Istebna G256 (see Geroch, 1960, fig. 2., tab. 4); 1, 4 – apertural view; 3-5 – spiral view; 2 – sideview. 6-19: specimens from the Juraszki and Koniaków - Rupie ka sections of the Fore-Magura Thrust (SW of Żywiec); 6-9, 18 – apertural view; 10-13, 19 – spiral view; 14-15- sideview; 16-17 – spiral view in immersion; scale bars = 500µm.



**Plate 2.** SEM images of *Trochammina quadriloba* sensu Geroch, 1960; specimens from the Koniaków - Rupie ka sections of the Fore-Magura Thrust (SW of Żywiec). 1, 6, 8 – apertural view; 2, 4, 5, 7 – spiral view; (4 = 19 in Plate 1); 3, 10 – sideview; 9 – *Ammolagena clavata* attached to *T. quadriloba*.