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LATE OLIGOCENE FORAMINIFERA FROM THE KROSNO BEDS IN THE SAN VALLEY SECTION (BIESZCZADY MOUNTAINS); SILESIAN UNIT, POLISH OUTER CARPATHIANS

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Abstract: Foraminifera in the upper division of the Krosno Beds in the San river outcrops in the Bieszczady Mts. (Silesian Unit; Dźwiniacz Górny Syncline) indicate that deposits above the Zagórz Limestone chronohorizon represent a continuous section of early Egerian age. The succession of planktic foraminifers, dominated by small tenuitellids, shows that some species (*Tenuitella liverovskae, T. munda* and *Tenuitellinata angustiumbilicata*) have longer stratigraphic ranges in the studied deposits than accepted earlier for the Polish part of the Central Paratethys. The benthic foraminiferal assemblage consists mainly of cylindrical and conical forms of genera *Praeglobobulimina*, *Fursenkoina*, *Chilostomella*, *Allomorphina* and species *Bulimina elongata*, which are interpreted as an association adapted to oxygen-depleted waters. Some of the benthic forms are for the first time referred from the Oligocene of the Polish part of the Outer Carpathians. The paper contains description of most determined foraminifers.

Abstrakt: Otwornice z najmłodszej części górnego oddziału warstw krośnieńskich w profilu rzeki San w Bieszczadach (jednostka śląska, synklina Dźwiniacza Górnego) wskazują, że osady powyżej chronohoryzontu wapienia z Zagórza reprezentują dolny eger. Niektóre z otwornic planktonicznych w tym profilu, wśród których dominują tenuitelle o małych rozmiarach, są młodsze niż to dotychczas opisywano z polskiej części Centralnej Paratetydy (*Tenuitella liverovskae, T. munda, Tenuitellinata angustiumbilicata*). Zespół otwornic bentonicznych tworzą cylindryczne i stożkowe formy z rodzajów: *Praeglobobulimina*, *Fursenkoina*, *Chilostomella*, *Allomorphina* oraz gatunek *Bulimina elongata*. Taki skład zespołu może być interpretowany jako asocjacja ze strefy minimum tlenowego. Niektóre gatunki otwornic bentonicznych zostały po raz pierwszy opisane z osadów oligocenu polskiej części Karpat Zewnętrznych. W artykule zawarto opis większości oznaczonych otwornic.

Key words: Foraminifera, taxonomy, stratigraphy, Oligocene, Silesian Unit, Polish Outer Carpathians.

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INTRODUCTION

This paper presents the distribution of planktic and benthic foraminifers in a section comprising the uppermost part of the Krosno Beds (above the Zagórz Limestone chronohorizon) in the southeastern part of the Silesian Unit, outcropped in the Polish part of the Bieszczady Mts. area. The discussion on stratigraphy of these deposits is based on planktic foraminifers. Calcareous nannoplankton data, provided by M. Garecka, M.Sc. (Polish Geological Institute, Carpathian Branch, Cracow) are used for comparison.

Most data on biostratigraphy of the Krosno Beds in the eastern part of the Polish Outer Carpathians, come from the inner part of the Silesian Unit (from the area located to the west and north of the Bieszczady Mts.) and from the Skole Unit. They have been based on foraminifers, diatoms and calcareous nannoplankton (e.g., Olszewska, 1982a, b, 1984a, b, 1997, 1998; Olszewska *et al.*, 1996, Kotlarczyk & Kaczmarska, 1987; Koszarski *et al.*, 1995; Jugowiec, 1996; Garecka & Olszewska, 1998). The biostratigraphical data of the Oligocene from the southeastern part of the Silesian Unit are very scarce, comprising two short notes with the index of foraminifers. They present the results of deep drillings in the neighbouring area (Suche Rzeki and Polanki wells; Morgiel, 1972, 1973).

STUDY AREA

The southeastern part of the Silesian Unit within the Polish part of the Outer Carpathians in the Bieszczady Mountains is built from 3.5 km sequence of flysch, called Krosno Beds. The Krosno Beds are the youngest in the succession of Upper Jurassic through Miocene flysch deposits in the Polish Outer Carpathians. They are composed mainly of carbonate-rich polimictic sandstones and grey marl-

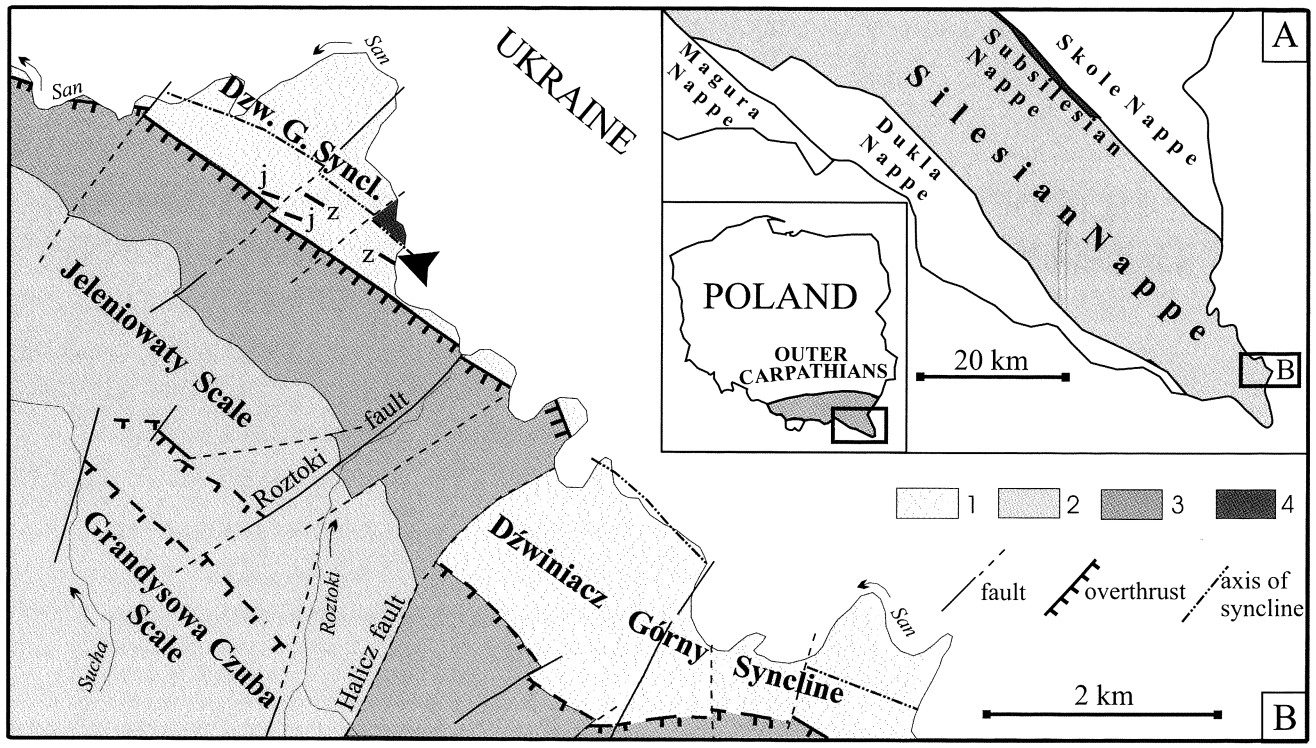

Fig. 1. Location of the study area. **A.** Position within the Polish part of the Outer Carpathians. **B.** Geological map (after Haczewski *et al.*, A, *submitted to print*) showing distribution of examined outcrop (black arrow); Krosno Beds: *1* – upper division; *2* – middle division; *3* – lower division; *4* – thick-bedded sandstones within upper division; j – Jasło Limestone; z – Zagórz Limestone; Dzw. G. Syncl. – Dźwiniacz Górny Syncline

stones.

The Krosno Beds have been subdivided on three informal lithostratigraphic units, named as the lower, middle and upper divisions in the Polish part of the Bieszczady Mts. area (Żytko, 1968). Their lithology and stratigraphy on that area have been studied during the detailed mapping (Dźwiniacz Górny sheet (1069) of Detailed Geological Map of Poland, scale 1:50,000) by G. Haczewski and K. Bąk (Haczewski *et al.*, A, *submitted to print*). The lower division of the Krosno Beds, of which up to 700 m are exposed in the cores of anticlines, consists of medium- and thin-bedded sandstones and marlstones. The characteristic feature of the middle division (up to 1,800 m thick) is a series of thick-bedded sandstones – the so-called Otryt Sandstones. The upper division (up to 1,200 m thick), examined during these studies, consists mostly of non-fissile marlstones with convolute- and cross-laminated, thin-bedded sandstones. Black, marly and non-calcareous shales with 2–3 cm thick concretions (whirl-balls) occur subordinate in series of 1–2 m thick. Rare are thick-bedded, medium-grained, structureless sandstones, locally with clasts of laminated mudstone and medium-bedded ferrous dolomites. Lenticular packages of thick-bedded, medium-grained, parallel-laminated sandstones (up to 30 m thick) occur in the highest preserved part of the upper division in Dźwiniacz Górny.

Two horizons with coccolith limestone bands – the Jasło and the Zagórz limestones – occur within the middle part of the upper division. The Jasło Limestone, situated 370 m above the lower boundary of the upper division, is present in the southwestern limb of the Dźwiniacz Górny Syncline (Fig. 1). The Zagórz Limestone, in the same area lies *ca.* 120 m above the Jasło Limestone. A characteristic 4 cm thick non-laminated limestone layer is present in the Zagórz Limestone horizon.

The Jasło and Zagórz limestones are isochronous horizons (e.g., Jucha, 1958; Koszarski & Żytko, 1959, 1961; Jucha & Kotlarczyk, 1961; Haczewski, 1984, 1989). The Zagórz Limestone has been the stratigraphic marker in the present work.

SAMPLE LOCALITIES

Samples were collected from the left bank of the San River (the state boundary between Poland and Ukraine) in the ancient village of Dźwiniacz Górny, between boundary-posts, numbered 300 and 301 (Fig. 2). The section represents the youngest part of the Krosno Beds within the Dźwiniacz Górny Syncline, above the Zagórz Limestone. Samples San-57 and San-56 were taken from grey marlstones within the Zagórz Limestone horizon, a dozen centimetres above the main (4 cm thick) non-laminated limestone layer (Figs 3, 4). Calcareous nannoplankton was described by Garecka (1997 – sample Tar-1) from the same samples.

The whole section of the upper division of the Krosno Beds in the southwestern limb of the Dźwiniacz Górny Syncline is 410 m thick. However, its uppermost part is exposed only in the Ukrainian part of the San valley (Fig. 4). During the field studies, this outcrop has not been accessible for the author. Samples San-55 to San-50 have been collected from

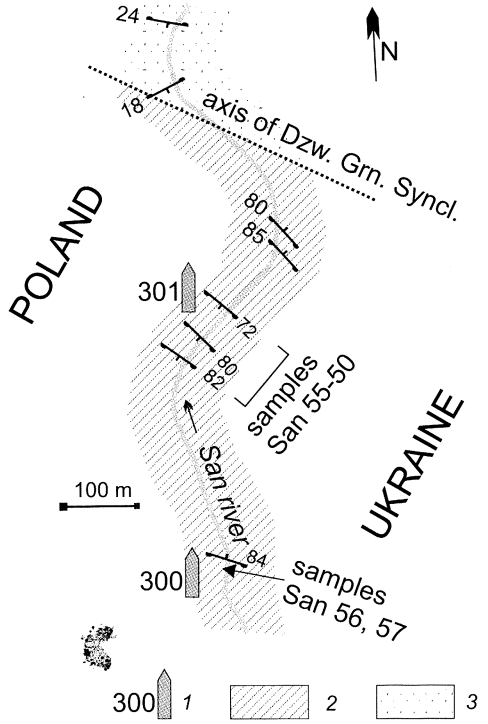

Fig. 2. Location of samples within the Krosno Beds in the San valley, Bieszczady Mts.; *1* – boundary-post (San River is boundary between Poland and Ukraine); *2* – upper division of the Krosno Beds; *3* – thick-bedded sandstones within the upper division; Dzw. Grn. Syncl. – Dźwiniacz Górny Syncline

a 70 m thick section exposed in the left bank of the San River. The uppermost deposits of this outcrop, from which the foraminiferal data are presented here, lie 270 m above the Zagórz Limestone. This part of the upper division of the Krosno Beds consists of grey and dark-grey marlstones with subordinate thin layers (10–20 cm) of black non-calcareous shales. Sandstones are a subordinate component of this division. The mean thickness of the beds is 30 cm. The majority of the sandstones are convolute- and cross-laminated. Two beds of 180 cm thick, poorly cemented, medium-grained, structureless sandstone are present in the upper part of the outcrop.

METHODS

Samples weighing 500–750 g were dried and disintegrated in a solution of sodium carbonate. Then the material was washed through sieves with mesh diameters of 63 μm and 1,500 μm. The microfauna were picked from fraction 63–1,500 μm and mounted on cardboard slides for microscopic examination.

Photographs of microfauna were prepared using the scanning microscope in Electronic Microscopy Laboratory in the Zoology Department, Jagiellonian University.

Microfaunal slides are housed in the Institute of Geography, Cracow Pedagogical University.

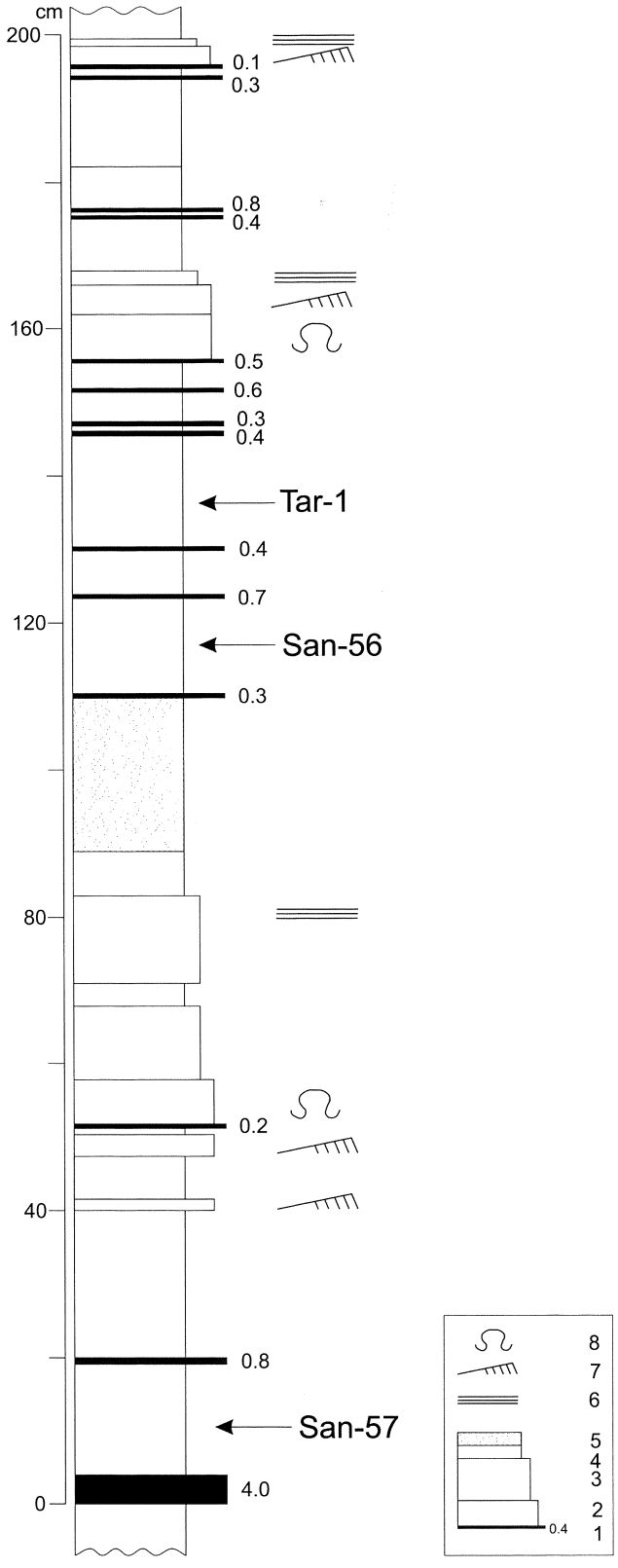

Fig. 3. Lithostratigraphical profile of the Zagórz Limestone horizon above its main 4 cm thick layer (outcrop near the boundary post no. 300), with location of samples: *1* – coccolith limestone layer with thickness (in cm); *2* – sandstone layer; *3* – mudstone layer; *4* – grey marlstones; *5* – dark-grey marly shales; *6* – horizontal lamination; *7* – cross lamination; *8* – convolute lamination

RESULTS

FORAMINIFERAL ASSEMBLAGE

Foraminifers dominate in the microfossil assemblage, except for two samples (San-57 and San-50) in which radiolarians are the most frequent. The foraminiferal assemblage includes 34 identified taxa (Table 1; Figs 6–11). The assemblage consists of predominant pyritized moulds of originally calcareous, hyaline, smooth-walled benthic foraminifers, less numerous pyritized moulds of small, microperforate planktic ones and rare agglutinated forms, among which tubular foraminifers from genus *Rhabdammina* prevail.

A characteristic feature of the calcareous benthos is the dominance of cylindrical and conical forms belonging to *Chilostomella*, *Virgulinella*, *Fursenkoina*, Guttulina, *Bulimina* and *Praeglobobulimina* (Table 1). Their total content within the foraminiferal assemblages exceeds 80 percent in most samples. The benthic foraminifers are very small. Most specimens do not exceed 0.3 mm although, their maxi-

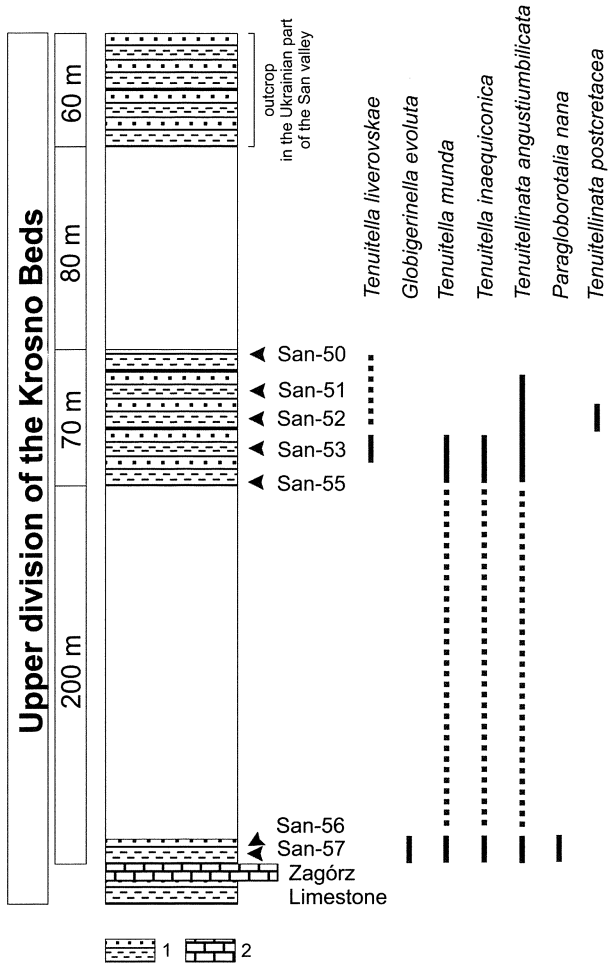

Fig. 4. Lithostratigraphical profile of the youngest part of the Krosno Beds in the studied area (southwestern limb of the Dźwiniacz Górny Syncline across the San valley) with ranges of planktic foraminifers: *1* – grey and dark-grey marlstones with subordinate intercalations of medium- to thick- bedded sandstones; *2* – coccolith limestone horizon

Table 1

Occurrence of microfauna in the investigated samples

	San 57	San 56	San 55	San 53	San 52	San 51	San 50
Bathysiphon sp.				1			
Rhabdammina cylindrica						55	
Nothia excelsa						2	
Rhabdammina sp.						20	
Rhizammina sp.				7	2	3	1
?*Saccammina* sp.						1	
Lagena cf. *striata*			1				
Globulina sp. A						1	
Guttulina problema frankei		2	1	10	1	1	
Oolina globosa			2				
Paragloborotalia opima nana		2					
Globigerinella evoluta		7					
Tenuitella inaequiconica		2	5	4			
Tenuitella liverowskae				5			?1
Tenuitella munda		2	4	4			
Tenuitella sp.		10	2	20	2	1	2
Tenuitellinata angustiumbilicata		3	4	1		1	
Tenuitellinata postcretacea					1		
Praeglobobulimina bathyalis			20	1		1	
Praeglobobulimina pupoides			29	3			
Praeglobobulimina pyrula			2	1			
Praeglobobulimina sp.				60			
Bulimina elongata		12	3	10	1		
Fursenkoina acuta		1		1			
Fursenkoina mustoni		1				2	
Fursenkoina sp.		2	7	4	2		
Virgulinella chalkophila		15	76	75	90		3
Virgulinella karagiensis		15	58	56	60		1
Virgulinella sp.		7	27	10	35		
Nonionella liebusi		1	48	48	1		
Chilostomella ovoidea		16	106	43		1	
Chilostomella sp.						1	1
Chilostomelloides oviformis				1			
Allomorphina trigona				1	1		
Diatomae - *Triceratium* sp.	1	7	42	10	6		
Diatomae - discoid morphotype		2	5	2	22		
Diatomae - ?*Odontella* sp.	1	27	131	3	18		1
Diatomae - ?*Pyxilia* sp.		3	4	1			
Radiolaria	30	13	292	15	5	3	28
fish teeth			12				
echinoid spines		23	27	35	23		
meteoric spherules						10	

mum dimensions described in literature, are much higher.

Planktic foraminifers make up 35 percent of the total foraminiferal assemblage. They are poorly diversified, dominated by small tenuitellids (Table 1). In general, they are well preserved in spite of pyritization of the tests. Surface structures of walls and apertures in most forms are well visible.

NANNOPLANKTON ASSEMBLAGE

All samples taken from the studied outcrops have been analysed for nannoplankton content (Garecka, 1997; Garecka, *pers. comm.*). Turbiditic marlstones in the Zagórz Limestone horizon contain predominantly *Cyclicargolithus floridanus* and transitional forms between *Cyclicargolithus abisectus* and *C. floridanus*. Other species include: *Coccolithus pelagicus*, *Cyclicargolithus abisectus*, *Dictyococcites bisectus*, *Discoaster barbadiensis*, *D.* cf. *distinctus*, *Ericsonia formosa*, *Pontosphaera multipora*, *Reticulofenestra hillae*, *R. lockeri*, *R. umbilica*, *Sphenolithus moriformis*, *Zygrhablithus bijugatus*.

The younger deposits contain a similar assemblage with additional forms belonging to: *Cribrocentrum coenurum*, *C.* cf. *reticulatum*, *Cyclicargolithus luminis*, *Dictyococcites scrippsae*, *Reticulofenestra dictyoda*, *Sphenolithus predistentus*, *S. pseudoradians* and *Toweius gammation*.

OTHER MICROFOSSILS

Pyritized **radiolaria** are a common element in the microfossil assemblage (Table 1). Their content changes from sample to sample between 2% and 93%. Practically all skeletons are poorly preserved. The silica was replaced by fromboidal pyrite (Fig. 11), and the specimens are unrecognisable (M. Bąk, *pers. comm.*).

Pyritized **diatoms** are a significant component of some samples (Table 1; Fig. 12). Most of them are gonioid diatoms, angular in outline, represented by triangular specimens of *Triceratium* sp. (Fig. 12F–H) and elliptical frustules of ?*Odontella* sp. (Fig. 12C–E). They make up to 22% of the microfossil assemblage. Additionally, there occur discoid diatoms (Fig. 12I, J) and specimens with long linear-elliptical valves (?*Pyxilia* sp.). A characteristic feature of the diatom assemblage is giantic dimensions of most specimens.

Pyritized **echinoid spines**, probably redeposited by turbidity currents, and **fish teeth**, are subordinate elements of microfossils in the studied samples, too (Table 1).

DISCUSSION

STRATIGRAPHY

The lower boundary of the studied deposits is placed within the Zagórz Limestone horizon. This chronohorizon is widely used as isochronous regional marker within the Oligocene flysch series of the Carpathians (Koszarski & Żytko, 1959, 1961; Jucha & Kotlarczyk, 1961; Haczewski, 1986, 1989). According to Haczewski (1984, 1989), laminae in the Zagórz Limestone are correlated up to 550 km.

Stratigraphic position of the Jasło and Zagórz Limestone horizons are referred in literature based predominantly on the calcareous nannoplankton data. Krhovský (1981) correlated the both horizons with the calcareous nannoplankton NP24 Zone. Jugowiec (1996) described the same age (NP24 Zone) based on the occurrence of *Cyclicargolithus abisectus*. Garecka (1997, and *pers. comm.*) having examined two samples of the Zagórz Limestone horizon, suggested a similar age (NP24 Zone *sensu* Martini, 1971) on the base of an occurrence of *Reticulofenestra lockeri* and *Cyclicargolithus abisectus*. According to Berggren *et al.* (1995), the calcareous nannoplankton zone NP24 corresponds to the transition between the Rupelian and the Chatian stages (boundary of the Kiscellian and Egerian stages of the Central Paratethys *sensu* Báldi, 1969, 1979).

Planktic foraminifers are numerous in the Jasło Limestone. They make up one percent of the rock volume (Jucha, 1969; Hanzliková & Mencik, 1965). Olszewska (1984b) determined the position of the Jasło and the Zagórz limestones on the base of planktic foraminifers at the planktic zone P21 (the Rupelian/Chatian transition).

Dozens of specimens of planktic foraminifers occur in the sample San-56 taken from the grey marlstones, within the Zagórz Limestone horizon. *Globigerinella evoluta* Subbotina, *T. inaequiconica* (Subbotina), *T. munda* (Jenkins), *Tenuitellinata angustiumbilicata* (Bolli) and *Paragloborotalia nana* Bolli are the only species in these sediments (Fig. 3).

Paragloborotalia opima nana has its last appearance in this section within the Zagórz Limestone (Figs 3, 4). This agrees with the data from Slovakia and other parts of the Carpathians (Cicha & Ctyroka, 1998; Olszewska, 1984b, 1997, 1998), where the last appearance of *P. opima nana* has been noted near the Kiscellian and Egerian boundary (close to the Jasło and Zagórz limestones). This boundary is defined (Báldi, 1979) near the last appearance of subspecies *Paragloborotalia opima opima* (Bolli) (Báldi, 1979). The forms belonging to *P. opima opima* was not found in the studied deposits. However, this fact should be examined carefully, because of probable influence of environmental changes on the population of this species in this part of the Central Paratethys (e.g., temperature of surface water), and unknown significance of taphonomic processes.

Taking into account the ranges of planktic foraminifers in the Central Paratethys (Fig. 5; Olszewska, 1982b; 1997, 1998; Rögl *et al.*, 1998; Krhovský, 1998; Bobrinskaya *et al.*, 1998; Popescu *et al.*, 1998) and accepting the lack of *Paragloborotalia opima opima* in the studied deposits due to its extinction, the stratigraphic position of the Zagórz Limestone is suggested here near the Kiscellian/Egerian boundary.

The well-preserved specimens of *Globigerinella evoluta* Subbotina (Fig. 7F–H) were found in the Zagórz Limestone horizon. The stratigraphic significance of this species is poorly documented from the Central Paratethys (Fig. 5). Strzępka (1981) referred the taxon from the lower Miocene under the overthrust of the Polish Carpathian flysch (well Sucha IG 1). Olszewska (1982b) and Olszewska *et al.* (1996) noted an occurrence of this species from the Egerian

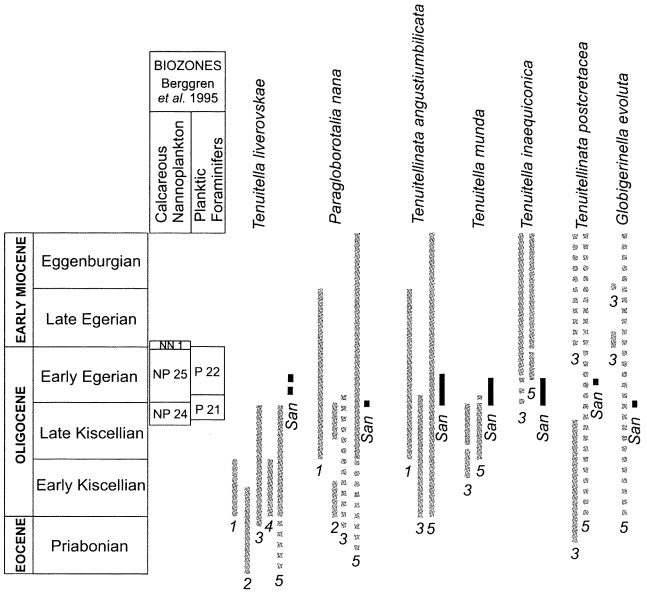

Fig. 5. Stratigraphic ranges of selected planktic foraminifers in the Central Paratethys area; Compilation for: 1 – Bavarian–Austrian Molasse Basin (Rögl *et al.*, 1998); 2 – Southern-Moravian Flysch Belt (Krhovský, 1998); 3 – Polish Carpathians (Olszewska, 1982b, 1997, 1998; Garecka & Olszewska, 1998); 4 – Western Ukraine and Moldavia (Bobrinskaya *et al.*, 1998); 5 – different sedimentary basins (Popescu *et al.*, 1998); San – study area in the San valley, Bieszczady Mts. Correlation of biozones *sensu* Berggren *et al.* (1995) with the Central Paratethys stages is followed after Rögl (1998)

through the Karpatian in the Polish Outer Carpathians. The range of *G. evoluta* in other regions of the Central Paratethys is poorly documented (see Popescu *et al.*, 1998).

In studied deposits, the younger than the Zagórz Limestone assemblage of planktic foraminifers is slightly different. Species of *Globigerinella evoluta* and *Paragloborotalia opima nana* are absent. Other planktic forms, *Tenuitellinata postcretacea* (Mjatliuk) and *Tenuitella liverovskae* (Bykova), are present in these deposits. No diagnostic early Miocene foraminifers, like *Turborotalia kugleri* (Bolli), *Globoquadrina dehiscens* (Chapmann, Parr & Collins), *Globorotalia foshi* (Cushman), were found in the San River section (Fig. 3).

The nannoplankton assemblage in these deposits also does not demonstrate the early Miocene age (Garecka, *pers. comm.*). Most of the coccoliths represent long-ranging species. The presence of *Cyclicargolithus abisectus* (Müller) suggests that the age of these deposits is not older than the NP24 Zone.

The upper age limit of the studied foraminifers is difficult to determine precisely, because of the lack of zonal markers for the uppermost Oligocene, both within the planktic foraminifers and the calcareous nannoplankton in the Central Paratethys (Olszewska & Garecka, 1996). The *Paragloborotalia inaequiconica* planktic acme zone that was distinguished around the Oligocene/Miocene boundary (Olszewska, 1977) has a wide range, from the late Chatian through the early Burdigalian. Similarly, no coccoliths diagnostic for the Late Oligocene Zone NP25 have been documented in the Central Paratethys (Rögl, 1998).

The studied section displays new information about ranges of some planktic foraminifers in the Polish Outer Carpathians. Forms belonging to *Tenuitella liverovskae*, *Tenuitellinata angustiumbilicata* and *Tenuitella munda*, which occur 200–270 m above the Zagórz Limestone horizon (Figs 4, 5), have longer stratigraphical ranges than have hitherto been described (Olszewska, 1984b, 1985, 1997, 1998). It seems, that *Paragloborotalia opima nana* disappeared within (? or just after) the deposition of the Zagórz Limestone.

REMARKS ON BENTHIC FORAMINIFERAL ASSEMBLAGE

Most benthic foraminifers found by the present author have been earlier described from the Menilite-Krosno series. Only a few species have not been previously referred from the Oligocene of the Polish Outer Carpathians. They include: *Praeglobobulimina bathyalis* (Reiser) (known from the Kiscellian and early Egerian of the Bavarian Molasse Basin; Reiser, 1987), *Chilostomelloides oviformis* (Sherborn & Chapman) (known from the Bavarian Molasse Basin and from the western part of the Carpathian Foredeep; Popescu *et al.*, 1998), *Oolina globosa* (Montagu) (described from the Kiscellian and early Egerian of the Bavarian Molasse Basin, Reiser, 1987), *Lagena* cf. *striata* (known from the early and middle Miocene of the Carpathian Foredeep; Wenger, 1987).

Numerous studies of the Oligocene benthic foraminifers in the Polish Carpathians (e.g., Olszewska, 1982a, 1984a, 1985) showed their close relationships with lithofacies. A common occurrence in the studied deposits of pyritized tests of *Praeglobobulimina*, *Fursenkoina*, *Chilostomella*, *Allomorphina* and some species of *Bulimina* may correspond to "benthic assemblage I" from the Menilite Beds (Olszewska, 1985), connected with anoxic facies.

On the other hand, numerous specimens of *Praeglobobulimina* spp. and *Chilostomella* spp. are markers of bathyal environment (Reiser, 1987). Forms belonging to *Fursenkoina schreibersiana* (d'Orbigny) (= *F. acuta*) and *Chilostomella ovoidea* Reuss have been reported from Holocene deep-water environments (Gupta, 1994). In the Indian Ocean and the Red Sea Deep Sea Drilling Project sites, these two species occurred in samples collected from depths of *ca.* 850 m (*F. schreibersiana*) and 4500 m (*Ch. ovoidea*). Some species belonging to nodosarids (*Oolina globosa* (Montagu), *Lagena striata* d'Orbigny), common in neritic facies, are also known from deep-water sediments (DSDP Site 270, Ross Sea; Leckie & Webb, 1985). These remarks suggest that sedimentation of the studied upper division of the Krosno Beds took place under the bathyal depths.

CONCLUSIONS

The biostratigraphic succession of the planktic foraminifers and calcareous nannoplankton indicates the lower Egerian age of the youngest part of the studied upper division of the Krosno Beds. The occurrence of the isochronous

horizon of the Zagórz Limestone, referred to the NP24 calcareous nannoplankton Zone (Martini, 1971), gave the opportunity to make more precise observations of the some planktic foraminiferal ranges. Based on the position of the Zagórz Limestone horizon, the last appearance of *Tenuitella liverovskae, Tenuitellinata angustiumbilicata* and *Tenuitella munda* documented in the studied deposits are younger than it has been hitherto believed.

The benthic foraminiferal association is represented mainly by cylindrical and conical forms (representatives of genera: *Praeglobobulimina*, *Fursenkoina*, *Chilostomella*, *Allomorphina* and some species of *Bulimina*) adapted to oxygen-depleted waters. Some of the species described here (*Praeglobobulimina bathyalis*, *Chilostomelloides oviformis*, *Oolina globosa*, *Lagena* cf. *striata*) are for the first time referred from the Oligocene of the Polish Outer Carpathians.

SYSTEMATIC PALEONTOLOGY

Taxonomical designation of all illustrated foraminifers (Figs 6–11), identified in the samples from the upper Oligocene of the Krosno Beds, is presented below. Subordinal classification in this paper follows Loeblich & Tappan (1992).

Class FORAMINIFERA Lee, 1990
Order ASTRORHIZIDAE Lankester, 1885
Superfamily ASTRORHIZACEA Brady, 1881
Family RHABDAMMINIDAE Brady, 1884
Subfamily RHABDAMMININAE Brady, 1884

Genus *Rhabdammina* Brady, 1884

Rhabdammina cylindrica Glaessner, 1937
Fig. 8 A

1937. *Rhabdammina cylindrica* Glaessner: p. 354, pl. 1, fig. 1.
1990. *Rhabdammina cylindrica* Glaessner: Kaminski *et al.*, pl. 1, fig. 4.

Description: Slender, tubular, straight test, medium to coarsely agglutinated; aperture at open ends of tube.
Measurements (mm): diameter – 0.15–0.35.
Distribution: *Rhabdammina cylindrica* was originally described from the Paleogene of the Caucasus. This species is cosmopolitan, known from the Cretaceous to Paleogene in the Tethyan flysch zones (e.g., Weidich, 1990).

Family BATHYSIPHONIDAE Avnimelech, 1952

Genus *Nothia* Pflaumann, 1964

Nothia excelsa (Grzybowski)
Fig. 8 B

1898. *Dendrophrya excelsa* Grzybowski: p. 272, pl. 10, figs 1-4.
1990. *Dendrophrya excelsa* Grzybowski: Kaminski *et al.*, pl. 1, fig. 10.
1993. *Nothia excelsa* (Grzybowski): Kaminski & Geroch, pl. 1, figs 2-6, 15a, b.

Description: Test tubular, flattened, dendritically branched, and finely agglutinated with siliceous cement; apertures at ends of tube.
Measurements (mm): diameter of tubes – 0.1–0.15.
Distribution: *Nothia excelsa* was originally described from the Paleogene of the Polish Outer Carpathians. This species is cosmopolitan, known from the Cretaceous to Recent flysch-type deposits.

Family SACCAMMINIDAE Brady, 1884
Subfamily SACCAMMININAE Brady, 1884

Genus *Saccammina* Carpenter, 1869

?*Saccammina* sp.
Fig. 8 C

Measurement (mm): diameter – 0.7.
Remarks: Test large, unilocular, subcircular in outline, compressed to disc with elevated periphery; wall agglutinated from fine to medium quartz grains; aperture not visible.

Order LAGENIDA Lankester, 1885
Superfamily NODOSARIACEA Ehrenberg, 1838
Family LAGENIDAE Reuss, 1862

Genus *Lagena* Walker & Jacob, in Kanmacher, 1798

Lagena cf. *striata* (d'Orbigny)
Fig. 8 P

1839. *Oolina striata* d'Orbigny: 21, pl. 5, fig. 12.
1983. *Lagena striata striata* (d'Orbigny): Cicha *et al.*, pl. 10, fig. 7.
1985. *Lagena striata* (d'Orbigny): Leckie & Webb, pl. 4, fig. 5.
1987. *Lagena striata* (d'Orbigny): Wenger, pl. 5, figs 2, 3.
1998. *Lagena striata* (d'Orbigny): Popescu *et al.*, pl. 27, figs 3, 4.

Description: Test unilocular; chamber elongate in outline; circular in cross-section; length approximately one and half times maximum width; maximum width about one-third distance from apical end to aperture; wall finely perforate, with regularly-orientated longitudinal costae; aperture terminal, produced on short, thick neck.
Measurements (mm): length – 0.3; thickness – 0.15.
Remarks: This form differs from the typical in poorly developed costae and more elongate shape. It resembles *Lagena gracilicostata* Reuss, but has not any bifurcating costae near apertural neck.
Distribution: *Lagena striata* (as *Oolina striata*) was originally described from the Recent deposits of the South Atlantic. This species was reported from the middle Miocene of the Paratethys (Vienna Basin – Mathes, 1939; Bavarian Molasse Zone – Wenger, 1987; Carpathian Foredeep – Łuczkowska in Popescu *et al.*, 1998). It was also described from the Badenian of the Neogene Basin in NW Bulgaria (Darakchieva, 1998). Late Oligocene range of this species was documented from the Ross Sea (Leckie & Webb, 1985). *Lagena* cf. *striata* occurs in grey marlstones about 200 m above the Zagórz Limestone horizon.

Superfamily POLIMORPHINACEA d'Orbigny, 1839
Family POLIMORPHINIDAE d'Orbigny, 1839
Subfamily POLYMORPHININAE d'Orbigny, 1839

Genus *Globulina* d'Orbigny, 1839

Globulina sp. A
Fig. 11 H

Description: Test spherical in outline; chambers strongly overlapping; wall finely perforate, with rare, regular pustules; aperture depressed at end of final chamber.
Measurement (mm): diameter – 0.3.
Remarks: This species differs from *Globulina granulosa* in more spherical outline and in different arrangement of pustules. Its aperture is distinctly depressed.
Distribution: *Globulina* sp. A occurs in grey marlstones about 250 m above the Zagórz Limestone in the studied section.

Genus *Guttulina* d'Orbigny, 1839

Guttulina problema frankei Cushman & Ozawa
Fig. 8 M, N

1930. *Guttulina frankei* Cushman & Ozawa: p. 28, pl. 4, fig. 1.
1987. *Guttulina problema frankei*: Reiser, p. 75, pl. 6, figs 3, 4, 8.

Description: Test elongate in outline; length about one and one-half times maximum width; maximum width at midpoint of test, plano-convex in cross-section; chambers increasing rapidly in size, strongly overlapping, added in spiral quinqueloculine pattern; sutures distinctly depressed, oblique to test margins; wall finely perforate; aperture terminal, radiate.
Measurements (mm): Length – 0.35–0.4; maximum width – 0.23–0.25.
Distribution: *Guttulina problema frankei* was originally described from the middle Oligocene of the North Germany. It was also reported from the late Oligocene (lower Egerian) of the Bavarian Molasse Zone (Reiser, 1987). This species occurs in the Zagórz Limestone horizon and in the marlstones up to 250 m above the horizon.

Subfamily RAMULININAE Brady, 1884

Genus *Oolina* d'Orbigny, 1839

Oolina globosa (Montagu, 1803)
Fig. 8 O

1803. *Vermiculum globosa* Montagu: p. 523, pl. 1, fig. 8 (*fide* Ellis & Messina).
1984. *Oolina globosa* (Montagu): Jones, p. 101, pl. 1, figs 10, 11.
1987. *Oolina globosa* (Montagu): Reiser, p. 77, pl. 6, fig. 23.
1998. *Oolina globosa* (Montagu): Robertson, p. 100, pl. 37, fig. 1.

Description: Test unilocular, ovate in outline; length approximately one and one-third times maximum width; maximum width about one-third to a one-half distance from apical end to aperture; circular in cross-section; wall finely perforate; aperture terminal, circular.
Measurements (mm): length – 0.35; maximum width – 0.26.
Remarks: Thin crenate lip around terminal aperture is poorly preserved.
Distribution: *Oolina globosa* (as *Vermiculum globosa*) was originally described from the Recent deposits of the North Sea. It has also been reported from the late Oligocene–early Miocene of the Ross Sea (Leckie & Webb, 1985), from the Oligocene of the Bavarian Molasse Zone (Reiser, 1987), and from the Miocene of Jamaica (Robertson, 1998). This species occurs in grey marlstones about 200 m above the Zagórz Limestone in the studied section.

Order GLOBIGERINIDA Lankester, 1885
Superfamily GLOBOROTALIACEA Cushman, 1927
Family GLOBOROTALIDAE Cushman, 1927

Genus *Paragloborotalia* Cifelli, 1982

Paragloborotalia opima nana (Bolli)
Fig. 6 A-C

1957. *Globorotalia opima nana* Bolli: p. 118, pl. 28, fig. 3.
1984a. *Turborotalia nana* (Bolli): Olszewska, p. 67, pl. 6, fig. 10.
1987. *Globorotalia opima nana* Bolli: Reiser, p. 112, pl. 16, figs 3, 4, 6.
1991. *Paragloborotalia opima nana* (Bolli): Spezzaferri & Premoli Silva, p. 248, pl. 11, fig. 4.
1993. *Paragloborotalia nana* (Bolli): Leckie *et al.*, p. 124, pl. 7, figs 1, 2.
1998. *Paragloborotalia opima nana* (Bolli): Popescu *et al.*, p. 116, pl. 39, figs 7, 8.

Description: Test small, trochospiral, subcircular in outline; biconvex; periphery rounded; surface medium perforate two whorls on spiral side; four chambers in last whorl slowly increasing in size; sutures straight, radial, depressed; umbilicus small; distinctive apertural arch in umbilical position.
Measurement (mm): diameter – 0.3.
Distribution: Originally *Paragloborotalia opima nana* was described from Oligocene of the Trinidad. This form has been reported from the Egerian of the Austrian Molasse Basin (Reiser, 1987; Rögl *et al.*, 1998), from the Kiscellian of the Moravian part of the Carpathian Foredeep (Krhovský, 1983; Cicha & Ctyroka, 1998), and from the uppermost Eocene through early Egerian (up to the Jasło Limestone horizon) in the Polish Outer Carpathians (Olszewska, 1981, 1984a, 1997, 1998). This species occurs in the Zagórz Limestone horizon in the studied section.

Family GLOBIGERINIDAE Carpenter, Parker & Jones, 1862
Subfamily GLOBIGERININAE Carpenter, Parker & Jones, 1862

Genus *Globigerinella* Cushman, 1927

Globigerinella evoluta Subbotina
Fig. 7 F-H

1960. *Globigerinella evoluta* Subbotina (in Subbotina *et al.*): p. 58, pl. 11, figs 8, 9.
1982. *Globanomalina evoluta* (Subbotina): Olszewska, p. 633-634, pl. 2, fig. 9.
1996. *Globigerinella evoluta* Subbotina: Odrzywolska-Bieńkowa & Olszewska, p. 583, pl. 147, fig. 7.
1998. *Tenuitella evoluta* (Subbotina): Popescu *et al.*, p. 131, pl. 30, figs 26, 27.

Description: Test small, planispiral, two side convex; wall smooth, microperforate; six globular to triangular chambers in final whorl; chambers of the final whorl increase rapidly in size; last chamber distinctly large and inflated; sutures radial, depressed; umbilicus medium, depressed; aperture a wide arch at the base of the last chamber.

Measurements (mm): diameter – 0.25–0.3; width of final chamber – 0.12–0.15.
Remarks: Studied forms have distinctive planispiral test and large aperture at the base of the last chamber.
Distribution: Originally *Globigerinella evoluta* was described from the lower Miocene of the Ukrainian Carpathian Foredeep. This form has been reported from the upper Kiscellian of the Austrian part of the Central Paratethys (Popescu *et al.*, 1998). Strzępka (1981) noted *Globigerinella evoluta* from the lower Miocene of the Carpathian Foredeep. Olszewska (1982b) described this species near the Radziszów tuff (Egerian/Eggenburgian boundary). This species occurs in the Zagórz Limestone horizon.

Family CANDEINIDAE
Subfamily TENUITELLINAE Banner, 1982

Genus *Tenuitella* Fleischer, 1974

Tenuitella inaequiconica (Subbotina)
Fig. 6 F-M

1960. *Acarinina inaequiconica* Subbotina (in Subbotina *et al.*): p. 202, pl. 7, figs 13, 14.
1996. *Tenuitella inaequiconica* (Subbotina): Odrzywolska-Bieńkowa & Olszewska, p. 576, pl. 97, fig. 4.
1998. *Paragloborotalia* ? *inaequiconica* (Subbotina): Popescu *et al.*, p. 115, pl. 39, figs 17-20.
1998. *Tenuitella inaequiconica* (Subbotina): Garecka & Olszewska, p. 718, pl. 1, fig. 3.

Description: Test small, trochospiral, umbilical side convex; spiral side almost flat; wall smooth, microperforate; five to six rectangular chambers in final whorl increasing rapidally in size; sutures straight to little curved, depressed; umbilicus medium, depressed; aperture a low extraumbilical arch, with lip.
Measurements (mm): diameter – 0.18–0.22; thickness of final chamber – 0.08.
Distribution: Originally *Tenuitella inaequiconica* (as *Acarinina inaequiconica*) was described from Egerian of the Ukrainian Carpathian Foredeep. This form has been reported from the Egerian through the ?lower Badenian of the Polish Outer Carpathians and of the Carpathian Foredeep (Odrzywolska-Bieńkowa & Olszewska, 1996; Olszewska, 1997; Garecka & Olszewska, 1998). Popescu *et al.* (1998) described its stratigraphical range from the Egerian through the early Badenian of the Central Paratethys. This species occurs in the Zagórz Limestone horizon and in the grey marlstones up to 230 m above this horizon.

Tenuitella liverovskae (Bykova)
Fig. 7 A-E, I

1960. *Globigerinella liverovskae* Bykova: p. 322, pl. 7, figs 1-3.
1968. *Globigerina liverovskae* (Bykova): Samuel & Salaj, p. 122, text-fig. 24.
1985. *Turborotalia liverovskae* (Bykova): Olszewska, p. 231-232, pl. 6, fig. 8.
1987. *Globorotalia liverovskae* (Bykova): Reiser, p. 113-114, pl. 18, figs 5, 8, 9.
1996. *Tenuitella liverovskae* (Bykova): Olszewska *et al.*, p. 125, pl. 38, figs 1, 2.
1998. *Tenuitella liverovskae* (Bykova): Popescu *et al.*, p. 131, pl. 30, figs 23-25.

Description: Test small, low trochospiral to pseudoplanispiral, two sides convex; wall smooth, microperforate; five to six globular (early) to triangular chambers in final whorl; sutures radial, depressed on umbilical side; umbilicus wide, depressed; aperture a low extraumbilical arch.
Measurements (mm): diameter – 0.2–0.3.
Distribution: Originally *Tenuitella liverovskae* (as *Globigerinella liverovskae*) was described from the lower Oligocene of the Ukrainian Carpathians. This form has been reported from the upper Eocene through the lower Oligocene of the Polish Outer Carpathians (up to the Jasło Limestone horizon; not found in the Zagórz Limestone) and the Inner Carpathians (Olszewska *et al.*, 1996; Olszewska, 1984a, b, 1997), and from the lower Oligocene of the Slovak Central Carpathians (Samuel & Salaj, 1968). Popescu *et al.* (1998) described its stratigraphic range from the late Eocene to the late Kiscellian in the Central Paratethys. This species occurs in the grey marlstones up to 250 m above the Zagórz Limestone horizon.

Tenuitella munda (Jenkins)
Fig. 6 D, E; Fig. 7 L

1966. *Globorotalia munda* Jenkins: p. 1121, fig. 14; pl. 13, figs 152-166.
1987. *Tenuitella munda* (Jenkins): Li, p. 310, pl. 2, fig. 13.
1992. *Tenuitella munda* (Jenkins): Li *et al.*, p. 579, pl. 1, fig. 8.
1996. *Tenuitella munda* (Jenkins): Olszewska *et al.*, p. 125, pl. 38, figs 9, 10.
1998. *Tenuitella munda* (Jenkins): Popescu *et al.*, p. 131, pl. 30, figs 35-38.

Description: Test small, low trochospiral, two sides slightly convex; wall smooth, microperforate; four quadrate chambers in final whorl increasing rapidly in size; last chamber comprises one third of test; sutures radial, depressed; umbilicus medium, depressed; aperture a low extraumbilical arch, with lip.
Measurement (mm): diameter – 0.17–0.2.
Distribution: Originally *Tenuitella munda* (as *Globorotalia munda*) was described from the Oligocene of the New Zealand. This form has been reported from lower and older parts of the upper Oligocene of the Polish Outer and Inner Carpathians (Olszewska *et al.*, 1996; Olszewska, 1997). Popescu *et al.* (1998) described its stratigraphical range from the Kiscellian through the early Egerian of the Central Paratethys. This species occurs in the Zagórz Limestone horizon and up to 230 m above this horizon.

Genus *Tenuitellinata* Li, 1987

Tenuitellinata angustiumbilicata (Bolli)
Fig. 7 J, K

1957. *Globigerina ciperoensis angustiumbilicata* Bolli: p. 109, pl. 22, figs 12, 13.
1987. *Tenuitellinata angustiumbilicata* (Bolli): Li, p. 311, pl. 2, figs 15, 17-19.
1991. *Tenuitella angustiumbilicata* (Bolli): Huber, pl. 7, figs 6, 16.
1992. *Tenuitellinata angustiumbilicata* (Bolli): Li *et al.*, p. 579, pl. 1, figs 9, 10.
1996. *Tenuitellinata angustiumbilicata* (Bolli): Olszewska *et al.*, p. 126, pl. 15, fig. 8.
1998. *Tenuitellinata angustiumbilicata* (Bolli): Popescu *et al.*, p. 131, pl. 31, figs 1-4.

Description: Test small, medium trochospiral, with convex spiral side; wall densely microperforate and pustulated; five ventrally inflated, globular chambers in final whorl; sutures radial on umbilical side; umbilicus closed; aperture a low umbilical arch, lacking a bulla.
Measurements (mm): diameter – 0.2–0.25.
Distribution: Originally *Tenuitellinata angustiumbilicata* (as *Globigerina ciperoensis angustiumbilicata*) was described from the upper Oligocene of the Trinidad. This form has been reported from

the late Eocene through the Oligocene of the Polish Outer Carpathians (Olszewska *et al.*, 1996; Olszewska, 1984a, 1997) and from the lower Oligocene of the Polish Lowland (Olszewska *et al.*, 1996). Popescu *et al.* (1998) described its range from the early Oligocene through the Badenian in the Central Paratethys. This species occurs in the Zagórz Limestone horizon and up to 250 m above this horizon.

Tenuitellinata postcretacea (Mjatliuk)
Fig. 7 M

1950. *Globigerina postcretacea* Mjatliuk: p. 280, pl. 4, fig. 3.
1985. *Globigerina postcretacea* Mjatliuk: Olszewska, p. 233, pl. 7, fig. 6.
1996. *Tenuitellinata postcretacea* (Mjatliuk): Olszewska *et al.*, p. 126, pl. 39, figs 15, 16.
1998. *Globigerina postcretacea* Mjatliuk: Popescu *et al.*, p. 100, pl. 32, figs 1-4.
1998. *Tenuitellinata postcretacea* (Mjatliuk): Garecka & Olszewska, p. 718, pl. 1, fig. 5.

Description: Test small, highly trochospiral, with convex spiral side; wall with medium-sized perforations; five globular chambers in final whorl slowly increasing in size; sutures radial on umbilical side, depressed; umbilicus medium; aperture low umbilical arch.
Measurements (mm): diameter – 0.25–0.28.
Distribution: Originally *Tenuitellinata postcretacea* (as *Globigerina postcretacea*) was described from the lower Oligocene of the Ukrainian Carpathians. This form has been reported from the upper Oligocene through the lower Miocene of the Polish Outer Carpathians (Olszewska *et al.*, 1996; Olszewska, 1984a, 1997). Popescu *et al.* (1998) described its stratigraphic range from the early Oligocene through the Eggenburgian in the Central Paratethys. This species occurs in the grey marlstones about 250 m above the Zagórz Limestone horizon.

Order BULIMINIDA Fursenko, 1958
Superfamily BULIMINACEA Jones, 1875
Family BULIMINIDAE Jones, 1875

Genus *Praeglobobulimina* Hofker, 1951

Praeglobobulimina bathyalis (Reiser)
Fig. 10 I

1987. *Globobulimina bathyalis* Reiser: p. 78, pl. 6, figs 17, 20, 21.
1998. *Praeglobobulimina bathyalis* (Reiser): Popescu *et al.*, p. 119, pl. 48, figs 6-8.

Description: Test triserial, fusiform, length approximately one and one-third width, subcircular in cross-section; chambers increasing gradually in size, becoming greatly elongated and overlapping in final whorl; sutures thin, depressed, oblique; wall smooth, finely perforate, aperture elongate slit in face of final chamber, with curved toothplate.
Measurements (mm): length – 0.2; diameter – 0.16.
Distribution: Originally *Praeglobobulimina bathyalis* (as *Globobulimina bathyalis*) was described from the base of the Oligocene through younger part of the early Egerian in the Bavarian Molasse Basin. This species occurs in grey marlstones 200–250 m above the Zagórz Limestone horizon.

Praeglobobulimina pupoides (d'Orbigny)
Fig. 10 L

1846. *Bulimina pupoides* d'Orbigny: p. 185, pl. 11, figs 11, 12.
1967. *Praeglobobulimina pupoides* (d'Orbigny): Cicha & Zapletalová, p. 126, pl. 23a, fig. 3.
1996. *Praeglobobulimina pupoides* (d'Orbigny): Odrzywolska-Bieńkowa & Olszewska, p. 595, pl. 93, fig. 13.
1998. *Praeglobobulimina pupoides* (d'Orbigny): Popescu *et al.*, p. 119, pl. 48, figs 10, 14-17.

Description: Test triserial, fusiform, length approximately one and two-thirds width; subcircular in cross-section; four whorls with chambers increasing gradually in size, becoming greatly elongated and overlapping in final whorl; final three chambers comprise about half of test; sutures thin, depressed, oblique; wall smooth, finely perforate; aperture elongate slit in face of final chamber, with crescent lip in apertural opening.
Measurements (mm): length – 0.45; diameter – 0.27.
Distribution: Originally *Praeglobobulimina pupoides* (as *Bulimina pupoides*) was described from the Badenian of the Vienna Basin. This species has been reported from the Karpatian and the lower Badenian of the Carpathian Foredeep in its Moravian part (Strzępka, 1981; Odrzywolska-Bieńkowa & Olszewska, 1996; Popescu *et al.*, 1998). Popescu *et al.* (1998) described its stratigraphical range from the Egerian through the Badenian in the Central Paratethys. *Praeglobobulimina pupoides* occurs in grey marlstones 200–220 m above the Zagórz Limestone horizon.

Praeglobobulimina pyrula (d'Orbigny)
Fig. 10 M

1846. *Bulimina pyrula* d'Orbigny: p. 184, pl. 11, figs 9-10.
1984a. *Globobulimina pyrula* (d'Orbigny): Olszewska, p. 83, pl. 3, fig. 3.
1985. *Globobulimina pyrula* (d'Orbigny): Olszewska, p. 228, pl. 3, fig. 5.
1987. *Praeglobobulimina pyrula* (d'Orbigny): Wenger, pl. 7, figs 3-5.
1996. *Globobulimina pyrula* (d'Orbigny): Olszewska *et al.*, p. 154, pl. 27, fig. 12.
1998. *Praeglobobulimina pyrula* (d'Orbigny): Popescu *et al.*, p. 119, pl. 48, figs 11-13.

Description: Test triserial, fusiform; length approximately one and one-third width, subcircular in cross-section; two whorls with chambers increasing gradually in size, becoming greatly elongate and overlapping in final whorl; final three chambers comprise almost whole test; sutures thin, depressed, oblique; wall finely perforate; aperture elongate slit in face of final chamber, with crescent lip in apertural opening.
Measurements (mm): length – 0.3; diameter – 0.23.
Distribution: Originally *Praeglobobulimina pyrula* (as *Bulimina pyrula*) was described from the Badenian of the Vienna Basin. This species was referred from the upper Eocene through the early Miocene of the Polish Outer Carpathians (Olszewska, 1981, 1985). Popescu *et al.* (1998) noted its statigraphical age from a base of the Oligocene through the Badenian in the Central Paratethys. *Praeglobobulimina pyrula* occurs in the grey marlstones 200–220 m above the Zagórz Limestone horizon.

Genus *Bulimina* d'Orbigny, 1826

Bulimina elongata d'Orbigny
Fig. 9 A-E, G-J, L

1846. *Bulimina elongata* d'Orbigny: p. 187, pl. 11, figs 19, 20.
1971. *Bulimina elongata* d'Orbigny: Łuczkowska & Dyjor, pl. 8, fig. 7.
1983. *Bulimina elongata* d'Orbigny: Cicha *et al.*, pl. 12, fig. 2.
1985. *Bulimina elongata* d'Orbigny: Papp & Schmid, p. 73, pl. 63, figs 5-9.

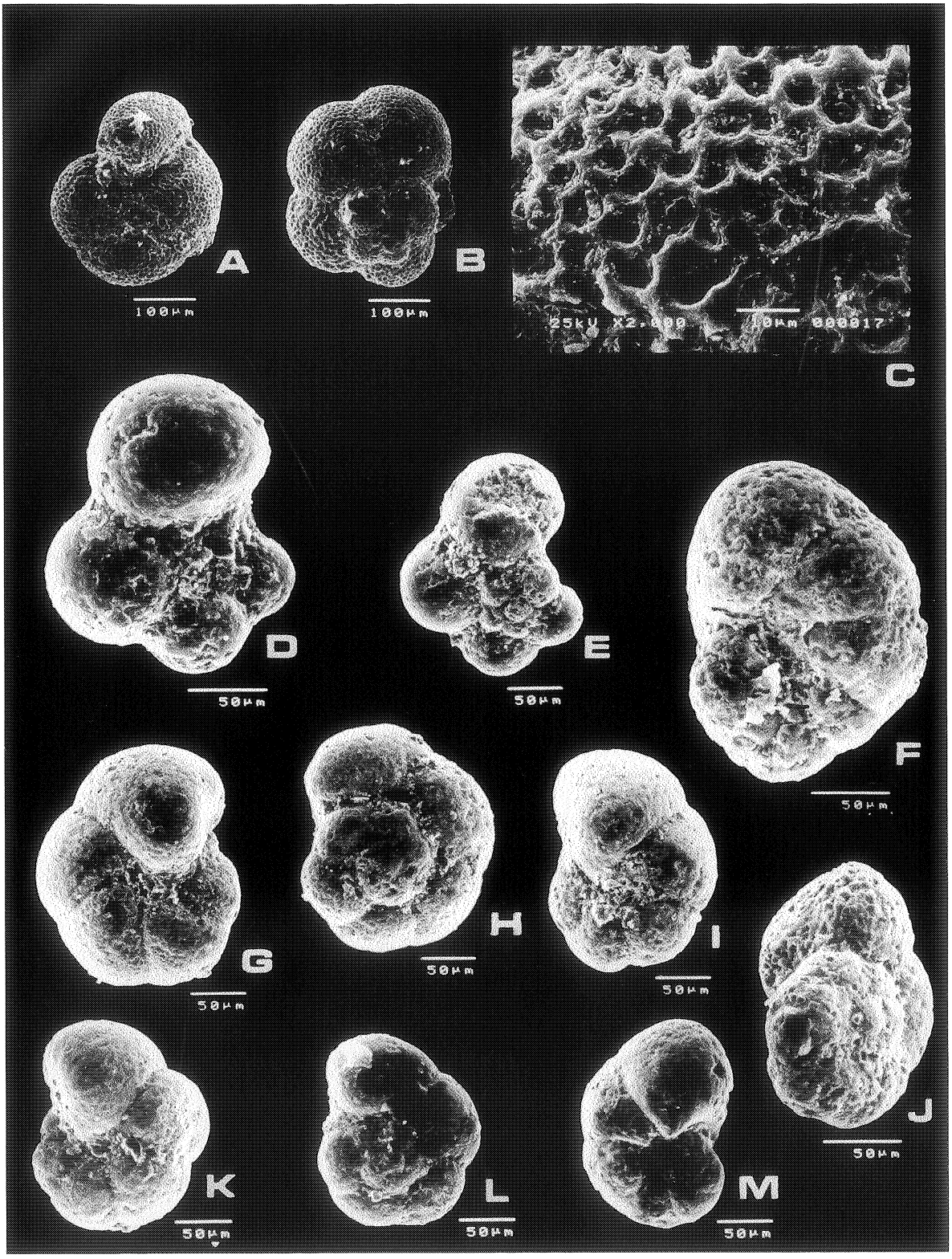

Fig. 6. Late Oligocene planktic foraminifers from the Krosno Beds. **A-B.** *Paragloborotalia opima nana* Bolli – sample S-56; **C.** Wall texture of *Paragloborotalia opima nana* – sample S-56; **D, E.** *Tenuitella munda* (Jenkins) – sample S-56; **F-M.** *Tenuitella inaequiconica* (Subbotina), F-I – sample S-55, J-M – sample S-53

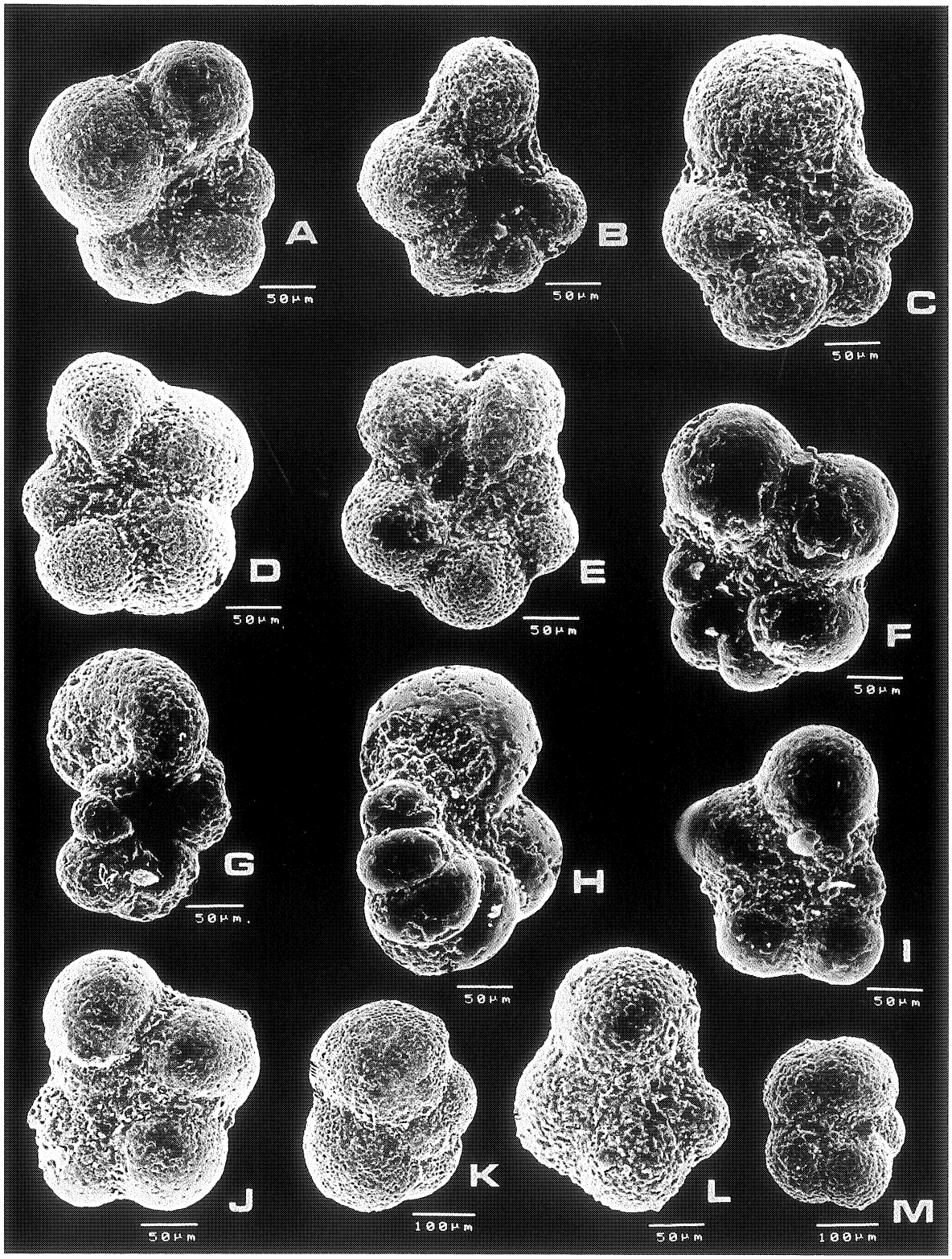

Fig. 7. Late Oligocene planktic foraminifers from the Krosno Beds. **A-E.** *Tenuitella liverovskae* (Bykova), A-C, E – sample S-53; D – sample S-55; **F-H.** *Globigerinella evoluta* (Subbotina) – sample S-56; **I.** *Tenuitella liverovskae* (Bykova) – sample S-56; **J, K.** *Tenuitellinata angustiumbilicata* (Bolli) – J – sample S-51, K – sample S-53, **L.** *Tenuitella munda* (Jenkins) – sample S-55; **M.** *Tenuitellinata postcretacea* (Mjatliuk) – sample S-52

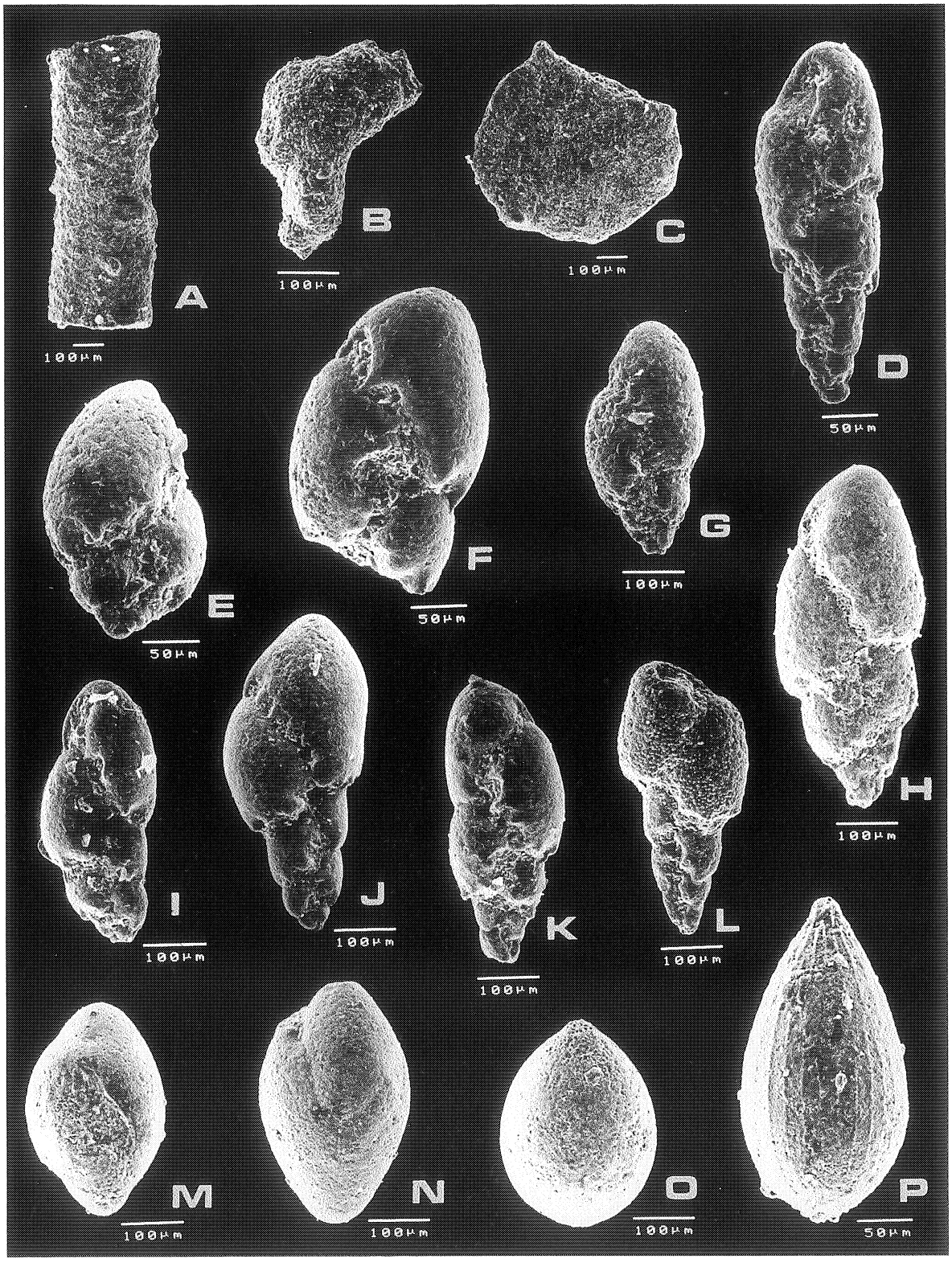

Fig. 8. Late Oligocene agglutinated and calcareous benthic foraminifers from the Krosno Beds. **A.** *Rhabdammina cylindrica* Glaessner – sample S-51; **B.** *Nothia excelsa* (Grzybowski) – sample S-51; **C.** ? *Saccammina* sp. – sample S-51; **D.** *Virgulinella chalkophila* (Hagn) – sample S-52; **E, F.** *Virgulinella karagiensis* Mikhailova – sample S-52; **G.** *Virgulinella* cf. *karagiensis* Mikhailova – sample S-52; **H-L.** *Virgulinella chalkophila* (Hagn), H, J, L – sample S-52, I, K – sample S-53; **M, N.** *Guttulina problema frankei* Cushman & Ozawa, M – sample S-55, N – sample – S-53; **O.** *Oolina globosa* (Montagu) – sample S-55; **P.** *Lagena* cf. *striata* (d'Orbigny) – sample S-55

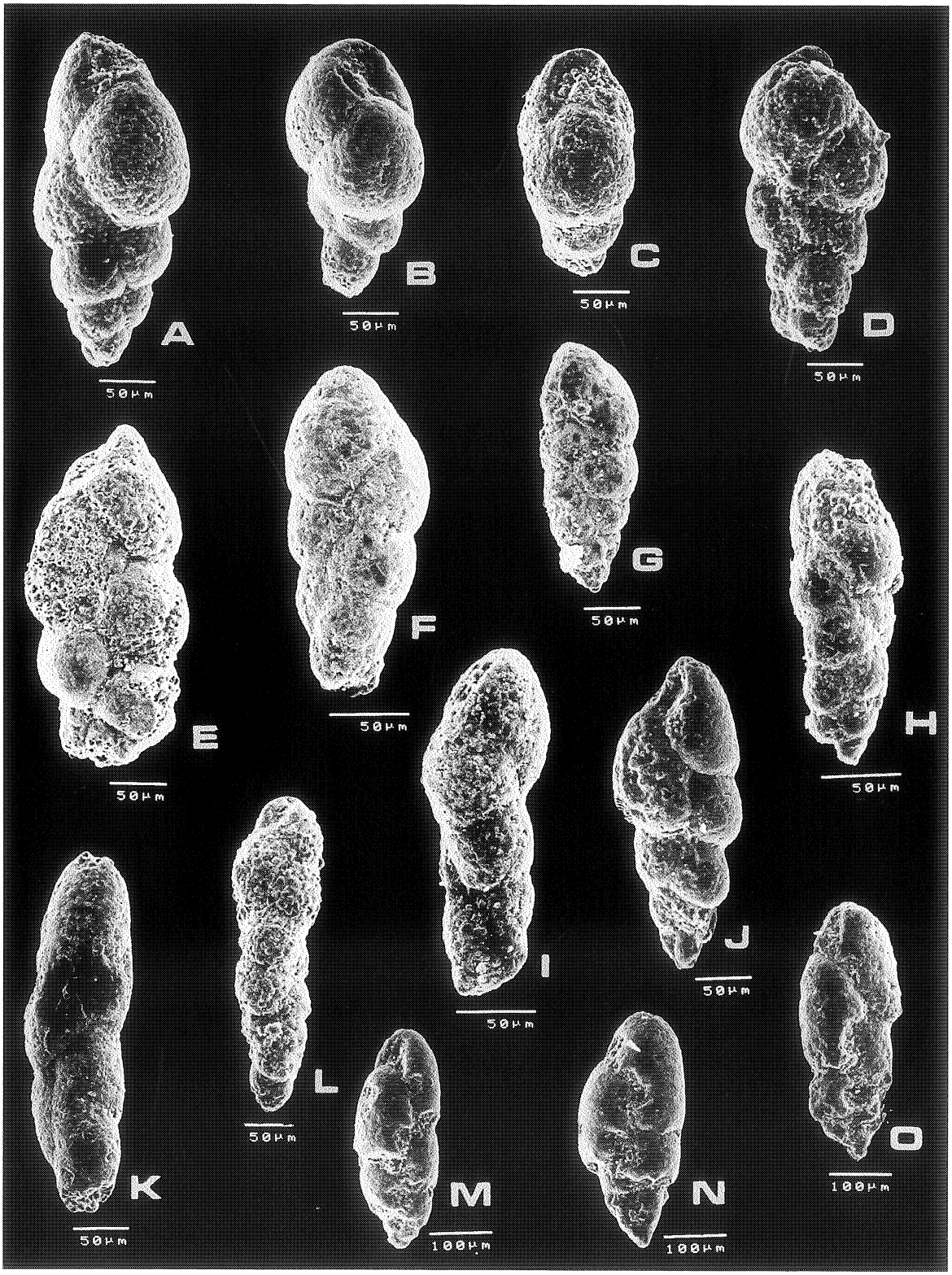

Fig. 9. Late Oligocene calcareous benthic foraminifers from the Krosno Beds. **A-E.** *Bulimina elongata* d'Orbigny, A, B, D, E – sample S-53; C – sample S-56; **F.** *Fursenkoina mustoni* (Andreae) – sample S-56; **G-J.** *Bulimina elongata* d'Orbigny, G, H – sample S-56, I – sample S-55, J – sample S-53; **K.** *Fursenkoina acuta* (d'Orbigny) – sample S-53; **L.** *Bulimina elongata* d'Orbigny – sample S-55; **M-O.** *Virgulinella chalkophila* (Hagn) – sample S-52

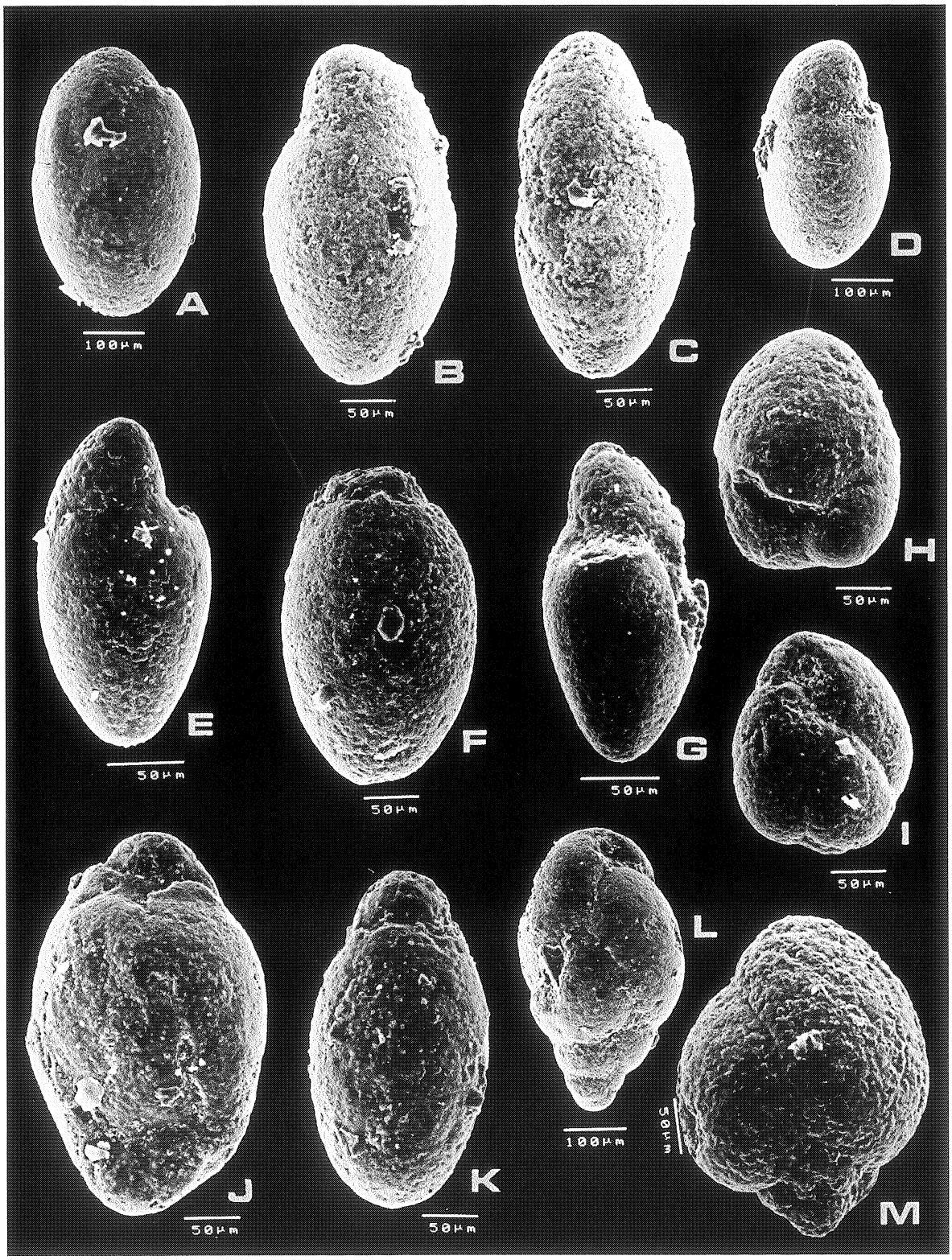

Fig. 10. Late Oligocene calcareous benthic foraminifers from the Krosno Beds. **A-E.** *Chilostomella ovoidea* Reuss, A, B, E – sample S-53, C, D – sample S-55; **F.** *Chilostomella oviformis* (Sherborn & Chapman) – sample S-53; **G.** *Chilostomella* sp. – sample S-51; **H.** *Allomorphina trigona* Reuss – sample S-53; **I.** *Praeglobobulimina bathyalis* (Reiser) – sample S-53; **J, K.** *Chilostomella ovoidea* Reuss – sample S-53; **L.** *Praeglobobulimina pupoides* (d'Orbigny) – sample S-55; **M.** *Praeglobobulimina pyrula* (d'Orbigny) – sample S-53

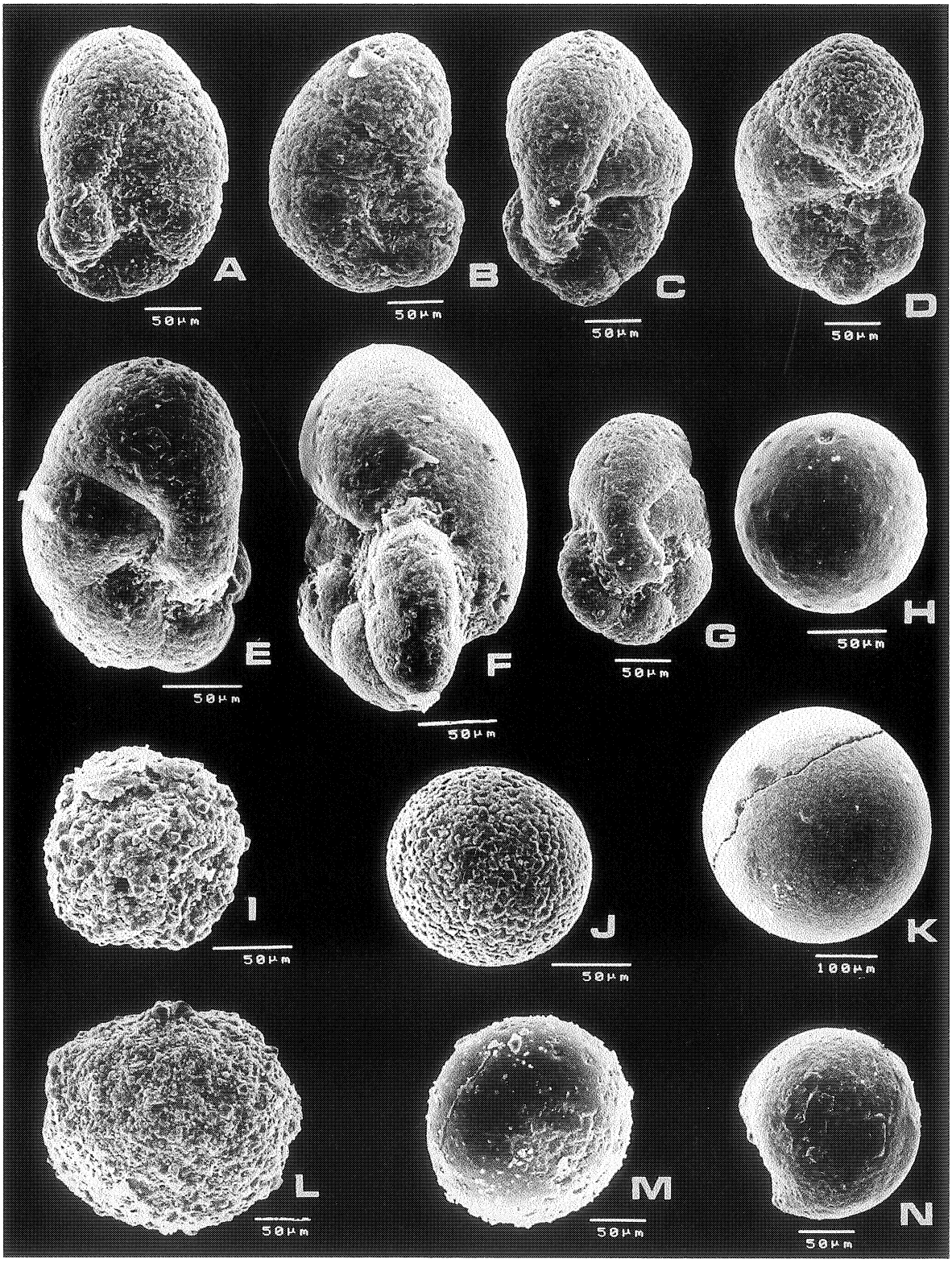

Fig. 11. Late Oligocene calcareous benthic foraminifers, radiolaria and ?meteoric spherules from the Krosno Beds. **A-G.** *Nonionella liebusi* – sample S-55; **H.** *Globulina* sp. A. – sample S-51; **I, J.** Radiolaria, I – sample S-55, J – sample S-56; **K.** ?meteoric spherule – sample S-51; **L, M.** Radiolaria – sample S-51; **N.** ?meteoric spherule – sample S-52

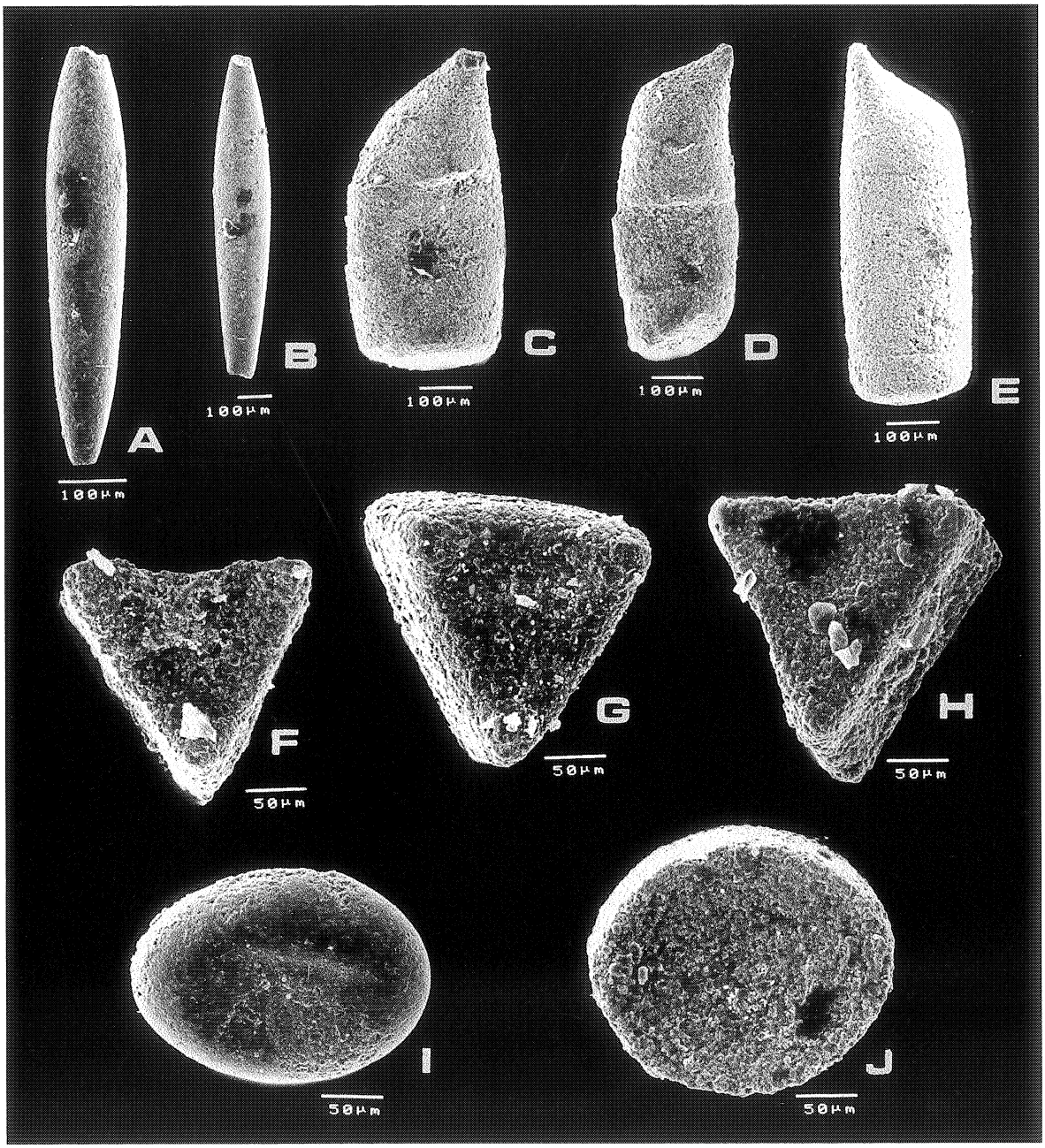

Fig. 12. Late Oligocene diatoms from the Krosno Beds. **A, B.** ?*Pyxilia* sp. – sample S-55; **C-E.** ?*Odontella* sp. – sample S-52; **F-H.** *Triceratium* sp. – sample S-52; **I, J.** Discoid morphotype – sample S-52

1996. *Bulimina elongata* d'Orbigny: Odrzywolska-Bieńkowa & Olszewska, p. 593, pl. 99, fig. 4.

Discription: Test triserial, elongate; length approximately two times width, subcircular in cross-section; chambers elongate, baggy, especially chambers of last three coils; sutures oblique, thin, strongly depressed, wall smooth, finely perforate; aperture loop-like, extending from base of final chamber, with lip.

Measurements (mm): length – 0.2–0.3; width – 0.12–0.15.

Remarks: Specimens from the studied section are significantly smaller than specimens from the collection of d'Orbigny.

Distribution: *Bulimina elongata* was originally described from the Badenian of the Vienna Basin. This species was reported from the lower Oligocene through the middle Miocene of the Central Paratethys (Cicha *et al.*, 1998). Olszewska (1984a, b) described *Bulimina tenera* Reuss (= *B. elongata* d'Orbigny) from around Kiscellian/Egerian boundary of the Polish Outer Carpathians. *Bulimina elongata* occurs in the Zagórz Limestone horizon and in the grey marlstones up to 220 m above this horizon.

Superfamily FURSENKOINACEA Loeblich & Tappan, 1961
Family FURSENKOINIDAE Loeblich & Tappan, 1961

Genus *Fursenkoina* Loeblich & Tappan, 1961

Fursenkoina acuta (d'Orbigny)
Fig. 9 K

1846. *Polymorphina acuta* d'Orbigny: p. 234, pl. 13, figs 4, 5; pl. 14, figs 5-7.
1848. *Virgulina schreibersiana* n.sp.: CŽjŽek, p. 11, pl. 13, figs 18-21.
1985. *Fursenkoina schreibersiana* CŽjŽek: Olszewska, p. 234, pl. 3, fig. 2.
1996. *Fursenkoina schreibersiana* CŽjŽek: Odrzywolska-Bieńkowa & Olszewska: p. 599, pl. 99, fig. 5.
1998. *Fursenkoina acuta* (d'Orbigny): Popescu *et al.*, p. 97, pl. 55, fig. 1.

Description: Test twisted biserial; elongate, narrow in outline; length approximately four times maximum width, elongate in cross-section; nearly cylindrical in outline; five pairs of elongated chambers, increasing rapidly in size; sutures thin, depressed, oblique; wall finely perforate; aperture an elongate slit in face of final chamber.
Measurements (mm): length – 0.28–0.35; width – 0.06–0.08.
Distribution: *Fursenkoina acuta* (as *Polymorphina acuta*) was originally described from the Badenian of the Vienna Basin. This species was reported from the lower Oligocene through the middle Miocene of the Polish Outer Carpathians and the Carpathian Foredeep (Olszewska, 1981, 1984a, b, 1985 1997; Odrzywolska-Bieńkowa & Olszewska, 1996), and from the upper Oligocene through the lower Miocene of the Ukrainian Carpathians (Bobrinskaya *et al.*, 1998). *Fursenkoina acuta* occurs in the Zagórz Limestone horizon and in the grey marlstones up to 220 m above this horizon.

Fursenkoina mustoni (Andreae)
Fig. 9 F

1884. *Virgulina mustoni* Andreae: p. 254, pl. 11, fig. 4.
1987. *Fursenkoina mustoni* (Andreae): Reiser, p. 80, pl. 7, figs 4, 9.

Description: Test twisted biserial; elongate, narrow in outline; length approximately two and one-half times maximum width, elongate in cross-section; four pairs of elongated chambers, increasing rapidly in size; sutures thin, depressed, oblique; wall finely perforate; aperture an elongate slit in face of final chamber.
Measurements (mm): length – 0.2, width – 0.08.
Distribution: *Fursenkoina mustoni* was originally described from the Oligocene of the Lotharyngia. This species was reported from the lower Oligocene through the lower Miocene of the Bavarian Molasse Zone (Rögl *et al.*, 1998). *Fursenkoina mustoni* occurs in the Zagórz Limestone and in the grey marlstones up to 250 m above this horizon.

Family VIRGULINELLIDAE Loeblich & Tappan, 1984

Genus *Virgulinella* Cushman, 1932

Virgulinella chalkophila (Hagn)
Fig. 8 D, H-L; Fig. 9 M-O

1952. *Loxostomum chalkophilum* Hagn: p. 172, pl. 2, fig. 11.
1973. *Loxostomum chalkophilum* Hagn: Blaicher, p. 123, fig. 2, pl. 7, fig. 1.
1980. *Virgulinella chalkophila* (Hagn): Geroch & Nowak, p. 375, text-figs 8.6, 8.7.
1981. *Loxostomum chalkophilum* Hagn: Olszewska, p. 155, pl. 4, fig. 7.
1987. *Virgulinella chalkophila* (Hagn): Reiser, p. 81, pl. 7, figs 16, 20.
1996. *Virgulinella chalkophila* (Hagn): Olszewska *et al.*, p. 161, pl. 27, fig. 11.

Description: Test triserial in early stage, tending toward biserial in later stages, elongate in outline, compressed in cross-section; length approximately two and one-half times maximum width; last three pairs of chambers distinctly larger, increasing gradually in size; sutures deep, wide and meandering in biserial part, oblique to test margins; wall finely perforate; aperture an elongate slit in face of final chamber.
Measurements (mm): length – 0.3–0.6; width – 0.13–0.25.
Distribution: *Virgulinella chalkophila* (as *Loxostomum chalkophilum*) was originally described from the lower Oligocene of the Bavarian Molasse Zone. This species was reported from the upper Kiscelian of the Ždanice Unit (within the Carpathians; Cicha & Ctyroka, 1998) and the Hungarian Paleogene Basin (Báldi, 1998). It was described also from the Oligocene of the Polish Carpathians (Kozikowski, 1958; Jurkiewicz, 1967; Morgiel, 1972; Blaicher, 1973; Liszkowa, 1971; Olszewska, 1984a, b, 1998) and from the upper Oligocene–lower Miocene of the Bavarian Molasse Zone (Reiser, 1987; Rögl *et al.*, 1998). *Virgulinella chalkophila* occurs in the Zagórz Limestone horizon and up to 270 m above this horizon.

Virgulinella karagiensis Mikhailova
Fig. 8 E, F

1968. *Virgulinella karagiensis* Mikhailova: p. 67, text.-figs 1.1-1.17.
1980. *Virgulinella chalkophila* (Hagn): Geroch & Nowak, text.-figs 8.4, 8.5, 8.8.
1987. *Virgulinella chalkophila* (Hagn): Reiser, p. 81, pl. 7, fig. 20.
1996. *Virgulinella karagiensis* Mikhailova: Olszewska *et al.*, p. 162, pl. 27, fig. 14.

Description: Test triserial in a short early stage, tending toward biserial in later stage, elongate in outline, compressed in cross-section; length approximately one and one-half times maximum width; last pair of chambers consist about two-thirds of whole test's length; sutures deep, wide and meandering in biserial part, oblique to test margins; wall smooth, finely perforate; aperture an elongate slit in face of final chamber.
Measurements (mm): length – 0.22–0.3; width – 0.13–0.25.
Distribution: *Virgulinella karagiensis* was originally described from the upper Oligocene of the Crimea. This species was reported from the lower Oligocene of the Polish Outer Carpathians (Geroch & Nowak, 1980; Olszewska *et al.*, 1996). It occurs in the Zagórz Limestone horizon and in the grey marlstones up to 270 m above this horizon.

Superfamily NONIONACEA Schultze, 1854
Family NONIONIDAE Schultze, 1854
Subfamily NONIONINAE Schultze, 1854

Genus *Nonionella* Cushman, 1926

Nonionella liebusi Hagn
Fig. 11 A-G

1952. *Nonionella liebusi* Hagn: p. 161, pl. 2, fig. 10.
1980. *Nonionella liebusi* Hagn: Geroch & Nowak, text-figs 1, 2.
1987. *Nonionella liebusi* Hagn: Reiser, p. 95, pl. 10, figs 8, 9, 12.

Measurements (mm): length – 0.2–0.24; width – 0.14–0.16; thickness – 0.13–0.14.
Remarks: Last chamber of the studied specimens has different shape than those from the Bavarian Molasse Flysch (Reiser, 1987). It is wider in its base, overlapping a part of the older chamber, and it is narrower at its end, covering smaller part of umbilicus.
Distribution: *Nonionella liebusi* was originally described from the Oligocene of the Bavarian Molasse Flysch. This species was reported from the Oligocene of the Krosno Beds in the Polish Outer Carpathians (Geroch & Nowak, 1980; Olszewska, 1982, 1984b). *Nonionella liebusi* occurs in the Zagórz Limestone horizon and in the grey marlstones up to 230 m above this horizon.

Superfamily CHILOSTOMELLACEA Brady, 1881
Family CHILOSTOMELLIDAE Brady, 1881
Subfamily CHILOSTOMELLINAE Brady, 1881

Genus *Chilostomella* Reuss, 1849

Chilostomella ovoidea Reuss
Fig. 10 A-E, J, K

1850. *Chilostomella ovoidea* Reuss: p. 380, pl. 47, fig. 12.
1983. *Chilostomella ovoidea* Reuss: Cicha *et al.*, pl. 14, fig. 3.
1987. *Chilostomella ovoidea* Reuss: Wenger, p. 302, pl. 14, figs 7, 8.
1996. *Chilostomella ovoidea* Reuss: Olszewska *et al.*, p. 192, pl. 30, fig. 17.
1998. *Chilostomella ovoidea* Reuss: Popescu *et al.*, p. 90, pl. 67, figs 15, 16.
1998. *Chilostomella ovoidea* Reuss: Robertson, p. 234, pl. 93, figs 3, 4.

Description: Test planispiral, involute, ovate in outline, circular in cross-section; length approximately one and two-third times width; two chambers per whorl, embracing previous chambers; sutures faint; wall finely perforate; aperture an interiomarginal, crescent slit in face of final chamber.
Measurements (mm): length – 0.2–0.45; maximum width – 0.12–0.28.
Distribution: Originally *Chilostomella ovoidea* was described from the Miocene of Austria. This form has been reported from Oligocene of the Polish Outer Carpathians (Olszewska *et al.*, 1996), from the Eggerian and the Eggenburgian of the Bavarian Molasse Zone. This species has also been found in the lower? Oligocene through the Miocene of the mid-Atlantic (Robertson, 1998). *Chilostomella ovoidea* occurs in the Zagórz Limestone horizon and in the grey marlstones up to 250 m above this horizon.

Genus *Chillostomelloides* Cushman, 1926

Chilostomelloides oviformis (Sherborn & Chapman)
Fig. 10 F

1886. *Lagena (Obliquina) oviformis* Sherborn & Chapman: p. 745, pl. 14, fig. 19 (*fide* Ellis & Messina).
1982. *Chilostomelloides oviformis* (Sherborn & Chapman): Sztràkos, pl. 21, fig. 19.
1987. *Chilostomelloides oviformis* (Sherborn & Chapman): Reiser, p. 96, pl. 11, fig. 6.
1998. *Chilostomelloides oviformis* (Sherborn & Chapman): Popescu *et al.*, p. 90, pl. 67, figs 17-19.

Description: Test planispiral, involute, ovate in outline, nearly circular in cross-section; length approximately one and one-half times width; two chambers per whorl, embracing previous chambers; sutures faint; wall finely perforate; aperture an interiomarginal, flat in face of final chamber.
Measurements (mm): length – 0.29; maximum width – 0.17.
Distribution: Originally *Chilostomelloides ovoiformis* was described from the Eocene of England. This form has been reported from the upper Oligocene of Hungary (Sztràkos, 1982) and from the lower Oligocene of the Bavarian Molasse Zone (Reiser, 1987). Popescu *et al.* (1998) described its stratigraphic range from the base of Oligocene through the younger part of the early Kiscellian. This species occurs in the grey marlstones 220 m above the Zagórz Limestone horizon.

Genus *Allomorphina* Reuss, 1849

Allomorphina trigona Reuss
Fig. 10 H

1850. *Allomorphina trigona* Reuss: p. 380, pl. 48, fig. 14.
1984. *Allomorphina trigona* Reuss: Olszewska, pl. 9, fig. 6.
1987. *Allomorphina trigona* Reuss: Reiser, p. 96-97, pl. 10, figs 13-15.
1996. *Allomorphina trigona* Reuss: Olszewska *et al.*, p. 191, pl. 34, fig. 6.
1998. *Allomorphina trigona* Reuss: Popescu, p. 78, pl. 67, figs 11-14.

Description: Test trochospiral, ovate in outline, subcircular in cross-section; length approximately one and one-third times width; three chambers in last whorl; last chamber comprises two-third of whole test; sutures thin depressed; wall smooth, finely perforate; aperture at a base of final chamber.
Measurements (mm): length – 0.22; maximum width – 0.17.
Distribution: Originally *Allomorhina trigona* was described from the Miocene of Austria. This form has been reported from the Oligocene of the Polish Outer Carpathians (Olszewska, 1981, 1984a, b, 1997) and from the Oligocene of the Bavarian Molasse Zone (Reiser, 1987). Popescu *et al.* (1998) described its stratigraphic range from the late Eocene through the Badenian in the Central Paratethys. This species occurs in grey marlstones 220–240 m above the Zagórz Limestone horizon.

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Streszczenie

PÓŹNOOLIGOCEŃSKIE OTWORNICE Z WARSTW KROŚNIEŃSKICH W PROFILU DOLINY SANU W BIESZCZADACH; JEDNOSTKA ŚLĄSKA, POLSKIE KARPATY ZEWNĘTRZNE

Krzysztof Bąk

Celem niniejszej pracy było określenie wieku najmłodszej części warstw krośnieńskich występujących powyżej wapienia z Zagórza, sprecyzowanie składu zespołu otwornic, określenie ich zasięgów stratygraficznych a także porównanie zespołu otwornic i ich zasięgów z innymi obszarami Centralnej Paratetydy. Dla określenia wieku osadów wykorzystano badania nanoplanktonu wapiennego (Garecka, 1997; Garecka, *inf. niepublik.*).

Prace geologiczne prowadzone w celu wykonania arkusza "Dźwiniacz Górny" Szczegółowej Mapy Geologicznej Polski w skali 1: 50 000 (Haczewski *et al.*, A i B, *oddane do druku*) pozwoliły rozpoznać w obrębie najbardziej południowo-wschodniej części jednostki śląskiej w Bieszczadach dwie głębokie synkliny (synklina Dźwiniacza Górnego i synklina Beniowej), w których występują 1200 m miąższości osady fliszowe górnego oddziału warstw krośnieńskich. W ich obrębie znaleziono dwa poziomy wapieni kokolitowych, wapienia jasielskiego i wapienia z Zagórza. Mogą być one reperem dla celów biostratygraficznych, stanowiąc horyzonty izochroniczne w obrębie serii menilitowo-krośnieńskiej w Karpatach fliszowych. Jeden z tych poziomów występujący na badanym obszarze (wapień z Zagórza), był dla autora markerem w badaniach wieku osadów oraz zasięgów otwornic.

Próbki do badań pobrano z odsłonięć w dolinie Sanu, w rejonie dawnej wsi Dźwiniacz Górny, pomiędzy słupkami granicznymi 300 i 301 (Fig. 1, 2). Miąższość najmłodszej części warstw krośnieńskich w tym profilu (SE skrzydło synkliny Dźwiniacza Górnego) wynosi 410 m (Fig. 3). Jednakże ich najwyższa część nie była dostępna autorowi ze względu na położenie odsłonięć po stronie ukraińskiej. Dolną granicę dla badań stratygraficznych stanowił poziom wapienia z Zagórza (próbki San-57, 56, Tar-1; Fig. 4). Strop górnej części uwzględnionej w tych badaniach jest położony 270 m powyżej poziomu wapienia z Zagórza (próbki San 55-50).

Osady badanej części górnego oddziału warstw krośnieńskich tworzy seria szarych łupków marglistych z podrzędnymi, cienkimi pakietami (10–20 cm) łupków bezwapnistych, typu menilitowego. Udział piaskowców jest nieliczny. Dominują warstwy o miąższości średnio 30 cm, wykazujące najczęściej laminację przekątną i konwolutną. W profilu tym występują również dwie grube ławice (180 cm) rozsypliwego piaskowca bezstrukturalnego. Wapień z Zagórza charakteryzuje obecność jasnokremowej homogenicznej warstewki o grubości 4 cm, znanej z innych odsłonięć w Karpatach (Haczewski, 1989), rozdzielonej 1 mm laminą ilastą. Powyżej tej głównej warstewki, w obrębie 2 metrowego profilu z przewagą szarych łupków marglistych, występuje jeszcze kilkanaście cienkich warstewek wapienia o grubości od 1 do 8 mm (Fig. 4).

W zespołach mikrofauny przeważają otwornice (Fig. 6–11). Ponadto znaleziono promienice (Radiolaria) (Fig. 11), okrzemki (Fig. 12) oraz kolce jeżowców. Cała mikrofauna jest spirytyzowana. Wśród otwornic oznaczono 34 taksony (Tab. 1). Zespół tworzą przede wszystkim otwornice bentosowe wapienne z rodzajów: *Chilostomella*, *Virgulinella*, *Fursenkoina*, *Guttulina*, *Bulimina* i *Praeglobobulimina*. Niektóre z otwornic wapiennych zostały tutaj po raz pierwszy opisane z utworów polskiej części Karpat, a część z nich nie była znana z osadów oligocenu. Dotyczy to form należących do gatunków: *Praeglobobulimina bathyalis* (Reiser), *Bulimina elongata* d'Orbigny, *Chilostomelloides oviformis* (Sherborn & Chapman), *Oolina globosa* (Montagu) i *Lagena* cf. *striata*.

Otwornice aglutynujące, z wyjątkiem form rurkowatych w próbie San-51, praktycznie nie występują w badanych osadach (Tab. 1). Znaleziono jedynie pojedyncze formy z rodzaju ?*Saccammina* sp. (Fig. 8).

Plankton otwornicowy jest reprezentowany przede wszystkim przez małe, gładkościenne ośródki tenuitelli (Fig. 6, 7): *Tenuitella liverovskae* (Bykova), *T. inaequiconica* (Subbotina), *T. munda* (Jenkins), *Tenuitellinata angustiumbilicata* (Bolli), *T. postcretacea* (Mjatliuk) oraz gatunki *Globigerinella evoluta* Subbotina, *Paragloborotalia opima nana* (Bolli).

Ośródki promienic znalezione w badanych próbkach są nieoznaczalne (Marta Bąk; *inf. ustna*), bowiem krzemionka została zastąpiona dużymi fromboidami pirytu. Udział promienic w zespole zmienia się pomiędzy 2 i 93%.

Wśród spirytyzowanych szkieletów okrzemek większość należy ze względu na kształt do gonioidów. Są one reprezentowane przez duże formy triangularne z rodzaju *Triceratium* (Fig. 12F-H) oraz elipsoidalne z rodzaju ?*Odontella* (Fig. 12C-E). Znaleziono również okrzemki dyskoidalne i linearne (?*Pyxilia* sp.), które ze względu na brak widocznych szczegółów struktury szkieletu, nie mogły zostać bliżej zaklasyfikowane. Ogółem, udział okrzemek sięga do około 22% zespołu składników biotycznych.

Wiek badanych osadów określono na podstawie nanoplanktonu wapiennego i otwornic planktonicznych.

Wiek wapienia z Zagórza, ze względu na występowanie w obrębie nanoplanktonu wapiennego bardzo licznych form z gatunku *Cyclicargolithus floridanus*, form przejściowych pomiędzy *Cyclicargolithus abisectus* i *C. floridanus* a także *Reticulofenestra lockeri* został określony przez Garecką (1997; oraz *inf. niepubl.*) na co najmniej poziom NP 24 *sensu* Martini (1971). Taki sam wiek ma starszy, również izochroniczny poziom wapienia jasielskiego, którego dane biostratygraficzne były określane w innych profilach polskiej i słowackiej części Karpat fliszowych (np., Krhovský, 1981; Olszewska, 1984; Jugowiec, 1996). Odpowiada to w przybliżeniu granicy rupelu i chatu w obszarze medyterańskim (Berggren *et al.*, 1995) lub granicy kiscellu i egeru w centralnej części Paratetydy (Báldi, 1969, 1979).

Na taki wiek wskazuje również zespół otwornic planktonicznych w próbkach z łupków rozdzielających kokolitowe warstewki wapienia z Zagórza, w obrębie którego odnotowano ostatnie pojawienie się gatunku *Paragloborotalia opima nana*. W słowackiej i polskiej części Karpat, moment ostatniego pojawienia się tego gatunku opisano dotychczas właśnie w pobliżu granicy kiscellu i egeru (Olszewska, 1997, 1998; Cicha, 1998). Jednym z markerów tej granicy jest również ostatnie pojawienie się otwornicy planktonicznej *Paragloborotalia opima opima* (Rögl, 1998). W badanych próbkach nie znaleziono okazów tego gatunku, co mogłoby potwierdzać powyższe dane stratygraficzne. Ten ostatni fakt należy jednak traktować ostrożnie, bowiem brak tej formy w osadach może być związany ze zmianami pewnych parametrów środowiska (np. temperatury) w tej części Paratetydy lub też możliwy jest udział czynników tafonomicznych uniemożliwiających zachowanie się skorupek tego gatunku.

Wiek wyższej części badanych osadów jest trudny do określenia. Zespół nanoplanktonu wapiennego nie różni się zbytnio od tego z wapienia z Zagórza (z wyjątkiem częstości występowania poszczególnych taksonów; Garecka, 1997; Garecka *inf. niepubl.*). Brak jest niestety w obrębie Paratetydy gatunków wskaźnikowych dla najwyższego oligocenu (poziomu NP25; Rögl, 1998). Nie znaleziono również gatunków z wczesnego miocenu. Wśród planktonu otwornicowego, nie występują już formy z rodzaju *Paragloborotalia opima nana*, ale nie znaleziono również taksonów znanych z wczesnego miocenu (zob. Garecka & Olszewska, 1998). Interesujący jest natomiast fakt obecności otwornic planktonicznych z gatunku *Tenuitella liverovskae, T. munda i Tenuitellinata angustiumbilicata*, których moment ostatniego pojawienia się był odnotowywany nieco wcześniej w polskiej części Karpat fliszowych, tj. w poziomie wapienia jasielskiego (Olszewska, 1998). W badanych profilach występują one w osadach około 350 m powyżej wapienia jasielskiego. W próbce pobranej w obrębie poziomu wapienia z Zagórza znaleziono rów- nież gatunek *Globigerinella evoluta* Subbotina, którego znaczenie stratygraficzne nie jest jeszcze w pełni jasne (Popescu *et al.*, 1998).

Skład zespołu otwornic bentonicznych w badanych próbach bardzo przypomina ten opisany przez Olszewską (1985) jako "zespół bentosu I" z warstw menilitowych. Dominacja form o kształtach cylindrycznych i stożkowych, żyjących jako infauna, wskazuje na niską zawartość tlenu w wodach przydennych i w najwyższej części osadu. Duży udział okazów z rodzaju *Praeglobobulimina* i *Chilostomella* może być ponadto wskaźnikiem sedymentacji badanych osadów w strefie batiału (Reiser, 1987).