Annales Societatis Geologorum Poloniae (2005), vol. 75: 71–93.

FORAMINIFERAL BIOSTRATIGRAPHY OF THE EGERIAN FLYSCH SEDIMENTS IN THE SILESIAN NAPPE, OUTER CARPATHIANS, POLISH PART OF THE BIESZCZADY MOUNTAINS

Krzysztof BĄK

Institute of Geography, Cracow Pedagogical University; Podchorążych 2, 30-084 Kraków, Poland; sgbak@cyf-kr.edu.pl

Bąk, K., 2005. Foraminiferal biostratigraphy of the Egerian flysch sediments in the Silesian Nappe, Outer Carpathians, Polish part of the Bieszczady Mountains. *Annales Societatis Geologorum Poloniae*, 75: 71–93.

Abstract: Planktonic and benthic Foraminifera have been studied from the youngest deposits of the Krosno beds in the inner part of the Silesian Nappe (Outer Carpathians) in the Bieszczady Mountains. The studied part of the Krosno beds consists of Egerian (upper Oligocene–lower Miocene) flysch sediments, deposited within the Outer Carpathian Basin, a part of the Central Paratethys. Two interval zones: *Tenuitella munda* Zone and *Globigerinelloides primordius* Zone have been distinguished basing on the succession of planktonic Foraminifera. Additionally, *Paragloborotalia inaequiconica* Interval Subzone has been defined within the first one. Occurrence of calcareous nannoplankton, dinocyst assemblages and isochronous horizons of coccolith limestones (the Jasło Limestone and Zagórz Limestone) enabled correlation of the planktonic foraminiferal zones with chronostratigraphy. The boundary between the two distinguished zones corresponds to the base of NN1 nannoplankton Zone (defined by the occurrence of *Helicosphaera scissura*) equivalent to the Oligocene/Miocene boundary. The base of the *P. inaequiconica* Subzone corresponds to the position of the Zagórz Limestone, refferred to NP 24 Zone (early Egerian).

The benthic foraminiferal assemblages are dominated by bathyal, calcareous, hyaline, smooth-walled taxa, indicative of anoxic environment. The benthic assemblages remained relatively stable throughout the late Oligocene and were more diversified during the earliest Miocene, most probably in response to the oxygenation of bottom waters, due to the opening of new connections between the Central Paratethys and the Mediterranean region.

Key words: Foraminifera, biostratigraphy, Egerian, Outer Carpathians, Central Paratethys, Bieszczady Mountains.

Manuscript received 30 July, 2004, accepted 21 January 2005

INTRODUCTION

Plate tectonic processes at the end of the Eocene were the reason for the vanishing of the Western Tethys. The continuing collision of the European and African plates resulted, among others, in the birth of the Paratethys Sea, in front of the northwards advancing orogenic belts (Dercourt *et al.*, 1993). The Paratethys Sea had restricted connections with the surrounding deep basins, mainly the Mediterranean Sea (cf. palaeogeography by Rögl, 1998b), which led to the evolution of largely endemic faunas and floras (cf. Jones & Simmons, 1996), assigned to the Paratethys bioprovince. This renders stratigraphic correlation between the established standard Mediterranean and the Paratethyan stages difficult (cf. Andreyeva-Grigorovich & Gruzman, 1994; Rögl, 1998a; Garecka & Olszewska, 1998).

In the Polish part of the Carpathians, a restricted basin (a part of the Central Paratethys Sea) with deposition of organic-rich Menilitic Shales was formed at the beginning of the Oligocene. During the early late Oligocene, this synorogenic basin became filled with a thick series of micaceous calcareous sandstones and grey marlstones, known as the Krosno beds. These facies are diachronous across the Outer Carpathian subbasins, including the older Fore-Magura, Dukla, Silesian-Subsilesian, and Skole-Tarcau subbasins.

The present paper presents the significance of planktonic Foraminifera in stratigraphy of the uppermost part the Krosno beds in the Silesian-Subsilesian subbasin. These sediments, which are youngest in this unit, have been studied within the eastern, internal part of the Silesian Nappe in the Bieszczady Mountains, near the Polish/Ukrainian boundary.

These results are a continuation of the author's earlier research (Bąk, 1999), undertaken in the area built up of the thickest succession of flysch sediments, overlying the isochronous coccolith limestone bands. These isochronous horizons are used here as markers for estimation of the stratigraphical ranges of planktonic Foraminifera.

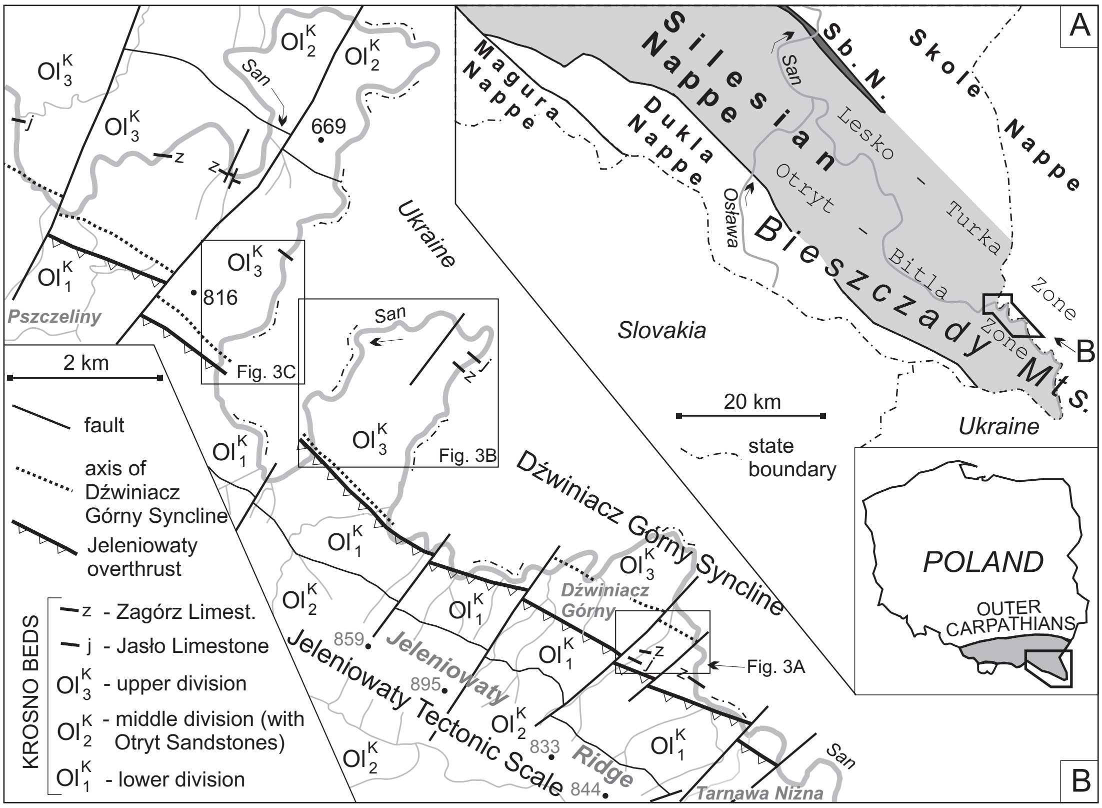

Fig. 1. Location of the studied area. **A** – Position within the Polish part of the Outer Carpathians. **B** – Geological map of the studied area (after Haczewski *et al.*, A, C, *submitted to print*; Haczewski, 1972; summarised). Sb. N. – Subsilesian Nappe

The biostratigraphical data on the youngest sediments in this region are very scarce (Morgiel, 1972, 1973; Bąk *et al.*, 1998; Bąk, 1999). Most of thedata about the stratigraphy of the Krosno-Menilite series come from more external parts of the Outer Carpathians (e.g., Olszewska, 1982a, 1984a, 1985, 1998; Kotlarczyk & Kaczmarska, 1987; Koszarski *et al.*, 1995; Ślęzak *et al.*, 1995; Garecka & Olszewska, 1998).

GEOLOGICAL SETTING

The Silesian Nappe, one of the largest tectonic units of the Outer Carpathians, belongs to the middle group of nappes (the so-called Menilite-Krosno group). This nappe consists of a succession of the Upper Jurassic through Miocene flysch deposits. The southeastern part of the Silesian Nappe in the Bieszczady Mountains is built up of at least a 3.5 km-thick sequence of flysch deposits, represented by the Krosno beds. These sediments include a series of Oligocene thick-bedded sandstones (more than 1.5 km thick; the so called Otryt Sandstones – used as a base for the division of the Silesian Nappe in two parts: the inner, one called Bieszczady zone or Otryt-Bitla zone (with the Otryt Sandstones) and the outer, one called Lesko-Turka zone (without them; Żytko, 1968, 1999) (Fig. 1A). The Bieszczady zone extends westward to the Osława and Hoczewka Rivers (in Poland) and eastward to the upper drainge basin of the Terebla River (in Ukraine) over a distance of about 150 km (Żytko, 1999). Its southern limit is the overthrust of the Dukla Nappe; the northern limit is defined by the outermost thrust sheets with the Otryt Sandstones. The Bieszczady zone extends for 15 to 20 km in a transversal section, including several folds and thrust sheets.

The study area lies within the Dźwiniacz Górny Syncline (Haczewski, 1972; Haczewski *et al.*, *submitted to print*, A–D), which is the outermost fold within the Bieszczady zone of the Silesian Nappe (Fig. 1). This syncline contains a thick series of the Krosno beds, dominated by carbonate-rich, polymictic sandstones and grey marlstones. In the Polish part of the Bieszczady Mts, the Krosno beds have been subdivided into three informal lithostratigraphic units (Fig. 2), named as the lower, middle and upper divisions (Żytko, 1968). The lower division of the Krosno beds (up to 700 m thick) consists of medium- and thin-bedded sandstones and marlstones. The characteristic feature of the middle division (up to 1,300 m thick) is the presence of intercalations of thick-bedded, polymictic sandstones – the Otryt Sandstones. The upper division (up to 1,200 m thick), whose uppermost part was examined during these studies, consists mostly of non-fissile marlstones with convolute- and cross-laminated, thin-bedded sandstones. Thick-bedded, medium-grained, structureless sandstones, locally including clasts of laminated mudstone and medium-bedded ferroan dolomites are rare. Black, marly and non-calcareous shales with 2–3 cm thick concretions (whirl-balls) occur subordinately in a series of 1–2 m thick intercalations. The highest part of the upper division in the Dźwiniacz Górny

Syncline includes lenticular packages of thick-bedded, medium-grained, massive and parallel-laminated sandstones (up to 30 m thick).

The middle part of the upper division of the Krosno beds includes two horizons with coccolith limestone bands – the Jasło and the Zagórz limestones. The Jasło Limestone is present in two limbs of the Dźwiniacz Górny Syncline (Fig. 1). It is situated 370 m above the lower boundary of the upper division in the southwestern limb and 750 m in the northeastern limb of the syncline. The Zagórz Limestone occurs *ca.* 120 m above the Jasło Limestone in the same area. The Jasło and Zagórz limestones are widely used as isochronous regional markers within the Oligocene deposits of the Outer Carpathians (e.g., Jucha, 1958, 1969; Koszarski & Żytko, 1959, 1961; Jucha & Kotlarczyk, 1961; Haczewski, 1984, 1989).

The micropalaeontological studies have been carried out on the samples collected in four sections of the Dźwiniacz Górny Syncline: the Dźwiniacz Górny, Kiczera Dydiowska, and Czeresznia sections (Fig. 1). The sections are situated between the Pszczeliny (to the northwest) and Tarnawa Niżna (to the southeast) villages, along the San River (state boundary between Poland and Ukraine) and its tributaries. Another section, located on the San River at the site of the now-extinct village of Dźwiniacz Górny (Bąk, 1999) was additionally used in stratigraphic analyses.

Dźwiniacz Górny section

The section lies within the southwestern limb of the Dźwiniacz Górny Syncline, along the left tributary which flows from the Jeleniowaty ridge (Figs 3A, 4). It comprises 420 m thick deposits of the upper division of the Krosno beds. The section includes two isochronous horizons of coccolith limestones. The first one, the Jasło Limestone horizon, consists of one layer of laminated micritic limestone, about 20 cm thick, and a few laminated limestone layers, 1–12 mm thick, dispersed in 170 cm of grey marlstones with some thin-bedded, parallel-laminated mudstones. Tectonic disturbances in the shales point to a possible tectonic reduction within the Jasło horizon at this section.

The Zagórz Limestone horizon consists of a characteristic, 4 cm thick non-laminated limestone layer and a few 1–5 mm thick, non-laminated limestone layers dispersed in 120 cm of grey and dark-grey marly shales and rare, thin-bedded laminated mudstones.

The uppermost part of the section, from which the microfossil data are presented here, lies 170 m above the Zagórz Limestone. However, a small change in the strike of the layers (see Fig. 3A) may suggest a tectonic shortening of this succession.

Kiczera Dydiowska sections

Two sections have been sampled within the northeastern limb of the Dźwiniacz Górny Syncline (Figs 3B, 5). They are situated along the San River, on both sides of the Kiczera Dydiowska Hill, between boundary posts 316 and 325. The first section lies west of the Kiczera Dydiowska Hill and includes a 190 m-thick succession of the upper division of the Krosno beds, with the Jasło and Zagórz limestone horizons. These horizons were described by Haczewski (1971). The second section is situated in the eastern part of San River meander. The sediments of this section, 1050 m thick, belong to the uppermost part of the upper division of the Krosno beds. Two packages, several dozen metres thick, of thick-bedded (up to 2 m), medium-grained massive and parallel- to convolute-laminated sandstones with intercalations of grey marlstones occur in the upper-

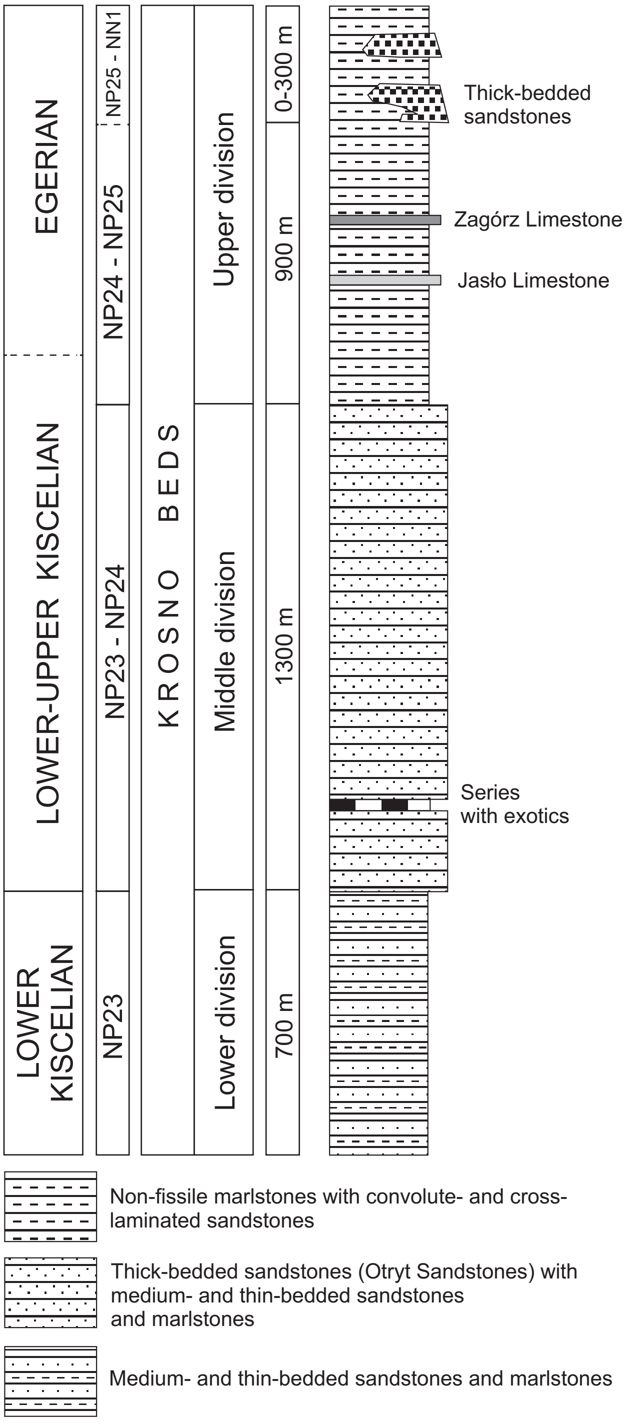

Fig. 2. Lithostratigraphical profile of the the Krosno beds in the eastern part of the Bieszczady Mountains (Poland) with calcareous nannoplankton zonation (after Haczewski *et al.*, A, *submitted to print*)

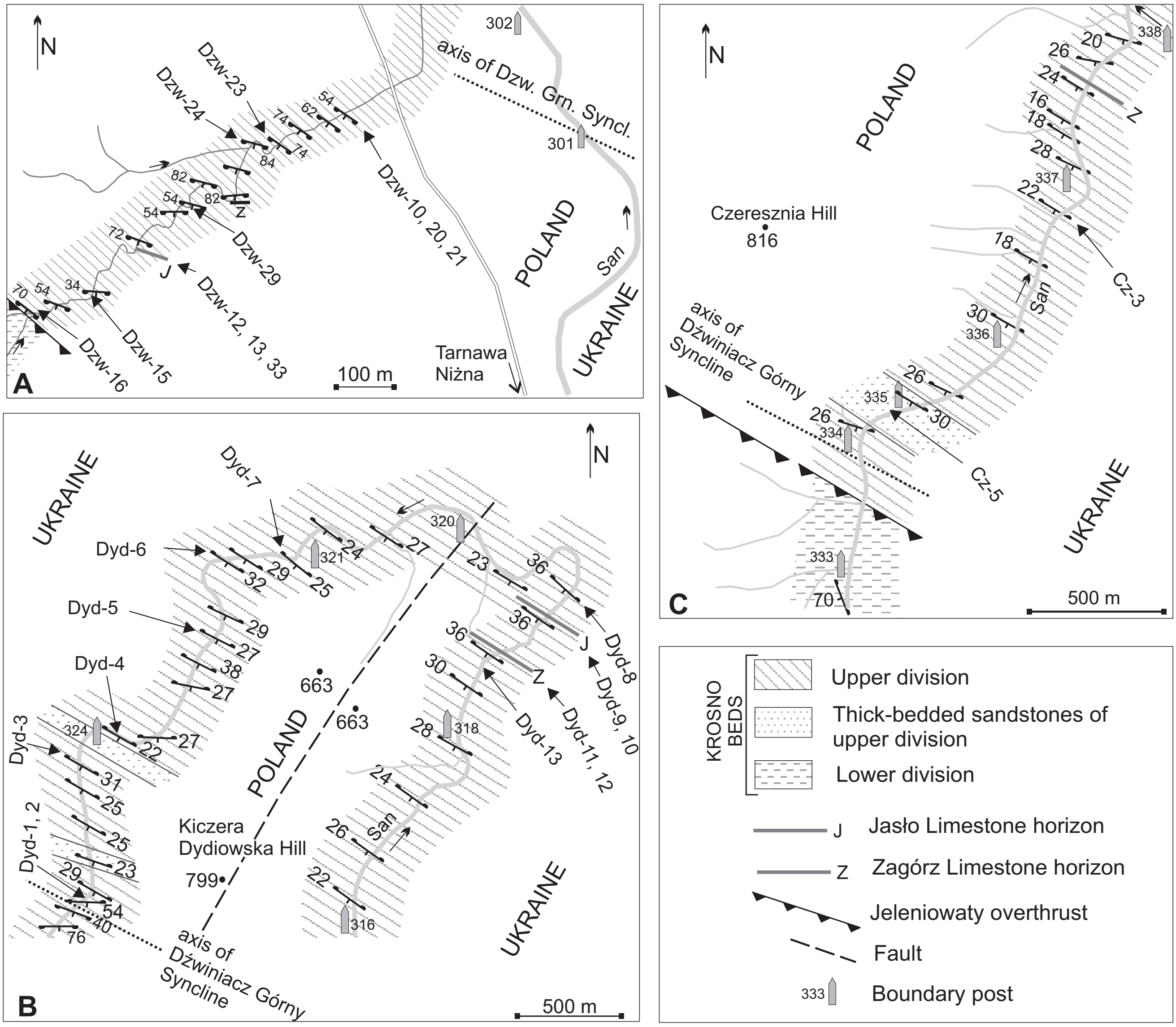

Fig. 3. Detailed geological maps of the Dźwiniacz Górny Syncline (DGS) with posision of studied samples (A, B after K. Bąk in Haczewski *et al.*, A, *submitted to print*). **A** – Dźwiniacz Górny section; southwestern limb of the DGS; **B** – two sections around the Kiczera Dydiowska Hill; northeastern limb of the DGS; **C** – section along the San River, to SE of the Czeresznia Hill; norteastern limb of the DGS

most part of the section. These packages are a characteristic element in all sections of the upper division of the Krosno beds in the Bieszczady Mountains.

Czeresznia section

The section is situated on the left bank of the San River east of the Czeresznia Hill, between boundary posts 334 and 338 (Figs 3C, 6). It includes the youngest part of the upper division of the Krosno beds, above the Zagórz Limestone.

The Zagórz Limestone is poorly exposed in this section, in the 0.5 m high Holocene terrace. The horizon includes a characteristic, 4 cm thick, non-laminated limestone layer and a few 1–8 mm thick limestone layers, dispersed in *ca.* 1.5 m of thick, grey, marly shales and thin-bedded, parallel-laminated mudstones. The upper division of the Krosno beds is 690 m thick in the Czeresznia section, including in its uppermost part a 110 m thick package of thick-bedded (up to 2 m), medium-grained, massive and parallel- to convolute-laminated sandstones, bearing intercalations of grey marlstones.

MATERIAL AND METHODS

Twenty-six samples taken from three sections were collected for foraminiferal studies (Figs 4–6). The samples from these sections were examined earlier for calcareous nannoplankton (Garecka in Haczewski *et al.*, B, D, *submitted to print*) and for dinocysts (Gedl; in Haczewski *et al.*, B, *submitted to print*). These data are used here for comparison of stratigraphical ranges of planktonic Foraminifera. The calcareous nannoplankton, dinocyst and – partly – foraminiferal assemblagess were studied in the course of mapping for the Detailed Geological Map of Poland (Dźwiniacz Górny Sheet; Haczewski *et al.*, *submitted to print*, B, D).

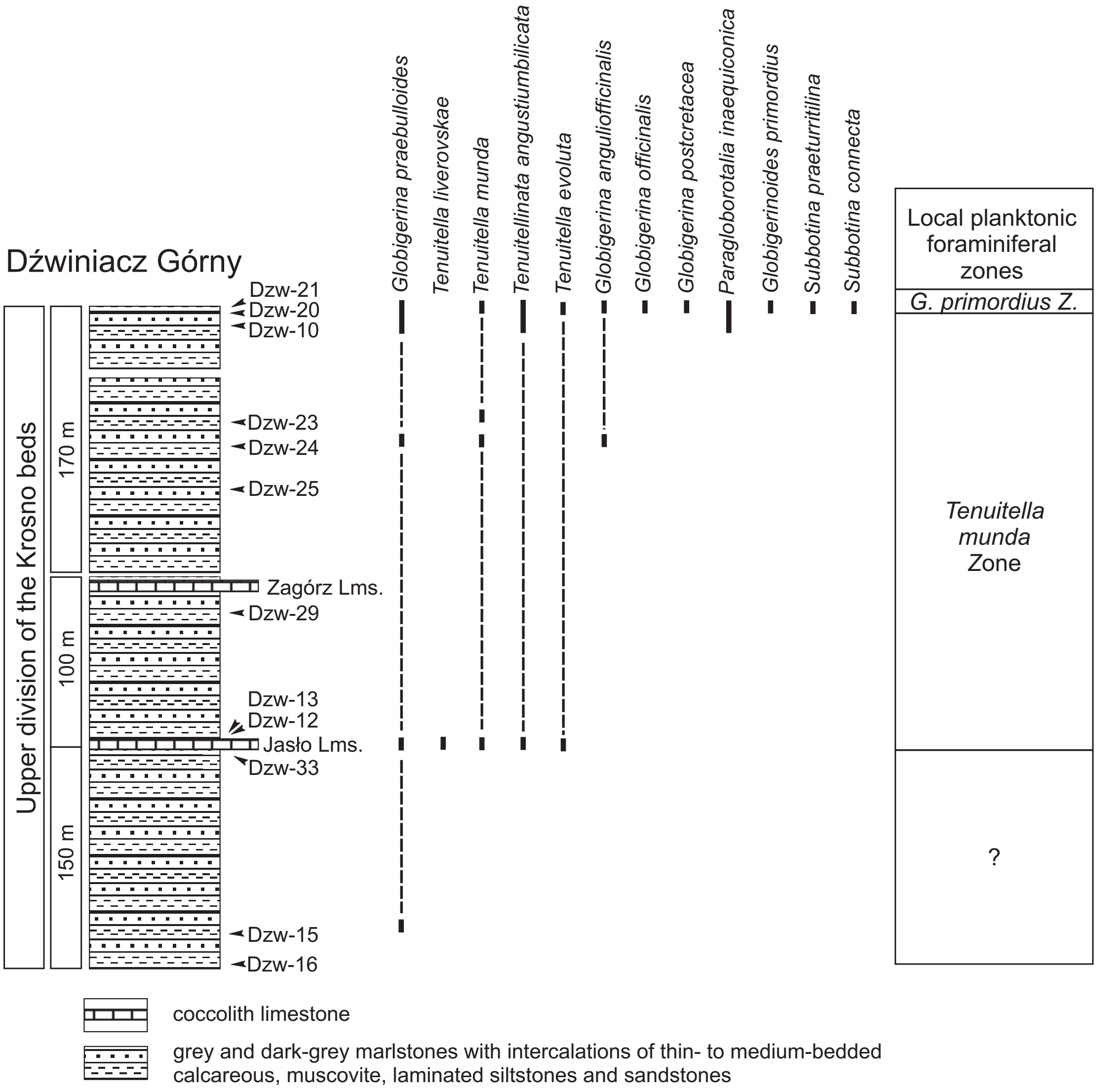

Fig. 4. Lithostratigraphic log of the Dźwiniacz Górny section with ranges of planktonic Foraminifera

The samples for foraminiferal analyses, 500–750 g each, were dried and disintegrated in solution of sodium carbonate. The material was then washed through sieves with mesh diametres 63 µm and 1.5 mm. The microfauna were picked from the 0.063–1.5 mm fraction and mounted on cardboard slides for microscopic examination. At least 300 foraminiferal tests were picked, except for the samples where Foraminifera were extremely rare.

The microfaunal slides are housed in the Institute of Geography, Cracow Pedagogical University (collection No 10Sl).

RESULTS

The foraminiferal assemblages listed below are referred to a few parts of the studied sections, whose boundaries make up the isochronous regional coccolith limestone horizons – the Jasło Limestone and the Zagórz Limestone (Koszarski & Żytko, 1959, 1961; Jucha & Kotlarczyk, 1961; Haczewski, 1984, 1986, 1989).

Foraminiferal assemblage below the Jasło Limestone

Generally, foraminiferal assemblages are very scarce in the Oligocene flysch sediments of the Krosno beds below the Jasło Limestone. Several samples taken from the studied sections were devoid of Foraminifera. One sample included pyritized moulds of originally calcareous benthic Foraminifera, including *Fursenkoina mustoni* (Fig. 7L–P), *Bulimina tenera* (Fig. 8G, J), *Chilostomella ovoidea*, *Allomorphina trigona* (Fig. 9J), *Virgulinella chalkophila* (Fig. 8E, F), *Praeglobobulimina pyrula* (Fig. 9E), and single planktonic forms, such as *Globigerina praebulloides*. One sample taken a dozen metres below the Jasło Limestone (s. Dyd-8; Table 2) includes a very rich and diversified assemblage of both planktonic and benthic Foraminifera. The planktonic forms consist of numerous globigerinids, such as *Globigerina praebulloides* (Fig. 11M, R), *G. ouachitaensis* (Fig.11J–L), *G. officinalis* (Fig. 12M, N) and *G. postcretacea*, as well as numerous small tenuitellids, mainly *Tenuitella munda* (Fig. 12C–E) and *T. liverovskae*, and a few specimens of *Paragloborotalia opima nana* (Fig. 11D) and

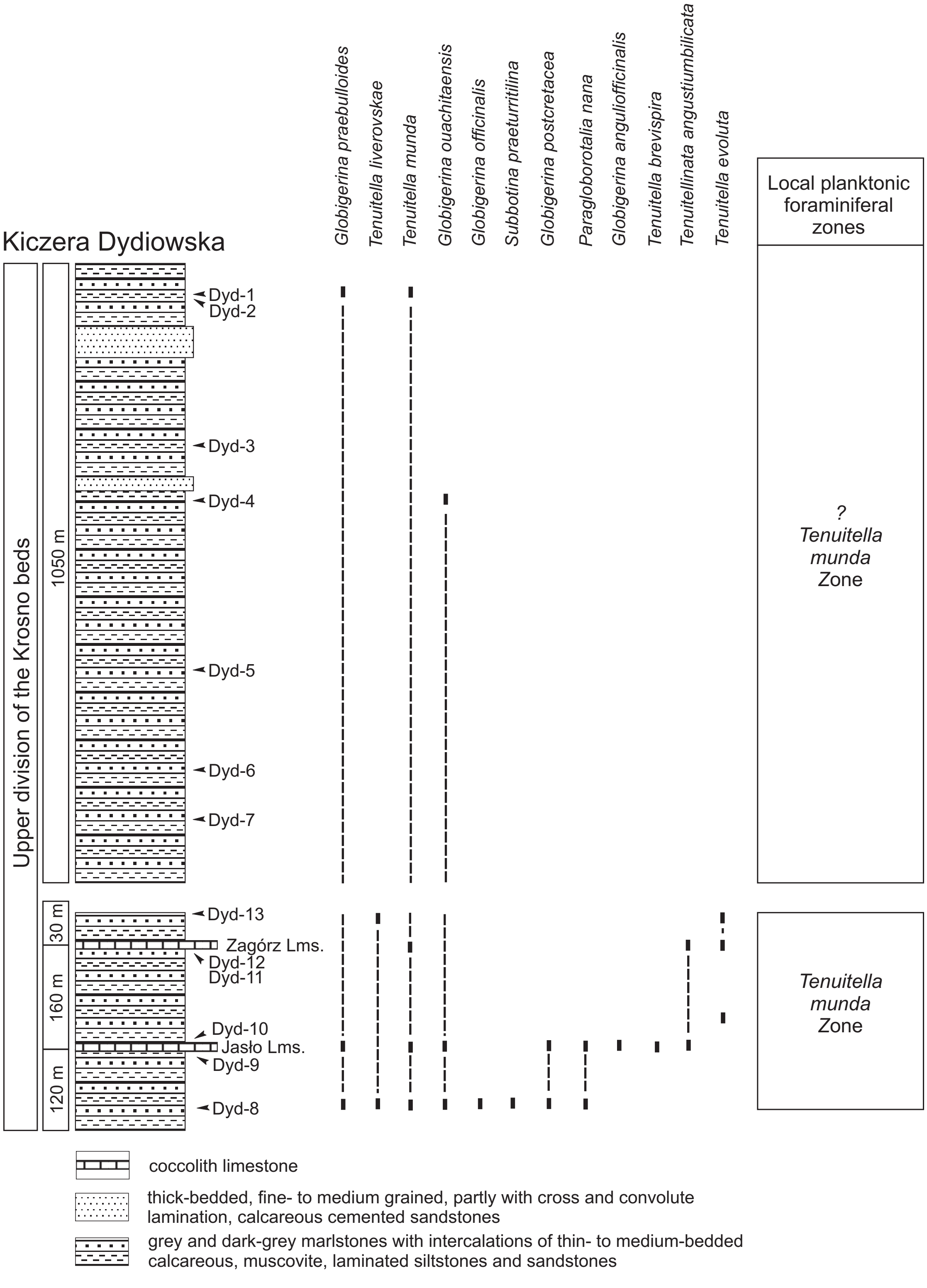

Fig. 5. Lithostratigraphic log of the Kiczera Dydiowska sections with ranges of planktonic Foraminifera

Subbotina praeturritilina (Fig. 11A). Benthic Foraminifera, also diversified, consist of well preserved, pyritized, originally calcareous, hyaline smooth-walled forms. They are dominated by *Virgulinella chalkophila*, *V. karagiensis*, *Chilostomella ovoidea* (Fig. 9P), *Allomorphina trigona* and *Nonionella liebusi*, accompanied by *Bolivina subtumida*, *B.* ex gr. *bayerichi* (Fig. 10A), *B.* cf. *molassica* (Fig. 10B), *Bulimina coprolithoides*, *B. elongata*, *B. tenera* (Fig. 8G, J), *Praeglobobulimina pupoides*, *Anomalinoides granosus*, *Biapertobis alteconicus*, *Cibicidoides* sp., and *Stilostomella* cf. *emaciata* (Fig. 7F).

Foraminiferal assemblage from the Jasło Limestone

Microfauna from calcareous shales within the studied Jasło Limestone horizons consists of abundant planktonic Foraminifera whose numbers vary from sample to sample. For example, sample Dyd-10 includes only planktonic forms (Table 2), and the other samples are enriched in benthic forms with scarce planktonic ones (ss. Dzw. 33, 12, 13; Table 1). Taxonomically, the planktonic Foraminifera are similar to those in the underlying sediments (Table 3), with single specimens of new taxa, such as *Globigerina anguliofficinalis* (Fig. 11B), *Tenuitella brevispira* (Fig. 10K), *T. evoluta*, *T. liverovskae* (Fig. 10C, D), and *Tenuitellinata angustiumbilicata*. The benthic assemblage is less diversified and less numerous in comparison to the underlying deposits, though there occur other forms, not found in the older deposits, belonging to *Praeglobobulimina bathyalis* (Fig. 9B, D) and *P. pyrula* (Fig. 9E).

Foraminiferal assemblage from the Zagórz Limestone

Significantly less numerous and less diversified Foraminifera have been recovered from the shales around the main, 4 cm thick, non-laminated coccolith limestone layer of the Zagórz Limestone (Tables 1–3). Only single specimens of *Tenuitella munda*, *T. evoluta* and *Tenuitellinata angustiumbilicata* have been found there. In the neighbouring San section at Dźwiniacz Górny (Bąk, 1999), the shales include also *Paragloborotalia inaequiconica* and *Paragloborotalia opima nana*. Benthic Foraminifera are poorly diversified in this horizon, including numerous *Virgulinella chalkophila* and *V. karagiensis* (Fig. 8D), and a few specimens of *Chilostomella ovoidea*, *Nonionella liebusi*, *Praeglobobulimina* sp., *Stilostomella* sp., and *Bathysiphon* sp.

Foraminiferal asssemblage above the Zagórz Limestone

Planktonic Foraminifera are scarce and poorly diversified in the highest part of the studied sections above the Zagórz Limestone (Tables 1–3). The most frequent species is *Globigerina praebulloides* (Fig. 11N–P), accompanied (a few specimens per sample) by *Subbotina* ex. gr. *tapuriensis*, *Tenuitella evoluta*, *T. munda* (Fig. 12F, L), *T. liverovskae* (Fig. 10C), *Paragloborotalia inaequiconica*, and *Catapsydrax* sp. (Fig. 12P). The planktonic assemblage differs from that in the coccolith limestones in the occurrence of *Paragloborotalia inaequiconica*. This species appears in the Zagórz Limestone and occasionally occurs higher up in the sections. The assemblage of benthic Foraminifera practically does not change. The most numerous are *Virgulinella chalkophila* (Fig. 8E), *Chilostomela ovoidea*, *Fursenkoina mustoni* (Fig. 7M, N, P), accompanied by *Nonionella liebusi* (Fig. 7H, I), *Virgulinella karagiensis*, *Stilostomella* cf. *emaciata* (Fig. 7E), *Laevidentalina communis* (Fig. 7D), and tubular agglutinated forms, such as *Rhabdammina* sp. (Fig. 7A), *Bathysiphon* sp. (Fig. 7C), and *Reophax* sp. (Fig. 7B).

Foraminiferal assemblage from the youngest deposits

Three samples (Dzw-10, 20, 21), taken from deposits at the top of the preserved sequence in the Dźwiniacz Górny Syncline (SW limb) contain a more diversified and numerous foraminiferal assemblage (Table 1). Planktonic Foraminifera and some benthic forms are only partly pyritized. Planktonic foraminiferal assemblage includes a single specimen, important for stratigraphy, of *Globigerinoides primordius* (Fig. 12A, B), accompanied by *Paragloborotalia inaequiconica* (Fig. 10F–H), *Tenuitella evoluta* (Fig. 10E), *T. munda*, *Globigerina praebulloides*, *G. postcretacea*, *G. officinalis*, *G. anguliofficinalis*, *Subbotina connecta* (Fig. 10N), and *S. praeturritilina*.

Benthic Foraminifera are also more diversified. Some taxa – ?*Cyclophorina* sp. (Fig. 7K) and *Gyroidinoides mamilatus* (Fig. 7J) – appeared here for the first time.

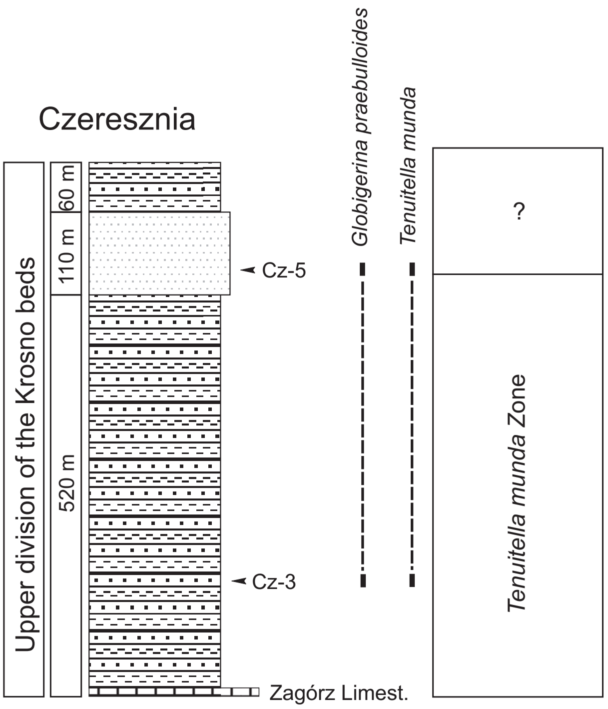

Fig. 6. Lithostratigraphic log of the Czeresznia section with ranges of planktonic Foraminifera; for lithological symbols – see Fig. 5

OTHER MICROFOSSILS

Radiolarians, diatoms and bolboforms

Pyritized radiolarian specimens are a subordinate component in the microfossil assemblages (Tables 1, 2). Their content varies from sample to sample in a wide range, up to a dozen percent of the whole microfaunal assemblage, though their number is very difficult to calculate, because of their poor preservation. Silica was replaced by framboidal pyrite (Fig. 13C). Consequently, a lot of spherical micronodules, overgrown by large pyrite crystals resemble radiolarian moulds.

Pyritized large diatoms are a significant component in most samples (Tables 1, 2). Most of them are gonioid diatoms, angular in outline, represented by triangular specimens of *Triceratium* sp. (Fig. 13I) and elliptical frustules of *Odontella*? sp. (Fig. 13E, F). There are also discoid diatoms

Table 1

Occurrence of microfauna in samples from the Dźwiniacz Górny and Czeresznia sections;
Z – Zagórz Limestone

	Dzw -16	Dzw -15	Dzw -33	Dzw -12	Dzw -13	Dzw -29	Dzw -25	Dzw -24	Dzw -23	Dzw -10	Dzw -20	Dzw -21	Cz-3	Cz-5
			Jasło Limestone			Z								
Bathysiphon sp.						1								
Rhabdammina sp.									30		1			
Repmanina charoides (Jones & Parker)				1										
Reophax sp.			1											
Stilostomella cf. *emaciata* (Reuss)					1									
Stilostomella sp.						1								
Dentalina sp.				1	1									
Laevidentalina communis (d'Orbigny)													1	1
?*Cycloforina* sp.											1			
Catapsydrax sp.								1						
Globigerinoides primordius Blow & Banner											1			
Globigerina cf. *anguliofficinalis* Blow								1			1			
Globigerina postcretacea Myatlyuk												1		
Globigerina praebulloides Blow		2	1	5	1		1	149		3	17	22	5	
Globigerina officinalis Subbotina											1			
Subbotina connecta (Jenkins)											1			
Subbotina praeturritilina (Blow & Banner)												1		
Subbotina ex. gr. *tapuriensis* (Blow & Banner)								1						
Tenuitella evoluta (Subbotina)			1		1						8	3		
Tenuitella liverovskae (Bykova)				1										
Tenuitella munda (Jenkins)					2			15	1		4	3	20	
Tenuitella sp.				2	2					3	17	4		
Tenuitellinata angustiumbilicata (Bolli)				1						1	2	2		
Paragloborotalia inaequiconica (Subbotina)										5	6	3		
Paragloborotalia sp.											1			
Anomalinoides sp.										1				
Gyroidinoides mamillatus (Andreae)											1			
Bolivina ex. gr. *bayerichi* Reuss					1									
Bolivina molassica Hofmann					3					1	1	1		
Bolivina subtumida Hofmann												3		
Bulimina tenera Reuss		3	4		10		1			1	2	5		
Praeglobobulimina bathyalis (Reiser)			3		5							1		
Praeglobobulimina pupoides (d'Orbigny)											4	2		
Praeglobobulimina pyrula (d'Orbigny)		3	1		5		1				1	5		
Praeglobobulimina sp.					4	1					3	4		
Fursenkoina mustoni (Andreae)		9	2		27		1			7		22		
Fursenkoina sp.					2			4		10	4	3		
Virgulinella chalkophila (Hagn)		1	9	1	85	50	8			3		28	2	1
Virgulinella karagiensis Mikhailova			14			22					9	13	7	
Virgulinella sp.						26		3			21	70	6	
Nonionella liebusi Hagn					1	1				7	3	9		
Chilostomella ovoidea Reuss		2	10		1	2	12				3	7		
Chilostomella sp.					1							2	1	
Allomorphina trigona Reuss		1			5									

Table 1 continued

Occurrence of microfauna in samples from the Dźwiniacz Górny and Czeresznia sections;
Z – Zagórz Limestone

	Dzw -16	Dzw -15	Dzw -33	Dzw -12	Dzw -13	Dzw -29	Dzw -25	Dzw -24	Dzw -23	Dzw -10	Dzw -20	Dzw -21	Cz-3	Cz-5
			Jasło Limestone			Z								
Diatomae – *Triceratium* sp.		3			10	9		1			1			
Diatomae – discoid morphotype		3			124	226		5	1		22	4	31	2
Diatomae – ?*Odontella* sp.		43	12	4	21	20		5	1		2	1		
Diatomae – ?*Pyxilia* sp.					25									
Bolboforma rotunda Daniels & Spiegler											1	4		
spherical moulds of ?Radiolaria	180	5	230		12			1	1		2	1	1	
echinoid spines		1	4		1	3								

(Fig. 13H) and specimens with long linear-elliptical valves (*Pyxilia*? sp.). The diatoms are abundant in the lower part of the studied sections, mainly close to the coccolith limestone horizons, and they are less frequent in the uppermost part of the studied succession.

Single specimens of *Bolboforma rotunda* Daniels & Spiegler (Fig. 13A, B) have been recorded from the youngest sediments of the Krosno beds. This species is one of the two taxa described from the Egerian and Eggenburgian sediments of the Central Paratethys (cf., Spiegler & Rögl, 1992).

Calcareous nannoplankton and dinocysts

The samples from the studied sections were examined earlier for calcareous nannoplankton content (Garecka; in Haczewski *et al.*, B, D, *submitted to print*) and for dinocyst content (Gedl; in Haczewski *et al.*, B, *submitted to print*). Preliminary stratigraphic results of these studied have been summarised by Bąk *et al.* (1998).

The Jasło Limestone contains calcareous nannoplankton assemblage dominated by *Cyclicargolithus floridanus* (Roth et Hay; *in* Hay *et al.*) Bukry (Garecka; in Haczewski *et al.*, B, D, *submitted to print*). Rare forms of *Coccolithus pelagicus* (Wallich) Schiller and *Cyclicargolithus abisectus* (Müller) Wise are also present. The latter taxon is important for the age assignment of the Jasło Limestone horizon. The FAD of *C. abisectus* is noted in the NP24 Zone *sensu* Martini (Bystrická, 1979; Báldi-Beke, 1984; Perch-Nielsen, 1985; Martini & Müller, 1986). Marlstones in the Jasło Limestone contain also numerous dinocysts characteristic of the Oligocene, including abundant *Homotryblium plectilum* Drugg & Loeblich Jr (Gedl; in Haczewski *et al.*, B, *submitted to print*).

Calcareous nannoplanton in the marlstones of the Zagórz Limestone horizon include poorly preserved and recrystallized forms with numerous *Cyclicargolithus floridanus*, *C. abisectus*, and forms transitional between *C. abisectus* and *C. floridanus* (Garecka; in Haczewski *et al.*, D, *submitted to print*). An occurrence of *C. abisectus* suggests also the NP24 Zone for the Zagórz Limestone horizon, similarly to the Jasło Limestone.

The youngest sediments found at the top of the Dźwiniacz Górny section contain calcareous nannoplankton, including the species *Helicosphaera scissura* Müller, characteristic of the Miocene (Garecka; in Haczewski *et al.*, B, D, *submitted to print*; Bąk *et al.*, 1998). The occurrence of this species in the oldest part of the Miocene (NN1 Zone) was noted in other localities in the Polish part of the Paratethys (Koszarski *et al.*, 1995; Ślęzak *et al.*, 1995).

Dinocysts from the youngest part of the studied sediments represent abundant and diversified assemblage including forms known from the Oligocene (Gedl; in Haczewski *et al.*, B, *submitted to print*). On the other hand, there are no forms of subfamily Wetzelielloideae, typical of the Oligocene (cf. ranges of Wetzelielloideae by Ionescu & Popescu, 1995), thus suggesting an age of these sediments younger than the Oligocene.

STRATIGRAPHIC IMPLICATIONS

In the Paratethys (especially in the Central Paratethys), the lower Oligocene deposits are distinguished as the Kiscelian stage, equivalent to the Mediterranean Rupelian and lower part of Chattian stages. It is correlated with standard planktonic foraminiferal zones P18 through P21 (without the upper part of the latter, close to the LAD of *Paragloborotalia opima opima*, within the NP24 nannoplankton Zone) (Báldi, 1979). The upper Oligocene and lower Miocene have been distinguished as the Egerian stage, correlative with the Mediterranean Chattian (without its lower part) and Aquitanian stages. The Egerian corresponds to the upper part of P21b through the lower part of M2 planktonic foraminiferal zones, and to the uppermost part of NP24 through NN2 (without its upper part) calcareous nannoplankton zones (for discussion – see Rögl, 1998a). However, it should be stressed out that the Kiscellian/Egerian boundary is being variously placed within the pelagic and flysch deposits of the Paratethys. For example, it was placed in the middle part of NP24 Zone in the Ždanice and Pouzdrany units (Krhovský, 1998) and in the middle part of P21 Zone in the Polish Outer Carpathians (Olszewska, 1998), which roughly corresponds to the middle part of the NP24 Zone.

Table 2

Occurrence of microfauna in samples from the Kiczera Dydiowska sections;
J – Jasło Limestone; Z – Zagórz Limestone

	Dyd-8	Dyd-10	Dyd-12	Dyd-13	Dyd-7	Dyd-6	Dyd-4	Dyd-5	Dyd-2	Dyd-1
		J	Z							
Bathysiphon sp.										1
Rhabdammina sp.				47	440			1		124
Reophax sp.										1
Repmanina charoides (Jones & Parker)						1				
Lagena cf. *striata* (d'Orbigny)						1				
Stilostomella cf. *emaciata* (Reuss)					1					
Stilostomella sp.	1									
Nodosaria sp.					1					
Globigerina anguliofficinalis Blow		6								
Globigerina officinalis Subbotina	2									
Globigerina ouachitaensis Howe & Wallace	1	13					1			
Globigerina postcretacea Myatlyuk	1	3								
Globigerina praebulloides Blow	103	190								1
Paragloborotalia nana (Bolli)	1	11								
Subbotina praeturritilina (Blow & Banner)	1									
Tenuitella brevispira (Subbotina)		2								
Tenuitella evoluta (Subbotina)			1	1						
Tenuitella liverovskae (Bykova)	1			1						
Tenuitella munda (Jenkins)	10	72	1							2
Tenuitella sp.	40	90						1		6
Tenuitellinata angustiumbilicata (Bolli)		8	1							
Bolivina subtumida Hofmann	1									
Bulimina coprolithoides Andreae	2									
Bulimina elongata d'Orbigny	2									
Bulimina tenera Reuss	2									
Praeglobobulimina bathyalis (Reiser)				1						
Praeglobobulimina pupoides (d'Orbigny)	3			1						
Praeglobobulimina pyrula (d'Orbigny)										
Praeglobobulimina sp.	2									
Fursenkoina mustoni (Andreae)	2			1						
Virgulinella chalkophila (Hagn)	9			36						
Virgulinella karagiensis Mikhailova	2			2						
Virgulinella sp.	21			20					1	
Nonionella liebusi Hagn	4			3						
Chilostomella ovoidea Reuss	12		5	14						1
Anomalinoides granosus (Hantken)	2									
Cibicidoides sp.	2									
Biapertorbis alteconicus Pokorny	2									
Allomorphina trigona Reuss	6									
Diatomae – *Triceratium* sp.							1	1		1
Diatomae – discoid morphotype				5	44		4	4	4	4
Diatomae – ?*Odontella* sp.	12		4	6	1			4	1	1
Diatomae – ?*Pyxilia* sp.				1						1
Bolboforma rotunda Daniels & Spiegler	1									
spherical pyritized moulds of ?Radiolaria	2			140		2			1	
echinoid spines	3			50					1	18

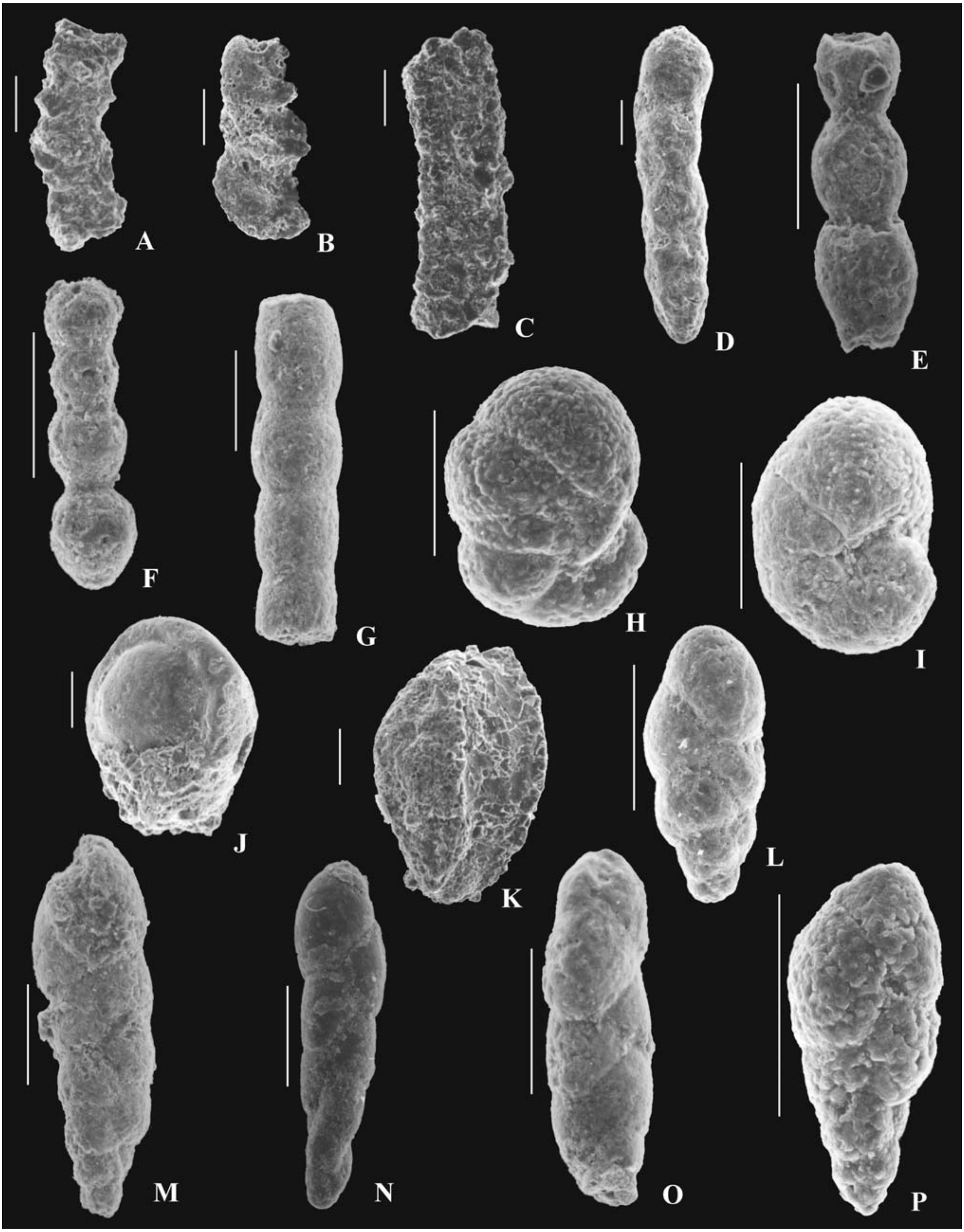

Fig. 7. Benthic Foraminifera in the upper division of the Krosno beds (Silesian Nappe, Polish Outer Carpathians): **A** – *Rhabdammina* sp., sample Dyd-1; **B** – *Reophax* sp., sample Dyd-1; **C** – *Bathysiphon* sp., Dyd-1; **D** – *Laevidentalina communis* (d'Orbigny), sample Czer-3; **E, F** – *Stilostomella* cf. *emaciata* (Reuss), E – sample Dyd-7; F – sample Dzw-13; **G** – *Dentalina* sp., sample Dzw-21; **H, I** – *Nonionella liebusi* Hagn, sample Dyd-13; **J** – *Gyroidinoides mamilatus* (Andreae), sample Dzw-20. **K** – *Cycloforina* sp., sample Dzw-20. **L–P** – *Fursenkoina mustoni* (Andreae), L – sample Dzw-21, M, N, P – sample Dzw-13; O – sample Dzw-10. Scale bar – 100 µm

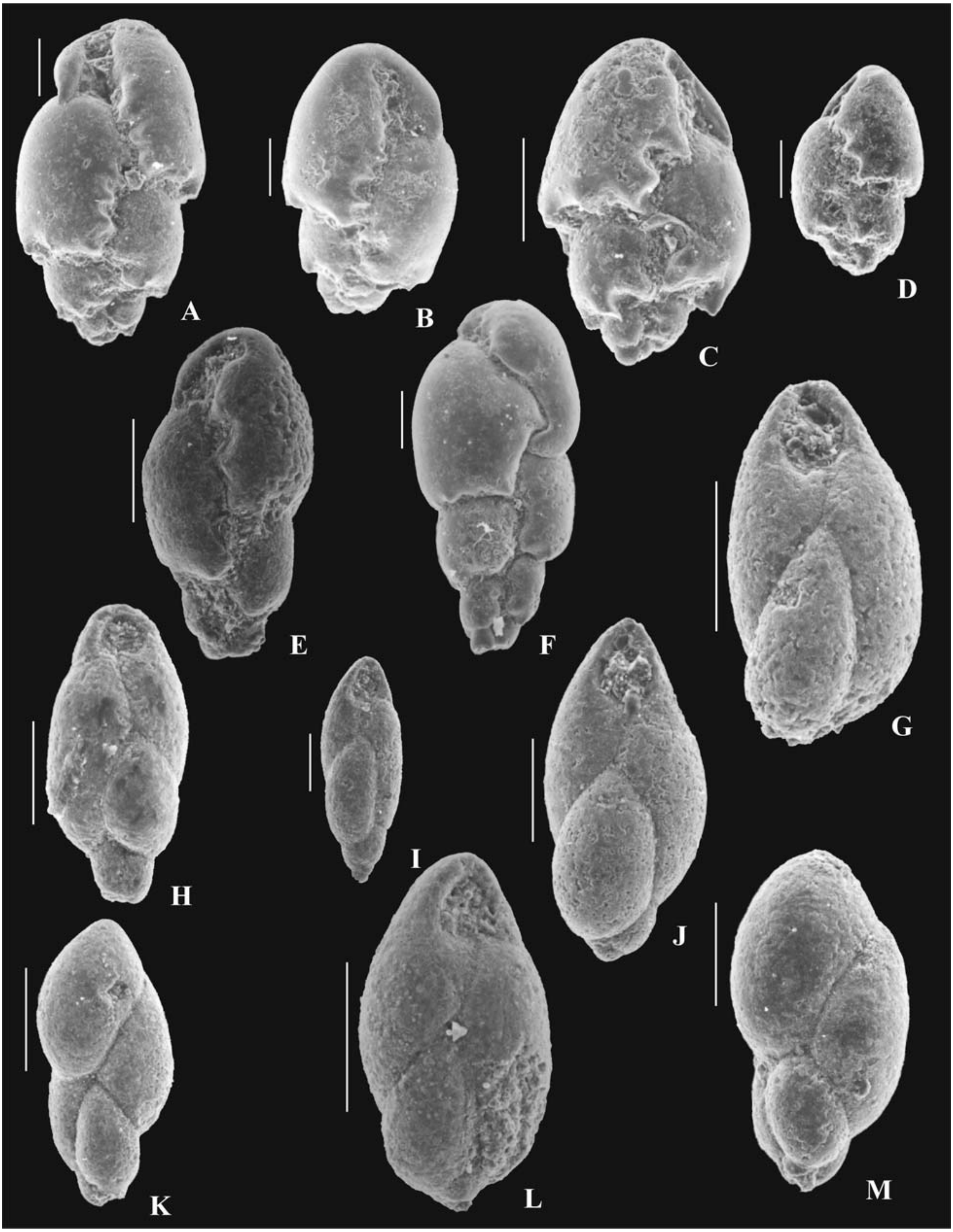

Fig. 8. Benthic Foraminifera in the upper division of the Krosno beds (Silesian Nappe, Polish Outer Carpathians): **A–D** – *Virgulinella karagiensis* Mikhailova, A–C – sample Dzw-33; D – sample Dzw-29; **E, F** – *Virgulinella chalkophila* (Hagn), E – sample Dyd-13, F – sample Dzw-33; **G–M** – *Bulimina tenera* Reuss, G, J – sample Dzw-15, H, I, K–M – sample Dzw-13. Scale bar – 100 μm

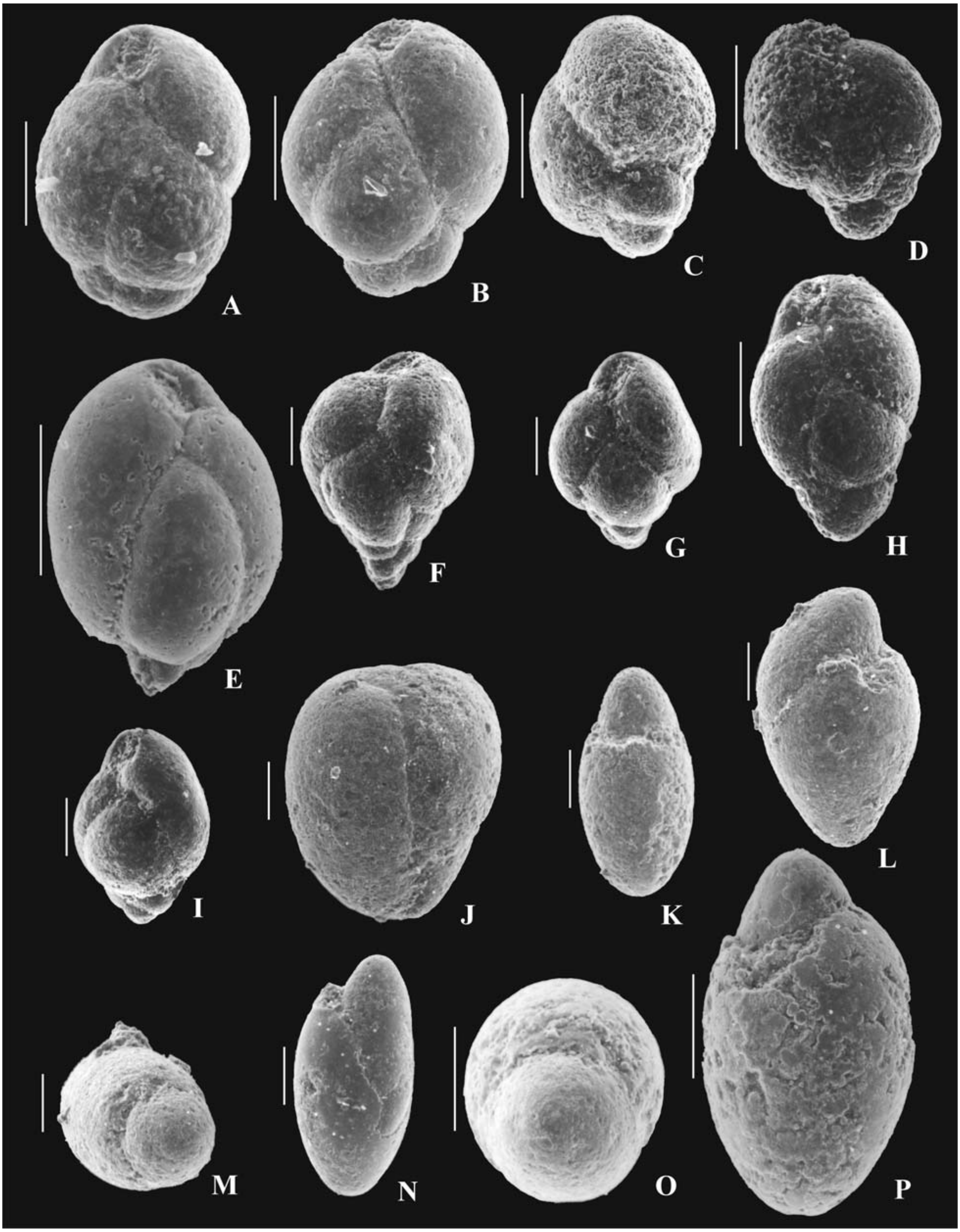

Fig. 9. Benthic Foraminifera in the upper division of the Krosno beds (Silesian Nappe, Polish Outer Carpathians): **A–D** – *Praeglobobulimina bathyalis* (Reiser), A – sample Dyd-13, B–D – sample Dzw-33; **E** – *Praeglobobulimina pyrula* (d'Orbigny), sample Dzw-33; **F–I** – *Praeglobobulimina pupoides* (d'Orbigny), sample Dzw-20; **J** – *Allomorphina trigona* Reuss, sample Dzw-15; **K–P** – *Chilostomella ovoidea* Reuss, K–O – sample Dzw-33, P – sample Dyd-8. Scale bar – 100 µm

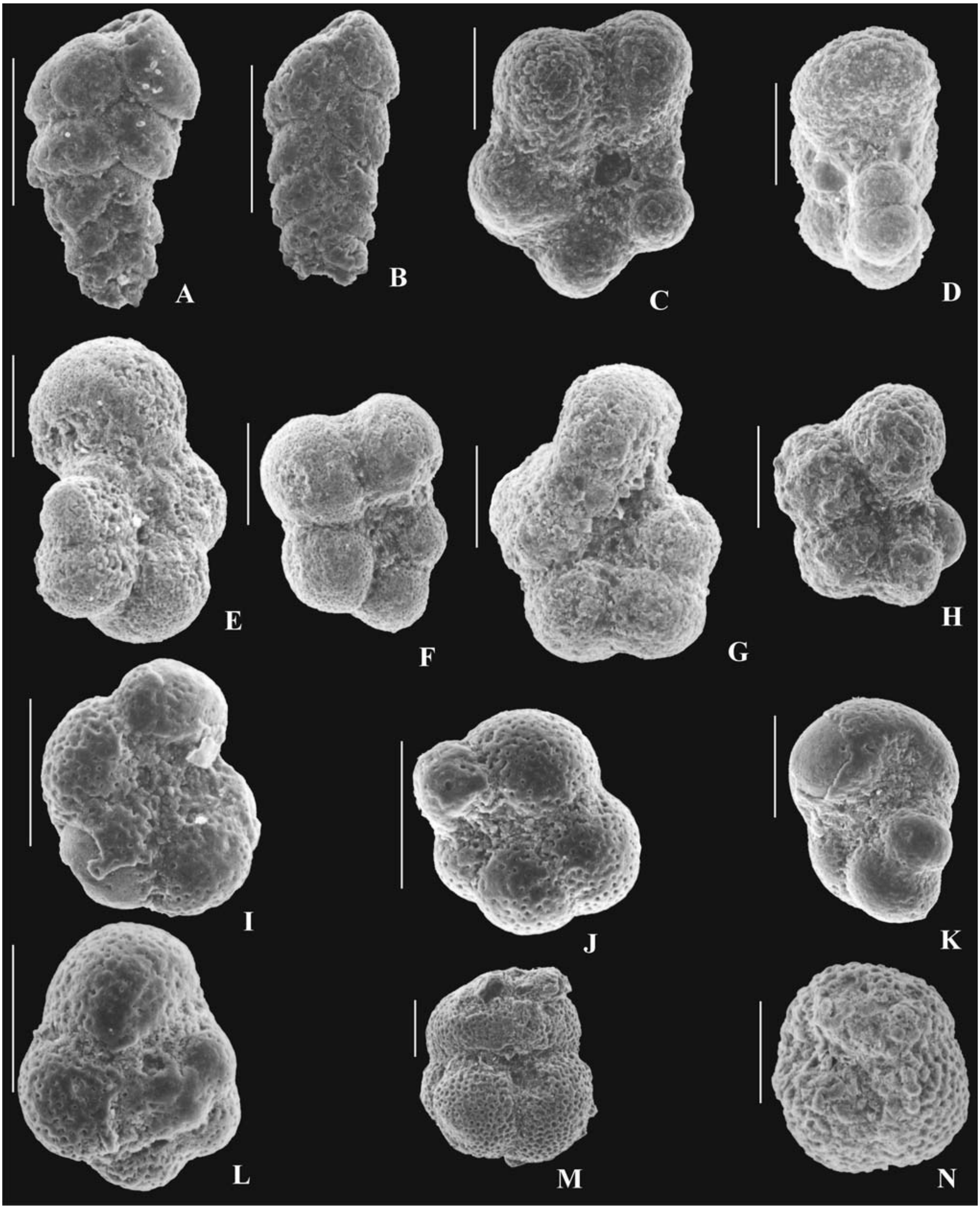

Fig. 10. Benthic and planktonic Foraminifera in the upper division of the Krosno beds (Silesian Series, Polish Outer Carpathians): **A** – *Bolivina* ex gr. *bayerichi* Reuss, sample Dzw-13; **B** – *Bolivina* cf. *molassica* Hofmann, sample Dzw-13; **C, D** – *Tenuitella liverovskae* (Bykova), C – sample Dyd-13; D – sample Dzw-33; **E** – *Tenuitella evoluta* (Subbotina), sample Dzw-20; **F–H** – *Paragloborotalia inaequiconica* (Subbotina), Dzw-20; **I, J** – *Globigerina postcretacea* Mjatliuk, Dyd-10; **K** – *Tenuitella brevispira* (Jenkins), sample Dyd-10; **L** – *Tenuitellinata angustiumbilicata* (Bolli), sample Dyd-10; **M** – *Subbotina* ex gr. *tapuriensis* Blow & Banner, sample Dzw-24; **N** – *Subbotina connecta* (Jenkins), sample Dzw-20. Scale bar – 100 µm

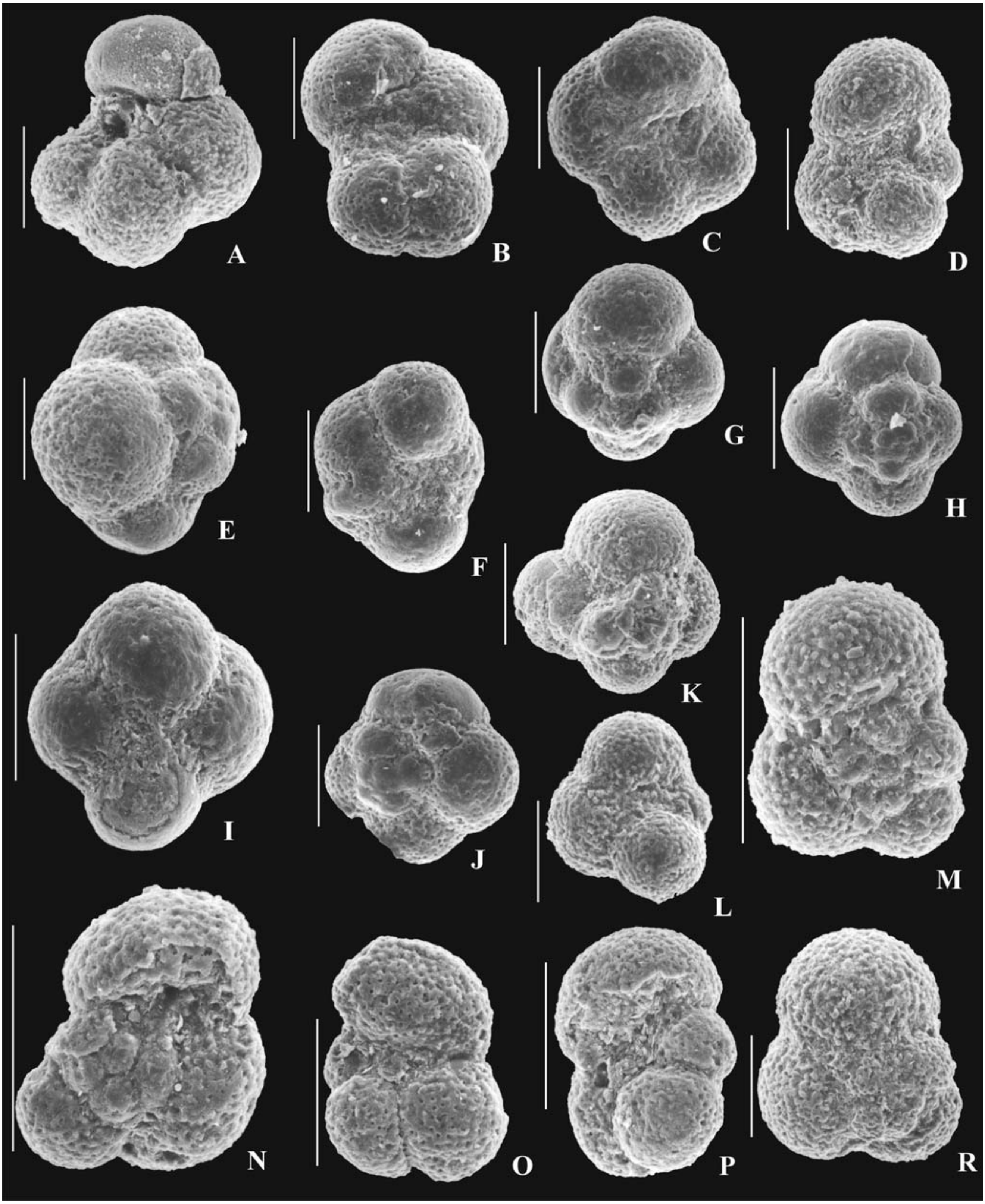

Fig. 11. Planktonic Foraminifera in the upper division of the Krosno beds (Silesian Nappe, Polish Outer Carpathians): **A** – *Subbotina praeturritilina* (Blow & Banner), sample Dyd-8; **B** – *Globigerina anguliofficinalis* Blow, sample Dyd-10; **C, D** – *Paragloborotalia opima nana* (Bolli), C – sample Dyd-10, D – Dyd-8; **D–L** – *Globigerina ouachitaensis* Howe & Wallace, D-I sample Dyd-10, J–L – sample Dyd-8; **M–R** – *Globigerina praebulloides* Blow, M, R – sample Dyd-8, N–P – sample Dzw-24. Scale bar – 100 µm

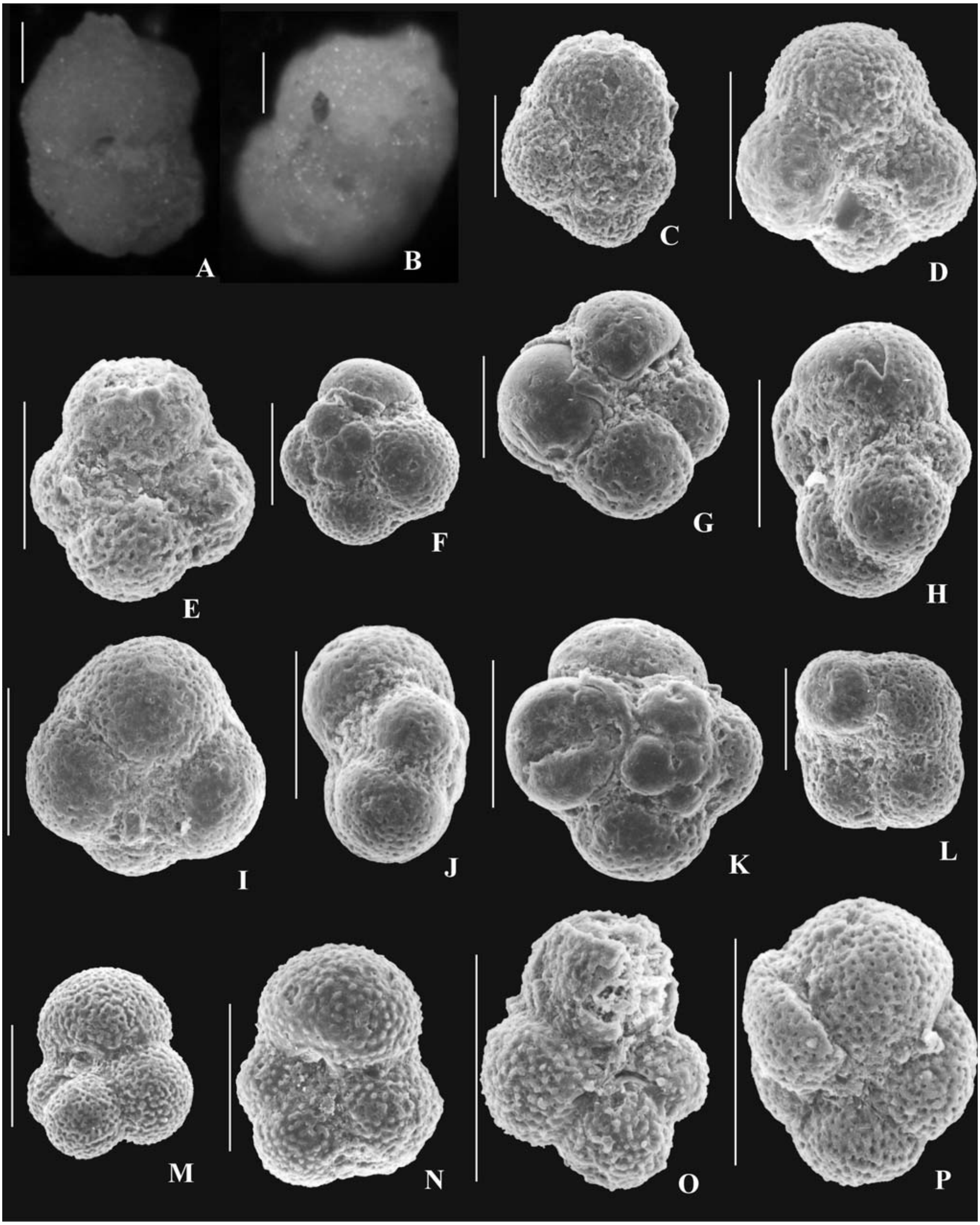

Fig. 12. Planktonic Foraminifera in the upper division of the Krosno beds (Silesian Nappe, Polish Outer Carpathians): **A, B** – *Globigerionoides primordius* Blow & Banner, sample Dzw-20; **C–L** – *Tenuitella munda* (Jenkins): C–E – sample Dyd-8, F–L – sample Dyd-10; **M, N** – *Globigerina officinalis* Subbotina, sample Dyd-8; **O** – *Globigerina* cf. *angulisuturalis* Bolli, sample Dzw-24; **P** – *Catapsydrax* sp., sample Dzw-24. Scale bar – 100 μm

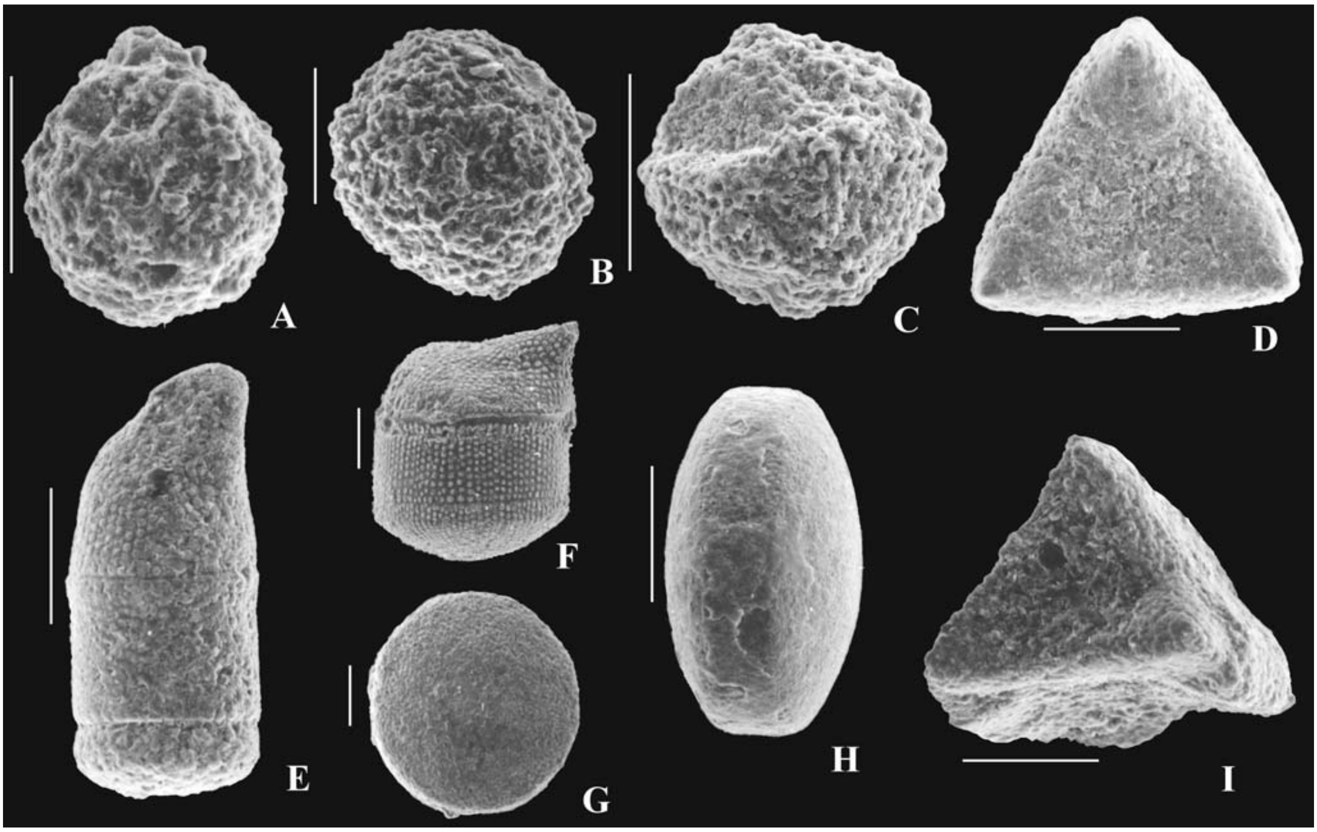

Fig. 13. Microfossils in the upper division of the Krosno beds (Silesian Nappe, Polish Outer Carpathians): **A, B** – *Bolboforma rotunda* Daniels & Spiegler, sample Dzw-20; **C** – pyrytized ?Radiolaria, sample Dyd-8; **D** – *Triceratium* sp., sample Dzw-29; **E, F** – ?*Odontella* sp. E – sample Pr-1, F – sample Dzw-15; **G** – Diatomae indet gen sp., sample Dzw-29; **H** – Diatomae – discoid morphotype, sample Dzw-23; **I** – *Triceratium* sp., sample Dzw-29; sample Dzw-20. Scale bar – 100 µm

There are also some problems with defining the Oligocene/Miocene boundary in the Paratethys. A proposal for this boundary has been presented by Steininger (1994) – as the boundary between chrons C6Cn2r and C6Cn2n, near the FAD of *Paragloborotalia kugleri* (Bolli) and near the extinction of calcareous nannofossil *Reticulofenestra bisecta* (base Zone NN1) (see also discussion by Rögl, 1996). Unfortunatelly, the usefulness of *P. kugleri* as a marker for this boundary is limited by its palaeoecological restriction to the tropical-subtropical belt. Because of such problems, there are some attempts to propose other taxa within various groups of microfossils as the markers of the Oligocene/Miocene boundary in the Paratethys (e.g., Andreyeva-Grigorovich & Gruzman, 1994; Ionescu & Popescu, 1995; Melinte, 1995; Akhmetiev & Zaporozhets, 1996).

Planktonic Foraminifera across the isochronous coccolith limestones

Numerous planktonic Foraminifera were reported from various localities of the Jasło Limestone (Hanzliková & Menčik, 1965; Olszewska, 1984b). Stratigraphic position of this horizon was initially suggested as the base of the Rupelian/Chatian transition (Olszewska, 1984b). Later, its position was referred to the planktonic foraminiferal zone P21, equivalent to the youngest part of the Egerian (Olszewska, 1998).

Calcareous nannoplankton data on the Jasło Limestone indicate its position within the NP24 Zone *sensu* Martini (1971) (Krhovský, 1981; Jugowiec, 1996; Rusu *et al.*, 1995, 1996), which was also confirmed in the studied sections (Garecka; in Haczewski *et al.*, B, D, *submitted to print*). It means that the base of the studied sections may roughly correspond to the base of the Egerian stage. The planktonic Foraminifera from the Jasło Limestone, described above, may confirm this suggestion. The diversified assemblage does not include *Paragloborotalia opima opima*, whose LAD is near the Kiscellian/Egerian boundary (Báldi, 1979). This species is not known from the Egerian deposits of the Austrian and Polish sectors of the Central Paratethys (Olszewska, 1984b; Rögl *et al.*, 1998), and was noted from the base of Egerian in the Ukrainian Carpathians only (Bobrinskaya *et al.*, 1998).

The planktonic foraminiferal assemblages from both the Jasło Limestone and deposits underlying this horizon, include numerous specimens of *Tenuitella munda*. This is an index taxon of the acme zone established by Olszewska (1997) for the upper Kiscellian and lowermost Egerian in the Polish part of the Central Paratethys. According to this author, the *T. munda* Zone spans P18–P21 standard zones, and its top corresponds to the Jasło Limestone (Olszewska, 1998). The data from the studied sections reveal high abundance of this species also above the Zagórz Limestone (Table 3); this species is present (as single specimens) even in

Table 3

Occurrence of planktonic Foraminifera in the youngest deposits of the Krosno beds (Dźwiniacz Górny Syncline; Silesian Nappe, Bieszczady Mountains) including data from the San section (Bąk, 1999)

Stratigraphic position	*T. liverovskae*	*T. munda*	*T. brevispira*	*T. evoluta*	*T. angustiumbilicata*	*G. primordius*	*G. praebulloides*	*G. officinalis*	*G. angulioffícinalis*	*G. ouachitaensis*	*G. postcretacea*	*S. praeturritilina*	*S. ex. gr. tapuriensis*	*S. connecta*	*P. inaequiconica*	*P. opima nana*
Uppermost part (NN1 Zone)		r		r	r	r	f				r	r		r	r	
Above Zagórz Limestone	r	f		r	r		a		r		r		r		r	
Zagórz Limestone		r		r	r										r	r
Jasło Limestone	r	c	r	r	r		a		r	f	r					f
Below Jasło Limestone	r	f					a	r		r	r	r				r

r – rare (1–4 specimens); f – frequent (5–19 specimens); c – common (20–49); a – abundant (50 specimens)

the uppermost part of the succession, corresponding to the Oligocene–Miocene transition.

Consequently, I propose to change the status of the **Tenuitella munda Zone** from acme zone to interval zone. Its lower boundary is defined by the FO of the index species (not recorded here), and the upper boundary – by the FO of the Early Miocene taxa (*Globigerinoides primordius* and *G. trilobus*). Basing on the presented data, its upper boundary is correlated with the Oligocene/Miocene boundary.

The other species appearing higher up in the succession is *Paragloborotalia inaequiconica*, which has its FO in the next higher isochronous horizon, the Zagórz Limestone (cf., Bąk, 1999). Olszewska (1997) proposed to distinguish an acme zone of this taxon, which extends from the late Chattian (FAD within the Jasło Limestone) to the early Burdigalian.

The data from the studied succession show that more frequent occurrence of *P. inaequiconica* begins near the Oligocene–Miocene transition and that in the underlying deposits this species occurs only occasionally. Because of its low frequency in the Oligocene part of the studied deposits, I propose to distinguish the ***P. inaequiconica*** **interval Subzone** (within the *Tenuitella munda* Zone) (Fig. 14). Its base is defined by the FO of this species, corresponding to the isochronous horizon of the Zagórz Limestone, attributed to the NP 24 calcareous nannoplankton Zone. The upper boundary of this subzone is defined by the FOs of the Early Miocene taxa.

Planktonic Foraminifera from the Oligocene–Miocene transition

The uppermost part of the upper division of the Krosno beds of the Dźwiniacz Górny Syncline contains a foraminiferal assemblage that may be referred to at least the Oligocene–Miocene transition or, most probably, to the lowermost Miocene. This assemblage includes *Globigerinoides primordius*, *Paragloborotalia inaequiconica*, *Tenuitella evoluta*, *T. munda* and *Subbotina connecta*. The first species in this assemblage may be used as a marker for the Oligocene/Miocene boundary. Originally, *G. primordius* was described from the tropical belt, from the Lower Miocene *Globorotalia kugleri* Zone in Trinidad and from Sicily and East Africa (Eames *et al.*, 1962). Later studies, from both oceanic realms and high latitudes, confirmed its occurrence in Lower Miocene (Aquitanian) foraminiferal assemblages (e.g., from the type section of Aquitanian and Burdigalian in France by Jenkins, 1966; or from the Ukrainian Carpathians by Gruzman & Trofimovich, 1995). Single data from the North Atlantic show that this species has its FO in the highest Oligocene (at the base of C6C Chron; close to the base of NN1 Zone) (Miller *et al.*, 1985; Miller & Katz, 1987).

I propose to distinguish the ***Globigerinoides primordius*** **interval zone**, whose lower boundary is defined by the FO of the index species (Fig. 14). All the other taxa mentioned above as occurring within this zone (*P. inaequiconica*, *T. evoluta*, *T. munda* and *S. connecta*), have been earlier reported from the oldest Miocene assemblage in the Polish part of the Central Paratethys (Garecka & Olszewska, 1998).

An Early Miocene age of this zone is supported also by the occurrence of *Helicosphaera scissura*, a calcareous nannoplankton species, one of the markers of the NN1 Zone (Garecka; in Haczewski *et al.*, B, D *submitted to print*; Bąk *et al.*, 1998). In the Romanian Flysch Carpathians and in the Transylvanian Basin, this species has been used to distinguish the Oligocene/Miocene boundary, together with *Helicosphaera mediteranea*, *Spenolithus conicus* and *S. compactus* (Melinte, 1995; Rusu *et al.*, 1995). In the Polish part of the Central Paratethys, *H. scissura* appeared earlier than *H. mediterranea* (Koszarski *et al.*, 1995); both species are noted together from the NN2 Zone (Olszewska & Garecka, 1998).

Additional confirmation for the age of this zone is provided by a dinocyst assemblage which does not include forms from the subfamily Wetzelielloideae. The absence of

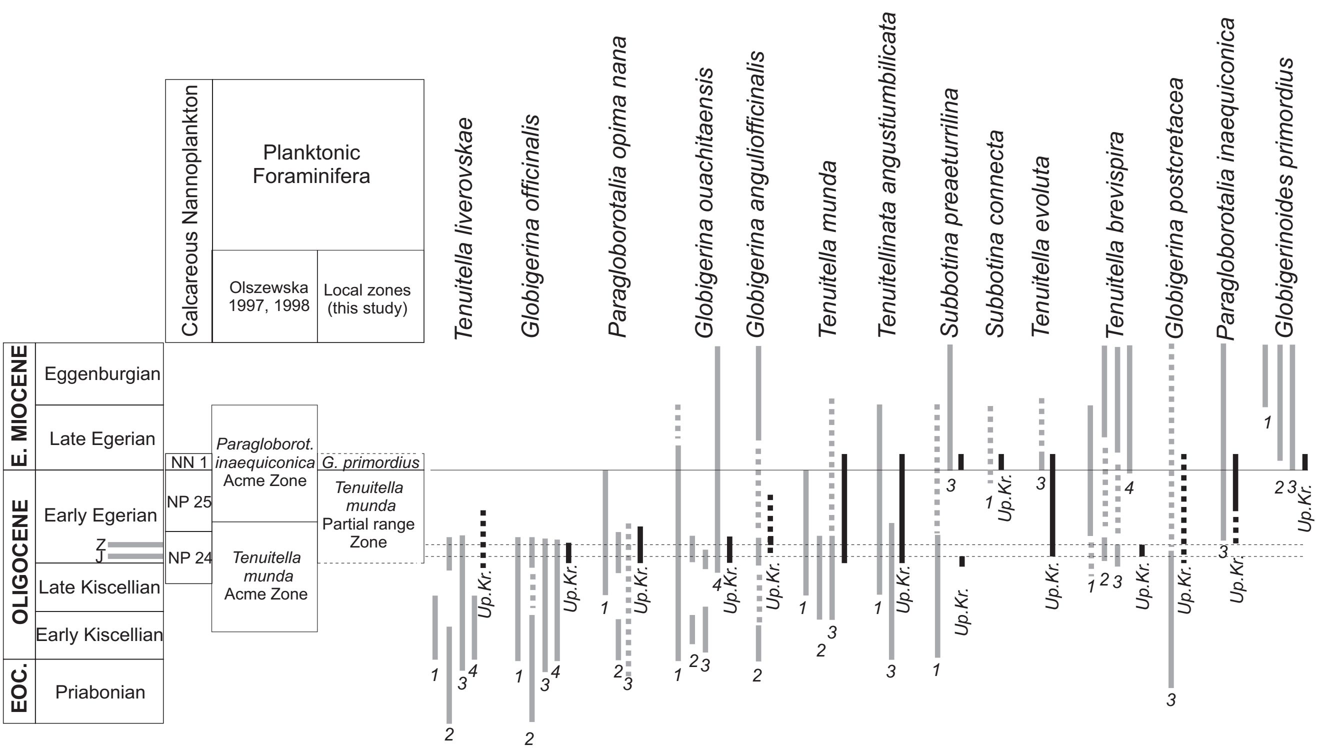

Fig. 14. Stratigraphic ranges of selected planktonic Foraminifera in the Central Paratethys; compilation for: 1 – Bavarian – Austrian Molasse Basin (Rögl *et al.*, 1998); 2 – Southern Moravian Flysch Belt (Krhovský, 1998); 3 – Polish Carpathians (Olszewska, 1982b, 1997, 1998; Garecka & Olszewska, 1998); 4 – Western Ukraine and Moldavia (Bobrinskaya *et al.*, 1998); Up. Kr. – Upper division of the Krosno beds in the Dźwiniacz Górny Syncline (Bieszczady Mts); data correlated on the basis of position of the Jaslo (J) and Zagórz (Z) Limestones and calcareous nannoplankton data. Central Paratethys stages followed after Rögl (1998a); calcareous nannoplankton zones after Martini & Müller (1986)

this subfamily above the Oligocene/Miocene boundary was recorded in the Central Paratethys by Ionescu and Popescu (1995).

PALAEOCOLOGICAL COMMENTS

Planktonic foraminiferal assemblages are dominated by *Globobigerina praebulloides* and small (mostly 100–150 μm), microperforate foraminifers from genus *Tenuitella* within the *Tenuitella munda* Zone (and *P. inaequiconica* Subzone) (Table 3). These microperforate (0.5–0.8 μm) taxa are known mainly from high latitudes (south and north), where they constitute up to 90% of all planktonic Foraminifera in the 150 μm size fractions in Oligocene and Miocene samples (e.g., Li & Radford, 1991; Li *et al.*, 1992). These forms are cool-temperate indicators, as was documented by their abundance and isotope data from various latitudes in the Oligocene–Miocene oceanic records (Spezzaferri, 1995). Such a composition of the planktonic Foraminifera assemblage is related to the position of the Central Paratethys in temperate latitudes, its restricted connections with the Mediterranean Sea and the Indian Ocean, and the influence of cool waters from the North Sea Basin (cf. palaeogeography by Rögl, 1998b).

The small changes in microfossil assemblages which took place around the Oligocene–Miocene transition, were caused probably by changes in palaeogeography. During the earliest Miocene (NN1 to lower NN2 chrones), the configuration of Central and Western Paratethys did not changed significantly, compared to the Oligocene. However, the connection with the North Sea Basin via the Rhine Graben was closed and a broad connection between the Paratethys seas and the Indian Ocean and the Mediterranean Sea did exist (Rögl, 1998b).

SUMMARY

Stratigraphic distribution of the Egerian Foraminifera, studied from the youngest sediments of the Krosno beds in the Silesian Nappe in the Bieszczady Mountains, allows to distinguish two zones: *Tenuitella munda* Zone and *Globigerinelloides primordius* Zone and the *Paragloborotalia inaequiconica* Subzone. *Tenuitella munda* and *P. inaequiconica* were used earlier by Olszewska (1997) to define acme zones. Unfortunately, their low frequency in deposits from the internal part of the Silesian Nappe does not allow to recognize such zones. Consequently, I propose to change their status and to distinguish them as interval zones and a subzone. The boundary between the *T. munda* and *G. primordius* zones is correlated with the base of the NN1 Zone. Because of the low stratigraphic resolution offered by the existing standard zonations in the marginal basins of the Paratethys, it is very carefully stated here that this boundary corresponds to the Oligocene/Miocene boundary. The lower boundary of the *T. munda* Zone and the upper boundary of the *G. primordius* Zone have not been recorded in the studied sections. The lower boundary of the *P. inaequiconica* Subzone corresponds to the isochronous horizon of the Zagórz Limestone (correlated with NP 24 Zone), and its upper boundary is the FO of *G. primordius*.

The benthic foraminiferal assemblages are relatively persistent throughout the Oligocene, similarly to other temperate zones in oceanic regions (cf. data from the North Atlantic; Miller & Katz, 1987). They are dominated by bathyal, calcareous, hyaline, smooth-walled taxa, known from modern anoxic environments. The earliest Miocene assemblage displays higher diversity and a lower degree of pyritization, most probably related to the oxygenation of bottom waters caused by the opening of new connections with the Mediterranean Sea.

Acknowledgements

Special thanks are due to Marta Bąk (Institute of Geological Sciences, Jagiellonian University, Kraków), who examined siliceous microfossils. Thanks are extended to Irena Chodyń (Jagiellonian University) for her help in sample preparation, and to Jadwiga Faber (Institute of Zoology, Jagiellonian University) who made the scanning electron micrographs. I greatfully acknowledge the constructive criticisms of the anonymous reviewers of this paper. The author also thanks Grzegorz Haczewski (Institute of Geography, Cracow Pedagogical University) for his discussion during the mapping of the study area and for improving of the English text, Michał Krobicki for his editorial help, and the authorities of the Bieszczady National Park for granting the permission for the field work in the protected area.

This research was supported in part by the DS grant (project no 03/IG AP).

REFERENCES

Akhmetiev, M. A. & Zaporozhets, N. I., 1996. The Oligocene–Miocene transition in the Southern Russia and Kazachstan. In: *Material of Symposium, IGCP Project No. 326, Oligocene–Miocene transition in the Northern hemisphaere, Romanian Journal of Paleontology*, 76: 49–50.

Andreyeva-Grigorovich, A. S. & Gruzman, A. D., 1994. The biostratigraphic basis of the Paleogene–Neogene boundary in the Central (Ukrainian Carpathians) and Eastern (Black Sea Depression, Northern Caucasus) Paratethys. *Geologica Carpathica*, 45: 333–342.

Báldi, T., 1979. Changes of Mediterranean (?Indopacific) and boreal influences on Hungarian marine mollusc faunas since Kiscellian until Eggenburgian times; the stage Kiscellian. *Annales Geologiques des Pays Helleniques Publication, tome hors-series*, 1: 39–49.

Báldi-Beke, M., 1984. The nannoplankton of the Transdanubian Palaeogene formations. *Geologica Hungarica, Series Paleontologica*, 43: 152–307.

Bąk, K., 1999. Late Oligocene Foraminifera from the Krosno Beds in the San valley section (Bieszczady Mountains); Silesian Unit, Polish Outer Carpathians. *Annales Societatis Geologorum Poloniae*, 69: 195–217.

Bąk, K., Haczewski, G., Olszewska, B., Garecka, M., Oszczypko-Clowes, M. & Gedl, P., 1998. Age of the youngest strata in the Silesian Unit in the SE part of the Polish Carpathians. In: Janoschek et al. (eds), *Abstracts of XVIth Congress Carpatho-Balkan Geological Association, August 30th to September 2nd, 1998, Geocenter, University of Vienna, Austria*, p. 52.

Bobrinskaya, O. G., Gruzman, A. D., Krasheninnikov, V. A., Serova, M. Y. & Venglynkyi, I. V., 1998. Stratigraphy of the Oligocene and Miocene deposits of the western Ukraine and Moldavia. In: Cicha *et al.* (eds), *Oligocene–Miocene foraminifera of the Central Paratethys*. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 549, pp. 34–43.

Bystrická, H., 1979. Middle Oligocene calcareous nannoplankton in the Banskobystricka Kotlina (depression). *Západne Karpaty, Séria Paleontologia*, 4: 123–145.

Dercourt, J., Ricou, L. E. & Vrielynck, B. (eds.), 1993. *Atlas Tethys Paleoenvironmental Maps*. Gauthiers-Villars, Paris, 307 pp, 14 maps, 1 plate.

Eames, F. E., Banner, F. T., Blow, W. H. & Clarke, W. J., 1962. *Fundamentals of mid-Tertiary stratigraphical correlation*. Cambridge University Press, England, 163 pp.

Garecka, M. & Olszewska, B., 1998. Biostratigraphy of the Early Miocene of the Southern Poland based on planktic foraminifera and calcareous nannoplankton. *Przegląd Geologiczny*, 46, 8/2: 712–721.

Gruzman, A. D. & Trofimovich, N. A., 1995. Organic fossils of Neogene deposits: Foraminifera. (In Ukrainian). *Paleontologičieskij Sbornik (Lvov)*, 31: 14–20.

Haczewski, G., 1971. *Sprawozdanie z badań przeprowadzonych w latach 1970-74 na arkuszu Łupków mapy 1 : 200 000*. (In Polish). Unpublished. Archiwum Oddziału Karpackiego Państwowego Instytutu Geologicznego.

Haczewski, G., 1972. Badania geologiczne między Smolnikiem a Mucznem w Bieszczadach. *Kwartalnik Geologiczny*, 16: 488–489.

Haczewski, G., 1984. Correlation of laminae in chronohorizons of Jasło limestone and Zagórz limestone (Outer Carpathians). (In Polish, English summary). *Kwartalnik Geologiczny*, 28: 675– 688.

Haczewski, G., 1986. Miejsce i rola litologicznych poziomów przewodnich w lito- i biostratygrafii. *Przegląd Geologiczny*, 34: 247–250.

Haczewski, G., 1989. Coccolith limestone horizons in the Menilite-Krosno series (Oligocene, Carpathians) – identification, correlation and origin. (In Polish, English summary). *Annales Societatis Geologorum Poloniae*, 59: 435–523.

Haczewski, G., Bąk, K. & Kukulak, J., A – submitted to print. *Arkusz Dźwiniacz Górny (1069) Szczegółowej Mapy Geologicznej Polski w skali 1:50,000.* Państwowy Instytut Geologiczny, Warszawa.

Haczewski, G., Bąk, K. & Kukulak, J., B – submitted to print. *Objaśnienia do arkusza Dźwiniacz Górny (1069) Szczegółowej Mapy Geologicznej Polski w skali 1:50,000.* Państwowy Instytut Geologiczny, Warszawa.

Haczewski G., Bąk K. & Kukulak J., C – submitted to print. *Arkusz Ustrzyki Górne (1068) Szczegółowej Mapy Geologicznej Polski w skali 1:50,000.* Państwowy Instytut Geologiczny, Warszawa.

Haczewski G., Bąk K. & Kukulak J., D – submitted to print. *Objaśnienia do arkusza Ustrzyki Górne (1068) Szczegółowej Mapy Geologicznej Polski w skali 1:50,000.* Państwowy Instytut Geologiczny, Warszawa.

Hanzliková, E. & Menčik, E., 1965. Das Foraminiferenplankton in den Jasło-Schiefertonen der polnischen Flyschkarpaten. (In Czech, German summary). *Véstnik Ústředního Ústavu Geologického*, 40: 345–352.

Ionescu, A. & Popescu, G., 1995. Correlation of Oligocene and Lower Miocene plantonic foraminifera and palynomorphs assemblages in the Vima Formation (North Transylvania). In: *Abstracts of 10-th Congress of the Regional Committee on Mediterranean Neogene Stratigraphy, Romanian Journal of Stratigraphy*, 76, suppl. 7/1: 45–47.

Jenkins, D. G., 1966. Planktonic Foraminifera from the type Aquitanian-Burdigalian of France. *Contributions from the Cushman Foundation for Foraminiferal Research*, 17, part 1: 1–15.

Jones, R. W. & Simmons, M. D., 1996. A review of the stratigraphy of Eastern Paratethys (Oligocene – Holocene). *Bulletin of Natural History Museum, London (Geology)*, 52: 25–49.

Jucha, S., 1958. Contributions on Jasło shaly limestones in the Polish Carpathians. *Bulletin de l'Académie Polonaise des Sciences, Série des Sciences Géologiques et Géographiques, Varsovie,* 6: 681–688.

Jucha, S., 1969. Les schistes de Jasło, leur importance pour la stratigraphie et la sédimentologie de la série ménilitique et des couches de Krosno; Carpathes flyscheuses. (In Polish, French summary). *Prace Geologiczne PAN Oddział w Krakowie*, 52: 1–128.

Jucha. S. & Kotlarczyk J. 1961: La série des couches à menilite et des couches de Krosno dans le flysch des Karpates. (In Polish, French summary). *Prace Geologiczne PAN Oddział w Krakowie*, 4: 1–155.

Jugowiec, M., 1996. Biostratigraphy of the Jasło Limestone near Sanok, based on the calcareous nannoplankton. (In Polish). *Przegląd Geologiczny*, 44: 1142–1145

Koszarski, L. & Żytko, K., 1959. Remarks on the development and stratigraphical position of the Jasło shales in the Menilitic and Krosno series in the Middle Carpathians. (In Polish, English summary). *Kwartalnik Geologiczny*, 3: 996–1015.

Koszarski, L. & Żytko, K., 1961. Jasło shales in the Menilite-Krosno series in the Middle Carpathians. (In Polish, English summary). *Biuletyn Instytutu Geologicznego*, 166, 87–232.

Koszarski, A., Koszarski, L., Ślęzak, J. & Iwaniec, M., 1995. Calcareous nannoplankton from the terminal deposits of the Silesian nappe, Polish Flysch Carpathians: stratigraphic implications. In: Flores, J. A. & Sierro, F. J. (eds), *Proceedings of the 5th INA Conference in Salamanca, Spain*, pp. 115–123.

Kotlarczyk, J. & Kaczmarska, I., 1987. Two diatom horizons in the Oligocene and (?)Lower Miocene of the Polish Outer Carpathians. *Annales Societatis Geologorum Poloniae*, 57: 143–188.

Krhovský, J., 1981. Stratigrafia i paleontologia menilitovych souvarstvi Ždanickej jednotky i diatomitov Pouzdřanskej jednotky. (In Czech). *Zemny Plyn a Nafta*, 26: 45–62.

Krhovský, J., 1998. Geology, stratigraphy and paleoenvironment of the Southern-Moravian Flysch Belt. In: Cicha *et al.* (eds), *Oligocene–Miocene foraminifera of the Central Paratethys. Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 549, pp. 18–23.

Li, Q. & Radford, S. S., 1991. Evolution and biogeography of Paleogene microperforate planktonic foraminifera. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 83: 295–320.

Li, Q., Radford, S. S. & Banner, F. T., 1992. Distribution of microperforate tenuitellid planktonic foraminifers in holes 747A and 749B, Kerguelen Plateau. In: Wise, S. W. Jr, Schlich, W. *et al.* (eds), *Proceedings of the Ocean Drilling Program, Scientific Results*, 120, pp. 569–594.

Martini, E., 1971. Standard Tertiary and Quaternary calcareous nannoplankton zonations. In: Farrinacci, A. (ed.), *Proceedings of 2nd Planktonic Conference, Roma 1970*, Edizioni Tectoscienza, Roma, 2, pp. 739–785.

Martini, E. & Müller, C., 1986. Current Tertiary and Quaternary calcareous nannoplankton stratigraphy and correlations. *Newsletter on Stratigraphy*, 16: 99–112.

Melinte, M., 1995. Changes in nannofossils assemblages during the Oligocene–Lower Miocene interval in the Eastern Carpathians and Transylvanian Basin. In: *Abstracts of 10-th Congress of the Regional Committee on Mediterranean Neogene Stratigraphy, Romanian Journal of Stratigraphy*, 76, suppl. 7/1: 171–174.

Miller, K. G., Aubry, M.-P., Khan, M. J., Melillo, A. J., Kent, D. V. & Berggren, W. A., 1985. Oligocene–Miocene biostratigraphy, magnetostratigraphy, and isotopic stratigraphy of the western North Atlantic. *Geology*, 13: 257–261.

Miller, K. G. & Katz, M. E., 1987. Oligocene to Miocene benthic foraminiferal changes in the North Atlantic. *Micropaleontology*, 33: 97–149.

Morgiel, J., 1972. Wyniki badań mikropaleontologicznych otworu wiertniczego Suche Rzeki IG 1 w Bieszczadach. (In Polish). *Kwartalnik Geologiczny*, 16: 1059–1060.

Morgiel, J., 1973. Wyniki badań mikropaleontologicznych otworu wiertniczego Polanki 1 w Bieszczadach. (In Polish). *Kwartalnik Geologiczny*, 17: 637–638.

Olszewska, B., 1982a. Some remarks on biostratigraphy of the Menilite-Krosno series in the Polish Outer Carpathians. (In Polish, English summary). *Kwartalnik Geologiczny*, 26: 137–145.

Olszewska, B., 1982b. Foraminifers found near the tuff horizon V in the Krosno Beds at Radziszów (Polish Outer Carpathians). (In Polish, English summary). *Kwartalnik Geologiczny*, 26: 627–645.

Olszewska, B., 1984a. Biostratigraphy of the Menilite-Krosno series in the vicinity of Przemyśl (Skole Unit, Polish External Carpathians). (In Polish, English summary). *Biuletyn Instytutu Geologicznego*, 340: 45–87.

Olszewska, B., 1984b. Some remarks on accompanying foraminifer assemblages in Jasło limestones in the Polish Outer Carpathians. *Kwartalnik Geologiczny*, 28: 689–700.

Olszewska, B., 1985. Foraminifera of the Menilite Beds (Polish External Carpathians). *Annales Societatis Geologorum Poloniae*, 55: 201–250.

Olszewska, B., 1997. Foraminiferal biostratigraphy of the Polish Outer Carpathians: a record of basin geohistory. *Annales Societatis Geologorum Poloniae*, 67: 325–337.

Olszewska, B., 1998. The Oligocene of the Polish Carpathians. In: Cicha *et al.* (eds), *Oligocene–Miocene foraminifera of the Central Paratethys, Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 549, pp. 23–28.

Perch-Nielsen K. 1985: Cenozoic calcareous nannofossils. In: *Plankton stratigraphy*, pp. 427–554.

Rögl, F., 1996. *Paragloborotalia kugleri* (Bolli). An index fossil for the Paleogene/Neogene boundary. In: Steininger, F. F. (ed.), *The Global stratotype section and point; the GSSP for the base of the Neogene. Giornale di Geologia, Bologna*, 58: 151–155.

Rögl, F., 1998a. Paratethys Oligocene–Miocene stratigraphic correlation. In: Cicha *et al.* (eds), *Oligocene–Miocene foraminifera of the Central Paratethys, Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 549, pp. 3–7.

Rögl, F., 1998b. Palaeogeographic considerations for Mediterranean and Paratethys Seaways (Oligocene to Miocene). *Annalen des Naturhistorischen Museums in Wien*, 99A: 279–310.

Rögl, F., Reiser, H., Rupp, Ch. & Wenger, W. F., 1998. Bavarian – Austrian Molasse Basin. In: Cicha *et al.* (eds), *Oligocene–Miocene foraminifera of the Central Paratethys, Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 549, pp. 7–15.

Rusu, A., Popescu, G., Melinte, M. & Stefanescu, M., 1995. New marker levels in Oligocene and Lower Miocene deposits from NW Transylwania (Romania). In: *Abstracts of 10-th Congress of the Regional Committee on Mediterranean Neogene Stratigraphy, Romanian Journal of Stratigraphy*, 76, suppl. 7/1: 105–107.

Rusu, A., Popescu, G. & Melinte, M., 1996. East Carpathians bend area overview on the Oligocene – Lower Miocene from the Outer flysch zone; Excursion guide to Field Symposium on Oligocene – Miocene transition and main geological events in Romania. *Romanian Journal of Paleontology*, 76: 3–47.

Spezzaferri, S., 1995. Planktonic foraminiferal paleoclimatic implications across the Oligocene–Miocene transition in the oceanic record (Atlantic, Indian and South Pacific). *Palaeogeography, Palaeoclimatology, Palaeoecology*, 114: 43–74.

Spiegler, D. von & Rögl, F., 1992. Bolboforma (Protophyta, incerte sedis) im Oligozän und Miozän des Mediterran und der Zentralen Paratethys. *Annalen des Naturhistorischen Museums in Wien*, 94A: 59–95.

Steininger, F. F., 1994. *Proposal for the global stratotype section and point (GSSP) for the base of the Neogene (The Paleogene/Neogene Boundary)*. Inst. Paleont. Univ. Vienna, 41 pp.

Ślęzak, J., Koszarski, A. & Koszarski, L., 1995. Calcareous nanoplankton stratigraphy of terminal flysch deposits from the Skole nappe (Oligocene–Miocene), Polish Carpathians, Krosno Beds). In: Flores, J. A. & Sierro, F. J. (eds), *Proceedings of the 5th INA Conference in Salamanca, Spain*, pp. 267–277.

Żytko, K., 1968. *Geologia Karpat pomiędzy dorzeczem Strwiąża i Wetliną w Bieszczadach*. (In Polish, unpublished). Państwowy Instytut Geologiczny, Oddział Karpacki, Kraków.

Żytko, K., 1999. Correlation of the main structural units of the Western and Eastern Carpathians. In: Peryt, T (ed.), Analysis of Tertiary Basin of the Carpathian Foredeep. (In Polish, English summary). *Prace Państwowego Instytutu Geologicznego*, 168: 135–164.

Streszczenie

BIOSTRATYGRAFIA OTWORNICOWA UTWORÓW EGERU PŁASZCZOWINY ŚLĄSKIEJ KARPAT ZEWNĘTRZNYCH W POLSKIEJ CZĘŚCI BIESZCZADÓW

Krzysztof Bąk

W pracy przedstawiono zespoły otwornic egeru z najmłodszych utworów jednostki śląskiej w bieszczadzkiej części Karpat Zewnętrznych. Otwornice planktoniczne były podstawą do wydzielenia poziomów biostratygraficznych, których granice zostały porównane z danymi opartymi o wapienny nanoplankton (Garecka; w: Haczewski *et al.*, A, B, oddane do druku) i dinocysty (Gedl; w: Haczewski *et al.*, A, oddane do druku), a także odniesieniu ich do pozycji stratygraficznej dwóch chrohoryzontów – wapienia jasielskiego i wapienia z Zagórza. Praca niniejsza jest kontynuacją badań na tym obszarze (Bąk, 1999) i stanowi ich podsumowanie.

Płaszczowina śląska jest na obszarze Bieszczadów zbudowana wyłącznie z warstw krośnieńskich (Fig. 1, 2) o miąższości ok. 3,5 km, w tym z ponad 1,3 km miąższości serią zawierającą grubolawicowe, grzbietotwórcze piaskowce otryckie. Ich obecność w warstwach krośnieńskich była podstawą do wyróżnienia w tej części jednostki śląskiej tzw. strefy bieszczadzkiej (lub strefy Otryt – Bitla), której długość wynosi ok. 150 km, a szerokość 15–20 km. W przekroju Bieszczadów strefa ta zbudowana jest z kilku łusek i fałdów, wśród których synklina Dźwiniacza Górnego zawiera bardzo miąższe i najmłodsze serie utworów fliszowych. Dotychczasowe prace stratygraficzne na tym obszarze (Haczewski *et al.*, A, B oddane do druku) wskazywały na oligoceński wiek całej serii warstw krośnieńskich, w tym również warstw najmłodszych.

W niniejszej pracy przedstawiono rezultaty opróbowania najmłodszej serii warstw krośnieńskich, tzw. warstw nadotryckich (oddział górny warstw krośnieńskich), które występują powyżej serii z piaskowcami otryckimi. Warstwy nadotryckie (maks. miąższość ok. 1050 m) tworzy seria silnie wapnistych, szarych i ciemnoszarych łupków marglistych, o charakterystycznej grubej ("mydlastej") oddzielności, przeławicających się z wapnistymi, cienkoławicowymi, laminowanymi mułowcami i piaskowcami. Lokalnie wśród tej serii występują grube ławice piaskowców średnioziarnistych, bezstrukturalnych oraz pojedyncze, czarne serie z wirowcami (o miąższości 1–2 m). W najwyższej części warstw nadotryckich występuje jeden lub kilka soczewkowatych pakietów piaskowców średnioziarnistych, gruboławicowych, z laminacją równoległą, przekątną i konwolutną, o sumarycznej miąższości ok. 30 m. W niższej części warstw nadotryckich wykartowano ponadto 2 ważne dla stratygrafii horyzonty wapieni kokolitowych, tzw. wapień jasielski i wapień z Zagórza. W obrębie badanych utworów zostały one znalezione w obu skrzydłach synkliny Dźwiniacza Górnego. Wapienie te, znane z wielu miejsc w Karpatach Zewnętrznych są poziomami korelacyjnymi (Jucha, 1958; 1969, Koszarski & Żytko, 1959, 1961; Jucha & Kotlarczyk, 1961; Haczewski, 1984, 1989), a w niniejszej pracy są one ważnym elementem stratygrafii.

Analizy mikropaleontologiczne wykorzystano na próbach pobranych z kilku profili w obrębie wspomnianej synkliny, tj.: w profilu Dźwiniacza Górnego (Fig. 3A, 4), w 2 profilach wokół Kiczery Dydiowskiej (Fig. 3B, 5) i w profilu Czereszni (Fig. 3C i 6). Ponadto wykorzystano dane z profilu Sanu w rejonie Dźwiniacza Górnego, będące wcześniej przedmiotem osobnej publikacji (Bąk, 1999). Zespoły otwornic opisano z kilku serii warstw nadotryckich, których granice stanowią horyzonty wapieni kokolitowych oraz wydzielono dodatkowo najwyższą część warstw nadotryckich, którą charakteryzuje odmienny zespół taksonów.

Otwornice z serii poniżej wapienia jasielskiego zawierają nieliczny plankton otwornicowy, z charakterystyczną formą *Globigerina praebulloides*. Liczniejsze są spirytyzowane otwornice bentoniczne, w tym *Fursenkoina mustoni* (Fig. 7L–P), *Bulimina tenera* (Fig. 7G, J), *Chilostomella ovoidea*, *Allomorphina trigona* (Fig. 8G–M), *Virgulinella chalkophila* (Fig. 8E, F), *Praeglobobulimina pyrula* (Fig. 9E). Tylko w jednej próbie (Dyd-8; Tab. 2) zespół otwornicowy jest bardziej zróżnicowany, zawierając m.in. liczne otwornice planktoniczne należące do *Globigerina praebulloides* (Fig. 11M, R), *G. ouachitaensis* (Fig.11J–L), *G. officinalis* (Fig. 12M, N), *G. postcretacea*, *Tenuitella munda* (Fig. 12C–E), *T. liverovskae*, *Paragloborotalia opima nana* (Fig. 11D) i *Subbotina praeturritilina* (Fig. 11A). Brak w zespole planktonu gatunku *Paragloborotalia opima opima* może wskazywać, że ta część serii należy do najstarszego egeru. Chociaż granica kiscelu i egeru jest definiowna w opraciu o inne zespoły fauny (Báldi, 1979) to w jej pobliżu ma miejsce ostatnie wystąpienie (LO) *P. opima opima*. Ma to miejsce w obrębie standardowego poziomu otwornicowego P21b (Báldi, 1979; Rögl, 1998) i w obrębie poziomu nanoplanktonu wapiennego NP24 (Báldi, 1979).

Zespół otwornicowy z wapienia jasielskiego jest bardzo wzbogacony w plankton w stosunku do utworów niżejległych, jak to zresztą opisywano z innych stanowisk (Hanzliková & Menčik, 1965; Olszewska, 1984b). Taksonomicznie jest on podobny do zespołu opisywanego ze starszej części warstw nadotryckich, a w badanych utworach zawiera dodatkowo takie formy jak *Globigerina anguliofficinalis* (Fig. 11B), *Tenuitella brevispira* (Fig. 10K), *T. evoluta*, *T. liverovskae* (Fig. 10C, D) i *Tenuitellinata angustiumbilicata*. Wśród otwornic bentonicznych brak jest wyraźnych zmian; odnotowano natomiast występowanie nowych taksonów, *Praeglobobulimina bathyalis* (Fig. 9B, D) i *P. pyrula* (Fig. 9E). Wapienny nanoplankton zdominowany przez *Cyclicargolithus floridanus* wskazuje na poziom NP24 (Garecka; w: Haczewski *et al.*, A, B, oddane do druku), w oparciu o obecność *Cyclicargolithus abisectus*. Z kolei zespół dinocyst zawiera bardzo liczne formy z gatunku *Homotryblium plectilum* oraz inne, typowe dla oligocenu, lub mające szerszy zasięg stratygraficzny (Gedl; w: Haczewski *et al.*, A, B, oddane do druku).

Otwornice z wapienia z Zagórza są znacznie mniej zróżnicowane niż w niżejległym wapieniu jasielskim (Tab. 1–3). Znaleziono jedynie pojedyncze formy z gatunków: *Tenuitella munda*, *T. evoluta* i *Tenuitellinata angustiumbilicata,* a w opisanym wcześniej profilu nad Sanem (Bąk, 1999), występują ponadto *Paragloborotalia inaequiconica* i *Paragloborotalia opima nana*. Bentos otwornicowy jest również słabo zróżnicowany. Poza licznymi formami z gatunku *Virgulinella chalkophila* i *V. karagiensis* (Fig. 8D) nielicznie występują *Chilostomella ovoidea*, *Nonionella liebusi*, *Praeglobobulimina* sp., *Stilostomella* sp. i *Bathysiphon* sp. Nanoplankton wapienny z łupków w obrębie wapienia z Zagórza jest podobny jak w wapieniu jasielskim, wskazując również na poziom NP24 (Garecka; w: Haczewski *et al.*, A, B, oddane do druku).

Zespół otwornicowy powyżej wapienia z Zagórza jest bardzo ubogi (Tab. 1–3). Wśród planktonu dominuje *Globigerina praebulloides* (Fig. 11N–P) a *Subbotina* ex gr. *tapuriensis*, *Tenuitella evoluta*, *T. munda* (Fig. 12F, L), *T. liverovskae* (Fig. 10C), *Paragloborotalia inaequiconica* i *Catapsydrax* sp (Fig. 12P) występują pojedynczo. Udział *P. inaequiconica* zwiększa się w górę profilu. Zespół bentosu nie wykazuje zmian w stosunku do zespołów starszych.

Zespół otwornicowy z najmłodszej części warstw nadotryckich, znaleziony w SW skrzydle opróbowanej synkliny zawiera *Globigerinoides primordius* (Fig. 12A, B), wskazujący na sedymentację tej części warstw nadotryckich w pobliżu granicy oligocenu i miocenu lub też w najmłodszym miocenie (Miller *et al.*, 1985; Miller & Katz, 1987; Gruzman & Trofimovich, 1995; Olszewska, 1997, 1998; Garecka & Olszewska, 1998). Wśród planktonu otwornicowego występują ponadto *Paragloborotalia inaequiconica* (Fig. 10F–H), *Tenuitella evoluta* (Fig. 10E), *T. munda*, *Globigerina praebulloides*, *G. postcretacea*, *G. officinalis*, *G. anguliofficinalis*, *Subbotina connecta* (Fig. 10N) i *S. praeturritilina*. Bentos otwornicowy jest podobny jak w utworach starszych, chociaż stwier- dzono też nowe formy, należące do ?*Cyclophorina* sp. (Fig. 7K) i *Gyroidinoides mamilatus* (Fig. 7J).

Wczesnomioceński wiek tego zespołu może potwierdzać zespół wapiennego nanoplanktonu (Garecka; w: Haczewski *et al.*, A, B, oddane do druku), w którym występuje *Helicosphaera scissura*, gatunek opisywany z Centralnej Paratetydy od dolnej granicy poziomu NN1 (Koszarski *et al.*, 1995; Ślęzak *et al.*, 1995; Melinte, 1995; Rusu *et al.*, 1996). Zespół dinocyst (Gedl; w: Haczewski *et al.*, A, oddane do druku) również wykazuje pewne zmiany w stosunku do oligoceńskiej części, poprzez brak form należących do podrodziny Wetzelielloideae, które zanikają w pobliżu granicy oligocenu i miocenu w utworach Paratetydy (Ionescu i Popescu, 1995). W tej części warstw nadotryckich znaleziono również pojedyncze osobniki *Bolboforma rotunda* Daniels & Spiegler (Fig. 13A, B). Jest to jeden z dwóch gatunków występujących w Centralnej Paratetydzie w utworach egeru i egenburgu (Spiegler & Rögl, 1992).

Powyższa sukcesja otwornic planktonicznych stwierdzona w profilu warstw nadotryckich stanowi podstawę lokalnej zonacji. Gatunki w niej wykorzystane były wcześniej użyte jako taksony wskaźnikowe dla poziomów rozkwitu, w zaproponowanej przez Olszewską (1997, 1998) zonacji dla Karpat Zewnętrznych.

W mojej opinii, ze względu na generalne ubóstwo fauny otwornicowej w całej serii warstw nadotryckich, należy stosować poziomy biostratygraficzne oparte na ograniczonych zasięgach taksonów indeksowych. Stąd też proponuję, przynajmniej w lokalnej zonacji tej części jednostki śląskiej wyróżnić dwa poziomy: poziom ograniczonego zasięgu *Tenuitela munda* (jego dolna granica to moment pierwszego pojawienia się (FO) tego gatunku; nie obserwowany w warstwach nadotryckich) i poziom ograniczonego zasięgu *Globigerinoides primordius* (jego dolna granica to FO tego taksonu; jest to jednocześnie górna granica poziomu *T. munda*). Dodatkowo, w obrębie poziomu *T. munda* proponuję wydzielić podpoziom ograniczonego zasięgu *Paragloborotalia inaequiconica* ("pod" – ze względu na nieliczne występowanie). Jego dolna granica (FO tego gatunku) występuje w obrębie poziomu wapienia z Zagórza, natomiast górna – odpowiada dolnej granicy poziomu *G. primordius*.

Wapienny nanoplankton wskazuje, że granica pomiędzy poziomami *T. munda* i *G. primordius* występuje w spągu NN1, czyli w pobliżu granicy (lub na granicy) oligocenu i miocenu. Ta ostrożność w definiowaniu granicy paleogenu i neogenu wynika z faktu, że brak jest dotychczas danych paleomagnetycznych z tej części Paratetydy, które pozwoliłyby odnieść zonacje otwornicowe i nanoplanktonowe do zaproponowanej przez IUGS (Steininger; 1994) definicji tej granicy (jest to granica pomiędzy chronami C6Cn2r i C6Cn2n). Brak jest też jednoznaczych korelacji biostratygraficznych rejonu Centralnej Paratetydy i obszarów prowincji tropikalnej i subtropikalnej, gdzie zarówno mikrofauna, jaki i nanoflora reprezentowane są przez bardzo różne zespoły, a takson zaproponowany jako marker granicy oligocenu i miocenu, *Paragloborotalia kugleri* (Rögl, 1996) nie jest w ogóle znajdowany w utworach Centralnej Paratetydy.