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LITHO- AND BIOSTRATIGRAPHY OF THE MAGURA NAPPE IN THE EASTERN PART OF THE BESKID WYSPOWY RANGE (POLISH WESTERN CARPATHIANS)

Ewa MALATA[1], Tomasz MALATA[2] & Nestor OSZCZYPKO[1]

[1] *Instytut Nauk Geologicznych Uniwersytetu Jagiellońskiego 30-063 Kraków, ul. Oleandry 2a*
[2] *Państwowy Instytut Geologiczny, Oddział Karpacki Kraków, ul. Skrzatów 1*

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Abstract. Lithostratigraphy, biostratigraphy and structure of the Bystrica and Rača subunits of the Magura nappe have been studied in the eastern termination of the Beskid Wyspowy Range. In the Młyńczyska area a new occurrence of the Senonian-Paleocene deposits of the Bystrica subunit has been documented. Five foraminiferal zones have been proposed for the Upper Cretaceous–Lower Eocene strata. A major part of the so called Inoceramian or Ropianka Beds are Paleocene in age. Continuous facies transitions between Bystrica and Rača subunits have been found. However, this detailed geological study does not confirm the formely suggested presence of the Rača subunit tectonic window in the Młyńczyska area.

Abstrakt. Rozpoznano lito- i biostratygrafię oraz tektonikę utworów płaszczowiny magurskiej we wschodniej części Beskidu Wyspowego (strefa raczańska i bystrzycka). W okolicy Młyńczysk po raz pierwszy stwierdzono osady senońsko-paleoceńskie strefy bystrzyckiej. W utworach górnokredowo-dolnoeoceńskich wyróżniono 5 lokalnych zon otwornicowych. Większość tzw. wartw inoceramowych czy ropianieckich jest paleoceńskiego wieku. Między osadami strefy bystrzyckiej i raczańskiej stwierdzono ciągłe przejścia facjalne. Obecność znanego z wcześniejszych opracowań okna tektonicznego Młyńczysk nie została potwierdzona.

Key words: lithostratigraphy, biostratigraphy, Upper Cretaceous, Paleogene, tectonics, Magura nappe, Western Carpathians.

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INTRODUCTION

The Beskid Wyspowy Range is a morphological element in the middle part of the Polish Outer Carpathians (Fig.1). The range is built mainly of the rocks of the Rača and partly of the Bystrica subunits of the Magura nappe and it is located north of the Mszana Dolna and Szczawa tectonic windows. This part of the Rača subunit is built up of several synclines which are filled with the Magura Formation underlain by the older formations. The SE branch of the range, with the highest Mogielica mountain (1170 m of altitude), is located in the area built of the Bystrica subunit, which includes several thrust-sheets. In the eastern part of the Magura nappe, the overthrust contact between the Bystrica (Sącz) and Rača subunits is commonly accepted (Sikora, 1970; Węcławik, 1969; Oszczypko, 1973, 1979). This overthrust has been traced up to the western termination of the Nowy Sącz Basin (Oszczypko, 1973, see also Oszczypko & Wójcik, 1992). The western prolongation of this contact was already questioned by Książkiewicz (1971).

In 1980, the Łącko sheet of the Detailed Geological Map of Poland was published by Z. Paul. According to author, a small tectonic window, covering an area of 3 sq km (Fig. 2), occurs in the northern part of the sheet (the Młyńczyska village in the SE prolongation of the Beskid Wyspowy Range). In his opinion the Młyńczyska tectonic window belongs to the Rača subunit and the Magura Beds (the Poprad Sandstone Member of the Magura Formation according to Oszczypko (1991) are the youngest deposits in it. The tectonic window is surrounded by the Paleogene strata of the Bystrica subunit (Fig. 2). The occurrence of the Młyńczyska tectonic window was already questioned by Oszczypko on the General Geological Map of Poland, sheet Nowy Sącz (see Burtan *et al.*, 1981). During the last few years detailed geological mapping of the Bystrica subunit has been made for the surroundings of the Szczawa tectonic window (see Oszczypko *et al.*, 1991). In 1991-1995 the Młyńczyska area was the subject of geological investigation

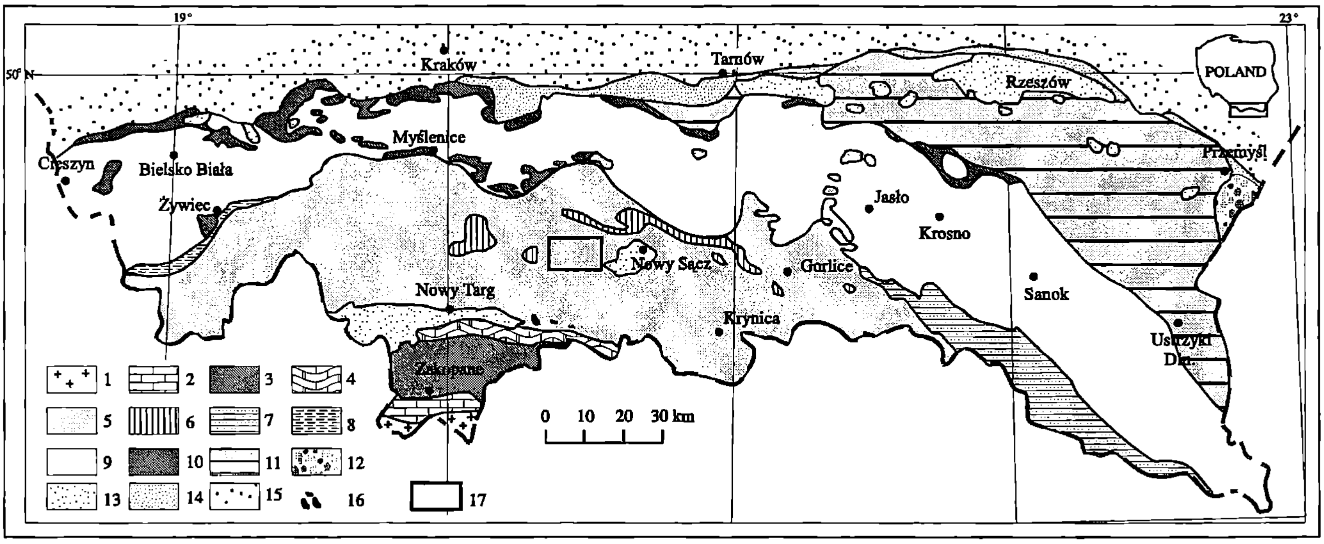


Fig. 1 Sketch-map of the middle part of the Polish Carpathians. *1* – crystaline rocks of the Tatra Mts., *2* – sedimentary rocks of the Tatra Mts., *3* – Podhale Flysch, *4* – Pieniny Klippen Belt, *5* – Magura Nappe, *6* – Grybów unit, *7* – Dukla unit, *8* – Fore-Magura unit, *9* – Silesian unit, *10* – Sub- Silesian unit, *11* – Skole unit, *12* – Stebnik unit – folded Miocene deposits, *13* – Miocene lying on Carpathians, *14* – Zgłobice Unit – folded Miocene deposits, *15* – autochtonous Miocene deposits of the Carpathian foredeep, *16* – Miocene andesites, *17* – study area

by the second and third authors, whereas the micropaleontological studies were carried out by the first author. The first results of the investigations were presented by T. Malata (1992) in his M. Sc. thesis. These studies enable us to propose litho-and biostratigraphical divisions in the SE part of the Beskid Wyspowy and to provide a new interpretation on the Bystrica and Rača subunits relationship in this area. According to our results there is no tectonic window in the Młyńczyska area.

LITHOSTRATIGRAPHY

In the studied part of the Magura nappe both the formal and informal lithostratigraphic units are in use. Among them, the Ropianka Beds (Formation) cause the most confusion (see Ślączka & Miziołek, 1995). The Upper Senonian-Paleocene deposits overlying variegated shales and followed by the Lower Eocene variegated shales were traditionally called the Inoceramian Beds, though the name Ropianka Beds was in use at the same time. Within these deposits there are several lithostratigraphic units of a lower rank. Part of them is clearly defined and commonly used. It refers to the Hałuszowa Formation (Birkenmajer & Oszczypko, 1989; Malata & Oszczypko, 1990), to the Kanina Beds (Burtan *et al.*, 1978; Oszczypko *et al.*, 1991) and to the Szczawina Sandstone (Sikora & Żytko, 1959; Oszczypko *et al.*, 1991). The section regarded as the stratotype of the Ropianka Beds has been lately studied by Ślączka & Miziołek (1995). It has been found that this section contains deposits of different age (from Upper Cretaceous do Oligocene) belonging to the Dukla and Magura units. According to Ślączka & Miziołek (1995) the name "Ropianka beds" should not be applied in the Magura unit, but considering tradition they suggest to use it only for the thin-to medium-bedded turbidites of the upper Inoceramian Beds. This suggestion is in agreement with the present paper though formal lithostratigraphic division of the Upper Cretaceous-Paleocene deposits still waits to be worked out. Thus as the Ropianka Beds (pro parte) we understand only thin-bedded turbidites overlying the Szczawina Sandstone and covered by the Eocene variegated shales.

Bystrica subunit

Malinowa Shale Formation (Upper Senonian)

In the Młyńczyska area the oldest deposits of the Bystrica subunit are represented by variegated shales of the Malinowa Fm., cropping out in the Jeżowa Woda stream (Fig. 3). Tectonicaly reduced thickness of this formation is not more than a few metres. These shales were described by Paul (1980) as Eocene variegated shales of the Rača subunit (Fig. 2).

Hałuszowa Formation (Maastrichtian)

The variegated shales pass upward into thin-bedded turbidites with intercalations of limestones and grey-yellowish marls which are analogous to those in the Hałuszowa Fm. in the Zasadne section (Malata & Oszczypko, 1990) and in the Kanina Beds (Cieszkowski *et al.*, 1989). At the top of this formation, a complex (few metres thick) of thin- to thick-bedded sandstones and marls, with frequent intercalations of red shales and red marls has been observed. These marls are rich in *Helminthoida* ichnosp. (= *Nereites irregularis* (Schafhautl) according to Uchman, 1995) whereas the basal surfaces of the sandstones display many trace-fossils with *Lorenzinia*. These deposits have been recognized as the Hałuszowa Formation (see Birkenmajer & Oszczypko, 1989; Malata & Oszczypko, 1990). In the Młyńczyska section the thickness of the formation attains at least 100 m, while in the

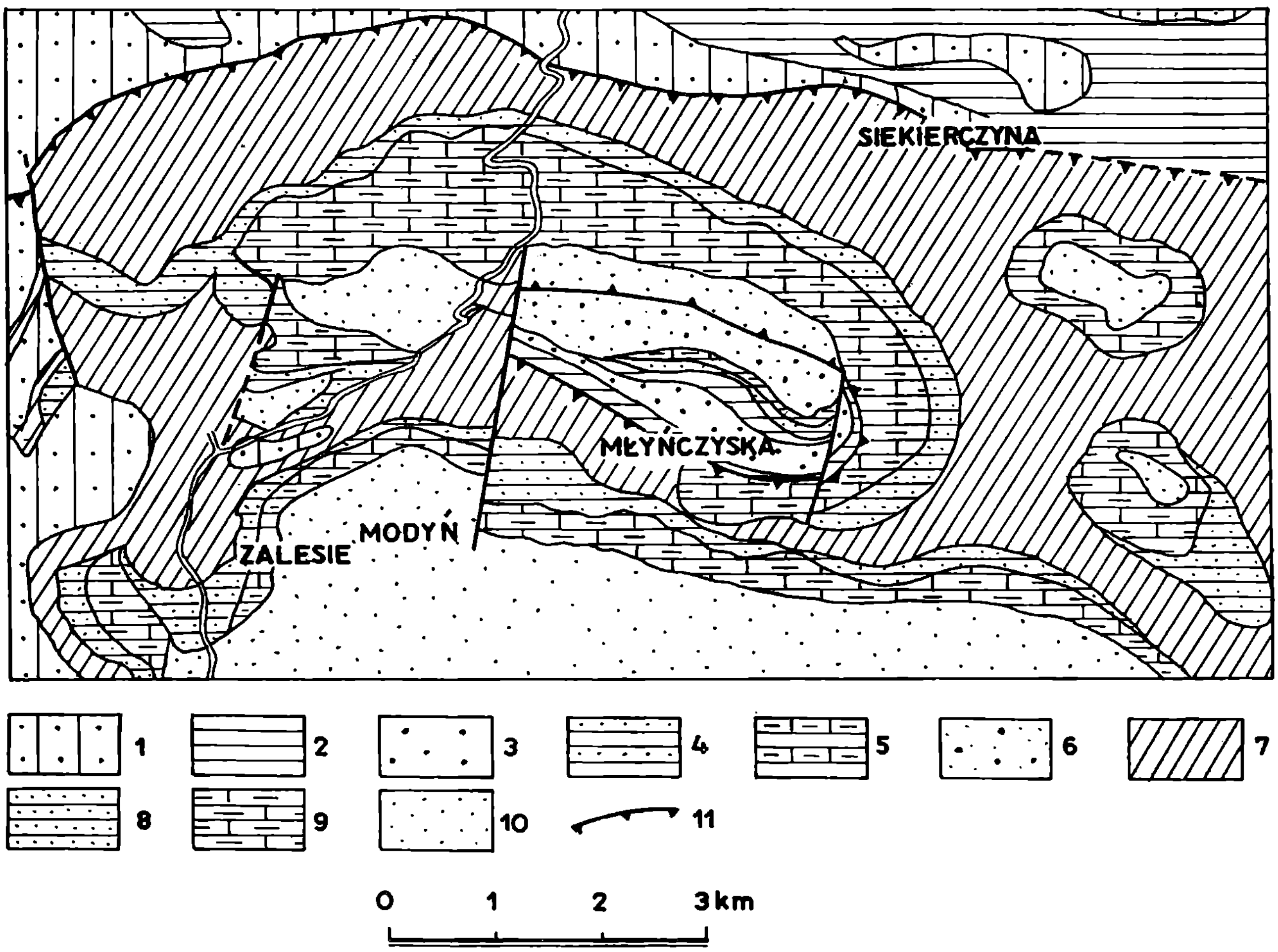


Fig. 2 Geological map of the Magura nappe in the Młyńczyska area (after Paul, 1980, simpliefed). *1* – Inoceramian Beds of Rača and Bystrica subunits; (*2-6*) Rača subunit: *2* – variegated shales, *3* – Ciężkowice Sandstone, *4* – Hieroglyphic Beds, *5* – Sub-Magura Beds, *6* – Magura Beds; (*7-10*) Bystrica (Sącz) subunit: *7* – variegated shales, *8* – Beloveza Beds, *9* – Łącko Beds, *10* – Magura Beds, *11* – overthrust

Zasadne section it is only 80 m (Figs. 4 and 5). These strata were described by Paul (1980) as Eocene variegated shales and Hieroglyphic Beds of the Rača subunit (Fig. 2).

Szczawina Sandstone (?Maastrichtian-Lower Paleocene)

The Szczawina Sandstone (see Cieszkowski *et al.*,1989 and Oszczypko *et al.*, 1991) is cropping out in the Jastrzębia stream and in the upper course of the Jeżowa Woda stream (Fig. 3). It is represented mainly by thick-bedded sandstones. Its basal portion, ca 25 m thick, is dominated by thin- to medium-bedded calcareous sandstones with intercalations of turbidite limestones and marls. Flute-cast measurements display palaeotransport from SE (125-140°). This part of the sequence resembles the Kanina Beds (see Cieszkowski *et al.*, 1989). The Kanina-like flysch passes upwards into thick-bedded sandstones (1.0-2.0 m), which reveal the $T_{abc+conv}$. Bouma divisions. The sandstones are very coarse- to fine-grained, muscovitic with carbonate cement, rich in shale clasts up to 15 cm in diameter and some of them occasionally armoured. The sandstone beds are intercalated by rare dark-grey shales up to a few dozen cm thick. The sandstones were deposited by paleocurrents flowing from SE (140-160°). The maximum thickness of the Szczawina Sandstone is 100 m. The strata in question were previously described (Paul, 1980) as the Ciężkowice Sandstone of the Rača subunit and the Magura Beds of the Bystrica subunit (Fig. 2).

Ropianka Beds (Paleocene)

The Ropianka Beds are best exposed in the Jeżowa Woda stream and on the southern slope of the Ostra mountain (Fig. 3). The formation is represented by thin-bedded turbidites with subordinate intercalations of thick-bedded sandstones. The sandstone beds (5 to 15 cm thick) are mainly fine- to very fine-grained, calcareous, muscovitic with cross and convolute lamination. The blue-greyish sandstones are intercalated with dark-grey and blue, usually carbonate-free shales. The uppermost part of the formation contains a few intercalations of red shales (5-10 cm thick), whereas transition to Szczawina Sandstone is sharp. Trace-fossils in the Ropianka Beds are rare. The thickness of the Ropianka Beds attains 300 m (Figs. 4 and 5), but in the

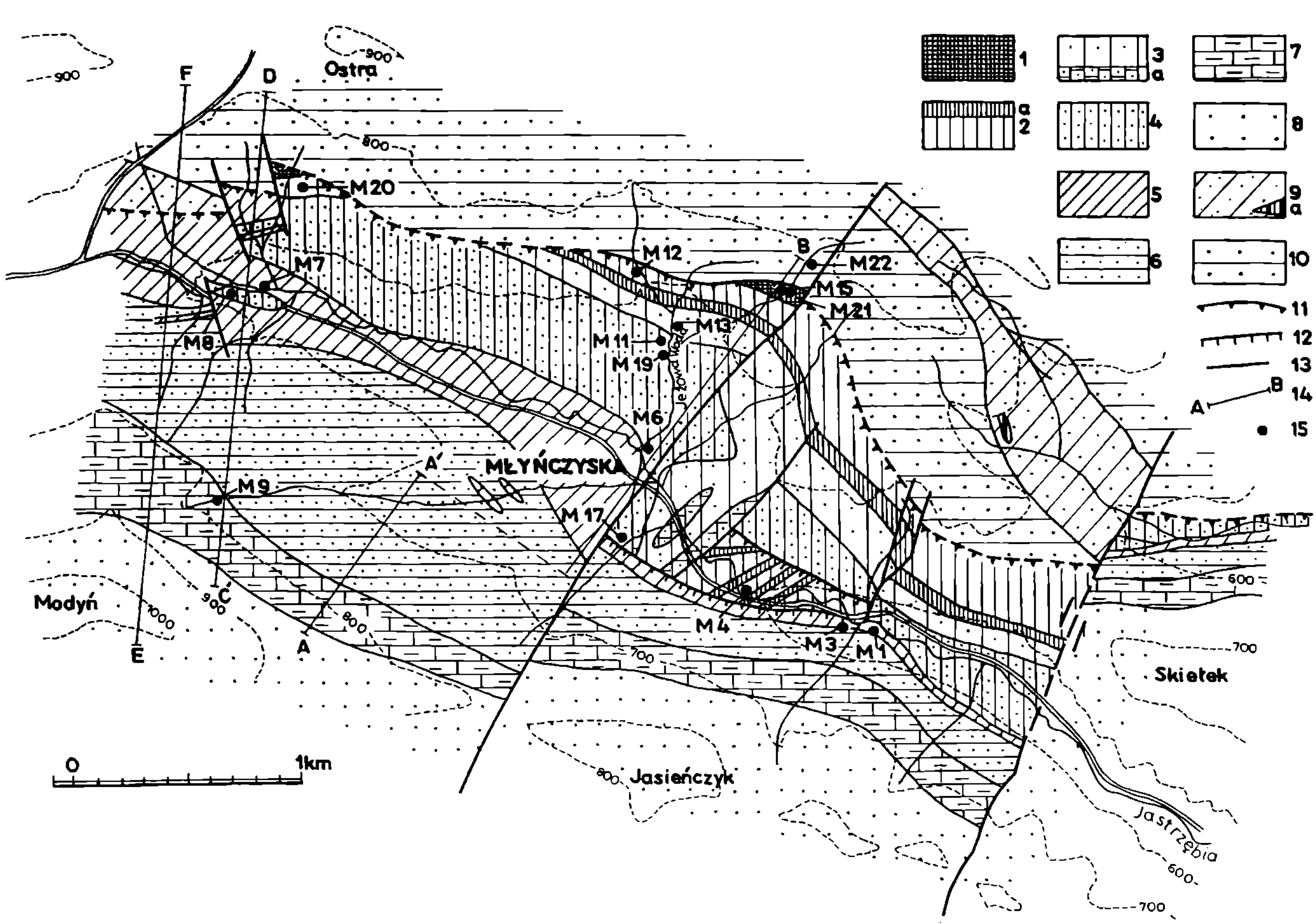


Fig. 3 Geological map of the Magura Nappe in the Młyńczyska area, (after Malata, 1992, simplified). (*1-8*) Bystrica sububit: *1* – Malinowa Sh. Formation, *2* – Hałuszowa Formation, (a – variegated shales), *3* – Szczawina Sandstone (a – turbidite limestone), *4* – Ropianka Beds, *5* – Łabowa Sh. Formation, *6* – Beloveza Formation, *7* – Żeleźnikowa Formation, *8* – Maszkowice Member of the Magura Formation; *(9-10)* Rača subunit: *9* – Hieroglyphic Beds (a – variegated shales), *10* – Poprad Sandstone Member of the Magura Formation; *11* – overthrust of Bystrica subunit, *12* – other overthrusts, *13* – fault, *14* – cross-section, *15* – location of samples

southern limb of the Młyńczyska anticline it is strongly tectonically reduced (Fig. 3).

Łabowa Shale Formation (Lower Eocene)

The deposits belonging to the Łabowa Sh. Fm. (Oszczypko, 1991) occur in a broad zone along the Jastrzębia stream (Fig. 3). They are mainly red, subordinately green or blue shales with intercalations of thin-bedded sandstones. The turbidite sequence usually begins with thin-bedded (1-6 cm), very fine-grained, green, carbonate-free sandstones passing up to a few centimetres of green shales, and finally to few centimeters of red shales. The shales are mainly soft and carbonate-free. In the Młyńczyska section (Figs. 4 and 5) the thickness of the formation attains up to 150 m, whereas towards the south (Zasadne section) it decreases to 25 m (Oszczypko, 1991).

Beloveza Formation (Middle Eocene ?)

The Beloveza Fm. (see Oszczypko, 1991) is cropping out along the northern slopes of the Modyń, Jasieńczyk and Skiełek hills (Fig. 3). The best exposures of this formation are located in the Modyń stream. The Beloveza Formation is represented mainly by thin- to medium-bedded turbidites. Shales, varying in colour (green, grey, blue, brown and yellowish), distinctly prevail over sandstones. In the basal part of the formation there occur sequences of alternating layers of different coloured shales. A few intercalations of red shales have also been observed in this part of the section. Yellowish and brown shales are usually calcareous, while the green ones are, as a rule, carbonate-free. The accompanying muscovite sandstones are very fine-grained and thin-bedded (5-12 cm). These sandstones reveal Bouma $T_{c+conv.}$ divisions passing upwards into massive mudstones and shales. The medium-bedded T_{bc} sandstones (20-40 cm) appear only in the higher part of the section. In the Młyńczyska area the thickness of the Beloveza Formation ranges from 100 m (E part) to 300 m (W part) and it is distinctly less than in the Zbludza section (500 m; Fig. 5; see also Oszczypko, 1991). In the Młyńczyska area the age of the Beloveza Fm. has not been investigated, but by comparison with the Zasadne section (see Oszczypko, 1991) the Middle Eocene age was accepted.

Żeleźnikowa Formation ("Lower Łącko beds", Middle Eocene)

The Żeleźnikowa Fm (see Oszczypko, 1991) occurs on

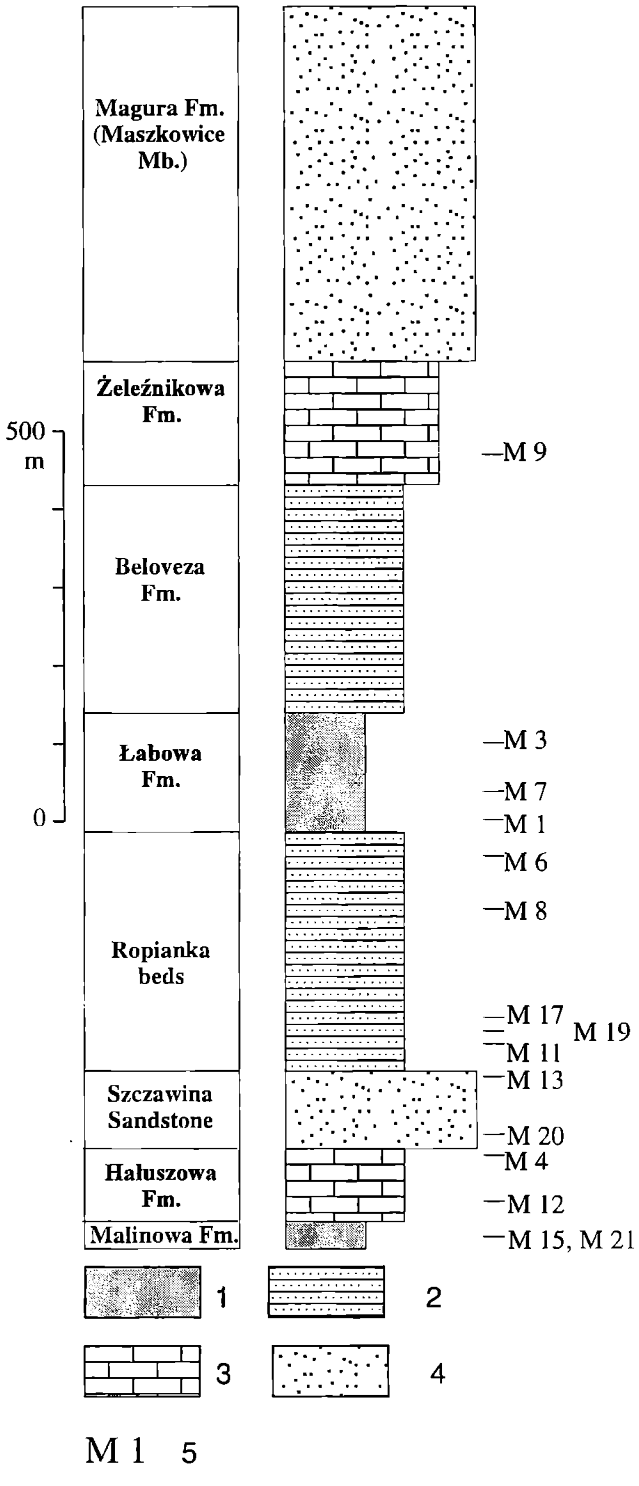


Fig. 4 Position of micropaleontological samples against the lithostratigraphic section of the Bystrica (Sącz) subunit in the Młyńczyska area. *1* – red shales, *2* – thin-bedded turbidites, *3* – thin- to medium-bedded turbidites with limestone and marl intercalations, *4* – thick-bedded turbidites, *5* – sample numbers

the northern slopes of the Modyń and Skiełek hills (Fig. 3). This formation comprises thin- to medium-bedded turbidites of the Beloveza lithotype with intercalations of the Łącko Marls. The marls are massive, sometimes silicified, brown or blue-to-grey and whitish as weathered. The thickness of the individual beds of the Łącko Marls ranges from 2 to 5 m and sporadically up to 15 m. The intercalations of the "Beloveza type" flysch are 0.5 to 2 m thick. The thickness of the Żeleźnikowa Formation can be roughly estimated at 150 m (Fig. 4). In the Zbludza section (Fig. 5) this formation attains 500 m (Oszczypko, 1991).

Maszkowice Member of the Magura Formation (Upper Eocene)

This member (see Oszczypko, 1979, 1991) builds up the tops of the Modyń, Jasieńczyk and Skiełek hills (Fig. 3). There are good exposures of the formation in the Jastrzębie stream. This member is represented by thick-bedded muscovitic sandstones (usually 1-1.5 m), coarse- to fine-grained, graded, passing upwards to parallel-laminated interval, roofed with green, muddy shales up to 15 cm thick. Small erosional channels and load-casts are present on the lower surfaces of the sandstones. The minimum thickness of the Maszkowice Member is 500 m (Figs. 4 and 5).

Rača subunit

In the Młyńczyska area only the youngest deposits of the Rača subunit have been investigated. The complete sections of this unit are known from the works of Paul (1980) and Oszczypko (1973).

Hieroglyphic Beds (Middle/Upper Eocene)

These beds are cropping out on the NE slope of the Młyńczyska valley (Fig. 3). They are represented by thin-to medium-bedded turbidites. The green-greyish and greyish shales are intercalated by thin- to medium-bedded (T_{bc}) muscovitic sandstones. Higher up in the sequence, blue-greyish marls and brown to yellowish shaly marls are observed. The muscovitic sandstones are mainly medium-bedded with domination of T_{abc} Bouma divisions. The upper part of the Hieroglyphic Beds contains a few tens of metres thick layer of conglomerates and thick-bedded sandstones. The conglomerates are composed of clasts of milky quartz and subordinately green phyllites and clasts of sedimentary rocks up to 1 cm in diameter. These conglomerates are probably an equivalent of the Pasierbiec Sandstone. In the uppermost part of the Hieroglyphic Beds, 100 m thick, thin intercalations of variegated shales have been observed (Fig. 5).

Poprad Sandstone Member of the Magura Formation (Upper Eocene)

The Poprad Member (see Birkenmajer & Oszczypko, 1989; Oszczypko, 1991) is the youngest lithostratigraphic unit of the Rača subunit and it crops out in the Ostra hill (Fig. 3). This member is developed as thick-bedded (1-4 m), muscovitic sandstones with occasional intercalations of greyish shales. The thickness of the formation is about 600 m (Fig. 5).

LITOSTRATIGRAPHIC CORRELATION

The Zasadne, Zbludza and Młyńczyska sections of the Bystrica subunit have been compared with a combined sec-

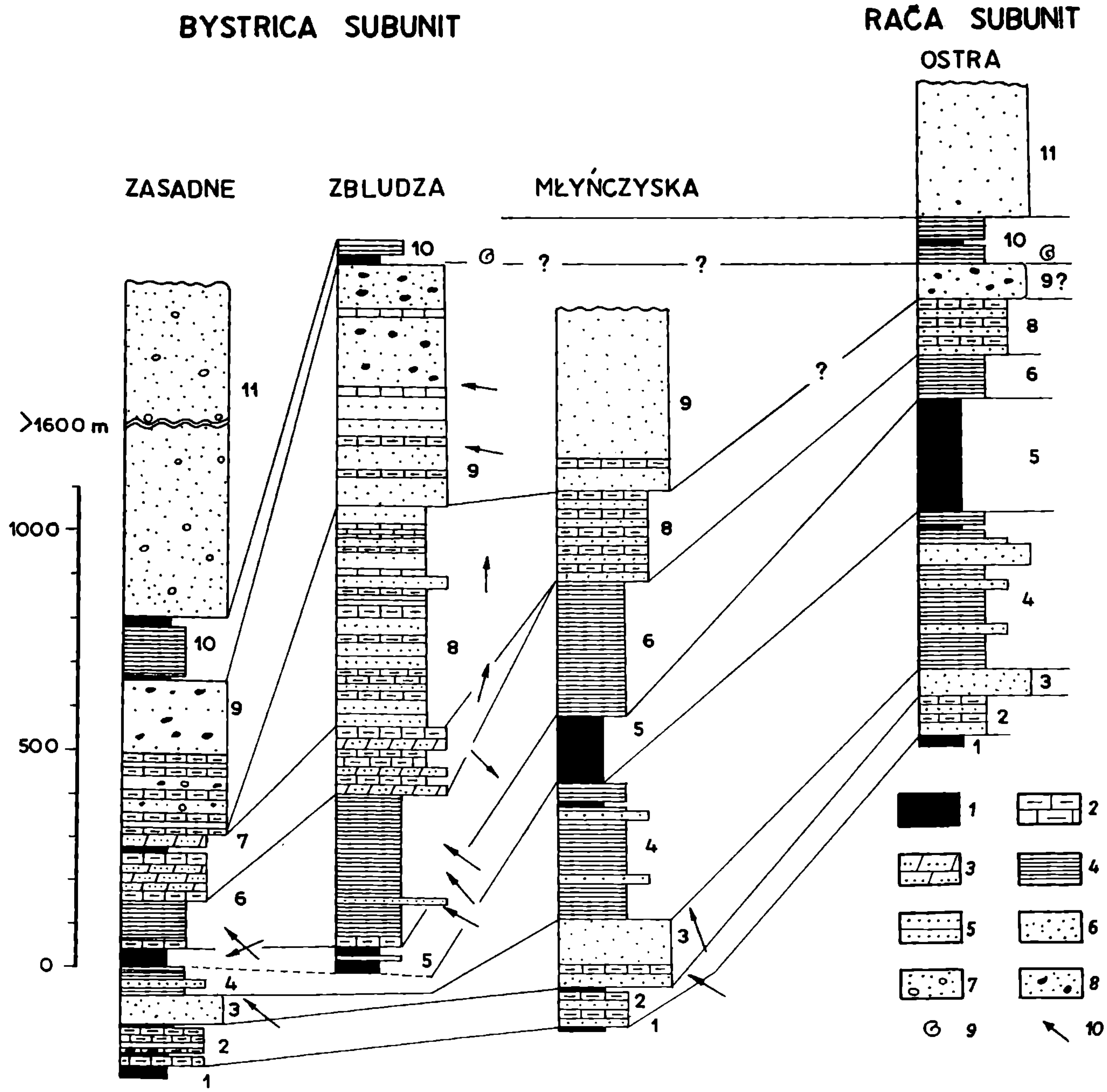


Fig. 5 Lithostratigraphic correlation of the Magura nappe in the Beskid Wyspowy Mts.. *1* – variegated shales, *2* – marls (turbiditic limestones), *3* – thick-bedded glauconitic sandstones, *4* – thin-bedded turbidites, *5* – medium-bedded sandstones, *6* – thick-bedded sandstones, *7* – conglomerates and sandstones, *8* – sandstones with mudstone clasts, *9* – *Reticulophragmium (Cyclammina) amplectens* (Grzybowski), *10* – palaeocurrent direction.
Lithostratigraphic units: 1 – Malinowa Sh. Formation, 2 – Haluszowa Formation, 3 – Szczawina Sandstone, 4 – Ropianka Beds, 5 – Łabowa Sh. Formation, 6 – Beloveza Formation, 7 – Bystrica Formation, 8 – Żeleźnikowa Formation and sub-Magura Beds (Rača Subunit), 9 – Maszkowice Member of the Magura Formation, 10 – Mniszek Member of the Magura Formation (Hieroglyphic Beds in the Rača subunit), 11 – Poprad Sandstone Member of the Magura Formation. Zasadne and Zbludza sections after Oszczypko (1991), Ostra section partly after Oszczypko (1973, modified)

tion of the southern part of Rača subunit (Fig. 5). Generally, there is a good lithostratigraphic correlation between these subunits, although some differences are observed:

1) the thicknesses of the Ropianka Beds and of the Łabowa Shale Formation distinctly increase towards the north; 2) the thicknesses of the Beloveza and Zeleźnikowa Formations increase from the Zasadne to the Zbludza section, and then decrease in the northern direction; 3) the Maszkowice Member of the Magura Formation disappears in the Rača subunit, and is probably replaced by the Pasierbiec Sandstone; 4) the upper part of the Hieroglyphic Beds can be an equivalent of the Mniszek Shale Member of the Magura Formation (see Oszczypko, 1991).

This correlation shows a continuous facies transition between the Bystrica and the Rača facies zones. Consequently, the tectonic and facies boundaries between these two subunits are not in line.

Table 1

Distribution of foraminiferal taxa in the Malinowa Fm. (M15, M21) and in the Hałuszowa Fm. (M4, M12) Symbols: I – 1 to 5 specimens; II – 6 to 12; III – 13 to 26; IV – 27 to 50; V – more than 50 specimens. Zone markers printed in bold type

SAMPLES	M15	M21	M12	M4
SPECIES				
Agglutinated forms				
Ammodiscus siliceus	I	III	I	I
Ammosphaeroidina pseudopauciloculata		II		
Aschemmocella carpathica				I
Aschemmocella grandis				I
Aschemmocella subnodosiformis				I
Bathysiphom sp.	III	V		
Gerochammina lenis			I	
Glomospira diffundens			I	I
Glomospira gordialis	II	I		
Glomospira irregularis	I	I	I	
Glomospira serpens			I	I
Haplophragmoides retroseptus				I
Haplophragmoides sp.		I		
Hormosina excelsa		I	IV	II
Hormosina gigantea	**V**	**V**		
Hormosina ovulum	V	V	III	II
Kalamopsis grzybowskii		I		
Nodellum velascoense		I	I	
Nothia excelsa				I
Paratochamminoides div. sp.	IV	IV	II	II
Recurvoides div.sp.	III	III	I	II
Remesella varians			**II**	**III**
Reophax duplex		II	I	
Reophax sp.		I	I	I
Reophax div.sp.	III			
Rhabdammina linearis		V		
Rhabdammina robusta				I
Rhizammina indivisa	I	I	I	I
Rzehakina epigona				I
Rzehakina inclusa	I		I	
Rzehakina sp.			I	I
Saccammmina placenta	III	III	II	I
Sphaerammina gerochii				I
Spiroplectammina sp.			I	
Spiroplectamminella dentata			II	
Subreophax splendidus				I
Thalmannammina subturbinata	I			I
Trochammina globigeriniformis		I		
Trochamminoides contortus			I	I
Trochamminoides grzybowskii		I		
Trochamminoides proteus		I	I	
Calcareous forms				
Eponides sp.				I
Gyroidina sp.			I	
Foraminiferal zones (this paper)	I		2	

BIOSTRATIGRAPHY

In the Bystrica subunit the Upper Senonian-Lower Eocene deposits (Malinowa Fm. up to Łabowa Shale Fm.) and the Middle Eocene Łącko Marls were the subject of detailed micropaleontological studies (Figs. 3 and 4). In the Rača subunit only the Hieroglyphic Beds were examined. The agglutinated foraminifers are either the only or dominating component of the assemblages recovered from the Upper Senonian - Lower Eocene deposits. Single specimens of calcareous benthonic foraminifers were found in the uppermost Senonian and Paleocene. Planktonic foraminifers occur in the Lower-Middle Paleocene. Microfauna of the Łącko Marls represents mixed-type assemblage with a considerable amount of calcareous benthonic and planktonic foraminifers. The poorest assemblages occur in the Hieroglyphic Beds of the Rača subunit. A few agglutinated species are accompanied by piritizied specimens of calcareous benthonic foraminifers.

Foraminiferal assemblages

Malinowa Sh. Formation

The oldest foraminiferal assemblage has been found in the variegated shales of this formation (see Tab.1). It is exclusively agglutinated fauna of moderate diversity with *Hormosina gigantea* Geroch occurring in considerable amount. *Hormosina ovulum* Grzybowski and tubular forms *Rhabdammina*, *Nothia*, *Bathysiphon* are also numerous. *Hormosina gigantea* is one of the most distinctive Upper Cretaceous species not only in the Tethyan flysh-type assemblages but also in the North Atlantic (Morgiel & Olszewska, 1981; Kuhnt *et al.*, 1989; Kuhnt, 1990). According to the zonation by Geroch & Nowak (1984), Hormosina gigantea Zone characterizes Upper Campanian and Maastrichtian biofacies.

Table 2

Distribution of foraminiferal taxa in the Szczawina Sandstone (M20, M13) and Ropianka Beds (M11, M19, M17, M8, M6). Symbols see Tab. 1

SAMPLES	M20	M13	M11	M19	M17	M8	M6
SPECIES							
Agglutinated forms							
Ammobaculites agglutinans				II		II	
Ammodiscus siliceus		I	I	I	I	I	I
Ammolagena clavata						III	
Ammosphaeroidina pseudopauciloculata				I	I		I
Aschemocella sp.			I	I			
Bathysiphon sp.		I					
Cribrostomoides trinitatensis						I	
Dorothia crassa	I						I
Gerochammina conversa			I	I		I	I
Glomospira diffundens					I		I
Glomospira gordialis				I		I	
Glomospira irregularis					I	I	
Glomospira serpens				I	I	I	
Glomospirella grzybowskii	I		I		I	I	II
Haplophragmoides suborbicularis			I				
Haplophragmoides sp.					I		I
Hormosina excelsa	I				I		
Hormosina ovulum	IV						
Hyperammina sp.	I					I	
Kalamopsis grzybowskii			II		II	I	I
Karrerulina coniformis							I
Lituotuba lituiformis				I	I		
Nodellum velascoense					I	II	I
Nothia excelsa	I			I			I
Paratrochamminoides div. sp.			III	I	III	III	III
Recurvoides div. sp.	I	II	III	IV	III	V	II
Remesella varians		**II**	**II**	**I**			
Reophax duplex			I	I	I		I
Reophax pilulifer			I		I	I	
Rhabdammina cylindrica			I		I		I
Rhabdammina discreta			I	I	I	I	I
Rhabdammina linearis		I			IV	IV	II
Rzehakina epigona	I				III	I	I
Rzehakina fissistomata					**II**	**I**	**II**
Rzehakina minima	I	I	I		II	I	
Saccammina placenta	I	I	II		III	II	II
Sphaerammina gerochii						I	
Spiroplectammina spectabilis			II	II			
Spiroplectinella dentata	I						
Subreophax gutiffer						I	I
Subreophax splendidus						I	I
Thalmannammina subturbinata					I		I
Trochammina globigeriniformis	I				II		I
Trochamminoides div.sp.			I		III		III
Tritaxia sp.				I			
Calcareous forms							
Aragonia sp.			I				
Dentalina sp.			I				
Globigerina triloculinoides			I				
Globigerina sp.		I		III			
Morozovella pseudobulloides		I	II	I			
Morozovella sp.			I				
Nuttallides sp.			IV				
Indeterminate calcareous				II			
Foraminiferal zones (this paper)	2	3			4		

Haluszowa Formation

Deposits overlying the red shales contain more diverse fauna with the following species of agglutinated foraminifers: *Hormosina excelsa* (Dylążanka), *Rzehakina inclusa* (Grzybowski), *Rzehakina epigona* (Rzehak), *Glomospira diffundens* (Cushman & Renz) and *Spiroplectammina dentata* (Alth). *Remesella varians* (Glaessner), belonging to a group of calcareous agglutinants, is common and very characteristic. Single specimens of poorly preserved calcareous benthic foraminifers were also found. *Remesella varians* is known from the Maastrichtian-Paleocene in the Polish Outer Carpathians (Morgiel & Olszewska, 1981). It is considered as an indicator of Middle Maastrichtian and younger strata in other areas (Kuhnt & Kaminski, 1989). The other mentioned species have a longer stratigraphic range but altogether form a characteristic assemblage of the uppermost Senonian. This fauna can be an equivalent of the *Rzehakina inclusa* assemblage distinguished by Morgiel & Olszewska (1981) in the Upper Senonian.

Table 3

Distribution of foraminiferal taxa in the Łabowa Shale Fm. (M1, M7, M3) and in the Łącko Marl (M9). Symbols see Tab. 1

SAMPLES	M1	M7	M3	M9
SPECIES				
Agglutinated forms				I
Ammodiscus siliceus	I	I	I	II
Ammosphaeroidina pseudopauciloculata		I	I	I
Bathysiphon sp.			I	I
Budashevella sp.		I		
Gerochammina conversa	I		I	II
Glomospira charoides & gordialis	V	V	V	
Glomospira gordialis				I
Glomospira irregularis	I		I	I
Haplophragmoides horridus				I
Haplophragmoides walteri			III	II
Hyperammina sp.	I			
Karrerulina apicularis		I		
Karrerulina coniformis				I
Lituotuba lituiformis			I	
Nothia excelsa	I			III
Paratrochamminoides div. sp.	I	II		
Recurvoides div. sp.	II	III		I
Reophax subnodulosus	I		I	
Reophax sp.	I			
Reophax div.sp.				II
Rhabdammina discreta			I	I
Rhabdammina linearis				I
Rzehakina epigona	I			
Rzehakina sp.	I			
Saccammmina placenta	I	I		
Sphaerammina subgaleata	I			
Subreophax guttifer		I		I
Subreophax splendidus		I		
Subreophax scalaris		I	I	
Textularia sp.	I			
Trochammina globigeriniformis				I
Trochammina quadriloba				I
Trochamminoides div.sp.	II	IV	II	I
Calcareous forms				
Abyssamina quadrata				III
Acarinina ex. gr. *bulbrooki*				V
Acarinina pentacamerata				I
Anomalina sp.				I
Clinapertina sp.				I
Chilostomella sp.				III
Dentalina sp.				I
Globigerina cf. corpulenta				I
Globigerina eocena				I
Globigerina officinalis				I
Globigerina senni				I
Globigerina sp.				I
Morozovella oragonensis				I
Morozovella lensiformis				I
Nonion sp.				I
Nuttallides trumpyi				III
Pullenia sp.				I
Pleurostomella div.sp.				II
Turborotalia frontosa				I
Indeterminate calcareous				II
Foraminiferal zones (this paper)	5			

Szczawina Sandstone

A relatively scanty assemblage from the lower part of the section does not allow for precise age determination while in its upper part the Paleocene age is well proved (see Tab. 2). Planktonic species *Morozovella pseudobulloides* (Plummer) has occurred in the assemblage with dominating agglutinated foraminifers. The first occurrence of this species falls on the Early Paleocene (P1 zone), its total range being P1-P3 zones except for the lowest and uppermost parts (Toumarkine & Luterbacher, 1985).

Ropianka Beds

Foraminiferal fauna from this formation display good preservation and the highest diversity (see Tab. 2.) In the lower part of the section the assemblages are dominated by the agglutinated foraminifers (Tab. 2 - M11, M19). Distinctive species are *Remesella varians* (Glaessner), *Spiroplectammina spectabilis* (Grzybowski) and *Glomospirella grzybowskii* (Jurkiewicz). The planktonic foraminifers were also recovered such, as *Morozovella pseudobulloides* (Plummer), *Subbotina triloculinoides* (Plummer) and calcareous benthonic *Nuttallides* sp. and *Aragonia* sp. The age of this fauna is within the range of *Morozovella pseudobulloides* i.e. Early-Middle Paleocene (Toumarkine & Luterbacher, 1985). Samples from the higher part of this formation (Tab.2 - M19, M 17, M 8, M 6) yielded the exclusively agglutinated assemblages with frequent *Rzehakina fissistomata* (Grzybowski), *Rzehakina epigona* (Rzehak), *Rzehakina minima* Cushman et Renz and *Glomospirella grzybowskii* (Jurkiewicz). *Saccammina placenta* Grzybowski, *Kalamopsis grzybowskii* (Dylążanka) and *Ammolagena clavata* (Jones et Parker) are also common as well as the numerous specimens of the genera *Rhabdammina*, *Paratrochamminoides*, *Recurvoides* and *Trochamminoides*. The age of the assemblage of such composition is commonly regarded as the Paleocene (Morgiel & Olszewska, 1981; Jednorowska & Pożaryska, 1983; Geroch & Nowak, 1984). Its position in the section suggests that this fauna may correspond to the upper part of the Paleocene.

Łabowa Shale Formation

The foraminiferal fauna in this formation, compared with the preceding one, is less diversified and consists entirely of agglutinated species (see Tab. 3). The distinctive feature of the assemblage is the acme of abundance of *Glomospira charoides* (Jones et Parker) and *Glomospira gordialis* (Jones et Parker). They occur along with *Recurvoides* div. sp., *Trochamminoides* div. sp., *Reophax* div. sp. and *Subreophax* div. sp. The assemblage with numerous specimens of *Glomospira* is characteristic for the Lower Eocene deposits of the Polish Outer Carpathians (Morgiel & Olszewska, 1981). In one case, *Rzehakina epigona* and *Rzehakina* sp. have been found together with abundant *Glomospira*. According to Geroch and Nowak (1984) the last appearance datum (LAD) of *Rzehakina epigona* is noted at the Paleocene/Eocene boundary. Morgiel and Olszewska (1981) mentioned its last occurrence in the lower part of Lower Eocene. Based on these data, the fauna can be considered as an indicator of the Paleocene/Eocene boundary or the lower part of the Lower Eocene.

Łącko Marl of the Żeleźnikowa Formation

Foraminiferal assemblage from the Łącko Marl displays relatively good preservation and contains a considerable amount of calcareous species (see Tab. 3). Agglutinated foraminifers are represented by the long-ranging forms: *Haplophragmoides walterii* (Grzybowski), *Gerochammina conversa* (Grzybowski), *Karrerulina coniformis* (Grzybowski), *Recurvoides* div. sp. and *Reophax* div. sp.

Among calcareous benthonic foraminifers *Abyssammina quadrata* Schnitker and Tjalsma is the most common species. It is known to be rare to common from lower Upper Paleocene to upper Middle Eocene in the deep-water deposits of the Atlantic (Tjalsma & Lohmann, 1983). *Nuttallides trumpyi* (Nuttall) and the representatives of the genera *Nodosaria*, *Pleurostomella*, *Nonion*, *Anomalina*, *Pullenia* and *Clinapertina* are also present.

Planktonic foraminifers are the most important component of this assemblage. The specimens designated as *Acarinina* ex. gr. *bulbrooki* (Bolli) are the most numerous. Taxonomic problems connected with this group have been discussed in Stainforth *et al.*, (1975); Berggren, (1977); Toumarkine & Luterbacher (1985). This group commonly occurs abundantly in the Middle Eocene (Stainforth *et al.*, 1975). *Globigerina corpulenta* (Subbotina), *G. eocena* Guembel, *G. officinalis* Subbotina, *G. senni* Beckmann and others are represented by single specimens. The oldest planktonic species among them is *Morozovella lensiformis* (Subbotina) known from the Lower Eocene, and the youngest one is *Globigerina officinalis* with its first occurrence (FO) in the uppermost Middle Eocene (Toumarkine & Luterbacher, 1985). The presence of the species of different ages indicates redeposition of the sediments. Thus the age of this fauna corresponds at least to the FO of *Globigerina officinalis*.

Hieroglyphic Beds of the Rača subunit

Impoverished microfauna consists of a few species of agglutinated foraminifers *Reophax elongatus* Grzybowski, *R. nodulosus* Brady along with single specimens of *Haplophragmoides walterii* (Grzybowski), *Sphaerammina subgaleata* Vasiček and one specimen of *Reticulophragmium amplectens* (Grzybowski). Pyritizied representatives of *Chilostomella* are specific for this assemblage. Fauna of such content is known in the Magura unit from the upper part of the Eocene (Malata, 1981).

Zonal scheme

Stratigraphic distribution of a few species regarded as markers allowed us to suggest four local interval zones (LIZ) and one local abundance zone (LAZ) (Tab. 4). They partly correspond to the Geroch & Nowak zones (1984) based on agglutinated foraminifers, with some modifications. The distinguished planktonic zone was also earlier described in other areas (Gradstein *et al.*, 1988).

1. Hormosina gigantea Zone (LIZ)

Age: Campanian – ?Early Maastrichtian

The lower boundary is the beginning of the studied section. The upper boundary is the lower boundary of the Remesella varians Zone.

Abundance of the index species is specific for this zone. *Hormosina excelsa* and *Rzehakina inclusa* appear for the first time.

2. Remesella varians Zone (LIZ)

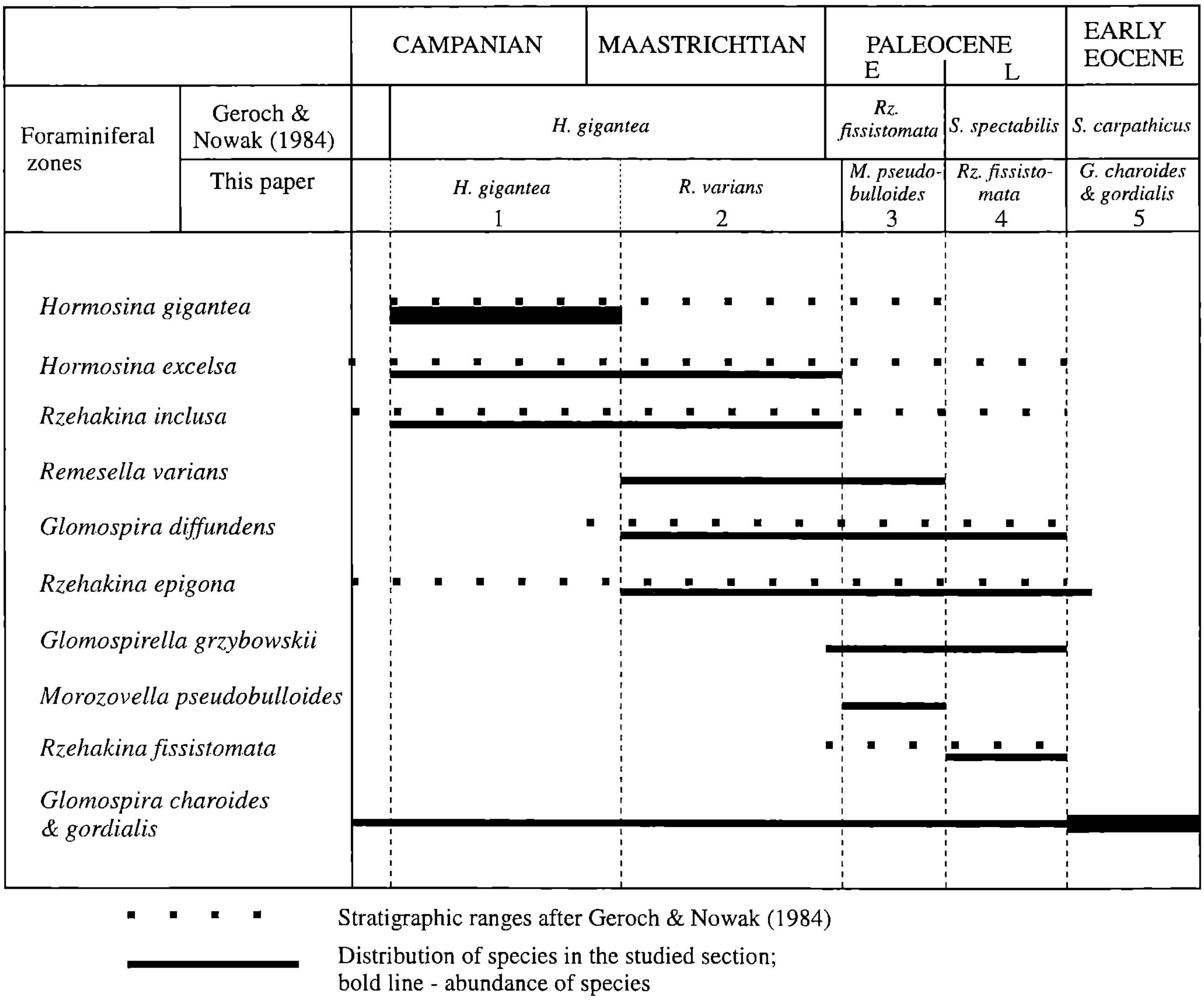
Age: Maastrichtian – earliest Paleocene

The lower boundary is defined by the lowest occurrence of the index species. Upper boundary corresponds to the lower boundary of the Morozovella pseudobulloides Zone.

Besides the index species, *Hormosina excelsa* is common. *Rzehakina epigona* and *Glomospira diffundens* have their first appearance. Single specimens of calcareous ben-

Table 4

Zonal scheme based on the distribution of the main foraminiferal marker species



thic foraminifers are also present.

3. Morozovella pseudobulloides Zone (LIZ)
Age: Early Paleocene (P1-P3)

This zone is defined by the lowest and highest occurrence of the index species.

Remesella varians has its last appearance. *Rzehakina minima*, *Spiroplectammina spectabilis* and *Glomospira grzybowskii* are present. *Subbotina triloculinoides*, *Aragonia* sp., *Nuttallides* sp. also occur in this zone.

4. Rzehakina fissistomata Zone (LIZ)
Age: Late Paleocene

Lower boundary coincides with the upper boundary of the Morozovella pseudobulloides Zone. The upper boundary is determined by the highest occurrence of the marker.

Exclusively agglutinated foraminifers are highly diversified. Genus *Rzehakina* is represented by a few species and it is quite numerous in some samples. *Glomospirella grzybowskii*, abundant *Recurvoides* div. sp. and *Trochamminoides* div. sp. are always present. *Glomospira diffundens* and *Hormosina excelsa* disappear in this zone.

5. Glomospira gordialis and Glomospira charoides Zone (LAZ)
Age: Early Eocene

Lower boundary is defined by the upper boundary of the Rzehakina fissistomata Zone. The upper boundary is the end of the section.

Abundance of the marker genera and the exclusively agglutinated fauna of moderate diversity are characteristic for this zone. *Rzehakina epigona* has its last appearance in the lowest part of the zone.

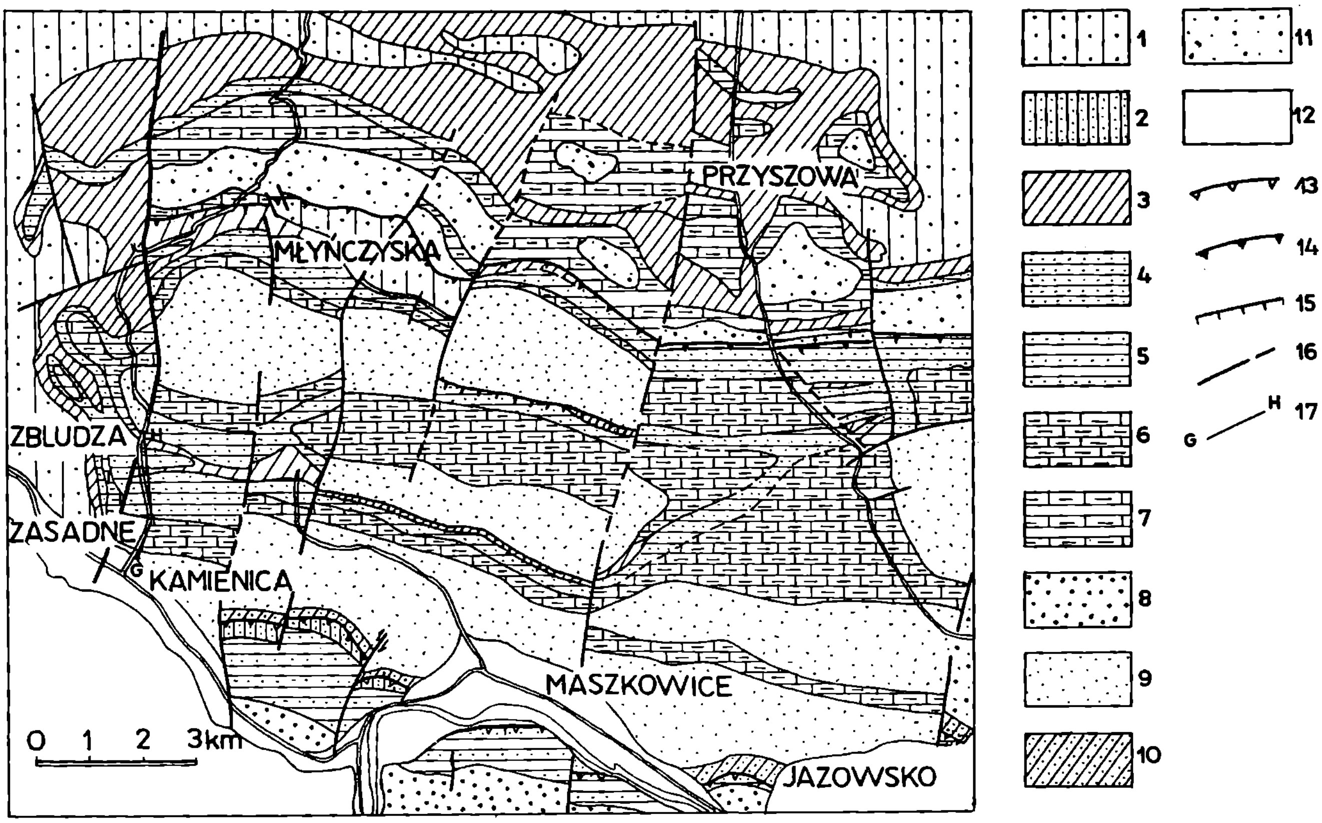


Fig. 6 Geological map of the eastern part of the Beskid Wyspowy Mts. (after Oszczypko, 1973; Oszczypko *et al.*, 1991, and Oszczypko in Paul (1980). *1* – Malinowa Sh. Fm. and Inoceramian (Ropianka) Beds (undivided), *2* – Szczawnica Formation, *3* – Łabowa Sh. Formation, *4* – Beloveza Formation, *5* – Zarzecze Formation, *6* – Bystrica and Żeleźnikowa Formations, *7* – sub-Magura Beds; Magura Formation: *8* – Piwniczna Sandstone Member, *9* – Maszkowice Member, *10* – Mniszek Sh. Member, *11* – Poprad Sandstone Member, *12* – Quaternary deposits, *13* – Krynica subunit overthrust, *14* – Bystrica (Sącz) subunit overthrust, *15* – overthrusts, *16* – faults, *17* – cross-section along the Zbludza stream

STRUCTURE

The area in question is located in the middle part of the Magura nappe, about 15 km southward from the front of the nappe (Fig. 1). It also occupies a transitional position between the Mszana Dolna, Szczawa (Oszczypko *et al.*, 1991) elevated structure in the west, and the Dunajec river depressed structure (Nowy Sącz Basin, see Oszczypko, 1973) in the east (Fig. 1). This segment of the Magura nappe belongs to the Rača and Bystrica (Sącz) subunits (Figs. 3, 5, 6, 7.). The Bystrica subunit is built up of several thrust-sheets, while the Rača subunit is characterised by more or less regular folds (Fig. 7). Similarly to other locations in the Magura nappe (Oszczypko, 1973; Oszczypko *et al.*, 1991), a distinct structural contrast was observed between strongly deformed and overturned Upper Cretaceous-Paleocene strata (Hałuszowa Fm. and Ropianka Beds) and relatively flat lying variegated shales (Łabowa Fm.-Lower Eocene) (Fig. 7). In the centre of Młyńczyska village the Łabowa Sh. Fm. is flatly thrust onto the older deposits (Senonian-Paleocene). Along the thrust many mesoscopic W-E and SW-NE trending folds accompanied by small N-S trending drag folds have been developed in the Hałuszowa Fm. (Fig. 8). Mesoscopic WNW-ESE and W-E imbricated folds are characteristic for the Łabowa and Beloveza formations. The Bystrica and Rača subunits are separated by a NW-SE trending overthrust (Figs. 6 and 7) traced towards the east (Oszczypko, 1973; Oszczypko & Wójcik, 1992). In the Młyńczyska area, the oldest (Upper Cretaceous-Paleocene) deposits of the Bystrica subunit are thrust onto the youngest deposits (Upper Eocene) of the Rača subunit. East from Młyńczyska, the Upper Cretaceous-Paleocene deposits disappear, and the base of the Bystrica subunit is built up of the Łabowa Sh. Formation (Lower Eocene). The Bystrica overthrust line is disturbed by a system of conjugated NE-SW and NW-SE trending faults. The main fault running through the centre of the Młyńczyska village is distinctly marked in relief. In the footwall of this fault the thickness of the Łabowa and Beloveza Formations is reduced. The studied area is dissected by several, mainly NNE-SSW trending, both sinistral and dextral oblique-slip faults (Figs. 3 and 6). More important is the Zbludza-Zalesie system of faults which separates the studied area from the elevated structures of Mszana Dolna and Szczawa. In the elevated area the base of the Magura nappe overthrust attains altitudes of up to 750 m and 450 m in the centre of the Mszana Dolna and Szczawa tectonic windows, respectively. A few kilometres east from Szczawa, in the Zbludza valley, this tectonic elevation

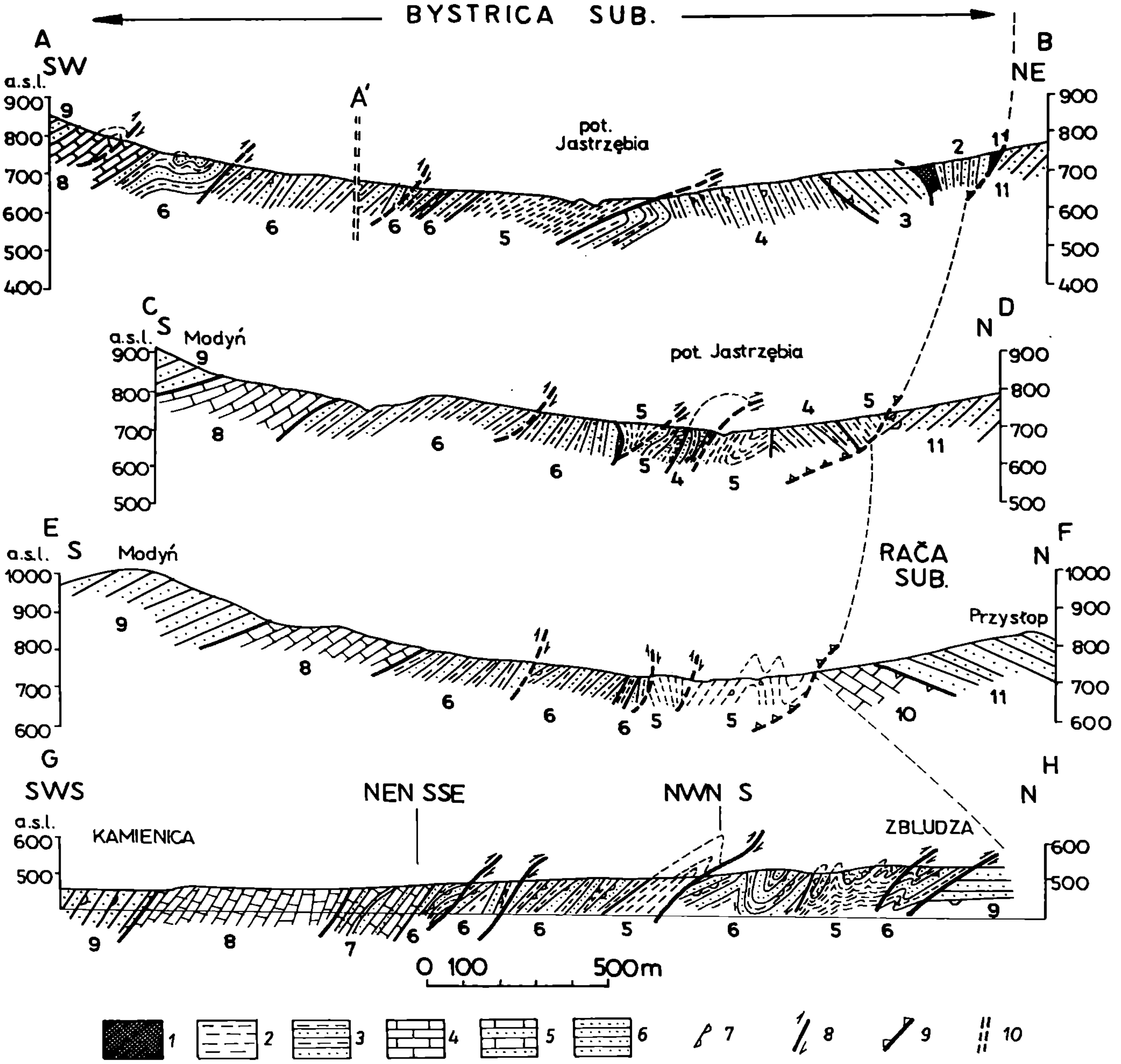


Fig. 7 Geological cross-sections (A-B, C-D and E-F after Malata, 1992, and G-H after Oszczypko, 1992). *1* – variegated shales and marls, *2* – variegated shales, *3* – thin-bedded turbidite, *4* – marls and medium-bedded turbidite, *5* – thick-bedded glauconitic sandstones and marls, *6* – thick-bedded sandstones, *7* – position of sole marks, *8* – inverse fault, *9* – overthrust, *10* – shift of cross-section in Fig. 3. Lithostratigraphic units: 1 – Malinowa Sh. Formation, 2 – Hałuszowa Formation, 3 – Szczawina Sandstone, 4 – Ropianka Beds, 5 – Łabowa Sh. Formation, 6 – Beloveza Formation, 7 – Bystrica Formation, 8 – Żeleźnikowa Formation, 9 – Maszkowice Member of the Magura Formation, 10 – Sub-Magura and Hieroglyphic Beds in the Rača subunit, 11 – Poprad Sandstone Member of the Magura Formation

is cut out by the Zbludza-Zalesie normal fault. The eastern wall of the fault was thrown down at least 1500 m (Słopnice 1, 14, 9, 17 and Leśniówka-3 boreholes, see Połtowicz, 1985). It is a young fault connected with terminal (last) movement of the Magura nappe, respectively to its foreland. This movement took place after the Early Badenian and prior to Late Badenian-Sarmatian deposition in the Nowy Sącz Basin (see Oszczypko *et al.*, 1991). To the east of this fault, the Bystrica overthrust is not recognized because the lithological contrast between the Senonian-Paleocene deposits of Bystrica and Rača subunits is indistinct. We should emphasize that our detailed geological investigation does not prove the occurrence of the Młyńczyska tectonic window as put forward by Paul (1980).

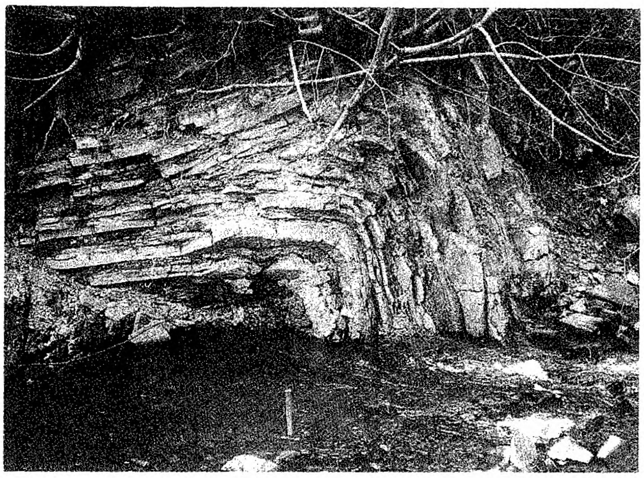


Fig. 8 NE-SW trending anticline in the Jastrzębia stream. Thin to medium-bedded turbidites at the top of the Hałuszowa Formation with intercalations of red marls rich in *Helmintoida* ichnosp.

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Streszczenie

LITO- I BIOSTRATYGRAFIA PŁASZCZOWINY MAGURSKIEJ WE WSCHODNIEJ CZĘŚCI BESKIDU WYSPOWEGO (POLSKIE KARPATY ZACHODNIE)

Ewa Malata, Tomasz Malata & Nestor Oszczypko

Litostratygrafia

W badanej części płaszczowiny magurskiej wyróżniane są zarówno formalne jak i nieformalne jednostki litostratygraficzne. Utwory fliszowe wyższego senonu-paleocenu leżące na pstrych łupkach górnokredowych i przykryte łupkami pstrymi dolnego eocenu tradycyjnie nazywane były warstwami inoceramowymi. Równocześnie dla tych samych utworów była w użyciu nazwa warstwy ropianieckie. W obrębie tych utworów występuje szereg jednostek litostratygraficznych niższego rzędu. Część z nich została dobrze zdefiniowana i jest powszechnie używana. Dotyczy to formacji z Hałuszowej (Birkenmajer & Oszczypko, 1989; Malata & Oszczypko, 1990), warstw z Kaniny (Burtan *et al.*, 1978; Oszczypko *et al.*, 1991) i piaskowców ze Szczawiny (Sikora & Żytko, 1959; Oszczypko *et al.*, 1991). Profil uważany za stratotypowy dla warstw ropianieckich był ostatnio przedmiotem badań Ślączki i Miziołka (1995). Profil ten zawiera różnowiekowe osady od kredy górnej po oligocen należące do jednostek dukielskiej i magurskiej. Zdaniem tych autorów nazwa warstwy ropianieckie nie powinna być stosowana dla utworów jednostki magurskiej. Jedynie ze względów historycznych dopuszczają oni stosowanie tej nazwy dla cienko- i średnio-ławicowych osadów wyższej części warstw inoceramowych. W przedstawionej pracy wydzielenie warstw ropianieckich jest zgodne z tą sugestią, choć autorzy zdają sobie sprawę, iż kwestia ta wymaga dalszych badań w wielu profilach. Przez warstwy ropianieckie (pro parte) należy więc rozumieć tylko cienko i średnioławicowy flisz, leżący na piaskowcach ze Szczawiny a przykryty przez paleogeńskie łupki pstre.

Strefa bystrzycka. Najstarsze utwory strefy bystrzyckiej ukazują się wzdłuż kontaktu ze strefą raczańska i należą do senonu (Fig. 3). Są to łupki pstre formacji z Malinowej (fm) (kampan-mastrycht) oraz margle, łupki pstre i cienkoławicowe turbidyty formacji z Hałuszowej (fm) (mastrycht) (Fig. 8) Sumaryczna miąższość obu formacji nie przekracza 80 m (Fig. 4). Poprzednio utwory te zaliczane były do eoceńskich łupków pstrych i warstw hieroglifowych strefy raczańskiej (Paul, 1980). Wyżej w profilu, występuje około stumetrowa seria gruboławicowych, muskowitowych piaskowców, które zaliczono do piaskowców ze Szczawiny (mastrycht?-dolny paleocen). Spągowa cześć tych warstw to cienko- i gruboławicowe piaskowce z wkładkami wapieni turbidytowych, odpowiadające warstwom z Kaniny w okolicach Szczawy (Cieszkowski *et al.*, 1989). Dotychczas utwory te zaliczane były do piaskowców ciężkowickich strefy raczańskiej oraz warstw magurskich strefy bystrzyckiej (Paul, 1980). Ponad piaskowcami ze Szczawiny zalega gruba seria cienkoławicowego fliszu (ok. 300 m), którą tymczasowo zaliczono do warstw ropianieckich. Na podstawie bogatej mikrofauny wiek opisywanych warstw ustalono na paleocen. Poprzednio omawiane utwory zaliczono do eoceńskich łupków pstrych strefy raczańskiej i bystrzyckiej (Paul, 1980). Kompleks utworów senońsko-paleoceńskich przykrywają, lokalnie wzdłuż kontaktu tektonicznego, dolnoeceńskie łupki pstre [formacja z Łabowej (fm)] o miąższości do 150 m (Fig. 4). Wyżej w profilu występuje środkowoeoceńska? formacja beloweska (fm) o miąższości do 300 m. Są to cienko- i średnioławicowe, wapniste turbidyty, barwy niebiesko-szarej. Przykrywa je cienko-ławicowy flisz litofacji beloweskiej z przeławiceniami piaskowców gruboławicowych oraz pakietami margli łąckich. Utwory te zaliczono do formacji z Żeleźnikowej (fm) tj. dawnych "dolnych warstw łąckich" (por. Oszczypko, 1992). W spągowej części formacji, w jednej z ławic margli łąckich stwierdzono bogatą bentoniczną i planktoniczną mikrofaunę wapienną, zawierającą między innymi, gatunek *Globigerina officinalis*, którego pierwsze pojawienie (FAD) znane jest z najwyższej części środkowego eocenu. Najmłodsze utwory strefy bystrzyckiej to co najmniej pięćsetmetrowa seria gruboławicowych muskowitowych piaskowców, które zaliczono do ogniwa piaskowców z Maszkowic (og) formacji magurskiej. Przez analogię do profilu Zbludzy (por. Oszczypko, 1992) utwory te można uznać za środkowo-górnoeoceńskie.

Strefa raczańska. W strefie tej przedmiotem naszego zainteresowania były tylko najmłodsze utwory, odsłaniające się przed czołem nasunięcia bystrzyckiego. Należą do nich warstwy hieroglifowe (środkowy-górny eocen) oraz ogniwo piaskowców popradzkich (og) (górny eocen) formacji magurskiej (fm). W warstwach hieroglifowych stwierdzono kilkudziesięciometrowy pakiet zlepieńców i gruboławicowych piaskowców, który może być odpowiednikiem piaskowców pasierbieckich z obszaru babiogórskiego. Ponadto w opisywanych warstwach zaobserwowano cienką wkładkę łupków pstrych.

Rozpoznany w okolicach Młyńczysk profil strefy bystrzyckiej doskonale koreluje się z innymi profilami tej strefy w rejonie Szczawy (Fig. 5). Z porównania badanych profili wynika, że w kierunku północnym zaznacza się wyraźnie wzrost miąższości paleoceńskich warstw ropianieckich oraz dolnoeoceńskich łupków pstrych (formacja z Łabowej). Te ostatnie utwory prawdopodobnie częściowo zastępują formację beloweską, której miąższość jest wyraźnie mniejsza niż w profilu Zbludzy (Fig. 5, por. Oszczypko, 1992). Profil strefy raczańskiej w Młyńczyskach wykazuje wyraźne podobieństwo do profili z północnego obrzeżenia Kotliny Sądeckiej (Oszczypko, 1973), a ponadto zazębia się facjalnie z profilem strefy bystrzyckiej.

Biostratygrafia

W badanych utworach podjednostki bystrzyckiej (górna kreda-wyższy eocen) stwierdzono następstwo zespołów małych otwornic od górnej kredy do dolnego eocenu. Otwornice aglutynujące są dominującym lub wyłącznym składnikiem tych zespołów. Największe zróżnicowanie odnotowano w paleoceńskich zespołach warstw ropianieckich. Nieliczne bentoniczne otwornice wapienne występują w mastrychcie i niższym paleocenie a planktoniczne w niższym paleocenie.

W oparciu o zasięgi i występowanie ważniejszych gatunków wskaźnikowych wyróżniono następujące lokalne zony: 1 – Hormosina gigantea (kampan-?dolny mastrycht); 2 – Remesella varians (mastrycht-najniższy paleocen); 3 – Morozovella pseudobulloides (dolny paleocen); 4 – Rzehakina fissistomata (wyższy paleocen); 5 – Glomospira charoides & gordialis (dolny eocen). Pstre łupki formacji z Malinowej obejmują poziom Hormosina gigantea a formacja z Haluszowej zonę Remesella varians; w wyższej części piaskowcow ze Szczawiny została udokumentowana zona Morozovella pseudobulloides; w warstwach ropianieckich stwierdzono obecność zon Morozovella pseudobulloides i Rzehakina fissistomata a w pstrych łupkach formacji z Łabowej obecne są otwornice zony Glomospira charoides i G. gordialis.

Mikrofauna margli łąckich reprezentuje mieszany typ fauny ze znaczną ilością otwornic wapiennych planktonicznych i bentonicznych. Wiek tego zespołu określono w oparciu o najmłodsze gatunki planktoniczne jako najmłodszy środkowy eocen.

W podjednostce raczańskiej badania mikrofaunistyczne wykonano dla warstw hieroglifowych. Dostarczyły one ubogich zespołów, w których obok nielicznych otwornic aglutynujących występują spirytyzowane okazy rodzaju *Chilostomella*. Tego typu fauna znana jest z wyższej części eocenu.

Tektonika

Opisywany obszar należy do podjednostek bystrzyckiej i raczańskiej płaszczowiny magurskiej. Podjednostka bystrzycka charakteryzuje się budową łuskową i stromym nachyleniem warstw, podczas gdy w podjednostce raczańskiej obserwuje się mniej lub bardziej regularne fałdy i w miarę płaskie zapadanie warstw. Podjednostki te kontaktują ze sobą wzdłuż linii nasunięcia (uskoku inwersyjnego, Fig. 6, 7), biegnącej od Kotliny Sądeckiej po dolinę Zbludzy (Fig. 6, por. Oszczypko, 1973; Oszczypko & Wójcik, 1992), gdzie wygasa na uskoku poprzecznym Zbludza-Zalesie. Opisywany teren pocięty jest licznymi sprzężonymi uskokami poprzeczymi o kierunku NE-SW oraz NW-SE. Wśród tych dyslokacji bardzo ważną rolę odgrywa uskok Zbludza-Zalesie, obcinający od wschodu elewowaną strefę okien tektonicznych Mszany Dolnej i Szczawy. Wzdłuż uskoku zrzucona została wschodnia część Beskidu Wyspowego. Wielkość zrzutu jest nie mniejsza od 1500 m. Jest to młody uskok powstały po środkowobadeńskim dosunięciu płaszczowiny magurskiej, a przed powstaniem późnobadeńsko-sarmackiego basenu w Kotlinie Sądeckiej (Oszczypko *et al.*, 1992).