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UPPER MAASTRICHTIAN AND PALEOCENE DEPOSITS AT SZAFLARY, PIENINY KLIPPEN BELT, CARPATHIANS, POLAND

(4 Fig., 1 Tab.)

Utwory górnego mastrychtu i paleocenu w Szaflarach, pieniński pas skałkowy

(4 fig., 1 tab.)

Abstract: At the contact of the Pieniny Klippen Belt with the Podhale Flysch (Palaeogene) at Szaflary (Polish Carpathians), occur late Maastrichtian and Paleocene deposits of small thickness, characterized by abundant, predominantly planktonic foraminiferal assemblages, developed in a facies unknown from the Klippen successions in Poland. These deposits correspond to a zone known in Slovakia as the „peri-Klippen" zone, resp. Myjava Furrow, which was situated to the south of the Klippen Belt basin and its southern exotic massif, and to the north of the folded Central Carpathian (Sub-Tatric and High-Tatric) units.

INTRODUCTION

At the contact of the Pieniny Klippen Belt and the Podhale Palaeogene flysch at Szaflary (Polish Carpathians), occur late Maastrichtian and Paleocene deposits developed in a facies unknown from the Klippen successions of Poland. These rocks are younger than the youngest lithostratigraphic units of the Klippen successions, which are represented by preorogenic flysch of the Sromowce Formation (Coniacian to Lower Campanian — see Birkenmajer, 1977) in the southern tectonic units, and by pelagic *Globotruncana* marls of the Pustelnia Marl Member (Turonian to Lower Maastrichtian — see Alexandrowicz, 1975; Birkenmajer, Jednorowska, 1976; Birkenmajer, 1977) in the northernmost part of the geanticlinal Czorsztyn Succession.

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The Paleocene rocks at Szaflary have been recognized in 1964 by Durand-Delga (1965) on microfaunal investigation by J. Magné. Small outliers of the Campanian-Maastrichtian, Paleocene (?) and Eocene-Oligocene rocks of small thickness, have been traced west of Szaflary, along the boundary of the Pieniny Klippen Belt with the Podhale Palaeogene, by Morgiel and Sikora (1972, 1973). The sequence discussed differs both in age and in facies from those recognized in the Klippen successions (Birkenmajer, 1965, and later papers), and represents an independent succession which was attributed to the so-called „Złatne succession" by Morgiel and Sikora (*op. cit.*), but correlated with the Myjava succession of West Slovakia by Birkenmajer (1977, p. 140). The Maastrichtian unit of the succession is partly coeval with the Maastrichtian flysch and molasse of the Jarmuta Formation, which is represented by coarsely to fine-detrital clastics with abundant rock material from the Klippen successions as secondary deposit, and which was deposited unconformably upon folded Klippen successions and, besides, in the Magura basin (Grajcarek Unit — see Birkenmajer, 1965, 1970, 1977) — to the north of the Czorsztyn geanticline.

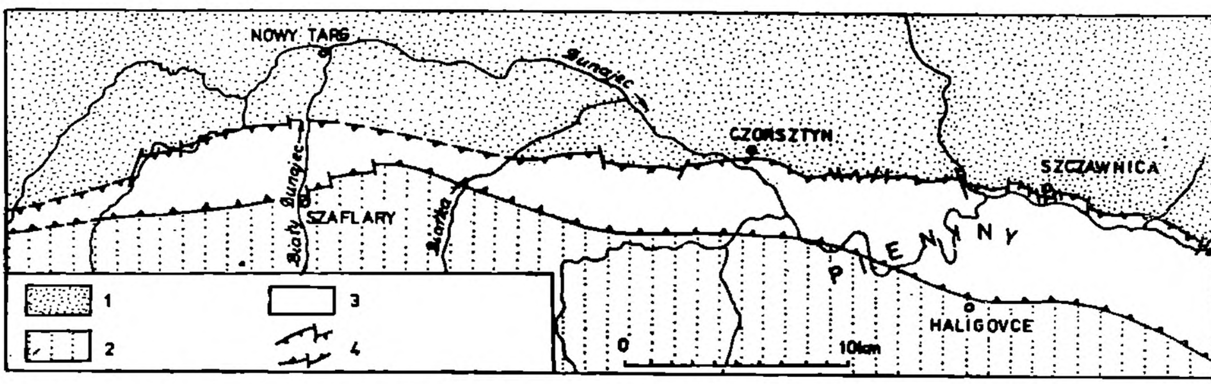

Fig. 1. Location of Szaflary within the Pieniny Klippen Belt. 1 — Magura Nappe; 2 — Podhale Flysch; 3 — Pieniny Klippen Belt; 4 — Northern and southern tectonic boundaries of the Pieniny Klippen Belt

Fig. 1. Położenie Szaflar w pienińskim pasie skałkowym. 1 — płaszczowina magurska; 2 — flisz podhalański; 3 — pieniński pas skałkowy; 4 — północna i południowa granica tektoniczna pienińskiego pasa skałkowego

The present paper gives the results of lithologic and microfaunal investigations of a section exposed along the right bank of the Dunajec River at Szaflary (Fig. 1), at the southern contact of the Pieniny Klippen Belt. The field work was done in 1969.

LITHOLOGY, MICROFAUNA AND AGE OF THE DEPOSITS

The section along the right bank of the Biały Dunajec River exposes several Upper Cretaceous lithostratigraphic units of the Pieniny Succession (Fig. 2: *6—8*) on the north, and a 25 m thick complex of

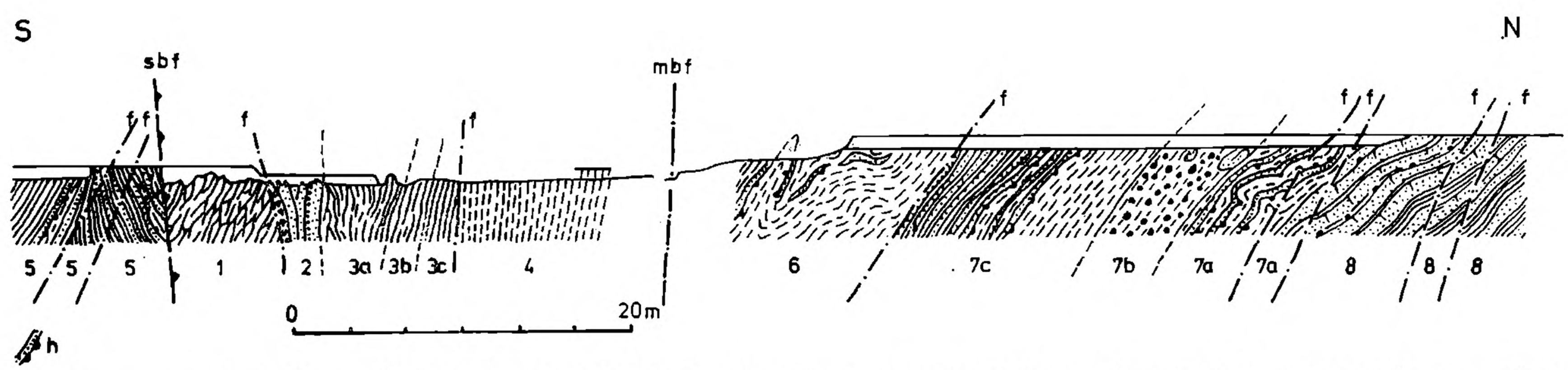

Fig. 2. Exposure at Szaflary, right bank of the Biały Dunajec River. „P e r i - K l i p p e n" (M y j a v a) z o n e (1—3 — Upper Maastrichtian; 4 — Middle Paleocene): 1 — unit 1 (whitish marls); 2 — unit 2 (sedimentary breccia and graded sandstones); 3 — unit 3 (3a — whitish marls; 3b — variegated marls; 3c — greenish marls); 4 — unit 4 (cherry-red shale and marly shale). P o d h a l e F l y s c h: 5 — Zakopane Formation (Upper Eocene). P i e n i n y S u c c e s s i o n (6—7 — „Jaworki Marl Formation): 6 — Skalski Marl Member, Cenomanian (marly shale with sandstone intercalations); 7 — Snežnica Siltstone Member, Cenomanian-Turonian (7a — marly shale with sandstone and silstone intercalations; 7b — marly shale with exotic pebbles and sandstone slump balls; 7c — marly shale with thin sandstone intercalations); 8 — Sromowce Formation, Coniacian-Campanian (flysch: sandstone and shale). f — Tectonic contacts; sb — southern boundary fault of the Pieniny Klippen Belt; mbf — tectonic contact of the „peri-Klippen" Senonian-Palaeogene with the Pieniny Succession; h — position of sole markings

Fig. 2. Odsłonięcie w Szaflarach na prawym brzegu Białego Dunajca. S t r e f a „p r z y s k a ł k o w a" (m y j a w s k a): 1—3 — górny mastrycht; 4 — środkowy paleocen. F l i s z p o d h a l a ń s k i: 5 — formacja zakopiańska (górny eocen). S u k c e s j a p i e n i ń s k a (6—7 — formacja margli z Jaworek): 6 — ogniwo margli ze Skalskiego, cenoman; 7 — ogniwo mułowców śnieżnickich, cenoman-turon; 8 — formacja sromowiecka, koniak-kampan. f — kontakty tektoniczne; sb — południowa dyslokacja pienińskiego pasa skałkowego; mbf — kontakt tektoniczny strefy senonu-paleogenu „przyskałkowego" z sukcesją pienińską; h — pozycja hieroglifów spągowych

Maastrichtian and Paleocene rocks on the south, at the contact with the Podhale Flysch (Zakopane Formation, Upper Eocene). The rocks are vertical or dip at very steep angles to the south or to the north, and are often recumbent. The Maastrichtian-Paleocene complex is repre-

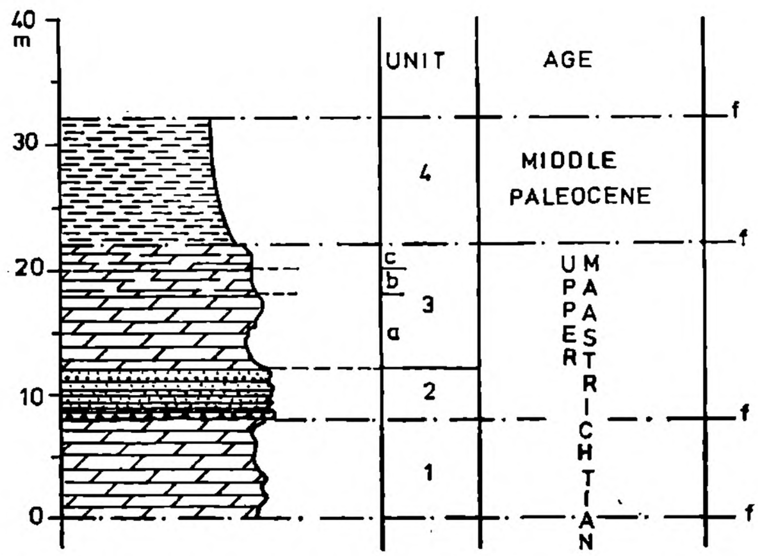

Fig. 3. Lithostratigraphic column of the Upper Maastrichtian and Middle Paleocene sediments at Szaflary. f — Tectonic contacts

Fig. 3. Kolumna litostratygraficzna osadów górnego mastrychtu i środkowego paleocenu w Szaflarach. f — kontakty tektoniczne

sented by two lithostratigraphic units of formation rank: the older marly complex (with sandstone-sedimentary breccia intercalation in the middle) which yielded Upper Maastrichtian foraminifers, and the younger, shaly complex which yielded Paleocene foraminifers (Fig. 3).

Upper Maastrichtian

Unit 1 (8 m)

The oldest part of the Maastrichtian complex tectonically contacts with the Podhale Flysch (Zakopane Formation, Upper Eocene) which is overturned in a narrow zone adjoining the contact, then (further south) it dips normally towards the south. The Maastrichtian unit *1* is represented by pale-grey, pale-green, whitish weathered, strongly cleaved marls and marly limestones (Fig. 2: *1*).

Ten samples for microfauna were taken. The microfossils were difficult to separate from hard marls and marly limestones, where they were often deformed, and only softer marls yielded determinable forms. The dominant element of the microfaunal spectrum (Tab. 1: assemblage *1*) is represented by planktonic forms, of which *Globotruncana stuartiformis* Dalbiez is the most common, and is associated with stratigraphically important *G. stuarti* (Lapparent), *G. conica* White, *Abathomphalus mayaroensis* (Bolli) and *Pseudotextularia* spp. Of the

Table 1

Microfaunal spectra of the Upper Maastrichtian (units 1, 3) and Middle Paleocene (unit 4) pelagic sediments from Szaflary

s — single; r — rare; f — few; c — common; a — abundant

Species	Lithostratigraphic unit: 1	3	4
	Assemblage: 1	2	3
Reophax sp.	—	s	s
Hormosina ovulum (Grzybowski)	s	r	s
Nodellum velascoense (Cushman)	—	s	—
Glomospira charoides (Jones et Parker)	—	—	r
Glomospira gordialis (Jones et Parker)	s	s	s
Ammodiscus siliceus (Terquem)	s	s	r
Trochamminoides irregularis White	—	—	s
Textularia plummerae Lalicker	—	s	s
Spiroplectammina semicomplanata (Carsey)	r	r	—
Gaudryina cf. *pyramidata* Cushman	s	s	s
Tritaxia tricarinata Reuss	r	s	s
Arenobulimina sp.	s	s	s
Dorothia bulleta Carsey	s	s	s
Dorothia trochoides (Marsson)	r	s	s
Lenticulina macrodisca (Reuss)	s	s	—
Lenticulina wilcoxensis (Cushman et Ponton)	s	—	—
Astacolus compressus (d'Orbigny)	—	s	—
Vaginulina trilobata (d'Orbigny)	s	—	—
Neoflabellina cf. *numismalis* Wedekind	s	—	—
Pseudoglandulina parallela (Marsson)	—	s	—
Gyroidinoides nitidus (Reuss)	s	r	—
Stensioeina caucasica (Subbotina)	s	s	—
Stensioeina pommerana Brotzen	r	s	—
Eponides cf. *frankei* Brotzen	—	r	—
Anomalina cf. *welleri* (Plummer)	—	—	s
Gavelinella pertusa (Marsson)	s	—	—
Pseudovalvulineria cf. *praeacuta* Vassilenko	s	—	—
Cibicidoides cf. *actulagayensis* Vassilenko	s	—	—
Globigerina triloculinoides Plummer	—	—	a
Globorotalia aequa Cushman et Renz	—	—	r
Globorotalia angulata (White)	—	—	c
Globotruncana arca (Cushman)	f	f	—
Globotruncana contusa (Cushman)	f	c	—
Globotruncana conica White	f	r	—
Globotruncana cf. *gagnebini* Tilev	s	—	—
Globotruncana gansseri Bolli	r	—	—
Globotruncana stuarti (Lapparent)	r	s	—
Globotruncana stuartiformis Dalbiez	c	r	—
Abathomphalus mayaroensis (Bolli)	r	—	—
Rugoglobigerina rugosa (Plummer)	f	c	—
Reussella szajnochae (Grzybowski)	s	s	—
Pleurostomella sp.	s	s	—
Aragonia ouezzanensis (Rey)	—	s	—
Bolivina incrassata Reuss	—	s	—
Bolivinoides giganteus Hiltermann et Koch	s	—	—
Pseudotextularia acervulinoides (Egger)	r	s	—
Pseudotextularia elegans (Rzehak)	f	s	—
Pseudotextularia varians (Rzehak)*	s	s	—

benthic forms, the most characteristic are: *Gavelinella pertusa* (Marsson), *Stensioeina pommerana* Brotzen, *S. caucasica* (Subbotina) and *Reussella szajnochae* (Grzybowski). The variation within the foraminiferal spectrum between the samples is negligible, and depends on the percentage of benthos (10—20%). The assemblage indicates the Upper Maastrichtian, possibly the latest Upper Maastrichtian, age of the marls.

Unit 2 (4 m)

The unit starts with a sedimentary breccia (0.1 m) composed of whitish or greenish marl fragments (0.5—2 cm in diameter) of the same type as that of the underlying unit 1, fine fragments of *Inoceramus* shells and of quartz grains. The colour of the rock is grey-green. There follow several thin layers (2—10 cm thick) of grey, grey-blue, fine to medium-grained calcareous sandstone, passing at the top to arenaceous marl. Small fragments of white to green marl of the same type as that of the first unit, are frequently met with in the basal, graded part of the sandstone layers. The highest part of the unit is formed by two layers of grey-bluish or grey-green, fine to medium-grained calcareous sandstone, with well developed normal graded bedding marked by coarser quartz grains at the sole (facing south) of the higher layer.

No microfauna has been obtained from the sandy-brecciose complex. The rocks resemble very much the Maastrichtian Orbitoid-bearing breccias and sandstones of West Slovakia.

Unit 3 (10 m)

The youngest part of the Maastrichtian complex is represented (from the bottom to the top) by: a) cleaved marls and shaly limestones, grey-green, weathered pale-grey (6 m); b) shaly marls, pinkish-grey, greenish and variegated (2 m); c) soft shaly marls, grey-green (2 m).

The microfaunal assemblages investigated from 6 samples were generally very similar to those from the lower marls (unit *1*). Particularly frequent is *Globotruncana contusa* (Cushman), besides *Rugoglobigerina rugosa* (Plummer), less frequent are foraminifers of the genus *Pseudotextularia*. The benthos is represented i.a. by *Nodellum velascoense* (Cushman), *Eponides* cf. *frankei* Brotzen, *Aragonia ouezzanensis* (Rey) and *Bolivina incrassata* Reuss (Tab. 1: assemblage 2). The ratio of planktonic to benthic forms is similar to that of the lower marls (unit 1). The assemblage indicates the Upper Maastrichtian age of the unit.

Paleocene

Unit 4 (10 m)

The unit consists of soft marly shale and shaly marl, cherry-red, sometimes variegated. The planktonic foraminifers investigated from 9 samples, decidedly predominate (90% of the assemblage) over benthic ones. The plankton is represented by three species, particularly important for determination of the age of unit 4: *Globigerina triloculinoides* Plummer (Fig. 4: 2a-c), *Globorotalia angulata* (White) (Fig. 4: 1a-c) and *G. aequa* Cushman et Renz (Fig. 4: 3a-c). The first species occurs in all investigated samples where it forms 60—70% of the whole assemblage, the second species is less common in the same samples, the third one occurs only in the stratigraphically highest samples. The benthic forms are subordinate, the most common are arenaceous forms *Glomospira* and *Ammodiscus;* calcareous benthos is rare (Tab. 1: assemblage 3).

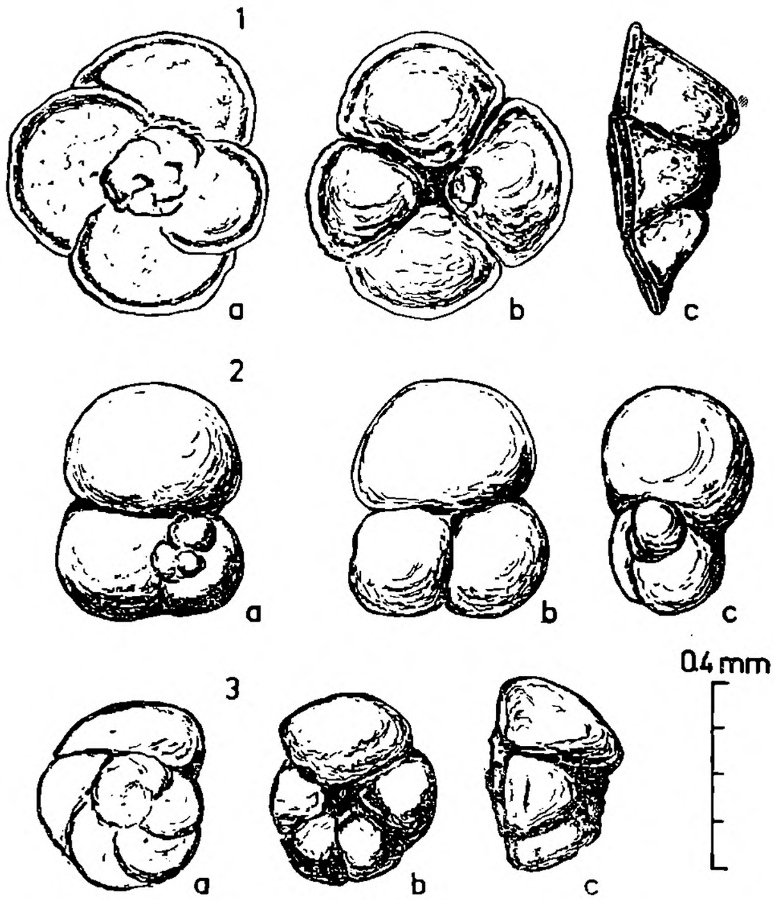

Fig. 4. Planktonic foraminifers from the Middle Paleocene at Szaflary. 1a—c — *Globorotalia angulata* (White); 2a—c — *Globigerina triloculinoides* Plummer; 3a—c — *Globorotalia aequa* Cushman et Renz

Fig. 4. Planktoniczne otwornice z środkowego paleocenu Szaflar. 1a—c — *Globorotalia angulata* (White); 2a—c — *Globigerina triloculinoides* Plummer; 3a—c — *Globorotalia aequa* Cushman et Renz

The presence of *Globigerina triloculinoides* (Lower-Middle Paleocene) and *Globorotalia angulata* (zonal index for the Middle Paleocene) in the lower samples, and together with *G. aequa* (Middle-Upper Paleocene and Lower Eocene) in the upper samples, clearly indicate a Middle Paleocene (Landenian) age of unit 4: *Globorotalia angulata* Zone, resp. *G. pusilla pusilla* Zone (early Landenian), and lower part of *G. aequa*

Zone (late Landenian to early Ilerdian), recognized over wide areas of the Tethys (P o s t u m a, 1971), including the West Carpathians of Slovakia (S a m u e l, S a l a j, 1968) and Poland (J e d n o r o w s k a, 1975).

It should be noted that J. M a g n é (in D u r a n d - D e l g a, 1965) recognized the following foraminifers in a sample taken from unit 4: *Truncorotalia* (= *Globorotalia*) *aequa* Cushman et Renz, *T. angulata* White, *T.* gr. *velascoensis* Cushman, *T.* aff. *rex* Martin, *Globigerina* cf. *linaperta* Finlay, *G. triangularis* White, *G. velascoensis* Cushman, and others (not listed). Magné was of the opinion that this microfauna is „certainement éocène et très probablement du Paléocène supérieur".

CONCLUSIONS

1. The Upper Maastrichtian and Paleocene (Landenian) units at Szaflary are well defined by their microfaunal assemblages and lithology, and may be treated as two separate lithostratigraphic units of formation rank. The units are left unnamed until further investigation.

2. The tectonic contacts at the bottom of the Maastrichtian marls and at the top of the Paleocene shales, separate the succession from both the Podhale Flysch (Zakopane Formation: Upper Eocene) and the Upper Cretaceous lithostratigraphic units of the Pieniny Succession. The Maastrichtian-Paleocene rocks and their microfauna show close analogies with the so-called „peri-Klippen" Senonian-Palaeogene succession of East and West Slovakia (see S a m u e l, 1972; A n d r u s o v, S a m u e l, 1973) which occur at the southern margin of the Pieniny Klippen Belt, at the contact with Central Carpathian tectonic units of Upper Cretaceous age, and Inner-Carpathian Palaeogene.

3. The appearance of reworked Maastrichtian marls as fragments in fine-grained sedimentary breccia and fine-medium grained, graded sandstone, is explained as the effect of bottom erosion by turbidity currents which temporarily interrupted pelagic marl sedimentation in the Maastrichtian, to form fine-clastic turbidites.

4. Based on lithology, there seems to be a passage from the Upper Maastrichtian marls, which become pinkish-grey and variegated in the upper part, to the Paleocene cherry-red shales at Szaflary. However, the lack of Lower Paleocene (Danian and Montian) microfaunal indices in the cherry-red shales, would rather suggest a tectonic hiatus or non-deposition at the contact of units 3 and 4.

5. Compared with coarsely-detrital development of the Maastrichtian Jarmuta Formation (molasse and flysch — see Birkenmajer, 1977) of the Pieniny Klippen Belt of Poland in the nearest vicinity at Szaflary (about 1 km toward the north), the pelagic sedimentation of marls, marly limestones and marly shales at the boundary of Cretaceous and Pa-

laeogene, represented by the succession here described from Szaflary, indicates that these plankton-rich, open-sea sediments were laid down in a geosynclinal furrow not affected by folding at the Cretaceous-Tertiary boundary. The palaeotectonic position of this zone would be to the south of the already folded Klippen Belt arc and its southern Exotic Massif (which was the main source of clastics supplied to the Pieniny Klippen Belt basin during the Aptian through Maastrichtian), but to the north of the folded Central Carpathian zone (Sub-Tatric and High-Tatric nappes of the Slovakian Block), within the Myjava Furrow *sensu* Scheibner (1968, Fig. 2).

6. The Maastrichtian marls 7.6 m thick described by Morgiel and Sikora (1972, p. 1054) from the left bank of the Biały Dunajec River at Szaflary (Morgiel and Sikora, 1972, p. 1053, erroneously write „right bank", but from the text of their paper „west of Biały Dunajec" it is clear that they refer to the left bank), are a close equivalent of the marls from the right bank here described.

7. The flysch-flyschoid and shaly development of the Campanian-Maastrichtian, ?Paleocene and Eocene-Oligocene age, described from the area of the Skrzypny stream near Maruszyna (west of Szaflary) by Morgiel and Sikora (1972, p. 1054; 1973, p. 641), should also belong to the „peri-Klippen" vel Myjava Furrow zone. Taking into account strong tectonic reductions, it cannot be solved at present, whether the succession from the Skrzypny stream belongs to the same succession as that from Szaflary, or the differences observed are caused by the presence of different lithostratigraphic units in these two sections.

8. The Maastrichtian-Paleocene sequence at Szaflary, and the Campanian-Maastrichtian, ?Paleocene and Eocene-Oligocene sequence of the Skrzypny stream, were included by Morgiel and Sikora (1972, 1973) to the „Złatne succession" *sensu* Sikora (1969, 1971) which, in his opinion, represents a continuous sequence of Jurassic through Oligocene sediments typical for the southernmost part of the Pieniny Klippen Belt of Poland. However, as already mentioned by Birkenmajer (1977, p. 11), Sikora's „Złatne succession" is a heterogeneous unit. It includes both the earlier defined Klippen successions (Jurassic through Upper Cretaceous), the Palaeogene mantle of the Klippen successons, and the „peri-Klippen" (vel Myjava Furrow) Senonian-Palaeogene successions. The continuous passage from the Cretaceous to the Tertiary, though not proven so far, may be assumed in Poland only for the zone of the „peri-Klippen" (Myjava) tectonic scales, but not for the rest of the Pieniny Klippen Belt, where there is an important hiatus between the folded Jurassic to Campanian Klippen successions and the Maastrichtian Jarmuta Formation (molasse and flysch), resp. the transgressive Lower Eocene conglomerate-flysch sequence of the Klippen Mantle (see Birkenmajer, 1970, 1977).

9. The present fragmental occurrence of the Maastrichtian to Palaeogene pelagic rocks of small thickness along the southern boundary of the Pieniny Klippen Belt in the Carpathians, is the result of the early Neogene (Savian) folding.

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STRESZCZENIE

Na kontakcie pienińskiego pasa skałkowego z fliszem podhalańskim w Szaflarach występują osady górnego mastrychtu (białawe margle i wapienie margliste z wkładką brekcji sedymentacyjnej i frakcjonowanych piaskowców) i środkowego paleocenu (czerwone łupki i margle łupkowate) o małej miąższości, z obfitą, w przewadze planktoniczną, mikrofauną otwornicową. Facjalnie osady te są różne od osadów sukcesji skałkowych w Polsce. Odpowiadają one strefie znanej w Słowacji jako strefa „peri-skałkowa" lub bruzda myjawska, która w ujęciu paleotektonicznym znajdowała się na południe od basenu skałkowego i jego południowego masywu egzotycznego, natomiast na północ od sfałdowanych jednostek centralnokarpackich (reglowych i wierchowych). W strefie tej jest możliwe ciągłe przejście od utworów kredowych do paleoceńskich, jednakże — jak dotychczas — osady dolnego paleocenu (danu i montu) nie zostały w Polsce rozpoznane na podstawie zespołów mikrofauny.