

PROBLEMS OF WESTERN CARPATHIAN CRETACEOUS BIOSTRATIGRAPHY ON THE BASIS DISTRIBUTION OF PLANKTONIC FORAMINIFERS

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Abstract: Up to present zonal division of Cretaceous sediments of the Western Carpathians of Slovakia on the basis of planktonic foraminifers is synthetic.

In the Lower Cretaceous, when also are continuous profiles, the predominating facies are limestones. In the Kostolec sequence the layers of marls present from the Hauterivian permit division of the Hauterivian–Aptian on the basis of planktonic foraminifers. In the Czorsztyn sequence it is the Albian–Lower Campanian rich in planktonic foraminifers, in the Pieninic sequences from the Aptian to the Turonian.

In the Periklippen zone was continuous sedimentation to the Upper Paleocene, but development of planktonic foraminifers in this zone was affected by several negative factors. In the first place it was formation of an archipelago zone in the Middle Albian–Turonian and Coniacian–Lower Santonian (Salaj 1990a). Further on, sedimentation of prevalingly detrital sediments in these intervals sections, equally as also their shallow-water character and overheating of water masses (development of corals, hippurites, bryozoans a.o.) also in adjacent deeper zones with flysch sedimentation. Besides overheated surface waters, the proximity of continents, higher contamination of water by turbidity washings of detrital material adjacent slopes of cordiller zones and continents were of unfavourable influence on planktonic foraminifers.

Key words: Cretaceous, foraminifers, negative factors, archipelago zones, paleoecology, paleogeography, Western Carpathians.

Introduction

Zonal division of Cretaceous sediments on the basis of planktonic foraminifera worked out by Salaj and Samuel (1966, 1977, 1984) for the Western Carpathians, although very detailed is synthetic only. This results from the fact that no continuous profile exists there, in which the individual zones could be traced from the Berriasian to Maastrichtian. Besides that, in the partial sequence of the individual tectonic units in certain stages no planktonic foraminifers are present and when they are present, so very scarcely represented in associations of benthonic foraminifers or forming very impoverished layers. Differentiation of the individual foraminifer associations mainly results from different bathymetric conditions and different facial development in the individual tectonic units. Further on, there is no rich species differentiation in all Cretaceous stages of the Western Carpathians if we take them in relation to other areas, belonging in their paleogeographical position to the tropical part of Tethys, e. g. the Tunisian Atlas. This rich species

differentiation, as known generally, is the result of ideal ecological conditions, i. e. it is depending on the so called K-selection, during which is a rich development also of planktonic species. We observe a distinct impoverishment in species composition of planktonic foraminifer associations mainly in the Upper Turonian–Coniacian and Middle–Upper Campanian.

Stratigraphy

Lower Cretaceous

In the Western Carpathians the data about the occurrence of planktonic foraminifers to the Aptian are more or less sporadic and mostly known from thin section material. Free associations of planktonic foraminifers were proved scarcely from Hauterivian and Barremian marly layers in the wider area of Trstie and from Upper Barremian marls, cherty marly limestones of the Kysuca sequence in the Myjava and Považská Bystrica sections of the Klippen Belt.

In the Aptian of the West Carpathians four zones of planktonic foraminifers are proved by Salaj and Samuel (1984): *Planomalina (Globigerinelloides) ferreolensis*, *Planomalina (Globigerinelloides) algeriana*, *Biglobigerinella barri* and *Hedbergella rohri*. The planktonic foraminifer associations of the first two zones are found in the Lower Aptian where, moreover, also the occurrence of the species *Leupoldina cabri* (Sigal) was found with them. The problem in biozonal division of the Aptian is that the species *Planomalina (Globigerinelloides) ferreolensis* Moullade, *Planomalina (Globigerinelloides) algeriana* (Cushman and Ten Dam) *Leupoldina cabri* (Sigal) as index fossils were originally described from the basal Gargasian or from the uppermost Lower Aptian with the remark that in the Lower Aptian they are not found yet. In this conception Sigal (1987) worked out the latest microbiostratigraphical range of the mentioned species may be explained by different bathymetric conditions in the individual sedimentation areas and late migration of these index species to the areas, which began to be deepened later. In order to confirm this opinion it is necessary to mention that *Leupoldina cabri* (Sigal) and *Leupoldina pustulans* (Bolli) are unambiguously proved in Tunisia together with ammonites (Wiedmann in Salaj 1980; Salaj 1990b) from the uppermost Barremian continuously to the uppermost Gargasian. *Planomalina (Globigerinelloides) algeriana* (Cushman and Ten Dam) is proved from the Lower Aptian, from the base of the *Deshayesi deshayesi* Zone, not only in Tunisia, but also in the Western Carpathians, only in zones where no facies of shallow-water Urgonian limestones is developed in the Barremian–Aptian.

The Middle–Upper Aptian in marly development is characterized by rich foraminifer associations of the *Biglobigerinella barri* Zone and *Hedbergella rohri* Zone.

Albian–Middle Turonian

The standard world zonal division of the Albian – Middle Turonian for carbonate pelagic facies deposited above the CCD level on the basis of planktonic richly differentiated foraminifers can also be applied in full extent in the Western Carpathians. The difference is there that in the Albian of the Western Carpathians instead of the *Ticinella bejaouensis* Zone we use the name of the *Ticinella roberti* Zone. In the upper part of this zone the species *Ticinella bejaouensis* Sigal is present too. The Middle Albian (lower part) is characterized by the *Ticinella gaultina* (Morozova) and *Ticinella primula* Luterbacher and Premoli Silva. It is still necessary to stress that in the individual Albian–Lower Turonian zones of the Western Carpathians in flysch sediments the individual associations of planktonic foraminifers are already distinctly impoverished. This implies that in the Albian–Middle Turonian represented by flysch sediments no such associations were found, in which we should observe a variability and differentiation necessary for the study of the individual phylogenetic lines of planktonic genera and species. Such a variability of species as we know from North Africa at transition from one zone to other we do not observe in the Western Carpathians, even not in marly facies. Thus it is evident that in the Western Carpathians we have practically more or less stabilized types of planktonic foraminifer associations, which migrated to the Western Carpathians from the more southern part of the Tethys zone.

In carbonate facies which were deposited on raised bottom,

already in facies transgressive variegated marls of the Czorsztyn unit or in facies of Lower Albian shallow-water organodetrital glauconite limestones of the Manín unit, in most cases a mono-association of the species *Ticinella roberti* (Gandolfi), prevailing with glauconite filling in their tests is present. It may be interpreted in a way that this, when also distinct pelagic species of the Ist depth biological zone, could also be satisfied with relatively very little depth. The possibility is not excluded that in most cases this species could have been transported here from greater depth, corresponding maximum to 50 m, by ascending currents.

In the Middle Albian Butkov glauconite marls immediately overlying the hard ground lying above dark Lower Albian cherty limestones, a foraminifer association of the *Thalmaninella ticinensis subticinensis* Zone is found. It is evident that also in this case there was a shallow depth as most specimens of the species *Thalmaninella ticinensis subticinensis* Gandolfi and *Thalmaninella ticinensis* (Gandolfi) are represented by small dimensions (Salaj and Samuel 1966) and thus there is a juvenile stage of this species. Adult large specimens are not developed here at all as these were originally living deeper, in the IIrd and IIIrd depth biological zone.

Besides that, the author in cooperation with Boorová found abundant perfectly preserved glauconitic cores of the species *Thalmaninella ticinensis subticinensis* Gandolfi confirming their primary occurrence from the base of the Butkov marls and their deposition in distinctly shallow-water environment of raised bottom situated in pelagic environment of open sea.

In flyschoid turbidity, prevailing distal, Albian–Upper Turonian synorogenic sediments of the Central, Manín and Klape zones we have several types of foraminifer associations:

a) Planktonic but not richly differentiated associations prevailing found together with benthonic calcareous and agglutinated foraminifer. In these original associations often redeposited planktonic as well as calcareous benthonic species distinctly affected by dissolution are present, practically from the same stratigraphic horizons (Plate 1 – Figs. 8, 10; Plate 2 – Figs. 1–9). In hemipelagic clays of these turbidity cycles (Te-f) in most cases only agglutinate foraminifers are present, testifying to their original living nests being below CCD level (Plate 1 – Figs. 1–7, 9, 11–12).

b) Planktonic foraminifers are also present in Middle Cenomanian–Middle Turonian variegated marls which are found as layers in flyschoid sediments of the Drietoma unit. In most cases also radiolarians are present in these layers.

c) In many cases in various stratigraphic horizons in marls of Middle Cretaceous flysch sediments agglutinate foraminifers are found only whereas in carbonate, carbonate-detrital (carbonate fine-grained conglomerates) or Albian–Cenomanian carbonate sediments of the archipelago zone of the Klape sedimentation area orbitolines together with small, benthonic, calcareous and agglutinate foraminifers are present.

d) Radiolarian horizons occur prevailing together with planktonic foraminifers. They are present in the Upper Albian *Whiteinella gandolfii* and *Planomalina buxtorfi* zones, then in the Middle and Upper Cenomanian in the *Rotalipora montsalvensis* and *Rotalipora turonica* zones. The uppermost radiolarian horizon in flyschoid sediments occur in the Upper Turonian of the Kysuca sequence. In the facies of variegated marls radiolarians were found in the Upper Cenomanian and Middle Turonian (Salaj and Samuel 1977).

As a problem specific for the Alpine–Carpathian microbiostratigraphy the absence of planktonic foraminifers of the Ist

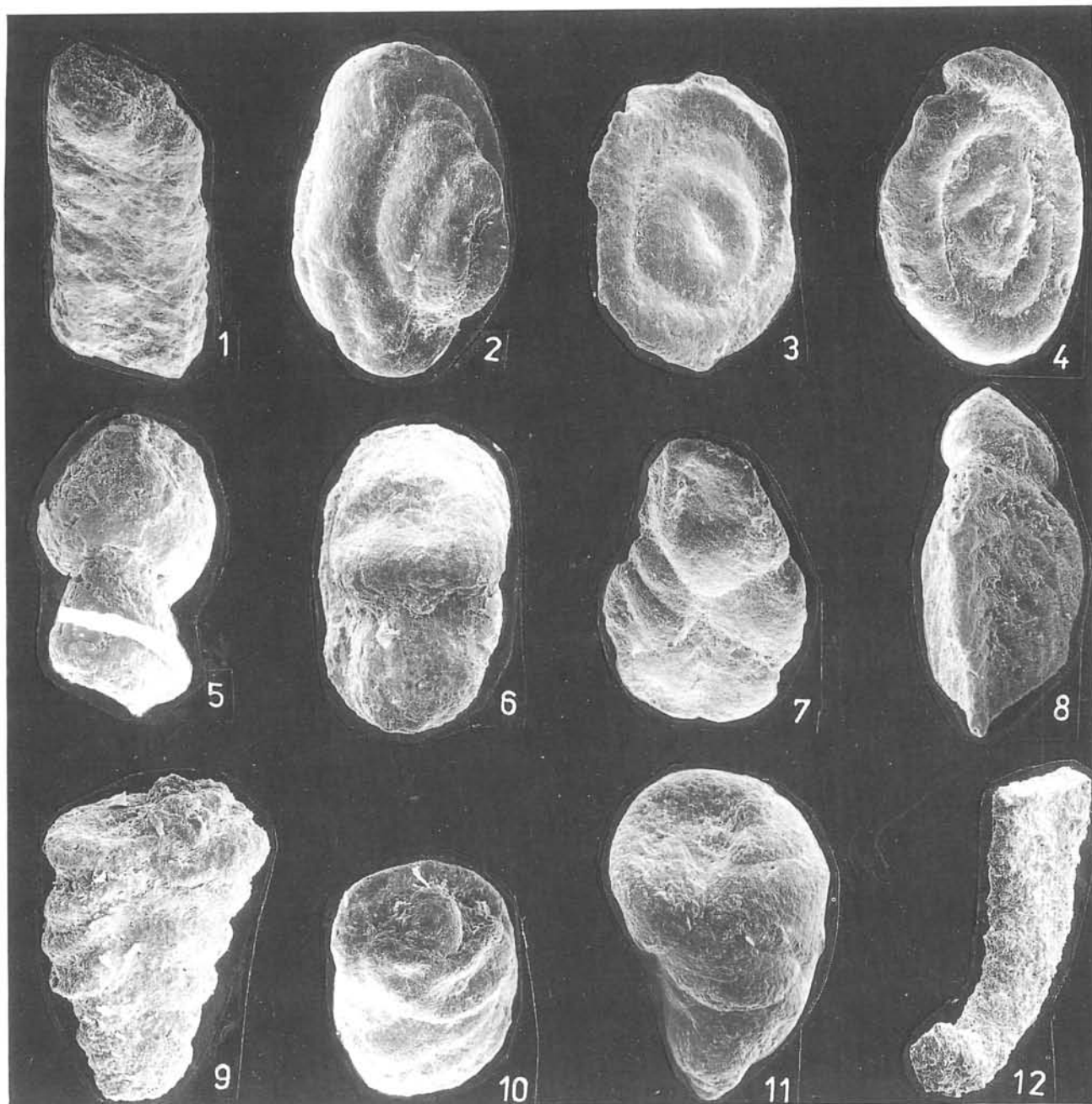


Plate 1: Fig. 1 – *Dendrophrya robusta* Grzybowski x 60; Fig. 2 – *Glomospira charoides* (Parker et Jones) x 110; Figs. 3, 4 – *Glomospira gordialis* (Parker et Jones) x 90, x 100; Fig. 5 – *Reophax ovuloides* Grzybowski x 150; Fig. 6 – *Haplophragmoides nonioninoides* (Reuss) x 100; Fig. 7 – *Haplophragmoides concavus* (Chapman) x 75; Fig. 8 – *Tristix excavatum* Reuss x 75; Fig. 9 – *Dorothia* sp. x 110; Fig. 10 – *Dorothia oxycona* (Reuss) x 110; Fig. 11 – *Arenobulimina chapmani* Cushman x 110; Fig. 12 – *Rhabdammina* sp. x 70.
Figs. 1–12 – Sample No. DB 90/449. Upper Albian of the Klape Unit, area of the Považská Bystrica.

depth biological zone (representatives of the genera *Hedbergella*, *Whiteinella* and *Heterohelix*) in the Lower–Middle Turonian should be stressed (Gašpariková and Salaj 1984).

Upper Turonian–Santonian

Planktonic foraminifera in the facies of variegated marls and in the flyschoid facies are relatively little represented as to species variability. They are represented more numerous at

least in the facies of variegated marls, in which, as known, far instance, from the Beňatina section of the Klippen Belt (Samuel 1962), also benthonic calcareous foraminifera are distinctly represented.

When compared with the Upper Turonian–Santonian associations of more southern areas of Tethys it is necessary to consider, the Carpathian association of planktonic foraminifera as to their species spectrum as one of the poorest and unsuitable to phylogenetic study. Therefore we have the

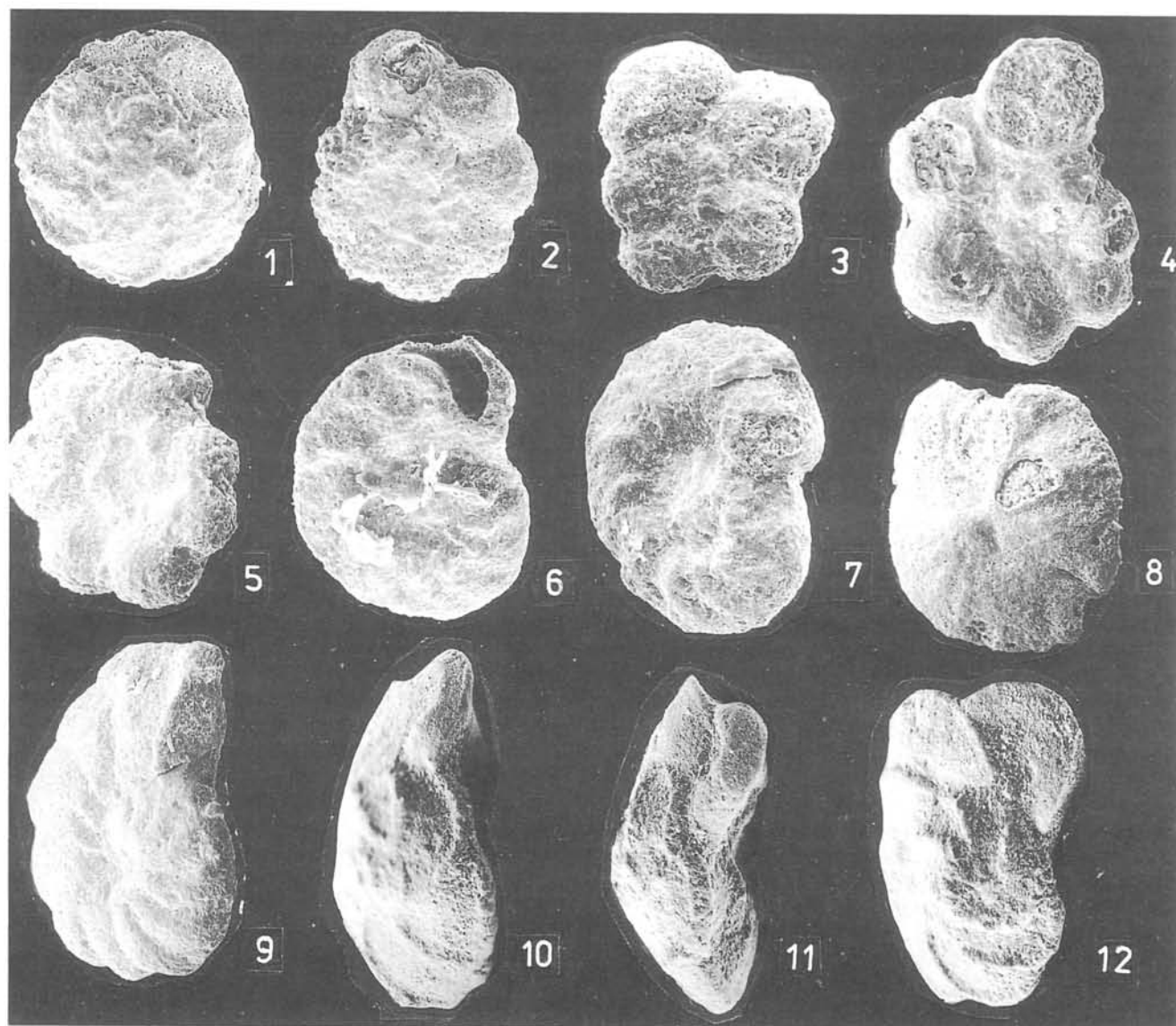


Plate 2: Fig. 1 – *Thalmaninella ticinensis* (Gandolfi) x 80; Fig. 2 – *Ticinella roberti* (Gandolfi) x 100; Fig. 3 – *Whiteinella gandolfii* Gašpariková et Salaj x 150; Fig. 4 – *Hedbergella globigerinelloides* (Subbotina) x 125; Fig. 5 – *Biglobigerinella barri* Bolli, Loeblich et Tappan x 165; Fig. 6 – *Anomalina* sp. x 80; Fig. 7 – *Planomalina buxtorfi* (Gandolfi) x 85; Fig. 8 – *Epistomina* sp. x 85; Fig. 9 – *Anomalina* sp. x 50; Figs. 10–12 – *Thalmaninella appenninica* (Renz) x 70, x 80, x 65.

Figs. 1–9: Sample No. DB 90/449. Upper Albian of the Klape Unit, area of the Považská Bystrica.

Figs. 10–12: Sample No. 294/1969. Bytča, Lower Cenomanian of the Kysuca sequence.

greatest problems in detailed division of the Upper Turonian–Santonian sediments in Western Carpathian planktonic biostratigraphy of the Upper Cretaceous.

As to agglutinate foraminifers (with prevalence of the species *Uvigerinamina jankoi* Majzon), they attain maximum representation in the Upper Turonian of the Kysuca sequence when there was obviously also the greatest deepening and sedimentation below CCD level. This is also testified by scarcely represented redeposited calcareous foraminifers with distinct marls not only of mechanical transportation but also with traces of chemical dissolution of their calcareous tests.

It is evident that the original associations of planktonic foraminifers are very rare represented in Coniacian–Santo-

nian flyschoid sediments. These, when also present, are prevalently thanatocenoses originally deposited on the continental slope and later redeposited by turbidites into the basin. Thus the foraminifer associations are sorted, mixed and distinctly impoverished.

For this reason problem was also with division of the Santonian Gosau sediments in the Myjavská pahorkatina Upland (Salaj and Priečhodská 1987). It is still necessary to stress that in Upper Turonian and Lower Santonian flyschoid sediments of the Periklippen zone of the Western Carpathians planktonic foraminifers of the Ist depth biological zone are practically missing and if they are present in place, so insignificantly only. This was connected with the renewed Coniacian archipelago zone in the Klape sedimentation area

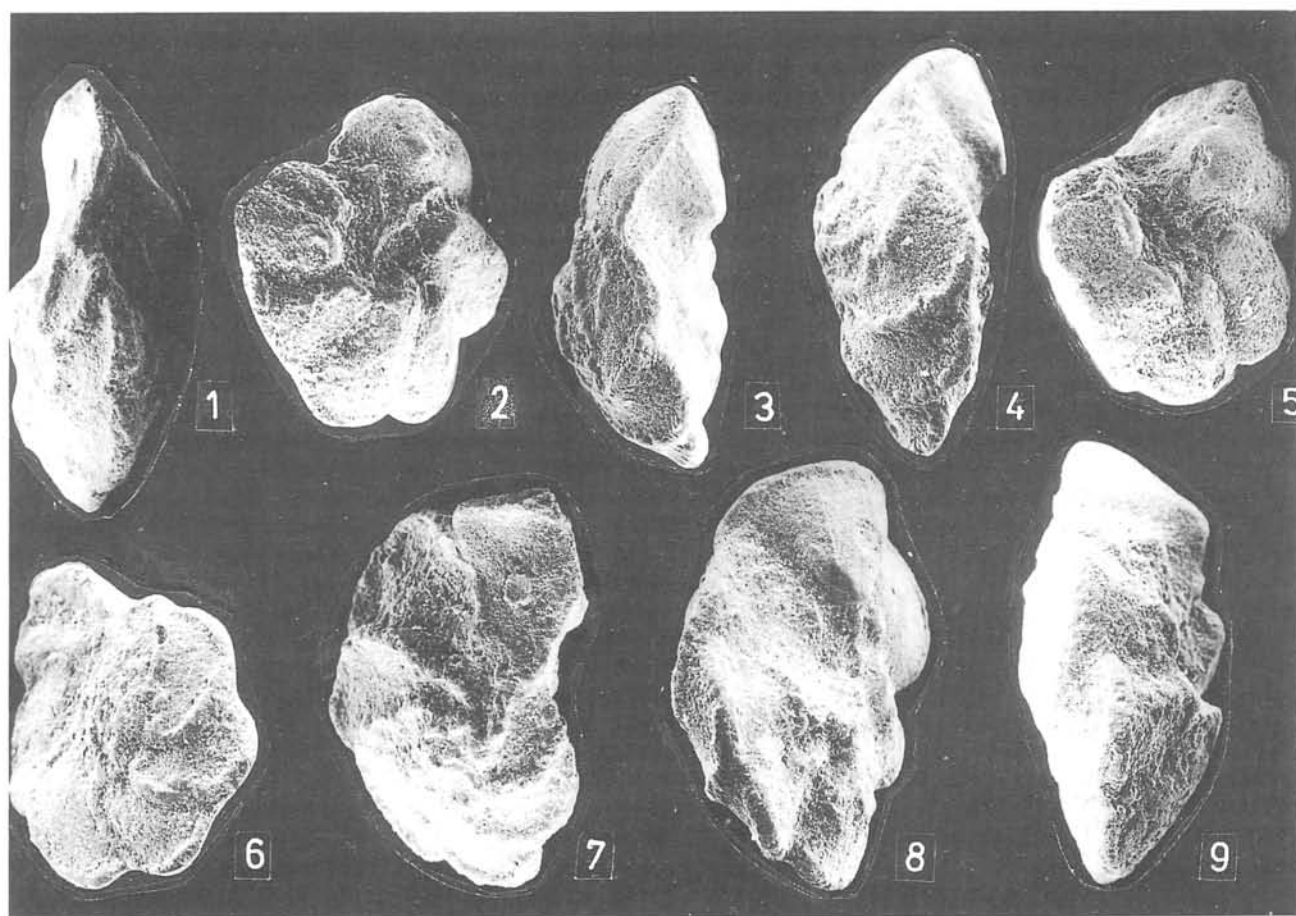


Plate 3: Figs. 1, 2, 3 – *Thalmanninella globotruncanoides* (Sigal) x 65; Figs. 4, 5, 6 – *Thalmanninella globotruncanoides* (Sigal) x 70, x 65, x 65; Figs. 7, 8 – *Thalmanninella globotruncanoides* (Sigal) x 65, x 70; Fig. 9 – *Thalmanninella globotruncanoides* (Sigal) x 90 (= morphotype *Th. gandolfii*).

Figs. 1–9: Sample No. DB 90/1964 – Bytča. Lower Cenomanian of the Kysuca sequence.

with shallow overheated waters with rich coral and hippurite fauna (Salaj 1990a). It is evident that penetration of oceanic psychrophilous planktonic foraminifers into the adjacent basins with overheated waters of the Ist depth biological zone was practically excluded or it was their incidental penetration.

Lower Campanian

This is generally represented with the facies of pelagic variegated marls of regional extension with uncommonly abundant planktonic, richly differentiated foraminifers of all four depth biological zones. Their species variability is considerable and approximately such as it was in the more southern areas of Tethys.

Upper Campanian–Maastrichtian

This interval, so far as represented by the facies of variegated marls or facies inoceram marlstones, is also rich in planktonic foraminifers of all four depth biological zones. The only more serious problem for biozonal division of these sediments is the absence of some species of the tropical belt,

as, for instance, *Radotruncana subspinoso* (Pessagno), *Kasabiana falsocalcarata* (Kerdany and Abdel Salam) equally also *Radotruncana calcarata* (Cushman). The latter of them, although proved in the Western Carpathians, has very sporadic finds. Even representatives of the Maastrichtian genus *Plummerita* are not present.

The Upper Campanian–Maastrichtian flyschoid sediments represented by the facies of the Jarmuta beds contain mainly agglutinate foraminifers. The planktonic foraminifers are present too, but they are mostly redeposited, similarly as orbitoid foraminifers, mainly found in detrital allodapic limestones.

Conclusion

In the course of the Cretaceous there were certain intervals in the Western Carpathian region, in which ideal ecological conditions for development and species differentiation of planktonic foraminifers by K-selection existed. In most cases these were already stabilized as to variability when compared with the southern areas of Tethys also distinctly impoverished.

The isolation of the originated northern Tethys branch which lost its oceanic character in the Middle–Upper Cretaceous, proximity of continents, the existence of archipelago zones, contamination of waters by turbidites and certain cooling in the Middle–Upper Campanian played a significant role in this impoverishment.

The greatest problems in the study of Cretaceous microbiostratigraphy are in the division of the Upper Turonian–Lower Santonian sediments and Upper Campanian–Maastichtian beds.

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