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# ALBIAN AND CENOMANIAN FORAMINIFERA FROM THE KOSARZYSKA SECTION, NIEDZICA SUCCESSION, PIENINY KLIPPEN BELT, CARPATHIANS, POLAND

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**Abstract:** The Kosarzyska section of the Niedzica Succession, Pieniny Klippen Belt, Poland yielded the Late Albian planktonic foraminiferal biozones from Rotalipora ticinensis–Planomalina praebuxtorfi to Planomalina buxtorfi–Rotalipora appenninica (sensu Gasinski 1988). The Early Cenomanian microfaunal zones have not been recognized in this section due to tectonic disturbances. The Late Cenomanian Rotalipora cushmani Zone has been recognized contacting with the Upper Albian strata. Quantitative distribution of bathymetrically diagnostic planktonic species does not correlate to the standard eustatic curve.

**Key words:** Carpathians, Pieniny Klippen Belt, Niedzica Succession, Cenomanian, Albian, paleobathymetry, biostratigraphy, Foraminifera.

## Introduction

The Kosarzyska section (Fig. 1) was first described by Birkenmajer in 1954 and attributed to the "Pieniny Transitional Succession: Kosarzyska type". It was later renamed the Niedzica Succession (e.g. Birkenmajer 1977). In 1956, an assemblage of Albian macrofauna, consisting mainly of ammonites, belemnites and bivalves was determined from this section, in greenish-black marly shales overlying the Pieniny Limestone Formation, (Kokoszynska & Birkenmajer 1956). This macrofauna was very poorly preserved, pyritized and limonitized, including the ammonites: *Hamites* aff. *attenuatus* Sow. (5 specimens), and *Hamites* aff. *flexuosus* d'Orb. (4 specimens), a belemnite *Neohibolites minimus* (List.) (1 specimen), and bivalves *Aucellina* aff. *gryphaeoides* Sow. (5 specimens) and *Tellina* sp. (5 specimens). The Albian age was confirmed by micropaleontological investigations carried out by Alexandrowicz (1966) and by Klosowska & Gasinski (1995).

Paleobathymetric and palinspastic reconstructions (Birkenmajer 1986; Gasinski 1991; Birkenmajer & Gasinski 1992) indicate the location of the Niedzica Succession on the middle part of the intra-oceanic Czorsztyn Ridge slope of the Pieniny Klippen Belt Basin (PKBB).

## Lithostratigraphy of Albian and Cenomanian strata of the Niedzica Succession

The formal lithostratigraphic units of Albian and Cenomanian age in the Niedzica Succession include: the Kapusnica (Aptian–Albian) and the Jaworki Formations (Upper Albian–Santonian) (Birkenmajer 1977; Birkenmajer & Jednorowska 1987). The Kapusnica Formation is subdivided into the Brodno Member (Aptian–Lower Albian) and the Rudina Member (Middle Albian–Lower Cenomanian). Only the latter member occurs in the Niedzica Succession. The overlying sediments belong to the Jaworki Formation (Fig. 2).

The Rudina Member consists of dark-grey, black and green marly limestones, sometimes with silty limestone, fine-grained sandstone and fine conglomerate intercalations. The thickness of the Rudina Member in the Niedzica Succession is only up to 3–5 m.

## Methods

Seventeen samples, about 1kg each, were collected every 30 cm along a section 3–4 m long. The samples were disintegrated and processed with Glaubert's salt (multiple freezing, heating) and sieved with a minimum mesh of 0.06 mm. For quantitative analyses, about 300 specimens from each sample were used (30 specimens from sample KO12, because of scarce microfauna). SEM micrographs were prepared at the Zoological Institute of the Jagiellonian University by SEM JEOL JSM 35 and at the Micropalaoentological Department of Christian-Albrechts University in Kiel. Field and laboratory studies were carried out in 1993–1994.

## Biostratigraphic zones

On the basis of qualitative analyses of planktonic foraminifers and using already existing local biostratigraphic zonation for the PKB (e.g. Gasinski 1983; 1988), the following biostratigraphical zones have been recognized. They have been based on the Last Appearance Datums (LADs) and the Taxon Range Zones (TRZs) (Fig. 3).

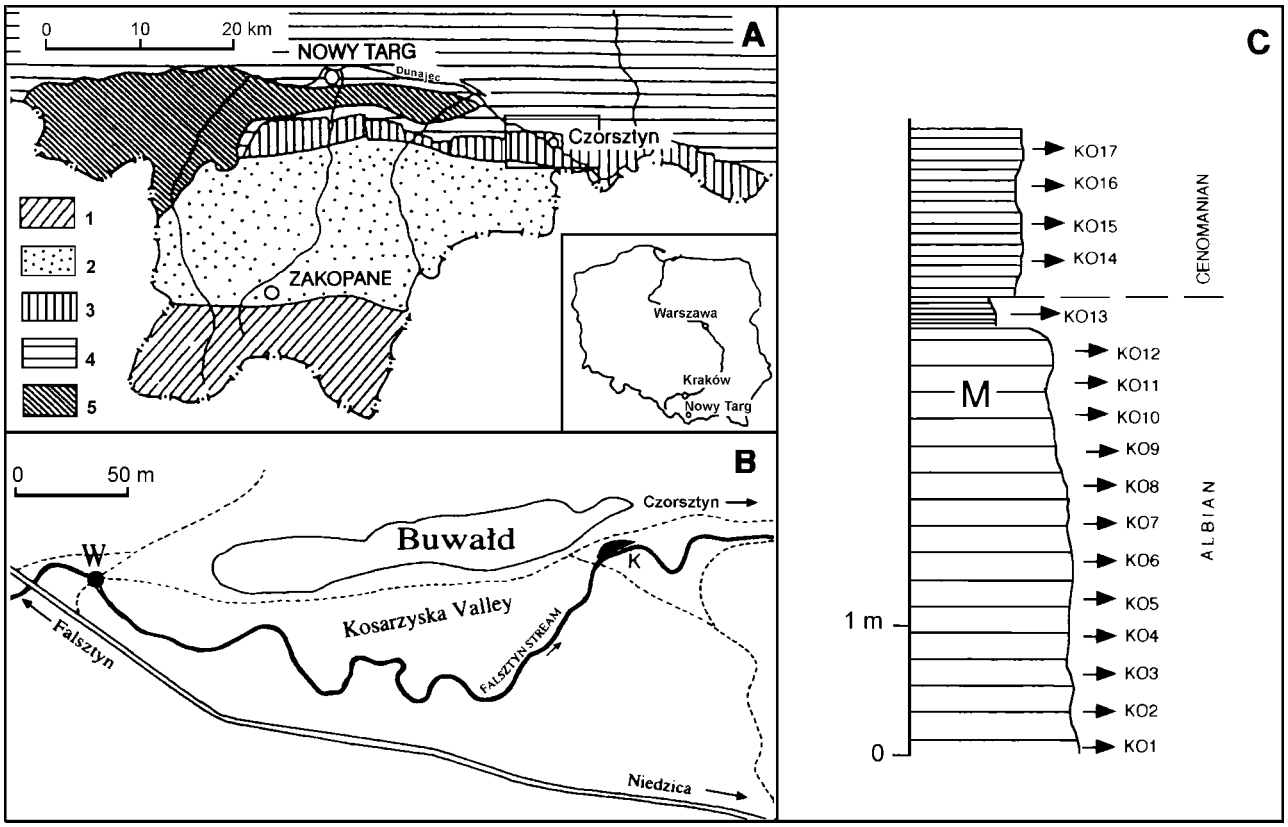


**Fig. 1.** **A** — Position of the Kosarzyska section (rectangle) in southern Poland. 1 — Tatra Mountains; 2 — Podhale Flysch; 3 — Pieniny Klippen Belt; 4 — Magura Flysch; 5 — Fresh-water Miocene-Pliocene. **B** — Location of the Kosarzyska Valley. K — location of the studied section. W — waterfall. **C** — Simplified profile of the studied section. *Samples:* KO1–KO12 (grey-greenish marls); KO13 (dark shales); KO14–KO17 (red shales/marls). M — location of the macrofossil assemblage.

***Zone Rotalipora ticinensis–Planomalina praebuxtorfi (LAD)***

**Lower boundary:** not exposed in this section

**Upper boundary:** LAD of *Planomalina praebuxtorfi*

**Assemblage:** predominance of planktonic foraminifers, which constitute 97 % of the whole assemblage, represented mainly by: *Hedbergella delrioensis* (Carsey) (Pl. II: Figs. 1, 2), *Praeglobotruncana delrioensis* (Plummer), *P. stephani* (Gandolfi), *Planomalina buxtorfi* (Gandolfi) (Pl. I: Figs. 8, 9), *Rotalipora appenninica* (Renz) (Pl. II: Figs. 3, 4), *R. ticinensis* (Gandolfi) (Pl. II: Fig. 5), *Hedbergella planispira* (Tappan), *H. simplex* (Morrow), *Planomalina praebuxtorfi* (Wonders) and *Globigerinelloides bentonensis* (Morrow) being less abundant. Benthic foraminifers represent up to 3 % of the whole assemblage; the calcareous (45 %) ones are represented by: *Gavelinella intermedia* (Berthelin), *Gyroidinoides* sp., *Glandulina* sp.; the agglutinated ones (42 %) are represented by: *Trochammina* sp., *Textularia* sp., *Tritaxia gaultina* (Morozova) (Pl. I: Fig. 2), *Spiroplectammina* sp., *Spiroplectinata annectens* (Parker & Jones), *Gaudryina* sp., *Dorothia gradata* (Berthelin), *D. oxycona* (Reuss), *Arenobulimina preslii* (Reuss). The Nodosaridae (13 %) are represented by: *Lenticulina gaultina* (Berthelin), *Tribrachia excavata* (Reuss) and *Dentalina* sp.

**Age:** Late Albian

***Zone Rotalipora ticinensis–Planomalina buxtorfi (LAD)***

**Lower boundary:** LAD of *Planomalina praebuxtorfi*

**Upper boundary:** LAD of *Rotalipora ticinensis*

**Assemblage:** predominance of planktonic foraminifers, which constitute 98 % of the whole assemblage. The most abundant are: *Hedbergella delrioensis* (Carsey), *Praeglobotruncana delrioensis* (Plummer), *P. stephani* (Gandolfi), *Planomalina buxtorfi* (Gandolfi), *Rotalipora appenninica* (Renz) and less abundant *R. ticinensis* (Gandolfi), *Ticinella roberti* (Gandolfi), *Globigerinelloides bentonensis* (Morrow), *Hedbergella simplex* (Morrow), *H. planispira* (Tappan). Benthic foraminifers represent up to 2 % of the whole assemblage; the calcareous ones (62 %) are represented by: *Gavelinella* sp. (Pl. I: Fig. 7), *Gyroidinoides* sp., *Gavelinella* ex gr. *berthelini*, *Glandulina* sp., *Ellipsoglandulina* sp.; the agglutinated (23 %) by: *Trochammina* sp., *Tritaxia gaultina* (Morozova), *T. amorpha* (Cushman), *Textularia* sp. (Pl. I: Fig. 4), *Dorothia gradata* (Berthelin), *Gaudryina* sp., *Ataxophragmium* sp., *Arenobulimina* sp. (Pl. I: Fig. 3), *Ammodiscus* sp. (Pl. I: Fig. 1). The Nodosariacea (15 %) include: *Lenticulina* sp. (Pl. I: Fig. 5), *Tribrachia* sp., *Dentalina* sp.

**Age:** Late Albian

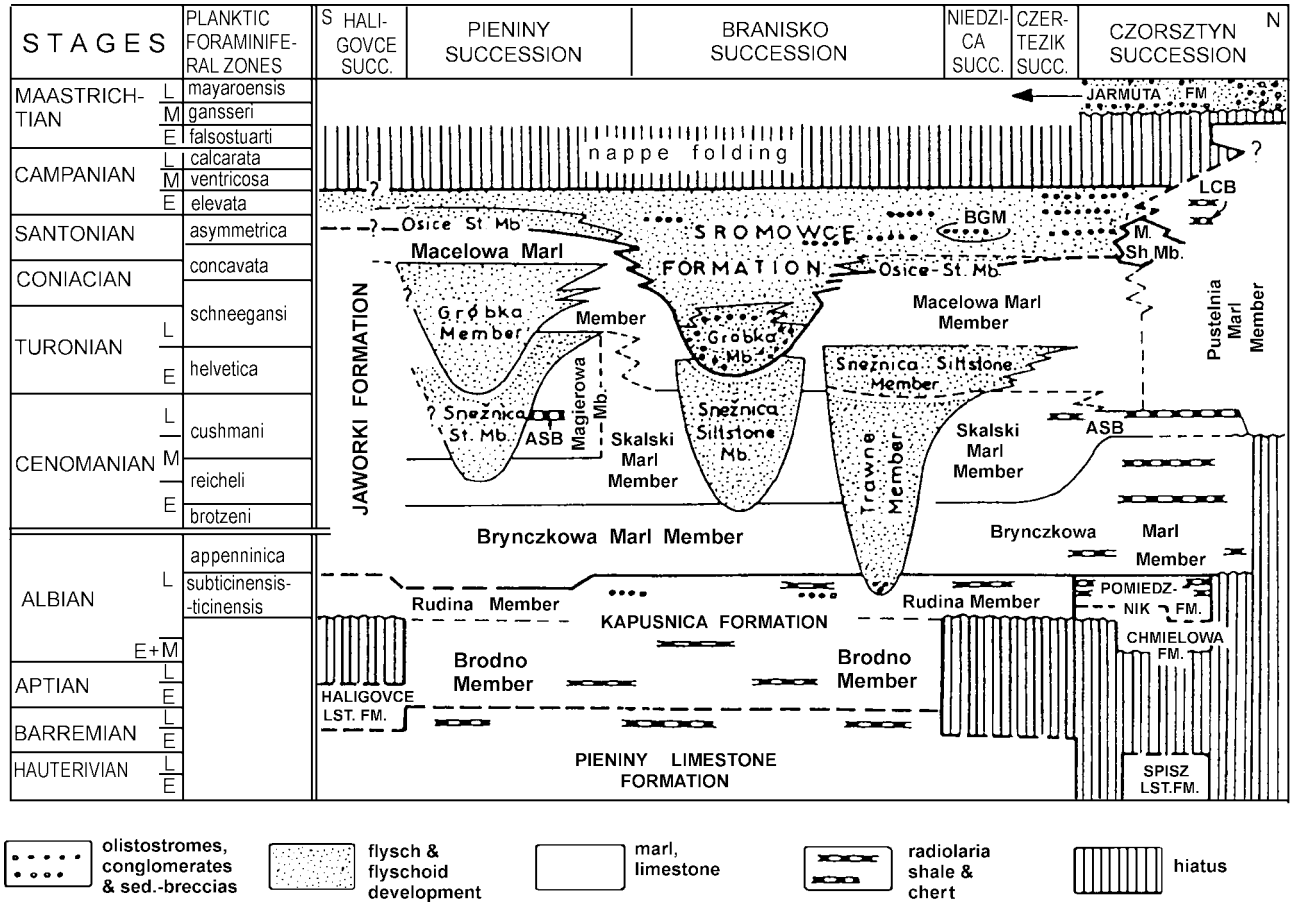


**Fig. 2.** Age and mutual relationships of Cretaceous lithostratigraphic units in the Pieniny Klippen Belt, Poland (after Birkenmajer & Jednorowska 1987). **ASB** — Altana Shale Bed; **BGM** — Bukowiny Gravelstone Member; **LCB** — Lorencowe Chert Bed; **MShMb** — Malinowa Shale Member.

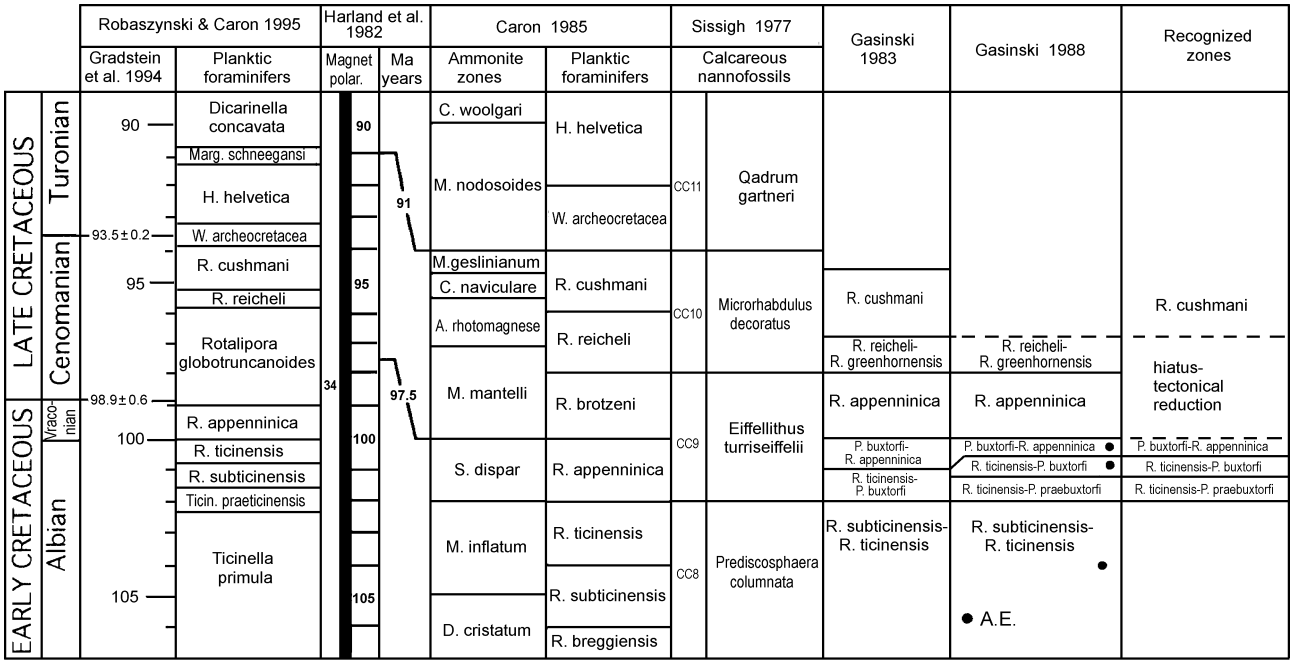


**Fig. 3.** Local Albian and Cenomanian biostratigraphical zonation in the Pieniny Klippen Belt (compared with the ortho- and parastratigraphic zonations of other areas. A.E. — anoxic events episodes; after Gasinski 1988) and zones recognized in the Kosarzyska section.

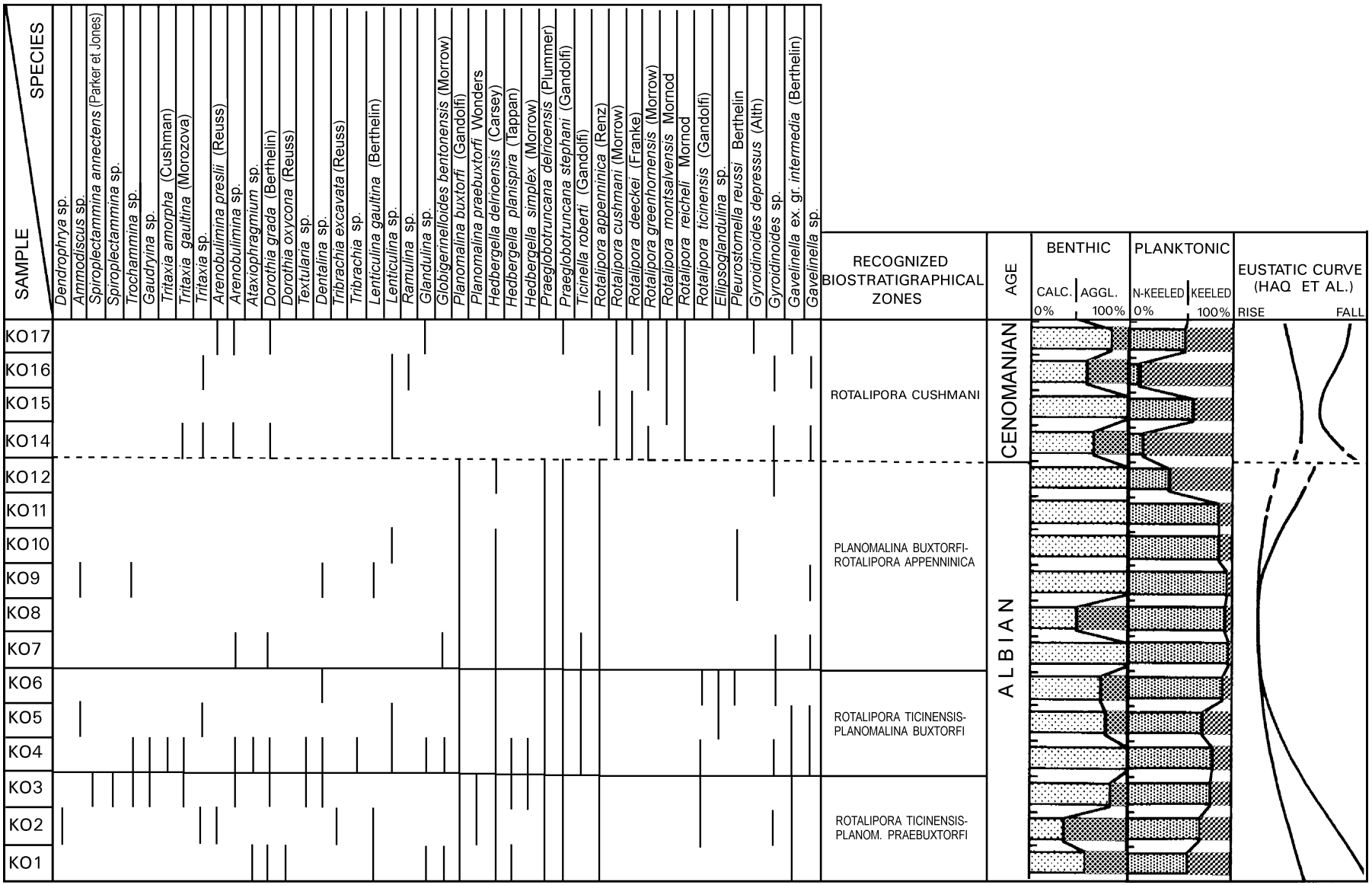


**Fig. 4.** Correlation of stratigraphical ranges of the identified foraminifers, recognized local biozones sensu Gasinski (1988) and foraminiferal assemblages compositions to the eustatic curve of Haq et al. (1987). Dashed line — missing zones (tectonic break).

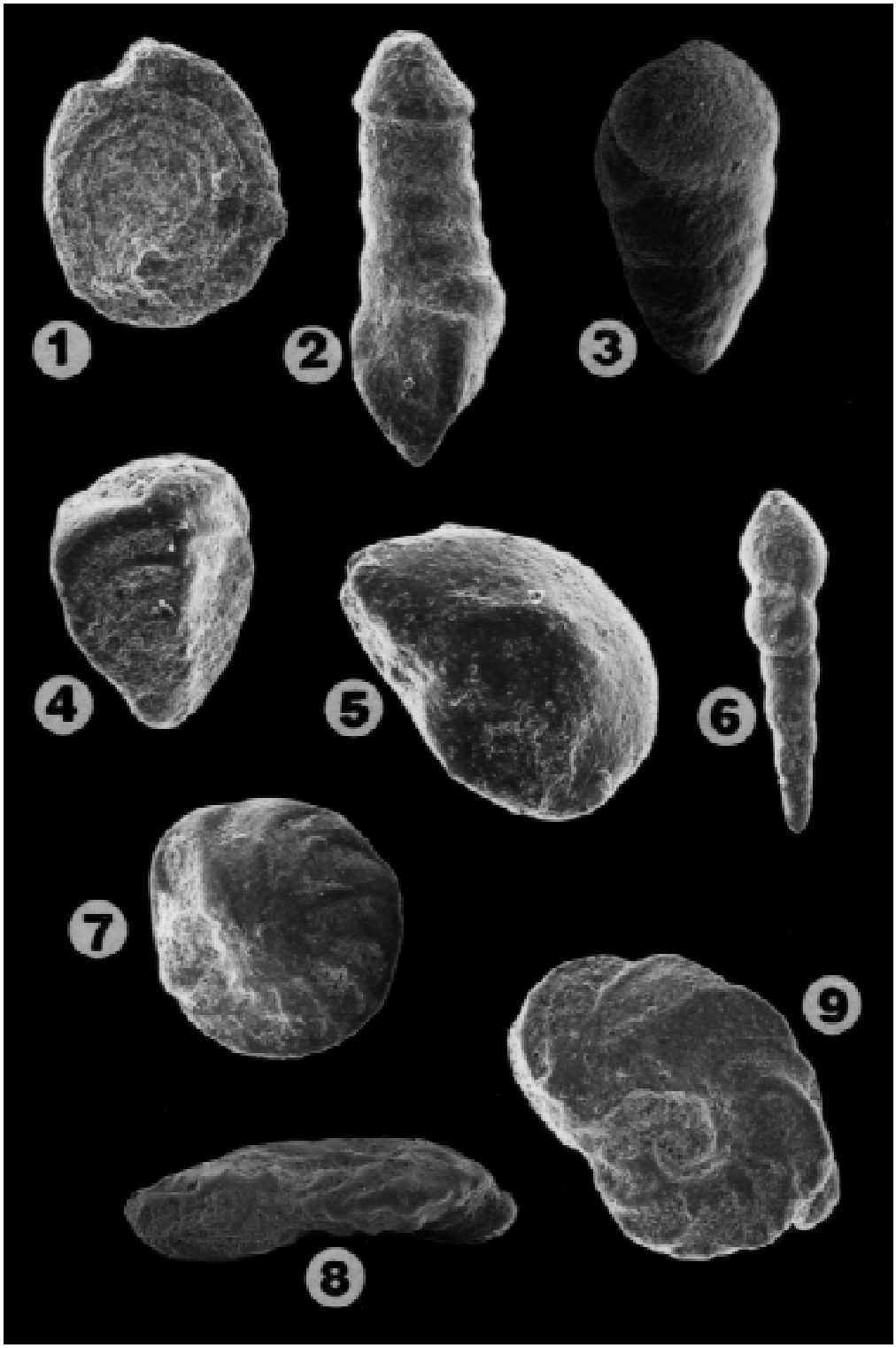


**Plate I: Fig. 1** — *Ammodiscus* sp., ×85, sample KO9; **Fig. 2** — *Tritaxia gaultina* (Morozova), ×85, sample KO4; **Fig. 3** — *Arenobulimina* sp., ×47, sample KO17; **Fig. 4** — *Textularia* sp., ×85, sample KO17; **Fig. 5** — *Lenticulina* sp., ×120, sample KO4; **Fig. 6** — *Pleurostomella reussi* Berthelin, ×40, sample KO6; **Fig. 7** — *Gavelinella* sp., ×85, sample KO1; **Fig. 8**,**9** — *Planomalina buxtorfi* (Gandolfi), ×85, sample KO6.

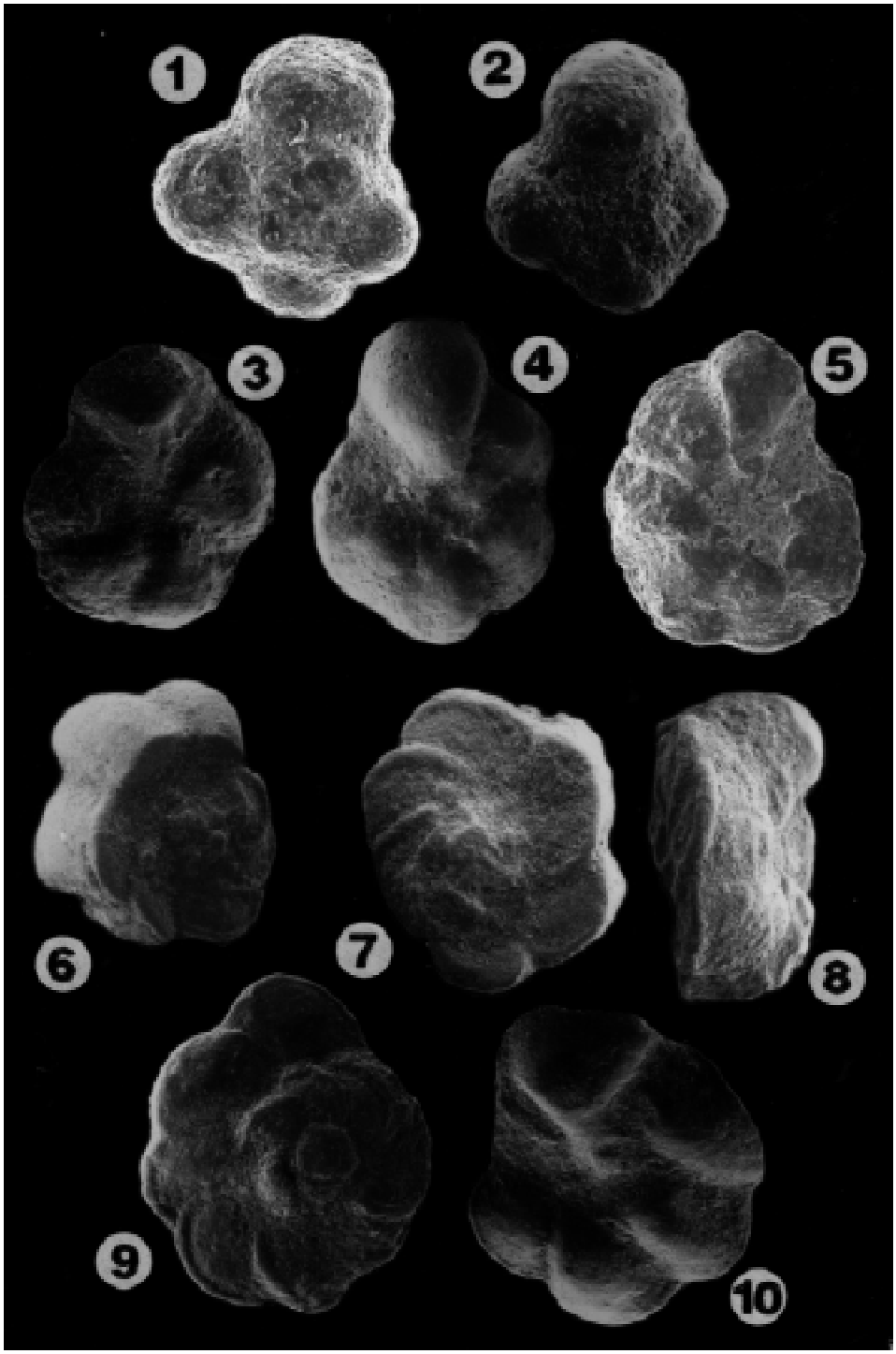


**Plate II: Fig. 1** — *Hedbergella delrioensis* (Carsey), ×120, sample KO6; **Fig. 2** — *H. delrioensis* (Carsey), ×170, sample KO2; **Fig. 3** — *Rotalipora appenninica* (Renz), ×55, sample KO5; **Fig. 4** — *R. appenninica* (Renz), ×70, sample KO9; **Fig. 5** — *Rotalipora ticinensis* (Gandolfi), ×85, sample KO3; **Fig. 6** — *Rotalipora reicheli* Mornod, ×55, sample KO15; **Fig. 7,8** — *Rotalipora deeckei* (Franke), ×60 ×65 (side view), sample KO14; **Fig. 9** — *Rotalipora cushmani* (Morrow), ×55, sample KO16; **Fig. 10** — *R. cushmani* (Morrow), ×60, sample KO17.

***Zone Planomalina buxtorfi–Rotalipora appenninica (LAD)***

**Lower boundary:** LAD of *Rotalipora ticinensis*

**Upper boundary:** not preserved in this section due to tectonic reduction

**Assemblage:** predominance of planktonic foraminifers (99 %), represented by: *Hedbergella delrioensis* (Carsey), *Praeglobotruncana delrioensis* (Plummer), *P. stephani* (Gandolfi), *Planomalina buxtorfi* (Gandolfi) and *Rotalipora appenninica* (Renz). Benthic foraminifers constitute up to 1 % of the whole assemblage; the calcareous ones (50 %) are represented by: *Gavelinella* sp., *Pleurostomella reussi* Berthelin (Pl. I: Fig. 6), *Gyroidinoides* sp.; the agglutinated ones (50 %) by: *Tritaxia gaultina* (Morozova), *Trochammina* sp., *Arenobulimina* sp., *Ammodiscus* sp.

**Age:** Late Albian

***Zone Rotalipora cushmani (TRZ)***

**Lower boundary:** not preserved in this section due to tectonic reduction

**Upper boundary:** not exposed in this section

**Assemblage:** predominance of planktonic foraminifers, which constitute about 99 % of the whole assemblage. They are represented by: *Rotalipora cushmani* (Morrow) (Pl. II: Figs. 9, 10), *R. reicheli* (Mornod) (Pl. II: Fig. 6), *R. montsalvensis* (Mornod), *R. deeckei* (Franke) (Pl. II: Figs. 7, 8), *R. greenhornensis* (Morrow), *R. appenninica* (Renz) and *Praeglobotruncana stephani* (Gandolfi). Among the benthic foraminifers, the calcareous ones (64 %) include: *Gavelinella intermedia* (Berthelin), *Gavelinella* sp., *Gyroidinoides* sp., *Glandulina* sp., *Ramulina* sp. Agglutinated foraminifers (29 %) are represented by: *Tritaxia gaultina* (Morozova), *Tritaxia* sp., *Dorothia gradata* (Berthelin), *Arenobulimina preslii* (Reuss), *Arenobulimina* sp. The Nodosariacea (7 %) include *Lenticulina* sp.

**Age:** Middle Cenomanian to lower part of the Upper Cenomanian

The proposed local biostratigraphical zones are equivalent to those established by Gasinski (1988) for the Pieniny Klippen Belt in Poland. The Rotalipora cushmani local zone (sensu Gasinski 1983, 1988) representing the middle part of the Middle Cenomanian to Late Cenomanian, occurs in the investigated section in tectonic contact with the deposits of the P. buxtorfi–R. appenninica Zone (Fig. 3).

## Paleoecological remarks and conclusions

The Kosarzyska section of the Niedzica Succession, where in 1956 Kokoszynska and Birkenmajer found a unique macrofossil assemblage has been dated on the basis of planktonic foraminifers to the Late Albian (Vraconian).

The Albian-Cenomanian foraminiferal assemblages from the Kosarzyska section have been attributed to local biozones (Fig. 3). In these biozones, the frequency of agglutinated and calcareous benthic foraminifers never exceeds 3 % of the whole assemblage. This varies from the values established in other sections of the Niedzica Succession by Birkenmajer & Gasinski (1992; association "B1"), i.e. between 35–40 %. Among plankton, in older, the latest Albian samples, predominance of non-keeled forms as *Hedbergella* sometimes with *Globigerinelloides* and *Ticinella* over keeled forms as *Rotalipora* and *Praeglobotruncana* is observed. The former represent up to 70–80 % of the planktonic assemblage whereas in younger Cenomanian samples (Rotalipora cushmani Zone) they form only about 36 % of the planktonic assemblage (Fig. 4).

The ratio of keeled to non-keeled planktonic foraminifers, which is treated by several authors (e.g., Sliter 1972, 1976; Sliter & Baker 1972; Haig 1979) as an indication of paleobathymetry, is in disagreement with the regression-trangression curve proposed for this time-span by Haq et al. (1987; see: Fig. 4). It is clearly visible that onlap bending of Haq's curve is correlated with the frequency decrease of the keeled forms. These forms are always diagnostic for deepening of the basin (bathypelagic dwellers). This might be related to the local tectonical events and could suggest an unstable (mobile) bottom of this part of the PKBB.

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