New Aspects on Tethyan Cretaceous Fossil Assemblages.
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4.1. Albian and Cenomanian foraminifera from the Pieniny Klippen Belt (Carpathians, Poland)

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Abstract

A local stratigraphic zonation based on planktonic foraminifera has been established for the almost uninterrupted sequences of Albian to Cenomanian sediments of the Polish part of the Pieniny Klippen Belt. The assemblages resemble those of the Southern Alps and the Umbria-Marche Apennins. Assemblages of agglutinated foraminifera from the Flysch Carpathians situated to the North of the Pieniny Klippen Belt resemble those of the Moroccan Rif. The foraminifera assemblages are Tethyan in their composition. Several anoxic events have been distinguished by dating intercalations of black shales in the sequence.

1. Introduction

Microfauna assemblages from the regional Cretaceous formation stratotypes and sections of the Polish part of the Pieniny Klippen Belt indicate an almost uninterrupted sedimentation during Albian and Cenomanian times. Detailed locality data, lithological descriptions and formal lithostratigraphy of the section have been presented by GASINSKI (1988). Previous investigations have shown that samples from these sections contain abundant and well-preserved foraminifera. Planktonic forms are dominant (GASINSKI, 1983, 1988; BIRKENMAJER & JEDNOROWSKA, 1984, 1987), and allow the establishment of a stratigraphical local zonation (Fig. 2). Several authors have described the Cretaceous foraminiferal assemblages and the stratigraphy of these deposits (ALEXANDROWICZ, 1966, 1979; BIRKENMAJER, 1977, 1987; BIRKENMAJER & JEDNOROWSKA, 1984, 1987; JEDNOROWSKA, 1979, 1980, and others). The nannofossils

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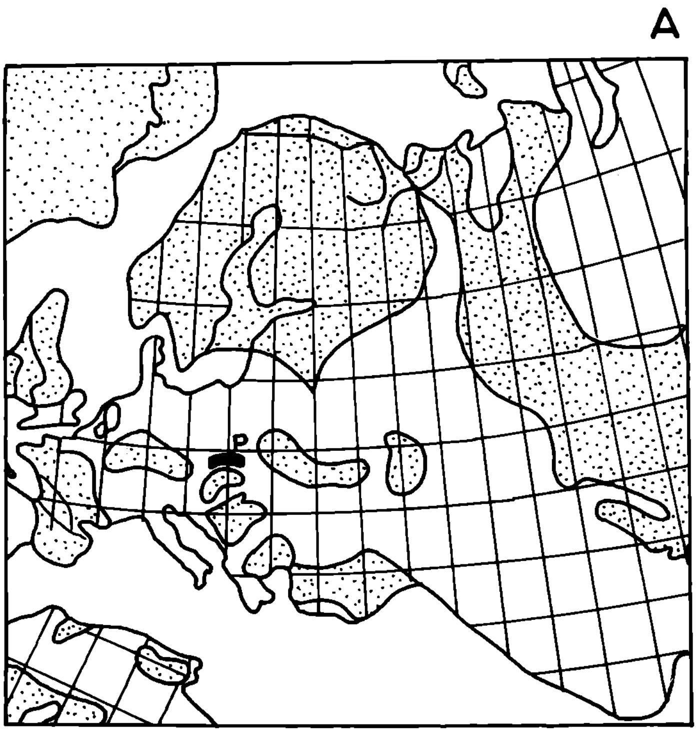

Fig. 1A: Location of the Pieniny Klippen Belt Basin (P.) on the paleogeographic map at 100 m.y. Each time increment is illustrated with a Mercator and a north and south polar Stereographic projection. 30° paleolatitude lines are indicated (after BARRON et al. 1981. Plate 5).

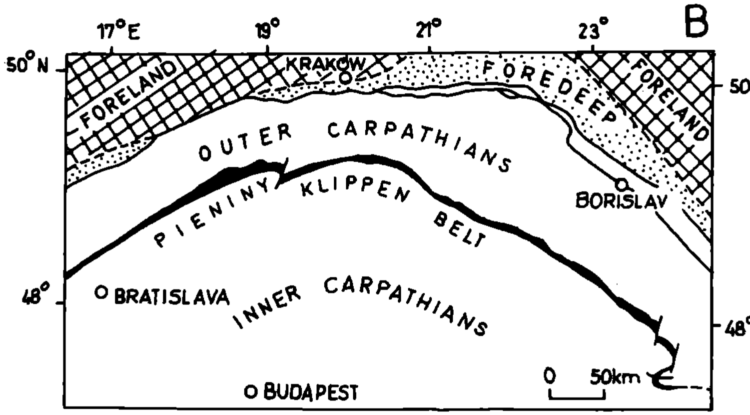

Fig. 1B: Position of the Pieniny Klippen Belt in the Carpathians (after BIRKENMAJER & JEDNOROWSKA, 1987).

have been described by DUDZIAK (1979, 1981 et al.). The analysis of the dinocysts has recently been initiated by LEEREVELD & GASINSKI within IGCP project 262. Megafossils are scarce. The magnetostratigraphy did not yield any results (magnetic long normal zone, see fig. 2).

2. Geological setting

The Pieniny Klippen Belt is situated at the boundary between the Inner and Outer (Flysch) Carpathians (Fig. 1B). A detailed subdivision of this belt, its paleogeographic and palinspastic reconstructions, as well as its tectonic evolution were presented by BIRKENMAJER (1977, 1986). During the Cretaceous the Pieniny Klippen Belt Basin belonged to the northern part of the Tethys (Fig. 1A). Depending on the deposition area in the basin the sediments are developed as marly limestones, marls, shales and turbidites, with intercalating black shales.

The unit, informally called Trawne Beds has been revised recently and was formally named Trawne Member by BIRKENMAJER (1987).

The location and numeration of the investigated samples are given in a previous article (GASINSKI, 1988). Sections without adequate natural outcrops were exposed in trenches.

3. Foraminiferal assemblages

Planktonic foraminifera constitute about 80% of almost all assemblages and are characteristic for the Tethyan realm (REYMENT & BENGTSON, 1986, p. 125). The species belong mainly to *Globigerinelloides, Planomalina, Hedbergella* and *Rotalipora* (GASINSKI, 1983, fig. 5–6; 1988, p. 225, tab. 1). Some of the characteristic foraminifera species are shown on plates 1–3. Detailed descriptions of the taxa were presented by GASINSKI (1983, 1984, 1988). In several samples collected from turbidites a high percentage of agglutinated foraminifera was found.

The following local biostratigraphic zonation based on the first and last occurrence of planktonic index species of foraminifera is proposed (FAD and LAD; Fig. 2):

Hedbergella local assemblage zone (LAZ, informal zone, not on Fig. 2)
FAD of *R. subticinensis?*

Rotalipora subticinensis – Rotalipora ticinensis, local concurrent range zone (LCRZ). Upper boundary: FAD of *P. praebuxtorfi* and LAD of *R. subticinensis.*

Rotalipora ticinensis-Planomalina praebuxtorfi (LCRZ). Upper boundary: FAD of *P. buxtorfi* and LAD of *P. praebuxtorfi.*

Rotalipora ticinensis-Planomalina buxtorfi, local partial concurrent range zone (LPCRZ). Upper boundary: FAD of *R. appenninica.*

Planomalina buxtorfi-Rotalipora appenninica (LCRZ). Upper boundary: LAD of *R. ticinensis* and LAD of *P. buxtorfi.*

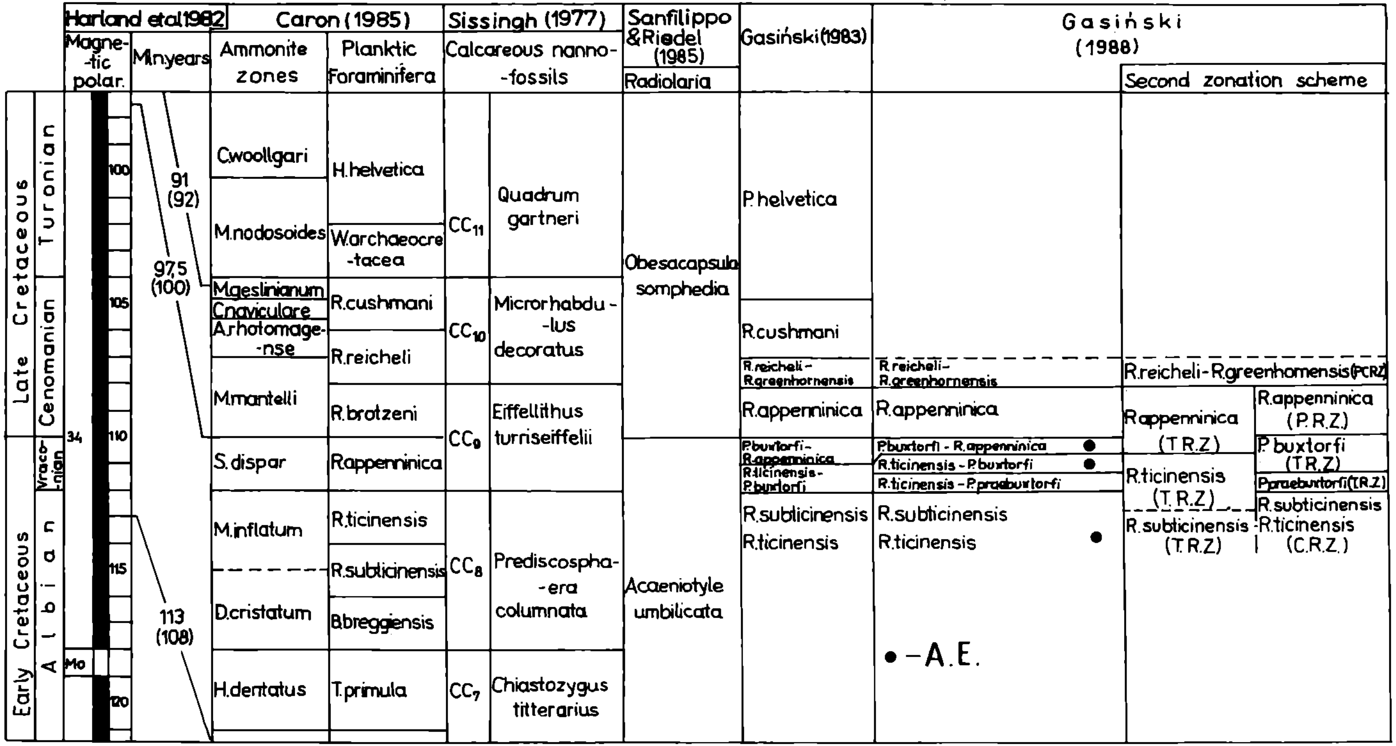

Fig. 2: Local Albian and Cenomanian biostratigraphic zonation in the Pieniny Klippen Belt compared with the ortho- and parastratigraphic zonations of other areas (A.E. anoxic events episodes; after GASIŃSKI, 1988, simplified).

Rotalipora appenninica, local partial range zone (LPRZ). Upper boundary: FAD of *R. reicheli* and FAD of *R. greenhornensis.*

Rotalipora reicheli-Rotalipora greenhornensis (LPCRZ). Upper boundary: FAD of *R. cushmani.*

A second zonation scheme, based on the Taxon Range Zones (TRZ) for facilitating practical application is also proposed (Fig. 2). Descriptions of these local zones with the analyses of assemblages, including correlations and comparisons with other recently proposed zonations were presented. A comparison with the Breggia and Moria sections was discussed (GASINSKI, 1988). BIRKENMAJER & JEDNOROWSKA (1987) have recognized zones established by ROBASZYNSKI &

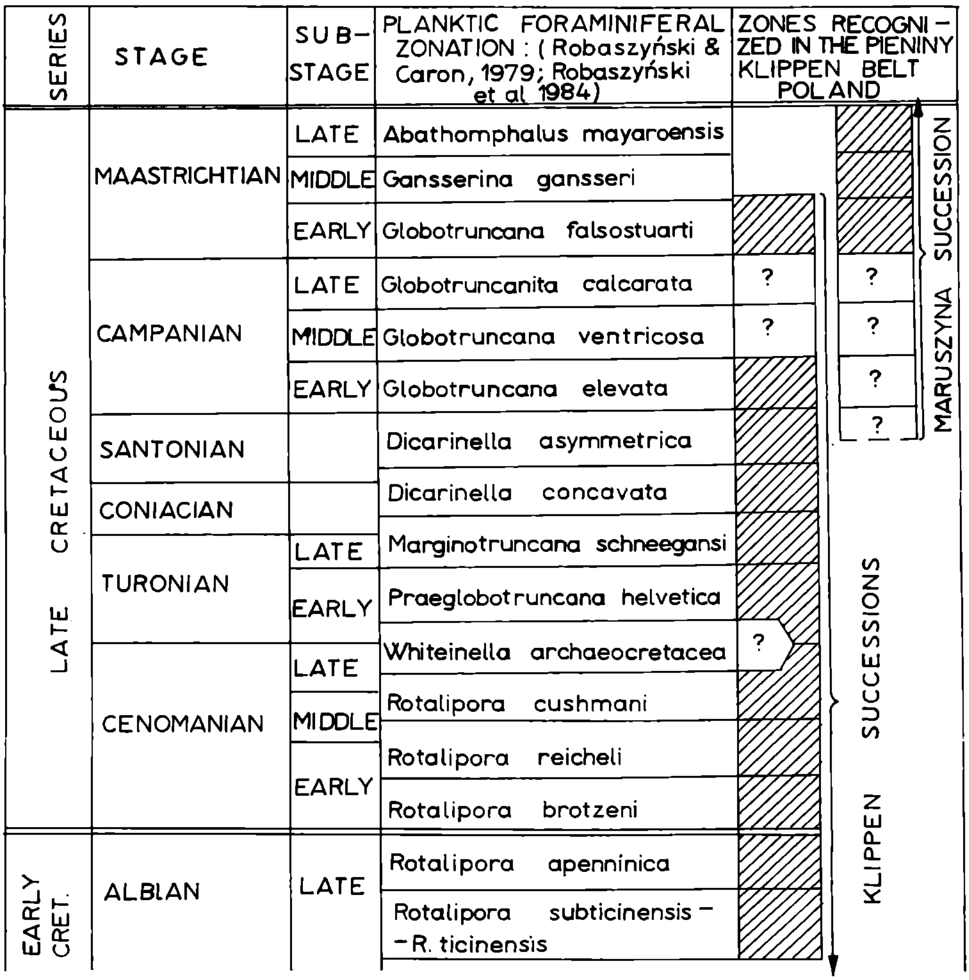

Fig. 3: Foraminiferal zonations by ROBASZYŃSKI & CARON (1979) and ROBASZYŃSKI et al. (1984), recorded in the Pieniny Klippen Belt by BIRKENMAJER & JEDNOROWSKA (1987).

Caron (1979) and Robaszynski et al. (1984) in the Pieniny Klippen Belt (fig. 3). A comparison of the author's local zones to those established by Robaszynski & Caron (1979) was presented earlier (Gasinski, 1983, Fig. 15).

4. Paleoecological remarks

The investigated foraminifera assemblages are similar in composition and species morphology to those of the Southern Alps (Breggia section, Lombardy Basin) and the Umbria-Marche Apennines (Moria section; see Gasinski, 1988).

Assemblages of agglutinated foraminifera from the Outer (Flysch) Carpathians, situated to the north of the Pieniny Klippen Belt (Fig. 1 B) resemble those of the Moroccan Rif (Morgiel & Olszewska, 1982).

The affiliation of the Flysch Carpathian foraminifera assemblages to the Tethys has been confirmed by Olszewska (1984). Pieniny foraminifera assemblages are definitely different from those described from areas north of the Carpathians especially in the composition of the benthos (Heller, 1975; Peryt, 1980, 1988 and others). These differences are similar to those recorded by Price (1977) between the Tethyan and the Boreal province. The Tethyan character of the investigated microfauna is therefore confirmed. A bathymetric differentiation of the Pieniny Klippen Belt Basin into a deeper part (Pieniny-Branisko furrow) and more shallow part (Czorsztyn s. l. ridge) have been confirmed by foraminiferal assemblages.

For the Albian and the Cenomanian three paleobathymetric associations have been established:

a) "Czorsztyn association", shelf-upper slope, large proportion of nodosarids and miliolids,

b) "Pieniny A association", middle part of slope, oligotaxic planktonic assemblages dominant,

c) "Pieniny B association", bathymetric position similar to "Pieniny A", but with larger portion of agglutinated taxa; characteristic association of pelagic sediments with turbiditic intercalations.

All associations correspond to the various parts of the "*Marssonella*" association of Haig (1979).

Black shale layers within the sequence are interpreted with Schlanger & Jenkyns (1976), Arthur & Schlanger (1979) and others as reflexions of oceanic anoxic events. Investigations of foraminiferal assemblages in sediments below, above, as well as within the black shales by the author reveal several episodes of anoxia (within OAE1 sensu Arthur & Schlanger, 1979) in the *R. subticinensis – R. ticinensis, R. ticinensis – P. buxtorfi,* and *P. buxtorfi – R. appeninica* local zones (fig. 2). These episodes have also been observed by the author in the Breggia and Moria sections. The well-known Cenomanian-Turonian anoxic event ("Bonarelli Level") can be also observed in the Pieniny Klippen Belt (Birkenmajer & Jednorowska, 1984, 1987; Gasinski, 1988). Based on the composition of foraminiferal assemblages the model A (Black Sea model) and model B (mid-water oxygen minimum model) of Arthur & Schlanger (1979) can be distinguished. Some samples directly overlying black shales in the investigated sections are enriched in Radiolaria. This suggests the existence of upwelling following anoxic episodes (REYMENT & BENGTSON, 1986; GASINSKI, 1988, p. 241).

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Plate 1.

Fig. 1. *Tritaxia gaultina* (MOROZOVA). SAMPLE FL-26, *R. ticinensis – P. buxtorfi* LPCRZ (x 100).
Fig. 2. *Dorothia oxycona* (REUSS). Sample Cz-3, *R. ticinensis – P. buxtorfi* LPCRZ (x 120).
Fig. 3. *Biticinella breggiensis* (GANDOLFI). Sample Fl-4, *R. subticinensis – R. ticinensis* LCRZ (x 200).
Fig. 4. *Globigerinelloides bentonensis* (MORROW). Sample FL-16, *R. ticinensis – P. buxtorfi* LPCRZ (x 200).
Fig. 5. *Globigerinelloides bentonensis* (MORROW). Sample Kp-5, *R. subticinensis – R. ticinensis* LPCRZ (x 300).
Figs. 6–7. *Hedbergella delrioensis* (CARSEY). Sample Fl-7, *R. subticinensis – R. ticinensis* LCRZ (x 300).
Figs. 8–9. *Hedbergella delrioensis* (CARSEY). Sample Fl-14, *R. subticinensis – R. ticinensis* LCRZ (x 200).

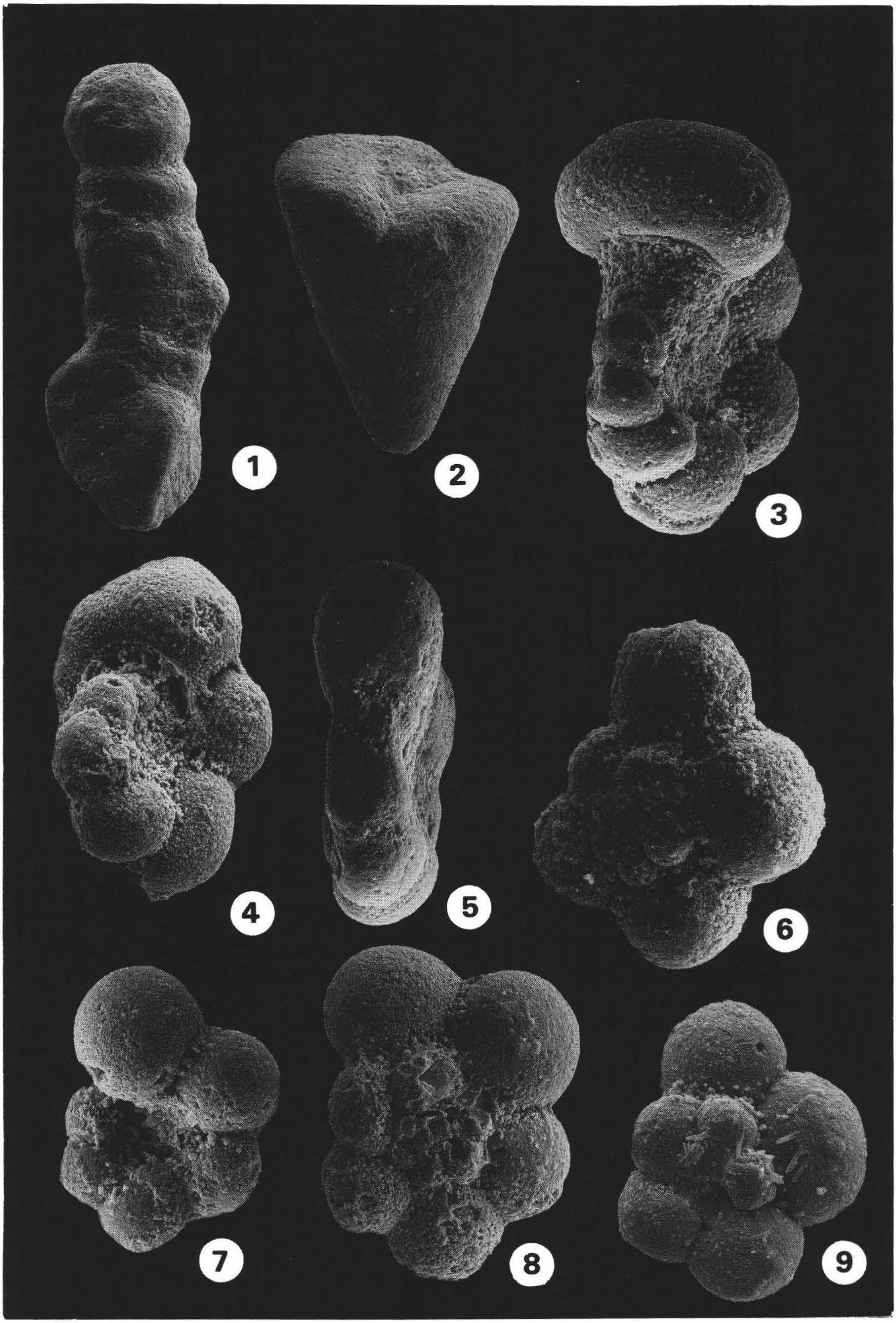
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Plate 2

Figs. 1–2. *Hedbergella delrioensis* (CARSEY). Sample Kp-4, *R. ticinensis* – *R. praebuxtorfi* LCRZ (1 : x 200; 2 : x 240).

Fig. 3. *Hedbergella delrioensis* (CARSEY). Sample Cz-3, *R. ticinensis* – *P. buxtorfi* LPCRZ (x 300).

Fig. 4. *Hedbergella delrioensis* (CARSEY). Sample Kp-7, *P. buxtorfi* – *R. appeninica* LCRZ (x 200).

Fig. 5. *Hedbergella simplex* (MORROW). Sample Fl-34, *P. buxtorfi* – *R. appenninica* LCRZ (x 320).

Fig. 6. *Hedbergella planispira* (TAPPAN). Sample Fl-8, *R. subticinensis* – *R. ticinensis* LCRZ (x 160).

Fig. 7. *Hedbergella simplex* (MORROW). Sample H-7, *R. reicheli* – *R. greenhornensis* LPCRZ (x 260).

Fig. 8. *Planomalina buxtorfi* (GANDOLFI). SAMPLE FL-28, *P. buxtorfi* – *R. appenninica* LCRZ (x 160).

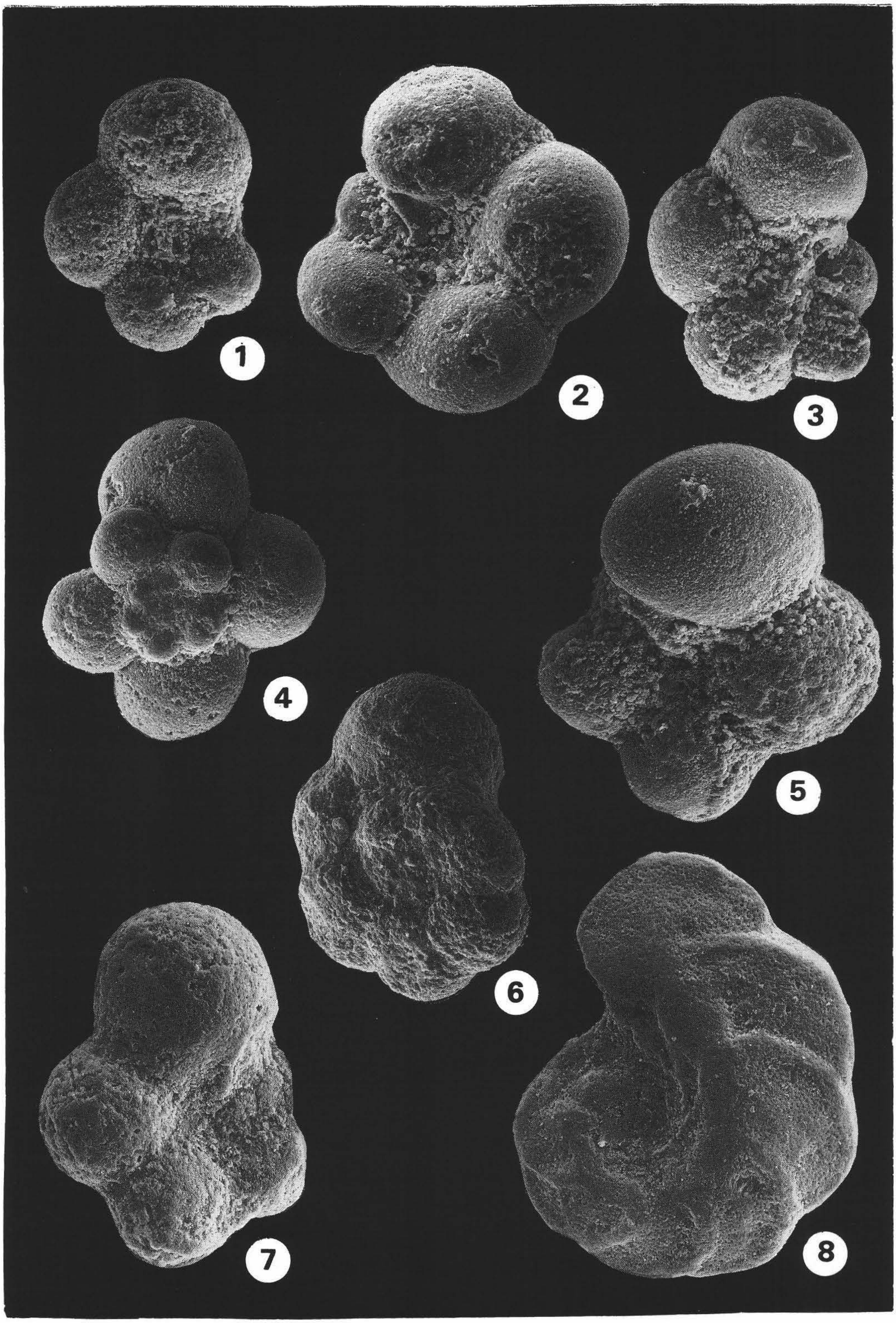
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Plate 3

Fig. 1. *Rotalipora subticinensis* (GANDOLFI). Sample Kp-1, *R. subticinensis – R. ticinensis* (LCRZ (x 150).

Fig. 2. *Rotalipora subticinensis* (GANDOLFI). Sample Fl-5, *R. subticinensis – R. ticinensis* LCRZ (x 150).

Fig. 3. *Rotalipora ticinensis* (GANDOLFI). Sample Fl-8, *R. subticinensis – R. ticinensis* LCRZ (x 130).

Fig. 4. *Rotalipora ticinensis* (GANDOLFI). Sample Kp-1, *R. subticinensis – R. ticinensis* LCRZ (x 130).

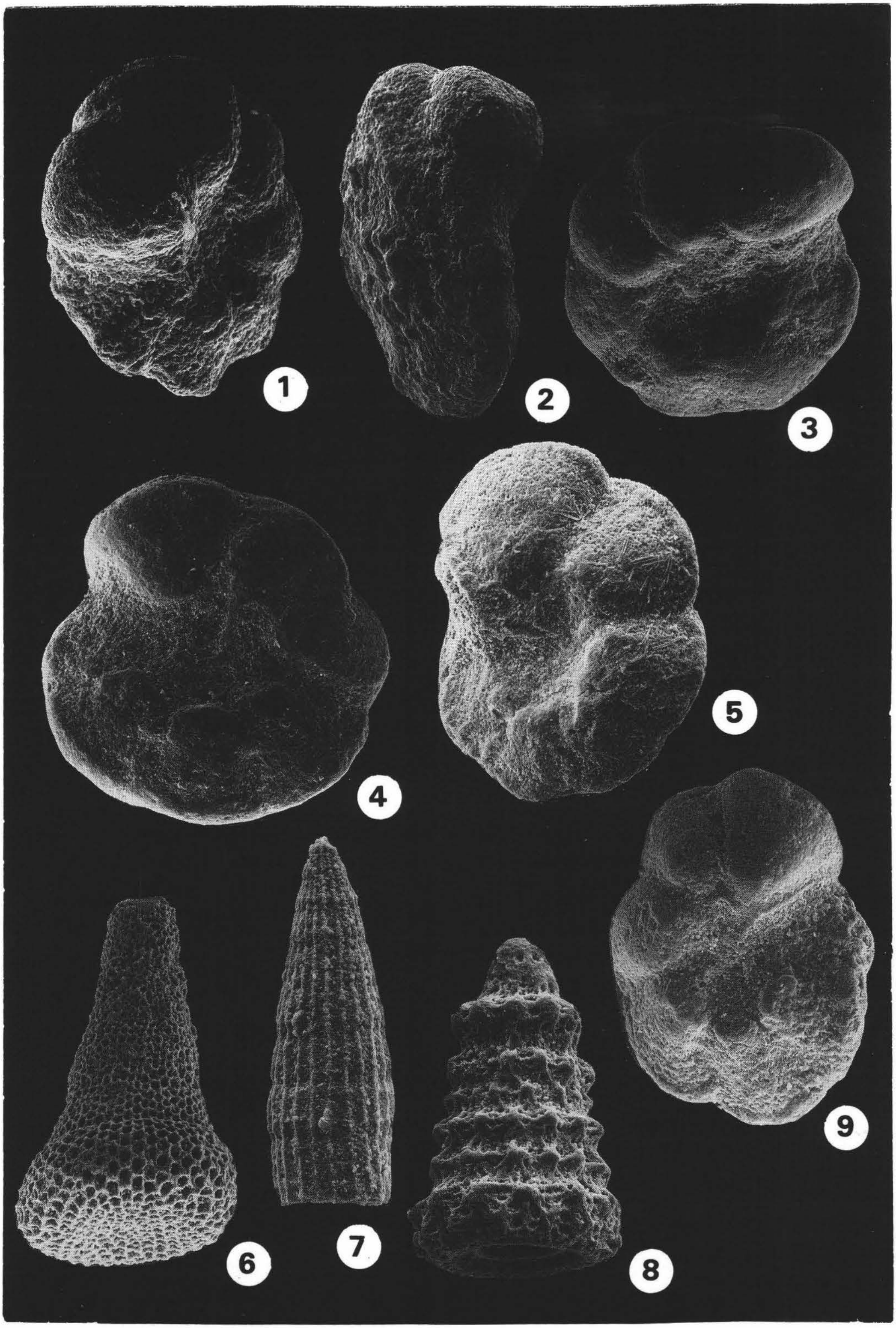
Fig. 5. *Rotalipora appenninica* (RENZ). Fl-33, *P. buxtorfi – R. appenninica* LCRZ (x 160).

Fig. 6. *Radiolaria,* gen. indet. Sample Cz-3 (x 120).

Fig. 7. *Archaeodictyomitra* sp. Sample Fl-19 (x 240).

Fig. 8. *Dictyomitra koslovae* FOREMAN. Sample Kp-6, *R. ticinensis – P. buxtorfi* LPCRZ (x 240).

Fig. 9. *Rotalipora appenninica* (RENZ). SAMPLE KP-9, *R. appenninica* LPRZ (x 160).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