ZÁPADNÉ KARPATY

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SÉRIA

paleontológia 17

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Obsah — Contents — Inhalt

MILOŠ RAKÚS

Lias ammonites of the West Carpathians
Part one: Hettangian

30 text-figs., 8 pls. (I — VIII), Slovak summary

A b s t r a c t . The article systematically describes ammonite fauna from the Kopienec Formation of the Krížna Nappe and Hybe Member of the Choč Nappe in the West Carpathians. A total of 16 species have been described, including two new ones: *Kammerkarites sokolensis* n. sp. and *Saxoceras langei* n. sp.
The ammonite fauna exhibits strong affinity to Alp assemblages, comprising a number of common species.
The ammonite assemblage confirms the presence of Lower, but mainly Middle Hettangian.

Introduction

The Hettangian stage in the West Carpathian literature was, and often still is, associated with the "Gresten Member". This association dates back to the mid-19th century when ŠTÚR (1860) applied this term to designate a formation between the Kössen Formation and Lias "Fleckenmergel" (= Allgäu Formation).

Detailed lithostratigraphic studies carried out since the late 1970s (GAZDZICKI et al., 1979; MICHALÍK et al., 1982; SÝKORA, 1987) have proved, however, that it is unjustified to use the term "Gresten Member" in the West Carpathians because of different lithology! The term Kopienec Formation was firstly introduced by GOETEL (1917) and then forgotten, should be used instead of "Gresten Member". This term, however, can only be applied in the Krížna Nappe. It definitely cannot be employed when talking about the Hronic and Silicic Nappe systems.

Lithostratigraphically, the Hettangian stage can be characterized as a sequence of dark claystones intercalated with calcareous sandstones, sandy and organodetrital limestones. Lumachelle, ooid and so called cyanophyta limestones (Veľká Fatra Mts.) are sometimes abundant. The thickness seldom exceeds several tens of metres.

The boundary with the underlying Kössen Member is problematic (SÝKORA, 1987), lithologically can hardly be defined. And so it is the case with the upper boundary, if the Kopienec Formation is overlain by the Allgäu Formation.

In general, the Kopienec Formation can be easily morphologically identified because it forms depressed landforms.

Brief lithologic characteristics of the Kopienec Formation

The Kopienec Formation sediments were divided into smaller units by GAZDZCKI et al. (1979). The formation's lower part consists of the so called basal clastics as well as claystone, siltstone,

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sandstone and rarely also limestone facies. The pelitic sediments are very often laminated and interbedded with coarser clastics. All kinds of bedding identified in this part of the formation suggest the environment of tidal flats but some signs typical of recent tidal flats are missing (intensive bioturbation, marked erosional discordances etc.).

The clastic deposits are interlayered with limestone beds (so called lower limestones). Their deposition probably resulted from climatic changes - relatively drier periods in which sinking of the sedimentary basin was not compensated for by the deposition of clastics from the continent but by a transgressive onset of carbonate sediments with benthonic and exceptionally also planktonic organisms (such as ammonites). These rocks often contain oncoids (previously termed cyanophyta nodules) and lithoclasts. As is suggested by their textures and substratum erosion, some of the limestone beds are tempestites.

The "lower" limestone member is overlain by a formation of the main claystone. In its lower part, the claystone frequently contains rhythmic bedding - thin- and microbanded. The textures suggest that the tidal-flats sedimentation gradually gave way to the deposition of claystone facies on an open shelf, as is also indicated by bioclasts attesting to communication with open sea - silicisponge spicules, radiolarians and exceptionally also brachiopods.

The uppermost unit of the Kopienec Formation is the so called Upper Limestones characterized by regularly alternating limestone and claystone beds. The limestones lack visible internal textures and probably were laid down in deeper neritic.

Biostratigraphy

From a faunistic viewpoint, the Hettangian stage is less rich than the Rhaetian. By far the most abundant component of the faunistic assemblage is lamellibranchiates (KOCHANOVÁ, 1967). Gastropods and brachiopods occur less frequently.

Until recently, brachiopod occurrences were scarce. However, a representative ammonite collection was lately obtained by M. SÝKORA from the locality Sokol in the Malá Fatra Mts. Studies of this fauna as well as revision of earlier collections from the Strážovská hornatina Mts., Humenské pohorie Mts. and Liptovské hole Mts. substantially enriched our knowledge on the Hettangian ammonite fauna.

A total of 16 species were identified, including two new ones. The systematic studies of the brachiopod fauna allowed us to divide the Hettangian into zones and correlate it with the Alps area and NW Europe.

The faunistic studies revealed a number of systematic-taxonomic problems some of which were not explained satisfactorily. This applies primarily to the family *Schlotheimiidae* whose classification scheme is very controversial.

The most complex problem concerns the index species *Schlotheimia angulata* whose lecotype is based on the juvenile stage and probably did not originate in the Upper Hettangian. This fact undermines the validity of the biostratigraphic zone of the same name. In our study we accepted GUEX's proposal (1980 and 1987) which seemingly the best reflects a new systematic trends.

The submitted article is the first part of the prepared monographic study on the West Carpathian Lias ammonites.

Lithostratigraphy of significant Hettangian localities in the Krížna Nappe of the West Carpathians

As mentioned in the introduction, the most significant paleontologic localities occur exclusively in the Krížna Nappe. Of the total number of 25 localities, only five most important ones are described. They either contain noteworthy fauna or illustrate the sequence of beds of the Kopienec Formation.

Whenever outcrops were sufficient, we performed horizontal fauna collections. Unfortunately, early collections largely were not horizonted.

Section: *Babky* (West Tatra Mts.)
(the section was compiled after M. SÝKORA's records)

The Rhaetian of the Kössen Formation is overlain by gray to olive-green claystones with thin (1 — 2 cm) siltstone intercalations of the same colour. Thickness 12 m.

The claystones are overlain by alternating beds (20 cm thick) of dark-gray, sandy, organodetrital limestones and claystones. In these limestones, M. SÝKORA found *Psiloceras psilonotum* (QU.) indicating the Lower Hettangian, zone planorbis. Thickness 1 m.

Section: *Mouth of Sokol Valley into ZázriváValley* (Malá Fatra Mts.)
(detailed microfacies study of the section was carried out by SÝKORA, 1984)

The lowermost member consists of brown-green claystones and siltstones with parallel laminae of fine sandstones. In the upper part (bed 66) there is a bed of organodetrital limestones in which *Caloceras* cf. *torus* (d'ORB.) was identified. This species indicates the upper part of zone planorbis, subzone johnstoni of the Lower Hettangian. Further finds include *Tucheria* cf. *heberti* (TERQ.), *Cardinia* sp., *Astarte* sp., *Chlamys* sp. and *Gryphaea* sp.

The overlying member is composed of dark-gray ooidic bedded limestones with large intraclats (2.8 m).

Gray-green claystones with laminae of calcareous sandstones and limestones (4.5 m).

A formation of gray ooidic organodetrital limestones — (wackestones, grainstones) and foraminifer limestones. *Alsatites liasicuc* sensu WAEHNER and LIMA cf. *hettangiensis* TERQ. were found in the upper part of the limestones (bed 14). Both these species indicate the Middle Hettangian, zone liasicus. Bed 14 corresponds to bed 3 at locality Sokol. Thickness some 3.5 m.

The uppermost part of the section consists of alternating dark-gray, organodetrital, more or less sandy limestones and claystones (clayey shales). Thickness some 8.5 m.

Section: *Sokol Valley* (Malá Fatra Mts.)

Owing to its rich paleontological content, this site discovered by M. SÝKORA belongs among the most significant Hettangian localities.

It is situated in a stream cut approximately 1 km upstream from the foregoing locality. Because of the mode of deposition (the beds are upright and inclined parallel with the slope), only a small fraction of the Kopienec Formation is exposed here.

The lowermost member consists of three beds of dark-gray organodetrital limestone. Bed No. 2 contains the following fauna: *Cardinia* sp. *Kammerkarites extracostatus* (WÄH.), *K. megastoma* (GÜMB.), *Saxoceras langei* n. sp., *Schlotheimia taurina* (WÄHN.) The fauna attests to Middle Hettangian age, zone liasicus.

Fauna from bed No. 3 (3a, b, c) comprises *Cardinia* sp., *Lima hettangiensis* TERQ., *Cenoceras* sp., *C. malherbii* (TERQ.), *Alsatites liasicus* sensu (WÄHN.), *K. sokolensis* n. sp., *K. frigga* (WÄHN.), *K.* cf. *frigga* (WÄHN.), *Saxoceras langei* n. sp., *Schlotheimia* aff. *taurina* (WÄHN.) and *Atractites* sp.

This fauna, like that in the bed 2, also suggests Middle Hettangian age, zone liasicus.

The limestones are the most probably overlain by gray claystones, of which only the uppermost part is exposed on the surface (beds 4 and 5). Thickness some 140 cm.

Dark-gray thin-bedded (5 — 8 cm) limestones with uneven bedding planes passing into "pseudonodular" limestones whose carbonatic nodules are surrounded with clayey groundmass. Thickness 70 cm (6).

Dark-gray fine-grained biomicritic limestones (7).

Section: *Borišov* (Veľká Fatra Mts.)

The section is situated on the NE ridge Borišová leading from the tourist chalet towards Mt. Borišov (1512 m).

The Kössen Formation (2) is overlain by a thick (some 12 m) formation of olive-green claystones interlayered with a number of several tens of cm thick beds of calcareous, sometimes laminated sandstones and with a layer (3) of dark-gray organodetrital and ooid limestones (thickness 80 cm). In the upper part of the claystones (bed 3a) is a horizon of pelocarbonate nodules which contain *Schlotheimia* sp. (cf. Pl. IV, fig. 3). The fossil might suggest the Upper Hettangian.

Above is a 5 m thick layer of dark-gray, bedded, organodetrital, oolitic-oncoid limestones. Oncoid nodules (*Cyanophycae*) locally make up a substantial proportion of the rock which was designated accordingly - the so called *"Cyanophyta"* Limestone (MIŠÍK, 1964). The limestones contain *Chlamys valoniensis* (DEFR.). Upwards they pass into slightly crinoidal biomicrites.

Another unit is a formation of dark-gray marls alternating with marly limestones of the same colour. In the upper part of the formation (8a) below typical spotted marls of the Allgäu Formation, we have noted *Coroniceras* sp. suggesting that the formation is of the Lower Sinemurian age.

Section: *Úplaz pod Krížnou* (Veľká Fatra Mts.)

The section lies on the southern slope of a ridge extending westward from Mt. Krížna in an old avalanche scar.

Kössen Formation of Rhaetian age (MICHALÍK, 1976) is overlain by olive-green claystones intercalated with numerous thin beds of calcareous and laminated sandstones. In the lower part (4 m above the base) are the two horizons of the pelocarbonate nodules (bed 29) comparable with a similar horizon at Borišov. Thickness some 11 m.

The claystones are overlain by a 2.5 m thick layer of dark-gray organodetrital and oncoid limestones, their bedding planes being filled with claystones of the same colour. *Chlamys valoniensis* (DEFR.) (bed 32) was noted here.

Above the limestones is a thin (some 1.8 m) layer of olive-green claystones with an intercalation of organodetrital limestone. The claystones are replaced by greenish (near the base) to reddish, slightly crinoidal oolitic-oncoid limestones. The rock contains *Arnioceras* cf. *miserabile* (QU.) (bed 39) suggesting its Lower Sinemurian age.

Locality: *Kozinec ridge* (Strážovské Vrchy Mts.)

The locality was previously described by MAHEĽ (1962, 1985), KOCHANOVÁ (1976) and RAKÚS (1975, figs. 2, 3), but still new horizonted collections were necessary. A revision of the earlier collections confirmed the presence of *Kammerkarites* cf. *curviornatum* (WÄHNER) in fauna No. 4 (cf. RAKÚS, 1975, p. 24, fig. 3).

The locality also contains *Gonioptychceras viskupi* (RAKÚS); (fauna No. 6). Both above-mentioned species occur in the Middle Hettangian, zone liasicus.

Locality: *Hybe—Ružiakov úvoz* (Liptov Basin)

This well-known occurrence of Rhaetian fauna was in the past described by several scientists. Nevertheless, the first horizonted fauna collection was perfomed as late as 1973 by MICHALÍK who found several nautiloid brachiopods in the Hybe Member in the upper part of the Kössen Formation. In the same member, collector A. TURBA found an ammonite which was identified as *Pleuroacanthites* ex gr. *biformis* (SOW.) (see RAKÚS, 1992).

Understandably, the finds of this Hettangian fauna in the Hybe Member affect the stratigraphic range of the Kössen Formation in the West Carpathians.

Locality: *Rakytov* (Veľká Fatra Mts.)

The locality was discovered by ŠTÚR (1860) who described here the species *Ammonites psilonotus laevis* QUENSTEDT. As the locality contains the Kössen Formation which is generally regarded as exclusively Rhaetian, the find was not taken into account. Nevertheless, a Hettangian pleuroacanthid form found at the locality Hybe suggests that the uppermost parts of the Kössen Formation extended up to the Hettangian (RAKÚS, 1992). This find confirms earlier observations by ŠTÚR (1860).

Locality: *Čierna Lehota — surroundings* (Strážovské vrchy Mts.)

In the Čierna Lehota area, the shallow-water facies of the Krížna Nappe are extremely variegated (MAHEĽ, 1985). Despite numerous identified fossils, stratigraphic relationships of the Lias in this area are known only inadequately. This is mainly caused by the absence of horizonted collections along profiles.

A revision of earlier ammonite collections from gray-crinoidal-brecciated limestones with phosphorite clasts did not confirm the presence of the Lower and Middle Hettangian. The oldest ammonite fauna identified in the above-mentioned limestones is of a "mixed" Upper Hettangian — Lower Sinemurian character. We have so far identified: *Tayloricites waehneri* (RAKÚS), ?*Gyrophioceras* aff. *praesiratissimus* (WÄHN.), *Sulciferites charmassei* (d'ORB.), *S. martinischnidti* (LANGE), *Coroniceras subrotiforme* (PARONA).

11

Systematic Part

superfamily *Nautilaceae* DE BLAINVILLE, 1825
family *Nautilidae* DE BLAINVILLE, 1825
Cenoceras HYATT, 1883
Type species *Nautilus intermedius* SOWERBY, 1816 non d'ORBIGNY, 1842

Cenoceras malherbii (TERQUEM, 1855)
Text-fig. 1

1855 *Nautilus malherbii,* TQM.—TERQUEM, p. 243; Pl. 12, figs. 5, 5a, 5b
1984 *Cenoceras malherbii* (TERQUEM) — TINTANT, pp. 33 — 35; Pl. 1, figs. 1a, b, 2, figs. 2a — f in text

M a t e r i a l : An incomplete stone cast corresponding to phragmocone.

D i m e n s i o n s :	D	Wh	Ww	o
GÚDŠ/1533	76.0	48.5	~66.0	~12.0

D e s c r i p t i o n : The robust, fairly involute shell is characterized by a typical trapezoidal-depressed cross-section of the phragmocone and body chamber (text-fig. 1). The umbilicus is deep, umbilical wall is almost perpendicular at the plane of symmetry; umbilical margin is strongly rounded and gradually passes into slightly arched sides convergent to the external margin. The external area is flat and wide. Cross-section of subadult stages is widely rounded with centrally positioned sipho. Suture line is slightly sinuate; external lobe is slightly developed, while lateral one is wide and flat.

1 cm
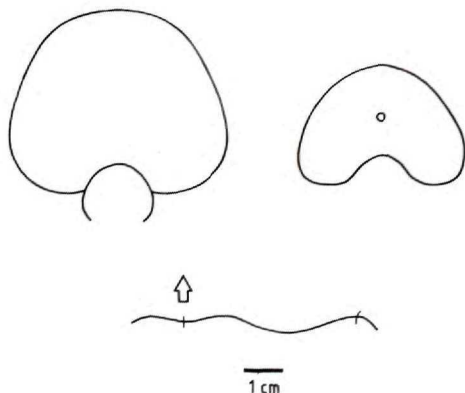
Fig. 1 *Cenoceras malherbii*

R e m a r k s : The shape of phragmocone cross-section and suture line of our specimen well corresponds to the description and illustration of the species put forward by TINTANT (1984; Pl. 1, fig. 1 and text-fig. 2).

G e o g r a p h i c d i s t r i b u t i o n a n d s t r a t i g r a p h i c r a n g e : The species was previously known exclusively in France (TINTANT, 1984). The West Carpathian find is the first occurrence in the Alpine-Carpathian area. At locality Sokol, it occurs in the Middle Hettangian, zone liasicus.

Cenoceras sp.

R e m a r k s : The cephalopod collection from the locality Sokol contains one partially preserved specimen undoubtedly belonging to the genus *Cenoceras*. The overall section of the laterally compressed last preserved whorl of our specimen is most similar to the species *C. schlumbergeri* (TERQ.). Like the foregoing fossil, this specimen was also found in the Middle Hettangian.

superfamily *Lytocerataceae* NEUMAYR, 1875
family *Pleuroacanthitidae* HYATT, 1990

genus *Pleuroacanthites* CANAVARI, 1883
Type species *Ammonites biformis* J. de C. SOWERBY, 1831

Pleuroacanthites ex gr. *biformis* (SOWERBY, 1831)
Pl. VI, fig. 7

1992 *Pleuroacanthites* ex. gr. *biformis* (SOWERBY, 1831) — RAKÚS, p. 39; Pl. II, fig. 2

M a t e r i a l : An incomplete, partially corroded stone cast.

D i m e n s i o n s :	D	Wh	Ww	o
SWMZ 21.029	36.4	13.6	-	13.2

D e s c r i p t i o n : A small evolute shell whose whorls have an oval to circular cross-section. The whorl sides are dotted with nodosites (?parabolic nodes) which, on the last whorl, are radiate. The last two nodosites are slightly rursiradiate. The suture line is very poorly preserved.

R e m a r k s : The specimen from Hybe—Ružiakov úvoz best resembles *Pleuroacanthites biformis* (SOW.) as is illustrated by CANAVARI (1888; Pl. 13, fig. 12) and LANGE (1952, Pl. 11, fig. 4). Because of its poor preservation, we were unable to identify it reliably. Nevertheless, signs such as involution stage and nodosites on the whorl sides allow us to assign our specimen into the genus *Pleuroacanhites*.

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : Our species is a typical Tethyan form which occurs only in the Alpine—Mediterranean area (CANAVARI, 1888; WÄHNER, 1894; LANGE, 1952). Its stratigraphic range is Hettangian, since planorbis zone (GUEX, 1987).

superfamily *Psilocerataceae* HYATT, 1867
family *Psiloceratidae* HYATT, 1867

genus *Psiloceras* HYATT, 1867
Type species *Ammonites planorbis* J. de C. SOWERBY, 1824

Psiloceras psilonotum (QUENSTEDT, 1843)
Pl. VIII, fig. 2

1843 *Ammonites psilonotus laevis* — QUENSTEDT, p. 127
1849 *Ammonites psilonotus laevis* — QUENSTEDT, p. 73; Pl. 3, fig. 18
1860 *Ammonites psilonotus laevis* — ŠTÚR, p. 378
1885 *Ammonites psilonotus laevis* — QENDSTEDT, p. 11; Pl. 1, figs. 1 — 7
1941 *Psiloceras psilonotum* (QUENSTEDT) — LANGE, pp. 73 — 76, text-fig. 58 — 61; Pl. 2, figs. 17. 18 (cum syn)

1963 *Psiloceras planorbis* (SOWERBY) — BLIND, p. 45; Pl. 1, fig. 1
1965 *Psiloceras psilonotum* F. A. QENSTEDT, 1849 — ELMI et MOUTERDE, p. 206; Pl. 3, figs. 2, 3 (non 4); Pl. 10, fig. 5
1976 *Psiloceras* (PS.) *planorbis* (SOW.) 1824 — SCHLEGELMILCH, p. 33; Pl. 4, fig. 14

M a t e r i a l : A negative impression in gray-brown organogene limestone found by M. SÝKORA.

Dimensions:	D	Wh	Ww	o
GÚDŠ 1510	25.0	8.4	-	9.9

D e s c r i p t i o n : The shell is small, evolute planspiral. The whorl cross-section is oval with a narrow venter and flat sides. The umbilicus is wide and shallow. Surface of the last whorl is covered with poorly visible prorsiradiate ribs which occur only on sides. The suture line was not preserved.

R e m a r k s : The specimen from Úplazy pod Babkami well corresponds to the species description and illustration submitted by QUENSTEDT (1885; Pl.1 , figs. 1 — 7) and LANGE (1941; Pl. 2, figs. 17, 18).

The first published find of this species in the West Carpathians dates back to 1860 (ŠTÚR, p. 378). It was found in a saddle north of Rakytov in the Veľká Fatra Mts. The occurrence of this species was ignored for long because the locality investigated by D. ŠTÚR is made up entirely of the Kössen Formation which, in the Carpathians, was considered to be exclusively Rhaetian. However, investigations at Hybe have proved that the stratigraphic range of this formation extends into the Hettangian stage (RAKÚS, 1992).

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : The species is fairly abundant in NW Europe, but occurs much less frequently in the Tethys area. In the Alps and West Carpathians, this scarce species has so far been identified at only two localities: Rakytov (Veľká Fatra Mts.) and Úplazy pod Babkami (western part of the West Tatra Mts.). Stratigraphically, it occurs exclusively in the Lower Hettangian, zone planorbis.

Caloceras HYATT, 1870
Type species *Ammonites torus* d'ORBIGNY, 1842

Caloceras cf. *torus* (d'ORBIGNY, 1844)
Pl. I, fig. 10

M a t e r i a l : An incomplete specimen and several whorl fragments.

R e m a r k s : In the lower tract of the section mouth of valley SOKOL, in bed 66, M. SÝKORA found several incomplete specimens whose whorl cross-section and ribs most resemble a species of the group *Caloceras torus* (d'ORB., 1844). Detailed identification was impossible because of poor preservation. Stratigraphically, we assign our specimens into the Lower Hettangian, zone planorbis, subzone torus — johnstoni.

Gonioptychoceras LANGE, 1941
Type species *Aegoceras gonioptychum* WÄHNER, 1886

R e m a r k s : Taxonomic validity of the genus *Gonioptychoceras* is not generally accepted. Primarily English scientists regard it synonymous with the genus *Alsatites*. Nevertheless, as was recently documented by GUEX (1987), we have a number of reasons to consider it a separate genus.

The species comprises small to medium, polygyrate laterally compressed forms with distinct but fine ribs, whose subadult stage has a roof-like venter.

Gonioptychoceras viskupi (RAKÚS, 1975)
Text-figs. 3, 4, 5; Pl. I, figs. 5, 6

1962 *Alsatites* aff. *galbergensis* LANGE — RAKÚS in MAHEĽ, p. 102
1975 *Alsatites viskupi* sp. n. — RAKÚS, p. 12 — 14, text-figs. 5, 6; Pl. 104, fig. 2

M a t e r i a l : Two stone casts with partly preserved calcified shell. The holotype is an almost complete specimen.

D i m e n s i o n s :	D	Wh	Ww	o
Paratype (GÚDŠ)	30. 4	7.8	-	18.0
Holotype SNM-26322	51.7	11.2	7.4	30.8

D e s c r i p t i o n : The shell is small, planispiral-coiled. Juvenile specimens (up to 7 mm in diameter) are smooth, their cross-section being circular. If the diameter exceeds some 15 mm, the height increases and the whorl becomes oval. Subadult specimens up to some 30 mm across have a roof-like venter and flat parallel sides (text-fig. 3). The roof-like venter stretches as far as the beginning of the body chamber, which occupies more than a half of the last whorl. Towards its end the body chamber' s cross-section becomes narrower thus attesting to the proximity of peristome,
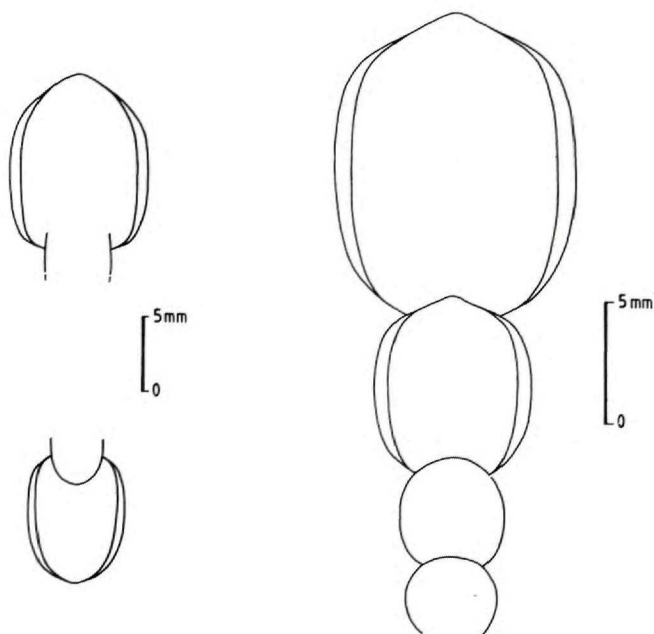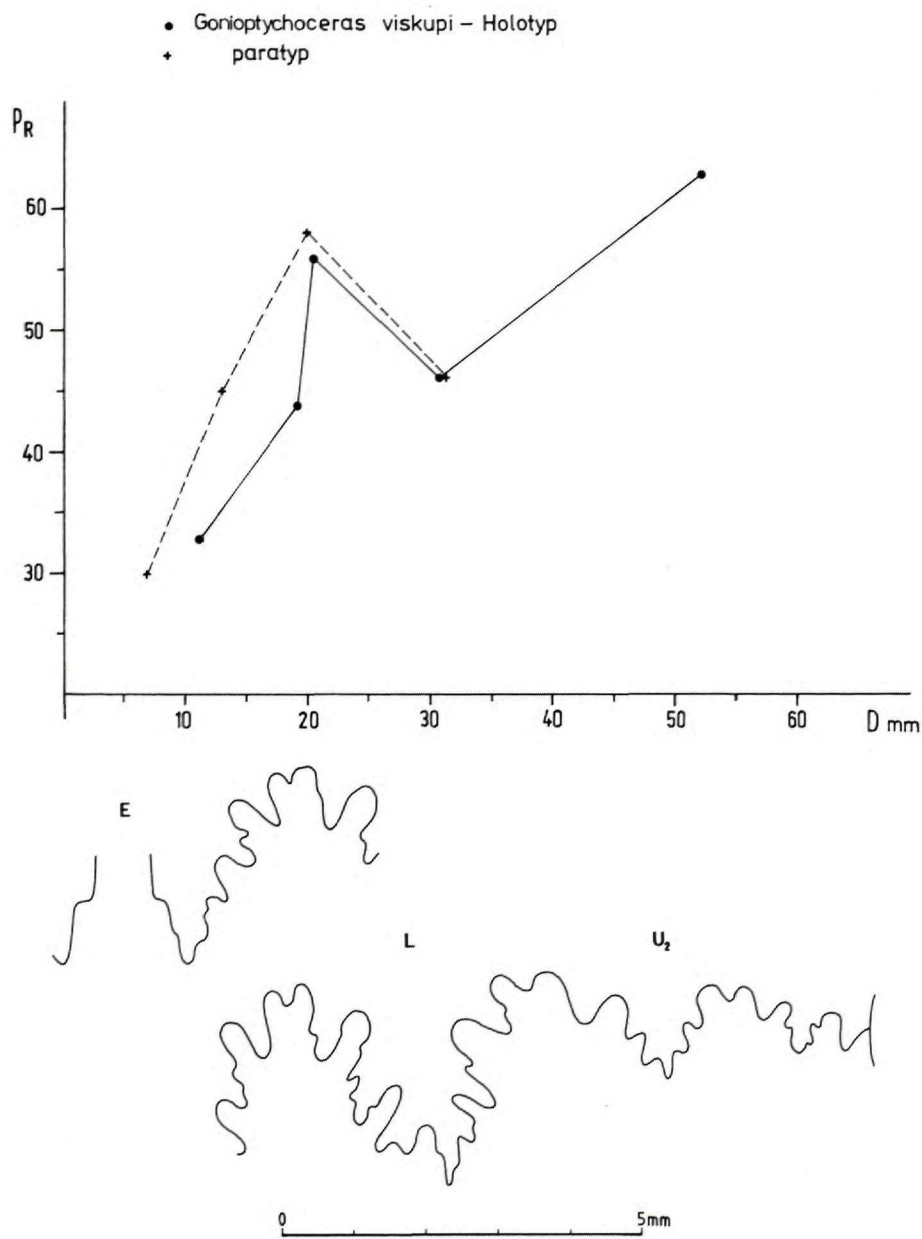

Fig. 2 *Gonioptychoceras gonioptychum*   Fig. 3 *Gonioptychoceras viskupi*

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Figs. 4, 5 *Gonioptychoceras viskupi*

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which seems to be single with a small ventral rostrum. The ornamentation consists of simple, fairly fine but dense ribs. The initially rectiradiate ribs gradually tend to become prorsiradiate. The first fine ribs appear at the diameter of 7 mm. Their number grows rapidly, amounting to some 58 at the diameter of about 20 mm. At diameter between 20 and 30 mm, the number of ribs falls to 46 only to grow to 64 on the last whorl (text-fig. 4). The suture line (text-fig. 5) has psiloceratoid appearance and is rather simple. E and L are almost equally deep, saddles are shallow and folioles bear signs of spatulation. U_2 is small in comparison with L.

R e m a r k s : The species *viskupi* was originaly assigned into the genus *Alsatites* (RAKÚS, 1975). However, new studies have shown that the assignation was incorrect (GUEX, 1989). Our species differs from the typical species in much larger evolution and higher density of ribs. The type of ribbing of our species is similar to that of *Alsatites laqueus* (QUENSTEDT, 1856) and *A. gallbergensis* LANGE, 1941.

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : The species has so far been noted only in the West Carpathians at the locality Kozinec-Chrbát, west of Valaská Belá (Strážovská hornatina Mts.); Middle Hettangian, zone liasicus.

family *Schlotheimiidae* SPATH, 1923
genus *Kammerkarites* SPATH, 1924
Type species *Aegoceras diploptychum* WÄHNER, 1882

Kammerkarites extracostatus (WÄHNER, 1884)
Text-figs. 6, 7; Pl. I, figs. 1, 2

1884 *Aegoceras extracostatum* n. f. — WÄHNER, p. 74; Pl. 14, figs. 1a — h
1952 *Storthoceras extracostatum* (WAHNER) — LANGE, p. 126, text-fig. 60; Pl. 15, fig. 18

M a t e r i a l : A partly, but relatively well preserved cast and several whorl fragments.

D i m e n s i o n s :	D	Wh	Ww	o
GÚDŠ 1503	100.0	29.0	19.4	49.0

D e s c r i p t i o n : The form is medium-sized, evolute, laterally concave. Whorl cross-section of juvenile specimens is circular to oval. From the third whorl, however, the height exceeds width and the whorl cross-section is highly oval until the adult stage (text-fig. 6).

The ornamentation initially consists of fine numerous prorsiradiate regular ribs. Subadult specimens have strong regular prorsiradiate ribs which, when passing onto sides, bend towards the aperture and less distinctly continue onto the other side forming a rounded chevron. The weakened ribs on the venter and rhombic facets formed as the "chevron" bent sometimes evoke the illusion of a keel band like that of genus *Schlotheimia*. The ribs of adult specimens are slightly sigmoidal. Our species have much more ribs on each whorl than all other species.

The suture line (text-fig. 7) is symmetric with a wide external saddle. Right lateral lobe is small and shallow. The first lateral saddle is lower than the other.

R e m a r k s : Our specimen well corresponds to the original WÄHNER' S description and illustration (that author described a number of related species). It is noteworthy, however, that the subadult stages can only very hardly be distinguished from each other. Our species best resembles *K. curviornatum* (WÄHNER, 1884) which, however, has blunter and less abundant ribs. *K. megastoma* (GUEMBEL, 1861) differs in more radiate and less dense ribs.

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : This is the first known occurrence of our species in the West Carpathians. It was only noted at one locality: valley Sokol in the Malá Fatra Mts. in the Middle Hettangian, zone liasicus. In the Alps, the species occurs at Schreinbach and Fonsjoch.

Figs. 6, 7 *Kammerkarites extracostatus*

5mm
0

0   5 mm

18
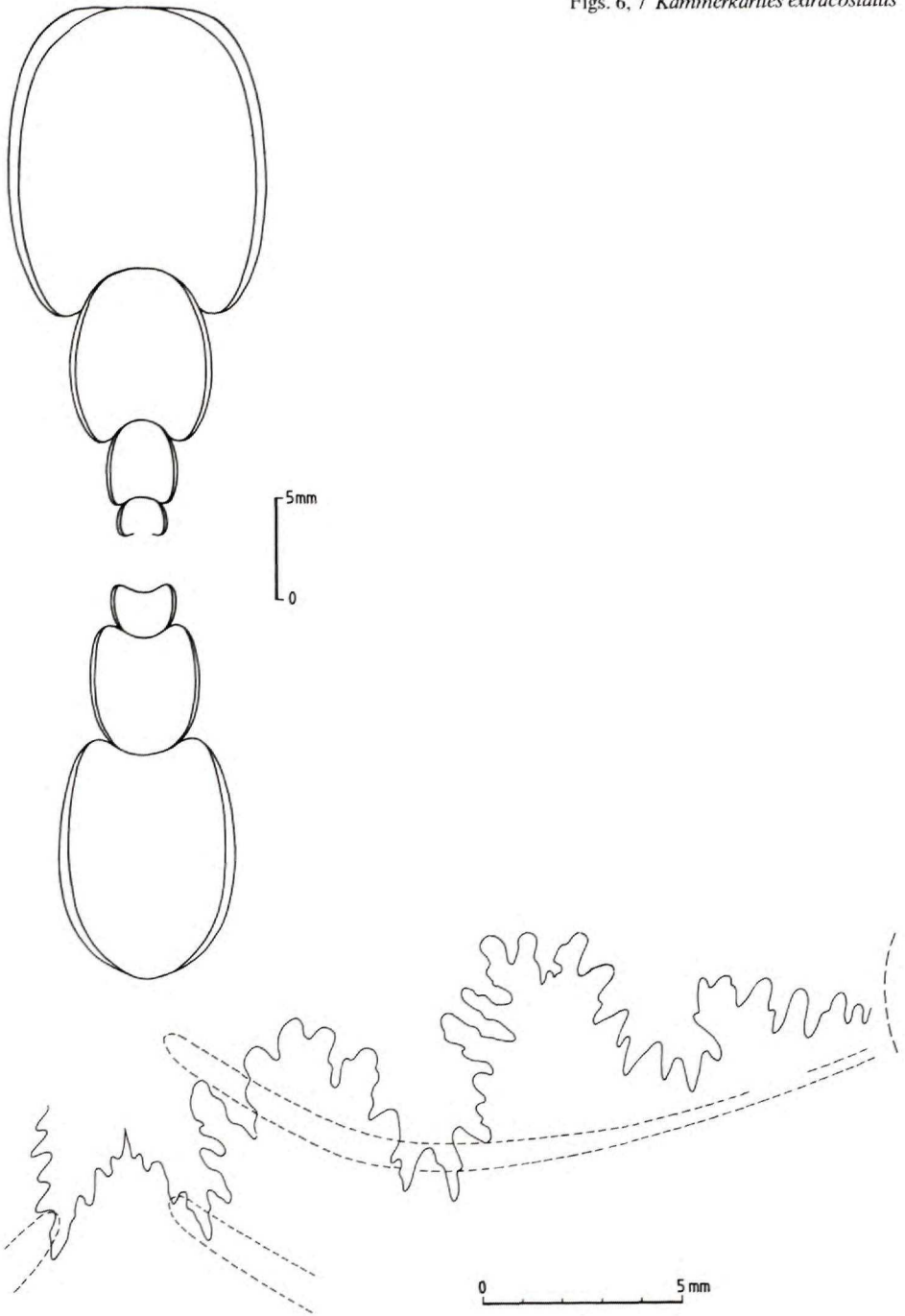
Kammerkarites sokolensis sp. n.
Text-figs. 8, 9, 10, 11; Pl. I, fig. 8; Pl. II, figs. 1, 5

H o l o t y p e : Species illustrated in Pl. II, fig. 1, deposited in the Slovak National Museum, No SNMZ 21274.

D e r i v a t i o   n o m i n i s : Named for its occurrences in valley Sokol.

L o c u s   e t   s t r a t u m   t y p i c u m : Valley Sokol, W of Mt. Lysica, Malá Fatra Mts., Middle Hettangian, liasicus zone.

M a t e r i a l : Ten stone casts with partly preserved calcified shells.

D i m e n s i o n s :

	D	Wh	Ww	o
GÚDŠ/1458	18. 0	8.0	6.2	6.6
GÚDŠ/1488	17.0	7.0	-	5.4
GÚDŠ/1484	18.7	7.8	5.8	5.8
GÚDŠ/1489	19.0	8.3	-	6.3
GÚDŠ/1480	20.0	8.6	6.2	6.8
GÚDŠ/1481	25.0	10.8	7.5	8.6
GÚDŠ/1483	27.8	11.2	8.5	8.4
Paratype GÚDŠ/1487	64.0	23.0	17.7	19.8
Holotype SNMZ/21.274	172.0	63.0	39.0	68.0

D i a g n o s i s : Convolute *Kammerkites* whose subadult stages have slightly sigmoidal ribs, rounded on the venter. The adult specimens are characterized by plicate ribs, developed only on sides. The suture line is asymmetric.

D e s c r i p t i o n : The first two whorls have a circular cross-section, then the height exceeds the width and so the cross-section becomes highly oval with flat sides. The subadult and adult specimens have elliptic whorl cross-sections (text-figs. 8, 9, 10).
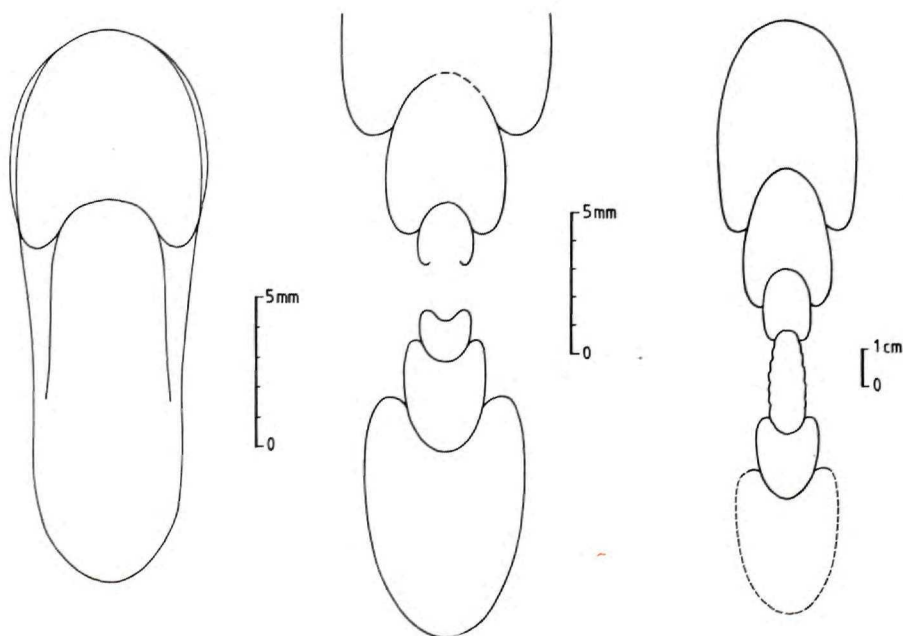
Figs. 8, 9, 10 *Kammerkarites sokolensis*

As the whorls significantly overlap each other (involution), the umbilicus is fairly narrow in comparison with the other species of the genus *Kammerkites* (macroconchs).

Ornamentation: The first ribs appear at a diameter of some 9 mm. They start in the periumbilical area, are slightly sigmoidal and tend to become rursiradiate. The ribs gradually thicken and, in places where the sides pass into the venter, they abruptly bend towards the aperture and become thinner. The late subadult and adult stages have typical plicate ribs extending as far as above the living chamber.

Suture line: (text-fig. 11) is very asymmetric as regards the shape and size of the right and left first lateral saddle S_l: left S_l is strongly reduced and narrow while S_l on the right-hand side is much larger.

R e m a r k s : The subadult specimens of the new species most resemble the species *K. frigga* (WÄHNER, 1866) which differs from ours maily in its tuberculate stage and much more sigmoidal ribs. The degree of involution of the new species is similar to that of *K. toxoforus* (WÄHNER, 1886). However, our species has much sparser ribbing.

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : The new species is known to exist only in the West Carpathians in Sokol Valley where it occurs in the Middle Hettangian, liasicus zone.

▲ **Kammerkarites** sokolensis sp. n. Holotyp
● **Kammerkarites** sokolensis sp. n. Syntypy
+ **Kammerkarites** frigga (Wähner) Lectotyp pl. 23, f. 1
□ **Kammerkarites** frigga (Wähner) pl. 23, f. 2
o **Kammerkarites** frigga (Wähner) Lange pl. 16, f. 6

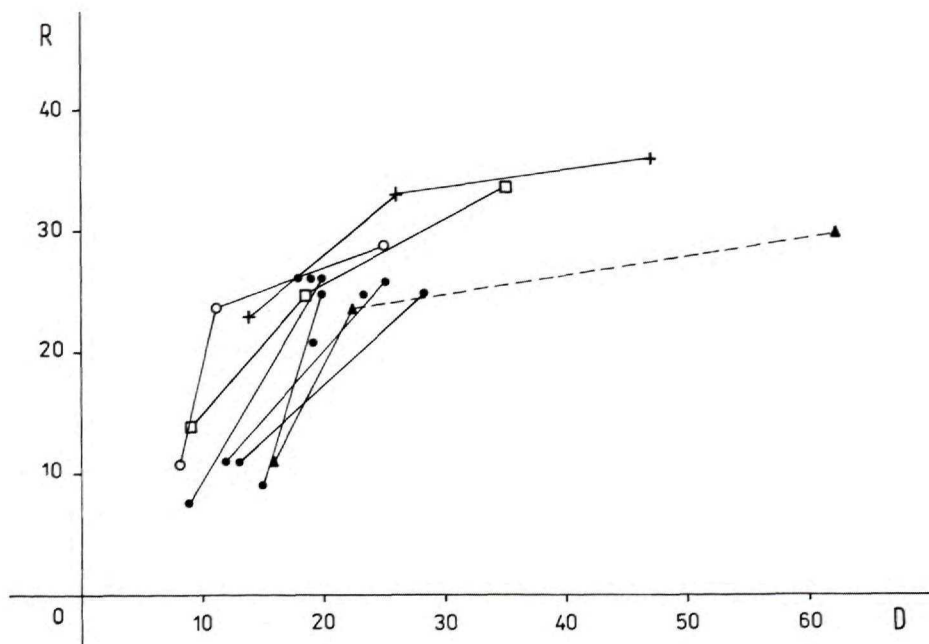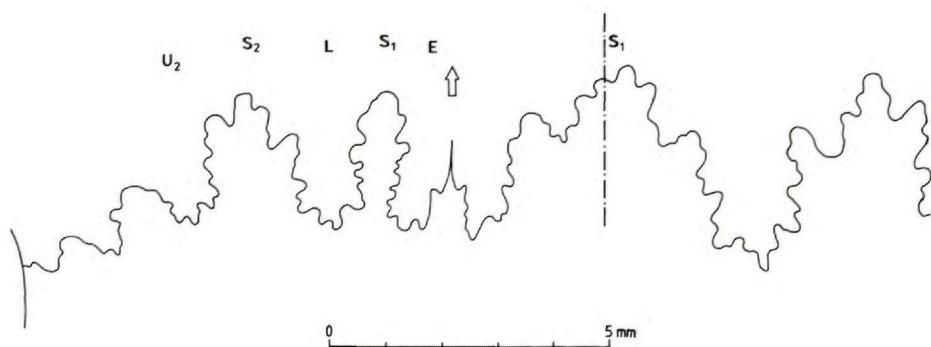

Fig. 10a *Kammerkarites sokolensis*

Fig. 11 *Kammerkarites sokolensis*

Kammerkarites aff. *sokolensis* n. sp.
Pl. III, fig. 1

M a t e r i a l : An almost complete specimen preserved as a stone cast.

D i m e n s i o n s :	D	Wh	w w	o
SNMZ 21275	167.0	54.0	-	75.0

R e m a r k s : Ammonite collection from Sokol Valley comprises a specimen whose type of ribbing is identical with that of the species sokolensis. However, the latter is much less evolute.

Kammerkarites megastoma (GUEMBEL, 1861)
Text-fig. 12; Pl. 4, fig. 1

1861 *Ammonites megastoma* GUEMB. — GÜMBEL, p. 474
1882 *Aegoceras megastoma* GÜMB. — WÄHNER, p. 78; Pl. 18, figs. 1 — 6
1941 *Megastomaceras megastoma* (GÜMBEL) — LANGE, p. 41 and 42
1952 *Storthoceras (Megastonoceras)* cf. *megastoma* (GÜMBEL) — LANGE, p. 137; Pl. 17, fig. 8
1963 *Psiloceras (Discamphiceras) megastoma* (GUMBEL) — BLIND, p. 53; Pl. 2, fig. 2

M a t e r i a l : A partly preserved, but almost complete specimen.

D i m e n s i o n s :	D	Wh	Ww	o
GÚDŠ/1534	180.0	48.0	31.8	91.6

D e s c r i p t i o n : Juvenile tuberculate stage is followed by subadult stage with distinct radiate ribs, which become thinner and stretch behind the venter. Adult stages have distinct ribs only on side.

Subadult specimens have an oval cross-section of their whorls and a fairly wide venter. Adult whorls have an elliptic cross-section (text-fig. 12a). The suture line (text-fig. 12b) is deeply dissected, particularly the second lateral saddle. The external saddle is pyramidal with an oblique basis.

R e m a r k s : Subadult specimens of the genus *K. megastoma* can hardly be distinguished from *K. diploptychus* (WÄHNER, 1882). Adult specimens have distinctive secondary inserted ribs and a manifestation of a blunt keel.

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : The species is fairly abundant in the Alpine area where it occurs in the Middle Hettangian. Megastoma zone (WÄHNER, 1886) was named for it. The species has not so far been known to exist in the West Carpathians.
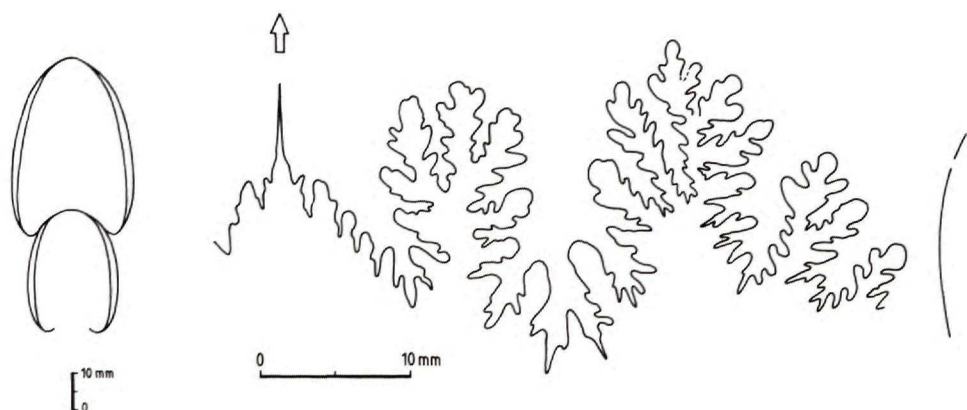
21

Fig. 12 *Kammerkarites megastoma*

Kammerkarites frigga (WÄHNER, 1884)

Text-figs. 13, 14, 15; Pl. II, figs, 2, 3, 4; Pl. III, figs. 2, 3, 4, 5

1884 *Aegoceras frigga* n. f. — WÄHNER, p. 106, Pl. 23, figs. 1 — 3
1886 *Psiloceras frigga* WÄHNER — WÄHNER, p. 196
1941 *Storthoceras frigga* (WÄHNER) — LANGE, p. 41
1952 *Storthoceras frigga* (WÄHNER) — LANGE, p. 127, text-fig. 61; Pl. 16, figs. 6, 9
1963 *Psiloceras (Storthoceras) frigga* (WÄHNER) — BLIND, p. 54

M a t e r i a l: Four incomplete stone casts and a few whorl fragments.

D i m e n s i o n s:	D	Wh	Ww	o
GÚDŠ/1485	20.0	7.6	6.5	5.5
GÚDŠ/1529	32.8	12.4	9.4	12.05
GÚDŠ/1482	34.0	13.0	9.0	12.7

D e s c r i p t i o n : A small, convolute, laterally concave shell with elliptic-oval whorl cross-section (text-figs. 13, 14). The juvenile stage (5 mm) is typically tuberculate. Protuberances are distinct and number 6 — 7 on each whorl. The subadult stage is initially characterized by faint radiate ribs which gradually grow thicker and become sigmoidal. The ribs are particularly distinct on the sides. On the transition between the sides and the venter, they bend aperturally and join the opposite rib at a sharp but rounded angle thus forming rounded "chevrons". The suture line (text-fig. 15) is only slightly asymmetric. The first lateral lobe (L) is trifid, deeply cut. The right S_1 is narrower than the left S_1. Dorsal lobe I is narrow and deeply cut.

R e m a r k s : Specimens from the locality Sokol Valley are very similar to the type of the species illustrated by WÄHNER (1884; Pl. 23, fig. 1). However, our specimens are somewhat more involute. Owing to this sign, our species resembles the species *K. frigga altius* (LANGE, 1952). Nevertheless, the ribs of our species are sparser and thicker.

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : The species is fairly abundant in the Northern Calcareous Alps. It was not previously known in the West Carpathians. The described specimens originate from the locality Sokol Valley (Malá Fatra Mts.).

Stratigraphically, it comes from the Middle Hettangian, liasicus zone.

22
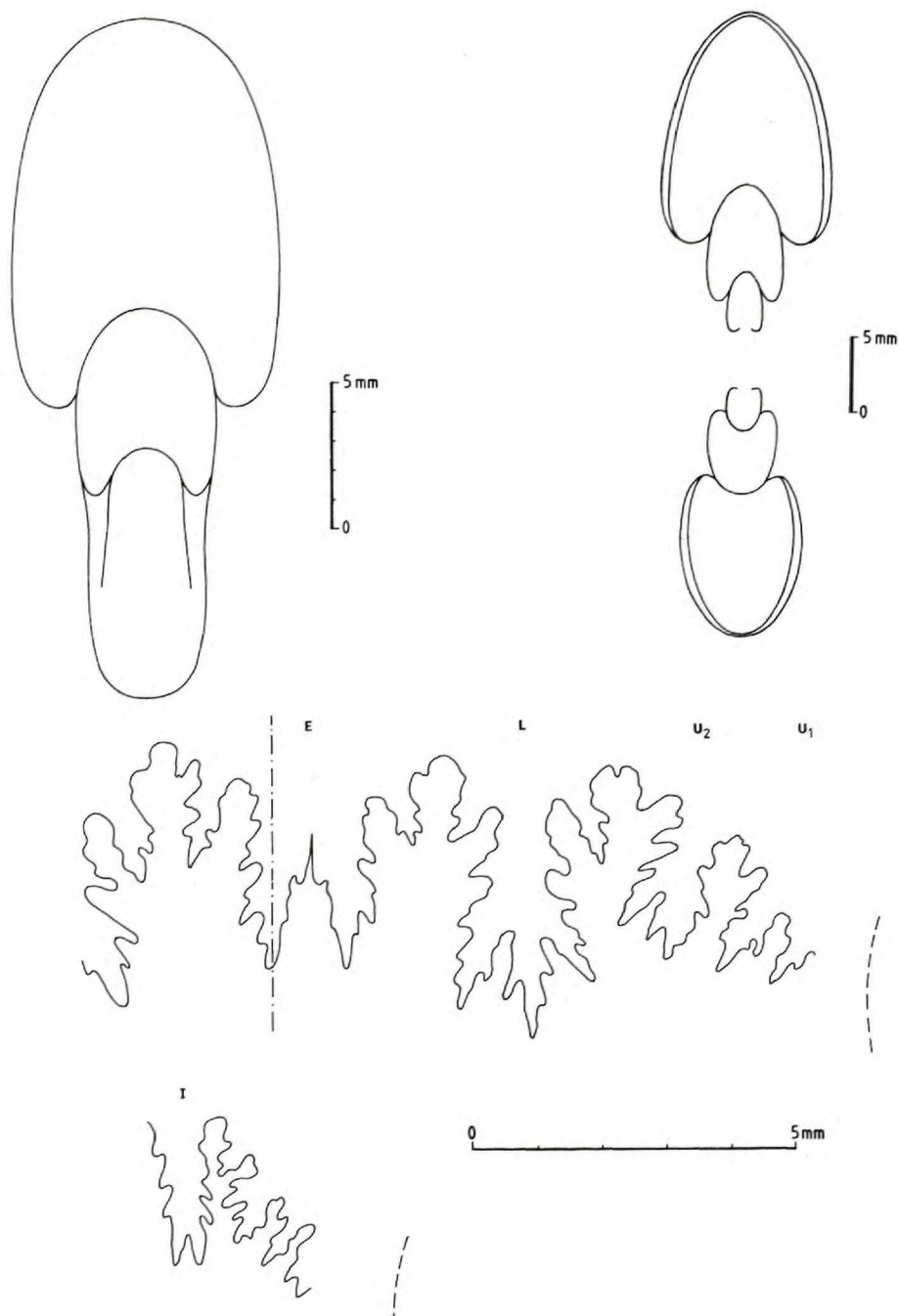
Figs. 13—15 *Kammerkarites frigga*

23

Kammerkarites cf. curviornatum (WÄHNER, 1884)
Text-fig. 16; Pl. IV, figs. 2, 4

M a t e r i a l : Nine incomplete, partly deformed stone casts and several whorl fragments.

D e s c r i p t i o n : A small, evolute, laterally concave shell of oval whorl cross-section. The whorl surface is covered with distinct, arched, slightly prorsiradiate ribs which are particularly distinct on the sides. On the transition to the venter, they bend forward and becoming thinner they stretch onto the other side. At the diameter of some 30 mm their number oscillates around 29.
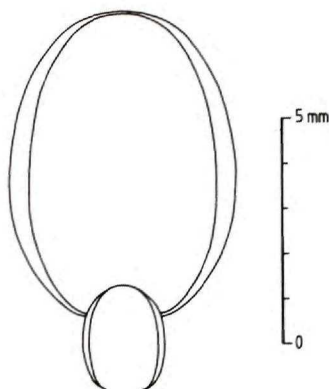
Fig. 16 *Kammerkarites* cf. *curviornatum*

R e m a r k s : Specimens from the locality ridge of Mt. Kozí vrch were formerly designated by the author as *W. (Curviceras)* aff. *engonium* (LANGE, 1924) in RAKÚS, 1975. However, a revision of earlier material has shown that these specimens most resemble the species *K. curviornatum*. Thanks to their sparser ribbing, our specimens are also similar to *K. haploptychus* (WÄHNER, 1884).

It is worth mentioning that reliable identification of subadult stages of the genus *Kammerkarites* is sometimes impossible.

The above-described species occurs in the West Carpathians only at the locality ridge of Mt. Kozí vrch (Strážovská hornatina Mts.) of Middle Hettangian age, liasicus zone.

G e o g r a p h i c d i s t r i b u t i o n a n d s t r a t i g r a p h i c r a n g e : The species is distributed in the Alps and West Carpathians where it occurs in the Middle Hettangian, liasicus zone.

Saxoceras LANGE, 1924
Type species *Psiloceras costatum* LANGE, 1921

Saxoceras langei n. sp.
Text-figs. 17, 18, 19; Pl. V, figs. 1, 2, 3, 4; Pl. VI, figs. 1, 2, 3

1884 *Aegoceras angulatum* SCHLOTH. var ind. — WÄHNER, p. 171; Pl. 20, fig. 16
1952 *Schlotheimia (Scamnoceras) angulata* — LANGE, p. 145; Pl. 11, figs. 6, 7

H o l o t y p e : The specimen illustrated in Pl. 5, fig. 1, deposited in the Slovak National Museum, No. SNMZ 21. 175.

L o c u s e t s t r a t u m t y p i c u m : Valley Sokol, Malá Fatra Mts., Middle Hettangian, liasicus megastoma zone.

D e r i v a t i o n o m i n i s : Named for W. LANGE, a brilliant expert on Hettangian ammonites.

M a t e r i a l : 5 more or less complete stone casts with remains of calcified shells belonging to subadult stages. One almost complete adult specimen (holotype) and several dozens of whorl fragments of subadult stages.

D i m e n s i o n s :	D	Wh	Ww	o	N/2		
	24.5	9.0	8.2	9.2	9 2/18	24 5/21	
GÚDŠ/1552	25.8	9.0	8.0	9.4		9 4/16	ø 25 8/20
	33.0	10.8	8.4	13.0	6 0/~8±1	13 0/15	33 0/22
Paratype GÚDŠ/1530	~32.0	11.0	8.6	14.2	14 0/21	ø 32 0/22	
Holotype SNMZ 21 276	165.0	/31/	30.0	78.0	/21/ ø ~20.0/20±1/		ø 40.0/21 46.6

D i a g n o s i s : A medium-sized, convolute form with an angulate subadult stage. The adult stage has elliptic whorl cross-section with ribs exclusively on sides. The ribbing persists throughout the ontogeny, suture line is characterized by robust saddles.

D e s c r i p t i o n : The juvenile stage occupies roughly two and a half whorl, has a depressed-circular whorl cross-section and the surface of the whorls is smooth.
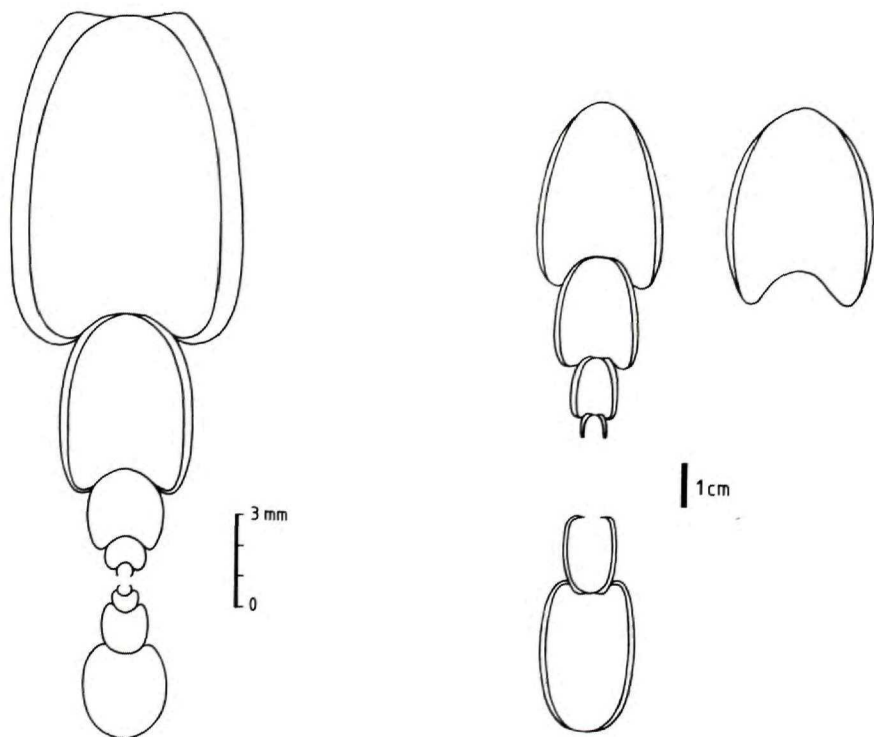
Figs. 17, 18 *Saxoceras langei*

Subadult stage: between the second and third whorl there gradually appear fine prorsiradiate ribs which quickly become thick and very distinct. On the transition between the sides and the venter they bend aperturally and end abruptly forming a ventral band ("furrow"). The intercostal distances are somewhat larger than the rib which (Pl. VI, fig. 1). This growth stage has a typical angulate character and can only hardly be distinguished from identical stage of the species *Sch. angulata* (our species is more evolute). From the third whorl on, the whorl cross-section becomes highly oval and remains unchanged during the whole ontogeny (text-figs. 17, 18).

Adult stage: is characterized by a highly oval whorl cross-section. Ornamentation consists of densely spaced prorsiradiate ribs which thin and stretch over the venter.

Suture line: (text-fig. 19) is characterized by robust but weakly-cut saddles and highly positioned, small U_2.
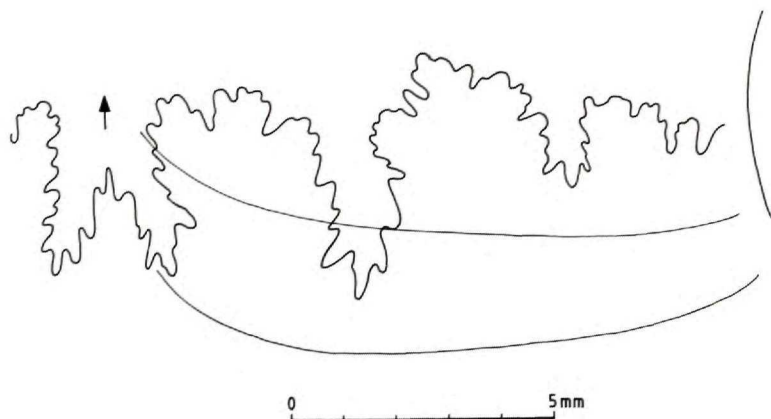
Fig. 19 *Saxoceras langei*

R e m a r k s : Subadult stages of the new species can hardly be reliably distinguished from equal growth stages of forms grouped around the species *Schlotheimia extranodosa* (WÄHNER, 1884).

However, advanced subadult and adult stages can be distinguished reliably.

The new species differs from the species *Schlotheimia extranodosa* (WÄHN.) mainly in the absence of branched ribs. Furthermore, its saddles are markedly more robust and less deep. Our new species differs from the species *Sch. taurina* (WÄHNER, 1884) as to its finer and denser ribs and narrower whorl cross-section.

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : The new species has so far been known from the locality Schreinbach (WÄHNER, 1884), Pfonsjoch (LANGE, 1952) and also Sokol, where it occur in the Middle Hettangian, liasicus zones.

Schlotheimia BAYLE, 1878
Type species *Ammonites angulatus* SCHLOTHEIM, 1820

Schlotheimia taurina (WÄHNER, 1884)
Text-fig. 20a; Pl. VI, figs. 4, 5, 6

1884 *Aegoceras taurinum* n. f. — WÄHNER, p. 172; Pl. 19, fig. 5

M a t e r i a l : Two stone casts and whorl fragment.

D e s c r i p t i o n : Juvenile stage (approx. 2.5 whorls) has a circular-oval whorl cross-section and is smooth. The subadult stage has a rounded oblong whorl cross-section, the height only slightly exceeding the width, and so the whorl cross-section has a robust appearance (text-fig. 20a). The first ribs appear at a diameter of some 6 mm. They are radiate to slightly prorsiradiate, distinct. Intercalar distances are twice as wide as the ribs. On the transition between the ribs and venter, they bend toward the aperture and, without getting thinner, they end near the median line. They meet ribs from the opposite side at a blunt angle.

5 mm
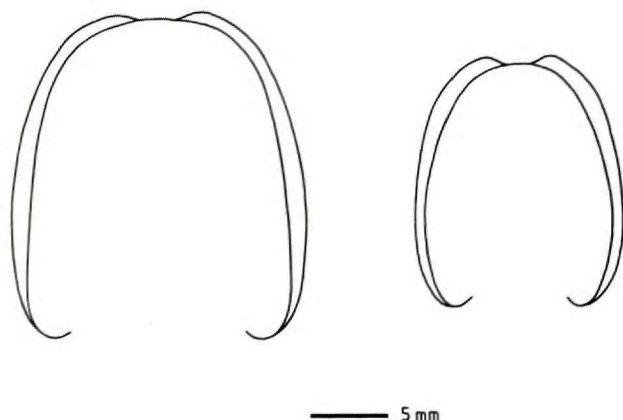
Fig. 20a *Schlotheimia taurina* ; 20b *Schlotheimia* aff. *taurina*

R e m a r k s : Subadult stages of the species *Sch. taurina* and *Sch. exoptycha* (WÄHNER, 1884) seen laterally can only hardly be distinguished from each other. They only differ in their venters. Unlike the species *Sch. taurina*, ribs of the species *Sch. exoptycha* meet each other on the venter at a sharp angle.

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : The species is known from the Northern Calcareous Alps (Kammerkaralpe) where it most probably is of the Upper Hettangian age. It also occurs at the locality Sokol Valley in liasicus zone.

Schlotheimia aff. *taurina* (WÄHNER, 1884)
Text-fig. 20b; Pl. VI, figs. 8, 9

M a t e r i a l : Two incomplete stone casts.

R e m a r k s : In addition to *Sch. taurina*, the locality Sokol Valley also contains specimens which undoubtedly are related to this species, but differ from it mainly in their laterally concave whorl cross-section (text-fig. 20b) and sparser ribbing.

family *Arietitidae* HYATT, 1874
subfamily *Alsatitinae* HYATT, 1874

genus *Alsatites* HAUG, 1894
Type species *Ammonites liasicus* d'ORBIGNY, 1844.

Alsatites liasicus (d'ORB.) sensu WÄHNER, 1887
Text-figs. 21 — 26; Pl. I, figs. 3, 4, 7; Pl. VII, figs. 1, 3, 4, 5; Pl. VIII, fig. 7

1887 *Arietites liasicus* ORB. — WAHNER, p. 293; Pl. 20, fig. 1
1924 *Alsatites quedlinburgensis* n. sp. — LANGE, p. 197
1941 *Proarietites (Alsatites) quedlinburgensisi* LANGE — LANGE, p. 161; Pl. 19, figs. 10 — 13, text-fig. 135

M a t e r i a l : Ten more or less complete, fairly well preserved stone casts.

Dimensions:	D	Wh	Ww	o
GÚDŠ/ 1490	16.3	4.5	5.7	9.0
GÚDŠ/1491	24.5	4.6	7.4	14.0
GÚDŠ/1492	32.0	6.4	8.6	18.3
GÚDŠ/1493	35.0	9.3	10.5	21.8
GÚDŠ/1494	40.2	9.0	10.7	24.5
GÚDŠ/1495	41.8	10.6	12.0	24.0
GÚDŠ/1496	42.5	10.0	-	30.6
GÚDŠ/1497	43.2	10.0	11.8	25.8
GÚDŠ/1498	49.5	10.0	12.0	31.0
GÚDŠ/1511	223.0	47.0	40.6	137.0

D e s c r i p t i o n : The shell is medium-sized, evolute, polygyrate. The juvenile stage is smooth, occupies roughly 2.5 whorls and has a concave cross-section. The 3rd and 4th whorls are oval in cross-section (text-fig. 21). From the 5th whorl, the cross-section is subcircular (text-fig. 21). Venter of the subadult stage consists of a wide, slightly angular arch (text-fig. 22) which gradually passes into convex sides. Adult whorls have a blunt keel (text-fig. 23).

Ornamentation: The first 2.5 whorls are smooth. The first ribs appear abruptly between the 2nd and 3rd whorl. The ribs are radial, thick and wider than intercalar distances. This type of ribbing persists until a diameter of 11 mm. From this diameter onwards, the intercostal distances increase and always exceed the width of the ribs. The ribs are most distinct in the middle of the whorl height. Towards the venter they become thinner and continue onto the other side as single or double, forming chevrons. From a diameter of 25 mm the ribs become prorsiradiate — simple. Passing over the venter they become thinner or vanish completely. As shown in a graph (text-fig. 24) the number of ribs abruptly increases until a diameter of 15 — 17 mm reaching 20 to 25 ribs per whorl. Then the number of ribs becomes rather constant and, at diameters 17 to 40 mm, varies from 20 to 30 ribs per whorl.

The suture line has a psilocerathoid character. The first lateral lobe is only slightly cut and bifid. U_2 is also shallow reaching only a half of the height L.

R e m a r k s : It results from the relevant literature that the definition of the species *A. liasicus* (d'ORB.) varies greatly from one author to another (cf. DONOVAN, 1952 or ELMI et MOUTERDE, 1965). The whorl cross-section of the specimens from the Sokol Valley well coresponds to *A. liasicus* (d'ORB.). However, they differ from the lectotype of that species (cf. DEAN et al., 1961; Pl. 63, fig. 3) in much sparser ribbing on the whorls. Nevertheless, the number and shape of ribs as well as whorl cross-section of our specimens are virtually equal to those of *A. liasicus* sensu WÄHNER, 1887. However, the species *liasicus* sensu WÄHNER differs from the

28
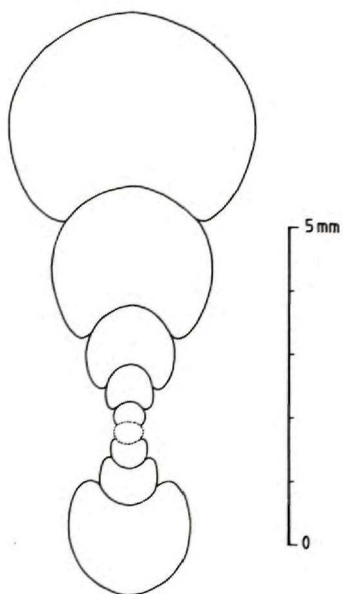
Fig. 21
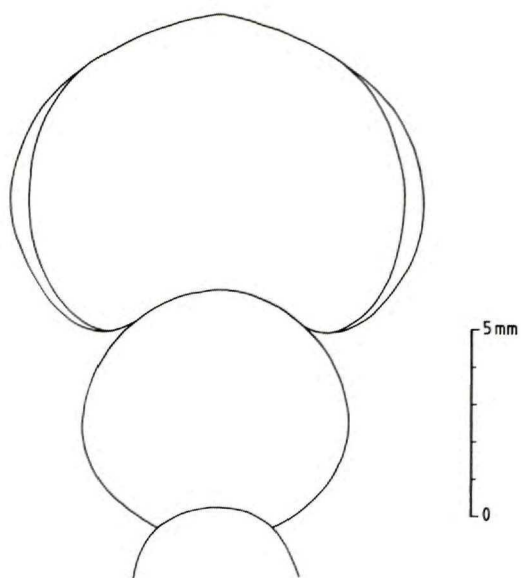
Fig. 22

E   L   U$_2$
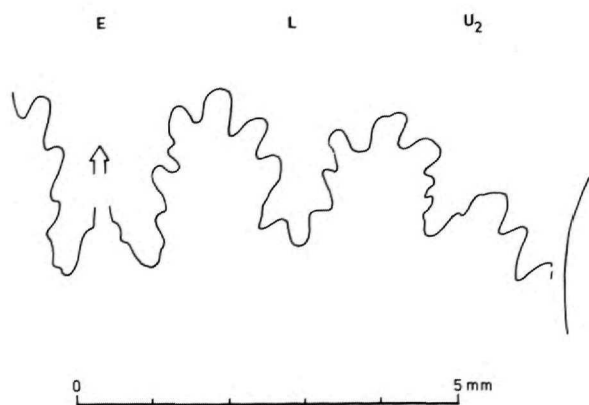
Fig. 25
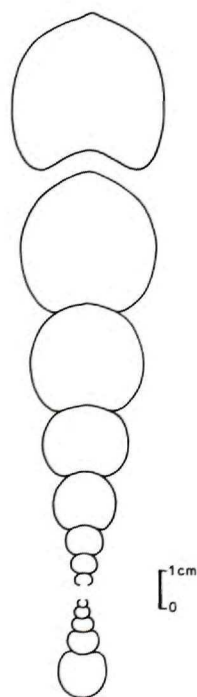
Fig. 23

Figs. 21—23, 25 *Alsatites liasicus*

type *liasicus* in sparser ribbing. Owing to the smaller number of ribs as well as their shape, our specimens are very similar to the species *Alsatites quedlinburgensis* LANGE, 1924. LANGE's illustration (1941; Pl. 19, figs. 10 — 13), however, shows only subadult stages.

Geographic distribution and stratigraphic range: The species is known from the Northern Calcareous Alps. Sokol Valley is its first occurrence in the West Carpathians. It occurs in the Middle Lias, liasicus zone.

- ■ A. laqueolus (Schloth.) – Holotyp
- ▲ A. quedlinburgensis Lange – Holotyp
- • A. liasicus (d' Orbigny) – dolina Sokol
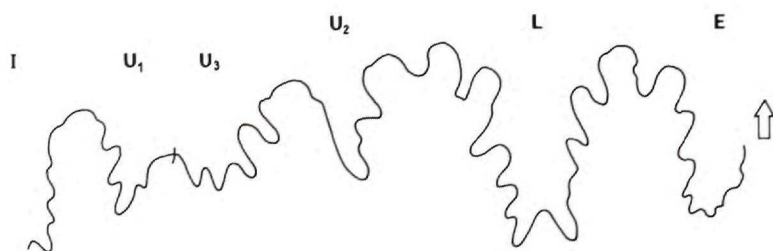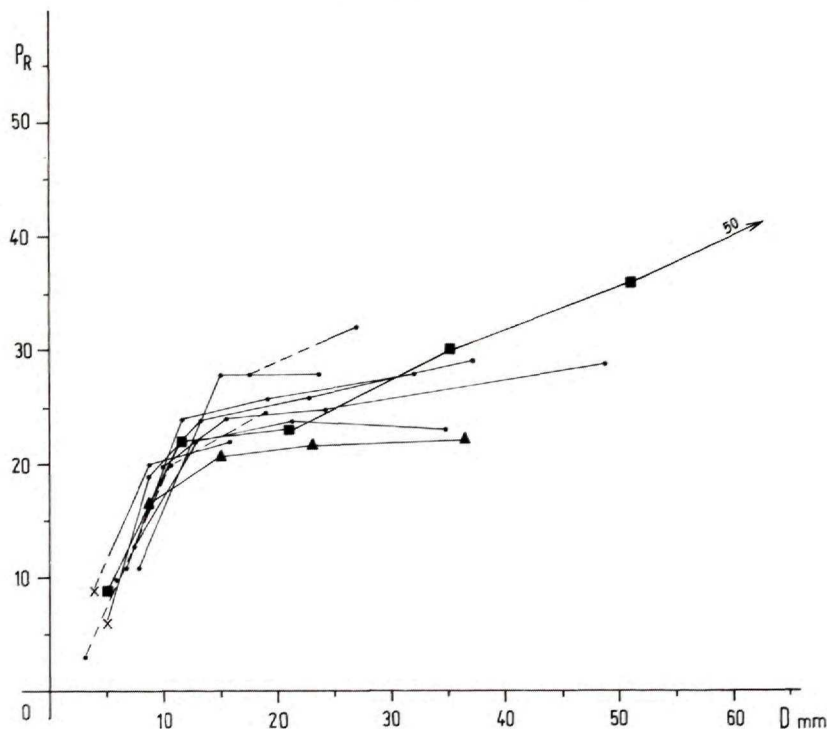
Figs. 24, 26 *Alsatites liasicus*

Alsatites sublaqueus (WÄHNER, 1886)
Text-fig. 27; Pl. VII, fig. 2; Pl. VIII, fig. 1

1886 *Aegoceras sublaqueus* n. f. — WÄHNER, p. 142; Pl. 15, fig. 1; Pl. 16, fig. 10; Pl. 30, fig. 4
1952 *Storthoceras (Laqueoceras) sublaqueus* (WÄHNER) — LANGE, p. 143, text-fig. 69; Pl. 17, fig. 10

M a t e r i a l : An incomplete, highly corroded core of an adult specimen.

D i m e n s i o n s :	D	Wh	Ww	o
GÚDŠ/1535	~157.0	27.0	22.5	103.5

D e s c r i p t i o n : Medium-sized, extremely polygyrate target-like shell. The subadult stages have an oval-concave whorl cross-section. Later, the whorl cross-section becomes laterally concave-elliptic, the venter being composed of a short arch. Such a whorl cross-section persists until the adult stage (text-fig. 27a). The whorl surface is covered with dense, flat, slightly prorsiradiate ribs passing over the venter onto the other side in the form of rounded chevrons (text-fig. 27b).The suture line (text-fig. 27c) is characterized by spatulate - terminated folioles and highly positioned divided by a high secondary saddle.
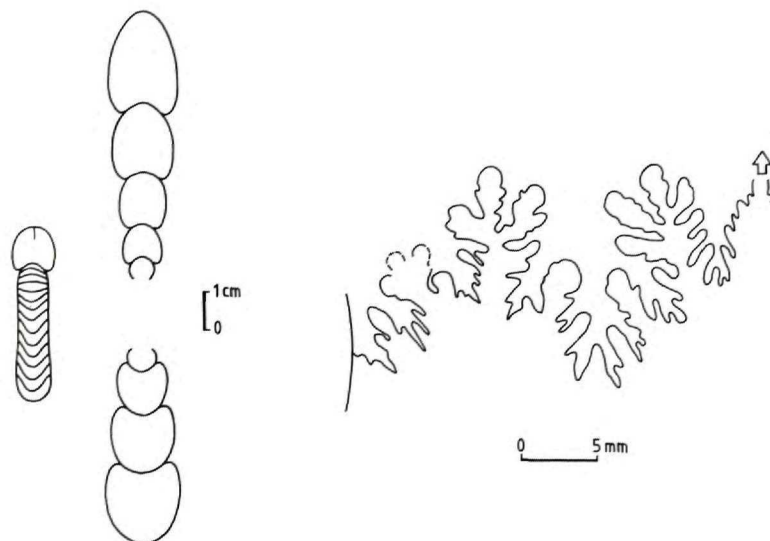
Fig. 27 *Alsatites sublaqueus*

R e m a r k s : The specimen from Sokol Valley corresponds very well to WÄHNER's original. Owing to its concave cross-section, but mainly characteristic course of ribs, our form can easily be distinguished from the other species of the genus *Alsatites*. Our species differs from the genus *Palacaroceras* in the absence of keel.

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : The species is so far known from the Northern Calcareous Alps and West Carpathians. In both these areas it occurs in the Middle Hettangian, liasicus zone.

?*Gyrophioceras* SPATH, 1924
Type species *Arietites praespiratissimum* (WÄHNER, 1886)

?*Gyrophioceras* ex gr. *praespiratissimum* (WÄHNER, 1886)
Text-figs. 28, 29; Pl. VIII, figs. 5, 6

M a t e r i a l : An incomplete stone cast

D i m e n s i o n s :	D	Wh	Ww	O
GÚDŠ/317	59.0	9.2	12.0	44.3

D e s c r i p t i o n : This small evolute-coiled form is characterized by a circular, later oval to slightly depressed whorl section. The venter is slightly roof-like with an indistinct blunt keel and a manifestation of accompanying bands (text-fig. 28).

On the whorl sides are distinct, initially radiate, then rursiradiate ribs. The ribs are most distinct on the sides. On the transition to the venter they quickly weaken and disappear before reaching the blunt keel. The suture line (text-fig. 29) is generally simple, with obliquely oriented lobes U_2 and U_3.

R e m a r k s : The validity of the genus *Gyrophioceras* is rather problematic and therefore the assignation of our specimen into the sphere of forms *G. praespiratissimum* (WÄHN.) is arbitrary. Owing to its type of ribbing and a blunt keel, our specimen resembles the type species but is not identical.

G e o g r a p h i c d i s t r i b u t i o n a n d s t r a t i g r a p h i c r a n g e : The species is known from the Northern Calcareous Alps and West Carpathians where it was identified in a small valley N of Čierna Lehota. Like in the Alps, its stratigraphic position in the West
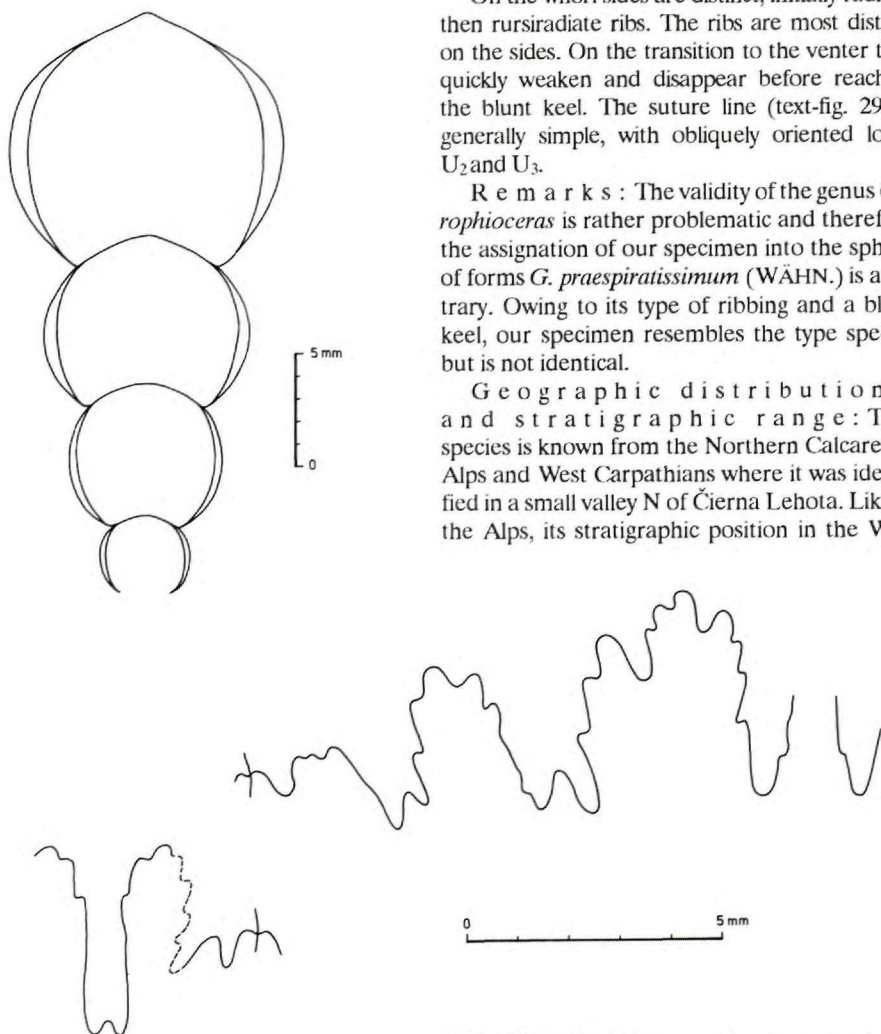
Figs. 28, 29 *Gyrophioceras* aff. *praespiratissimum*

Carpathians is unclear. For the time being we assign it into the uppermost Hettangian — Lower Sinemurian because of its joint occurrence with *Angulaticeras*.

Incertae sedis

Tayloricites QUEX, 1987
Type species *Tayloricites crebricinctus* (WÄHNER, 1886)

Tayloricites waehneri (RAKÚS, 1975)
Text-fig. 30; Pl. VIII, figs. 3, 4

1975 *Ectocentrites waehneri* n. sp. — RAKÚS, p. 10, text-fig. 4; Pl. 104, fig. 1

M a t e r i a l : An incomplete core with a partly preserved calcified shell.

Dimensions:	D	Wh	Ww	o
SNMZ 6321	30.5	9.8	7.4	15.0

D e s c r i p t i o n : A small planispiral evolute form characterized by an articulate juvenile stage of circular section of the whorls. In contrast, whorls of the subadult and adult stages are oval in section (text-fig. 30).

The articulate stage is replaced by marked ribbing. The ribs are simple, prorsiradiate. They extend across the venter uninterrupted forming a convex arch (text-fig. 30a). No ventro-lateral

Fig. 30 *Tayloricites waehneri*

projections were noted. At a diameter of 10 mm, R/2 amounts to 16. The two final ribs before the aperture on the living chamb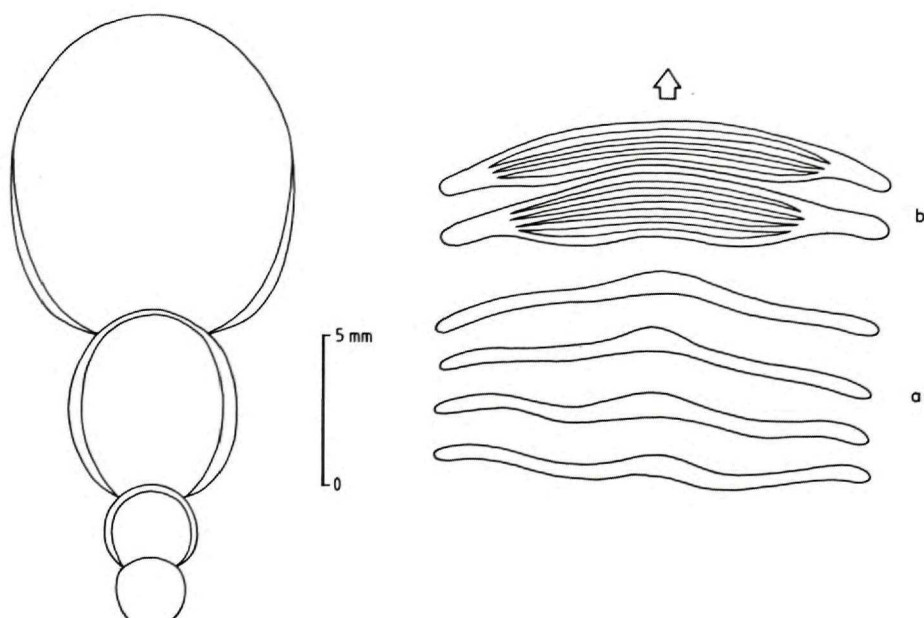er are swollen in the periumbilical part. This swelling is followed by fasciculation into 3 — 4 secondary ribs (text-fig. 30a). The peristome is simple.

R e m a r k s : Because of its typical articulate stage, we first assigned this species into the genus *Ectocentrites*. A study by GUEX (1987, p. 466) has shown that our species is closely related to the species *T. crebricinctus* (WÄHNER, 1886) and therefore we assigned it to a different genus, *Tayloricites* GUEX, 1987. It is worth mentioning, however, that the taxonomic position of this new genus has not yet been cleared up.

G e o g r a p h i c   d i s t r i b u t i o n   a n d   s t r a t i g r a p h i c   r a n g e : The species is fairly rare. It has so far been noted at only two localities in the Alps and West Carpathians (Hluchá dolina Valley in the Stážovské vrchy Mts.). In the Alps, the species is accompanied by *Arietites* (WÄHNER, 1897; p. 168), indicating the Lower Sinemurian. Its stratigraphic position in the West Carpathians in not known reliably. As the species is accompanied by a bivalvian assemblage of Hettangian age, we assign it to the uppermost Hettangian.

Biostratigraphic division of Hettangian stage in the West Carpathians and its correlation with adjacent territories

In the classical area of northwestern Europe the Hettangian stage is divided into three standard zones: planorbis, liasicus and angulata. In the Tethyan province, which also includes the Alpine—Carpathian region, this division can only hardly be applied (ARKELL, 1946 and DEAN et al., 1961).

The first attempt to overcome the problems of direct correlation was made by WÄHNER (1886) who proposed the following zonal division: calliphyllum, megastoma-proaries and marmorea. These three zones were defined as equivalents of the standard zones. However, later researches sometimes showed that the classical and WÄHNER's zones are not coeval. On our opinion, the correlation problems arise from these facts:

a — Hettangian succession are largely condensed,

b — absence of detailed horizonted sections,

c — different ammonite assemblage (bioprovinces).

In the early 1980s, much progress was made in the correlation between the Tethyan zones and standard zones thanks to GUEX's (1980) and BLOOS's (1988) studies. Having studied sections in New York Canyon (Nevada), the former author defined succession of Alpine ammonite faunas that can sufficiently reliably be correlated with the standard scale as follows:

— assemblage of smooth and ribbed psiloceruses corresponds to psilonotus zone,

— assemblage *Kammerkarites, Alsatites, Saxoceras, Gonioptychoceras* and first *Schlotheimia* corresponds to liasicus zone,

— assemblage *Schlotheimia, Sulciferites, Angulaticeras* corresponds to "angulata" zone.

It is noteworthy that the validity of angulata zone is very problematic because the type species angulata is based on juvenile stage (LANGE, 1951; Pl. 1, fig. 2); (species inquirenda) and furthermore we cannot rule out that it is subadult *Saxoceras*!

In the West Carpathian region, the Hettangian stage has been paleontologically proved in only two nappes: Krížna (Zliechov facies) and Choč (Biely Váh facies). Our studies as well as those performed by SÝKORA (1987) have revealed that an uninterruped succession of strata between the Rhaetian and Hettangian is very rare and as a result the Lower Hettangian is also scarce. The Lower Hettangian, planorbis zone has been reliably proved only at Babky (Krížna Nappe, West Tatra Mts., l.c.p.), mouth of Sokol Valley into Zázrivá Valley (l.c.p.), Hybe—Ružiakov úvoz (RAKÚS, 1992) and Rakytov (Veľká Fatra Mts., cf. ŠTÚR, 1860).

P l a n o r b i s zone is represented by this specific assemblage:

Pleuroacanthites ex gr. *biformis* (SOW.) — Hybe—Ružiakov úvoz
Psiloceras psilonotum (QU.) — Babky, Rakytov
Caloceras cf. *torus* (d'ORB.) — mouth of Sokol Valley.

The Middle Hettangian is one of the best documented stratigraphic units and is known from several localities in the Malá Fatra and Strážovské vrchy Mts.

L i a s i c u s zone comprises these species:

Gonioptychoceras viskupi (RAKÚS) — Kozinec
Alsatites liasicus (d'ORB.) sensu WÄHN. — Sokol
A. sublaqueus (WÄHN.) — Sokol
Kammerkarites extracostatum (WÄHN.) — Sokol
K. sokolensis n. sp. — Sokol
K. megastoma (WÄHN.) — Sokol
K. frigga (WÄhN.) — Sokol
K. cf. *curviornatus* (WÄHN.). — Kozinec
Saxoceras langei n. sp. — Sokol
Schlotheimia taurina (WÄHN.) — Sokol
S. aff. *taurina* (WÄHN.) — Sokol.

The presence of the species *Schlotheimia* from the group extranodosa/taurina in the Middle Hettangian — liasicus zone is worth mentioning. This fact was first noted by WÄHNER (1886) and recently by GUEX (1987).

The uppermost Hettangian "angulata" zone in the West Carpathians is the least documented. Moreover, accurate stratigraphic position of some species is unclear as these species might also occur in the Lower Sinemurian. "Angulata" zone includes the following species:

Schlotheimia cf. *oxygonia* LANGE — Osobitá (ANDRUSOVOVÁ — ANDRUSOV, 1968)
Schlotheimia sp. — Borišov
?Gyrophioceras aff. *praespiratissimum* (WÄHN.) — Čierna Lehota
Tayloricites waehneri (RAKÚS) — Čierna Lehota
Sulciferites martinischmidti (LANGE) — Čierna Lehota
Sulciferites charmassei (d'ORB.) — Čierna Lehota.

From a paleobiogeographic point of view, the West Carpathian Hettangian assemblage displays the highest generic and specific affinity with the Alpine assemblage described by WÄHNER (1882 — 1898).

Aside from typical Tethyan elements (*Pleuroacanthites*), the scarce Lower Hettangian ammonite assemblage shows certain, but not too convincing, relationships with the European-praeboreal bioprovince (*Ps. psilonotum*).

In contrast, the Middle and Upper Hettangian assemblages have a clear Tethyan character. A multitude of species, such as *Kammerkarites extracostatus, K. megastoma, K. frigga*, etc., occur both in the West Carpathians and Alpine regions thus undoubtedly indicating a direct communication between them. Nevertheless, there is an astonishing fact: the absence of *Phylloceratids* in the West Carpathian assemblage! This problem has not yet been reliably explained (? bathymetric control).

Some independence and "distance" from the Alpine radiation centre is suggested by the existence of new endemic species *Kammerkarites sokolensis, Gonioptychoceras viskupi* in the West Carpathian region.

The Hettangian assemblage in the Rumanian Carpathians (PATRULIUS and POPA, 1971) is generically comparable with ours but specifically is different. Furthermore, its specific assemblages are much les variegated.

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MILOŠ RAKÚS

Biostratigrafické členenie hetanžského stupňa v Západných Karpatoch a jeho korelácia s priľahlými oblasťami

Resumé

V klasickej oblasti sz. Európy je hetanžský stupeň delený na tri štandardné zóny: planorbis, liasicus a angulata. V tetýdnej provincii, do ktorej spadá alpsko—karpatská oblasť, je toto členenie použiteľné len s ťažkosťami (ARKELL, 1946 a DEAN et al., 1961).

Prvý, kto sa pokúsil v minulosti preklenúť ťažkosti priamej korelácie, bol WÄHNER (1886), ktorý navrhol takéto zonálne členenie: calliphyllum, magastoma—proaries a marmorea. Tieto tri zóny mali byť ekvivalentné štandardným zónam. Ako však ukázali neskoršie výskumy (napr. BLIND, 1963), nie vždy sa podarilo potvrdiť súvekosť WÄHNEROVEJ zonácie klasickými zónami.

Korelačné problémy podľa nášho názoru vyplývajú z týchto skutočností:

a — hetanžské sukcesie sú vo väčšine kondenzované

b — chýbanie detailných horizontovaných profilov

c — rozdielne amonitové asociácie (bioprovincie)

Počiatkom 80. rokov nastáva v problematike korelácie tetýdnych zón so štandardnými zónami k výraznému pokroku vďaka štúdiám GUEXA (1980) a BLOOSA (1988). Prvý z autorov na základe štúdia v New York Canyon (Nevada) stanovil sukcesie alpínskych amonitových faun, ktoré sú s dostatočnou vierohodnosťou takto korelovateľné so štandardnou škálou:

— spoločenstvo hladkých a rebrovaných psilocerasov zodpovedá zóne psilonotus

— spoločenstvo *Kammerkarites, Alsatites, Saxoceras, Gonioptychoceras* a prvé *Schlotheimia* zodpovedá zóne Liasicus

— spoločenstvo *Schlotheimia, Sulciferites, Angulaticers* zodpovedá zóne "Angulata".

Treba poznamenať, že validita zóny Angulata je značne problematická vzhľadom na fakt, že typ druhu Angulata je založený na juvenilnom štádiu (LANGE, 1951; Pl. 1, fig. 2); (species inquirenda) a naviac nie je vylúčené, že je to subadultný *Saxoceras!*

V západokarpatskej oblasti sa paleontologicky datovaný hetanžský stupeň vyskytuje len v dvoch príkrovoch: krížňanskom (zliechovský vývoj) a chočskom (biolovážsky vývoj). Ako to vyplýva ďalej z našich štúdií a štúdií SÝKORU (1987), len výnimočne poznáme neprerušený vrstevný sled medzi rétom a hetanžom, v dôsledku čoho je prítomnosť spodného hetanžu vzácna. Spoľahlivo preukázaný je spodný hetanž, zóna Planorbis len z lokality Babky (krížňanský príkrov, Západné Tatry); l.c.p., vyústenie doliny Sokol do Zázrivskej doliny; l.c.p., Hybe-Ružiakov úvoz (RAKÚS, 1992) a z lokality Rakytov (Veľká Fatra, cf. ŠTÚR, 1860).

Zóna P l a n o r b i s je reprezentovaná touto asociáciou druhov:

Pleuroacanthites ex gr. *biformis* (SOW.) — Hybe—Ružiakov úvoz
Psiloceras psilonotum (QU.) — Babky, Rakytov
Caloceras cf. *torus* (d'ORB.) — vyústenie doliny Sokol.

Stredný hetanž patrí k najlepšie dokumentovaným a je známy z viacerých lokalít Humenského pohoria, Malej Fatry a Strážovských vrchov.

Zónu L i a s i c u s reprezentujú tieto druhy:

Gonioptychoceras viskupy (RAKÚS) — Kozinec
Alsatites liasicus (d'ORB.) sensu WÄHN. — Sokol
A. sublaqueus (WÄHN.) — Sokol
Kammerkarites extracostatum (WÄHN.) — Sokol
K. sokolensis n. sp. — Sokol
K. megastoma (WÄHN.) — Sokol
K. frigga (WÄHN.) — Sokol
K. cf. *curviornatus* (WÄHN.). — Kozinec
Saxoceras langei n. sp. — Sokol
Schlotheimia taurina (WÄHN.) — Sokol
S. aff. *taurina* (WÄHN.) — Sokol.

Za povšimnutie stojí zistenie prítomnosti druhov *Schlotheimia* zo skupiny *extranodosa/taurina* v strednom hetanži — Liasicus zóne. Tento fakt už nakoniec signalizoval WÄHNER (1886) a v nedávnej dobe GUEX (1987).

Najvyšší hetanž — zóna "Angulata" je v Západných Karpatoch doposiaľ najslabšie doložený. Najviac presná stratigrafická pozícia niektorých druhov je neistá a tieto druhy by sa mohli vyskytovať aj v spornom sinemúre.

Do zóny "A n g u l a t a" zaraďujeme tieto druhy:

Schlotheimia cf. *oxygonia* LANGE — Osobitá (ANDRUSOVOVÁ — ANDRUSOV, 1968)
Schlotheimia sp. — Borišov
?Gyrophioceras aff. *praespiratissimum* (WÄHN.) — Čierna Lehota
Tayloricites waehneri (RAKÚS) — Čierna Lehota
Sulciferites martinischmidti (LANGE) — Čierna Lehota
Sulciferites charmassei (d'ORB.) — Čierna Lehota.

Z paleobiogeografického hľadiska má západokarpatské hetanžské spoločenstvo najväčšiu aj druhovú afinitu s alpským spoločenstvom opísaným WÄHNEROM (1882 — 1898).

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Málo početné amonitové spoločenstvo spodného hetanžu okrem typických tetýdnych prvkov *(Pleuro-acantithes)* vykazuje isté, hoci nie celkom presvedčivé vzťahy k európskej — praeboreálnej bioprovincii *(Ps. psilotonum).*

Naproti tomu spoločenstvo stredného a vrchného hetanžu má vyložene tetýdny charakter. Mnohé druhy, napr. *Kammerkarites extracostatus, K. megastoma, K. frigga* atď. sú spoločné s alpskou oblasťou, takže nemôžu byť pochyby o priamej komunikácii medzi nimi. Predsa tu však je jeden zarážajúci fakt: neprítomnosť zástupcov *Phylloceratid* v západokarpatskom spoločenstve! Túto skutočnosť doposiaľ nevieme uspokojívo vysvetliť (?batymetrická kontrola).

Odozvou na predsa len istú samostatnosť a "vzdialenosť" od alpského radiačného centra západokarpatského priestoru je existencia lokálnych — endemitských nových druhov: *Kammerkarites sokolensis, Goniop-tychoceras viskupi.*

Hetanžské spoločenstvo rumunských Karpát (PATRULIUS a POPA, 1971) je v rodovej zostave porovnateľné s naším, ale druhove je rozdielne. Okrem iného tu pristupuje aj oveľa chudobnejšia druhová asociácia.

Explanation of Plates I — VIII

Plate I

Figs. 1, 2 *Kammerkarites extracostatus* (WÄHNER, 1884), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; slightly magn.

Figs. 3, 4 *Alsatites liasicus* (d'ORB.) sensu WÄHNER, 1887, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 1 x magn.

Figs. 5, 6 *Gonioptychoceras viskupi* (RAKÚS, 1957), locality Kozinec (Strážovské vrchy Mts.)

Fig. 7 *Asatites liasicus* (d'ORB.) sensu WÄHNER, 1887, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; slightly magn.

Fig. 8 *Kammerkarites sokolensis* n. sp., syntype, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 0.5 x magn.

Fig. 9 *Kammerkarites frigga* (WÄHNER, 1884), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; slightly magn..

Fig. 10 *Caloceras* cf. *torus* (d'ORB.), locality: mouth of the Sokol Valley to the Zázrivá Valley, Middle Hettangian, zone planorbis; 0.5 x magn.

Plate II

Fig. 1 *Kammerkarites sokolensis* n. sp., holotype, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; actual size

Fig. 2 *Kammerkarites frigga* (WÄHNER, 1884), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 1 x magn.

Figs. 3, 4 *Kammerkarites frigga* (WÄHN.), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 0.5 x magn.

Fig. 5 *Kammerkarites sokolensis* n. sp., paratype, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 0.5 x magn.

Plate III

Fig. 1 *Kammerkarites* aff. *sokolensis* n. sp., locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; actual size

Figs. 2—5 *Kammerkarites frigga* (WÄHNER, 1884), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 0.5 x magn.

Plate IV

Fig. 1 *Kammerkarites megastoma* (GUEMBEL, 1861), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; actual size

Figs. 2, 4 *Kammerkarites* cf. *curviornatum* (WÄHNER, 1884), locality Kozinec (Strážovské vrchy Mts.), Middle Hettangian, zone liasicus; 0.5 x magn.

Fig. 3 *Schlotheimia* sp., locality Borišov (Veľká Fatra Mts.), Late Hettangian; 0.5 x magn.

Plate V

Fig. 1 *Saxoceras langei* n. sp. holotype, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; actual size

Figs. 2, 3 *Saxoceras langei* n. sp., syntype, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 1 x magn.

Fig. 4 *Saxoceras langei* n. sp., paratype, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 0.5 x magn.

Plate VI

Figs. 1—3 *Saxoceras langei*, n. sp., syntype, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 1 x magn.

Figs. 4, 5 *Schlotheimia taurina* (WÄHNER, 1884), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; actual size

Fig. 6 *Schlotheimia taurina* (WÄHNER, 1884), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 0.5 x magn.

Fig. 7 *Pleuroacanthites* ex. gr. *bifornis* (SOWERBY, 1831), locality Hybe-Ružiakov úvoz (eastern part of the Liptov Basin), Early Hettangian, zone planorbis; slightly magn.

Figs. 8, 9 *Schlotheimia* aff. *taurina* (WÄHNER, 1884), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; actual size

Plate VII

Fig. 1 *Alsatites liasicus* (d'ORB.) sensu WÄHNER, 1887, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; actual size

Fig. 2 *Alsatites sublaqueus* (WÄHNER, 1886), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; slightly magn.

Figs. 3—5 *Alsatites liasicus* (d'ORB.) sensu WÄHNER, 1887, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 0.5 x magn.; Fig. 5 — actual size

Plate VIII

Fig. 1 *Alsatites sublaqueus* (WÄHNER, 1886), locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; slightly magn.

Fig. 2 *Psiloceras psilonotum* (QUENSTEDT, 1843), locality Babky (West Tatra Mts.), Early Hettangian, zone planorbis; 0.5 x magn.

Figs. 3, 4 *Tayloricites waehneri* (RAKÚS, 1975), holotype, locality Čierna Lehota (Strážovské vrchy Mts.), Uppermost Hettangian —Early Sinemurian; 0.5 x magn; Fig. 4 — 2 x magn.

Figs. 5, 6 *?Gyrophioceras* ex gr. *praespiratissimum* (WÄHNER, 1886), locality Čierna Lehota (Strážovské vrchy Mts.), Uppermost Hettangian —Early Sinemurian; actual size

Fig. 7 *Alsatites liasicus* (d'ORB.) sensu WAHNER, 1887, locality Sokol Valley (Malá Fatra Mts.), Middle Hettangian, zone liasicus; 0.5 x magn.

ZDENĚK VAŠÍČEK — MILOŠ RAKÚS

Upper Albian ammonites from locality Považský Chlmec near Žilina (Klape unit, Klippen Belt, Slovakia)

2 text-figs., 3 pls. (IX—XI), Slovak summary

A b s t r a c t . The submitted article deals systematically with Albian ammonite fauna found in the Klape unit at Považský Chlmec near Žilina. A total of 210 ammonite specimens were collected, on the basis of which 11 taxons have so far been identified. The assemblage contains fairly abundant heteromorphic forms (*Ancyloceratina*). The species *Dipoloceras cristatum* and *Hysteroceras orbignyi* identified at the locality make it possible to assign the assemblage in the lower part of the Upper Albian—*Mortoniceras (M.) inflatum* zone.

Key words. Slovakia, Western Carpathians, Upper Albian ammonites, systematic, zones.

Introduction

During his field works, primarily geological mapping and sedimentological studies 1976—78 (MARSCHALKO—KYSELA, 1979, 1980), Dr. J. KYSELA of the Dionýz Štúr Institute of Geology in Bratislava collected fairly abundant cephalopod fauna from several localities in the Klape unit of the Klippen Belt (in the area between Považská Bystrica and Žilina). The collected macrofauna was partly identified by Dr. KYSELA (1975) himself, but because of his premature death he failed to study it completely and publish the results.

KYSELA's macrofauna finds mostly lack accurate locations, the enclosed labels usually contain only a general designation of the locality. His richest finds came from two nearby localities designated as Považský Chlmec and Strážov. Ammonites from these two localities were preliminary classified and studied by I. KUŽELOVÁ as part of her student and scientific activity.

KUŽELOVÁ's (1988) studies suggest that the ammonites from these localities are of Upper Albian age. Their assemblages, however, indicate that the finds could not have been collected from a single faunistic layer, but from at least two to three layers assigned to different Upper Albian ammonite zones.

The locality Považský Chlmec is more easily accessible and therefore one of the authors collected further specimens from the local outcrops in 1989 and 1990. The studies confirmed that the ammonite assemblage in the Považský Chlmec area vary from the outcrop to another. KYSELA's ammonite collection and our finds were consequently systematically studied and the results are put forward in this article.

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Geological setting and locality description

The investigated locality is situated near the town of Žilina in the Klippen Belt which is bordered by the Bystrica unit of the Magura Flysch Belt in the north and by the Manín unit or Súľov Conglomerates of the Central Carpathians Paleogene in the south (see Fig. 1 in MARSCHALKO —KYSELA, 1980 and geological map HAŠKO—POLÁK, 1980).

The studied faunistic locality is situated in the Klape unit of the Klippen Belt. The locality consists of several outcrops distributed along the foot of a wooded ridge near the confluence of the Kysuca and Váh Rivers (see text-fig. 1). The Klape unit here was overthrusted towards the northwest onto variegated marls of uppermost Cretaceous age which are part of the Klippen Belt Kysuca Group. The Klape unit has a strongly scaly structure and is tectonically dissected. In the Lower Albian—Middle Cenomanian, a thick flysch formation was laid down in the Klape unit. Its conglomerate + sandstone/pelite ratio is variable. Pelites locally prevail over the clastic sediments. The pelites sometimes contain clay ironstone concretions to thin layers which, in earlier literature, are referred to as siderite or pelosiderite marls (e.g. ANDRUSOV, 1959). According to MARS-CHALKO and KYSELA (1980), Albian to Cenomanian flysch deposits of the Klape unit attain thicknesses of 400 to 700 m.
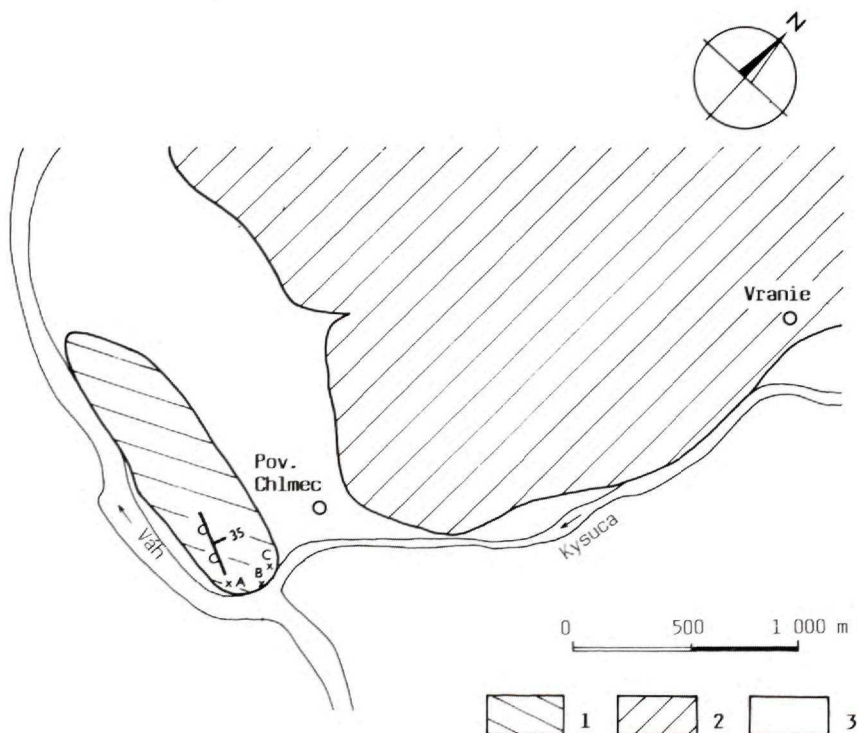
Fig. 1 Location of fossiliferous layers near Považský Chlmec:
A—abandoned quarry near boat dock; B—outcrop near the confluence of the Váh and Kysuca Rivers, now covered by talus; C—outcrop on a slope above the Kysuca. 1—Klape unit (Albian), 2—Kysuca unit (Turonian - Maastrichtian), 3—Quaternary deposits

The above-mentioned flysch deposits in the Považský Chlmec area are the best exposed in an abandoned quarry near a boat dock on the right bank of the Váh River some 100 m down stream from its confluence with the Kysuca River, south of the village of Považský Chlmec (locality A in text-fig. 1). The overturned beds (28/35) are exposed over a thickness of about 9 m. The pelitic sequence is exposed particularly well (see text-fig. 2). The gray silty and sandy marlstones are thinly bedded. They break down to form plates and ovoids. Gray to brownish-gray sandtones (tarnish brown) are commonly fine-grained, sometimes laminated. The thickest layers are as much as 2 m thick. The sandstone beds are boudinaged. The sandstones lower bedding planes are with sole marks as is typical for flysch deposits. The macrofauna in two main layers marked in the lithological column in text-fig. 2. The lower fossiliferous layer (A_1) some 5 cm thick (because of the overturned bed sequence, this bed is exposed higher than A_2) contains fairly rare macrofauna

Fig. 2 Lithological section of the quarry near boat dock: 1—pelites, 2—sandstones, 3—faunistic layers

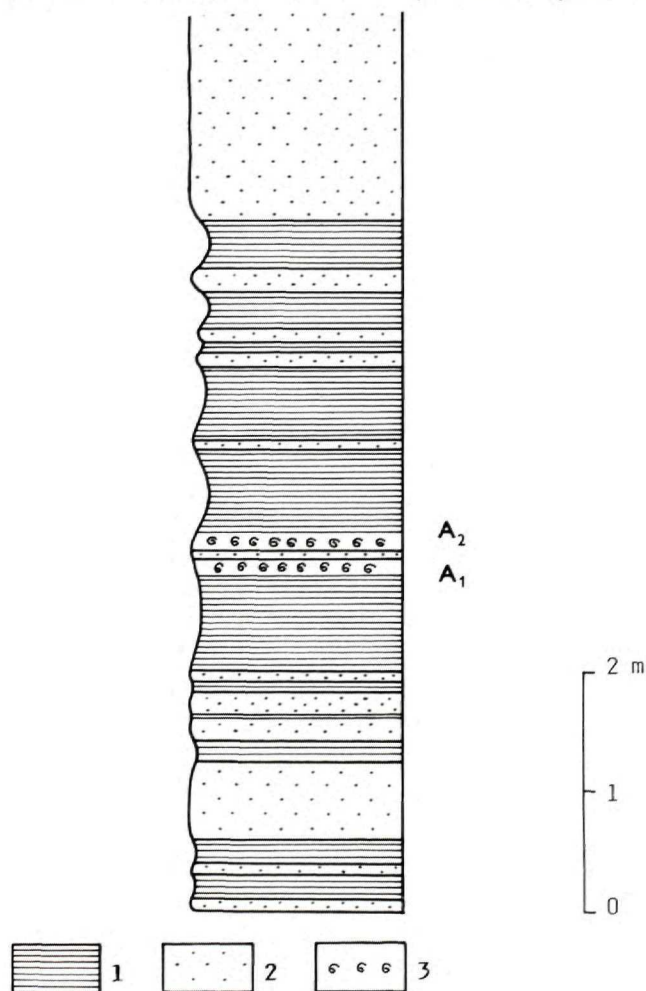dominated by lytocerate and heteromorphic ammonites irregularly distributed within the layer. The upper fossiliferous layer (A_2) containing macrofauna is nearly 50 cm thick. Its base contains only small fragments of ammonite shells. Upwards, the number of shells and their size increase. They are dominated by ammonites of the genus *Puzosia*. Biggest but broken shells occur immediately below a thin sand layer with bioglyphs in a layer some 2 cm in thickness. The sand layer is overlain by a few cm of pelites without macrofauna which in turn are overlain by a sandstone bed of the overlying sedimentation rhythm. Aside from ammonites, the layer also contains abundant pelecypods (also *Birostrina sulcata* PARKINSON) and exceptional sea urchins, gastropods and belemnites. No representatives of the genus *Hysteroceras* were noted among the ammonites.

According to KYSELA, another faunistic layer (B) is allegedly situated directly at the confluence of the Kysuca and Váh Rivers. As the riverbank in this spot is currently covered by debris, no revision collection can be made.

The third faunistic layer (C) is a natural outcrop on a slope immediately above a trail along the Kysuca River, 50 m upstream from its confluence with the Váh River. The deposits exposed here have the character of pelosiderite or spherosiderite marls. The ammonite fauna includes abundant specimens of the genera *Hysteroceras* and *Puzosia*. In addition to ammonites, pelecypod shells, similar to those collected on the outcrop A, are also present. Strike and dip 14/32 in overturned position.

Systematic Part

The ammonite species are described in a manner commmnoly applied in our professional paleontologic literature. The section - Measurements - contains the following abbreviations: D - shell diameter, H - whorl height, U - umbilicus width. Parentheses following the measured values H and U contain H/D and U/D ratios which characterize the shell coiling.

The systematic assignation is based on the fundamental system put forward by ARKELL et al. (1957) and later updated.

Superfamily *Phyllocerataceae* ZITTEL, 1884
Family *Phylloceratidae* ZITTEL, 1884

Genus *Phylloceras* SUESS, 1865
Subgenus *Hypophylloceras* SALFELD, 1924

Phylloceras (Hypophylloceras) ex gr. *velledae* (MIICHELIN, 1834)
Pl. IX, fig. 1

1965 *Phylloceras (Hypophylloceras) velledae velledae* MICHELIN; WIEDMANN, p. 209; Pl. 11, fig. 1; Pl. 13, fig. 4, Pl. 21, fig. 4, text-fig. 49 (cum syn.)
1985 *Phylloceras (Hypophylloceras)* cf. *velledae velledae* (MICHELIN); THIEULOY in SOUQUET et al., p. 227; Pl. 6, figs. 1, 2
1990 *Ph. (H.) velledae velledae* (MICHELIN); MARCINOWSKI and WIEDMAN, p. 23; Pl. 1, fig. 1, text-fig. 13 (cum syn.)

M a t e r i a l : Only deformed internal moulds, sometimes with poorly visible sutures.

D e s c r i p t i o n : Medium-sized involute shells. The whorls are high and, as a result of the deformation, secondarily slightly arched. Whorl flanks pass almost gradually into the point umbilicus. They also pass onto the outer side which was probably rounded prior to the deformation.

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The ornamentation consits of dense, thin ribs of equal type, slightly S-like curved. The ribs are only visible on the outer half of the whorl.

M e a s u r e m e n t s : The maximum diameter of the shell Pch-72 (corresponding to the axis of elongation) is over 40 mm. Further measurements are meaningless because of the strong deformation.

R e m a r k s : Due to the imperfect preservation of the material, particularly unknown whorl diameter, our specimens cannot be reliably assigned into the species *Ph. (H.) velledae*, although they have equal ornamenation.

D i s t r i b u t i o n : According to MARCINOWSKI and WIEDMANN (1990), reliably identified representatives of the species *Ph. (H.) velledae* are known from the Upper Aptian to Upper Albian of southeastern Europe, southern Atlantic Ocean, south Africa and Mozambique as well as from the Cenomanian of Madagascar. They were also noted in glauconitic limestones of the Vysoké Tatry series in the Vysoké Tatry Mts. (condensed Albian) on the Polish territory.

Superfamily *Tetragonitaceae* HYATT, 1990
Family *Gaudryceratidae* SPATH, 1927
Subfamily *Guadryceratinae* SPATH, 1927

Genus *Kossmatella* JACOB, 1907
Subgenus *Kossmatella* JACOB, 1907

Kossmatella (K.) cf. muhlenbecki (FALLOT, 1885)
Pl. IX, fig. 7

1968 *K. (Kossmatella) muhlenbecki* (E. FALLOT); WIEDMANN and DIENI, p. 39; Pl. 2, fig. 9; Pl. 3, figs. 9, 11, 12, text-fig. 8
?1985 *Kossmatella (K.) cf. muhlenbecki* (FALLOT, 1885); THIULOY in SOUQUET et al., p. 221; Pl. 5, fig. 6

M a t e r i a l : A fragment of a fairly large half-whorl with remains of the shell itself.

D e s c r i p t i o n : The preserved half-whorl has a low flat flanks which are fairly distinctly separated from the not very wide, arched outer side. They are also distinctly separated from the low umbilical wall which passes obliquelly onto the umbilicus.

The ornamentation on the outer part of the whorl consists of elevated stretches separated from each other by roughly equally wide, fairly deep furrows. The arched stretches form umbilical tubercles on the division between the flanks and umbilical wall. The furrows are S-shaped. They start immediately on the line of coiling. The furrows are deep in the lower part of the whorl, but toward the outer side they become narrower and shallower. On the outer side they are considerably narrower but continuous and convexely curved relative to the aperture. The whole shell is covered by fine, dense growth lines that have the same pattern as the furrows.

M e a s u r e m e n t s : The specimen is deformed and incomplete but still the maximum shell diameter in the axis of elongation can be estimated at 46 mm. With this diameter there are 10 umbilical tubercles and the same number of furrows on the half-whorl.

R e m a r k s : The shell is incomplete and deformed and therefore it cannot be reliably identified. Some doubts arise even as to systematic assignation on the generic level because dense growth lines and numerous furrows on the whorl occur not only by the genus *Kossmatella* but also by some species of the genus *Anagaudryceras* SHIMIZU, 1934 (see e.g. *A. buddha* FORBES in KENNEDY and KLINGER,1979; Pls. 8—11). However, juvenile whorls of the genus *Anagaudryceras* are devoid of furrows and therefore this genus can be ruled out. Deep furrows passing onto the outer side and flat flanks resemble the species *K. muhlenbecki.*

O c c u r r e n c e : The only specimen comes from the quarry at Považský Chlmec.

D i s t r i b u t i.o n : WIEDMANN and DIENI (1968), note that the species concerned occurs exclusively in the Upper Albian of France, Spain and Sardinia.

Kossmatella (K.) schindewolfi WIEDMANN et DIENI, 1968
Pl. IX, fig. 2

1968 *Kossmatella schindewolfi* nov. sp.; WIEDMANN and DIENI, p. 41; Pl. 3, fig. 13; Pl. 4, figs. 1, 3, ?2, text-figs. 11, 12

1990 *K. (Kossmatella) schindewolfi* WIEDMANN et DIENI; MARCINOWSKI and WIEDMANN, p. 30; Pl. 2, fig. 8 (cum syn.)

M a t e r i a l : Two flattened fairly small specimens with remain of the shell, partly deformed by lateral pressures.

D e s c r i p t i o n : An evolute medium-sized shell with numerous whorls. The whorls are low, the inner ones have rather rounded flanks gradually passing onto the outer and inner side alike. Probably as a result of deformation, the final whorl has flat flanks which are separated from the narrow and flat outer side by a barely visible edge.

The ornamentation of the earliest preserved part (D=5.5 mm) consist of dense and thin ribs of two different types - slightly thicker main ribs extending as far as the umbilicus between which there are 1 to 2 shorter and thinner ribs. Such a thinner rib may sometimes be diverted from the main one near the umbilicus thereby forming indistinct tubercles. By the shell diameter of some 11 mm, the ribs have a uniform character. At the same time there appear furrows on the whorl which create a characteristic ornamentation of wider arched stretches separated by furrows. The arched stretches with conspicuous wart-like forms begin on the final whorl above the line of coiling. The furrows become shallower and thinner towards the outer side and the stretches above the tubercles become wider.

M e a s u r e m e n t s : The maximum diameter of the deformed shell is some 32 mm. By D=23.0 mm (measured between two main axes of deformation) H=6.2 mm (0.27), U=10.8 mm (0.47). By the maximum shell diameter, the whole whorl is dotted with 16 tubercles and 15 furrows.

R e m a r k s : In spite of the deformation, numerous low evolutely coiled whorls, wart-like tubercles on the umbilicus, flat outer side, the number of tubercles per whorl and some other signs correspond to the diagnosis of the species concerned.

O c c u r r e n c e : The species in question occurs in the quarry at Považský Chlmec in layer A_1 marked in the section (along with the zone species *Dipoloceras cristatum*).

D i s t r i b u t i o n : The species' s authors note that *K. schindewolfi* occurs in the condensed Albian of southern Germany, France, Sardinia and Polish tract of the Vysoké Tatry Mts.

Superfamily *Ancyclocerataceae* GILL, 1871
Family *Hamitidae* HYATT, 1900

Genus *Hamites* PARKINSON, 1811
Subgenus *Hamites* PARKINSON, 1811

Hamites (Hamites) compressus J. SOWERBY, 1814
Pl. IX. figs. 3—5; Pl. XI. fig. 3

1941 *Hamites compressus* SOW.; SPATH, p. 617; Pl. 68, figs. 10—13, text-fig. 222 (cum syn.)
1968 *Hamites (Hamites) compressus* J. SOW.; WIEDMANN and DIENI, p. 57, text-figs. 30, 31 (cum syn.)

M a t e r i a l : Abundant fragments of postjuvenile whorls of various sizes and 3 juvenile shells (one of them from the locality Strážov), all of which are flattened in a bedding plane.

D e s c r i p t i o n : The shape of juvenile shells, fragments of adult whorls and SPATH's (1941) data suggest that the shells were crioceraticone-coiled throughout their ontogeny. The most juvenile part, roughly corresponding to the first whorl, is smooth, but further on there begins ornamentation composed of simple, fairly dense and sharp ribs which are slightly convexly bent towards the aperture. The ribs on the outer and inner side alike bear no signs of thinning.

M e a s u r e m e n t s : The biggest juvenile shell is some 24 mm in diameter. By $D = 16$ mm there are 31 ribs on a half-whorl.

R e m a r k s : The whorls of our specimens are deformed and therefore their section is unknown. The type and density of ribs best correspond to the species *H. compressus*. The species *Hamites rotundus* SOWERBY, 1814 also has a similar ornamentation except for its rursiradiate ribs. Owing to their outer morphology, the juvenile shells resemble the Barremian genus *Karsteniceras* ROYO y GOMEZ,1945.

D i s t r i b u t i o n : According to WIEDMANN and DIENI (1968), *Hamites compressus* occurs in the Middle and deeper Upper Albian of England, Sardinia and Angola.

Subgenus *Metahamites* SPATH,1930

Hamites (Metahamites) passendorferi MARCINOWSKI et WIEDMANN, 1990
Pl. IX, figs. 6, 7

1930 *Hamites* sp.; PASSENDORFER, p. 662; Pl. 4, fig. 78
1990 *Hamites (Metahamites) passendorferi* sp. n.; MARCINOWSKI and WIEDMANN, p. 37; Pl. 3, figs. 2a, b, 3a, b, text-fig. 21

M a t e r i a l : Two fragments of the spiral part of the shell and four most complete specimens from the locality Strážov. All of them are strongly flattened in a bedding plane.

D e s c r i p t i o n : Shells whose initial parts are crioceraticone coiled (i.e. in a loose planispiral) and pass into a hook. The earliest preserved whorls are covered with a dense and thin uniform ribbing that is suddenly apparently grouped into ridges separated from each other by shallow depressions (starting by the diameter of 12 mm). On the ridges, 2 to 3 ribs join together to form faint marginal tubercle. In the beggining of the uncoiled part, the spaces between the individual ridges are wide, filled with as many as 6 simple ribs. On the straight shoulder, the number of ribs between ridge-like elevations with tubercles decreases to 3—4 and the ridges are even more pronounced by shallow grooves. The ribs become thicker near the hook. Some ribs fork on the bent. The total size of the shells is about 70—80 mm. The deformed spiral part is slightly more than 20 mm across.

R e m a r k s : Slovak specimens provided us with data on the so far unknown juvenile stage of the species *Metahamites passendorferi*. Related species *M. sablieri* (d' ORBIGNY, 1842) differs from *M. passendorferi* in the absence of marginal tubercles whereas *M. dalpiazi* WIEDMANN et DIENI, 1968 differs in the absence of ribbing. Overall morphology of a complete specimen (a specimen completely reconstructed by GEBHARD,1979; Pl. 2, fig. 6) as well as the type of its ornamentation and suture formation (GEBHARD,1979; text-fig. 30) make it possible to assign the species *Anisoceras arrogans*(GIEBEL) to the subgenus *Metahamites* rather than to the genus *Anisoceras*. Complete shells of the latter species are as much as 250 mm large.

D i s t r i b u t i o n : *Metahamites passendorferi* was previously known from the condensed Upper Albian of the Tatricum in the Polish tract of the Vysoké Tatry Mts. Our specimens were collected from the Upper Albian (*Dipoloceras cristatum* zone), the most complete specimens coming from the locality Strážov.

Genus *Hemiptychoceras* SPATH, 1925

Hemiptychoceras ex gr. *gaultinum* (PICTET, 1848)
Pl. XI, fig. 2

1985 *Hemiptychoceras gaultinum* (PICTET); THIEULOY in SOUQUET, p. 232; Pl. 7, figs. 1, 2
1990 *Hemiptychoceras gaultinum* (PICTET); MARCINOWSKI and WIEDMANN, p. 40, text-fig. 22

M a t e r i a l : An incomplete external mould of a juvenile specimen strongly flattened in a bedding plane.

D e s c r i p t i o n : A small ptychoceracone shell composed of two mutually contacting juvenile shoulders connected by a knee-like bent. The smaller shoulder is covered by a fine and dense, rather oblique ribbing. The ornamentation thickens on the bent where the ribs become thicker but more sparsely distributed. On the termination, the ribs are straight and roughly perpendicular at the contact between the two shoulders. At the end of the bent, the ribs are oblique but directed to the opposite side than on the juvenile shoulder. The juvenile but mainly the second manifestation of shoulder constriction which are accompanied by stronger ribs.

M e a s u r e m e n t s : The maximum preserved lenght is a mere 23 mm. The shoulder height in the bent is some 4 mm.

R e m a r k s : Unlike most published illustrations which show the second and third shoulder of the shell, the Slovak specimen only has the incomplete first (juvenile) and the second shoulder. The ribbing and presence of constrictions might *Hemiptychoceras gaultinum* or *H. subgaultinum* BREISTROFFER. As accurate specific assignation cannot be made because the shell is deformed and juvenile.

O c c u r r e n c e : The only specimen was collected in the quarry near Považský Chlmec.

D i s t r i b u t i o n : According to THIEULOY in SOUQUET et al. (1985), the species *Hemiptychoceras gaultinum* occurs in the Upper Albian of France and Sardinia whereas according to MARCINOWSKI and WIEDMANN (1990) also in Rumania. The specimes *H. subgaultinum* is known from the Tatric on the Polish territory.

Superfamily *Hoplitaceae* DOUVILLÉ, 1890
Family *Desmoceratidae* ZITTEL, 1895
Subfamily *Puzosiinae* SPATH, 1922

Genus *Puzosia* BAYLE, 1878
Subgenus *Puzosia* BAYLE, 1878

Puzosia (Puzosia) ex gr. *mayoriana* (d' ORBIGNY, 1841)
Pl. X, fig. 4; Pl. XI, fig. 4

1984 *Puzosia (Puzosia)* ex gr. *mayoriana* (d' ORBIGNY); WRIGHT and KENNEDY, p. 55; Pl. 3, figs. 1, 2, 4, 6, 9—12; Pl. 4, figs. 1, 2, 5—7, text-figs. 1A, B, 2C, H, M, 3N—R, 4A—E (cum. syn.)

M a t e r i a l : Abundant shells of different sizes subjected to various degrees of deforma-
tion. They were preserved either as internal moulds with incomplete sutures or as external moulds
sometimes with remains of the shells themselves.

D e s c r i p t i o n : Small, medium to large semiinvolute shells. When undeformed, the
shells have a steep and fairly low umbilical wall which passes into whorl flanks through a nar-
row rounded zone. The whorl flanks are fairly low, flatly rouded in the lower part while in the
upper part they gradually pass into a widely rounded outer side. The whorls are lined with
conspicuous sigmoidal constrictions which are short relatively thin ribs. The constrictions are
rather narrow and deep. In the centre of the whorl flanks, the constrictions are strongly
convexly arched towards the aperture and further on they form a lobe arched to the opposite
side. On the outer side they are convexly bent towards the aperture. On the front side, par-
ticularly on specimens with the preserved shell, the constrictions are accompanied by a rela-
tively thick rib. Between the constrictions there are dense, fairly thin ribs which occur exclu-
sively on the outer side. They continue uninerrupted onto the outer side. Here the ribs are
convexly bent towards the aperture. Between two constrictions there are some 18—22 ribs
but the largest specimens have only 16 of them. The above-described ribbing only occurs on
shells whose diameter exceeds 10 mm.

M e a s u r e m e n t s : On the specimen Pch-25 (flattened, only slightly deformed by lateral
pressure), at D=43.0 mm, H=15.0 (0.35) and U=14.8 (0.34). By the maximum diameter of 45
mm there are 5 constrictions per whorl.

R e m a r k s : Considerably arched constrictions on the whorl flanks, their overall sigmoidal
shape and depth as well as the fairly open umbilicus allow us to assign the Slovak specimens into
the sphere of the species *Puzosia mayoriana* (d'ORBIGNY). It is impossible to assign them accur-
ately because of the shell deformations and problems related to detailed identification of other
possible species from the sphere *P. mayoriana* (see WRIGHT—KENNEDY,1984).

D i s t r i b u t i o n : According to WRIGHT and KENNEDY (1984), *Puzosia mayoriana*
ranges in age at least from the Upper Albian to Upper Cenomanian. It is very widely distributed
throughout the world.

Superfamily *Acanthocerataceae* HYATT, 1900
Family *Brancoceratidae* SPATH, 1933
Subfamily *Brancoceratinae*, 1993

Genus *Hysteroceras* HYATT, 1900

Hysteroceras orbignyi (SPATH, 1922)
Pl. XI, fig. 6

1932 *Hysteroceras orbignyi* (SPATH); p. 483; Pl 49, fig. 4; Pl. 50, fig. 2; Pl. 52, figs. 3, 4, 8; Pl. 56, fig. 15, text-figs.
    161a—d, 166a, 167a—3 (cum syn.)
1990 *Hysteroceras orbignyi* (SPATH); MARCINOWSKI and WIEDMANN, p. 82, text-fig. 25c, d (cum syn.)

M a t e r i a l : A number of deformed, mostly small external and internal moulds.

D e s c r i p t i o n : Small to medium-sized evolute shells with a low umbilical wall, low whorls
and a weak keel on the circumference. The earliest part of the shell is smooth (until the diameter of
about 5 mm). Then start fairly wide ribs, either simple or forking near the umbilicus. The adult whorls
have conspicuous, S-shaped ribs. Interrib distances are much wider than the ribs themselves. The points
of forking are further pronounced by an umbilical tubercle. The rib forking on many specimens is only
very limited therefore simple ribs prevail. In this case, ribs starting with the umbilical tubercle regularly

alternate with inserted ribs that are slightly shorter and have no umbilical tubercle. On the circumference, all the ribs are bent aperturally and near the blunt keel they disappear.

M e a s u r e m e n t s : The maximum diameter of the shell Pch-116 is 42 mm. By D=35.5 (measured between the main axes of deformation), H=11.0 (0.31), U=16.7 (0.47). By the maximum diameter, the whole whorl has 38 ribs.

R e m a r k s : The species concerned has a somewhat variable ornamentation as regards rib density (normally 36—40 ribs per whorl) and the number of forked and simple ribs. As far as similar species are concerned, *Hysteroceras varicosum* (SOWERBY,1824) lacks conspicuous apertural bending of the ribs while *Hysteroceras carinatum* SPATH, 1934 has a perfect keel on the shell circumference.

O c c u r r e n c e : The species *H. orbignyi* is abundant in the faunistic horizon C.

D i s t r i b u t i o n : The species is the Upper Albian subzone species. It is known not only from Europe but also from Africa, Madagascar and Venezuela. MARCINOWSKI and WIEDMANN (1990) noted the species at the locality Wielka Rowień (Tatric) in the Vysoké Tatry Mts.

Hysteroceras carinatum SPATH,1922
Pl. XI, fig. 5

1982 *Hysteroceras carinatum* SPATH; RENZ, p. 49; Pl. 11, figs. 9a, b, 10a, b, 11a, b, text-fig. 34 (cum syn.)
1990 *Hysteroceras carinatum* SPATH; MARCINOWSKI and WIEDMANN, p. 83; Pl. 8, fig. 3

M a t e r i a l : An external mould flattened into a bedding plane.

D e s c r i p t i o n : An evolute shell with low whorls. They have flat flanks which become rounded only on the transition to the outer side. The outer side seems to be fairly narrow, with an indistinct keel on the circumference. The umbilical wall is low, probably rather steep on undeformed specimens.

The earliest whorls were smooth. The first ribs appear since the diameter of 7 mm. On the main ribs there gradually appear faint umbilical tubercles and thus the ribs acquire sigmoidal character. The main ribs mostly alternate with accessory ones.

M e a s u r e m e n t s : By D=18.0 mm, the specimen Pch-16 has H=7.0 (0.39) and U=7.2 (0.40). The final whorl has D=17.5 mm and 34 ribs on the circumference.

R e m a r k s : The specimen is characterized by a conspicuous keel (still more pronounced owing to shell deformation), which is a typical feature of this species.

D i s t r i b u t i o n : According to RENZ (1982), the species *Hysteroceras carinatum* occurs in *Hysteroceras orbignyi* subzone (Upper Albian). It is distributed in Europe, Africa, Venezuela and the Polish tract of the Vysoké Tatry Mts.

Subfamily *Mojsisovicsiinae* HYATT, 1903

Genus *Dipoloceras* HYATT, 1900
Subgenus *Dipoloceras* HYATT, 1900

Dipoloceras (Dipoloceras) cristatum (DELUC in BRONGNIART, 1822)
Pl. X, figs. 1—3

1931 *Dipoloceras cristatum* (DELUC MS); SPATH, p. 365; Pl. 32, figs. 1—3; Pl. 33, fig. 4; Pl. 35, figs. 6—8, 10—15, text-figs. 119—121, 122a, e—h (cum syn.)
1990 *D. (Dipoloceras) cristatum* (DELUC in BRONGNIART); MARCINOWSKI and WIEDMANN, p. 83; Pl. 8, fig. 4 (cum syn.)
1990 *Dipoloceras cristatum* (BRONGNIART); IVANOV and STOJKOVA, Pl. 3, fig. 4a, b

M a t e r i a l : Four strongly deformed external moulds with indistinct, poorly preserved inner whorls.

D e s c r i p t i o n : Large evolute shells with low whorls. The umbilical wall probably was not distinguished, the whorl flanks are likely to have been rounded prior to the deformation. The outer side is fairly narrow, with a keel.

The ornamentation consists of various ribs of different lenght. Subparallel rib couples positioned close to one another are conspicuous. They start on the umbilicus and are mutually separated by a deep inerrib furrow. In the middle of the whorl height or still lower these rib couples join together to form a single clearly collar-like rib. In the space between the collar-like ribs are two inserted ribs. The ribs have different lengths and thicknesses. In the adult part of the shell there are three inserted ribs. Two of them extend as far as the umbilicus and the third one ends in the middle of the whorl height. The shell (particularly in its juvenile part) was covered by a dense but inconspicuous spiral (i.e. transverse) ribbing. All the ribs initially were more or less straight, but on the outer half of the whorl they were strongly bent towards the aperture.

M e a s u r e m e n t s : The maximum diameter of the deformed specimen Pch-28 is some 85 mm. At this diameter there are 4 collar-like tubercles on a half-whorl and approximately 19 ribs on the circumference (including the rib couples on the umbilicus).

R e m a r k s : Though strongly deformed, the Slovak specimens still retained their characteristic collar-like ribs and spiral rib tubercles.

O c c u r r e n c e : The species *Dipoloceras cristatum* was found in the quarry Považský Chlmec in the faunistic layer A_1.

D i s t r i b u t i o n : The species concerned is a zone species of the lowermost Upper Albian. It is distributed worldwide. It has also been noted in the Tatric condensed Albian in the Polish tract of the Vysoké Tatry (MARCINOWSKI and WIEDMANN, 1990)

Subfamily *Mortoniceratinae* SPATH, 1925

Genus *Prohysteroceras* SPATH, 1921
Subgenus *Goodhalites* SPATH, 1932

Prohystoceras (Goodhalites) cf. *delabechei* SPATH, 1934
Pl. XI, fig. 1

1934 *Prohysteroceras (Goodhalites) delabechei* sp. nov.; SPATH, p. 456; Pl. 49, fig. 13; Pl. 52, fig. 1; Pl. 53, figs. 1—3; Pl. 54, fig. 9a, b

M a t e r i a l : A poorely preserved external mould. Impressions of juvenile whorls, the final one and a quarter of which is external mould damaged in two places. Flattened into a bedding plane and slightly deformed by lateral presesure. 2/3 of the final whorl are preserved (traceable).

D e s c r i p t i o n : A semievolute shell with a low umbilical wall gradually but swiftly passing into flat flanks of fairly low whorls; and a narrow, slightly rounded unlimited outer side. The keel on the circumference is lined with furrows on both sides. The ornamentation of the juvenile whorls is preserved as a impression (but that of the earliest whorls is missing) forming simple, slightly S-like bent ribs. The existence of inserted ribs cannot be ruled out as well. One such a rib may have been in each interval which starts with umbilical ridge-like tuberculation. In the beginning of such an interval preserved as external mould, the ornamentation is composed of main ribs regularly alternating with shorter inserted ribs. All the ribs widen towards the circumference. Main and inserted ribs alternate one by one on the final whorl. The main ribs start with an elongated umbilical tubercle above the umbilical wall, then gradually widen and are made pronounced by lateral tubercles. Further away, on the outer side, the ribs thicken and give rise to elevated trian-

gular forms. The inserted ribs occupy slightly more thah a half of the whorl height. They also have manifestations of lateral tubercles and, from this moment, they are quite similar to the main ribs. All the ribs on the outer side are alike and bent toward the aperture. They finally end near the keel. Throughout its height, the final whorl has a conspicuous spiral ornamentation.

M e a s u r e m e n t s : Dmax is some 52 mm. By the best preserved diameter (roughly between the axes of deformation) $D^+ = 49.0$ mm, $H^+ = 18.4$ mm (0.375 - 0.38), $U = 18.3$ mm (0.375). At this diameter, half-whorl has 8 main ribs and 15 or 16 marginal ones.

R e m a r k s : The spiral ornamentation, keel and tubercles on the ribs suggest a mortonicerathid. The two rows of tuberculation allow us to rule out the genus *Mortoniceras* MEEK. The very pronounced spiral ornamentation best corresponds to the subgenus *Goodhalites* which usually attains large dimensions. The Slovak specimens lack forked ribs on the umbilical tubercles and have extremely thick ribs on the outer side and therefore we assign them to the species *G. delabechei*.

O c c u r r e n c e : The only specimen comes from the outcrop at the confluence of the Kysuca and Váh Rivers (layer B).

D i s t r i b u t i o n : According to SPATH (1934), *G. delabechei* occurs in *H. varicosum* subzone (Upper Albian), England.

Fauna composition and stratigraphic assessment

The macrofauna finds at Považský Chlmec came from three places located close to one another as is suggested by text-fig. 1. The richest finds were collected in an abandoned quarry. Here, the following ammonite species were indentified:

Phylloceras (Hypophylloceras) ex gr. *velledae* (MICHELIN), *Kossmatella (K.) schindewolfi* WIEDMANN et DIENI, *K. (K.)* cf. *muhlenbecki* (FALLOT), *Hamites (H.) compressus* SOWERBY, *Hamites (Metahamites) passendorferi* MARCINOWSKI et WIEDMANN, *Hemiptychoceras* ex gr. *gaultinum* (PICTET), *Puzosia* ex gr. *mayoriana* (d'ORBIGNY), *Dipoloceras (D.) cristatum* (DELUC.) Aside from the genus *Puzosia*, other desmoceratid are also present here (e.g. representatives of the genus *Beudanticeras*). Nevertheless, as a result of a strong deformations, they can be hardly identified in detail. The accompanying fauna largely comprises pelecypods, mostly inoceramus-related, e.g. zone fossil *Birostrina sulcata* (PARKINSON), with less abundant gastropods, belemnites and sea urchins.

The percentages of the principal macrofaunistic elements the layer A_1 in the quarry are as follows:

Ammonoidea			82.0
	Phylloceratida	10	
	Lytoceratina	13	
	Ancyloceratina	25	
	Ammonitida	34	
Belemnoidea			6.5
Bivalvia			6.5
Gastropoda			2.5
Echinoidea			1.5
plant remnants			1.0
			———
			100.00

[+]D and H measured without the missing keel. If complete shells were preserved, the higher denominator would result in lower H/D but mainly U/D values.

The above percentages based on 210 finds show that cephalopods (including belemnites) account for 89 % of the fossils. The cephalopods comprise fairly abundant heteromorphic shells (*Ancyloceratina*) and order *Ammonitida* dominated by desmocerates, namely the genus *Puzosia* (over 20 %). Pelecypods are also relatively abundant.

The interesting species *Prolysteroceras (Goodhalites)* cf. *delabechi* SPATH was collected only on the outcrop near the confluence of the Kysuca and Váh Rivers.

The third layer is characterized by abundant ammonites *Puzosia* ex gr. *mayoriana* (d'OR-BIGNY) and *Hysteroceras orbignyi* (SPATH). *Hysteroceras carinatum* SPATH occurs only exceptionally. Pelecypods including the genus *Birostrina* are fairly numerous.

The zone division of the Albian is currently (HOEDEMAEKER and BULOT, 1990) based on standard ammonite zones and subzones of the so called European faunistic province put forward by OWEN (1979, 1984) whose subzones in the uppermost Albian zone were subsequently altered. The resulting updated Upper Albian division is as follows:

	Zones	Subzones
Upper Albian	*Stoliczkaia dispar*	S. (S.) dispar
		S. (F.) blancheti
		Callihoplites auritus
		Hysteroceras varicosum,
	Mortoniceras (Mortoniceras) inflatum	*Hysteroceras orbignyi*
		Dipoloceras cristatum
Uppermost Middle Albian	*Euhoplites lautus*	Anahoplites daviesi
		Euhoplites nitidus

The above scheme suggests that deposits exposed in the quarry near Považský Chlmec are of the Upper Albian age. The exceptional occurrence of the subzone species *Dipoloceras cristatum* proves the existence of the subzone of the same name corresponding to the basal Upper Albian. Similarly, the abundant species *Hysteroceras orbignyi* found on the right bank of the Kysuca River attests to the following Upper Albian subzone "orbignyi". As is suggested by *Prohysteroceras (goodhalites) delabechei* occurrence, the third, poor faunistic layer could probably be assigned close to the latter subzone.

Generally, the faunistic layers in the Klape unit near Považský Chlmec correspond to the lower part of the ammonite zone *Mortoniceras (M.) inflatum*, i.e. lower part of the Upper Albian.

Conclusion

The ammonite fauna assigned into two basal subzone of the Upper Albian ammonite zone *Mortoniceras inflatum* clearly has a Mediterranean character. The specific composition resembles that

of Upper Albian ammonites described by PASSENDORFER (1930) as well as MARCINOWSKI and WIEDMANN (1990) from the condensed Albian in the Tatricum of the Polands' s Vysoké Tatry Mts.

The ammonite assemblage from Klape unit flysch sediments in the Klippen Belt suggests that the Mediterranean faunistic province comprises not only the Central Carpathians but also the more northerly Klippen Belt because boreal elements of the so called hoplitid faunistic province are completely absent here.

The incompleteness of the ammonite shells and location of the individual faunistic horizons amidst flysch sediments at Považský Chlmec prove that their macrofauna was redeposited here from the shallower-water environments.

Translated by Ľ. Böhmer

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ZDENĚK VAŠÍČEK — MILOŠ RAKÚS

Vrchnoalbské amonity z lokality Považský Chlmec pri Žiline (Klapská jednotka, bradlové pásmo, Slovensko)

Resumé

Amonitová fauna preukazujúca stratigrafickú príslušnosť k dvom bazálnym subzónam vrchnoalbskej amonitovej zóny *Mortoniceras inflatum* je rýdzo mediteránneho charakteru. Druhové zloženie je do značnej miery blízke vrchnoalbským amonitom z kondenzovaného albu, ktoré popísali PASSENDORFER (1930) a MARCINOWSKI—WIEDMANN (1990) z tatrika poľskej časti Vysokých Tatier.

Amonitové spoločenstvo pochádzajúce z flyšových sedimentov klapskej jednotky v bradlovom pásme preukazuje, že nielen centrálne Karpaty, ale tiež severnejšie ležiace bradlové pásmo patrí k mediteránnej faunistickej provincii, lebo boreálne prvky tzv. hoplitidnej faunistickej provincie tu vôbec nie sú zastúpené.

Neúplnosť amonitových schránok a pozícia jednotlivých faunistických horizontov vo flyšových profiloch v Považskom Chlmci ukazujú, že táto makrofauna sa nenachádza v pôvodnom životnom prostredí, ale bola redeponovaná z plytkovodnejších podmienok.

Explanations of Plates IX—XI

Plate IX
Fig. 1 *Phylloceras (Hypophylloceras)* ex gr. *velledae* (MICHELIN), x1, specimen SNMZ 21.404. Považský Chlmec, quarry near boat dock
Fig. 2 *Kossmatella (K.) schindewolfi* WIEDMANN et DIENI, x1, specimen SNMZ 21.405 Považský Chlmec, quarry near boat dock
Figs. 3—5 *Hamites (H.) compressus* J. SOWERBY; Figs. 3, 4, x1 and Fig. 5, x1.5, specimen SNMZ 21.406 and SNMZ 21.407 (different magnification). Považský Chlmec, quarry near boat dock
Figs. 6, 7 *Hamites (Metahamites) passendorferi* MARCINOWSKI et WIEDMANN, x1, specimen SNMZ 21.408 with imperfectly preserved spiral juvenile part and specimen SNMZ 21.409. Quarry near Strážov

Plate X
Figs. 1—3 *Dipoloceras (D.) cristatum* (DELUC in BRONGNIART), x1, specimens SNMZ 21.410 and SNMZ 21.411
Fig. 2 View of the outer side of the specimen shown on Fig. 1. Považský Chlmec, quarry near boat dock
Fig. 4 *Puzosia (P.)* ex gr. *mayoriana* (d' ORBIGNY), x1, specimen SNMZ 21.412. Považský Chlmec, quarry near boat dock

Plate XI
Fig. 1 *Prohysteroceras (Goodhalites)* cf. *delabechei* SPATH, x1, specimen SNMZ 21.413. Považský Chlmec, outcrop near confluence of the Váh and Kysuca Rivers
Fig. 2 *Hemiptychoceras* ex gr. *gaultinum* (PICTET), x1, specimen SNMZ 21.414. Považský Chlmec, quarry near boat dock
Fig. 3 *Hamites (H.) compressus* J. SOWERBY, x1, specimen SNMZ 21.415. Považský Chlmec, quarry near boat dock

Fig. 4 *Puzosia (P.)* ex gr. *mayoriana* (d' ORBIGNY), x1, specimen SNMZ 21.416, quarry near Strážov
Fig. 5 *Hysteroceras carinatum* (SPATH), x1, specimen SNMZ 21.417. Považský Chlmec, outcrop on a slope above the Kysuca
Fig. 6 *Hysteroceras orbignyi* (SPATH) x1, specimen SNMZ 21.418. Považský Chlmec, outcrop on a slope above the Kysuca.
Fig. 7 *Kossmatella (K.)* cf. *muhlenbecki* (FALLOT), x1, specimen SNMZ 21.405. Považský Chlmec, quarry near boat dock

The shells were bleached by ammonia chlorides and then photographed by K. MEZIHORÁKOVÁ from the Ostrava University. The specimens are deposited at the Dionýz Štúr Institute of Geology and the Slovak National Museum in Bratislava under the above-given registration numbers.

KLEMENT FORDINÁL

Genus Melanopsis (Gastropoda) in Upper Miocene sediments in the Bratislava area

1 fig., 3 pls. (XII—XIV), Slovak summary

A b s t r a c t . The article deals with the occurrence of Upper Miocene taxons of the genus *Melanopsis* in central Bratislava, systematic assignation of the genus *Melanopsis*, way of life of individual species of this genus and their stratigraphic distribution.

Introduction

A few information is available on Upper Miocene (Pannonian and Pontian) molluscs in the West Carpathians.

Holes drilled by the Engineering and Hydrogeological Exploration as well as Dionýz Štúr Institute of Geology in central Bratislava revealed rich molluscan macrofauna. Following its assessment for stratigraphic assignation of intersected sediments and paleoecologic reconstruction of the investigated area during the Upper Miocene and Pliocene (FORDINÁL —TUBA, 1992), we started systematic studies of the individual molluscan genera.

This article deals with systematic treatment of the genus *Melanopsis*, some taxons of which are very important for the zoning of Pannonian shallow-water molluscan assemblages.

General characteristics

The genus *Melanopsis* is an important constituent of Pannonian and Pontian molluscan assemblages. Shells of individual representatives of this genus are extremely variegated. They include both small, only a few millimeters high forms as well as large ones attaining several tens of millimeters in height. Some species (subspecies) have smooth shells, without ornamentation, while others are dotted with spines, tubercles, ribs, keels, etc.

This great diversity resulted in several models dividing the genus *Melanopsis* into subgenera or species groups.

The earliest classification of the genus *Melanopsis* was put forward by HANDMANN (1887) who, on the basis of morphology and ornamentation, distinguished the following subgenera:

1. *Homalia*
2. *Lyrcea*
3. *Martinia*
4. *Canthidomus*
5. *Hyphantria.*

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PAPP (1953) rejected the division into subgenera, and introduced the so-called species groups instead. He distinguished the following species groups:

1. *Melanopsis impressa* KRAUSS
2. *Melanopsis bouei* FÉRUSSAC
3. *Melanopsis fuchsi* HANDMANN
4. *Melanopsis brusinai* LOERENTHEY.

KOROBKOV (1955) resumed the division of the genus *Melanopsis* into subgenera, which was first introduced by HANDMANN (1887), and suggested the following scheme:

1. *Melanopsis* s.s.
2. *Stylospirula* ROVERETO, 1899
3. *Lyrcaea* ADAMS, 1854
4. *Canthidomus* SWAINSON, 1840
5. *Spiridionia* COSSMANN, 1908
6. *Melanosteira* OPPENHEIM, 1891
7. *Fagotia* BOURGUIGNAT, 1884.

A somewhat modified and extended version of KOROBKOV's classification (1955) appeared in Osnovy paleontologii (1960). The genus *Melanopsis* is divided here into subgenera as follows:

1. *Melanopsis* s.s.
2. *Stylospirula* ROVERETO, 1899
3. *Lyrcaea* ADAMS, 1854
4. *Camplylostylus* SANDBERGER, 1875
5. *Canthidomus* SWAINSON, 1840
6. *Spiridionia* COSSMANN, 1908
7. *Zemelanopsis* FINLAY, 1927
8. *Melanosteira* OPPENHEIM, 1891
9. *Laituriella* GABS, 1953.

In Chronostratigraphie und Neostratotypen Miozän M₆, Pannonien (1986), PAPP still aplies his 1953 division of the genus *Melanopsis*.

In this article, the genus *Melanopsis* is divided according to PAPP (1953, 1986).

Way of life

Representatives of the genus *Melanopsis* reportedly live in shallow-water, brackish as well as freshwater environments, but concrete data assigning individual species (subspecies) of the genus *Melanopsis* into a certain habitat (salinity, depth) are scarce.

BARTHA (1971) gives data on some taxons described by us. He noted that the oligohaline (0.5—3.0 ‰) to miohaline (3—5 ‰) forms included *Melenopsis bouei affinis* HANDMANN, *M. bouei sturii* FUCHS and *M. tihanyensis* WENZ, whereas *Melanopsis vindobonensis* FUCHS thrived in mesohaline (5—9 ‰) to pliohaline (9—16 ‰) environments.

KORPÁS—HÓDI (1983) devided Pannonian molluscs into 3 zones and 12 paleoassemblages, on the basis of their occurrences in some environments. Of our taxons, she only assigned *Melanopsis pygmaea* M. HOERNES and *M. bouei sturii* FUCHS.

We may say that *Melanopsis pygmaea* M. HOERNES lived in miohaline to mesohaline brackish environments and *M. bouei* FUCHS, in oligohaline brackish to freshwater (?) environments. Both taxons occurred in molluscan paleoassemblages ranging in depth from 0 to 10 m.

Systematic Part

Family *Thiaridae* LATREILLE, 1825
Subfamily *Melanopsinae* COSSMANN, 1909

Genus *Melanopsis* FÉRUSSAC, 1807
Type species *Melanopsis praerosa* (LINNÉ)

Species group *Melanopsis impressa* KRAUSS

Melanopsis fossilis constricta HANDMANN, 1887
Pl. XIV, fig. 2

1887 *Mel. Martiniana Fér. Var. constricta*—R. HANDMANN: Die fossile Conchylienfauna etc. p. 26; Pl. 5, figs. 1—2

1944 *Melanopsis fossilis* MARTINI—E. JEKELIUS: Sarmat und Pont etc. p. 133; Pl. 52, figs. 1—5, 7—9 (non 6, 10, 11)

1953 *Melanopsis fossilis constricta* HANDMANN—A. PAPP: Die Molluskenfauna des Pannon etc. p. 134; Pl. 11, figs. 1—4

M a t e r i a l : 1 specimen.

D e s c r i p t i o n : A medium-sized shell composed of 5 whorls. The body whorl almost entirely covers the preceding ones. In the upper part it is concave, forming a depression along the whole whorl.

D i m e n s i o n s : Pl. XIV, fig. 2, height 19.5 mm, width 11.6 mm.

O c c u r r e n c e : Bratislava, drillhole Ma-1 (163.5—163.8 m), sandy lithofacies.

G e o g r a p h i c a n d s t r a t i g r a p h i c d i s t r i b u t i o n : It occurs in the Pannonian of Austria, in zones C (Leobersdorf), D (Siegendorf) and E (Vösendorf). It also occurs in Pannonian (zones C—D) sediments of Rumania.

Melanopsis vindobonensis FUCHS, 1870

1870 *Melanopsis Vindobonensis*—TH. FUCHS—F. KARRER: Geologische Studien etc. p. 139, fig. 5

1887 *Mel. Martinia Vindobonensis* FUCHS—R. HANDMANN: Die fossile Conchylienfauna etc. p. 27; Pl. 5, figs. 8—13

1892 *Melanopsis vindobonensis* FUCHS—S. BRUSINA: Fauna fossile terziaria etc. p. 132

1902 *Melanopsis vindobonensis* FUCHS—I. LÖRENTHEY: Die pannonische Fauna etc. p. 222; Pl. 15, fig. 6

1907 *Melanopsis Vindobonensis* FUCHS—O. TROLL: Die pontischen Ablagerungen etc. p. 62

1944 *Melanopsis vindobonensis* FUCHS—E. JEKELIUS: Sarmat und Pont etc. p. 135; Pl. 53, figs. 1—17

1953 *Melanopsis vindobonensis vindobonensis* FUCHS—A. PAPP: Die Molluskenfauna des Pannon etc. p. 137; Pl. 11, figs. 13—16

M a t e r i a l : 4 specimens.

D e s c r i p t i o n : A small, round shell. The body whorl almost completely covers the preceding ones. The shell height roughly equals its width.

O c c u r r e n c e : Bratislava, drillhole Ma-1 (141.0—141.6 m, 141.6—142.0, 147.0—147.2 m), sandy lithofacies.

G e o g r a p h i c a n d s t r a t i g r a p h i c d i s t r i b u t i o n : In Pannonian zones C—E of Austria and zones C—D of Rumania.

Melanopsis contigua HANDMANN, 1887
Pl. XIV, fig. 3

1887 *Mel. Martinia Vindobonensis* FUCHS *Var. contigua* —R. HANDMANN : Die fossile Conchylienfauna etc.
    p. 29; Pl. 6, figs. 11—12
1953 *Melanopsis vindobonensis contigua* HANDMANN—A. PAPP: Die Molluskenfauna des Pannon etc. p. 137;
    Pl. 11, figs. 9—10

M a t e r i a l : 1 specimen
D e s c r i p t i o n : A high shell. More than 3/4 of its height are occupied by the body cham-
ber. Roughly in the middle of the body whorl, the shell widens thus forming an oblique plateau
along the whole whorl. The shell bears clear signs of growth interruptions.
D i m e n s i o n s : Pl. XIV, fig. 3, height 41 mm, width 27 mm.
O c c u r r e n c e : Bratislava, drillhole JRD-206 (68.10—68.45 m), sandy lithofacies.
G e o g r a p h i c   a n d   s t r a t i g r a p h i c   d i s t r i b u t i o n : In Pannonian
zones D (Leobersdorf) and E (Stegersbach) of Austria.

Melanopsis pumila BRUSINA, 1902
Pl. XIII, fig. 2

1902 *Lyrcaea pumila* BRUS.—S. BRUSINA: Iconographia etc. Pl. 5, figs. 37—38
1953 *Melanopsis pumila* BRUSINA—A. PAPP: Die Molluskenfauna des Pannon etc. p. 139; Pl. 9, figs. 28—29

M a t e r i a l : 15 specimens
D e s c r i p t i o n : A small shell composed of 5—6 whorls. The body whorl has a spiralling
keel near the upper suture. The body whorl occupies more than a half of the shell height.
D i m e n s i o n s : Pl. XIII, fig. 2, height 7.0 mm, width 5.0 mm.
O c c u r r e n c e : Bratislava, drillholes JRD-206 (66.6—66.8 m, 68.10—68.45 m, 69.0—
70.0 m), Ma-1 (146.5—146.6 m, 161.5—162.5 m), sandy lithofacies.
G e o g r a p h i c   a n d   s t r a t i g r a p h i c   d i s t r i b u t i o n : The species occurs
in the Pannonian of Yugoslavia (Markushevec) and Pannonian zone D of Austria (Vösendorf).

Species group *Melanopsis bouei* FÉRUSSAC

Melanopsis bouei rarispina LÖERENTHEY, 1902
Pl. XII, fig. 6

1902 *Melanopsis rarispina* nov. sp.—I. LÖRENTHEY: Die pannonische Fauna etc. p. 215; Pl. 17, figs. 18—30,
    33—36
1902 *Melanopsis* SINZOWI nov. sp.—I. LÖRENTHEY: Die pannonische Fauna etc. p. 213; Pl. 17, figs. 31—32
1944 *Melanopsis bouei rarispina* LÖRENTHEY—E. JEKELIUS: Sarmat und Pont etc. p. 129; Pl. 48, figs. 8—13
1953 *Melanopsis bouei rarispina* LÖRENTHEY—A. PAPP: Die Molluskenfauna des Pannon etc. p. 145; Pl. 12,
    figs. 7—8

M a t e r i a l : 8 specimens
D e s c r i p t i o n : A low, wide shell composed of 5—6 whorls. Only the body whorl has an
ornamentation-2 rows of rounded spines. The body whorl occupies nearly 3/4 of the total shell
height. The shell coloration was also preserved. It consists of orange dots and lines.
D i m e n s i o n s : Pl. XII, fig. 6, height 10.6 mm, width 6.6 mm.

O c c u r r e n c e : Bratislava, drillholes JRD-203 (68.10—68.45 m), JRD-205 (48.0—48.5 m), JRD-206 (57.2—57.5 m, 68.10—68.45 m), sandy lithofacies.

G e o g r a p h i c a n d s t r a t i g r a p h i c d i s t r i b u t i o n : It occurs in Pannonian zone C of Austria (Leobersdorf), in the Pannonian of Hungary (Tinnye, Budapest—Köbánya) and Pannonian (zones C—D) of Rumania (Turislav).

Melanopsis bouei affinis HANDMANN, 1882
Pl. XII, fig. 3

1882 *Melanopsis affinis* n.f.—R. HANDMANN: Die fossile Molluskenfauna etc. p. 558
1887 *Mel. Canthidomus affinis* HANDM.—R. HANDMANN: Die fossile Conchylienfauna etc. p. 32; Pl. 7, figs. 9—12
1902 *Melanopsis affinis* HANDMANN—I. LŐRENTHEY: Die pannonische Fauna etc. p. 214; Pl. 17, figs. 1—15
1944 *Melanopsis bouei affinis* HANDMANN—E. JEKELIUS: Sarmat und Pont etc. p. 129; Pl. 48, figs. 14—17
1953 *Melanopsis bouéi affinis* HANDMANN—A. PAPP: Die Molluskenfauna des Pannon etc. p. 146; Pl. 12, figs. 9—11
1955 *Melanopsis bouéi affinis* HANDMANN—F. BARTHA: A Várpalotai pliocén etc. p. 299
1971 *Melanopsis affinis* HANDMANN—J. ŠVAGROVSKÝ: Das Sarmat etc. p. 324; Pl. 55, figs. 8—9
1976 *Melanopsis bouei affinis* HANDMANN—P. ČTYROKÝ—E. KNOBLOCH: Neue paläontologische Untersuchungen etc. p. 110; Pl. 4, figs. 19—20

M a t e r i a l : 34 specimens

D e s c r i p t i o n : The shell is higher than that of *Melanopsis bouei rarispina* LŐERENTHEY, consists of 6 whorls which gradually widen. In the upper part of the body whorl, near the suture there is one row of rounded spines. The body whorl occupies more than 2/3 of the whorl height.

D i m e n s i o n s : Pl. XII, fig. 3, height 12.0 mm, width 8.5 mm.

R e m a r k s : PAPP (1953) noted that ornamentation of *Melanopsis bouei affinis* changes with the character of the surrounding sediment. Coarse-grained sands contains forms with a smaller number of blunt spines (5) while fine-grained sands enclose forms dotted with more numerous, sharp spines (up to 12). Our specimens had 6—7 spines.

O c c u r r e n c e : Bratislava, drillholes JRD-203 (61.6—61.8 m, 63.8—64.0 m, 68.0—69.0 m), JRD-205 (38.0—39.0 m), JRD-206 (57.2—57.5 m, 68.10—68.45 m, 69.0—70.0 m), JRD-209 (70.8—71.0 m), Ma-1 (141.0—141.6 m, 141.6 —142.0 m, 162.5—163.5 m), VO-1 (35.8—36.0 m), VO-4 (35.4 —35.6 m), V-36 (17.3—17.6 m), sandy, exceptionally clayey lithofacies.

G e o g r a p h i c a n d s t r a t i g r a p h i c d i s t r i b u t i o n : This subspecies is known from the Sarmatian of Austria and Moravia, Pannonian of Austria, Hungary and Rumania.

Melanopsis bouei multicostata HANDMANN, 1882

1882 *Melanopsis Bouéi Fér.* var. *multicostata*—R. HANDMANN: Die fossile Molluskenfauna etc. p. 557
1887 *Mel. Canthidomus Bouéi Fér.* var. *multicostata*—R. HANDMANN: Die fossile Conchylienfauna etc. p. 36; Pl. 8, figs. 10—12
1902 *Melanopsis Bouéi Fér.* var. *multicostata* HANDM.—I. LŐRENTHEY: Die pannonische Fauna etc. p. 211
1944 *Melanopsis bouei multicostata* HANDMANN—E. JEKELIUS: Sarmat und Pont etc. p. 75, 130; Pl. 48, figs. 18—22
1953 *Melanopsis bouéi multicostata* HANDMANN—A. PAPP: Die Molluskenfauna des Pannon etc. p. 146; Pl. 12, figs. 12—14
1976 *Melanopsis bouei multicostata* HANDMANN—P. ČTYROKÝ—E. KNOBLOCH: Neue paläontologische Untersuchungen etc., p. 110

M a t e r i a l : 159 specimens

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D e s c r i p t i o n : A shell similar to that of *Melanopsis bouei affinis* but, unlike it, our specimens had two rows of spines.

R e m a r k s : In the Bratislava area *Melanopsis bouei multicostata* has smaller shells in Pontian sediments than in Pannonian ones.

O c c u r r e n c e : Bratislava, drillholes JRD-203 (62.8—63.0 m), JRD-205 (15.4—15.5 m), JRD-206 (22.4—24.0 m), JRD-207 (38.5—38.7 m, 48.9—49.0 m), Ma-1 (141.6—142.0 m, 194.1—194.4 m), VO-1 (35.8—36.0 m), VO-2 (38.3—38.4 m), VO-4 (35.4—35.6 m), TS-29 (22.5—22.7 m), TS-30 (18.9—19.0 m, 19.2—19.4 m, 20.0—20.1 m), V-31 (19.5—19.6 m), V-36 (17.3—17.4 m), sandy and clayey lithofacies.

G e o g r a p h i c a n d s t r a t i g r a p h i c d i s t r i b u t i o n : This subspecies is known from the Pannonian of Austria (Leobersdorf, Kottingbrunn), Moravia (Polešice, Ořechov, Těmice) and Sarmatian (Politioana) as well as Pannonian (Turislav) of Rumania.

Melanopsis bouei sturii FUCHS, 1873
Pl. XII, figs. 4—5

1873 *Melanopsis Sturii* nov. sp.—TH. FUCHS: Beiträge zur Kenntnis fossiler etc. p. 21; Pl. 4, figs. 18—19
1902 *Melanopsis Sturii* FUCHS—I. LÖRENTHEY: Die pannonische Fauna etc. p. 211; Pl. 17, figs. 16—17
1911 *Melanopsis Sturii* FUCHS—I. LÖRENTHEY: Beiträge zur Fauna etc. p. 130
1944 *Melanopsis sturii* FUCHS—E. JEKELIUS: Sarmat und Pont etc. p. 74; Pl. 17, figs. 1—17
1944 *Melanopsis bouéi sturii* FUCHS—A. PAPP: Die Molluskenfauna des Pannon etc. p. 146; Pl. 12, figs. 15—17
1955 *Melanopsis bouéi sturii* (FUCHS)—F. BARTHA: A Várpalotai pliocén etc. p. 298; Pl. 1, figs. 2—3

M a t e r i a l : 152 specimens

D e s c r i p t i o n : A slender, narrow shell composed of 6 whorls. The final three whorls are covered with two rows of spines which, on the first two whorls, are vertically connected with each other thus forming vertical ribs. On the body whorl there are two rows of sharp spines.

D i m e n s i o n s : Pl. XII, fig. 4, height 14.8 mm, width 5.7 mm Pl. XII, fig. 5, height 11.8 mm, width 5.6 mm.

R e m a r k s : Some drillholes (JRD-209, VO-1 to VO-3) contained thinner forms whose ornamentation consisted of vertical ribs on all whorls Pl. XII, fig. 4).

O c c u r r e n c e : Bratislava, drillholes JRD-202 (35.6—36.0 m), JRD-205 (15.4—15.5 m), JRD-206 (15.4—15.5 m, 22.4—24.0 m), JRD-207 (38.5—38.7 m, 38.7—38.8 m, 48.9—49.0 m), JRD-209 (43 m, 55.3—55.5 m, 55.5—55.7 m), VO-1 (18.8—18.9 m, 35.8—36.0 m), VO-2 (20.5—20.6 m), VO-3 (17.8—17.9 m, 48.4—48.5 m), TS-29 (22.5—22.7 m), TS-30 (18.9 —19.0 m, 19.2—19.4 m, 20.0—20.1 m), V-31 (18.1—18.2 m, 18.3—18.5 m, 19.5—19.6 m, 38.0—39.0 m), V-36 (17.3—17.6 m), sandy and clayey lithofacies.

G e o g r a p h i c a n d s t r a t i g r a p h i c d i s t r i b u t i o n : It occurs in the Pannonian and Pontian of Austria (Stegersbach, Götzendorf, Eichkogel), in the Pannonian of Hungary (Tinnye, Várpalota) and Rumania.

Melanopsis lebedai LUEGER, 1980
Pl. XII, fig. 1

1980 *Melanopsis lebedai* nov. sp.—J. P. LUEGER: Die Molluskenfauna aus dem Pannon etc. p. 104; Pl. 1, figs. 7, 14—16

M a t e r i a l : 87 specimens

D e s c r i p t i o n : A moderately high shell composed of 6—7 whorls. The final four whorls are covered with one row of spines in their upper part. In addition to the spines, the final whorl also has a spiralling keel in its lower part.

D i m e n s i o n s : Pl. XII, fig. 1, height 10.5 mm, width 5.7 mm.

R e m a r k s : *Melanopsis lebedai* LUEGER is very similar to the subspecies *Melanopsis Bouéri Fér. Var. doliolum* HANDMANN (HANDMANN, 1887, p. 35; Pl. 8, figs. 6—7).

O c c u r r e n c e : Bratislava, drillholes JRD-203 (64.4—64.6 m, 66.2—66.4 m, 68.0—69.0 m), JRD-205 (48.0—48.5 m), JRD-206 (56.4—56.5 m, 57.2—57.5 m, 66.6—66.8 m, 68.10—68.45 m, 69.0—70.0 m), Ma-1 (146.5—146.6 m, 147.0—147.2 m, 161.5—162.5 m, 162.5—163.5 m, 163.5—163.8 m), sandy lithofacies.

G e o g r a p h i c a n d s t r a t i g r a p h i c d i s t r i b u t i o n : In Pannonian zone D of Austria (Föllig).

Melanopsis scripta FUCHS, 1870
Pl. XIV, fig. 1

1870 *Melanopsis scripta* n. sp.—TH. FUCHS: Die Fauna der Congerienschichten etc. p. 544; Pl. 22, figs. 1—2
1887 *Mel. Canthidomus scriptus* FUCHS—R. HANDMANN: Die fossile Conchylienfauna etc. p. 31; Pl.7, figs. 7—8
1892 *Melanopsis scripta* FUCHS—S. BRUSINA: Fauna fossile terziaria etc. p. 133
1980 *Melanopsis scripta* FUCHS, 1870—J. P. LUEGER: Die Molluskenfauna aus dem Pannon etc. p. 104; Pl. 1, fig. 11

M a t e r i a l : 8 specimens.

D e s c r i p t i o n : A small, wide shell composed of 5 whorls. The body whorl is round, with one row of blunt spines in its upper part. The final whorl occupies more than a half of the total shell height. The aperture is egg-shaped.

D i m e n s i o n s : Pl. XIV, fig.1, height 8.3 mm, width 5.3 mm.

O c c u r r e n c e : Bratislava, drillholes JRD-203 (54.8—55.0 m, 62.8—63.0 m, 68.0—69.0 m), JRD-205 (38.0—39.0 m), JRD-206 (57.2—57.5 m, 66.6—66.8 m, 68.10—68.45 m), sandy lithofacies.

G e o g r a p h i c a n d s t r a t i g r a p h i c d i s t r i b u t i o n : It occurs in Pannonian zone D of Austria (Leobersdorf, Föllig) and in the Pannonian of Hungary and Yugoslavia.

Melanopsis varicosa nodifera HANDMANN, 1887
Pl. XIII, figs. 1, 4

1887 *Mel. Canthidomus nodifera* HANDM.—R. HANDMANN: Die fossile Conchylienfauna etc. p. 30; Pl. 7, figs. 4—6
1953 *Melanopsis varicosa nodifera* HANDMANN—A. PAPP: Die Molluskenfauna des Pannon etc. p. 149; Pl. 9, figs. 30, 34—35

M a t e r i a l : 16 specimens.

D e s c r i p t i o n : A small, smooth shell composed of 6 whorls. The body whorl is separated from the preceding whorls not only by the suture but also by a nearly-horizontal step which is pronounced by a keel. The final whorl occupies more than 3/4 of the shell height.

D i m e n s i o n s : Pl. XII, fig. 1, height 11.6 mm, width 7.0 mm Pl. XII, fig. 4, height 12.5 mm, width 7.0 mm

O c c u r r e n c e : Bratislava, drillholes JRD-203 (68.0—69.0 m), JRD-206 (56.4—56.5 m, 57.2—57.5 m, 68.10—68.45 m, 69.0—70.0 m), sandy lithofacies

G e o g r a p h i c a n d s t r a t i g r a p h i c d i s t r i b u t i o n : This subspecies occurs in Pannonian zone D of Austria (Leobersdorf, Siegendorf). LUEGER (1980) noted it in Pannonian zones D—E of Burgenland (Austria).

Melanopsis stricturata BRUSINA, 1892
Pl. XIII, fig. 3

1892 *Melanopsis stricturata* BRUSINA n.sp.—S. BRUSINA: Fauna fossile terziaria etc. p. 139
1902 *Melanopsis stricturata* BRUS.—S. BRUSINA: Iconographia etc. Pl. 5, figs. 48—50
1902 *Melanopsis stricturata* BRUS.—I. LÖRENTHEY: Die pannonische Fauna etc. p. 208; Pl. 18, fig. 2
1944 *Melanopsis stricturata* BRUSINA—E. JEKELIUS: Sarmat und Pont etc. p. 127; Pl. 47, figs. 3—11
1980 *Melanopsis stricturata* BRUSINA, 1902—J.P. LUEGER: Die Molluskenfauna aus dem Pannon etc. p. 106;
   Pl. 1, fig. 2

M a t e r i a l : 11 specimens.
D e s c r i p t i o n : A smooth shell composed of 6 whorls. In the upper part of the last but one whorl there is a spiralling keel and on the final one are two spiralling keels. The body whorl occupies more than a half of the total shell height.
D i m e n s i o n s : Pl. XIII, fig. 3, height 11.6 mm, width 6.4 mm.
O c c u r r e n c e : Bratislava, drillholes JRD-203 (68.0—69.0 m), JRD-206 (66.6—66.8 m), sandy lithofacies.
G e o g r a p h i c   a n d   s t r a t i g r a p h i c   d i s t r i b u t i o n : The species occurs in the Pannonian of Yugoslavia (Markushevec), Hungary (Tinnya) and Austria (Föllig).

Melanopsis pygmaea pygmaea M. HOERNES, 1856
Pl. XIII, fig. 5

1856 *Melanopsis pygmaea* PARTSCH—M. HOERNES: Die fossilen Mollusken etc. p. 599; Pl. 49, fig. 13
1870 *Melanopsis pygmaea* PARTSCH—TH. FUCHS: Die Fauna der Congerienschichten etc. p. 545; Pl. 22, figs.
   9—10
1887 *Mel. Homalia pygmaea* PARTSCH—R. HANDMANN: Die fossile Conchylienfauna etc. p. 12; Pl. 1, figs.
   2—3 (non 1, 4—5)
1892 *Melanopsis pygmaea* PARTSCH—S. BRUSINA: Fauna fossile terziaria etc. p. 140
1942 *Melanopsis pygmaea* PARTSCH—L. STRAUSZ: Das Pannon etc. p. 88; Pl. 5, figs. 25—28
1953 *Melanopsis pygmaea pygmaea* M. HOERNES—A. PAPP: Die Molluskenfauna des Pannon etc. p. 149; Pl.
   12, figs. 28—30, 33—34
1976 *Melanopsis pygmaea pygmaea* M. HÖRNES—P. ČTYROKÝ—E. KNOBLOCH: Neue paläontologische Untersuchungen etc. p. 111

M a t e r i a l : 243 specimens.
D e s c r i p t i o n : A smooth, slender shell composed of 6—8 whorls. The body whorl occupies roughly a half of the shell height.
D i m e n s i o n s : Pl. XIII, fig. 5, height 14.3, width 5.6 mm.
O c c u r r e n c e : Bratislava, drillholes JRD-203 (53.6—53.8 m, 54.8—55.0 m, 61.6—61.8 m, 67.0—67.3 m, 68.0—69.0 m), JRD-205 (37.0—38.0 m, 38.0—39.0 m), JRD-206 (22.4—24.0 m, 45.7—45.8 m, 56.4—56.5 m, 57.2—57.5 m, 68.10—68.45 m, 69.0—70.0 m), JRD-207 (38.5—38.7 m, 38.7—38.8 m, 48.9—49.0 m), JRD-209 (70.8—71.0 m), Ma-1 (141.0—141.6 m, 141.6—142.0 m, 146.5—146.6 m, 147.0—147.2 m, 148.0 —148.4 m, 161.5—162.5 m, 162.5—163.5 m, 163.5—163.8 m), VO-1 (35.8—36.0 m), VO-2 (38.3—38.4 m), TS-29 (22.5—22.7 m), TS-30 (19.2—19.4 m, 20.0—20.1 m), V-31 (18.1—18.2 m, 18.3—18.5 m, 38.0—39.0 m), V-36 (17.3—17.6 m), sandy and clayey lithofacies.
G e o g r a p h i c   a n d   s t r a t i g r a p h i c   d i s t r i b u t i o n : This subspecies is known from the Pannonian and Pontian of Moravia, Austria, Yugoslavia and Hungary.

Melanopsis pygmaea mucronata HANDMANN, 1887

1887 *Mel. Homalia pygmaea* PARTSCH *var. mucronata*—R. HANDMANN: Die fossile Conchylienfauna etc. p. 13; Pl. 1, fig. 1
1902 *Melanopsis culinopsis* BRUS.—S. BRUSINA: Iconographia etc. Pl. 5, figs. 42—44
1953 *Melanopsis pygmaea mucronata* HANDMANN—A. PAPP: Die Molluskenfauna des Pannon etc. p. 150; Pl. 12, figs. 31—32
1980 *Melanopsis pygmaea mucronata* HANDMANN, 1887—J.P. LUEGER: Die Molluskenfauna aus dem Pannon etc. p. 105; Pl.1, figs, 12—13

M a t e r i a l : 51 specimens.
D e s c r i p t i o n : A smooth shell, similar to, but thinner and smaller than *Melanopsis pygmaea pygmaea*.
O c c u r r e n c e : Bratislava, drillholes JRD-203 (68.0—69.0 m), JRD-205 (38.0—39.0 m), JRD-206 (57.2—57.5 m, 68.10—68.45 m, 69.0—70.0 m), Ma-1 (146.5—146.6 m, 161.5—162.5 m), TS-29 (22.5—22.7 m), TS-30 (19.2—19.4 m, 20.0—20.1 m), sandy lithofacies.
G e o g r a p h i c   a n d   s t r a t i g r a p h i c   d i s t r i b u t i o n : It is known from the Pannonian of Austria.

Melanopsis tihanyensis WENZ, 1928
Pl. XIII, fig. 6

1870 *Melanopsis gradata* n.sp.—TH. FUCHS: Die Fauna der Congerienschichten etc. p. 539; Pl. 20, figs. 13—14
1894 *Melanopsis gradata* FUCHS—E. LÖRENTHEY: Die pontische Fauna etc. p. 153
1911 *Melanopsis gradata* FUCHS—G. HALAVÁTS: Die Fauna der pontischen Schichten etc. p. 49; Pl. 2, fig. 15
1911 *Melanopsis gradata* FUCHS—I. LÖRENTHEY: Beiträge zur Fauna etc. p. 133
1928 *Melanopsis tihanyensis*—W. WENZ: Zur Fauna der pontischen Schichten etc. p. 219
1942 *Melanopsis tihanyensis* WENZ—L. STRAUSZ: Das Pannon etc. p. 91
1955 *Melanopsis tihanyensis* WENZ—F. BARTHA: A Várpalotai pliocén etc. p. 300; Pl. 1, figs. 1, 4, 8
1971 *Melanopsis tihanyensis* WENZ, 1928—F. BARTHA: A magyarországi pannon etc. p. 70; Pl. 16, figs. 14—16

M a t e r i a l : 29 specimens.
D e s c r i p t i o n : A small, thin shell composed of 7 whorls. The first two of them are smooth whereas the other are dotted with tubercles. The body whorl accounts for nearly a half of the total shell height.
D i m e n s i o n s : Pl. XIII, fig. 6, height 6.8 mm, width 3.6 mm.
R e m a r k s : This species was described by FUCHS in 1870 and denominated *Melanopsis gradata*. WENZ (1928) renamed it "tihanyensis" (for its type locality) because he found that the specific name "gradata" had been used earlier.
O c c u r r e n c e : Bratislava, drillholes JRD-203 (53.6—53.8 m, 68.0—69.0 m), Ma-1 (141.0—141.6 m, 194.1—194.4 m, 194.4—194.5 m, 195.0—195.5 m), sandy lithofacies.
G e o g r a p h i c   a n d   s t r a t i g r a p h i c   d i s t r i b u t i o n : It occurs in the lower and middle part of the Upper Pannonian (= Pontian in the Vienna Basin) of Hungary.

Species	Wienna basin (A. Papp 1953)								Danube basin (Bratislava)							
	Pannonian					Pontian			Pannonian					Pontian		
	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
Melanopsis fossilis constricta																
Melanopsis vindobonensis																
Melanopsis contigua																
Melanopsis pumila																
Melanopsis bouei rarispina																
Melanopsis bouei affinis																
Melanopsis bouei multicostata																
Melanopsis bouei sturii	?	?														
Melanopsis lebedai																
Melanopsis scripta																
Melanopsis varicosa nodifera																
Melanopsis stricturata																
Melanopsis pygmaea pygmaea																
Melanopsis pygmaea mucronata			?		?											
Melanopsis tihanyensis																
Melanopsis carasiensis																
Melanopsis austriaca																

Species group *Melanopsis fuchsi* HANDMANN

Melanopsis carasiensis JEKELIUS, 1944

1944 *Melanopsis carasiensis* n.sp.—E. JEKELIUS: Sarmat und Pont etc. p. 131; Pl. 49, figs. 7—10

M a t e r i a l : 16 specimens.

D e s c r i p t i o n : A small, thin, gradually widening shell composed of 5—6 whorls. The apperture is elliptic, the shell surface is smooth without ornamentation.

O c c u r r e n c e : Bratislava, drillholes JRD-206 (68.10—68.45 m), Ma-1 (161.5—162.5 m).

G e o g r a p h i c a n d s t r a t i g r a p h i c d i s t r i b u t i o n : This species was so far known only from the Pannonian of Rumania (Turislav).

Species group *Melanopsis brusinai* LOERENTHEY

Melanopsis austriaca HANDMANN, 1882
Pl. XII, fig. 2

1882 *Melanopsis Austriaca* n.f.—R. HANDMANN: Die fossile Molluskenfauna etc. p. 560
1887 *Mel. Hyphantria austriaca* HANDM.—R. HANDMANN: Die fossile Conchylienfauna etc. p. 38; Pl. 8, figs. 19—21
1907 *Melanopsis austriaca* HANDM.—O. TROLL: Die pontischen Ablagerungen etc. p. 57; Pl. 2, fig. 5
1953 *Melanopsis austriaca austriaca* HANDMANN—A. PAPP: Die Molluskenfauna des Pannon etc. p. 152

M a t e r i a l : 5 specimens.

D e s c r i p t i o n : A medium—sized, thin shell composed of 7 whorls, the final two of which retained their ornamentation composed of three rows of tubercles positioned one above another, the upper and lower of which are pronounced. The tubercles on the last but one whorl are vertically connected with each other to form ribs. On the final whorl, the tubercles are connected more distinctly in the horizontal direction than in the vertical. The lower row of tubercles forms a distinct keel.

D i m e n s i o n s : Pl. XII, fig. 2, height 11.6 mm, width 5.7 mm.

O c c u r r e n c e : Bratislava, drillholes JRD-206 (57.2—57.4 m, 66.6—66.8 m), Ma-1 (146.5—146.6 m).

G e o g r a p h i c   a n d   s t r a t i g r a p h i c   d i s t r i b u t i o n : It is known from the Pannonian zone D of Austria (Leobersdorf).

Conclusion

We have described 17 species (subspecies) of the genus *Melanopsis* from biostratigraphically assessed (FORDINÁL—TUBA, 1992) Upper Miocene sediments in central Bratislava.

From Pannonian zones C—E we noted *Melanopsis tihanyensis* WENZ, which had previously been known only from the lower and middle part of the Upper Pannonian of Hungary (= Vienna Basin Pontian); (BARTHA, 1971).

The Pannonian zone D was characterized by the following taxons: *Melanopsis fossilis constricta* HANDMANN, *M. contigua* HANDMANN, *M. pumila* BRUSINA, *M. bouei rarispina* LOERENTHEY, *M. lebedai* LUEGER, *M. scripta* FUCHS, *M. varicosa nodifera* HANDMANN, *M. stricturata* BRUSINA, *M. austriaca* HANDMANN and *M. carasiensis* JEKELIUS. *Melanopsis pygmaea pygmaea* M. HOERNES, *M. pygmaea mucronata* HANDMANN, *M. bouei affinis* HANDMANN and *M. bouei multicostata* HANDMANN occurred throughout the Pannonian and Pontian while *Melanopsis bouei sturii* FUCHS was noted only in the Pontian.

Translated by M. Böhmer

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KLEMENT FORDINÁL

Rod Melanopsis (Gastropoda) vo vrchnomiocénnych sedimentoch územia Bratislavy

Resumé

Z vrchnomiocénnych sedimentov územia centrálnej časti Bratislavy, biostratigraficky vyhodnotených (FORDINÁL—TUBA, 1992), sme opísali 17 druhov (poddruhov) rodu *Melanopsis*.

Zo zón C—E panónu bol opísaný *Melanopsis tihanyensis* WENZ, zatiaľ známy len zo spodnej a strednej časti vrchného panónu Maďarska (= pontu vo Viedenskej panve); (BARTHA, 1971).

Pre zónu D panónu boli charakteristické taxóny: *Melanopsis fossilis constricta* HANDMANN, *M. contigua* HANDMANN, *M. pumila*, *M. bouei rarispina* LOERENTHEY, *M. lebedai* LUEGER, *M. scripta* FUCHS, *M. varicosa nodifera* HANDMANN, *M. stricturata* BRUSINA, *M. austriaca* HANDMANN a *M. carasiensis* JEKELIUS.

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V panóne a ponte sa priebežne vyskytovali *Melanopsis pygmaea pygmaea* M. HOERNES, *M. pygmaea mucronata* HANDMANN, *M. bouei affinis* HANDMANN a *M. bouei multicostata* HANDMANN.
Na pont bol viazaný iba *Melanopsis bouei sturii* FUCHS.

Explanations to Plates XII—XIV

Plate XII
Fig. 1 *Melanopsis lebedai* LUEGER, JRD-206 (68.10—68.45 m), magn. 3.3 x
Fig. 2 *Melanopsis austriaca* HANDMANN, Ma-1 (146.5—146.6 m), magn. 3.1 x
Fig. 3 *Melanopsis bouei affinis* HANDMANN, JRD-209 (70.8—71.0 m), magn. 3.4 x
Fig. 4 *Melanopsis bouei sturii* FUCHS, JRD-209 (55.5—55.7 m), magn. 3.1 x
Fig. 5 *Melanopsis bouei sturii* FUCHS, JRD-206 (15.4—15.5 m), magn. 3.4 x
Fig. 6 *Melanopsis bouei rarispina* LOERENTHEY, JRD-206 (68.10—68.45 m), magn. 3.9 x

Plate XIII
Fig. 1 *Melanopsis varicosa nodifera* HANDMANN, JRD-206 (68.10—68.45 m), magn. 3 x
Fig. 2 *Melanopsis pumila* BRUSINA, JRD-206 (68.10—68.45 m), magn. 5 x
Fig. 3 *Melanopsis stricturata* BRUSINA, JRD-206 (66.6—66.8 m), magn. 3 x
Fig. 4 *Melanopsis varicosa nodifera* HANDMANN, JRD-203 (68.0—69.0 m), magn. 3.4 x
Fig. 5 *Melanopsis pygmaea pygmaea* M. HOERNES, JRD-206 (68.10—68.45 m), magn. 2.7 x
Fig. 6 *Melanopsis tihanyensis* WENZ, Ma-1 (194.1—194.4 m), magn. 6.2 x

Plate XIV
Fig. 1 *Melanopsis stricta* FUCHS, JRD-206 (68.10—68.45 m), magn. 4.8 x
Fig. 2 *Melanopsis fossilis constricta* HANDMANN, Ma-1 (163.5—163.8 m), magn. 2.1x
Fig. 3 *Melanopsis contigua* HANDMANN, JRD-206 (68.10—68.45 m), magn. 1.5x

Photographed by the author

KLEMENT FORDINÁL

Representatives of genus Parvidacna (Bivalvia) in Pannonian sediments of the Bratislava area

4 text-figs., 4 pls. (XV—XVIII), Slovak summary

A b s t r a c t . The article describes four species of genus *Parvidacna (Parvidacna petkovici, P. loerentheyi, P. pannonica* and *P. tinnyeana)* identified in Pannonian sediments of the Bratislava area (Danube Basin). This is their first known occurrence in Pannonian sediments of the West Carpathians.

Introduction

Investigations have revealed that molluscan assemblages in Pannonian sediments in the centre of Bratislava comprise small shells characteristic of genus *Parvidacna.*

This is their first known occurrence in Pannonian sediments of the West Carpathians.

Genus *Parvidacna* belongs among rare genera in the Upper Miocene molluscan assemblages.

The following genera have so far been described in sediments of the Pannonian and Eisenstadt Basins: *Parvidacna cryptoornatum* (JEKELIUS), *P. chartaceum* (BRUSINA), *P. loerentheyi* (PAVLOVIC), *P. petkovici* (PAVLOVIC), *P. tinnyeana* (LOERENTHEY), *P. pannonica* (LOERENTHEY) and *P. planicostata* STEVANOVIC.

None of these genera has been noted in the Vienna Basin. JIŘÍČEK (1985) has only described an occurrence of *Parvidacna* sp. at Hodonín.

In Pannonian sediments (sands, exceptionally sandy clays) in the centre of Bratislava, the following genera were identified: *Parvidacna petkovoci* (PAVLOVIC) (JRD-203, JRD-206, Ma-1), *P. loerentheyi* (PAVLOVIC), (Ma-1), *P. pannonica* (LOERENTHEY), (JRD-203, JRD-206, Ma-1) and *P. tinnyeana* (LOERENTHEY); (Ma-1), (text-fig. 1).

General characteristics

Genus *Parvidacna* defined by STEVANOVIC (1950) comprises small, thin and flat cardium forms.

PAPP (1953) assigned this genus, along with genera *Limnocardium, Monodacna* and *Didacna* into subphyllum *Limnocardiinae.*

Applying more or less morphological criteria EBERZIN (1965 ex EBERZIN, 1967) defined subphyllum *Paradacninae* composed of genera *Arcicardium, Panticapea, Parvidacna, Paradacna, Chartoconcha* and *Papyricardium.*

Phylogenic relationships between the individual genera of the subphyllum *Paradacninae* are only very little known (text-fig. 3).

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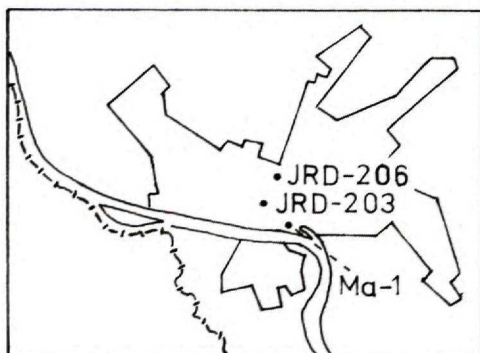
Fig. 1 Drillhole location in the Bratislava area

Systematic Part

Family *Cardiidae* LAMARCK, 1819
Subfamily *Paradacninae* EBERZIN, 1965

Genus *Parvidacna* STEVANOVIC, 1950
Type species *Parvidacna planicostata* STEVANOVIC, 1950

Parvidacna petkovici (PAVLOVIC, 1927)
Pl. XV, figs. 1—3; Pl. XVI, figs. 1—3; Pl. XVII, figs. 1—3

1927 *Limnocardium (Pseudocatillus) petkovici* nov. sp.—P. S. PAVLOVIC: Donjopontiski mekušci etc., p. 29, Pl. 4, figs. 5—9
1928 *Limnocardium (Pseudocatillus) petkovici* nov. sp.—P. S. PAVLOVIC: Les mollusques etc., p. 19; Pl. 4, figs. 5—9
1953 *Parvidacna petkovici* (PAVLOVIC)—A. PAPP: Die Molluskenfauna etc., p. 200; Pl. 22, fig. 10
1980 *Parvidacna petkovici* (PAVLOVIC, 1928)—J. P. LUEGER: Die Molluskenfauna aus dem Pannon etc., p. 115, abb. 5, fig. 1

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D i a g n o s i s : P. S. PAVLOVIC (1927), p. 29.
H o l o t y p e : Undefined.
T y p e   l o c a l i t y : Karagac (Yugoslavia).
S t r a t o t y p e : Pannonian—zone E.
M a t e r i a l : 70 specimens.
D i m e n s i o n s : Pl. XV   fig. 1; l = 3.9 mm, b = 2.1 mm
                              fig. 3; l = 4.1 mm, b = 2.6 mm
                     Pl. XVI fig. 1; l = 2.9 mm, b = 1.7 mm
                              fig. 2; l = 3.7 mm, b = 1.9 mm
                     Pl. XVII fig. 1; l = 4.7 mm, b = 2.7 mm
                              fig. 3; l = 4.0 mm, b = 2.8 mm.

D e s c r i p t i o n : The shell is small with a sharp and distinctive apex. The anterior cardinal margin is oblique and even, whereas the posterior cardinal margin is long, even and almost horizontal. On the front and central parts of the shell (text-fig. 2) there are 8—10 ribs that quickly widen from the apex towards the shell ventral margin. In the rear part of the shell, 5 narrow, sometimes poorly visible ribs are present. The cardinal of the right shell is clearly protruding, the lateral teeth are strongly reduced. The dorsal margin of the shell is sometimes covered with protuberances (spines); (Pl. XV, fig. 2). The ventral margin of the shell is undulated.
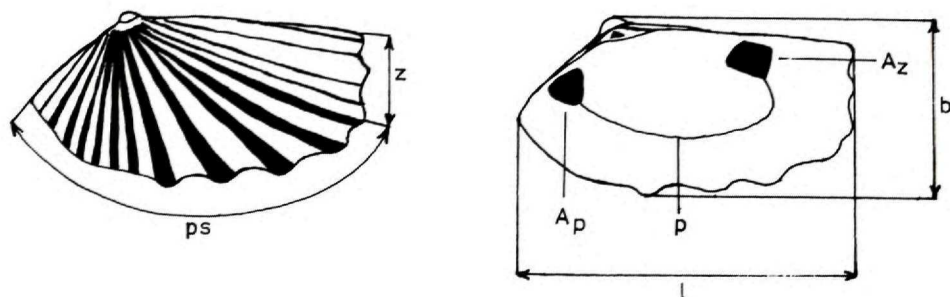
Fig 2 Shell morphology of *Parvidacna petkovici* (PAVLOVIC), magn. 15 x.
ps—anterior and central part of shell, z—posterior part of shell, A_p—impression of anterior abductor, A_z—impression of posterior abductor, p—pallial line, l—lenght of shell, b—width of shell

R e m a r k s : *Parvidacna petkovici* was described as a new species in 1927. The resume of the relevant article was published in 1928, which caused differences in quotations of the magazine in question and the year when the species was first defined (PAPP, 1953; LUEGER, 1980).

G e o g r a p h i c   a n d   s t r a t i g r a p h i c   d i s t r i b u t i o n s : Yugoslavia — Karagac, Tuzla -Husino (Pannonian - zone E), Austria—Stegersbach (Pannonian -z one E), Föllig (Pannonian - zone D, D/E), Slovakia—Bratislava (Pannonian - zone C—E).

O c c u r r e n c e : Bratislava, drillholes JRD-203 (56.3—56.5 m, 68.0—69.0 m), JRD-206 (66.6—66.8 m), Ma-1 (141.0—141.6 m, 141.6—142.0 m, 146.0—146.2 m, 147.0—147.2 m, 153.0—153.5 m, 155.2—155.4 m, 159.8—160.0 m, 161.5—162.5, 162.5—163.5 m, 195.0—195.5 m).

Parvidacna loerentheyi (PAVLOVIC, 1927)
Pl. XVIII, fig. 3

1927 *Limnocardium (Pseudocatillus) Lörentheyi* nov. sp.—P. S. PAVLOVIC: Donjopontiski mekušci etc., p. 29.
   Pl. 4, figs. 10—13
1928 *Limnocardium (Pseudocatillus) Lörentheyi* nov. sp.—P. S. PAVLOVIC: Les mollusques etc., p. 20, Pl. 4,
   figs. 10—13
1979/1980 *Parvidacna lörentheyi* (PAVL.)—P. STEVANOVIC: Neue Beitträge etc.; Pl. 4, figs. 8—10

D i a g n o s i s : P. S. PAVLOVIC (1927), p. 29.
H o l o t y p e : Undefined.
Ty p e   l o c a l i t y : Karagac (Yugoslavia).
S t r a t o t y p e : Pannonian—zone E.
M a t e r i a l : 1 specimen.
D i m e n s i o n s : l = 5.4 mm, b = 3.4 mm.

D e s c r i p t i o n : The shell is small and thin, similar to that of *Parvidacna petkovici* (PAV-
LOVIC). In contrast, however, the former has a less conspicuous apex positioned more closely to
the shell centre. The anterior cardinal margin is longer than that of *P. petkovici*. On the front and
central parts of the shell there are 12 ribs which widen from the apex towards the shell ventral
margin. The rear part has 4 ribs.

Fig. 3 Scheme illustrating *Paradacninae phylogeny* (EBERZIN, 1967)

Geographic and stratigraphic distributions: Yugoslavia—Karagac, Tuzla—Husino, Parcelo (Pannonian—zone E), Austria—southern Burgenland (Pannonian—zone E), Slovakia—Bratislava (Pannonian—zone D).
Occurrence: Bratislava, drillhole Ma-1 (146.5—146.6 m).

Parvidacna pannonica (LOERENTHEY, 1911)
Pl. XVII, figs. 1—2

1911 *Monodacna (Pseudocatillus) pannonica* nov. sp.—I. LÖRENTHEY: Beiträge zur Fauna etc., p. 76; Pl. 3, figs. 3—4
1963 *Monodacna pannonica* LÖR.—F. BARTHA: Lázi felsö—pannóniai etc.; Pl. 1, figs. 11, 13

Diagnosis: I. LÖRENTHEY (1911), p. 76.
Holotype: Undefined.
Type locality: Fonyód (Hungary).
Stratotype: Middle part of the Upper Pannonian.
Material: 3 specimens.
Dimensions: l = 2.5 mm, b = 1.5 mm.
Description: A very small, thin-walled and flat shell. On the anterior and central part of the shell there are 16 and on the posterior one 2 ribs. The ribs widen from the apex towards the ventral margin. The anterior cardinal margin is straight, the posterior one is fairly long and nearly horizontal.
Remarks: This species was assigned by SAUERZOPP (1952) into genus *Parvidacna*.
Geographic and stratigraphic distributions: Hungary—Fonyód (middle part of the Upper Pannonian), Lázi (lower part of the Upper Pannonian), Austria—Oberdorf (Pannonian—zone F), Slovakia—Bratislava (Pannonian —zone D).
Occurrence: Bratislava, drillholes JRD-203 (68.0—69.0 m), JRD-206 (68.10—68.45 m), Ma-1 (147.0—147.2 m).

Parvidacna tinnyeana (LOERENTHEY, 1911)
Pl. XVII, fig. 4

1902 *Limnocardium (Pontalmyra) Jagici* BRUS.—I. LÖRENTHEY: Die pannonische Fauna etc., p. 175; Pl. 11, figs. 13—18 (non Pl. 12, figs. 4—6)
1911 *Limnocardium (Pontalmyra) tinnyeana* LORENT—I. LÖRENTHEY: Beiträge zur Fauna etc., p. 76
1921 *Limnocardium ducici laevicosta* n. subsp.—W. WENZ: Zur Fauna der pontischen Schichten etc., p. 84
1953 *Parvidacna laevicostata* (WENZ)—A. PAPP: Die Molluskenfauna etc., p. 199; Pl. 22, figs. 8—9
1971 *Parvidacna tinnyeana* (LÖRENTHEY, 1991)—K. TÓTH: A vertés hegység etc., p. 359; Pl. 2, figs. 1—2; Pl. 3, fig. 2
1980 *Parvidacna laevicostata* (WENZ, 1921)—J. P. LUEGER: Die Molluskenfauna aus dem Pannon etc., p. 114, abb. 5, fig. 2

Diagnosis: I. LÖRENTHEY (1902), p. 175.
Holotype: Undefined.
Type locality: Tinnye (Hungary).
Stratotype: Lower part of the Lower Pannonian.
Material: 1 specimen.
Dimensions: l = 4.3 mm, b = 2.6 mm.

D e s c r i p t i o n : The shell is small, flat and fairly long. Its posterior margin is straight or obliquely cut, whereas the anterior one is rounded. The ribs are flat and relatively wide. In the posterior part of the shell they are somewhat narrower.

R e m a r k s : The name of this species underwent a fairly complicated development. A revision by TÓTH (1971) revealed that the valid specific name was *tinnyeana* introduced by LÖREN-THEY (1911).

Complications arose when LÖRENTHEY (1902), on the basis of BRUSINA's (1892) description, assigned fossils from Tinnya into species *Limnocardium jagici* BRUSINA. When an illustration of the species *Limnocardium jagici* BRUSINA (BRUSINA, 1902) was published, he found out that it actually was a new species and denominated it *Limnocardium tinnyeana* (LÖRENTHEY, 1911).

WENZ (1921) overlooked this fact, and LÖRENTHEY's specimens from Tinnya erroneously regarded as a new subspecies *Limnocardium ducici laevicosta*.

PAPP (1953) accepted WENZ's denomination, but classified the above—mentioned taxon as a species of genus *Parvidacna*.

This specific denomination is also applied by LUEGER (1980).

G e o g r a p h i c   a n d   s t r a t i g r a p h i c   d i s t r i b u t i o n s : Hungary — Tinnye (Lower Pannonian), Budapest—Kőbánya, Peremarton, Sopron, Austria—Leobersdorf, Föllig (Pannonian—zone C), Slovakia—Bratislava (Pannonian—zone C).

O c c u r r e n c e : Bratislava, drillhole Ma-1 (195.0—195.5 m).

	Pannonian					Pontian				A. PAPP /1953/
	A	B	C	D	E	F	G	H		
Sarmatian	Pannonian									F. BARTHA /1971/
	Lower Pannonian			Upper Pannonian						
				Lower	Middle	Upper				
					+				J	
				+	+				A	Parvidacna
			+	+	+				S	petkovici
▨									H	
					+				J	
					+				A	Parvidacna
				+					S	loerentheyi
▨									H	
					+				J	
				+					A	Parvidacna
▨									S	pannonica
						+			H	
		+							J	
		+							A	Parvidacna
									S	tinnyeana
▨		+							H	

Fig. 4 Distribution of described species of genus *Parvidacna*
J—Yugoslavia, A—Austria, S—Slovakia, H—Hungary

Conclusion

Four species of genus *Parvidacna/Parvidacna petkovici* (PAVLOVIC), *P. loerenthey* (PAVLOVIC), *P. pannonica* (LOERENTHEY) and *P. tinnyeana* (LOERENTHEY) / have been identified in Pannonian sediments of the Bratislava area.

On the basis of molluscan asesemblages, these sediments have been assigned into individual zones of the Pannonian (FORDINÁL—TUBA, 1992).

This stratigraphic scheme suggests that the majority of the above-described species of the genus *Parvidacna* have a wider stratigraphic range than was previously assumed.

Parvidacna petkovivi (PAVLOVIC) — its oldest occurrence was in Pannonian D zone of Austria (LUEGER, 1980). We have identified this species in Pannonian C zone along with *Congeria martonfii martonfii* LOERENTHEY, *C. martonfii pseeudauricularis* LOERENTHEY and *Limnocardium spinosum* LOERENTHEY as well as in sediments of the Pannonian D—E zones.

Parvidacna loerentheyi (PAVLOVIC) — was so far known exclusively in the Pannonian zone of Yugoslavia and Austria. In the Bratislava area, it has been identified in the sediments of the Pannonian D zone.

Parvidacna pannonica (LOERENTHEY) — was previously known in Pontian F zone of Austria and Pontian F—H zones of Hungary. We have noted its presence in sediments of the Pannonian D zone.

Parvidacna tinnyeana (LOERENTHEY) — like in Austria, we have noted this species in the Pannonian C zone.

Translated by Ľ. Böhmer

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KLEMENT FORDINÁL

Zástupcovia rodu Parvidacna (Bivalvia) v pannónskych sedimentoch územia Bratislavy

Resumé

V pannónskych sedimentoch územia Bratislavy bola po prvý krát v Západných Karpatoch zistená prítomnosť druhov: *Parvidacna petkovici* (PAVLOVIC), *P. loerenthey* (PAVLOVIC), *P. pannonica* (LOERENTHEY) a *P. tinnyeana* (LOERENTHEY)

Stratigrafické zaradenie sedimentov územia Bratislavy (FORDINÁL—TUBA, 1992) umožnilo konštatovať, že väčšina uvedených druhov má širšie stratigrafické rozšírenie ako bolo doteraz známe

Parvidacna petkovivi (PAVLOVIC) — doteraz známa len zo zón D—E panónu. Na území Bratislavy bola nájdená v sedimentoch zón C—E panónu

Parvidacna loerentheyi (PAVLOVIC) — jej výskyt bol doteraz uvádzaný len zo zóny E panónu. My sme zistili jej prítomnosť v sedimentoch zóny D panónu

Parvidacna pannonica (LOERENTHEY) — bola dotetaz známa zo zón F—H pontu. Na území Bratislavy bola nájdená v sedimentoch zóny D panónu

Parvidacna tinnyeana (LOERENTHEY) — jej prítomnosť bola zistená v sedimentoch zóny C panónu, podobne, ako je to známe z literatúry

Explanations of Plates XV — XVIII

Fig. 1 *Parvidacna petkovici* (PAVLOVIC), Ma-1 (161.5—162.5 m)
Fig. 2 *Parvidacna petkovici* (PAVLOVIC), Ma-1 (161.5—162. 5 m), close up view of a spine
Fig. 3 *Parvidacna petkovici* (PAVLOVIC), JRD-203 (68.0—69.0 m)

Plate XVI
Fig. 1 *Parvidacna petkovici* (PAVLOVIC), Ma-1 (195.0—195. 5 m)
Fig. 2 *Parvidacna petkovici* (PAVLOVIC), Ma-1 (161.6.—162. 5 m)
Fig. 3 *Parvidacna petkovici* (PAVLOVIC), Ma-1 (161.5—162.5 m), close up of hinge

Plate XVII
Fig. 1 *Parvidacna petkovici* (PAVLOVIC), Ma-1 (161.5—162.5 m.
Fig. 2 *Parvidacna petkovici* (PAVLOVIC), Ma-1 (161.5—162. 5 m), close up of anchylose line
Fig. 3 *Parvidacna petkovici* (PAVLOVIC), Ma-1 (146.5—146. 6 m)
Fig. 4 *Parvidacna tinnyeana* (LOERENTHEY), Ma-1 (195. 0—195.5 m)

Plate XVIII

Fig. 1—*Parvidacna pannonica* (LOERENTHEY), JRD-206 (68.10—68.45 m)
Fig. 2—*Parvidacna pannonica* (LOERENTHEY), JRD-206 (68.10—68.45 m), close up of hinge
Fig. 3—*Parvidacna loerenthcy* (PAVLOVIC), Ma-1 (146.5—146.6 m)

The fossils were photographed through a JSM—840 scanning miscroscope at the Dionýz Štúr Institute of geology. Operator: J. Stankovič

KLEMENT FORDINÁL

Microsculpture of Ervilia genus shells

2 figs., Slovak summary

A b s t r a c t : At the surface of shells of the species *Ervilia pusilla* PHIL. and *E. dissita* (EICHW.) regularly occurring pits of ellipsoidal outline have been established.

The genus *Ervilia* includes Heterodonta with small, relatively thick-walled equivalve shells with opistogyre beaks, of rounded triangular to oval outlines. The surface of valves is smooth or with growth lines. Its stratigraphical range is Paleogene to Recent (ŠVAGROVSKÝ, 1976).

In the West Carpathians it is mostly found in Sarmatian brackish sediments.

At present in the Atlantic Ocean and Mediterranean Sea *Ervilia castanea* Mtg. is living. Some authors consider it as identical with *E. pusilla* PHIL. from the Miocene (MERKLIN—NEVESS-KAJA, 1955).

In the study of shells of *Ervilia pusilla* PHIL. from the Badenian and *E. dissita* (EICHW.) from the Sarmatian of the Vienna Basin at electron microscope (JSM-840) regularly occurring pits of ellipsoidal outline were found at their surface/dimensions: diameter a = 2.0—2.2 micrometers, diameter b = 1.2 micreometer (Figs. 1—2).

Similarly shells of the genera *Donax*, *Mactra* and *Corbula* were then investigated, but analogous morphological elements have not been established.

The shell wall of bivalves is composed of 3 layers. The thin surficial periostracum is from the organic substance conchyolin and is the bearer of colouring. After death the animal easily decomposes, therefore fossil valves are white. Below the periostracum is the calcareous layer, the ostracum. It is composed of thin aragonite or calcite polyhedral prisms, oriented perpendicularly to shell surface. We call the inner layer hypoostracum. It is formed by platy small crystals of microscopic dimensions, arranged parallely with the inner shell surface or may be of various course, forming complicated structures, according to which they acqiure nacreous or porcellaneous habit (ŠVAGROVSKÝ, 1976).

It results from the mentioned shell wall structure that the surficial pits at shells of the genus *Ervilia* are found on the calcareous layer (ostracum).

The established microscopic pits at the shell surface of *Ervilia pusilla* PHIL. and *E. dissita* (EICHW.) could be of importance for identification when further investigation proves that the mentioned microsculpture elements are found at shells of *Ervilia* genus taxa.

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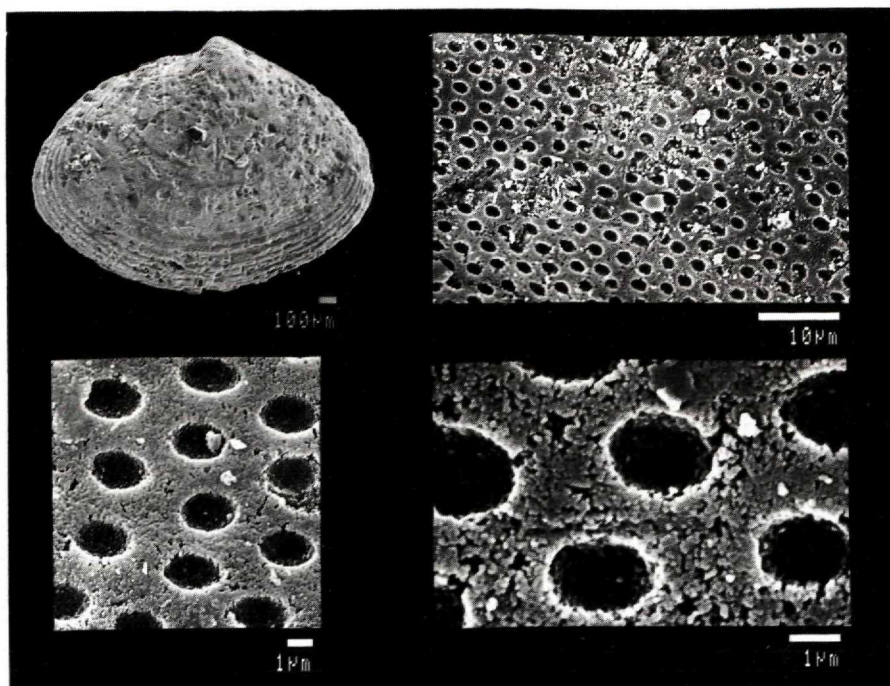
Fig. 1 *Ervilia pusilla* PHIL., borehole HGP-3 (Stupava) 108.9—109.0 m (Badenian)
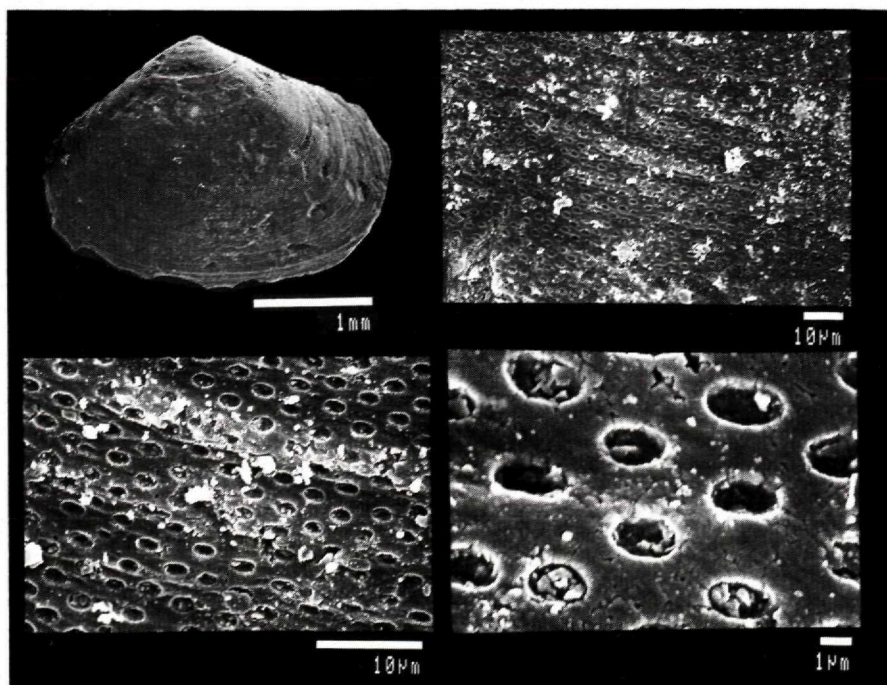
Fig. 2 *Ervilia dissita* (EICHW.), borehole BZ-49 (Unín) 6.0 — 6.4 m (Sarmatian)

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KLEMENT FORDINÁL

Mikroskulptúra schránok rodu Ervilia

Resumé

Pri štúdiu schránok druhov *Ervilia pusilla* PHIL. z bádenu a *E. dissita* (EICHW.) zo sarmatu Viedenskej panvy na elektrónovom mikroskope boli na ich povrchu zistené pravidelne sa vyskytujúce jamky elipsovitého obrysu. Tieto mikroskulptúrne prvky by mohli mať, ak sa dokáže, že sa všeobecne nachádzajú na schránkach rodu *Ervilia*, identifikačný význam.

ADRIENA ZLINSKÁ

New species of the genus Elphidium (Foraminifera) from the Sarmatian of the Eastern Slovakian Lowland

5 pls. (XIX—XXIII), Slovak summary

A b s t r a c t . The article describes the new foraminifer species *Elphidium samueli* sp. n. from the Sarmatian Stretava Formation at its type locality Kravany in the Eastern Slovakian Lowland.

Elphidium de MONTFORT, 1808
Type species *Nautilus macellus* var. beta FICHTEL et MOLL, 1798

Elphidium samueli **sp. n.**
Pl. XIX, figs. 4—9

H o l o t y p e : The species shown on Pl. XIX, figs. 4—9 is deposited in the Slovak National Museum in Bratislava, No. Z-21 255.

D e r i v a t i o   n o m i n i s : To honour the foremost Slovak paleontologist Dr. O. SAMUEL, DrSc.

S t r a t o t y p e : Stretava Formation, Sarmatian.

T y p e   l o c a l i t y : Eastern Slovakia, Kravany, borehole VST-11/58 —60 m.

M a t e r i a l : 113 specimens.

D i a g n o s i s : The test is planispiral, involute, symmetric in two directions, laterally inflated with an indistinct central pillar and marginal keel.

D e s c r i p t i o n : The test is dotted with 2 to 7 irregular smooth spines located on the shell margin opposite to the septal furrow as well as opposite to the chambers. The test consists of 1.5 whorl. The final whorl contains 10 to 17 triangular chambers. Septal filaments are arcuate, bent backward under an angle larger than that of the species *E. aculeatum* (ORB.). Septal bridges are separated from each other by small oval pits and only rarely join the next suture. Their number varies from 3 to 9. The test wall is covered by a fine granulation. The holotype test is characterized by the following parameters: width: 0.34 mm, length: 0.4 mm, thickness: 0.1 mm, number of spines: 4, spine length: 0.017—0.08 mm.

Paratype tests have dimensions as follows: width: 0.34—0.7 mm, length: 0.38—0.82 mm, thickness: 0.1 —0.28 mm, spine length: 0.017—0.11 mm.

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D i f f e r e n c e s : Our species differs from *E. aculeatum* (ORB.) in more abundant chambers, their shape, more arcuate sutures and irregular longer spines. It is dissimilar to *E. crispum* (L.) because the former has fewer chambers, different test cross-section and thinner test wall. Unlike the species *E. reginum* (ORB.), the spines of our species do not penetrate from the previous whorl through the wall of the next whorl.

O c c u r r e n c e s : The species was noted in the clayey-sandy facies of the brackish Lower Sarmatian (zone *Elphidium reginum*) at localities Kravany, Skároš, Nižná Myšľa, Slanská Huta in the Eastern Slovakian Lowland.

R e m a r k s : The studied specimens are characterized by a fairly wide variability within the species. A two-spine species was also noted whose outer as well as inner structure differs from the species described by us (Pl. XIX, figs. 1—3) that we regard as *Elphidium* sp. sp.n.

ADRIENA ZLINSKÁ

Nový druh rodu Elphidium (Foraminifera) zo sarmatu Východoslovenskej nížiny

Resumé

Vo východoslovenskej panve, zo stretavského súvrstvia spodnosarmatského veku bol opísaný nový druh *Elphidium samueli* sp. n., ktorý sa vyskytuje v zóne *Elphidium reginum.* Nový taxón je porovnaný s podobnými spodnosarmatskými druhmi. Je prechodnou formou medzi *Elphidium aculeatum* a *E. reginum.*

Vyznačuje sa málo výrazným centrálnym pilierom a okrajovým kýlom. Charakteristické sú nepravidelné hladké ostne vyrastajúce z obvodu schránky oproti septálnym švom aj oproti komôrkam.

Explanations of Plates XIX - XXII

Plate XIX
Figs. 1—3 *Elphidium* sp. sp. n
1, 3 side view; 2 seen from the apertural side
Figs. 4—9 *Elphidium samueli* sp. n., holotype
4, 6 side view; 5, 9 view of the aperture
7, 8 test granulation and close up view of a spine
Figs. 1—9 from locality Kravany

Plate XX
Elphidium samueli sp. n., paratype
Figs. 1, 3 side view
Figs. 2, 5, 6 view of the aperture
Figs. 4, 7, 8 close up of test wall
Figs. 1—8 from locality Kravany

Plate XXI
Figs. 1—8 *Elphidium samueli* sp. n., paratype
1, 3, 4 side view; 2, 7 apertural granulation
5 - 7 close up of the wall
Figs. 1—8 from locality Kravany

Plate XXII
Figs. 1—8 *Elphidium samueli* sp. n., paratypes
view of the inner structure
Figs. 9—13 *Elphidium reginum* (ORB.)
9 view of the inner structure, 13 side view
Figs. 10, 12 *Elphidium aculeatum* (ORB.)
10 view of the inner structure, 12 side view
Fig. 11 *Elphidium crispum* (L.), side view
Figs. 1—8 from locality Kravany; 9—13 from locality Skároš

Plate XXIII
Fig. 1 *Elphidium crispum* (L.), view of the outer test
Figs. 2—9 *Elphidium samueli* sp. n., paratypes
2, 3, 6 view of the test aperture, keel-like margin and spines; 4—5 side view; 7 close up of test wall; 8—9 close up view of the test inner structure
Fig. 1 from locality Skároš; 2—9 from locality Karavany

ADRIENA ZLINSKÁ—JIŘINA ČTYROKÁ

Some remarks to the taxonomy of genera Spiroplectammina Cushman, 1927 and Spiroplectinella Kiselman, 1972 from the Badenian of the Vienna Basin

6 pls. (XXIV—XXIX), Slovak summary

A b s t r a c t . Our contribution deals with the results of the morphological study of selected agglutinated foraminifer species *Textulariidae* EHRENBERG, 1838. They include the following forms: *Spiroplectinella carinata* (ORB.), *S. acuta* (RSS.), *Textularia deperdita* ORB. and *T. mariae* ORB.

Introduction

Agglutinated foraminifers are a significant microorganism group which has recently attracted much attention. Studies of these foraminifers may provide data necessary for large-scale regional correlations.

Detailed researches of these forms were carried out mainly by d'ORBIGNY (1846), CUSHMAN (1911), SPANDEL (1901), SCHUBERT (1902), HOFKER (1930), LALICKER (1935), HÖGLUND (1947), MARKS (1951), TAUBER (1958), CICHA—ZAPLETALOVÁ (1965), HALICZ—REISS (1979), PAPP—SCHMID (1985), CICHA—ČTYROKÁ (1987) and others.

This contribution deals with the results of morphological studies of selected species of the families *Spiroplectamminidae* CUSHMAN, 1927 and *Textulariidae* EHRENBERG, 1838. The investigated specimens were collected from the Badenian of the Vienna Basin at localities Devínska Nová Ves, Stupava, Láb and the Badenian holostratotype locality Soos in Austria.

Our morphological studies were based on diagnostic signs significant for foraminifer phylogeny, such as overall shell shape of microspherical as well as macrospherical generations, their growth parameters, sutures and sculpture; number, shape and size of chambers, chemistry and structure of the shell wall, shape and location of aperture and relationships with other forms. A system put forward by LOEBLICH—TAPPAN (1988) was employed to systematically assign the species.

Data on the stratigraphic distribution of the investigated species originated from a number of earlier paleontological works by Czech and Slovak and foreign authors alike as well as from our own observations of numerous specimens. Our contribution also includes a table showing stratigraphic distribution of these species in the Miocene of the Central Paratethys.

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Applied technique

The specimens of agglutinated foraminifers, whose shells are composed of variegated materials, were studied, as is common practise, under a binocular microscope in reflected light as well as by special methods such as binocular studies using penetrating light and immersion oil whose index was 1.515 and in oriented sections. However, this labour—intensive technique resulted in the destruction of numerous microfossil specimens.

In the beginning, we attempted to produce oriented sections by fastening the microfossil shells in paraffin and subsequent etching in diluted salt acid. This technique, however, requires much skill, otherwise the shell is quickly dissolved even at low concentrations of the acid including its important parts set in paraffin.

Another technique employed by us to study oriented sections of foraminifer shells was based on fastening them in liquid Canadian balsam. After the balsam had set hard, the shells were polished without any pressure on the glass plate using an extremely fine polishing powder.

Better results were obtained by finer polishing by a rough-surface glass plate. All the applied techniques require regular checking of the treated specimens under a binocular microscope.

The polarization-microscope studies also included taking photos of the fossils in penetrating light. The oriented sections and outer structure as well as shell morphology were investigated by a JSM-840 electron microscope.

Systematic Part

Family *Spiroplectamminidae* CUSHMAN, 1927
Subfamily *Spiroplectammininae* CUSHMAN, 1927

Genus *Spiroplectammina* CUSHMAN, 1927

The shell is loose, elongated, narrow, ovoid in cross-section, with widely rounded margins and a large initial planspiral whorl followed by biserially arranged chambers. The whorl is mostly wider than the first pairs of the biserial chambers. The shell is agglutinated, solid, noncanaliculate. The aperture is a low arch on the inner side of the last chamber.

D i s t r i b u t i o n : Carboniferous to Holocene, cosmopolitan.

The species *S. carinata* (d'ORBIGNY) and *S. acuta* (REUSS) had been in the past erroneously assigned into the genus *Spiroplectammina* CUSHMAN but later revisions as well as our studies revealed that they in fact belong into the genus *Spiroplectinella* KISELMAN.

Genus *Spiroplectinella* KISELMAN, 1972

The shell is loose with an initial planspiral whorl in microspherical stage, followed by a biserial mature stage that mostly quickly widens, has a rhomb-like cross-section and may have a marginal keel. The shell is agglutinated, noncanaliculate, with fine-grained interior coated with organic matter. The outer side of the wall is more coarsely agglutinated, the aperture is a narrow arch at the base of the aperture plane.

D i s t r i b u t i o n : Paleocene to Holocene, cosmopolitan.

Spiroplectinella carinata (d'ORBIGNY, 1846)
Pl. XXIV, figs. 1—12; Pl. XXV; Pl. XXVI, figs. 1—10; Pl. XXVII, figs. 1—9

1826 *Textularia carinata* d'ORBIGNY, p. 263 (nomen nudum)
1846 *Textularia carinata* d'ORBIGNY, p. 247; Pl. 14, figs. 32—34
1921 *Textularia pseudocarinata* CUSHMAN, p. 121; Pl. 42, figs. 15, 16
1951 *Spiroplectammina carinata* (d'ORBIGNY)—MARKS, p. 35; Pl. 6, fig. 2a, b
1955 *Spiroplectammina scaligera* LUCZKOWSKA, p. 101; Pl. V, fig. 4a, b
1958 *Textularia carinata* (d'ORBIGNY)—TAUBER, p. 3—16, Figs. 1—3
1965 *Spiroplectammina carinata* (d'ORBIGNY)—CICHA and ZAPLETALOVÁ, p. 102—106, Fig. 1a—e
1969 *Textularia carinata* (d'ORBIGNY)—RÖGL, p. 67; Pl. 1, fig. 2a, b
1981 *Spirorutilis carinata* (d'ORBIGNY)—BANNER and PERREIRA, p. 102
1985 *Spiroplectinella carinata* (d'ORB.)—PAPP and SCHMID, p. 86; Pl. 80, figs. 1—4
1988 *Spiroplectinella carinata* (d'ORB.)—LOEBLICH and TAPPAN; Pl. 120, figs. 11—15

R e m a r k s : The species was described in the Vienna Basin by d'ORBIGNY (1846) and later by SPANDEL (1901). The latter author studied specimens from the Oligocene of the Mohan Basin, Alsace and northern Germany. However, he assigned this form into genus *Spiroplecta* EHRENBERG and was the first to note that the embryonal chamber of the species *S. carinata* is of variable size. He noted that the proloculum of megalospherical specimens from the Rupelian of the Mohan Basin ranges from 0.03 to 0.04 mm in size and that of megalospherical forms in the Badenian varies from 0.05 to 0.06 mm. TAUBER (1958) studied shells of *S. carinata* from the Badenian of the Vienna Basin and Burgenland. He has found that the initial planispiral part of the shell of the microspherical generation is progressively reduced, whereas thee megalospherical form is much more conservative. However, he erroneously assumed that his observations contradicted earlier data on the planispiral beginnings of the mature biserial forms. In contradiction with CUSHMAN (1927), he assigned the species *S. carinata* into the genus *Textularia* DEFRANCE (1824).

Great morphological differences in the shell contours reflecting diverse ecological conditions gave rise to various ecological forms of this species. These forms were regarded by some authors as separate species or subspecies. CUSHMAN (1921) described a new species *Textularia pseudocarinata* from the recent seas off the Philippines, and LUCZKOWSKA (1955) established a new fossil species *S. scaligera* in the Upper Badenian Rabowiec Beds in Poland. BOGDANOVICH (1960) assigned some megalospherical forms of the species *S. carinata* identified in Oligocene sediments in the southern European tract of what was then the U.S.S.R., to a new species *S. terekensis*.

Later in the 1970s, up-to-date electron microscope researches of oriented sections provided us with further information on the internal structure of the shell and its wall. HALICZ and REISS (1979) studied largely recent specimens of selected species of the genera *Spiroplectinella* KISELMAN and *Textularia* DEFRANCE and described the presence of dendritic, circular or polygonal pseudopores on the shell wall which are terminated in a thin organic layer closing the pores from the inner side. This fact was also noted by these authors on a fossil Miocene specimen.

PAPP and SCHMID (1985) made a revision of d'ORBIGNY's original material collected in 1846 in the Vienna Basin Miocene and, solely on the basis of the outer shell morphology, assigned the species *Spiroplectammina carinata* d'ORBIGNY to the genus *Spiroplectinella* defined by KISELMAN (1972). It is noteworthy, however, that the authors of a new generic system of the order *Foraminiferida*—LOEBLICH and TAPPAN ignore the facts described by HALICZ and REISS in the diagnosis of the egenera *Spiroplectammina* and *Spiroplectinella* and, contrary to their diagnosis, state that the walls of the shells are noncanaliculate.

Our researches were therefore aimed at clearing up the inner structure and chemistry of the shell of this genus including fossil specimens from the Vienna Basin Miocene in the Czech and

shell of this genus including fossil specimens from the Vienna Basin Miocene in the Czech and Slovak territory. The above-described techniques using oriented sections allowed us to note irregular pseudopores (Pl. XXVI, fig. 10), a thin extremely fine-structured layer lining the interior of the individual chambers (Pl. XXV, figs. 2, 5, 6) and an inner organic coating.

S t r a t i g r a p h i c   s i g n i f i c a n c e   a n d   d i s t r i b u t i o n : The species ranges from the Oligocene shallow-water facies to the Upper Badenian in the West Carpathians. The richest occurrences are in the Middle Badenian (Wielician). This fact inspireed GRILL (1941) to introduce the term "fauna with *S. carinata*" designating Middle Badenian sediments in the Austrian tract of the Vienna Basin. Nowadays, these sediments are termed "zone *Spiroplectammina carinata*" or "agglutinated foraminifer zone". A graph compiled by CICHA and ZAPLETA-LOVÁ (1965) proves that the best way to use this species for stratigraphic purposes is to observe the size of its proloculum and dimensions of the shell. In the Egerian and Eggenburgian, shells of both generations display roughly equal dimensions: maximum length up 1.6 mm, width up to 0.76 mm and thickness up to 0.45 mm. In contrast, some Middle Badenian specimens (zone *S. carinata*) are as much as 2.25 mm long, 1.12 mm wide and 0.70 mm thick.

Spiroplectinella acuta (REUS, 1850)
Pl. XXVIII, figs. 4—6; Pl. XXIX, figs. 11—12

1850 *Textularia acuta* REUSS, p. 381; Pl. 49, fig. 1, 1a
1965 *Spiroplectammina acuta* (REUSS)—CICHA and ZAPLETALOVÁ, p. 106, Fig. 3a—d
1971 *Spiroplectammina acuta* (REUSS)—CICHA, ZAPLETALOVÁ, PAPP, ČTYROKÁ, LEHOTAYOVÁ, p. 243

R e m a r k s : The species was assigned into the genus *Spiroplectinella* on the basis of the following characteristics: shell wall chemistry, planspiral juvenile shells and the shape of aperture which is identical with the species *S. carinata*. The shell of this species is more finely agglutinated than that of the species *S. carinata* (see Pl. XXVIII, fig. 6).

In accordance with HALICZ and REISS's (1979) researches, we have also identified so called pseudopores on broken away parts of the shells (Pl. XXVIII, fig. 5). The pseudopores were overlooked by the author of the genus as well as by LOEBLICH and TAPPAN (1988).

S t r a t i g r a p h i c   s i g n i f i c a n c e   a n d   d i s t r i b u t i o n : Lower Miocene (Eggenburgian) shallow-water facies, sporadically Karpatian. Very rich occurerences of this species are associated with the Middle Badenian sublittoral facies (agglutinated foraminifer zone).

Family *Textulariidae* EHRENBERG, 1838
Subfamily *Textulariinae* EHRENBERG, 1838

Genus *Textularia* DEFRANCE, 1824

The shell as a whole is biserial or may have a third chamber positioned against the first pair of chambers in the microspherical generation. The shell is agglutinated, with transversal channels which may be either open, forming a perforation or clogged with an inner organic coating of the shell. The aperture is a narrow arch or a slot at the base of the apertural side of the shell.

D i s t r i b u t i o n : Paleocene to Holocene, cosmopolitan.

R e m a r k s : DEFRANCE (1824) described the genus *Textularia* with its typical species *T. sagittula*. As seen on the illustration, it is a form with a long shell (3 mm) which later becomes biserial. In his subsequent work, DEFRANCE mentioned fossil occurrences in the Pliocene of Italy (Sienna, Castel Arquato) and recent occurrences in the Mediterranean coastal regions of the same country.

LOEBLICH and TAPPAN (1964), in their treatise dealing with the systematic assignation of foraminifers, note that LACROIX (1929) investigated thousands of recent specimens about 1 mm large in the Bay of Biscay and Mediterranean Sea and found out that there existed no biserial forms. On the contrary, all forms had a spiral oldest part of the shell. As a result, a number of scientists came to the conclusion that the genera *Textularia* and *Spiroplectammina* are synonyms, also with regard to the fact that LACROIX himself considered both these genera valid, the only difference being in the oldest spiral part of the shell. Moreover, LACROIX is likely to have studied a completely different genus and species (other than *T. sagittula*), most probably the genus *Spiroplectammina* and that is why this form cannot be assigned into the genus *Textularia*.

Textularia deperdita d'ORBIGNY, 1846
Pl. XXVII, figs. 1—11; Pl. XXVIII, figs. 1—3

1846 *Textularia deperdita* d'ORBIGNY, p. 244; Pl. 14, figs. 23—25
1951 *Spiroplectammina deperdita* (d'ORB.)—MARKS, p. 36
1965 *Spiroplectammina deperdita* (d'ORB.)—SOUAYA, p. 305
1970 *Textularia deperdita* d'ORB.—DIDKOVSKIY and SATANOVSKAYA, p. 11; Pl. 4, fig. 3a, b
1985 *Textularia deperdita* d'ORB.—PAPP and SCHMID, p. 84; Pl. 78, figs. 7—9
1987 *Textularia deperdita* d'ORB.—REISER, p. 59; Pl. 2, figs. 4, 5

R e m a r k s : Because of similar outer morphology, this species was erroneously assigned by some authors into the genus *Spiroplectammina*. E.g., MARKS (1951) viewed this form as very close to the species *Spiroplectammina pectinata* (REUSS), or *Spiropleectammina acuta* (REUSS). SOUAYA was of the same opinion.

Our revision of agglutinated forms has revealed, on an oriented section of this species, that it in fact belongs into the genus *Textularia* DEFRANCE, 1824 (see Pl. XXVII, figs. 9, 10) as is suggested by its biserial structure and the absence of a spiral in the oldest part of the shell.

S t r a t i g r a p h i c   s i g n i f i c a n c e   a n d   d i s t r i b u t i o n : Upper Oligocene to Middle Badenian in the West Carpathians basins. The most abundant occurrences are situated in the Lower and Middle Badenian.

Textularia mariae d'ORBIGNY, 1846
Pl. XXVIII, figs. 7—10; Pl. XXIX, fig. 10

1846 *Textularia Mariae* d'ORBIGNY, p. 256; Pl. 14, figs. 29—31
1951 *Textularia mariae* (d'ORB.)—CICHA and ZAPLETALOVÁ. p. 123, Figs. 16a—d
1970 *Textularia mariae* d'ORB.—DIDKOVSKIY and SATANOVSKAYA, p. 12; Pl. 5, fig. 1a—v
1985 *Textularia mariae* d'ORB.—PAPP and SCHMID, p. 86; Pl. 79, figs. 5—8
1988 *Spiroplectinella mariae* (d'ORB.)—LOEBLICH and TAPPAN; Pl. 120, fig. 16

R e m a r k s : Like the foregoing species, this form was, on the basis of its outer shell morphology, intermittently assignated into the genera *Textularia* and *Spiroplectammina*, and in the latest foraminifer system (LOEBLICH and TAPPAN, 1988) into the genus *Spiroplectinella* KISELMAN.

SOUAYA (1965) described two different subspecies in the Suez region: *Spiroplectammina mariae mariae* (d'ORB.) and *S. mariae inermis* (REUSS). He notes that the small specimens of the former subspecies resemble the species *Plecanium spinulosum* REUSS which might be, in his opinion, identical with the species *S. mariae* (d'ORB.). However, having studied his illustration, we do not view the form inermis as a separate subspecies. MARKS (1951) considered the subspecies *P. mariae* defined by REUSS as a synonymum and a transient stage to the species *Spiro-*

plectammina mariae (d'ORB.). This assignation was based solely on the outer morphology, which we consider inadequate. Similarly, the assignation of this species to the genus *Spiroplectinella* KISELMAN by LOEBLICH and TAPPAN (1988) whose photo-tables show only the apertural part of the shell from the original d'ORBIGNY' s (1846) work is controversial.

The inner structure of the specimens which we studied in detail by the SEM method in reflected as well penetrating light allows us to assign this species into the genus *Textularia*. A photo of a shell whose two thirds are pyritized (Pl. XXIX, fig. 10) shows a clearly visible initial stage without a spiral arrangement of the chambers.

S t r a t i g r a p h i c s i g n i f i c a n c e a n d d i s t r i b u t i o n : It is one of significant Miocene index fossils. In the West Carpathian basins it only occurs in the substages Moravian and Wielician (Lower and Middle Badenian).

Elsewhere, its occurrences are known to exist in the Miocene of the SW Sinai Peninsula (SOUAYA, 1965).

Conclusion

In this contribution, we attempted to resolve the so far unreliable or controversial generic assignation of agglutinated foraminifers of the genus *Spiroplectinella* and *Textularia*. The employed techniques included a combination of special methods and study of detailed inner structure of shells. We have noted and confirmed:

a) presence of irregular pseudopores on the shell wall of *Spiroplectinella* KISELMAN,

b) presence of a coating on the inner wall of the shells of this genus,

c) systematic assignation of the species *Spiroplectammina carinata*, *S. acuta* to the genus *Spiroplectinella*,

d) on the basis of the inner structure seen in oriented sections, the systematic assignation of the taxons *Spiroplectammina deperdita* and *Spiroplectinella mariae* to the genus *Textularia*.

Translated by Ľ. Böhmer

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Niekoľko poznámok ku taxonómii rodov Spiroplectammina CUSHMAN, 1927 a Spiroplectinella KISELMAN, 1972 z bádenu viedenskej panvy

Resumé

Obsahom nášho príspevku sú výsledky morfologického štúdia vybraných druhov aglutinovaných foraminifer z čeľadí *Spiroplectammina* CUSHMAN, 1927 a *Textulariidae* EHRENBERG, 1838. Sú to tieto formy: *Spiroplectinella carinata* (d'ORB.), *S. acuta* (RSS.), *Textularia deperdita*, ORB. a *T. mariae* ORB.

Detailným štúdiom vnútornej stavby schránok a vonkajších diagnostických znakov sme sa za použitia kombinácie špeciálnych metód na orientovaných rezoch schránok mikrofosílií snažili upresniť ich neisté alebo sporné rodové zaradenie. Zistili sme a potvrdili sme: a) prítomnosť nepravidelných pseudopórov v stene schránok rodu *Spiroplectinella*, b) prítomnosť výstelky vnútornej steny komôrok u tohoto rodu, c) systematickú príslušnosť druhov *Spiroplectammina carinata* a *S. acuta* k rodu *Spiroplectinella*, d) na základe vnútornej stavby na orientovaných rezoch systematickú príslušnosť taxónov *Spiroplectammina deperdita* a *Spiroplectinella mariae* k rodu *Textularia*.

Explanation of Plates XXIV—XXIX

Plate XXIV
Various ecoforms of the species *Spiroplectinella carinata* (d'ORB.)
Figs. 1—11 form the locality Devínska Nová Ves, Badenian
Fig. 12 from the holostratotype locality Baden-Soos, Badenian

Plate XXV
Spiroplectinella carinata (d'ORB.)
Figs. 1, 2, 4 view of the inner shell structure
Fig. 3 planspiral stage of the shell
Figs. 5, 6 inner filling of chambers
Figs. 7—10 structure of the outer shell wall
Figs. 1—5 specimens from the locality Devínska Nová Ves, Badenian
Figs. 6—10 specimen from the locality Stupava, Badenian

Plate XXVI
Spiroplectinella carinata (d'ORB.)
Fig. 1 microspherical shell
Figs. 2, 4 view of the shell aperture
Fig. 3 macrospherical shell
Fig. 5 structure of the outer shell wall
Figs. 6—8 internal structure of the shell
Fig. 9 close-up view of the planspiral stage of the shell
Fig. 10 close-up view of the chamber
Figs. 1—10 specimens from the locality Stupava, Badenian

Plate XXVII
Textularia deperdita d'ORB.
Figs. 1, 3, 5, 8 overall view of the outer apperture of the shells
Figs. 2, 4, 6 view of the apertural side of the shell
Fig. 7 detail of the outer wall of the shell
Figs. 9, 10 internal structure of the shell

Fig. 11 detail of chambers
Figs. 1—8 specimens from the locality Devínska Nová Ves, Badenian
Figs. 9—11 specimens from the locality Stupava, Badenian

Plate XXVIII
Textularia deperdita d'Orb.
Fig. 1 overall view of the outer structure of the shells
Fig. 2 view of the apertural side of the shell
Fig. 3 detail of the outer shell wall structure
Figs. 4—6 *Spiroplectinella acuta* (Reuss)
Fig. 4 overall view of the outer structure of the shell
Fig. 5 view of the apertural side of the shell
Fig. 6 detail of the outer structure of the shell
Fig. 7 *Textularia mariae* d'Orb.
Fig. 7, 8 overall view of the outer structure of the shell
Fig. 9 view of the apertural side of the shell
Fig. 10 detail of the outer side of the shell wall
Figs. 1—7 specimens from the locality Devínska Nová Ves, Badenian
Figs. 8—10 specimens from the locality Stupava, Badenian

Plate XXIX
Figs. 1—9 *Spiroplectinella carinata* (d'Orb.) internal structure of the shell
Fig. 10 *Textularia mariae* d'Orb., inner side of the shell
Figs. 11—12 *Spiroplectinella acuta* (Reuss), internal shell structure
Figs. 1—7, 9—12 specimens from the locality Devínska Nová Ves, Badenian
Fig. 8 specimen from the locality Láb, Badenian

Note: Photos in Pls. XXIV—XVIII were taken by a JSM-840 electron miscroscope (operator K. Horák). Bar lengths are 100 μm, unless otherwise stated (in some specimens 10 μm). Photos in Pl. XXIX were taken by an optical microscope in penetrating light (photos: the auhtors). Bar lengths are 100 μm.

Stratigraphic distribution of the studied species of the genera *Spiroplectinella* and *Textularia*

Explanations: scarce .... ; common——; abundant xxxx

KATARÍNA HOLCOVÁ—ŠUTOVSKÁ

Quantitative analysis of foraminiferal assemblages—reccomendations for standartization of data

12 text-figs., Slovak summary

A b s t r a c t . To obtain comparable data methods of the quantitative analysis of foraminiferal assemblages should be standartized. Therefore, precise data about used methods should be mentioned in every presentation of the quantitative results. Following recommendation is based on a comparison of published data with own results:

1—The optimum size-fraction for quantitative analysis of Foraminifera could be the fraction $> 63\,\mu$m,
2—The optimum number of individuals for analysis of species proportion could be 300 specimens,
3—Broken tests could be counted as a fraction of whole specimen,
4—Detail characterization of paleoecological requirements of taxa, their stratigraphical ranges, size and shape variability of taxons in samples and a sedimentological and facial analysis of the study area represent a starting point for an analyse of postmortem processes.

Key words. Foraminifera, methods, quantitative analysis, postmortem transport.

Introduction

Species proportion and abundance are considered to be the most important quantitative characteristics of the foraminiferal assemblages. Species proportion is a starting point for a counting of the percentage of individual species (called dominance of taxon in biology), for a counting of numerical characteristics of the structure of the assemblages (e.g. diversity) and for a comparison of assemblages by similarity indexes. Species proportions represent also an input data for the multivariate statistics methods.

In recent micropaleontological journals, the quantitative analysis of foraminiferal assemblages is nearly "obligatory" in paleoecological studies. The quality of the analysis depends on numerous factors, like sampling methods, laboratory micropaleontological methods, statistical methods, methods for a recognizing of a proportion of reworked species in assemblages etc. While information about reliability of the statistical methods are described in special statistical manuals and the methods for ecological analysis of Recent biocenoesis in biological manuals (SOUTHWOOD, 1978; CAUSTON, 1986; KREBS, 1989, etc.), the reliability of micropaleontological techniques and problems of taphonomy must be analysed by micropaleontologists.

The principal question of the analysis of the reliability of the quantitative micropaleontological data can be: What is a foraminiferal "assemblage" separated from the washing residue ?

The "assemblage" represents a sample of certain number of tests from certian size-fraction of washing residue which originaly lived in sampling site or they was transported on sampling site

RNDr. K. HOLCOVÁ—ŠUTOVSKÁ, Department of Paleontology, Faculty of Sciences, Charles University,

from another part of basin and which were not destroyed mechanically or by dissolution. The assemblage can contain also older reworked foraminifers. Bioturbation forms "average" assemblages by mixing of succesive assemblages in depth range of bioturbation. Specific composition have foraminiferal "assemblages" from the event beds (e.g.turbidits, tempestites).

Following examples can give an information about an influence of the laboratory methods and the postmortem changes on the diversity of assemblages (counted according SIMPSON's formula) or the percentage of individual species.

Influence of the laboratory methods

In this paper, an influence of a sieve size, of a minimal number of analysed sample and of a way of analysing of broken specimens is discussed. Besides an influence of the laboratory methods, also sampling techniques, described generally in geology (e.g. MARSAL, 1987) or in micropaleontology (e.g. BUZAS—GIBSON, 1990), have influence on the results of the quantitative analysis.

Size-fraction of the washed residue

A discussion about representative size-fraction for the quantitative analysis of the Foraminifera has existed in the literature for many years. A summary of the discussion is given by SCHRÖDER et al. (1987). The authors recommended to use fraction $>63 \mu m$. However, PAWLOVSKI (1991) showed that also the size-fraction $32—63 \mu m$ contains as juvenile as adult foraminifers.

What size-fraction is used by recent authors ? According to the papers published within 90ies (mainly in volume 1992 of the Journal of foraminiferal research), the size-fraction $>63 \mu m$ is used prevailingly (JENNINGS — NELSON, 1992; GIBSON—HILL, 1992; WIDMARK—MALMGREN 1992; MURRAY, 1992; BARMAWIDJAJA et al., 1992). Occasionally authors use a variety of larger size-fractions ($>100 \mu m$ HALD—STEINSUND, 1992; SEIDENKRANTZ, 1992; $>125 \mu m$ HASEGAWA et al. 1990; $>150 \mu m$ GUPTA—SRINIVASAN, 1990).

What differences in results of quantitative analysis have been obtained, using different size-fractions? SCHRÖDER et al. (1987) described differences in percentage of some species (mainly small-size species like *Staiforthia concava* and *Epistominella exigua*) up to 15 % betweem size-fraction $>63 \mu m$ and $>125 \mu m$. Our example presents differences in diversity of "assemblages" obtained from size-fractions $>63 \mu m$, $>125 \mu m$ and $>200 \mu m$ (Fig. 1). The size-fraction $40—63$ μm practically does not content foraminifers. Analysed samples are from Rzehakia Mb. in the Southern Slovakia Basin (the Lower Miocene) characteristised by small-size foraminifers. Differences in the values of the index of diversity are about 20 %, occasionally up to 50 % between size fraction $>63 \mu m$ and $>125 \mu m$. The diversity can be higher in size-fraction $>125 \mu m$ if some species dominate in the assemblage from the size-fraction $63 \mu m—125 \mu m$ and size-fraction >125 μm contain diversified assemblage. The diversity is lower in the size-fraction $>125 \mu m$ if assemblage from the size-fraction $63 \mu m—125 \mu m$ is diversified and one species dominate in size-fraction $>125 \mu m$. The diversity can be similar (however, a species proportion can be different) if diversities of assemblages from the size-fractions $63—125 \mu m$ and $>125 \mu m$ are similar. In our samples with small-size Foraminifera, the size-fraction $>200 \mu m$ contents only larger Ammonia or does not content foraminifers.

R e c o m m e n d a t i o n : For a presenting of comparable quantitative data, it is necessary to mention the size-fraction of the analysed foraminiferal assemblages. A starting point for a selection of the most representative size-fraction can be the analysis of the foraminiferal assemblages from the succesive size-fractions (e.g. $40—63 \mu m$, $63—125 \mu m$, $125—150 \mu m$, $150—250$ μm, $>250 \mu m$) and selection of a range of the sieve size in which all Foraminifera can be analysed.

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In recent literature , the size-fraction >63 μm is prevailingly used. In our example, representative results is also obtained for the size-fraction >63 μm.

DIVERSITY OF SIZE-FRACTIONS
The Southern Slovakia Basin, L. Miocene
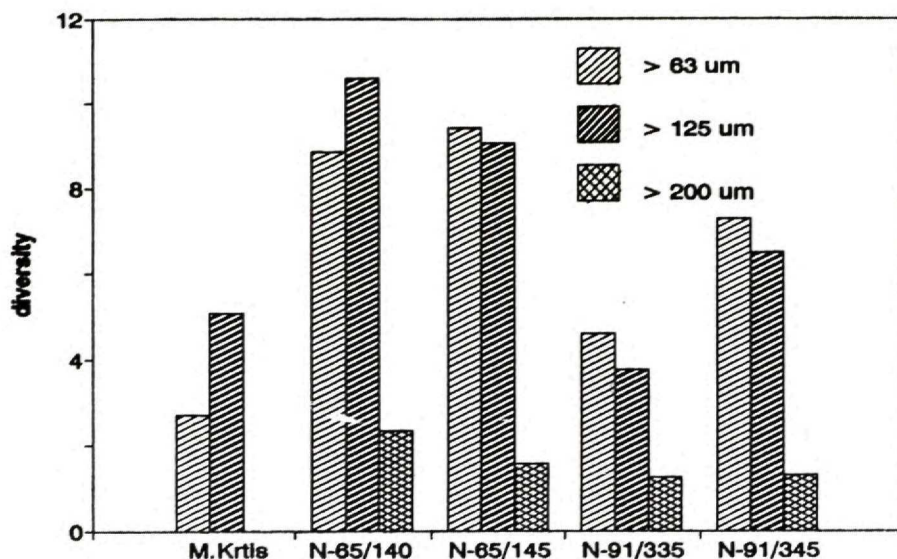
Fig. 1 Differences in diversities of foraminiferal assemblages from size-fraction >63 μm, >125 μm, >200 μm. Samples were collected in the mentioned boreholes from the Rzehakia Mb. of the Ipeľ Basin (Southern Slovakia Basin)

Minimal size of analysed sample

A minimal size of the analysed samples can be expressed by two ways:
1—as a volume of the analysed washing residue or dry sediments (mainly for Recent Foraminifera). Authors use prevailingly 10 ccm (HASEGAWA et al. 1990; GUPTA—SRINIVASAN, 1990), or larger volume (e.g. 10—15 ccm JENNINGS—NELSON, 1992; 30 ccm WOODRUF, 1988).Then the number of analysed foraminifers represents also an abundance of Foraminifera in a volume of dry sediment or in washing residue. An disadvantage of the method is caused by a non-equable abundance of Foraminifera—there are thousands of specimens in some samples and less than 100 in other samples (e.g. KANTOROVÁ, 1972 described assemblages of the Lower Miocene Foraminifera, where numbers of specimens in ccm of washing residue vary from 48 to 40 000 individuals.)

Therefore, some authors determine the minimal size of samples not only by the minimal volume of a sample, but also by the minimal number of the analysed specimens.
2—minimal number of analysed specimens is used mainly for fossil assemblages. On the basis of statistical testing of a minimal number of specimens for analysis of species proportion, BUZAS (1990) recomended 300—400 specimens. Majority of authors analyse minimally 300 specimens

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(e.g. BARMAWIDJAJA et al., 1992; GIBSON—HILL, 1992; HALD—STEINSUND, 1992; WOODRUF, 1988), however, several authors use the minimal size of samples under 300 specimens (250 specimens MURRAY, 1992; 200 specimens HASEGAWA, 1988; TAKAYANAGI et al., 1982). There are even papers dealing with the quantitative analysis of species proportion which do not mention the minimal size of analysed sample.

Our example shows differences in diversity, P/B-ratio and percentage of the commonest species counted gradually for 50, 100, 150, 200, 250, 300, 350, 400 specimens from three samples from Miocene of the Central Paratethys (Fig. 2a—c). Foraminiferal assemblages from the analysed samples differ by their number of species and their species proportion. The results demonstrate (Fig. 11) that the species proportion are reasonably constant (differences in species proportion, diversity and P/B-ratio range from 0 to 5 %) when the minimal size of analysed sample is 300 specimens.

R e c o m m e n d a t i o n : If quantitative analyse of Foraminifera is presented, it is always necessary to mention a minimal size of analysed samples. For the analyse of the species proportion in fossil assemblages, a limitation of the sample size by the minimal number of specimens is considered to be better then by the volume of washing residue. In agreement with the current praxis, our example shows that a sample of 300 specimens is adequate for quantitative study.

Assemblages with broken tests

Several taxons of Foraminifera, like *Stilostomella, Nodosaria, Dentalina, Marginulina, Amphycorina, Frondicularia, Bathysiphon,* more rare *Fursekoina, Bolivina, Bulimina, Spiroplectammina,* often occur in the washing residue in fragments. It is caused mainly by carelles washing of samples, or more rarely by postmortem transport of the tests.
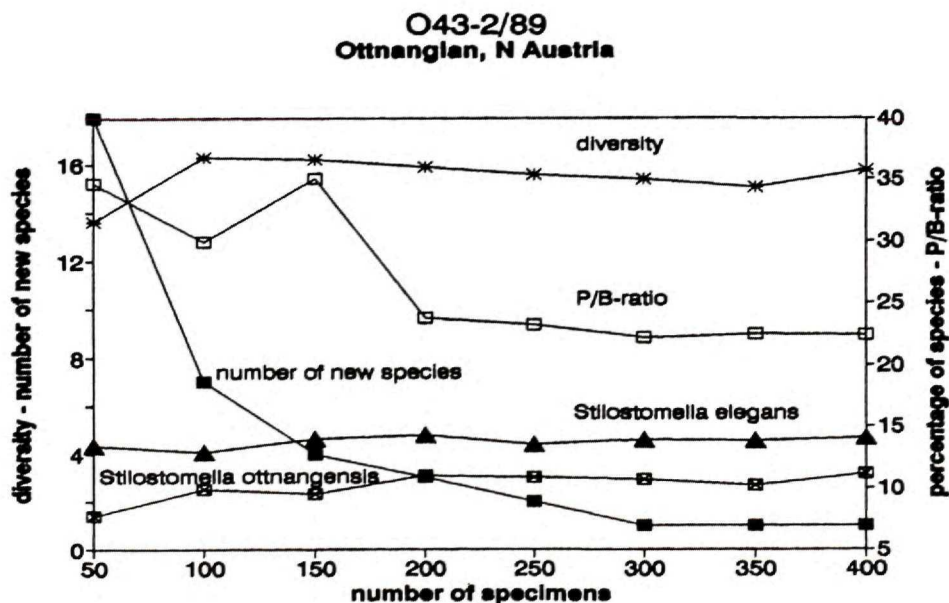
Fig. 2 Differences in diversity, P/B-ratio and percentage of the commonest species counted for different numbers of individuals in foraminiferal assemblages from the Ottnangian in N Austria (Fig. 2a), from Rzehakia Mb. in the Ipeľ Basin (Fig. 2b) and from the Upper Badenian of the Vienna Basin (Fig. 2c)

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N-65/340 m

Fig. 2b

DEVINSKA NOVA VES
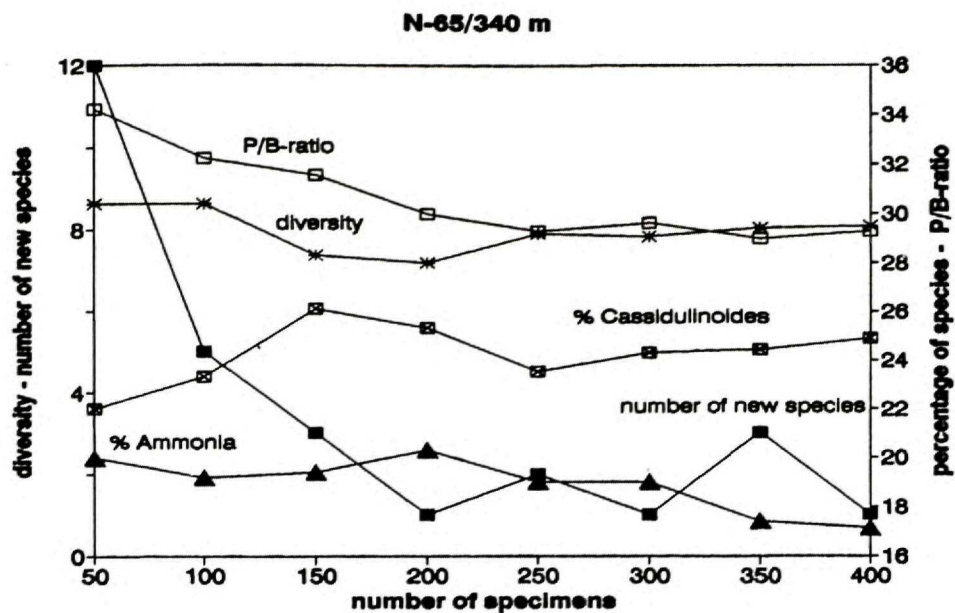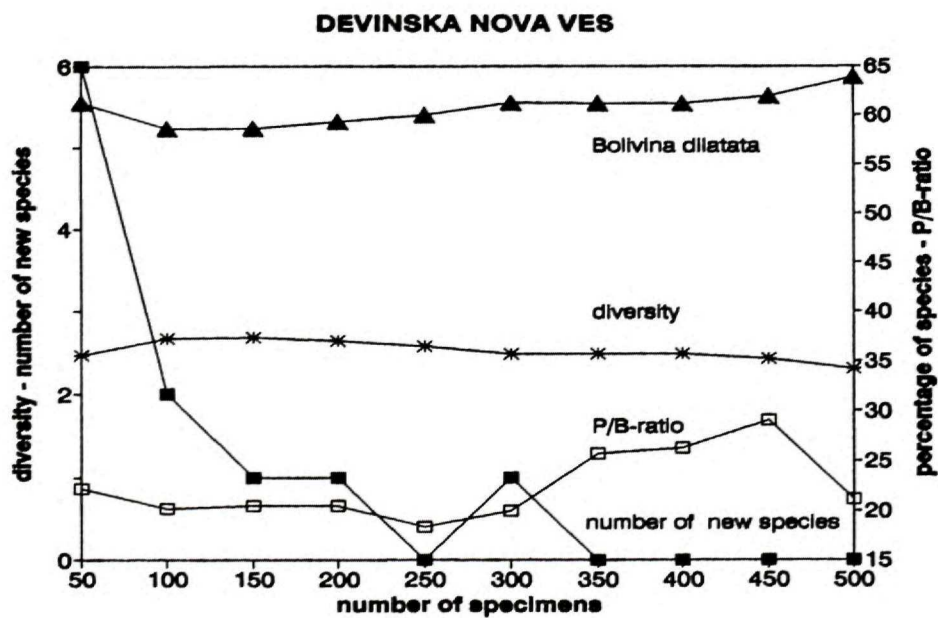
Fig . 2c

The fragments can be counted by the following methods:

1—only fragments bigger than a half of test is counted,

2—every fragment is counted as whole specimen,

3—the fragment can be counted as an aliquot part of specimens (e.g. 1/2, 1/3). Finaly the fractions of every species were added together. The determination of the aliqout part may be sometimes questionable (e.g. for species *Stilostomella, Nodosaria, Dentalina*).

Very often some fragments are taxonomically undeterminable, however this undeterminable rest is noted in literature very rare (e.g. RUPP 1987).

Our example (Fig. 3) shows differences in the diversity of assemblages with broken tests, using the methods 2 and 3 for a counting of the fragments. For a comparison,the percentage of broken species in assemblages is given. Differences in diversity may be high (75 % in assemblage with 50 % of broken specimens).

ERRORS IN DIVERSITY -
SAMPLES WITH BROKEN SPECIMENS
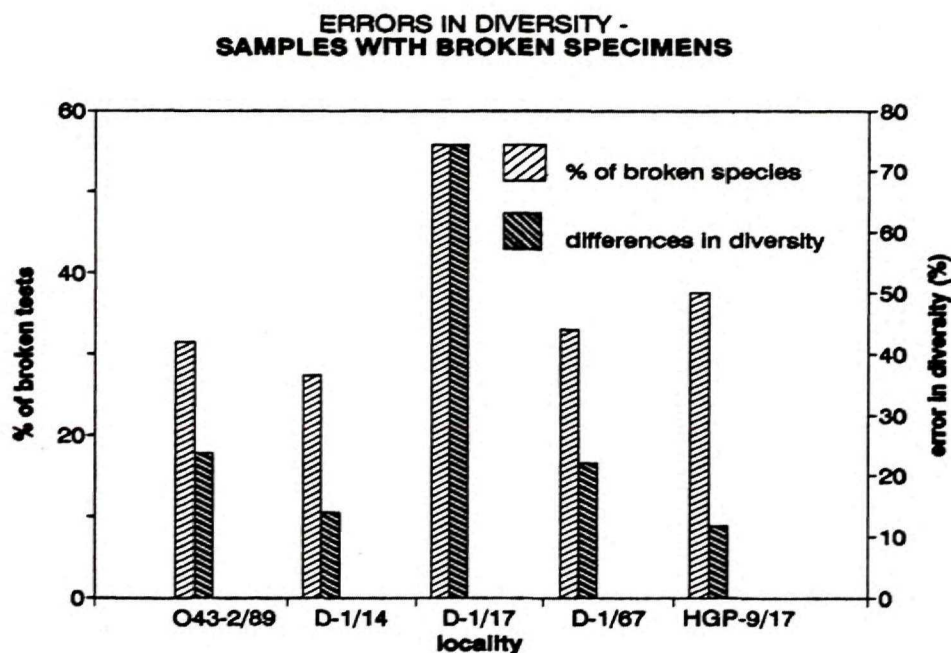
Fig. 3 Differences in diversity of foraminiferal assemblages with broken tests, using different methods for counting fragments (for explanation see text). For a comparison, the percentage of broken species in assemblages is given. Assemblages are from the Lower Miocene of the Central Paratethys

Recommendation : Astandard method of the counting of broken tests should be given when more than 10 % of broken specimens appears in analysed assemblages. Any mentioned method is not fully objective. On the basis of own observation, the counting of fragments like a parts of the whole specimens is considered to be the most convenient method. We can recommended to note a percentage of undeterminable fragments. The best solution is the prevention: to wash samples for the quantitive analysis very carefully, because careless washing causes the majority of the breakages of the foraminiferal tests.

Postmortal changes in foraminiferal assemblages

The transport of foraminiferal tests by various types of oceanic currents (e.g. tidal, waves, upwelling), turbidity currents, wind, ice and by floating plants or bioturbation and dissolution of foraminiferal tests (MURRAY, 1991) caused that in fossil record it is practically impossible to meet foraminiferal assemblage corresponding with living one. Therefore, an influence of the postmortem changes on assemblages must be evaluated if quantitative analysis of fossil foraminiferal assemblages is interpreted. Following examples show differences in the diversity of foraminiferal assemblages caused by postmortem changes.

Diversity of mixed assemblages

The commonest consequence of a transport of foraminiferal tests or of bioturbation is a mixing of two or more living foraminiferal assemblages. The diversity of the mixed assemblages depends on diversities of original living assemblages as well as on the differences among the original assemblages. The diversity of the mixed assemblages is always higher then the lowest diversity of the original assemblages and it can be higher than the highest diversity of original assemblages if similarity of the assemblages is low.

Fig. 4 shows time and space relationships among original assemblages in the mixed assemblage.

In fossil record it can be problematic to distinguish a mixing of isochronouos assemblages from a mixing of succesive assemblages if stratigraphical ranges of species are the same. An influence of these types of mixing on diversity of mixed assemblages are documented in our example (Figs. 5, 6). Input data are represented by observation of species proportion of Recent foraminiferal assemblages in two stations, in every months during a year (BUZAS et al., 1977). Seasonal changes in diversity of assemblages given in Fig.5 are not so high (about 30 %). They can be higher if seasonal changes of temperature and huminidy are decided. They can caused oscilations of salinity, O_2-content, fertility, etc. Then, high diversity of the mixed fossil assemblages (f.e. mixed by bioturbation) can record high seasonality. It can be distinguished according to the mixing of species with different ecological requirements.

The comparison of diversities of isochronous assemblages in two stations with mixed assemblage is given in Fig. 6. In this case, high diversity of fossil assemblage may indicate marked paleoenvironmental differences among original assemblages, and it shows heterogeneous environmental conditions in basin.

Fig. 7 shows diversities of fossil foraminiferal assemblages in paleoecologically unstable conditions from the Uppermost Egerian in the Southern Slovakia Basin. Assemblages with high diversity appear among low-diversified assemblages containing euryhaline species (predominantly *Ammonia*). Analysis of the life habitat of species from high-diversified assemblages enables distinguished a group of the euryhaline taxons (*Ammonia, Porosononion, Triloculina*) and group of euryoxibiont taxons (mainly *Bolivina*, rarely *Globocassidulina, Praeglobobulimina*). If indexes of diversity of these groups are counted, their values are similar to the values of indexes of the low-diversified assemblages. An interpretation of a cause of the mixing of the assemblages is questionable: primary assemblages might be isochronous and then the mixing of assemblage indicates transport of hyposalinic assemblages from marginal part of basin to badly-aerated deeper part of the basin. The second possibility is a mixing of succesive assemblages by bioturbation. In this case, the mixed assemblage shows short-time local change of salinity and water circulation in the basin.

R e c o m m e n d a t i o n s : Classic criteria for identifications of the postmortem transport of foraminiferal tests (different preservation of tests, size-assorted tests) become evident only under specific conditions. In the majority of samples it is necessary to find other criteria. It may

D=determination of the type of mixing, C=cause of mixing

time-distance difference in paleoenvironment of assemblages	NO Isochronic assemblages	SHORT-TIME n.10-n.10 years	LONG-TIME
SIMILAR PALEOENVIRONMENT	D: no indication of mixing under severe condition: size-sorted tests abraded & destroyed tests		D: different stratigraphical range under severe condition: size-sorted tests abraded & destroyed tests
	C: transport by powerfull tidal currents, 'storm waves, oceanic currents, gravity currents (rare)	C: bioturbation	C: gravity (turbity) current emersion and denudatition of underlying rocks
DIFFERENT PALEOENVIRONMENT	D: different life habitat under severe condition: size-sorted tests abraded & destroyed tests		D: different stratigraphical range different life habitat under severe condition: size-sorted tests abraded & destroyed tests
	C: mixing of planktonic, epiphytic, benthic species on the bottom, transport by powerfull tidal currents, 'storm waves, oceanic currents, gravity currents	C: bioturbation,	C: gravity (turbity) current, emersion and denudatition of underlying rocks

Fig. 4 Possibilities to mix the foraminiferal tests in time and space

SEASONAL CHANGES IN DIVERSITY
Station 1, N coast of Jamaica
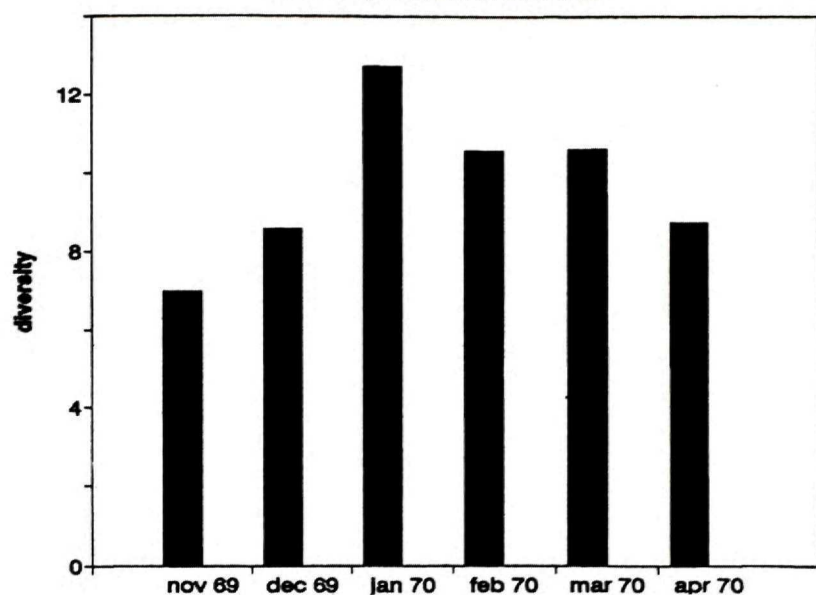
Fig. 5 Seasonal changes in diversity of foraminiferal assemblages. Input data were published by BUZAS et al. (1977)

DIFFERENCES IN DIVERSITY-STATION 1 & 2
N coast of Jamaica (Buzas et al. 1977)
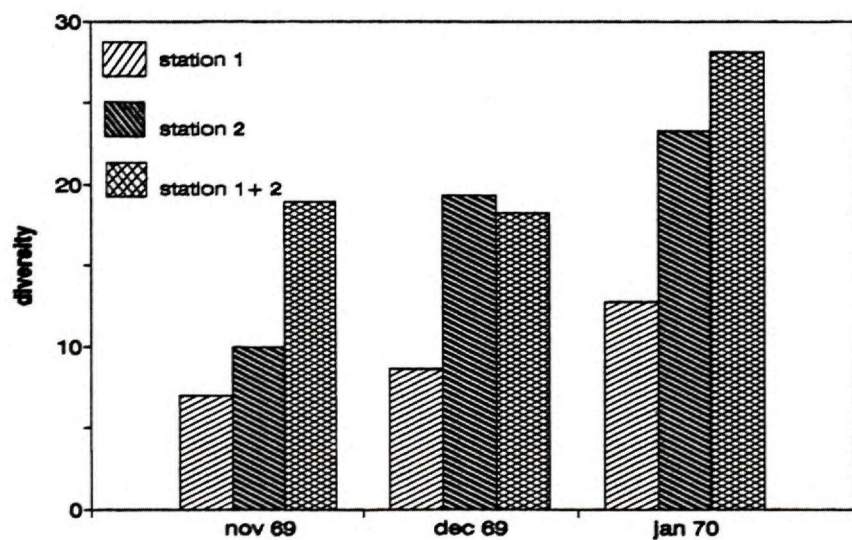
Fig. 6 Comparison of diversities of two isochronous assemblages with diversity of theoretically mixed assemblages. Input data were published by BUZAS et al. (1977)

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ČO-1 borehole
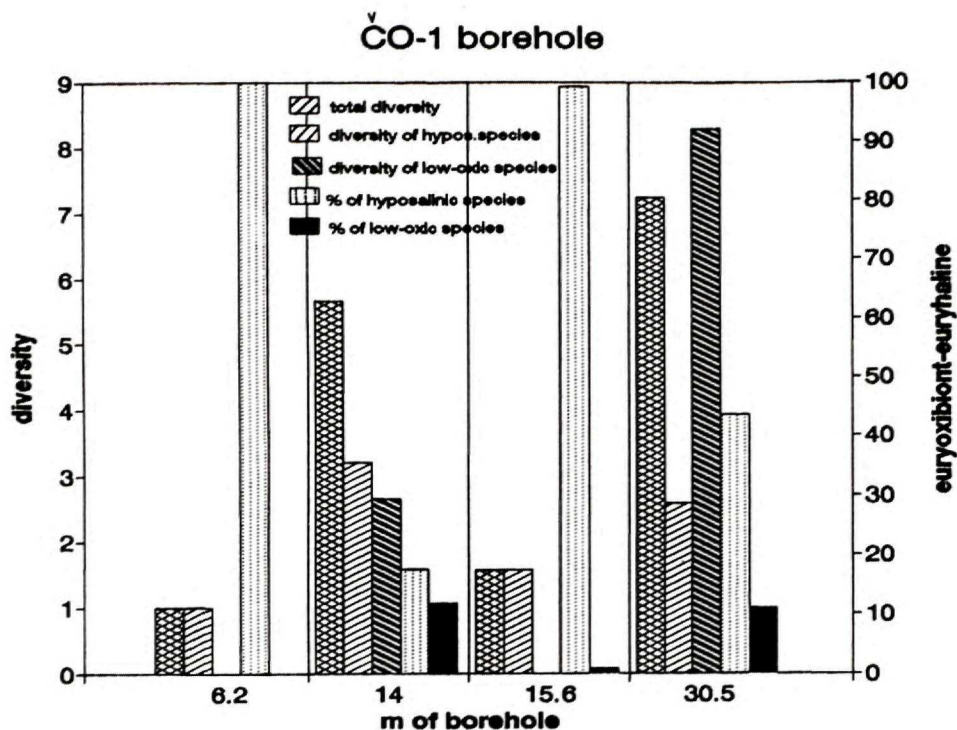
Fig. 7 Comparison of diversities of mixed and non-mixed foraminiferal assemblages in fossil record (for explanation see text). The samples were collected in sediments of the Uppermost Egerian in the Southern Slovakia Basin

be e.g. the co-existence of species with different stratigraphical ranges or different ecological requirements. Different paleoenvironment can be demonstrated also by the presence of different ecophenotypes of the same species. Many informations can give sedimentological and facial analysis, e.g. data about dynamics of sedimentary environment (on the base of Recent observation resumed by MURRAY, 1991, up to 20 % of reworked Foraminifera are in estuaries with tidal range up to 2 m, while 5—85 % in estuaries with tidal range over 4 m), bioturbation, an emergence and denudation of sediments with older Foraminifera, etc. However, in many cases the recognition of reworked tests is impossible. Therefore, it is necessary to consider the fossil foraminiferal assemblages (with exception of the assemblages from non-bioturbated sediments and from low-energy enviromnent) as an "average" group of taxons which lived during tens to thousands years in the area of a transport of the test-sized particles.

Foraminiferal "assemblages" in event beds

According to EINSELE and SEILACHER (1991), event beds are "the result of high energy episodes, in which bottom material (including its fauna) is reworked by current or wave action and gravity forces, transported some distance in suspension, and redeposited".

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A composition of foraminiferal "assemblages" in event beds depends on physical properties of the current (particles of certain size and form are transported under certain velocity and density of current) and on a composition of foraminiferal assemblages in the sources bottom material. Therefore, a composition of foraminiferal assemblages may be used for an analysis of the sources of clasts in turbidites (HEIKE et al., 1990). It is necessary to be carefull, because also the interbeds of event beds often do not content autochthonous Foraminifera, or autochthonous Foraminifera are worse preserved like reworked ones. It occurs e.g. in the Western Carpathian flysch.

The diversities of the foraminiferal assemblages from the Lower Miocene tempestites from the Southern Slovakia Basin are given in Fig. 8. Samples were collected in twos from lithologically different stratulums (Fig. 8). Different foraminiferal assemblages were expected in every litothyp, but our results showed that a pairs of overlying, litohologically different stratulums contain very similar assemblages distinguishable from other pairs. It could indicate that the deciding influence on composition of foraminiferal "assemblages" in analysed tempestites had a composition of Foraminifera in reworked and transported bottom material. An influence of the grading of foraminiferal tests during redeposition in suspension was not observed.

DIVERSITY OF FORAMINIFERA ASSEMBLAGES
Rzehakia Mb., The S.Slovakia Basin
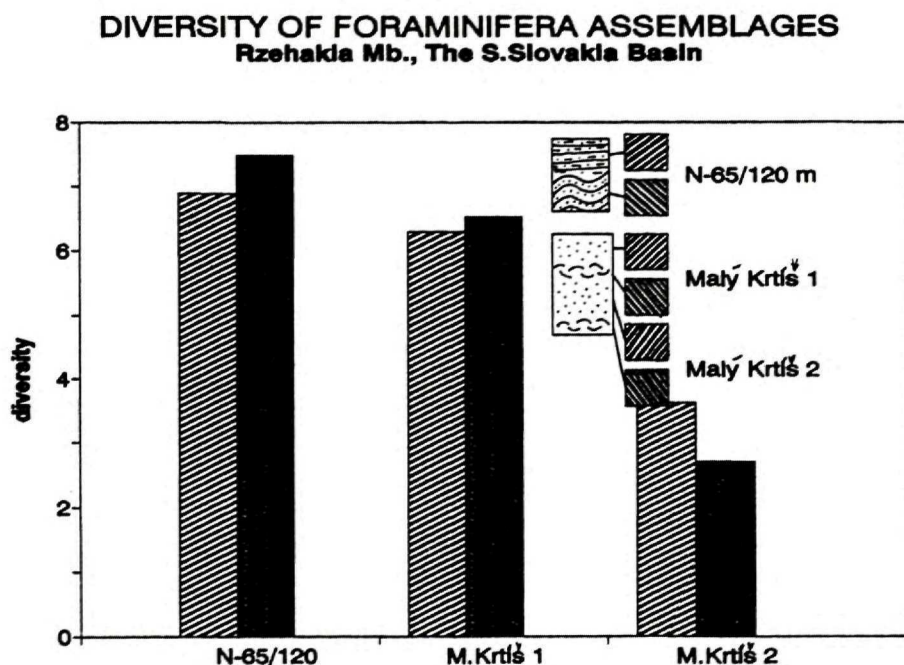
Fig. 8 Diversities of foraminiferal assemblages from event beds (tempestites (?) from Rzehakia Mb. in the Ipeľ Basin). Lithologic characteristic of analysed samples is given in the top right corner of the figure

R e c o m m e n d a t i o n : Analysis of foraminiferal assemblages from event beds gives information about sources material of the beds. Therefore, the analysis can be used for sedimentological study, not for paleoecological and biostratigraphical analysis in the place of resedimentation of the material from suspension.

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Destruction of foraminiferal tests

The foraminiferal tests can be destructed through dissolution, transport and abrasion, and disintegration of agglutinated tests held together by organic material.

Dissolution of the foraminiferal tests are well-know in deep-water sediments as well as in shallow-water ones. The dissolution of tests can be realized during sedimentation or during diagenesis. The diagenetic dissolution may be manifested by the occurrence of natural casts (e.g. glauconitic or pyritic). Selective character of dissolution of tests of different species is well-know (e.g. CORLISS—HONJO, 1981; BOLTOVSKOY, 1991).

The destruction of tests by a transport and abrasion can be manifested by presence only robust and often damaged (broken, abrased) tests. Similar preservation of tests can be caused by carelles washing of samples (see 1.2.).

The disintegration of agglutinated tests is indeterminable in fossil record. According to the recent observation, the disintegration is very quick and common process (SMITH, 1987; JORISSEN, 1988).

R e c o m m e n d a t i o n : Destruction of the foraminiferal tests represents a significant losses of fragile tests and tests susceptible to dissolution. Such losses are difficult to recognize in fossil record and their quantification is almost to impossible. Therefore, the quantitative analysis of the assemblages with evident indication of abrasion of tests or dissolution is pointless.

Foraminiferal abundance

There are more possibilities to express abundance of Foraminifera in fossil record:
    1—SCHOTT's foraminiferal number (= number of specimens in 1 g dry weight of sediment),
    2—number of foraminifers in 1 g of washing residue,
    3—number of foraminifers in a volume of dry sediment or washing residue.
It is important to realise that these abundance measurments give different information (Fig. 9). All measurements depend on: 1—original number of living foraminifera in the analysed place; 2—intensity of transport of the tests and their destruction; 3—intensity of supply of terrigenous material.

To eliminate the influence of different supply of the terrigenous material, the abundance of foraminifers can by calculated for a time interval. The calculation requires to know depositional rate and thickness of washing samples. (Core samples are the most convenient.) Abundance in a time k (A_t) can be counted according to the formula:

$$A_t = k \frac{n_f v}{d_c}$$

where n_f is number of foraminifers in sample, v is depositional rate and d_c is thickness of the core sample. The accuracy of counted value depends mainly on determination of depositional rate, because the rate is known for certain time interval, not for separate samples. Therefore, it is necessary to consider the index A_t as a rough estimate of the average abundance. It is showed in our example (Fig. 10). Given values of abundance were counted on the base of average depositional rates for the Oligocene and Miocene stages in the Ipeľ Basin (VASS, 1987). Foraminiferal numbers represent also average values for the stages. Naturally, these input data can give only a tentative information about the abundance. The example also shows differences among the measurements of the abundance.

The abundance of Foraminifera in the event beds depends on the abundance of foraminifers in the sources material as well as on the density of suspensed load. Fig.11 shows values of the

N-91 BOREHOLE
abundance of Foraminifera
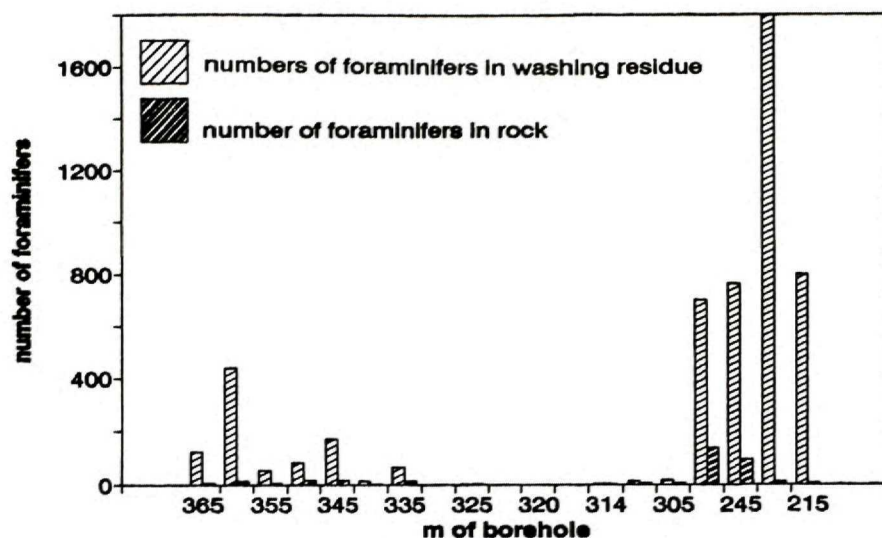
Fig. 9 Influence of different measurements on foraminiferal abundance in the N-91 borehole from Rzehakia Mb. in the Southern Slovakia Basin

AVERAGE ABUNDANCE OF FORAMINIFERA
Kiscellian-Karpatian, South.Slovakia B.
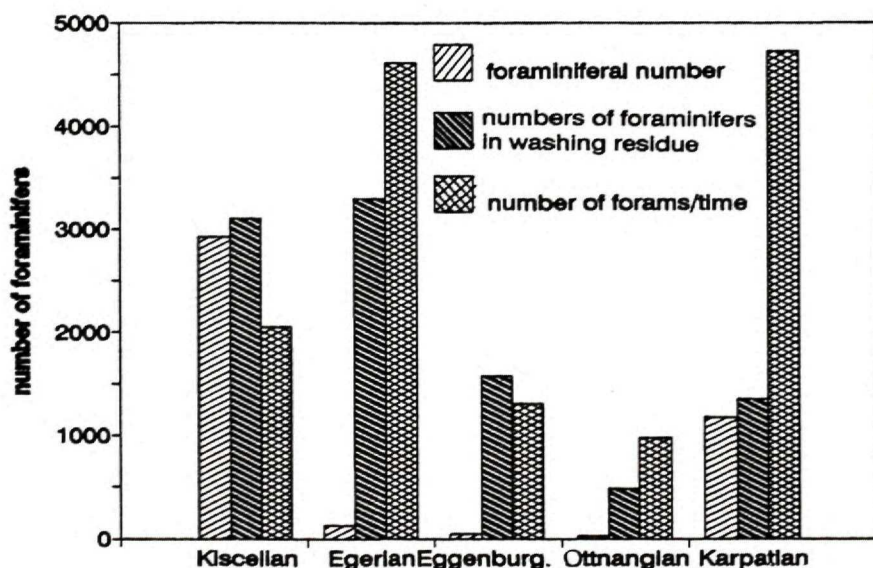
Fig. 10 Average abundance of Foraminifera from the Oligocene and Miocene in the Ipeľ Basin. Used depositional rates were published by VASS (1987)

abundance of foraminifers in the tempestites from Fig. 8. While the abundances are different in foraminiferal assemblages from pairs of samples from sandstone and siltstone, no differences were observed between the abundances of Foraminifera from sandstone and lumachelle.

R e c o m m e n d a t i o n : The abundance counted for fossil Foraminifera is a rough index. All presented measurments of the index give only tentative results depended on the abundance of living Foraminifera as well as depositional rates and an intensity of reworking of the assemblages. Rapid multiple increasing or decreasing of foraminiferal number indicate usually changes in the depositional rate.

ABUNDANCE OF FORAMINIFERA
Rzehakia Mb., The S. Slovakia Basin
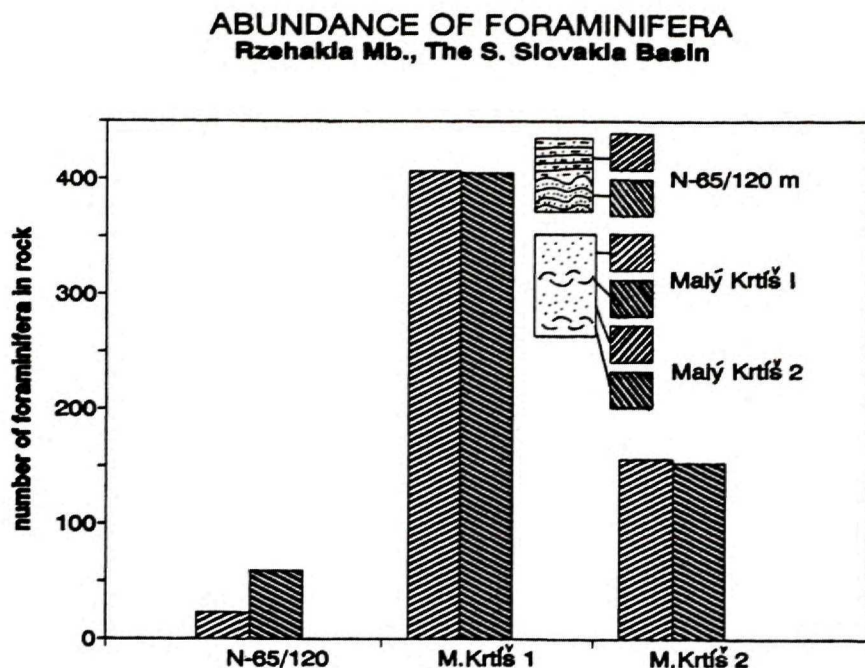
Fig. 11 Abundance of Foraminifera from event beds (tempestites (?) from Rzehakia Mb. in the Ipel' Basin). Lithologic characteristic of analysed samples is given in the top right corner of the figure. Diversities of the assemblages are given in Fig. 8

Conclusions

The recent level of knowledge about Foraminifera assemblages in the Central Paratethys makes possible to start with detail analysis of Foraminifera requiring a quantitative analysis of the assemblages. For obtaining of comparable data, it is necessary to use standard methods. In our paper, an influence of some factors on the quantitative analysis is presented. The summary of results is given in the Fig. 12. According to it, following recommendations for standardizing of the quantitative results can be given:

1—Minimal sample size for analysis of species proportion should be 300 specimens. The sample size is necessary to mention in the description of used methods.

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METHODS	minimal number of caunted specimens	error in diversity
	100	+ 8 - 15 %
	200	+ 2 - 10 %
	300	+ 0 - 2.5 %
	400	+ 2 - 4 %
	size fraction of assemblages	error in diversity
	> 63 um	0 %
	> 125 um	- 25 % + 85 %
	> 200 um	- 85 %
	percentage of broken specimens	error in diversity
	10 - 25 %	+ 10 %
	25 - 50 %	- 25 % + 25 %
	> 50 %	+ 75 %
POSTMORTEM CHANGES IN ASSEMBLAGES	differences in diversity during year	Recent + 30 %
	differences in diversity among biotops	Recent + 110 %
	differences in diversity between mixed and non-mixed assemblages	Recent - 10 % + 130 % Fossil - 15 % + 110 %

Fig. 12 Differences in diversity of foraminiferal assemblages caused by using of different methods or by postmortem changes in assemblages. The differences result from the examples given in this paper

2—Size fraction $>63 \mu$m is recommended for quantitative analysis of Foraminifera. In special cases, when very small-size foraminifers are observed in sample, analysis of more fine fraction is appropriate.

3—The best methods of counting of the fragments of tests is considered to count in them like a fractions of whole specimens and finaly to add them for every species.

4—Sedimentological and facial analysis is very usefull for a study of postmortem changes in the foraminiferal assemblages. All possible data would be mentioned like a input data for taphonomic analysis.

5—It is helpfull to analyse paleoecological requirements of taxa in assemblages, their stratigraphical ranges and a size and form of tests in assemblages, because it can give information about postmortal transport.

6—There are several measurments of the abundance of foraminifers (number of individuals in sediments, in washing residue and in time unit) which give different values. Every measurement represent a rough index depended on intensity of postmortem changes in assemblages and momentory depositional rate.

7—Foraminiferal assemblages from event beds record informations about source material transported in suspension. Therefore, their analysis can be used only for study of origin of the material.

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KATARÍNA HOLCOVÁ —ŠUTOVSKÁ

Kvantitatívne analýzy foraminiferových spoločenstiev — ako štandardizovať údaje

Resumé

Najnovšia úroveň poznatkov o spoločenstvách foraminifer v centrálnej Paratetýde umožňuje začať s ich detailnou analýzou, ktorá vyžaduje kvantitatívne vyhodnotenie spoločenstiev. Porovnateľné údaje získame len pri použití štandardných metód. V práci uvádzame vplyv niektorých faktorov na výsledky kvantitatívnej analýzy spoločenstiev, ktoré zhŕňuje obr. 12. Na tomto základe môžeme odporučiť tieto zásady štandardizácie kvantitatívnych výsledkov:

1—Minimálna veľkosť vzorky na výpočet pomerného zastúpenia taxónov v spoločenstve by mala byť 300 jedincov. V popise použitých metód by sme mali minimálnu veľkosť vzorky vždy uvádzať.

2—Kvantitatívne analyzovať spoločenstvá foraminifer odporúčame z frakcie nad 63 μm. V špeciálnych prípadoch, keď vzorka obsahuje veľmi drobné foraminifery, je vhodná aj analýza jemnejších frakcií.

3—Úlomky schránok odporúčame započítavať ako zlomky celých schránok, ktoré sčítame a priradíme k príslušným taxónom. Za vhodné pokladám uvádzať podiel neurčiteľného zvyšku.

4—Kvantitatívna analýza spoločenstiev by mala byť vždy spojená s ich taxonomickou analýzou. Východiskom takejto analýzy môžu byť údaje o paleoekologických nárokoch druhov v spoločenstve, ich stratigrafickom rozpätí, veľkostnej a tvarovej variabilite schránok vo vzorkách, ako aj sedimentologická a faciálna analýza spracúvaných profilov.

5—Hojnosť foraminifer býva vyjadrená viacerými spôsobmi, napr. počet jedincov v sedimente, počet jedincov vo výplave, ktoré môžu byť pri znalosti rýchlosti sedimentácie prepočítané na počet foraminifer za určitú časovú jednotku. Rôzne spôsoby vyjadrenia hojnosti foraminifer poskytujú rôzne hodnoty, ktoré musíme vo všetkých prípadoch chápať ako orientačné, závislé od intenzity postmortálnych zmien v spoločenstvách, okamžitého prínosu terigénneho materiálu a produktivity foraminifer.

6—Foraminiferové spoločenstvá zo sedimentov vznikajúcich epizodickou sedimentáciou (napr. z turbiditov, tempestitov) poskytujú informácie o zdrojovom materiáli, a nie o podmienkach na mieste uloženia tohto materiálu transportovaného v suspenzii. Analýza foraminiferových spoločenstiev sa preto môže použiť na štúdium pôvodu zdrojového materiálu.

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JÁN SOTÁK — LADISLAVA OŽVOLDOVÁ

Occurrences of Upper Jurassic radiolarites in the Outer Flysch Carpathians

2 text-figs., 8 pls. (XXX—XXXVII) Slovak summary

A b s t r a c t. By this time there have been no reliable references on the occurrences of the Upper Jurassic radiolarites in the Flysch Carpathians. In the article we give characteristics of the radiolarites from pebbles and block klippes of the Ždánice unit and from detritus of flysch sandstones in the Fore-Magura unit (Chvalčov beds). We have evaluated their microfacies, diagenetic features (preservation of radiolarian tests, types of veinlets etc.), species composition of extracted radiolarians (26 species), age of radiolarian associations (Upper Oxfordian), coeval facies of the other Upper Jurassic pelagites in the products of the Silesian cordillera and spatial distribution and paleotectonic significance of radiolarite period in the development of the Jurassic sedimentation of the Outer West Carpathians and Subalpine zone.

Introduction

Radiolarites rarely occur in the Flysch Carpathians and therefore each new datum on them is a valuable contribution. Radiolarites, or closely unspecified cherts, in the flysch units were not only in two sites. PÍCHA—HANZLÍKOVÁ (1965) described grey-brown cherts and reddish nodular limestones in block klippes near Zaječí (Ružový vrch), and MATĚJKA—ROTH (1949) noted occurrences of greenish, grey-green and pink radiolarite limestones near forester's cottage Baraní in the Moravskosliezske Beskydy Mts. Both these occurrences were correlated with Doggerian—Malmian radiolarite formations of the Klippen Belt or Krížna unit.

New radiolarite occurrences have been noted in conglomerate pebbles of the Ždánice unit and flysch detritus of the Chvalčov beds of the Fore-Magura unit. Thin-section studies yielded the first microfacies descriptions of these Outer Carpathians radiolarites. Rich assemblages of radiolarian microfauna were extracted by HF dissolution of radiolarite samples, which in turn made it possible to determine in more detail their age as well as make correlations based on the occurrences of characteristic species.

The Upper Jurassic radiolarites are sediments deposited below the CCD zone at a time of the greatest deepening of the Tethyan basins (GRUNAU, 1965; JENKYNS—VINTERER, 1982; WIECZOREK, 1988 and others). Their occurrences in the Flysch Carpathians therefore significantly influence the reconstruction of the Mesozoic development in this area (SOTÁK, 1990).

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Radiolarites from Ždánice unit conglomerates and block klippes near Zaječí

Variegated radiolarites have been noted in conglomerate pebbles of the Ždánice-Hustopeče beds in localities Velké Pavlovice and Milovice and in block klippes along Čejč-Zaječí zone thrust line near Zaječí (Fig. 1).

The radiolarites are either massive of a vitreous luster (radiolarite jaspers) or disintegrating into fragments and intercalated with red claystones. Their red, green or ochre-brown coloration is caused by ferrous-or ferric-oxide pigment (GRUNAU,1965). The greenish coloration of some radiolarites resulted from post-depositional reduction of hematite in parts poor in clay admixture or along diverse small joints and bedding planes (McBRIDGE— FOLK, 1979). That is why alternating bands of different colour (mottled radiolarites) occur even within a single sample. The radiolarite matrix consists of siliceous-marly or richly hematite-impregnated chalcedony. Its texture is microcrystalline. The radiolarian shells have calcified margins and their central capsules are filled with sheafy and spherulitic aggregates of pure chalcedony. The central aggregate has fibrous-radial texture and passive globular contours (compare MIŠÍK, 1973). In other instances, radiolarian shells were filled with fibrous chalcedony of two separate phases (peripheral and central), selectively calcified, filled with pigmented interstitial matter or Fe_2O_3 colloids or the shells were exceptionally replaced by an optically single calcite individual. Marly radiolarites, however, also host perfectly preserved nasellarian-and spumellarian-type shells (Pl. XXXI, figs. 3,4). In more silicified varieties, biogenic textures were obscured and the rock has the character of cryptogenic silicites. Their matrix consists of amorphous silica. They contain resorbed radiolarian shells in the form of spherulites ("molds"), dispersed tiny carbonate rhombohedrons and other authigenic products (apatite, rutile, chlorite pellets etc.).

The radiolarites are interlaced with a dense network of veinlets of several generations. Hair veinlets filled with one or two generations of fibrous ("asbestos") chalcedony were formed by the dehydration of siliceous gel in contraction joints. These are cut and segmented by younger calcite veinlets (Pl. XXXII, figs. 1, 2). Oblong vacuoles filled with radially fibrous and zebra-like chalcedony aggregates (Pl. XXXIII, fig. 1) are probably syngenetic as well. The younger calcite veinlets are orthogonal relative to the system of syngenetic veinlets. Calcite in these veinlets has coarse-grained druse or prismatic texture (recrystallized lattice-textured veinlets-see MIŠÍK, 1971). Corrosive rims of short-fibrous chalcedony along intercrystal planes in calcite or on the walls of the veinlets (Pl. XXXIII, fig. 2) suggest that the formation of some of these veinlets was accompanied by gradually ending migration of siliceous colloids. The epigenetic veinlets are filled with calcite containing inclusions of a radial-fibrous mineral which, as is suggested by its positive optical elongation, is quartzine and not chalcedony (chalcedony was only identified by optical methods in shell fillings and syngenetic veinlets).

A special case of the described rock type are epidotized silicites from pebbles at Milovice. Their colour and microscopic character are virtually equal to those of radiolarite cryptogenic varieties, but in contrast the silicites were epidotized along fissures and markly admixture in their siliceous groundmass underwent epidotization as well. In addition to epidot, the veinlets also contain authigenic quartz, albite and chlorite. Oval zoomorphs rarely present in the groundmass might be radiolarian remains. It is not clear, however, whether these metasomatic-metamorphosed silicites can be assigned into the Upper Jurassic radiolarite facies.

Exact biostratigraphic data on the age of the radiolarites from pebbles and blocky accumulations of the Ždánice unit were obtained by studies of extracted microfossils. Rich radiolarian assemblages were extracted from pebbles collected at Velké Pavlovice. These include the following genera and species: *Andromeda* cf. *praepodbielensis* BAUMGARTNER, *Archaeodictyomitra* sp., *Archaeospongoprunum implayi* PESSAGNO, *Bernoullius dicera* (BAUMGARTNER), *Emiluvia orea* BAUMGARTNER, *Emiluvia chica* FOREMAN, *Emiluvia sedecimporata salensis* PESSAGNO, *Homoeoparanaella elegans* (PESSAGNO), *Hsuum brevicostatum* (OŽVOLDOVÁ),

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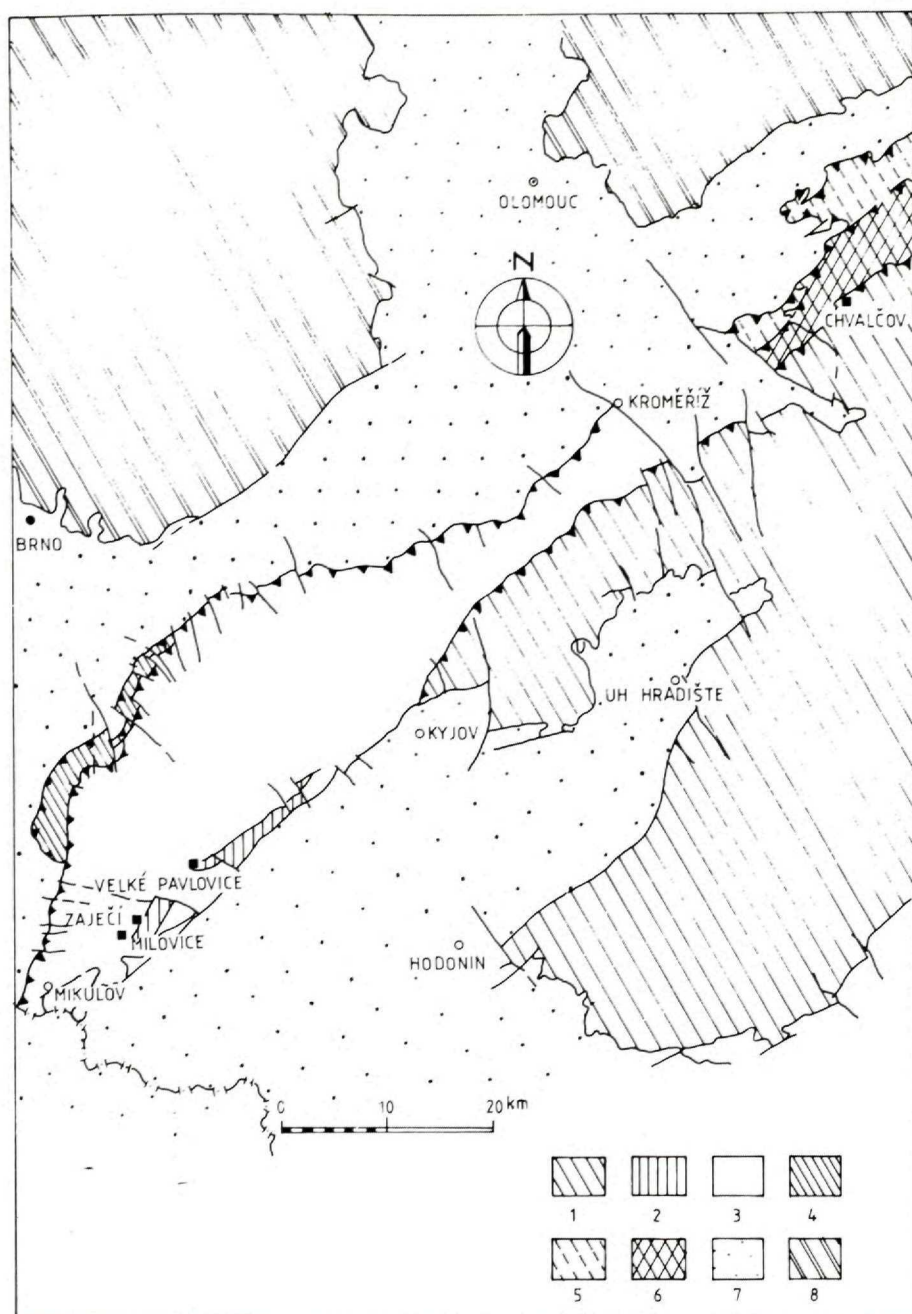
Fig. 1 Location of Upper Jurassic radiolarite occurrences in flysch units of the Outer Flysch Carpathians:
1—Magura group of units, 2—Čejč-Zaječí zone, 3—Ždánice unit, 4—Pouzdřany unit, 5—Subsilesian unit,
6—Silesian unit, 7—Miocene sediments of Vienna Basin and Carpathian Foredeep, 8—Bohemian Massif
crystalline

Mirifusus guadalupensis PESSAGNO, *Napora deweveri* BAUMGARTNER, *Orbiculiforma* sp., *Paronaella kotura* BAUMGARTNER, *Paronaella mulleri* PESSAGNO, *Patulibracchium* sp., *Perispyridium tamanense* PESSAGNO et BLOME, *Podobursa triacantha* (FISCHLI), *Pseudocrucella* cf. *procera* OŽVOLDOVÁ, *Sethocepsa leiostraca* FOREMAN, *Spongocapsula* cf. *perampla* PESSAGNO, *Staurosphaera antiqua* RÜST, *Tetraditryma pseudoplena* BAUMGARTNER, *Tetratrabs zealis* (OŽVOLDOVÁ), *Triactoma blakei* (PESSAGNO), *Triactoma jonesi* (PESSAGNO), *Tritrabs casmaliaensis* (PESSAGNO), *Tritrabs exotica* (PESSAGNO) and *Tritrabs hayi* (PESSAGNO).

The most abundant species are *Emiluvia orea* BAUMGARTNER and *Tetratrabs zealis* (OŽ-VOLDOVÁ). Abundant occurrences of species *Emiluvia orea* BAUMGARTNER known since U.A.7 zone of BAUMGARTNER's (1974) stratigraphic division and the presence of species *Bernoullius dicera* (BAUMGARTNER), *Mirifusus guadalupensis* PESSAGNO, *Napora deweveri* BAUMGARTNER, *Tritrabs casmaliaensis* (PESSAGNO) and *Tritrabs exotica* PESSAGNO whose last occurrences are in U.A.8 zone of BAUMGARTNER's (pers. comm.) stratigraphic division suggest that our assemblage corresponds to the upper part of the Lower Oxfordian to Upper Oxfordian (lower and upper parts of B zone according to BAUMGARTNER, 1987).

The Oxfordian age of the radiolarites is also indicated by their occurrence in block klippes near Zaječí where they are accompanied by other Upper Jurassic sediments. PÍCHA and HANZLÍ-KOVÁ (1965) here describe blocks of Oxfordian to Lower Tithonian calcareous claystones with radiolarians, rhaxae, foraminifers (abundant nodosarians, paalzovelles, spirillinas, *Kurnubia wellingsi* etc.), as well as limestone blocks with fragments of calpionelid, muddy limestones (Upper Tithonian), blocks of sandstones and sandy limestones etc.

The age and lithological character of the described radiolarites from pebbles and block klippes of the Ždánice unit are very similar to those of the Czajakowa Radiolarites of the Pieniny Klippen Belt. This is also confirmed by the fact that the identified radiolarian assemblages are in many respects equal to the assemblages from radiolarites of the Klippen Belt Kysuca succession at Myjava-Turá Lúka, Vršatec (upper part of radiolarite horizon) and in the Varín tract of the Klippen Belt at Brodno, Snežnica and Lopušné Pažitie (OŽVOLDOVÁ, 1975, 1987, 1988 etc.).

Radiolarites in flysch detritus of the Chvalčov beds

No radiolarites have so far been noted among pebbles of Magura belt conglomerates. Radiolaries, however, are brittle and readily break down in the course of transport and therefore they might have been overlooked. That is why it is necessary to search for them in the psammitic fraction. This was confirmed by microscopic investigations of sandstones of the Fore-Magura unit Chvalčov beds whose detritus was found to contain abundant radiolarite clasts (Pl. XXXI, fig. 1).

The fragments of reddish radiolarites and cherts in the flysch detritus of the Chvalčov beds reach as much as 3 mm in size. They are mostly cryptogenic, composed of amorphous, siliceous matter and spherulites of pure radial-fibrous chalcedony (radiolarian zoomorphs). The type with microcrystalline and colloform texture of groundmass were also noted. They often contain small carbonate rhombohedrons (dolomite, baroque dolomite etc.), clay-mineral microliths and authigenic minerals. The morphology of the radiolarian shells in sections is of little diagnostic value (they could not have been studied in insoluble residua because the grains are too small). The shells include almost exclusively disc-shaped and oval forms. Neither conical *Archaeodictyomitra*-and *Hsuum*-type nasellarians, nor *Emiluvia*-, *Tetratrabs*-, or *Homoeoparonaella*-type radial spumellarians were noted. That is why there is no direct evidence to prove Upper Jurassic age of the radiolarites from Chvalčov beds detritus. Nor the composition of pebble assemblages in the Chvalčov beds suggests that the pebbles came from Upper Jurassic sedimentary sequences. The radiolarites here are associated with Triassic dolomites and dedolomites (23.5 %), Middle Triassic shallow-water limestones (7.3 %), Upper Berriasian marly limestones with *Tintinnopsella longa*

(2.8 %), Upper Cretaceous spongolites (3.6 %) and spinel grains (frequency 7/13). The share of other components: Q = 41.5 %, Lm = 2.9 %, Biocl. = 0.1 %. In spite of this, the radiolarites from Chvalčov beds detritus are most probably of Upper Jurassic age.

Controversial radiolarite occurrences in the Fore-Magura unit of the Moravskosliezske Beskydy Mts.

We do not accept an earlier assumption that the radiolarites described by MATĚJKA and ROTH (1949) in the Moravskosliezske Beskydy Mts. are Doggerian—Malmian age. This is contradicted by the location of their occurrences near forester's cottage Baraní within a Middle Cretaceous horizon of green and red radiolarian cherts of the Fore-Magura unit (MENČÍK —PESL, 1966). It is a variegated Godula beds facies which is known also in the Lanckorona and Wieliczka areas in Poland (KSIAZKIEWICZ, 1951). In blocks in the vicinity of the forester's cottage Baraní (western slope of Mt. Konečná), we have identified only grey spotted limestones with *Colomisphaera fibrata* (NAGY) similar to the muddy-facies Tešchin Limestones.

Systematic Part

Systematic descriptions of radiolarians extracted from radiolarite pebbles in the Ždánice unit will deal only with those specimens whose specific assignation was problematic or that were not quite identical to the species diagnosis. The given stratigraphic data are based on BAUMGARTNER's (1984, 1987) biostratigraphic zoning.

Genus *Andromeda* BAUMGARTNER, 1980
Type species *A. crassa* BAUMGARTNER, 1980

Andromeda cf. *praepodbielensis* BAUMGARTNER, 1984
Pl. XXXVI, figs. 7, 8

1984 *Andromeda praepodbielensis* BAUMGARTNER n.sp. BAUMGARTNER, p. 756; Pl. 1, figs. 13—15

R e m a r k : Our specimens differ from the species *A. praepodbielensis* in the shape of the last segment which does not form a wide conus with the other segments but is markedly concave-bent.

Genus *Archaeodictyomitra* PESSAGNO, 1976: sensu PESSAGNO
Type species *A. squinaboli* PESSAGNO, 1976

Archaeodictyomitra sp.
Pl. XXXVII, fig. 6

D e s c r i p t i o n : A narrow-conical shell whose one half is cylindrical, and in the last two segments slightly narrows towards its end. 24—32 longitudinal ridges are separated from one another by a single line of pores.
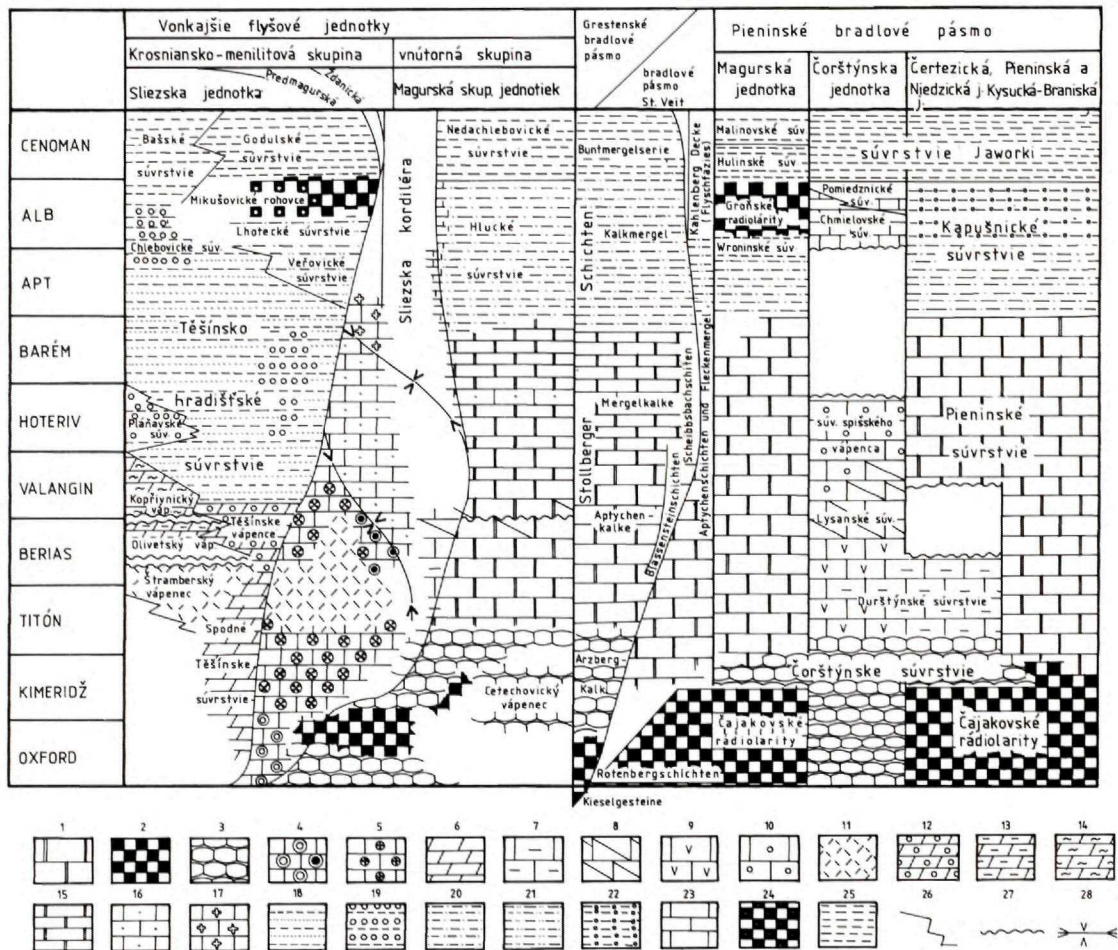
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Genus *Orbiculiforma* PESSAGNO, 1973
Type species *O. quadrata* PESSAGNO, 1973

Orbiculiforma sp.
Pl. XXXV, fig. 7

D e s c r i p t i o n : A disc-shaped circular shell with a central depression occupying about 1/4 of the shell diameter. The shell meshwork consists of polygonal pore frames which are much larger around the central depression. The central depression is made up of a meshwork composed of small and dense pores.

O c c u r r e n c e : These forms were also noted in radiolarites of the Klippen Belt Kysuca succession on Mt. Keblie near Púchov (U.A.5—U.A.6, i.e. Upper Callovian—lower part of Lower Oxfordian), Myjava-Turá Lúka (sample TL-6), Vršatec and in the Varín stretch of Klippen Belt-Snežnica (U.A.7—U.A.8, i.e. upper part of Lower Oxfordian—Upper Oxfordian) as well as Myjava-Turá Lúka (sample TL-2) — (transient interval between U.A.8—U.A.9, i.e. between Upper Oxfordian and Lower Kimmeridgian).

Genus *Patulibracchium* PESSAGNO, 1971
Type species *P. davisi* PESSAGNO, 1971

Patulibracchium sp.
Pl. XXXV, fig. 4

D e s c r i p t i o n : The shell consists of three short beams which in 1/3 of their length fan-like widen towards the end. The primary beam has clearly visible bracchiopyles with lateral spines whose number is unclear. The secondary and tertiary beams are terminated by one central and four lateral spines. The beams are oval in cross-section. The beam and central area meshwork consist of irregularly distributed quadrangular and triangular pore frames which are considerably smaller in the fan-like widened beams.

Genus *Pseudocrucella* BAUMGARTNER, 1980
Type species *Crucella sanfilippoae* PESSAGNO, 1977

Fig. 2 Synoptic stratigraphic column of the Outer West Carpathians and Subalpine zone from the Upper Jurassic to Cenomanian (compiled after MICHALÍK: et al., 1987; BIRKENMAJER, 1977; OBERHAUSER, 1980; MENČÍK et al., 1983; SOTÁK, 1990 etc.):
1—"majolica"-type limestones, 2—radiolarites, 3—"Ammonitico rosso"-type nodular limestones, 4-oolitic and microoncolite limestones with *Protopeneroplida* foraminifers or fragments of dasycladacean alga: 5—*Clypeina* limestones, 6—dark muddy limestones, 7—organodetrital-mudy limestones, 8—crinoidal-brachiopod limestones, 9—breccia-coquina limestones, 10—crinoidal limestones, 11—Štramberk-type reef limestones, 12—organogene-clastic limestones, 13—argillaceous limestones with organodetrital admixture, 14—clastic limestones, 15—marly limestones, 16—sandy limestones with *Pfenderinid* foraminifers, 17—freshwater *Charophyta* limestones, 18—marly-sandy and marly-clayey sediments, 19—conglomerates and slide sediments (tilloid paraconglomerates), 20—shales, marlstones and spotted nodular limestones of globigerina-radiolarian and radiolarian-nannoconid facies, 21—black (silicified) noncalcareous claystones intercalated with sandstones and pelosiderites, 22—marly foraminifer-sponge-radiolarian limestones, marly shales, marlstones and siltstones, 23—marly, shaly or nodular *Hedbergella*-radiolarian limestones, 24—spongolites, 25—"scaglia rossa"-type green, variegated and red marls in flysch formations, 26—lateral changing of facies, 27—disconformity, 28—uplift stages of Silesian cordillera

Pseudocrucella cf. *procera* OŽVOLDOVÁ, 1984
Pl. XXXVI, fig. 5

1984 *Pseudocrucella procera* OŽVOLDOVÁ, n.sp.-Ožvoldová-Sýkora, p. 270; Pl. 12, fig. 4; Pl. 14, fig. 2; Pl. 15, figs. 6, 7; Pl. 16, fig. 5

R e m a r k : Diagnostic signs of the specimens are almost identical with those of species *P. procera*, the only difference being that our specimens do not have the long spines characteristic of the latter species. Our specimens differ from the species *P. adriani* BAUMGARTNER by their regular longitudinal lines of rectangular pore frames and from *P. sanfilippoae* (PESSAGNO) by longer beams.

O c c u r r e n c e : These forms are also present in radiolarites of the Klippen Belt Kysuca succession at Myjava-Turá Lúka (sample TL-6-U.A.7—U.A.8, i.e. upper part of Lower Oxfordian and sample TL-2-transient interval between U.A.8 and U.A.9 - between Upper Oxfordian—Lower Kimmeridgian).

Genus *Spongocapsula* PESSAGNO, 1977
Type species *Spongocapsula palmerae* PESSAGNO, 1977

Spongocapsula cf. *perampla* (RÜST, 1985)
Pl. XXXVII, fig. 4

1885 *Lithocampe perampla* m.—D. RÜST, p. 31 (45); Pl. 39, fig. 11
1977 *Spongocapsula* sp. cf. *S. perampla* (RÜST)—PESSAGNO, p. 90; Pl. 11, fig. 15
1981 *Spongocapsula perampla* (RÜST)—KOCHLER, p. 94; Pl. 16, fig. 18

R e m a r k s : Our forms differ from species *S. perampla* by the regular conical shape of their shell whose last segments do not widen considerably. They differ from species *S. palmerae* PESSAGNO by a wider conical shell.

O c c u r r e n c e : These forms were also noted in radiolarites of the Klippen Belt Kysuca succession in Podhradská dolina valley near Pruské and at Červený Kameň near Podbiel (U.A.5—U.A.6, i.e. Upper Callovian—lower part of Lower Oxfordian), as well as at Myjava-Turá Lúka (U.A.7—U.A.8, i.e. upper part of Lower Oxfordian—Upper Oxfordian) and Lednica (transient interval between U.A.8 and U.A.9, i.e. between Upper Oxfordian and Lower Kimmeridgian).

Summary

The proved presence of Oxfordian radiolarites in the Outer Flysch Carpathians is a new contribution to the knowledge on the Mesozoic evolution of this area. The radiolarites occur in pebbles and block klippes together with other Mesozoic sediments and represent natural redeposited assemblages reflecting the composition of the source sedimentary sequences at the Magura-Flysch/Krosno-Menilite-Flysch boundary (Silesian cordillera - see SOTÁK, 1986, 1990 a, b etc.). In their age and facies, the radiolarites resemble some pre-calpionellid pelagic sediments-banded limestones with *Cadosina parvula* (uppermost Oxfordian—Kimmeridgian), olive-grey silicites with *Carpistomiosphaera borzai, Colomisphaera carpathica* and *Colomisphaera* ex gr. *fibrata* (uppermost Oxfordian—Kimmeridgian: their appearance is similar to that of Oxfordian so called banana siliceous limestones and radiolarites of the Czorsztyn sequence) and grey microsparitic limestones with *Carpistomiosphaera borzai* and *Colomisphaera* aff. *pulla* (Kimmeridgian?—lowermost Tithonian) from pebbles of the Rača unit. Slope facies of this period comprise Czorsz-

tyn-type nodular limestones of Callovian (limestones with *Protoglobigerina*), Oxfordian (limestones with ammonites *Perisphinctes uhligi, P. plicatilis, Cardioceras neumanni, Goliathiceras capax* and others-see NEUMANN, 1907), Kimmeridgian (saccocoma limestones with *Colomisphaera nagyi* and *Stomiosphaera mollucana* in Cetechovice klippes), and Lower—Middle Tithonian (limestones with *Colomisphaera* aff. *pulla* and first representatives of hyaline calpionelslids in Cetechovice klippes). Younger pelagic sediments in the outer zones of the Flysch Carpathians include mainly majolica (globochaete-calpionellid, calpionellid-radiolarian and radiolarian-nannoconid), slightly marly (radiolarian-sponge) and detrital muddy (crinoidal-cadosinid) facies. Calpionellids of standard zones A to D suggest that these rocks are Upper Tithonian to uppermost Berriasian in age. However, the whole Malm and lowermost Cretaceous in this area is a period of clear facies differentiation indicated, on the other side, by the deposition of sediments typical of carbonate platforms (microooncolite limestones with *Protopeneroplis striata, Clypeina* -limestones, tubiphyte and coral-tubiphyte limestones, limestones with skeleton and rudite components of reef-forming organisms-dasycladaceans, blue-green alga and chlorophytes, hydrozoans etc., limestones of intraplatform facies with bahamite-type particles and foraminifers *Protopeneroplis trochangulata,* oolitic limestones etc. - see SOTÁK, 1987a, b, 1989).

The Oxfordian period of maximum production of radiolarian ooze and radiolarite formation is a global event in the evolution of deep Tethyan basins (JENKYNS— WINTERER, 1982; LEFELD, 1988 etc.). That is why the Upper Jurassic radiolarite horizons are frequently used to make interregional correlations. The radiolarites in the Outer Flysch Carpathians are complementary to Oxfordian—Kimmeridgian radiolarite horizons in deep-sea and transitional Klippen Belt successions (i.e. Kysuca-Pieniny, Niedzica, Čertezice and Magura) and mark the pertaining of this area into the Pieninic domain (Fig. 2). The Pieninic paleogeographic zone thus seems to be a very diversified system the North Tethyan shelf areas also comprising those which were situated northward of the Czorsztyn geoanticlinal ridge. On the other side there is a considerable facies contrast of the Upper Jurassic radiolarites at Zaječí klippe and Ždánice unit pebbles with sediments of the Klentnice beds from the nearby klippes in the Pavlovské vrchy Mts. and autochtonous Jurassic sediments of the Bohemian Massif (Hrušovany, Vranovice and Novosedly Limestones, Mikulov Marls). These stratigraphic anomalies can be explained by tectonic nearing, disintegration and mixing of various sedimentary complexes on disctinct structural boundaries (e.g. transform zones-compare VAN DE FLIERT et al., 1980).

Translated by Ľ. Böhmer

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JÁN SOTÁK — LADISLAVA OŽVOLDOVÁ

K výskytom vrchnojurských rádiolaritov vo vonkajších Západných Karpatoch

Resumé

Z valúnov Ždánickej jednotky a blokových akumulácií pri Zaječí sme opísali rádiolarity vrchnojurského veku. Majú červené, zelené a okrovohnedé sfarbenie. Sú buď celistvé so sklovitým leskom (typ rádioláriových jaspisov), alebo črepinovito rozpadavé s preplástkami červených ílovcov. Matrix rádiolaritov je tvorený kremito-slienitou alebo chalcedónovou hmotou bohato impregnovanou hematitom. Variety s vyššou intenzitou prekremenenia naberajú až charakter kryptogénnych silicitov. Spôsoby zachovania rádiolárií odrážajú procesy rozpúšťania schránok a ich nahradzovania sférolitickými, snopcovitými a metakoloidnými agregátmi chalcedónu, procesy selektívnej kalcifikácie a procesy akumulácie Fe-koloidov v schránkach. Rádiolarity sú prestúpené hustou sieťou syngenetických a mezo-epigenetických žiliek (vláskovité žilky vyplnené dvoma generáciami "azbestovitého" chalcedónu, vakuoly vyplnené agregátmi radiálne-fibrózneho a zebrovitého chalcedónu, karbonátové žilky s korzívnymi lemami krátkovláknitého chalcedónu na interkryštálových plôškach kalcitu, karbonátové žilky s inklúziami kvarcínu atď.). Z valúnov boli extrahované početné asociácie rádiolárií (celkom 26 druhov). Najhojnejšie zastúpenie majú druhy *Emiluvia orea* BAUMGARTNER a *Tetratrabs zealis* (OŽVOLDOVÁ). Podľa prítomnosti druhov známych od zóny U.A.7 (*Emiluvia orea* BAUMGARTNER) a druhov, ktorých výskyt končí v zóne U.A.8 (*Bernoullius dicera* (BAUMGARTNER), *Mirifusus guadalupensis* PESSAGNO etc.), zodpovedá vek rádiolaritov vrchnej časti spodného oxfordu. Rádiolarity podobného charakteru sú výrazne zastúpené aj v úlomkovitom materiáli pieskovcov predmagurskej jednotky (chvalčovské vrstvy). Výskyty vrchnojurských rádiolaritov vo vonkajších flyšových jednotkách sú komplementárne k oxfordsko—kimeridžským horizontom v hlbokovodných a prechodných pieninských sukcesiách a znamenajú pričlenenie tohto priestoru do genetického celku pienid.

Explanations of plates XXX — XXXXVII

Plate XXX
Microfacies of Upper Jurassic radiolarites from Ždánice unit conglomerates
Fig. 1 Radiolarite with siliceous-marly groundmass and disc-shaped radiolarian shells. Locality Velké Pavlovice, thin-section no. 130/83, magn. 72x
Fig. 2 Radiolarite with hematite-pigmented chalcedony groundmass containing conical radiolarian shells. Locality Velké Pavlovice, thin-section no. 40/88, magn. 78x

Plate XXXI
Fig. 1 Reddish radiolarite in detrital sandstone assemblage from Chvalčov beds (Fore-Magura unit). Locality Chvalčov, thin-section no. Kl-5, magn. 48x
Figs. 2, 3 Well preserved spumellaria-type shells in radiolarites from Ždánice unit conglomerates. Fig. 2 Locality Velké Pavlovice, thin-section no. 40/88, magn. 126x; Fig. 3 Locality Velké Pavlovice, thin-section no. 2/83, magn. 138x

Plate XXXII
Thin veinlets filled with two generations of "asbestos" chalcedony cut by younger calcite veinlets and syneretic joints
Fig. 1 Locality Velké Pavlovice, thin-section no. 40/88, magn. 46x; Fig. 2 Locality Velké Pavlovice, thin-section 40/88, magn. 30x

Plate XXXIII
Meso-epigenetic phenomena in radiolarites from Ždánice unit conglomerates
Fig. 1 Oblong void filled with spherulitic aggregates of radial-fibrous and zebra-like chalcedony. Locality Velké Pavlovice, thin-section no. 2/83, magn. 46x
Fig. 2 Carbonate veinlet with corrosive rims of short-fibrous chalcedony along intercrystal planes in calcite. Locality Zaječí, thin-section no. 13/80, magn. 57x

Plate XXXIV
Radiolarian assemblages extracted from Ždánice unit pebbles
Fig. 1 *Archaeospongoprunum imlayi* PESSAGNO - 2242, magn. 170x
Fig. 2 *Triactoma blakei* (PESSAGNO) - 8923, magn. 140x
Fig. 3 *Triactoma jonesi* (PESSAGNO) - 8956, magn. 120x
Fig. 4 *Emiluvia chica* FOREMAN - 8943, magn. 130x
Fig. 5 *Emiluvia orca* BAUMGARTNER - 3018, magn. 115x
Fig. 6 *Emiluvia orca* BAUMGARTNER - 3017, magn. 75x
Fig. 7 *Staurosphaera antiqua* RÜST - 3007, magn. 125x
Fig. 8 *Emiluvia orca* BAUMGARTNER - 8948, magn. 100x, view of medullary shell
Fig. 9 *Paronaella mulleri* PESSAGNO - 3003, magn. 145x

Plate. XXXV
Radiolarian assemblages-continued
Fig. 1 *Tritrabs casmaliaensis* (PESSAGNO) - 2238, magn. 130x
Fig. 2 *Homoeoparonaella elegans* (PESSAGNO) - 2223, magn. 95x
Fig. 3 *Tritrabs hayi* (PESSAGNO) - 3022, magn. 90x
Fig. 4 *Patulibracchium* sp. - 8951, magn. 125x
Fig. 5 *Tritrabs exotica* (PESSAGNO) - 2995, magn. 140x
Fig. 6 *Paronaella kotura* BAUMGARTNER - 3026, magn. 65x
Fig. 7 *Orbiculiforma* sp. - 2226, magn. 150x
Fig. 8 *Tetraditryma pseudoplena* BAUMGARTNER - 3031, magn. 70x
Fig. 9 *Tritrabs exotica* (PESSAGNO) - 2224, magn. 100x
Fig. 10 *Tetratrabs zealis* (OŽVOLDOVÁ) - 8948, magn. 55x

Plate XXXVI
Radiolarian assemblages-continued
Fig. 1 *Napora deweveri* BAUMGARTNER - 2246, magn. 170x
Fig. 2 *Podobursa triacantha* (FISCHLI) - 3211, magn. 160x
Fig. 3 *Perispyridium tamanense* PESSAGNO et BLOME - 3013, magn. 170x
Fig. 4 *Emiluvia sedecimporata salensis* PESSAGNO - 2229, magn. 115x
Fig. 5 *Pseudocrucella* cf. *procera* OŽVOLDOVÁ - 2230, magn. 130x
Fig. 6 *Tetratrabs zealis* (OŽVOLDOVÁ) - 8908, magn. 80x
Fig. 7 *Andromeda* cf. *praepodbielensis* BAUMGARTNER - 3027, magn. 90x
Fig. 8 *Andromeda* cf. *praepodbielensis* BAUMGARTNER - 3028, magn. 115x

Plate XXXVII
Radiolarian assemblages-continued
Fig. 1 *Mirifusus guadalupensis* PESSAGNO - 3011, magn. 130x
Fig. 2 *Podobursa triacantha* (FISCHLI) - 9820, magn. 115x
Fig. 3 *Bernoullius dicera* (BAUMGARTNER) - 3015, magn. 170x
Fig. 4 *Spongocapsula* cf. *perampla* PESSAGNO - 3253, magn. 170x
Fig. 5 *Hsuum brevicostatum* (OŽVOLDOVÁ) - 3252, magn. 155x

RUDOLF HALOUZKA — PETER HOLEC

Mammuthus primigenius (Blumenbach, 1799) (Proboscidea, Mammalia) from Trstená (Orava region, Slovakia)

1 text-fig., 1 pl. (XXXVIII), Slovak summary

A b s t r a c t. A fossil mammoth tooth was found (in 1985, HALOUZKA) during systematic geological research of the southern and eastern Orava region (northern Slovakia) in the Quaternary terrace gravels of the Oravica River at Trstená. It was laid down in the superficial horizon of the gravel accumulation. In the Carpathian system of terraces (HALOUZKA, 1986) it is the accumulation of terrace step T IIb, i.e. second or main middle terrace (Early Riss in age).

Key words. Pleistocene, Orava mammoth.

Introduction

A team of Dionýz Štúr Institute of Geology workers directed by P. GROSS carried out systematic geological research and mapping in the Orava region. They found a fragment of a mammoth molar at Trstená. It was discovered by R. HALOUZKA on May 22, 1985 on the surface of the Oravica River terrace gravels in the object of the then farming cooperative at Trstená. Preliminary identification was made by P. HOLEC in October 1985. The find was mentioned and its first photos were issued in a research report of the Dionýz Štúr Institute of Geology in Bratislava (HALOUZKA in: GROSS—BEGAN —HALOUZKA et al., 1985, MS).

This is the second find of mammoth remains in the Orava region. A mammoth tusk was allegedly found in deluvial loams near Istebné in the lower Orava valley (e.g. ČAPLOVIČ, 1987, p. 19) along with remains of a fossile horse (Equus).

Geological setting

Detailed data on the geological setting at the locality concerned and its neighbourhood are given in unpublished research reports and their enclosures (see HALOUZKA in: GROSS— BEGAN — HALOUZKA et al., 1985, MS) and were summarized by HALOUZKA (in: DOVINA et al., 1990, MS). The stratigraphic system of the Orava River terrace sediments was put forward in a synthetizing study (HALOUZKA, 1986). The geological setting of the Trstená find is described also in a monography on the Orava region (including the Orava Basin) that is currently being prepared by GROSS et al.

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The mammoth tooth was found very close to the surface in a sandy-gravelly terrace accumulation of the Oravica River in the object of the farming cooperative at Trstená (see the location sketch text-fig. 1) situated on the left bank of the Oravica River in the village (above the railway line). The tooth was collected on the surface of the terrace remnant. According to the classification of the Carpathian terrace system in Slovakia (HALOUZKA, 1986), it is the so-called second or main middle terrace of the river. Its sandy-gravelly deposits are generally assigned (late cit.) into the Early Riss glacial stage (in the late Middle Pleistocene). That period (glacial age) is characterized by the culminating Pleistocene climate in the Slovak Carpathians (lowest temperatures, maximum glaciation in the Tatry area, periglacial and particularly solifluction processes etc.).
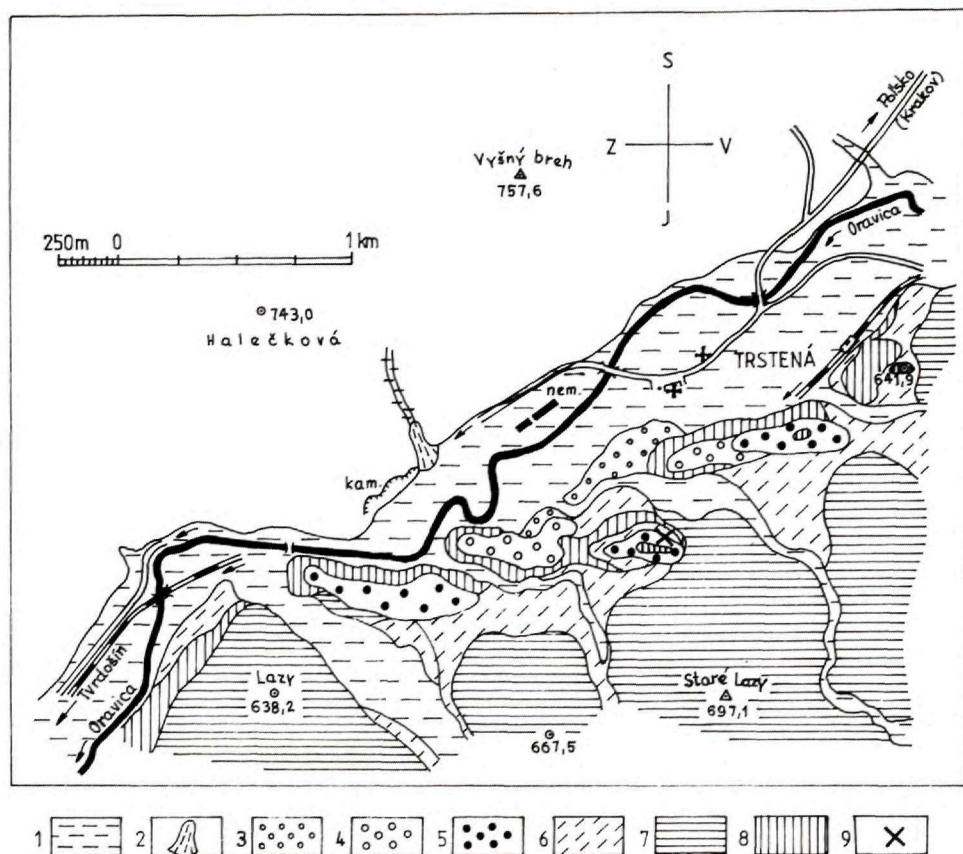
Fig. 1 Orientative geological map showing vicinity of the find locality Trstená. Compiled by HALOUZKA, 1992 Explanations: 1 to 6—Quaternary; 1—fluviatile floodplain sediments (loamy to gravelly-loamy), Holocene; 2—proluvial loamy-gravelly sediments (alluvial fan), Würm/Holocene boundary; 3—fluvial sediments of low terrace bench I (sandy gravels), Würm; 4—fluvial sediments of middle terrace bench IIa (sandy gravels), Late Riss; 5—fluvial sediments of middle terrace bench IIb (sandy gravels), Early Riss; 6—slope-wash sediments and polygenic deluvial loams, Quaternary undifferentiated; 7—rocks of the Inner Carpathian Paleogene; 8—rocks of Klippen Belt series, Mesozoic; 9—find locality of the fossil mammoth tooth

The terrace gravels in question were deposited on eroded Mesozoic rocks of the Klippen Belt, their base being 16 to 18 m above the Oravica River. The place where the tooth was found is composed of sandy gravels, largely medium to coarse (with pebbles 2—5—10 cm in diameter) but locally very coarse and bouldery (up to 15—25 cm across). The pebbles are dominated by quartzites (quartzy sandstones) and metaquartzites of different kinds. Paleogene sandstones and variegated rocks (primarily carbonatic) from the Mesozoic and klippes are less abundant whereas granites and crystalline rocks are scarce and their contents are very variable. The gravel terrace at Trstená is 1 to 6 m thick.

The described terrace at Trstená is part of the system of middle (Riss) terraces on the left bank of the Oravica River valley between Trstená and Tvrdošín (paleogeographically, this broad valley is significant because it is a southern extention of the Orava Basin).

The geological setting in which the mammoth tooth was found at Trstená (mainly as regards its near-surface position in the gravel layer) indicates its age only very vaguely-wide time span of the glacial ages — i. e. Early Riss or Late Riss or Würm, i.e. glacial ages since the "culminating" Pleistocene till its end. The fossil may be younger than the host bed.

Paleontologic Part

Superfamily *Elephantoidea* OSBORN, 1921
Family *Elephantidae* GRAY, 1821
Subfamily *Mammuthinae* SIMPSON, 1845

Genus *Mammuthus* BURNETT, 1830

Mammuthus primigenius (BLUMENBACH, 1799)
Pl. XXXVIII, fig. 1a, b

1954 *Mammonteus primigenius* (BLUMENBACH) —V. R. GARUTT: Južnyj slon *Archidiskodon meridionalis* (NESTI) iz pliocena etc., pp. 3—76
1957 *Mammuthus primigenius* (BLUMB.) —I. A. DUBROVO: K rodovej sistematike podsem. *Elephantinae* GRAY (slony), pp. 223—230
1957 *Mammonteus primigenius* BLUMENB. —V. TOEPFER: Die Mammutfunde von Pfännerhall in Geiseltal, pp. 8—39, Pl. 8—21
1960 *Mammonteus primigenius* BLUMB. —Z. SCHMIDT: Nález spodnej čeľusti mamuta etc., pp. 3—10, figs. 1—4
1960 *Mammonteus primigenius* BLUMB. —R. MUSIL: Štěrková terasa Moravy u Malých Levár, pp. 11—31, figs. 4, 5, 6, 7, 8
1968 *Mammonteus primigenius* (BLUMENBACH) —R. MUSIL: Die Mammutmolaren von Předmostí (ČSSR), pp. 5—191, Tab. 29, 30, 31, 33, 36, 37, fig. 2
1991 *Mammuthus primigenius* (BLUMB.) —A. ĎURIŠOVÁ —C. AMBROS: Fosílne zvyšky mamuta etc., pp. 13—40, fig. 3—6

Material description

The find is a preserved fragment of the mammoth first or second lower left molar (M1,2 ? sin.). The tooth has eleven lamellae but still 1 to 3 lamellae are missing in the front and back alike. The enamel is black, dentine and cement are darkochreous. The cement lining along the tooth sides is missing and so the lamellae are visible from the chewing plane as far as the crown base. The tooth roots were broken off. The first seven lamellae are more intensively polished by chewing

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than the other ones positioned backwards. The enamel patterns are banded and the first 5 lamellae are bent in various ways. The 6th, 7th and 8th lamellae are conspicuously bent toward the tooth base. This phenomenon cannot be seen on the other lamellae since their lateral (buccal) plane was badly damaged, broken, the 11th lamella being broken also on the inner (lingual) side. The tooth bears signs of transport which, aside from the above-mentioned damages, also include damaged tooth roots roughly from the 6th to 11th lamella. The tooth enamel is conspicuously thin. It is usually 1—2 mm thick by this species, but our specimen's one attains a mere 0.8—1.3 mm. This could suggest a progressive mammoth type that lived in the Würm, but we also cannot rule out the possibility that our specimen was exceptionally weak, poorly nourished.

D i m e n s i o n s   a n d   i n d i c e s : Maximum tooth length = 114.1 mm; tooth height = 93.7 mm on the 7th lamella (ling. plane); tooth width = 60.0 mm on the 8th lamella; enamel thickness on different places of chewing plane is 0.8, 0.9, 1.2 and 1.3 mm; DLQ = 10.37, DLI = 9.54, DŠQ = 1.90 (total length is not known accurately).

There are some 10 lamellae over the length of 10 cm. The tooth is deposited in the collections of the Dionýz Štúr Institute of Geology, Mlynská dolina 1, Bratislava.

The mammoths were adapted to the arctic climate but they could have lived in a more temperate zone as well. They avoided continuous forests and preferred open land instead, partly parkland. Distribution of mammoths in Europe was studied by MUSIL (1985). Throughout the Würm they were widespred in Central and Eastern Europe, but the western and southern limits of its distribution oscillated. At the beginning of the Würm it penetrated into southern France, northern Italy, northern Yugoslavia and whole Rumania. This state persisted unchanged until W3 when the species concerned suddenly disappeared from the whole territory.

Occurrences of mammoth remains in Slovakia are fairly abundant SCHMIDT (1960) mentions a mammoth lower jaw-bone found at Bojnice. Mammoth bones from Skalka near Púchov were described by SILNICKÝ (1930). Mammoth remains in the Riss at Chrámec near Dubovec were noted by ZÁZVORKA (1954). MUSIL (1960) notes mammoth remains from Malé Leváre. Mammoth remains from Vlčkovce were described by FEJFAR (1963). Late Paleolithic mammoth localities include Moravany nad Váhom, Trenčianske Bohuslavice and Ratnovce (unpublished). Mammoth remains in the village of Nána were described by SCHMIDT (1972). Similarly, mammoth remains at Banka near Piešťany were noted by ĎURIŠOVÁ and AMBROS (1991). SCHMIDT (1975) gives a total of 156 Late Pleistocene mammoth occurrences. In spite of this we may say that the mammoth molar found in the Orava region is a rarity.

Translated by Ľ. Böhmer

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RUDOLF HALOUZKA — PETER HOLEC

Mammuthus primigenius (Blumenbach, 1799) (Proboscidea, Mammalia) z Trstenej na Orave (Slovensko)

Resumé

Fosílny mamutí zub v Trstenej bol nájdený r. 1985 (HALOUZKA) pri sústavnom geologickom výskume regiónu južnej a východnej Oravy na severnom Slovensku (GROSS et al.), a to v priebehu mapovania kvartéru (HALOUZKA). Nález pochádza priamo z povrchovej polohy terasových štrkov Oravice — na jej ľavobreží pri južnom okraji Trstenej (areál hospodárstva roľníckeho družstva obce). Ide o akumuláciu tzv. hlavnej (druhej) strednej terasy, má hrúbku max. 6 m a leží na zrezanom podloží mezozoických hornín "skalky" bradlového pásma. Báza štrkov je tu v relatívnej výške + 16 až 18 m nad súčasným tokom. Litologicky sú to piesčité štrky, prevažne stredné až hrubé (ø 2—5—10 cm), miestami až s veľmi hrubými a balvanovitými valúnmi (ø 10—15—25 cm); z hornín prevažujú kremence a metakvarcity (podradné sú pieskovce paleogénu, pestré karbonatické horniny mezozoika, variabilný a menší je podiel žúl a kryštalických bridlíc). V karpatskom systéme riečnych terás (HALOUZKA, 1986) má stupeň druhej strednej terasy označenie T IIb a jeho akumulácia sa stratigraficky zaraďuje do strednopleistocénneho stupňa (glaciálu), ris starší.

Nález fosílneho zvyšku mamuta v Trstenej je na Orave druhým známym nálezom (prvý bol kel zo svahových hlín pri Istebnom). Je však jediný s presne dokumentovaným a identifikovaným nálezovým sedimentom a jeho stratigrafiou.

Paleontologicky bol stanovený fragment prvého alebo druhého spodného ľavého molára mamuta (M1,2 ? sin.). Zub má 11 lamiel a nesie známky transportu. Sklovina zuba je nápadne tenká (0.8—1.3 mm). Mohlo by to nasvedčovať, že ide o progresívny typ mamuta (würm), alebo o slabého jedinca. Zub je v zbierkach Geologického ústavu D. Štúra v Bratislave.

Explanations of plate XXXVIII

Pl. XXXVIII
Figs. 1a, b *Mammuthus primigenius* (BLUMENBACH, 1799), M1, 2 ? sin.,
a— chewing plane; b— lingual plane. Actual size
Photo: L. Osvald

ZDENĚK V. ŠPINAR — JOZEF KLEMBARA — ŠTEFAN MESZÁROŠ

A new toad from the Miocene at Devínska Nová Ves (Slovakia)

11 text-figs., 4 pls. (XXXIX—XLII), Slovak summary

A b s t r a c t . *Bufo priscus* n. sp. is based on a nearly complete skeleton, several isolated bones, and part of the vertebral column from the Middle Miocene of the Bonanza site at Devínska Nová Ves. The characters of the skull and partly also of the postcranial skeleton indicate that the species is a primitive Euroasiatic narrow-headed toad. The origin of toads and their migration is discussed.

Key words. Bufonidae (*Anura*), new species, skeletal anatomy, Miocene, Slovakia, migration.

Introduction

Remains of fossil toads are known from the Miocene through the Holocene in Slovakia. However, Miocene occurrences are rare both in Slovakia and worldwide. Only in the Late Pliocene and the Quaternary, do toads become more abundant. However, usually only isolated bone elements such as vertebrae, frontoparietals, pelvic bones, and limb bones have been found.

Š. MESZÁROŠ and colleagues have worked at the locality at Devínska Nová Ves near Bratislava in the years 1984—85 and succeeded in finding an almost entire, well preserved skeleton, part of the vertebral column, and other isolated frog bones in the sediments of Middle Miocene age. They come from a place named Bonanza which lies 2 km east of Devínska Nová Ves on the western outskirts of the city of Bratislava (HOLEC—KLEMBARA—MESZÁROŠ, 1987). Remains of frogs had previously been found at this locality, but in the ZAPFE fissures, already in 1960, 1961, 1962 and 1974 by parties led by Dr. O. FEJFAR of the Central Geological Survey, Prague. Some of these were described by HODROVÁ (1980: 311—316), who later studied also the vertebrae and isolated cranial bones from Bonanza (1988: 305—310).

A well preserved, almost entire skeleton and partial vertebral column of the genus *Bufo* discovered by Š. MESZÁROŠ represent the basis of this study. Additionally, three skull fragments representing the fused prooticooccipital and frontoparietal are also desrcibed in this paper. These specimens were mentioned and inadequately described by HODROVÁ (1988).

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CMH—Private collection of Dr. M. HORNÁČEK, Smolenice. CZICU—Zoological Institute of Comenius University, Bratislava. DPFNSP—Department of Paleontology, Faculty of Natural Sciences, Charles University, Prague. SNM—Slovak National Museum, Bratislava.

Comparative material studied

Bufo bufo DPFNSP 144/x176, 6351b, 272/89, 6372b, 1354, 1358, 6359b, 6350a, 6351b, 6350b; CZICU 2. *Bufo calamita* DPFNSP 1351, 6387a, 1360, 1511, 1364, 5869a, 5870a, 5871a. *Bufo marinus* DPFNSP 1357. *Bufo melanostictus* DPFNSP 1356. *Bufo radei* DPFNSP 1355. *Bufo spinosus* DPFNSP 2A. *Bufo valliceps* DPFNSP 4389. *Bufo viridis* DPFNSP 146x, 1353, 6464, 1352, 1359, 1362, 1361, 1363, 5873a, 5872a, 5874a, 5875a, 5876a, 6338a/107, 6379a/104, 6342a/108, 6337a/109, 6376a/101.

Systematics

Family *Bufonidae* GRAY, 1825; see also FROST, 1985: 25

Genus *Bufo* LAURENTI, 1768; Synops. Rept. 25
Type species *Bufo vulgaris* LAURENTI, 1768 = (*Rana bufo* LINNAEUS, 1758, by subsequent designation of TSCHUDI, 1838, Classification of Batr.: 88).

D i s t r i b u t i o n : Worldwide except of the Arctic region; absent in New Guinea, Australia and neighbouring islands.

Bufo priscus n. sp.
Text-figs. 1—11; Pls. XXXIX—XLII

1988 *Bufo* cf. *viridis*, HODROVÁ, p. 307

E t y m o l o g y : Latin *priscus* = old.
H o l o t y p e : SNM Z 15 300, relatively well-preserved, almost entire skeleton of an adult specimen exposed in dorsal view.
P a r a t y p e s : Part of the vertebral column in ventral view (four vertebrae and left sacral wing) deposited in the private collection of Dr. M. HORNÁČEK (CMH), and three frontoparietal-prooticooccipital complexes, SNM Z 15 301, Z 15 302 and Z 15 303. SNM Z 15 301 is depicted in dorsal view by HODROVÁ (1988, fig. 4: 8).
T y p e l o c a l i t y a n d h o r i z o n : The former Stockerau lime-kiln quarry about 2 km east of Devínska Nová Ves (western outskirts of the city of Bratislava). Sedimentary filling of the fissure "Bonanza" (see HOLEC—KLEMBARA—MESZÁROŠ, 1987) at the eastern edge of the quarry. Badenian, MN 6, Miocene.
D i a g n o s i s : Medium-size toad (estimated snout-vent length 7 cm). Medial part of nasal shorter than in European toads; lateral part considerably prolonged, paraorbital process long. Frontoparietal paired, elongated, anteriorly narrow, supraorbital tectum considerably extends laterally. Dorsal surface of frontoparietal more or less sculptured. Left and right frontoparietals posteriorly connected by median suture, anteriorly separated by fissure filled with membrane in

life. Channel for occipital artery deep and broad, in rear can be opened or closed dorsally. Supra-orbital tectum fused with paired prooticooccipitals which unite and do not always fuse with hind parts of frontoparietals. Lateral wall of endocranium fused with ventrolateral wall of frontoparietal. Occipital walls of prooticooccipital meet in median plane at relatively long contact. Squamosal has conspicuously broad and elongated otic lamina.

Vertebral column consists of nine procoelous, almost imbricate vertebrae with spinous processes of first through seventh vertebrae dorsally expanded into tear-like, sculptured facets. Transverse processes long. Sacral wing long, much broader distally. Urostyle with conspicuously broad horizontal lamina and high crista split by deep sagittal fissure.

Description

Skull (Pls. XXXIX, XLI; text-figs. 1, 2)

Dermal skull roof

Nasal. The nasals are irregularly triangular paired bones. Preserved are much of the medial widened part (pars medialis) and of an elongated pars lateralis, which relatively quickly narrows laterally. The margo orbitalis is massive, slightly concave, and combless. The margo maxillaris is slightly convex. The narrowed pars lateralis extends into a long processus paraorbitalis directed toward the processus frontalis maxillae, the part of which it abuts.

Frontoparietal. The frontoparietals are narrow paired bones that form much of the dorsal part of the skull. In SNM Z 15 300 only the right frontoparietal is fully preserved. In the left one a greater portion of the anterior half is absent. Left and right frontoparietals are connected posteriorly by a median suture (sutura sagittalis BAYER, 1890: 15; BOLKAY, 1919: 18), whereas anteriorly they are separated by a narrow slit which gradually tapers posteriorly and closes roughly at mid-length. In the Recent species *Bufo bufo* the left and right frontoparietals are sutured in the median plane. However, a narrow slot between the anterior halves of the frontoparietals can be observed in *Bufo viridis* (BAYER: 1890, tab. 1, fig. 10). The frontoparietal has the shape of an irregularly elongated triangle. In the holotype it is sculptured and is 11.2 mm long, its greatest width in the lower third being 7 mm; at the posterior end it is 3.5 mm wide and at the anterior end 3 mm wide. The anterior surface bears shallow grooves, whereas on the posterior surface the sculpture is more strongly developed, forming protuberances and grooves; the posterior end bears numerous small pits. This posteriormost pitted portion is slightly raised and separated from the sculptured surface by a shallow depression. In Z 15 301 the sculpture is most distinct on the medial margin of the middle part; in the anterior half, however, scattered, relatively large protuberances are present on a relatively smooth surface. The margo anterior is round, the margo occipitalis is slightly concave, and the margo sagittalis is almost straight (only slightly undulate). The posterior part of the frontoparietal is the widenest and in its lateral part passes the groove for the occipital artery. The tectum supraorbitale is sculptured on its dorsal surface. The margo orbitalis and the medial margin of the groove for the occipital artery (margo prootica sensu BOLKAY, 1919: 18, fig. 16) meet at ca. 140° angle. The groove for a. occipitalis (vessel groove of BAYER, 1890: 15; fossula limitans of BOLKAY, 1919: 295; occipital canal of MARTIN, 1972: 38) is wide and deep. In the holotype, this groove is widely open at the anterior end, whereas at the posterior end it is considerably narrowed and in Z 15 301 it is fully closed. In Z 15 302, however, this groove fully separates the dorsal surfaces of the frontoparietal. In Z 15 300 a distinct suture between the frontoparietal and underlying prooticooccipital is visible in the medial wall of this groove. Thus the groove for the occipital artery evidently passed down the surface of the prooticooccipital. In specimens Z 15 301—Z 15 303 this suture is not visible because the frontoparietal and the prooti-

cooccipital are fused. In Z 15 300 the suture is not visible on the lateral wall of this groove because the tectum supraorbitale is fused with the endocranium. The frontoparietal does not fuse with the occipital part of the prooticooccipital which is well visible in Z 15 301 at the junction of these bones in the median plane. Thus the frontoparietal is fused with the prooticooccipital to a variable degree in these adult individuals.

The ventral surface of the frontoparietal is completely visible in Z 15 301. The lateral wall of the endocranium is fused with the ventrolateral surface of the frontoparietal (cf. text-figs. 2B, C, D). The incrassatio frontoparietalis (cf. JAROŠOVÁ—ROČEK, 1982) refers to the presence of
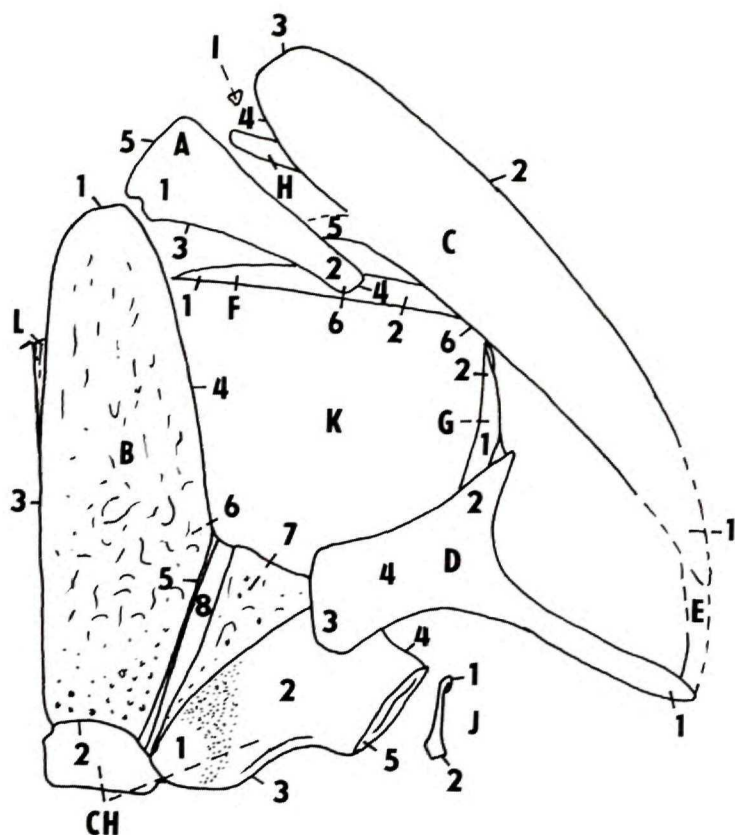
Fig. 1 *Bufo priscus* n. sp., SNM Z 15 300. Partly schematized right part of skull. Scale bar equals 1 mm A—*nasale*; 1—pars medialis; 2—pars lateralis; 3—margo orbitalis; 4—margo maxillaris; 5—margo medialis; 6—processus paraorbitalis. B—*frontoparietale*; 1—margo anterior; 2—margo occipitalis; 3—margo sagittalis; 4—margo orbitalis; 5—margo prootica; 6—processus prooticalis; 7—tectum supraorbitale; 8—canalis arteriae occipitalis. C—*maxillare*; 1—processus posterior; 2—margo inferior; 3—margo rostralis (syn. = m. anterior); 4—margo nasalis; 5—processus frontalis maxillae; 6—margo orbitalis maxillae. D—*squamosum*; 1—ramus posterior; 2—ramus zygomaticus; 3—ramus retrozygomaticus; 4—lamina oticalis. E—*quadratojugale*. F—*palatinum*; 1—extremitas ethmoidalis; 2—extremitas maxillaris. G—*pterygoideum*; 1—ramus maxillaris (syn. = r. anterior); 2—apex rami anterioris. H—mandibula (small fragment). Ch—*prooticooccipitale*; 1—torus terminalis; 2—pelvis prooticalis; 3—margo posterior; 4—margo anterior ; 5—margo lateralis. I—*probably a fragment of premaxilla.* J—*columella auris*; 1—operculum; 2—plectrum. K—*orbit.* L—*sphenethmoideum*

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frontal and parietal fenestrae in the dorsal wall of the endocranium (text-fig. 2). The margins of the incrassations are bordered by a slightly raised edges less clearly than in some Recent toads (e.g. *Bufo viridis*—cf. ŠPINAR, 1976: Pl. II, fig. 4). The incrassation reflects the elongated shape of the frontal fenestra in the dorsal endocranial wall and is laterally bordered by a straight to slightly obliquely (anteromedially-posterolaterally) passing ridge.

Maxillary. The maxillary is elongated, ca. 14.5 mm long, thick, poorly curved (laterally convex), bar-like, toothless bone. Its anterior half is substantially higher (up to 3.1 mm) than the hind one, in which the bone extends into a rapidly narrowing processus posterior. The margo inferior is smooth and toothless. The anterior end terminates in a wide, obliquely slanted rostral margin. From the dorsal side of the nasal margin (margo nasalis of BOLKAY, 1919: 286) extends a narrow processus frontalis to which is attached the processus paraorbitalis ossis nasalis (cf. ROČEK, 1981: 78, fig. 26).

Squamosal. The holotype preserves the entire right squamosal and an incomplete ramus retrozygomaticus of the left squamosal. The well ossified bone consists of three parts, ramus posterior (ramus posterolateralis sensu BOLKAY, 1919: 19), ramus zygomaticus (BOLKAY, 1919: 19), and ramus retrozygomaticus (BOLKAY, 1919: 20). The ramus posterior is long, whereas the ramus zygomaticus forms a short, pointed process. The ramus retrozygomaticus is conspicuously large and wide, with a great rectangular otic lamina (otic plate of BLAIR, 1972: 357) whose medial end is attached to the lateral side of the prooticum. In the holotype this bone is somewhat displaced anteriorly. Despite several fractures, it is well preserved.

Quadratojugal. The quadratojugal is a small bone of which only a fragment of the anteriorly projecting part (pars jugalis of BOLKAY, 1919: 287) is preserved.

The position of the skull-roof bones refers to a large, round orbit.

Palate

Palatine. The exposed part is long and slender.

Pterygoid. The pterygoid is incompletely preserved on the right side of the holotype, anteriorly of the squamosal. It consists of partial ramus maxillaris (BOLKAY, 1919: 304; ramus anterior of TRUEB, 1973: 82) including its pointed anterior part (apex rami anterioris pterygoidei), which is narrow, long, and slightly convex on both sides.

Mandible

Only a small fragment is visible anterolaterally of the nasal. It is difficult to determine whether this is part of the prearticular or of the dentary.

Endocranium

Sphenethmoid. It is visible only in a narrow slit between the anteromedial margins of the frontoparietals in the holotype. It is finely grooved.

Prooticooccipital. As already mentioned, the paired frontoparietals together with the ossified parts of the endocranium, i.e. the paired prooticooccipitals form a unit fused to a variable degree. It is partly seen in the holotype and more clearly in the Z 15 301, Z 15 302 and Z 15 303 specimens which represent almost entirely (Z 15 301) or partly (Z 15 302, Z 15 303) frontoparietal-prooticooccipital complexes of the right (Z 15 302, Z 15 303) or left (Z 15 301) side.

The dorsal wall of the prooticooccipital is covered by the posteriormost part of the frontoparietal and the two ossifications are not entirely fused (see the description of frontoparietal). Immediately above and under the hind margin of the frontoparietal this wall slopes relatively steeply posteroventrally; thus, there is a distinct groove between it and the posteroventral margin of the

frontoparietal. In the holotype the surface of the occipital wall is slightly sculptured. The junction of the occipital walls in the median plane is straight over a relatively long distance (in contrast to *Bufo bufo* CZICU 2, where the anterior parts of the medial margins are round and connected by tissue). The posteroventrally situated condylus occipitalis is conspicuously convex posteriorly and its axis passes dorsolaterally-ventromedially. Immediately laterally of the condyle is a large foramen jugulare directed anteromedially into the cranial cavity. In posterolateral view the otic capsule opens into the cranial cavity by a large, oval orifice which is divided into two openings by a tiny vertical partition. The medial opening (foramen perilymphaticum superius) is smaller and
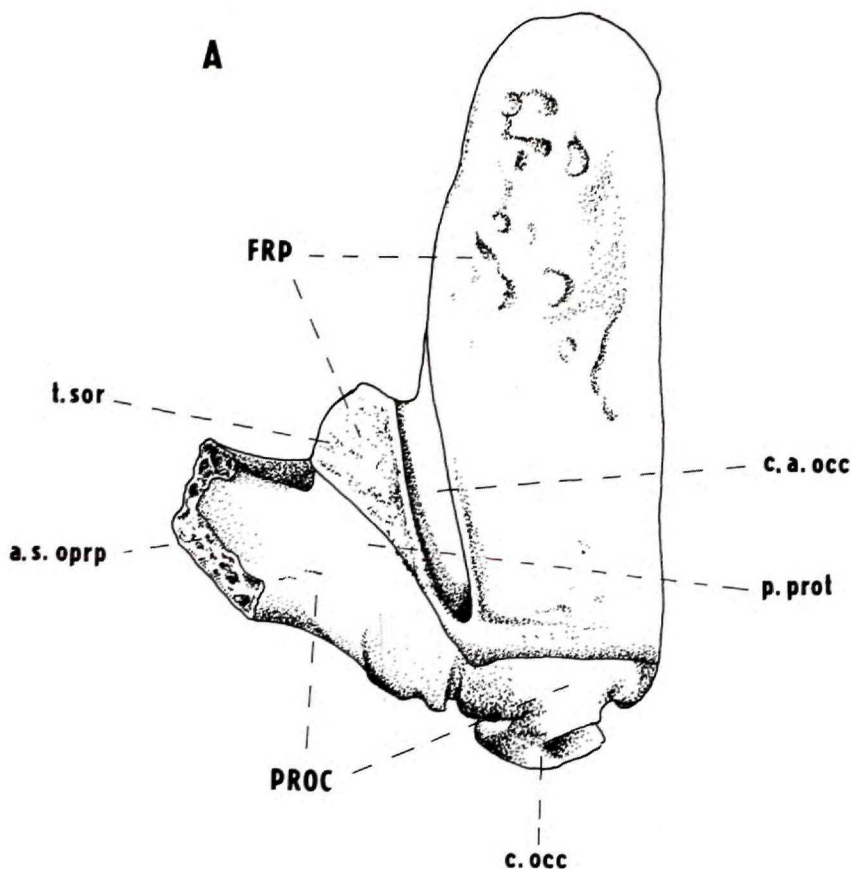
Fig. 2 *Bufo priscus* n. sp., Z 15 301
Prooticooccipital and frontoparietal in dorsal (A), ventral (B), dorsomedial (C), lateral (D) and posterior (E) views, max.length = 13.4 mm.
FRP—frontoparietal, PROC—prooticooccipital; a.s.oprp—articular surface for otic process of palatoquadrate, a.s.pbprp — articular surface for pseudobasal process of palatoquadrate, c.a.occ—canal for occipital artery, c.occ—occipital condyle, f.a.occ—foramen for occipital artery, f.ac.a, f.ac.p—anterior and posterior acoustic foramina, f.jug—jugular foramen, f.ov — fenestra ovalis, f.pl.i, f.pl.s—inferior and superior perilymphatic foramina, f.pot—prootic foramen, f.ptoc—pteroocipital fissure, iff, ifp — frontoparietal incrassation covering frontal and parietal fenestrae in dorsal endocranial wall, p.prot—prootic pelvis, t.sor—supraorbital tectum, t.ter—terminal torus

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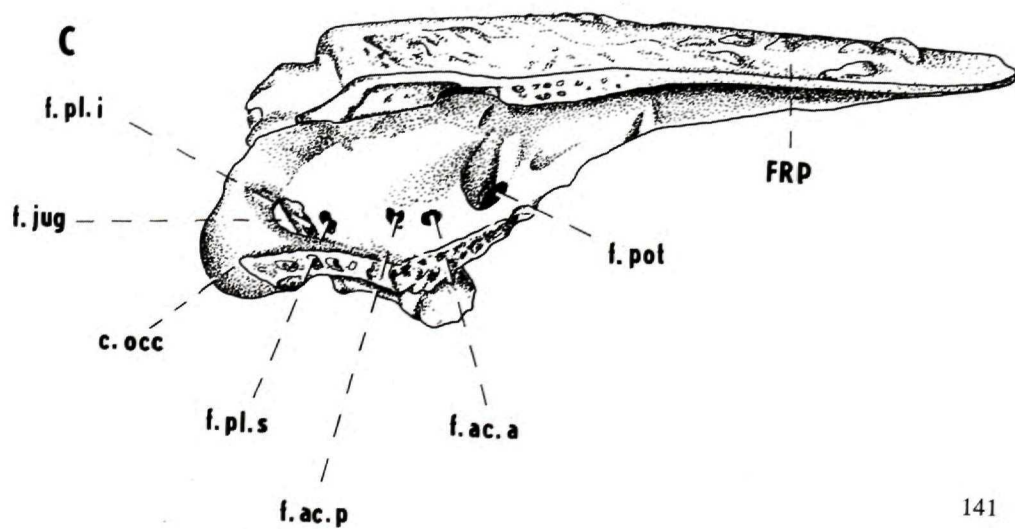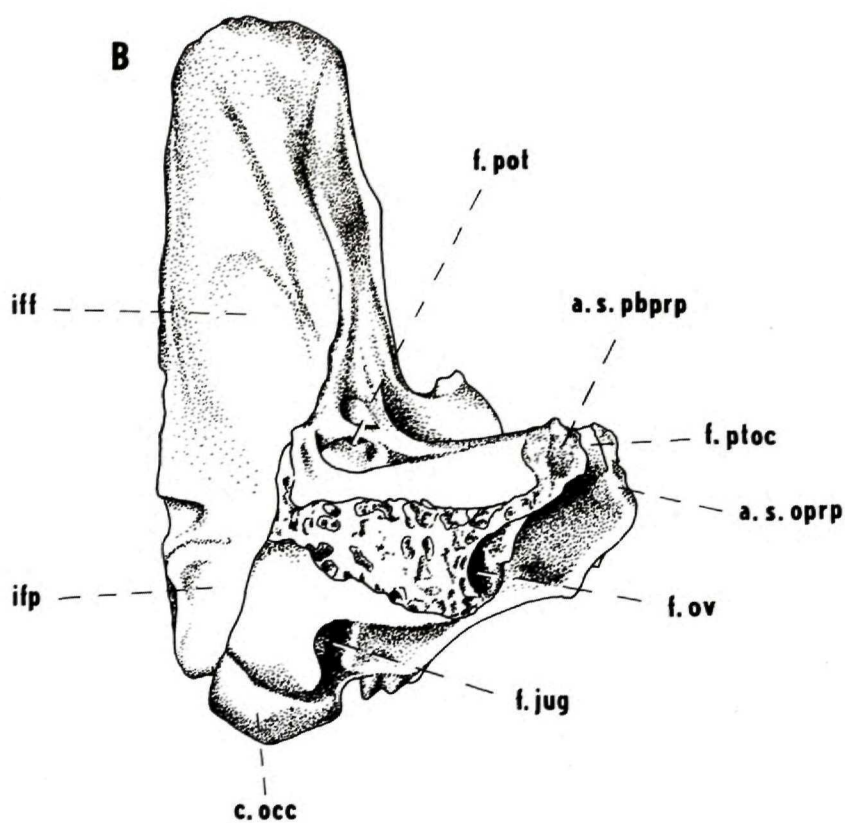
in Z 15 301 and Z 15 303 lies more dorsally than the larger and more lateral one (foramen perilymphaticum inferius). Immediately behind the posterolateral edge of the frontoparietal, or laterally of the posterior opening of the canal for the occipital artery, is a large torus terminalis (BOLKAY, 1919: 298), whose hind margin in Z 15 300 terminates in rounded condyles. This structure is in the region of the boundary of the original occipitale laterale and prooticum. There is no visible suture in Z 15 301—Z 15 303. However, in the skull Z 15 300, there is a slender line passing in the anterolateral-posteromedial direction on the dorsal surface of the left torus terminalis, which could indicate fusion of the originally independent ossifications. It is less distinct on the right side.

The prootic part of the prooticooccipital is conspicuously extended laterally, slightly raised dorsally at its distal end, and anterodorsomedially bears the hind portion of the tectum supraor-

bitale. It is fused with the prooticooccipital. Part of the smooth dorsal surface immediately behind the posterolateral margin of the tectum supraorbitale bears a conspicuous depression (pelvis prooticalis). Laterally the prooticooccipital forms two articulating, overlying areas. The upper area is preserved better, though not fully, in Z 15 303 and has the same slightly roughened surface as the lower one. Both surfaces are slightly concave. The upper articulation surface (text-fig. 2, a.s. oprp) is narrow in a well-preserved posterior half, passes anteroposteriorly, and faces dorsolaterally. Its anterior portion is not preserved in any specimen, but in Z 15 301 and Z 15 303 it is possible to observe the outline of its base. It shows that the articulation surface curved ventrally in its anterior part and passed almost perpendicularly. The otic process of the palatoquadrate articulated with the otic capsule at this point. The squamosal was attached dorsally in the horizontal plane. The lower articulation surface (text-fig. 2, a.s. pbprp) is more extensive than the upper one. It is squarish (Z 15 301) to elongate (Z 15 303) and faces ventrolaterally and slightly posteriorly. It represents a juncture of the pseudobasal process of the palatoquadrate with the otic capsule. On the anteroventral surface of this part of the otic capsule is a distinct, mediolaterally passing groove. The medial branch of the pterygoid was probably attached to it. Between the laterally projecting parts of the otic capsule, which bear the upper and lower articulating surfaces, is a narrow, deep fissure (fissura pterooccipitalis) for the vena jugularis. Its continuation on the anterior wall of the otic capsule forms a distinct, horizontal broad groove which disappears immediately in front of the prootic foramen. The fenestra ovalis is present posteromedially of the ventral articulation surface. Its posteromedial margin is conspicuously thickened.

In the lower part of the medial wall of the otic capsule is an oval opening with anteroposteriorly oriented long axis, which is divided by an almost vertical partition (its lower part lies already in the cavity of the otic capsule) into anterior and posterior openings, the foramen acusticum anterior et posterior. Thus the n. acusticus was divided upon entering the medial wall of the otic capsule. Dorsally of the acoustic foramina, in the upper part of the medial wall, lies a round foramen endolymphaticum (in Z 15 302). In Z 15 301 there is a narrow vertical fissure approximately in this area, but is situated more anteriorly, immediately behind the posterodorsal margin of the prootic foramen.

The prootic foramen is large, oval, and completely enclosed in the lateral wall of the endocranium (text-figs. 2B, C, D). This osseous wall lies mostly in the orbitotemporal region and is dorsally fused with the ventrolateral wall of the frontoparietal (from the region of the prootic foramen almost to the anterolateral edge of the frontoparietal).

Stapes. The stapes (columella auris) can be observed in the holotype on the right side of the skull behind the lateral margin of the prooticooccipital. It is a tiny bone, partly overlapped by the matrix. It consists of two parts. The larger, flat part is an operculum which passes into only partly preserved, relatively thin, elongated plectrum.

Postcranial skeleton (Pls. XXXIX, XL, XLII, text-figs. 3—11)

Columna vertebralis

The backbone is preserved in the holotype and CMH paratype, but in the latter it is not complete. In Z 13 500 it consists of nine slightly imbricate procoelous vertebrae (the procoelous nature is especially well discernible in the CMH specimen) which articulate by prezygapophyses and postzygapophyses. Neural arches cover canalis vertebralis from the dorsal side. Transverse processes are developed in the second through ninth vertebrae. On the 2nd vertebra they are 4.5 mm long and directed somewhat anterolaterally; on the 3rd vertebra they are 7.3 mm long and extend posterolaterally at less than 40°; on the 5th vertebra they are 6.5 mm long and extend posterolaterally at less than 40°; on the 6th vertebra they are 5.7 mm long and extend posterolaterally at less than

38°; on the 7th vertebra they are 50 mm long and extend laterally at 5°; on the 8th vertebra they are 3.5 mm long and extend anterolaterally at 40°; and on the 9th (sacral) vertebra they are 7.9 mm long, broadened into so-called sacral wings, and extend posterolaterally at 45°. In the holotype only the neural arch has been preserved and the sacral wings are lacking.

Comparing the construction of the backbone, especially the transverse processes of the two specimens studied, with that of *Bufo bufo* described and depicted by BAYER (1890: Pl. II, fig. A) only very small differences can be observed. They will be dealt with below in the discussion.

The distances of the distal ends of transverse processes from the median line in the holotype and paratype are as follows:

Holotype Z 15300

    1st vertebra — transverse process absent
    2nd vertebra — 7.6 mm
    3rd vertebra — 9.0 mm
    4th vertebra — 9.2 mm
    5th vertebra — 8.3 mm
    6th vertebra — 7.5 mm
    7th vertebra — 7.0 mm
    8th vertebra — 5.9 mm
    9th vertebra — 5.0 mm (fragmentary)

Paratype CMH

    1st vertebra — not preserved
    2ndvertebra — not preserved
    3rd vertebra — not preserved
    4th vertebra — not preserved
    5th vertebra — 7.5 mm (fragmentary)
    6th vertebra — 8.6 mm (fragmentary)
    7th vertebra — 8.3 mm (fragmentary)
    8th vertebra — 8.0 mm (fragmentary)
    9th vertebra — 9.0 mm (fragmentary)

The measurements show that the transverse processes of the fourth are longest and strongest. Compared with the Recent material (see BAYER 1890: Pl. II, fig. 23), very small differences in sizes and directions of transverse processes can be observed; nevertheless they are significant. The distal ends are truncated and were supplemented by cartilage, which allows the observation that they were hollow. Ribs are not observed.

The processus spinosi arise on the dorsomedial junction of both halves of the neural arch and their dorsal ends are broadened to variable degree. They are rough and covered with numerous minute pits. The processus spinosi of 1st—7th vertebrae display dorsal ends (carina neuralis of BOLKAY, 1919; dorsal crest of INGER, 1972: 116) which are exceedingly broad, flat uneven, and covered with minute pits. In the anterior vertebrae, these broadened areas lie at the anterior ends of the vertebrae, whereas in the posterior vertebrae they move progressively more posteriorly. In the 8th presacral vertebra the processus spinosus is already fairly narrowed and only slightly broadened. In this way the broadened tear-shaped areas form the dorsal ends of processus spinosi, which are extremely large in the specimen studied. In most Eurasian toads only one dorsal crest is present (see INGER, 1972: 115). Two carinae neurales occur only in East Asian toads, the *biporcatus* and the *asper* groups. However, six to seven carinae dorsales have been found by the

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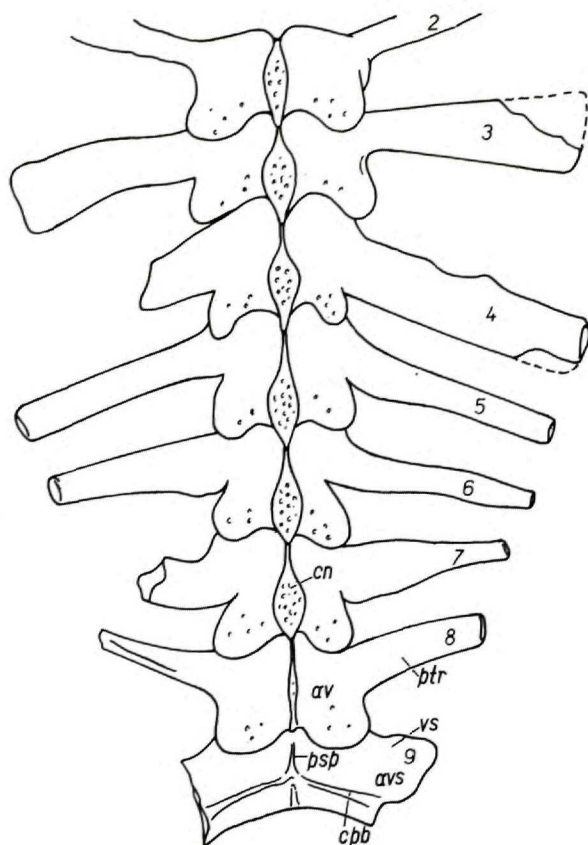
Fig. 3 *Bufo priscus* n. sp., Z 15 300. Part of vertebral column
av—arcus vertebrae; avs—ala vertebrae sacralis; cn—carina neuralis; cpb—crista posterobasalis; psp—processus spinosus; ptr—processus transversus; vs—vertebra sacralis; Nrs. 2—9 —numbers of vertebrae

present authors only in the species described here. It is clear that they served for attachment of longitudinal and transverse body muscles (DUELLMANN and TRUEB, 1986: 333—334), but it is not yet clear why they were so numerous. In the sacral vertebra the processus spinosus is hardly discernible. In immature specimens of our Recent species these dorsally broadened small areas of processus spinosus are distinctly smaller and can be observed only in the second vertebra.

Vertebra sacralis

In the holotype, only the neural arch and small fragments of sacral wings are preserved. The neural arch shows two prezygapophyses and a very reduced processus spinosus. From both sides of the latter (to left and right) runs sharply delineated crista posterolateralis (BOLKAY 1919: 35, fig. 34). Their moderately broadened distal ends probably represent elongated rudimentary postzygapo-

physes. The broad wings are well preserved in the paratype, where an almost complete left transverse process (wing) is visible from the ventral side. On the lateral side, two small condyles (caput glenoidale duplex of BOLKAY, 1919: 315) are present which serve for articulation with the urostyle. The CMH specimen preserves also the remains of the right and left prezygapophyses. The processus transversus vertebrae sacralis is directed posterolaterally at an angle of about 45° and is proximally narrow and distally broad. Along the axis of symmetry the 9 mm long sacral wing has been preserved. It is 4 mm broad proximally and 6 mm broad at the distal end. Its anterior and posterior margins are much more robust and better ossified than the other flat wings. The shape is nearly identical to that in *Bufo bufo*.
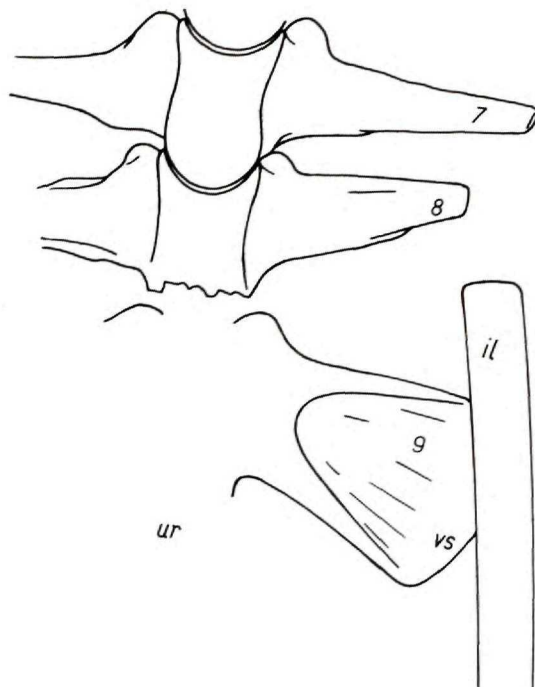
Fig. 4 *Bufo priscus* n. sp., CMH
wo presacral (7, 8) vertebrae, and one sacral vertebra (9) of paratype in ventral view; il—ilium; ur—urostyle; vs—vertebra sacralis

Urostyle

Except for a small part of the dorsal surface of the posterior end, the urostyle has been preserved almost completely in the holotype. This is a 16 mm long stock-shaped bone formed of several (probably 4—6) postsacral vertebrae and an ossified hypochordal cartilage. At its proximal end there are two articular pits (foveae condylicae seu fossae condyloidae ossis coccygei of BOLKAY, 1919: 319, fig. 43) into which fit two condyli vertebrae sacralis. This articulation is strengthened by a small intercondylar process (processus intercondylicus of ŠPINAR , 1972: 66) which runs from the lower part of the urostyle between the sacral condyles.

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In the median plane of its proximal end is the opening of a small canal (canalis coccygeus of BOLKAY, 1919: 319, fig. 43) and on its dorsal side is a high crest (crista ossis coccygei of BOLKAY, 1919: 319) whose top is divided by a deep groove into two parts. This groove rapidly shallows in the posterior third of its length. However, it is much deeper in the fossil specimen studied than that in Recent species. The basal part of the urostyle (corpus urostyli of ŠPINAR , 1972: 68), which originated by intergrowth of the vertebral bodies and the ossified hypochordal cartilage, is conspicuously laterally broadened in the proximal half to form broad longitudinal stripes (lamina horizontalis of BOLKAY, 1919: fig. 39) which run along the base of the crista urostyli up to its posterior third. About half way along the urostyle, the stripes gradually begin narrowing toward its caudal end, where they almost disappear. The end of the urostyle is partially broken off; however, it is possible to see the cavity of the canalis neuralis where at the base the ossified part of the hypochord is visible. The base (ventral side) of the urostyle is not half-globular as is the case in the Recent genera (see text-fig. 5C), but is flat (text-fig. 5B).
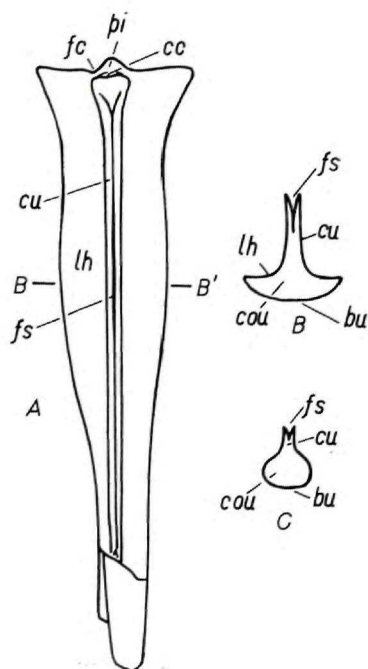
Fig. 5 *Bufo priscus* n. sp., Z 15 300 (A, B) and *Bufo bufo*, DPFNSP 272/89 (C)
A—urostyle in dorsal view. B—transverse section of urostyle. C—transverse section of urostyle. cc—canalis coccygeus; cou — corpus urostyli; cu—crista urostyli; bu—basis urostyli; fc — fovea condylica; fs—fissura sagittalis; lh—lamina horizontalis; pi—processus intercondylicus; B—B'—plane of section

Shoulder girdle

Only the right scapula in ventral view and both cleithra have been preserved.

Scapula

The right scapula (scapula dextra-facies interna) is a short, robust dorsoventrally elongated and moderately convex bone. Its broadened dorsal part (pars suprascapularis of BOLKAY, 1919: 51;

corpus scapulae of ŠPINAR , 1972: 78) ends in horizontal edge (margo suprascapularis of BOL-
KAY, 1919: 51; margo cleithralis of ŠPINAR , 1972: 28). The broadened ventral part is divided by
a deep incissure (incissura acromio-glenoidalis of ŠPINAR, 1972: 78) into two parts lying more
anteriorly (pars acromialis of BOLKAY, 1919: 55) and that lying more posteriorly (pars glenoidalis
of BOLKAY, 1919: 51). In its mid-length, the scapula narrows into the collum scapulae (ŠPINAR
1972: 78) and the posterior margin of scapula (margo caudalis of ŠPINAR , 1972: 78) are concave
in the direction toward the longitudinal axis, so that the bone has a waisted form. The pars acro-
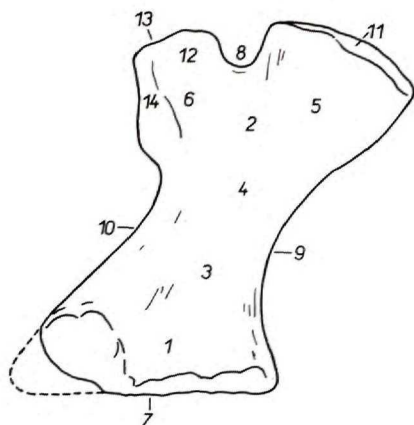
Fig. 6 *Bufo priscus* n. sp., Z 15 300. Right scapula, facies
interna
1—pars suprascapularis; 2—caput scapulae; 3—corpus
scapulae; 4—collum scapulae; 5—pars acromialis; 6—
pars glenoidalis; 7—margo suprascapularis; 8—incis-
sura acromio—glenoidalis; 9—margo anterior;
10—margo posterior; 11—margo clavicularis; 12—pro-
cessus coracoideus; 13—margo coracoidalis; 14—crista
supraglenoidalis

mialis scapulae ends in a broadened margin (margo clavicularis of BOLKAY, 1919: 51) which
accomodates the clavicle. The opposed pars glenoidalis carries on its facies externa a pit (cavitas
glenoidalis) for the caput humeri. This articular pit opens posterolaterally. The entire pars glenoi-
dalis scapulae forms a broad process (processus coracoideus) for attachment of the lateral end of
the coracoid. On the internal surface of this process is a distinct crista (crista supraglenoidalis)
which extends from the margo coracoidalis nearly to the collum scapulae.

Measurements of the scapula: The length between the centre of margo cleithralis and that of
margo clavicularis is 8 mm. The margo cleithralis is 5 mm long. The caput scapulae is 6 mm wide
and the collum scapulae is 3 mm wide. The outer surface (facies externa) is not visible.

Cleithrum

This element is relatively well preserved. It is a flat bone lying dorsolaterally in the shoulder girdle.
It consists of a flat, almost quadrangular body (corpus cleithri of ŠPINAR , 1972: 76) from which
extend two branches, a long oral branch (ramus anterior of ŠPINAR , 1972: 76) and a blunt, short
caudal branch (ramus posterior of ŠPINAR , 1972: 76). The body of the cleithrum sits by its even
lateral margin (margo scapularis of BOLKAY, 1919: 53) on margo suprascapularis of the scapula.
The anterior branch of the cleithrum (ramus anterior cleithri) is long, flat and broad, whereas the
posterior branch (ramus posterior cleithri) is much shorter and more blunt. Between the two
branches is a broad notch (sinus dorsalis of BOLKAY, 1919: 53). The anterior margin is moderately
bent and folded over onto the ventral side along its whole length. This is a strong, conspicuous
fold which has been called lamina recurvata by ŠPINAR (1972: 76). The posterior margin of the
cleithrum (margo posterior of BOLKAY, 1919: 53; margo caudalis of ŠPINAR , 1972: 76) is bent
only very slightly anteriorly. The space between the ramus anterior and ramus posterior was filled
during ontogeny by partly ossified cartilage which has been designated as the suprascapula
(BAYER 1890: 35).

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Measurements

Length of cleithrum across ramus anterior = 10.0 mm
Length of cleithrum across ramus posterior = 5.0 mm
Width of cleithrum body antero-posteriorly = 6.0 mm
Width of cleithrum body on margo scapularis = 5.3 mm

The cleithrum of the studied specimen differs fairly obviously from those of the Recent species. Compare text-fig. 6 with the shape of this bone in the Recent species of the genus *Bufo* given by MAŇOUROVÁ (1976, text-fig. 21). The coronoid is not preserved.
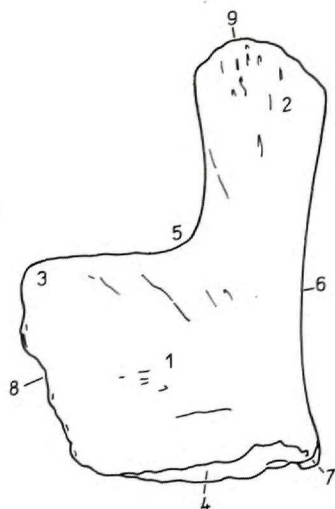
Fig. 7 *Bufo priscus* n. sp., Z 15 300. Right cleithrum, facies externa.
1—coprus cleithri; 2—ramus anterior; 3—ramus posterior; 4—margo scapularis; 5—sinus dorsalis; 6—margo anterior; 7—lamina recurvata; 8—margo posterior; 9—margo vertebralis

Anterior limb

The anterior limb is relatively well preserved. It is composed of 1/ humerus, which articulates proximally with the shoulder girdle; 2/ os antebrachii, composed of partly fused radius and ulna; and 3/ manus.

Humerus

The humerus is robust, cylindrical, elongated bone, with a globular epiphysis at its proximal end (caput humeri of BOLKAY, 1919: 55). The epiphysis fits into the glenoid cavity formed partly by the coracoid. In the specimen under study, both humeri are preserved but are incomplete and exposed in somewhat different positions.

The right humerus is exposed anterodorsally and is almost complete. The proximal epiphysis is lacking and the distal epicondylus radialis (BOLKAY, 1919: 55; epicondylus lateralis of ŠPINAR, 1972: 82) is partly broken off so that a large, globular eminentia capitata is well visible. The cylindrical body of the humerus is broad proximally and narrows in the distal direction. In the middle it is moderately S-shaped. Behind the epicondylus radialis is visible the olecranon scar. A distinct crista lateralis (BOLKAY, 1919: 55) runs from the preserved part of the lateralis process (epicondylus radialis) in the proximal direction but disappear near the centre of the bone.

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The left humerus is less complete, lacking about one-third of the proximal part. The preserved length is cca 15 mm. It is exposed posterodorsally and its distinctly S-shaped body can be seen. At the distal end there is a large epicondylus ulnaris (ŠPINAR , 1972: 82) and behind it an olecranon scar. A pronounced crest (crista medialis of BOLKAY, 1919: 55) extends from the epicondylus ulnaris towards the centre of the bone where it disappears. No characters have been observed on the humerus which would render it different from the Recent species *Bufo bufo*.
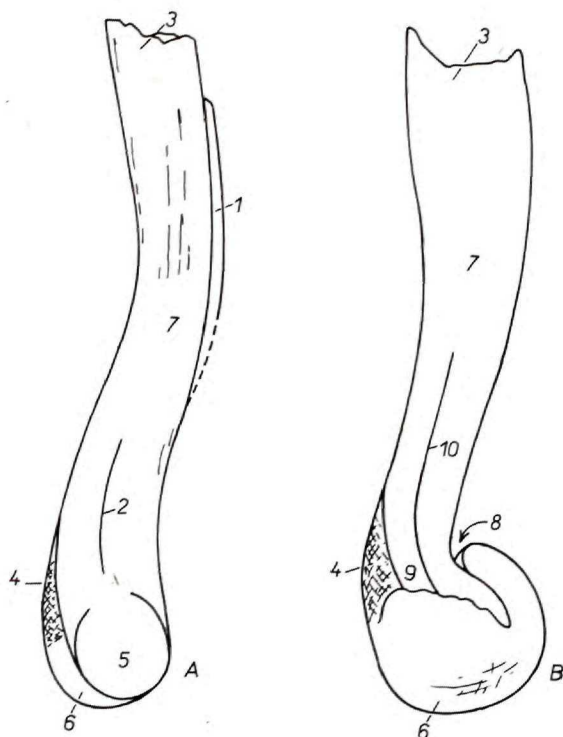
Fig. 8. *Bufo priscus* n. sp., Z 15 300
A—*left humerus in posterolateral view*. B—*right humerus in dorsolateral view*. 1—crista ventralis; 2— crista medialis; 3—epiphysis proximalis; 4—olecranon scar; 5—epicondylus ulnaris (= medialis); 6—eminentia capitata; 7—corpus humeri; 8—fossa cubiti ventralis; 9—epicondylus radialis (lateralis); 10—crista lateralis.

Radius and ulna

Both bones of the right side are almost completely preserved. They do not bear features different from the Recent species *Bufo bufo*.

Carpus

Only the carpus of the right limb is preserved to some extent. The whole autopodium is turned so that the metacarpus of the first digit (designation of digits after HOLMGREN, 1933) is placed

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above the ulna and the metacarpus of the fourth digit lies above the radius. Two rounded, irregularly reniform elements overlying the ulna probably correspond to the praeaxiale centrale (JAROŠOVÁ, 1973) which contains the carpale praepollicis and centrale 2. To the left of this element is another element which probably represents the fused centrale 1 and radiale. Under the metacarpi of digits II — IV is a large centrale postaxiale which probably includes centrale distale 2—4 and centrale 3—4. The metacarpus of the first digit is underlain by a triangular centrale distale 1 and an incomplete triangular element which can be regarded as the 1st phalanx of prepollex. In addition, between the radium and the large element underlying the metacarpi of IInd—IVth digits, there are indistinct impressions of two elements, one of which might be the ulnare, while the second one could perhaps be a relic of the prehallux.
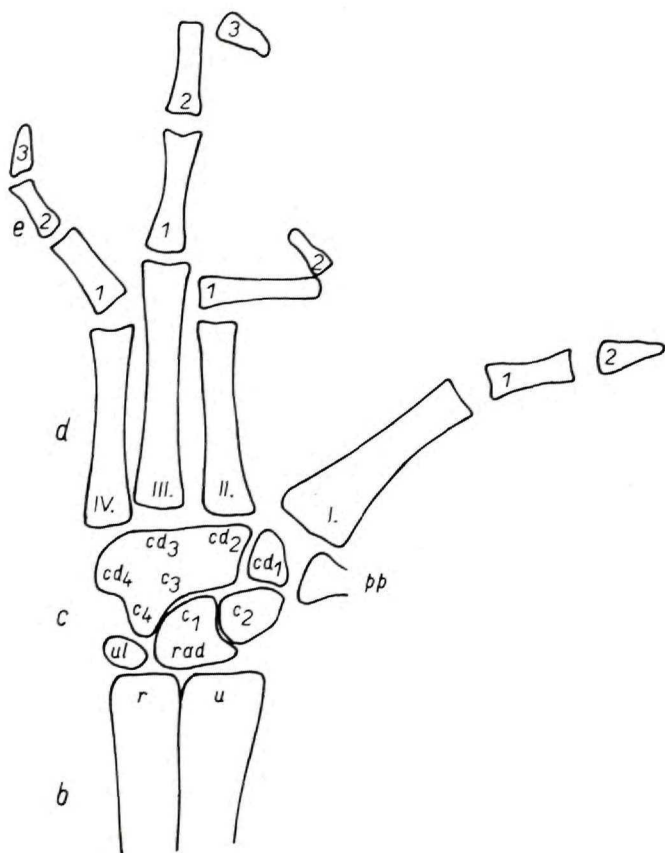
Fig. 9 *Bufo priscus* n. sp., Z 15 300. Forelimb

b—antebrachium; c—ossa carpi (carpus); d—ossa metacarpi (metacarpus); e—phalanges digitorum; r—radius; u—ulna; rad—radiale; ul — ulnare; c_{1-4}—centrale 1—4; cd_{1-4} —centrale distale 1—4; I—IV—metacarpus of 1—4 digits; 1—3—phalanges of digits; pp (?)—probably an incomplete prehalux

Metacarpalia and phalanges digitorum

The metacarpus of the I^{st} digit is the most massive and measures 5.0 mm.
The metacarpus of the IInd digit is the shortest and measures 4.9 mm.
The metacarpus of the IIIrd digit is the longest and measures 5.2 mm.
The metacarpus of the IVth digit is shorter than that in digit III and measures 5.0 mm.
The I^{st} digit has 2 phalanges 2.3 and 1.1 mm long and is the shortest.
The IInd digit has 2 phalanges 2.9 and 1.5 mm long.
The IIIrd digit has 3 phalanges 4.1, 2.1 mm and 1.3 mm long and is the longest.
The IVth digit has 3 phalanges 2.2 mm, 1.9 mm and 1.2 mm long.

The shortest, but most robust, is the I^{st} digit. Its metacarpus is proximally very robust and broad, and has a shallow groove on its proximal end. Only the above-mentioned incomplete phalanx is preserved of the prepollex. The prehallux is not preserved. The tips of the terminal phalanges are club-like. In the specimen studied, the I^{st} digit is the shortest, but BAYER (1890: 40) wrote that in the toads studied by him the shortest digit was the IInd. Some phalanges are preserved only as impressions.

P e l v i c   g i r d l e

The ilium

Both ilia are preserved in dorsomedial view. They are robust, relatively short bones trending antero-laterally along both sides of the urostyle toward the transverse process of the sacral vertebra. Their structure indicates that the animal was probably of the walking or creeping type. Both ossa ilium contain an angle of about 43—44°. Each of them consists of a long wing (ala), laterally convex that points anteriorly and runs anterolaterally of the urostyle from the broadened posterior part of the corpus ossis ilii. The rounded, cylindrical, posterior part of the ala is connected with the end of the broadened tranverse process of the sacral vertebra. The alae are rounded and cylindrical in the posterior half, whereas in the anterior half they bear a pronounced dorsal crista which extends all the way to the anterior end. In this feature, *B. priscus* differs from *B. bufo* in which the crista disappears before the anterior end. This crista serves for attachment of several muscles (m. iliacus externus, m. transversus, m. obliquus externus) which extend to the anterior end of the ilium. Toward the posterior end the ala passes into the broadened part (corpus ossis ilii of ŠPINAR , 1972: 86) where, on the top of the raised part (pars ascendens ossis ilii of BOLKAY, 1919: 58) is a pronounced node (tuber superius of BOLKAY, 1919: 58). It ends in two to three small, blunt processes. On its side are two small depressions where the muscles m. glutaeus magnus, m. iliofemoralis, and m. iliofibularis were attached. In contrast to *B. bufo*, this node is much larger and rises much more abruptly from the margin of the bone, in which it recalls e.g. the Recent South American *B. valliceps*. The pars ascendens ossis ilii continues and is still visible posteriorly of this node. Between it and the descending part (pars descendens ossis ilii of BOL-KAY, 1919: 58) is a small depression situated on the inner side, which continues to the posterior boundary called the ilio-ischiadic juncture (junctura ilio-ischiadica of BÖHME, 1982: 211). In the studied specimen the junctures on both ilia are covered by the matrix.

Os ischii

The ischium is paired flat bone of which only the right half is preserved. The ischia form the lowest part of the pelvis. They are connected by ossa ilium along the transversely running synchondrosis ilio-ischiadica. From the body of the bone (corpus ossis ischii of ŠPINAR , 1972: 87) a broad process (ager limitans posterior of BOLKAY, 1919: 334) runs laterally and is terminated by a disc-

like depression forming part of the acetabulum—a shallow depression for articulation of the pelvis with the caput femoris. A crista (crista communis ossis ischii) arises at the symphysis (symphysis pelvis), whose suture is readily discernible. This crista represents the most posterior part of the pelvis. The ischia are anteriorly overlain by the joined posterior ends of the ilia.

The ossa pubica are not preserved; they were cartilaginous.
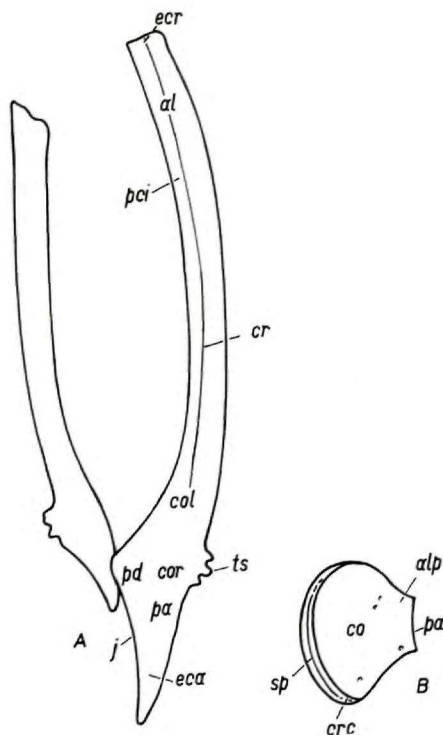
Fig. 10 *Bufo priscus* n. sp., Z 15 300
A—*os ilium*, al—ala ossis ilii; col—collum ossis ilii; cor—corpus ossis ilii; cr—crista ossis ilii; eca—extremitas caudalis ilii; ecr—extremitas cranialis ilii; j—junctura (articulatio) ilio—ischiadica; pa—pars ascendens; pci—pars cylindriformis ossis ilii; pd—pars descendens ilii; ts—tuber superius; B—*os ischii*; alp—ager limitans posterior; co—corpus ossis ischii; crc—crista communis; pa—pars acetabularis ossis ischii; sp — symphysis pelvis

Posterior limb

The posterior limb consists of the femur, crus, tarsus, metatarsus and phalanges digitorum. The posterior leg of the holotype is characterized by a relatively short femur and crus. The length of each is 24 mm. This indicates a walking type of locomotion for the animal which lived mostly on dry land.

Femur

The entire right femur and the proximal half of the left femur are preserved. The femur is a robust, cylindrical bone whose proximal end is substantially more massive than the distal one. The body of this bone (corpus femoris of BAYER , 1890: 42) is S-shaped and distinctly more slender in the

middle. On the ventral side is a rough crest (crista femoris of BAYER , 1890: 42) whose length approximately equals one-third of the bone length. Both joints were cartilaginous and are thus preserved only as impression. The proximal caput femoris (BAYER , 1890: 43) is almost globular, whereas distal end (apophysis distalis of BOLKAY 1919: 340) is relatively smaller and flatter. The foramen nutricium is not visible due to the position in which the bone is exposed. However, numerous longitudinal grooves can be seen in places of attachment of strong foot muscles.
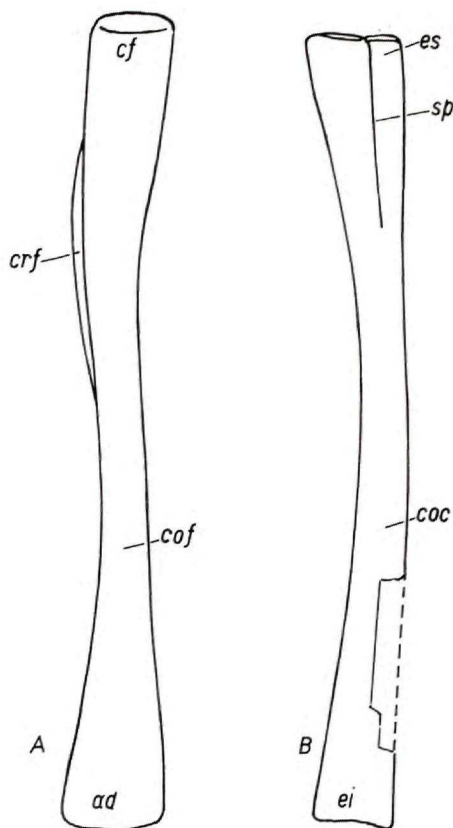
Fig. 11 *Bufo priscus* n. sp., Z 15 300
A—femur; ad—apophysis distalis; cf—caput femoris; cof—corpus femoris; crf—crista femoris; B—*os cruris*; coc—corpus ossis cruris; ei—epiphysis inferior; es—epiphysis superior; sp—sulcus proximalis ossis cruris

Crus

This bone has been preserved only on the right leg, where the lateral, fibular side is visible. It is as long but more slender than the femur. The epiphyses are broader than the middle and the whole bone is moderately bent laterally. The crus originated by fusion of the tibia and fibula. The suture groove (sulcus proximalis ossis cruris of BOLKAY, 1919: 65) is readily discernible in the proximal part. The distal end (epiphysis distalis) of the tibial part is damaged and exposed so that only its fibular part is visible. Of the tibial part, only a small piece at the proximal end is visible. In places

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where the sulcus distalis ossis cruris (BOLKAY, 1919: 65) is placed the bone is damaged and broken off. The distal end of the crus articulates with both bones of the proximal tarsal row. Of the cartilaginous proximal part of the crus (caput ossis cruris of BOLKAY, 1919: 65) only impressions are preserved, whereas the distal apophysis is preserved completely. The foramen nutricium is not visible.

Tarsus

This part of the posterior extremity is composed of two rows of bones. The proximal row (tarsalia proximalia of BAYER , 1890: 44) consists of astragalus and calcaneus which are not fused; and the distal row (tarsalia distalia of BAYER , 1890: 45) consists of several small bones.

In the proximal row only the calcaneus is fully visible, lying on the side of fibula and thus on the side of the Vth digit. The astragalus lies under the calcaneus and can be only partially seen. The calcaneus is a cylindrical bone the ends of which are more robust than the middle. It is 13.5 mm long and has no diagnostic features.

The bones of the distal row are very small. The smaller of them (probably tarsale distale 1) lies under the small metatarsals of the I^{st} and IInd digits. The larger one is somewhat elongated (probably tarsale distale 2 + 3) and underlies the metatarsals of the IVth and V^{th} digits. However, these ossified parts could also correspond to remains of the calcaneus (JAROŠOVÁ, 1974).

Metatarsalia I. — V.

These small bones are cylindrical and vary in length. The lengths of the individual small bones as well as those of phalanges digitorum are as follows:
   Metatarsus of the I^{st} digit is incompletely preserved (the fragment is 1.5 mm long)
   Metatarsus of the IIth digit measures 6.5 mm
   Metatarsus of the IIIrd digit measures 9.0 mm
   Metatarsus of the IVth digit measures 10.2 mm
   Metatarsus of the Vth digit measures 9.5 mm
Digits (phalanges digitorum)
   I^{st} digit has 2 phalanges 2.1 mm and 1 mm long
   IInd digit has 2 phalanges 2.8 mm and 1.2 mm long
   IIIrd digit has 3 phalanges 4.3 mm and 2.4 mm long and a fragment of the third phalanx
   IVth digit has preserved only 1 phalanx (6.3 mm long) and a fragment of the 2nd phalanx
   V^{th} digit has preserved only a 3.5 mm long fragment of the 1st phalanx and small fragments of 2nd and 3rd phalanges
   Considering the length of the metatarsus and the first phalanx of the digit, the IVth digit was the longest. Nothing is left of the Vth digit.

Discussion

Whereas Recent toads are abundant, the fossil ones are rare. The oldest disputible occurence has been described from the Eocene—Oligocene (FILHOL, 1877). The small number of occurrences of toads in other older Tertiary assemblages has two causes: 1. toads are predominantly terrestrial animals and as such are much more rare in the fossil record than aquatic animals; 2. their origin was late and their migration considerable. Occurrences of fossil toads are more common only from the Late Miocene onwards. It is probable that only late in this geological period the toads spread from their centre of origin in South America to North America and nearly through the entire Eurasia and Africa. They did not invade Australia and the neighbouring islands because of

changed paleogeographic conditions. They did not penetrate there either via the "north" way, i.g. through Alaska and around the East Asian coast to the south, or via the "south" way, i.e. through South America and Antarctica. This fact is very important for study of timing of their distribution. It is known that South America and Antarctica were separated in the Upper Cretaceous. Up to that time the older primitive Leiopelmatidae, which are close to the South American genera of fossil frogs, penetrated through South America and Antarctica and Australia. The bufonids, which arose from the leptodactylid frogs during the Upper Cretaceous, could not migrate this way because by then, the separation of South America from Antarctica was already completed (LYNCH, 1971). TIHEN (1972), BLAIR (1972), and SANCHIZ (1977) presumed that toads settled Europe from the east and by migrating from South America to the north along the west coast of North America (along the Cordilleras) to Alaska, from where they could enter Asia. From Asia they migrated to Euroasia and Africa. According to LOW (1967) and MARTIN (in BLAIR, 1972: 66), toad ancestors entered Europe from South America, through west Africa together with other ancestors of the Neobatrachia (RAGE and VERGNAUD—GRAZZINI, 1978: 177). This is based on the opinion of REIG (1972: 32) that the Neobatrachia and probably also the bufonids, arose already at the beginning of the Cretaceous and began to migrate when South America and Africa were still connected. However, these presumptions are not clear so far. The above routes are today either covered with extensive deserts or not studied enough (see MILLS and KEITH 1972: 161) and therefore adequate fossil data are not yet available. A priori this last possibility cannot be excluded.

It should be noted that the "more advanced narrow-headed" and "more primitive wide-headed" toads of the genus *Bufo* (see MARTIN , 1972: 65) could represent two lineages which arose at the end of the Mesozoic era.

TIHEN (1972: 12) wrote that no clear evidence existed of toad expansion before the Middle Miocene, but SANCHIZ (1977: 75—111) listed many occurrences from the Lower Miocene— (MN₄) of Europe (see SENEŠ, 1976). The occurrence of Tertiary toads in America (TIHEN, 1972: 9) indicate that this group underwent a conspicuous diversification in the Miocene in all parts of its range.

Some Middle Miocene find of toads are known from Spain, Slovakia and Bohemia (SANCHIZ, 1977; HODROVÁ, 1988). Those described by HODROVÁ (op. cit.) come from the same locality and are of the same age as our specimens. The authors who studied these findings always assumed that they were *Bufo* cf. *bufo* or *Bufo* cf. *viridis*. Some bones, however, were identified without the cf., i.e. as belonging to the Recent species. In these works some morphological features either were not observed or were explained as intraspecific variation.

We have studied only slightly damaged, almost entire articulated skeleton reminiscent of *Bufo bufo*. However, our detailed study showed the species to differ from all the known European Recent species. In the Middle Miocene species studied, the following observations have been made:

1. The frontoparietal is distinctly sculptured, which is not observed in any of the Recent species. It indicates a primitive state of the fossil specimen.

2. The tectum supraorbitale is substantially larger.

3. A narrow gap between the anterior halves of the frontoparietals gradually narrows posteriorly and disappears at mid-length. It differs from *Bufo bufo* but is reminiscent of *Bufo viridis*.

4. The canalis a. occipitalis in the holotype is open in the anterior part, but it is almost closed posteromedially on the right; in SNM Z 15301 it is completely closed posteriorly.

5. The prootic portion of the prooticooccipital has the form of an irregular trapezium and is posterolaterally concave. It is more similar to *B. viridis* than to *B. bufo*, in which it is circular to round.

6. The squamosal bears conspicuously elongated nearly rectangular otic lamina. In this feature it is reminiscent of *B. bufo*, but this lamina is smaller and shorter in the Recent toads.

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7. The spinous processes of first through seventh vertebrae have conspicuously broad, flattened and sculptured dorsal ends resulting in tear-shaped planes. In the Recent toads this widening is present in only one or rarely two vertebrae (3rd and 2nd), but only in two East Asian thermophile toads of the groups *asper* and *biporcatus*. However, they have only two carinae whereas there are seven very broad processes in the specimen studied.

Of the seven osteological characters studied by INGER (1972: 117) on the skeleton of the groups *bufo, viridis, orientalis, stomatictus, melanostictus, asper* and *biporcatus*, the following four can be observed in our fossil material: widening of the spinous processes on seven vertebrae, partly covered occipital canal of the frontoparietal, a rough to rugged dorsal surface of the frontoparietal, and the squamosal with a broad otic plane. These four characters were found only in the groups *asper* and *biporcatus* which have only two widened spinous processes, whereas our specimen has seven of them. These two groups are restricted to southeast Asia (Malaya, Sumatra, Java, Bali, Borneo and the southwestern Philippines). The possibility that these four osteological characters could indicate a distant affinity to the two thermophilous groups and thus show the east route of the Miocene migration cannot be altogether excluded.

8. The transverse processes of fourth through eighth vertebrae have different lengths. Those of the fourth vertebra are the longest and on the succession vertebrae gradually become shorter. An imaginary line connecting their lateral ends results in a conspicuously V-shaped contour.

Other smaller differences are also apparent but it is difficult to decide whether they are due to intraspecific and/or ontogenetic variation or sexual dimorphism. This difficulty notwithstanding, however, the characters 1—8 make it clear that the specimen studied represents a new species. It differs from the species below as follows:

1. *Bufo gessneri* (TSCHUDI, 1838): As the figures indicate, the transverse processes of the vertebrae are thicker, longer and bent more posterolaterally than in *Bufo bufo* and resemble those of the new species to some extent. However, the shape of the frontoparietal is unclear and seems to be quite different. According to TIHEN (1972: 10), *Bufo gessneri* is a narrow-headed species without any important keels on the skull and with an unsculptured frontoparietal.

2. *Bufo viridis* LAURENTI, 1768: The frontoparietal is not sculptured but there is a narrow fontanelle between the front halves of the left and right members. The tectum supraorbitale is absent. The occipital canal is free and fully open. The frontoparietal does not fuse with the prootic portion of the prooticooccipital. The spinous processes on the dorsal end are slightly widened but unsculptured.

3. *Bufo* aff. *B. viridis* (BAILON—HOSSINI, 1990), Miocene MN4, MN7, MN8, France. The frontoparietal is not sculptured. The fossula limitans runs more or less in parallel with the long axis of frontoparietal (in holotype of *B. priscus* n. sp. there is an angle of $16°$). On the prootic portion of the prooticooccipital, there is a transverse ridge which divides its surface into two nearly equal parts. This ridge is absent in *B. priscus*. On the spinous processes, the distinct carinae neurales are absent. The shape of the scapula (but partly also of the femur and ilia) differs from that in *B. priscus* n.sp..

4. *Bufo calamita* LAURENTI, 1768: There is a large fontanelle between the left and right frontoparietals. The frontoparietal is not sculptured. The tectum supraorbitale is absent. The frontoparietal fuses with the prootic portion of the prooticooccipital. The transverse processes of the VI—VIII vertebrae are short and slightly shortened posteriorly. The spinous processes on the dorsal end are nearly unexpanded.

5. *Bufo bufo* (LINNAEUS, 1758): The frontoparietal is not sculptured. There is a distinct suture between the left and right members, but a gap is not present. The frontoparietal fuses with the prootic portion of the prooticooccipital. The tectum supraorbitale is minute. The occipital canal is open. The transverse processes of VI to VII vertebrae are thin and shortened posteriorly. The spinous processes on the dorsal end are not widened in most of the vertebrae. The urostyle does not possess a conspicuously wide lamina horizontalis.

Conclusions

In comparison with other occurrences (BLAIR et al., 1972), *B. priscus* n. sp. belongs among the so-called narrow-headed toads, i.e. toads with narrow frontoparietals. MARTIN (1972: 63 — 65) stated that the problem centres on the types adapted to life in highlands; this can not be proved, but the occurrence near Bratislava does not contradict it. According to MARTIN (1972), these types belong to the Euroasian toads of the genus *Bufo*. Here belong the groups *viridis, calamita, bufo, melanostictus, stomatictus* and *asper*. *B. priscus* n. sp. is most closely related to the group *viridis* and less closely to the group *bufo*. It chares with these groups several characters but differs from them in others. It is more primitive in several respects, but it is also reminiscent of thermophyllous species of the *asper* and *biporcatus* groups. For that reason *B. priscus* is interpreted as an independent species. Studies of Recent toads have shown phenotypically very similar populations to be immunologically, cytogenetically or embryologically (BACHMAN et al., 1980) different and, therefore, assignable to separate species. In contrast, our material shows several morphological differences, and the erection of a new species is thus well justified.

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ZDENĚK V. ŠPINAR — JOZEF KLEMBARA — ŠTEFAN MESZÁROŠ

Nová ropucha z miocénu pri Devínskej Novej Vsi (Slovensko)

Resumé

Nový druh ropuchy—*Bufo priscus* n. sp.—je opísaný na základe takmer kompletnej kostry, niekoľkých izolovaných kostí a časti chrbtice. Materiál pochádza zo stredného miocénu lokality Bonanza pri Devínskej Novej Vsi. Znaky na lebke ako i čiastočne na postkraniálnom skelete indikujú, že nový druh žaby reprezentuje primitívnu euroázijskú úzkolebkovú ropuchu. V práci je diskutovaný i pôvod ropúch a ich migrácia.

Explanations of plates XXXIX—XLII

Plate XXXIX
Bufo priscus n. sp., holotype SNM Z 15 300 in dorsal view. Scale bar, 10 mm. Photo Miloš Heyduk

Plate XL
Bufo priscus n. sp., CMH (private collection), paratype. Part of vertebral column in ventral view. Scale bar, 10 mm. Photo Miloš Heyduk

Plate XLI
Bufo priscus n. sp., SNM Z 15 300, partial skull in dorsal view (cf. text-fig. 1). Scale bar, 1 mm. Drawing Ivan Kolebaba

Plate XLII
Bufo priscus n. sp., SNM Z 15 300.
Fig. 1 Right scapula (facies interna)
Fig. 2 Cleithrum in right lateral view. Scale bar, 1mm. Drawing Ivan Kolebaba

GERHARD O. W. KREMP

Was mass extinction of some organism in the transitional period of the Cretaceous — Paleogene caused by expansion of the Earth ?

18 figs.

A b s t r a c t. VOGEL's epoch-making terrella models indicate that the Earth has grown one third in size since Paleozoic. In Santonian time, magnetic reversals appeared, a sign that the Cenozoic Earth expansion phase has begun. Acceleration of the Alpine orogeny and other orogenies began. The continental seas then receded. Sea-shells dwelling in the continental seas lost their living space and so did the dinosaurs. As a consequence, the extinction phase of many species began in the Late Maastrichtian.

While an asteroid impact may probably have helped ignite the seven superplumes, the wild tectonic events, which occurred at K/T boundary time may have been the real deciding factor. Palynological evidence shows that the sea level changes occurred in El Haria (Tunisia) at the K/T border time. They are interpreted as Earth-expansion movements. In the Lower Paleocene time, a huge amount of the carbon dioxide remained in the atmosphere and caused "greenhouse efect", permitting development of an advanced Cenozoic life of plants and animals.

Key words. Mass extinctions, K/T boundary, Earth expansion.

Introduction

This paper was prepared for the International Symposium Paleofloristic and Paleoclimatic Changes during Cretaceous and Tertiary: September 14—20, 1992, Bratislava, Czechoslovakia, which I was not able to attend. A few month before, I had knee replacement surgery of both legs. The late Dr. EVA PLANDEROVÁ offered to read my paper. I would be very thankful if you let me know of comments, new information, or some criticism. Please write to my private address.

Príspevok bol prednesený na sympóziu "Paleofloristic and paleoclimatic changes during Cretaceous and Tertiary", konaného dňa 14.—20. IX. 1992 v Bratislave.

The Earth Expansion Theory

The time has come to discuss the likelihood of an expanding Mother Earth as the cause of the mass extinctions at Cretaceous/Tertiary time.

Until now, very few scientists of the world have heard about the Earth Expansion Theory or seen the illustrations of the epoch-making terrella models of the East German, KLAUS VOGEL. Fig. 1 shows 5 terrella models 40 % to 100 % of the Earth's present size. It demonstrates convicingly that on a globe of 60 % size the continents completely enveloped the Earth.

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| 40% | 60% | 66% | 75% | 60% | 100% |
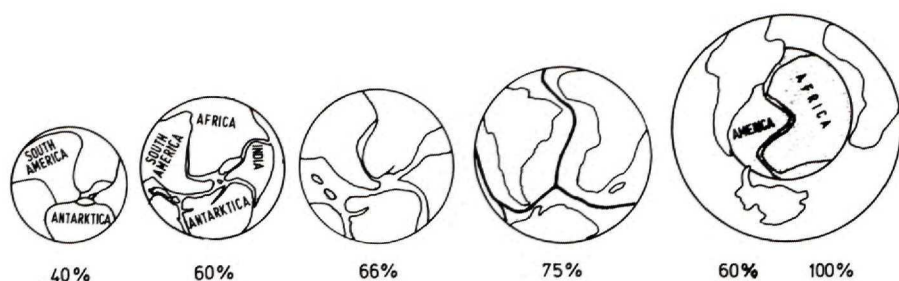
Fig. 1 VOGELs Terrella Models. About 1977 KLAUS VOGEL started to construct his first terrella models. He did not know at that time of CAREY's publications nor of HILGENBERG's terrella models. But he had followed the discussion concerning the new plate-tectonic ideas, especially the drift of India from the Gondwanalands, and he remembered WEGENER's inspiring teachings about which a "modern" geography teacher had lectured in his school when he was still a thirteen-year old boy. "The spark hit" he wrote (VOGEL, pers.comm., 1990). He started to experiment with terrella models and discovered that on models of 55% to 60% of the Earth's present size, the continents with shelves completely cover the surface of the globe. He calculated that the continents, without shelves, would fit on a globe approximately 40 % of the size of the present Earth. VOGEL realized that this was a theoretical possibility because the continental shelves could have formed after the brittle upper continental crust had broken into pieces (Photos courtesy of VOGEL, 1984)
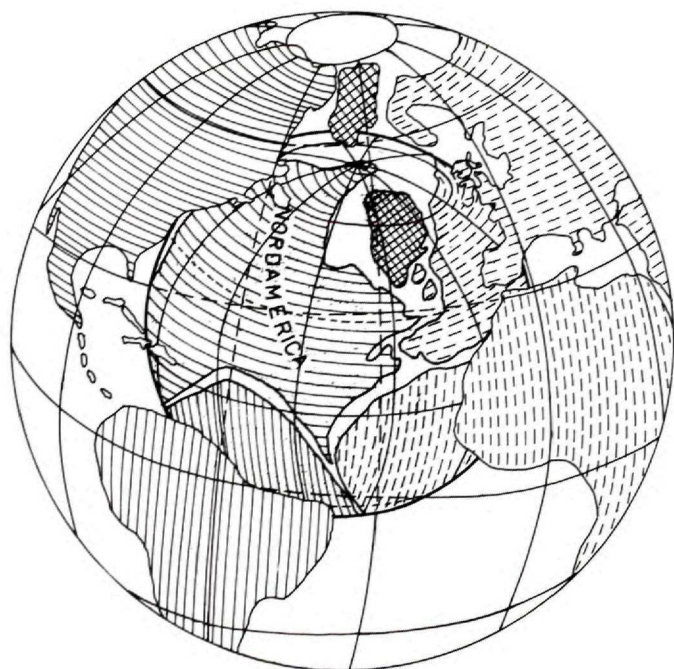
Fig. 2 VOGELs "60 % terrella" model enclosed in a glass "model of Earth's" present size. VOGELs construction indicates that continental crust is more or less fixed to its substratum and that since Paleozoic time, the crust has been pushed outward in radial direction by expansion forces of our planet. Yet, as the five oceans were growing at different speeds, the distribution pattern of the continents became more and more asymmetric (Courtesy of VOGEL, 1983)

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VOGEL was not the first to construct expanding terrella models. It was CHRISTOPHER OTTO HILGENBERG who, in 1933, became convinced of the reality of Earth expansion when he discovered that all of the Earth's continental plates fit neatly together and that they envelop the Earth almost totally with continental crust on a globe approximately 60 % of its present size. Stimulated by WEGENER's ideas, HILGENBERG was the first to construct expanding terrella models. However, at this time, continental drifts was considered a heresy and his work was soon forgotten.

VOGEL's investigations (Fig. 1) also demonstrates that on a globe of 60 % size, the continents completely enveloped the Earth. This challenges the steadfast belief that the Earth has remained static since the beginning of the Precambrian. HILGENBERG's and VOGEL's experiments can be easily repeated with simple materials. One needs an accurate globe of the Earth, an air balloon such as children play with, and some sheer fabric. On the fabric, trace the outline of the continents along their extended shelves, then carefully cut out the shapes. Inflate the balloon to two-thirds
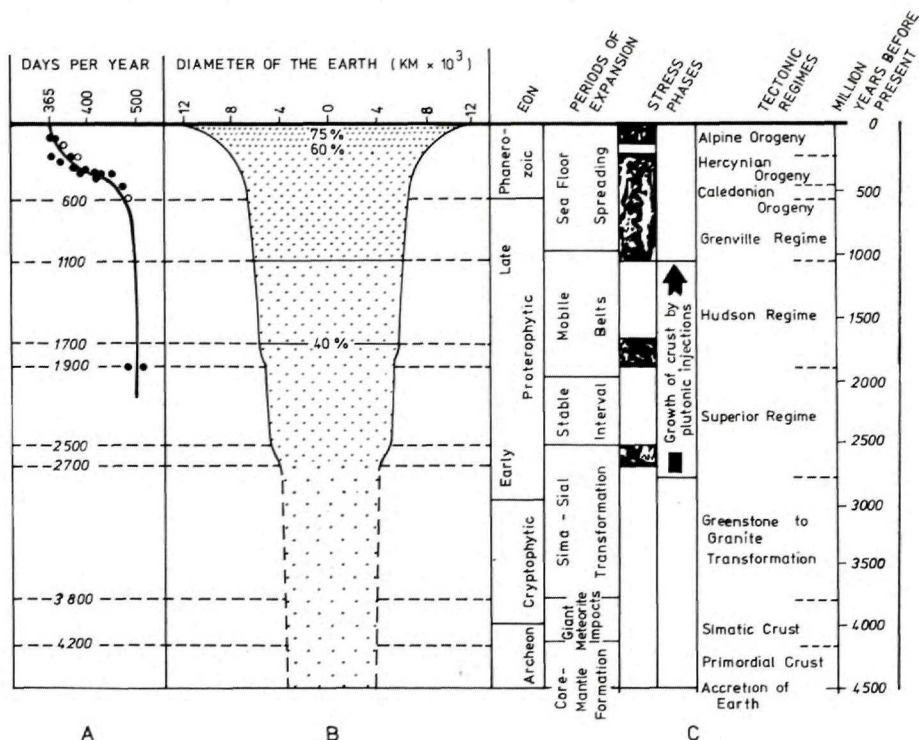
Fig. 3 Proposed "chart of the rapid increase" of the Earth's diameter over "the last 200 million" years. (A) Variations in the number of days per year since Gunflint time (ca. 1,900 MYA). The dots represent data obtained from growth line pattern measurements of Phanerozoic invertebrates as well as Gunflint stromatolite laminae as published by PANNELLA (1972). Circles indicate data reported by LAMBECK (1978). (B) Increase of the Earth's diameter since the earliest Precambrian, as tentatively assumed by the author. The geologic record indicates that VOGEL's 75% terrella model might present Earth at the beginning of the Cenozoic Earth expansion phase; the 40 % model perhaps around the stress phase of the Precambrian Hudson Regime. (C) Major geodynamic events since the earliest Precambrian. (B C from KREMP, 1983, revised in 1991). This chart, with its rapid increase of the Earth's diameter over the last 200 million years, looks almost like a fightening mushroom of an atomic explosion. The newest research information discussed in Chapter V gives the reader something to think about

the size of the globe and tape the "continents" to it according to their arrangements on VOGEL's 60 % model of Fig. 1. This arrangement will cover the air balloon with only narrow spaces between some of the "continents". When I tried this experiment, I became firmly convinced that HILGEN-BERG's and VOGEL's terrella models cannot be a hoax.

Fig. 2 shows VOGEL's 60 % terrella model enclosed in a glass model of the Earth's present size. It demonstrates that our planet expanded, more or less, in tangential directions. In general, the continents seem to be fixed at their substratum and retain their position to each other. It follows that the crustal movements are mainly determined by radial outward pressing of the continents and the filling-in of growing gaps by new oceanic crust according to seafloor spreading. This 60 % in 100 % model is the most convincing proof of Earth expansion.
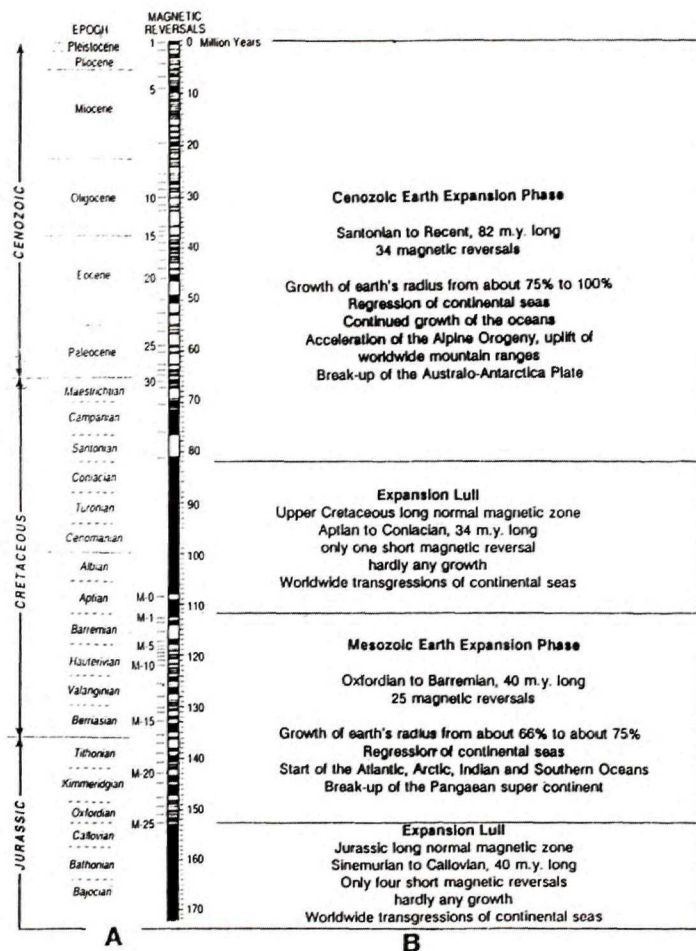
Fig. 4 (A) Magnetostratigraphic "geologic time scale of the last" 170 million years and (B) an interpretation of the last two Earth expansion cycles. (Geologic time scale after HEEZEN, LYNDE, and FORNARI's geologic map, concerning deep sea drillings and magnetic anomaly lineations found in the Indian Ocean, Lamonte-Doherty Geologic Observatory and Department of Geologic Sciences, 8 pp. and geologic map, Columbia University, New York, 1978); (B) From KREMP, 1991 (revised)

The magnetostratigrafic geologic time scale

Fig. 4 (side A) shows a magnetostratigrafic geologic time scale of the last 170 million years and (side B) the interpretation of the last two Earth expansion cycles. The scale on side A is the Magnetic Polarity Scale. The black sections indicate that this was a time period of "normal magnetism" on which a magnetic needle would have pointed toward the North Pole of the Earth. All white sections indicate that the magnetism was reversed and a magnetic needle would have pointed to the South Pole. The long uninterrupted black section of the middle Cretaceous time indicates that a long normal magnetic zone occurred during Cretaceous time. According to HEEZEN et al. (1978), it began in the Aptian about 113 million years ago and ended at the end of the Coniacian. This long normal magnetic zone (like all others shown in black) comes from normal magnetized dikes of mid-oceanic ridges; those in white are from reversely magnetized dikes.

HEEZEN et al. (1978) developed their geologic time scale after investigations of deep sea drillings in which magnetic anomaly lineations were found in the Indian Ocean. According to their interpretation, the span of the Reversed Magnetic Polarity #29 (the geologic time of the cataclysmic eruptions of the Deccan Traps Flood basalts, here discussed in chapter (IV) was between 65.5—65.0 MYA. Since then 3 more magnetographic geologic time scales have been published in which the span of polarity R29 varies somewhat; according to HARLAND (1982) the span of polarity R29 lies between 65.4—64.8 MYA; according to BERGGREN et al. (1985) between 66.8 —66.1 MYA, and according to HAQ et al. (1987) between 65—63.8 MYA.

It is strange that these important geologic time scales did not impress the geologists who insist that the Earth has never expanded. There were obviously (Fig. 4) at least two expansions lulls, a Cenozoic Earth Expansion Phase, an Upper Mesozoic and perhaps one in the Triassic.

Granted my assumption made in 1991 is not absolutely correct, namely that the Earth dilated perhaps from 60 % to 66% in the Triassic, from 66 % to 75 % perhaps in the Upper Mesozoic and from 75 % to 100 % of its present size perhaps in the Cenozoic Expansion Phase. In Coniacian time was the Earth dilated to 73 % or was it already 78 %? No one has tested this problem until now and no one has prepared a geologic map which will give the answer.

The beginning of the extinctions at early Maastrichtian time

The worldwide transgressions of the Aptian to Coniacian lull occurred during the Upper Cretaceous time (Fig. 4) and are interpreted by this author to represent the second expansion lull which may have lasted approximately 34 million years. During this normal magnetic zone, the Earth may have expanded very little or not at all. It is generally accepted that all the water in the ocean and the gases of the atmosphere were once contained within the Earth. The emanation of volatiles from the Earth's mantle was, and still is, the only source of juvenile water of the hydrosphere which is constantly emanated from mid-oceanic ridges and seamounts, resulting in an over-supply of new ocean water (HÉKINIAN, 1984).

As the ocean floor spreads, volcanoes once belonging to the mid-oceanic ridges become seamounts, which are then transported on the spreading seafloor much as goods on a giant conveyor belt are taken from source of supply to a delivery point (Fig. 6). It is safe to assume that the bulk of the thousands of seamounts which line up the 29 paleomagnetic reversal sections of the Tertiary seafloor were probably once active volcanoes situated at mid-oceanic ridges and are still emanating juvenile water.

At the same time that seamounts are being carried away, new volcanoes appear on the mid-oceanic ridges, thus continuing seafloor spreading and the emanation of juvenile water to supply the ever-increasing oceans with water. By studying sedimentary rocks, oceanographers concluded

that the composition of the ocean changed very little over the past 700 million years. This phenomenon does not make sense given the commonly accepted notion of a static Earth. However, the Earth Expansion Theory can explain this enigma.

After this Upper Cretaceous long normal magnetic zone, that is, in Santonian time, magnetic reversals again appeared, an indication that the Cenozoic Earth Expansion Phase had begun. Expansion forces pushed the rigid continental plates outward in ± radial directions and the growing oceans filled out the widening distances between the continents. Acceleration of the Alpine orogeny and other orogenies began and an uplift of worldwide mountain ranges followed. The continental seas then receded. Seashells dwelling in the continental seas lost their living space in the wetlands and so did the dinosaurs. The extinction phase of many species beginning in the Late Maastrichtian was the consequence.

Gas	%
Water Vapor (H_2O)	57.9
Carbon (CO_2)	23.5
Sulfur (S_2)	12.6
Nitrogen (N_2)	5.7
Trace Gases	.4

Fig. 5 An analysis "of lava gases emitted from the Mauna Loa and Kilauea volcanoes of Hawaii indicates that water vapor represents more than 50 %" of the gases expelled from the interior of the globe. The Hawaiian volcanoes are connected with hotspot-plumes originating at the core/mantle boundary (From RUBEY, 1951)
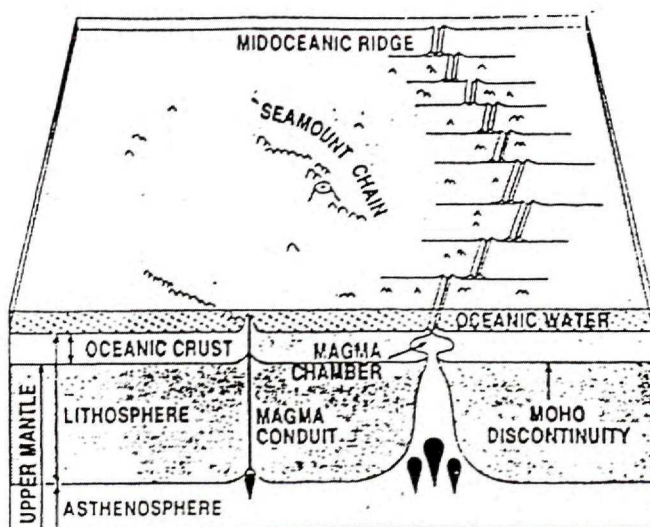
Fig. 6 The magma "chambers of the mid-oceanic ridges and the magma conduits of the seamounts are the places on the ocean floor where "volcanic eruptions take place and where juvenile water is emitted. (Modified from HÉKINIAN, 1984 by KREMP, 1991)

The worldwide transgressions which occurred during the Upper Cretaceous time are interpreted by this author to represent the last expansion lull (Fig. 4) which may have lasted approximately 34 million years. Consequently, throughout most of Upper Cretaceous time, sea level stood perhaps as high as at any time in Phanerozoic history of the Earth.

Known geologic evidence and tests of the magnetostratigraphic geologic time scale present convincing proof that VOGEL'S epoch-making terrella models reveal that, indeed, the Earth has grown about one third in size since the Paleozoic.
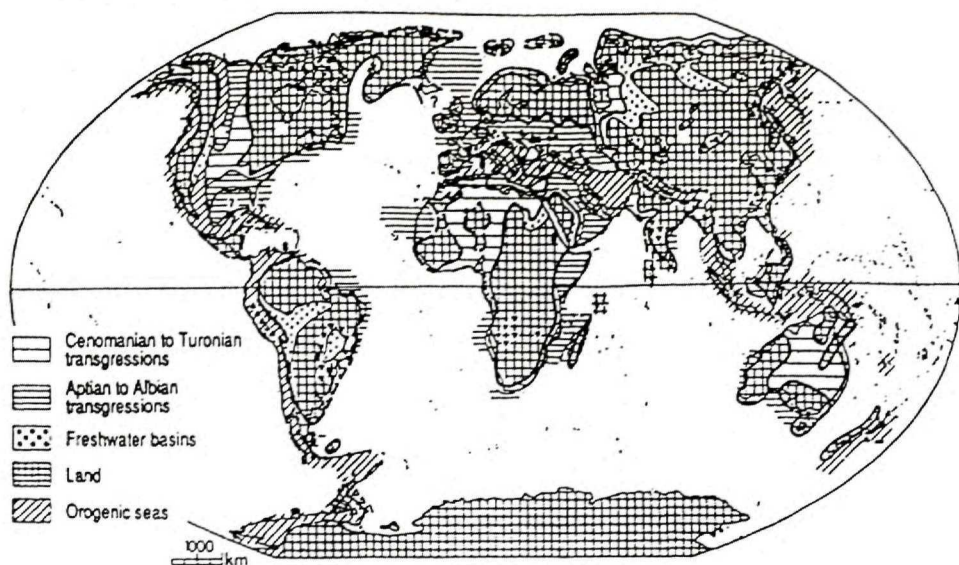
Fig. 7 Worldwide "transgressions of continental" seas during the expansion lull of the Aptian to Coniacian Long Normal "Magnetic Zone". (Simplified from the Cretaceous /Aptian to Turonian/ paleogeographic map of TRÖGER, 1984, p. 417)

Some seven superplumes caused the cataclysmic killings about 65 MYA

Around 65 MYA, during Magnetic Reversal No. 29 seven or more iridium-rich superplumes erupted. They are known as the Hawaiian-Emperor hotspot/plumes, the Reunion-Deccan Traps hotspot/plumes, the Iceland-Brito-Arctic hotspot/plumes, the Yellowstone hotspot/plume, the Tristan da Cunha hotspot/plume, the Walvis Ridge hotspot/plume, and the St. Pauls-Indochina and Sumatra hotspot/plumes. The best known is the Hawaiian superplume of the Hawaiian-Emperor hotspot/plume chain (Fig. 8).

This superplume left its traces on a chain of numerous islands and seamounts in the northern Pacific Ocean as the Pacific plate crept northward in Cenozoic time. The strand of this chain was bent at Anomaly 25, about 45 MYA. As CAREY (1988, Fig. 15) suspects, the reason is the 30° turn of the Alaskan Orocline. Like all other hotspot/plumes, the Hawaiian plume is believed to be of stationary nature and has exploded some 21 times since the K/T transition time from the same position below the crust of the Earth.

These superplumes were expelled from the thermal zone of the core/mantle boundary probably during the Mesozoic Earth Expansion Phase. At the crust, the temperatures of the arriving superplume may have been over 2000 °C. It is an open question if, after 65 million years, the lava

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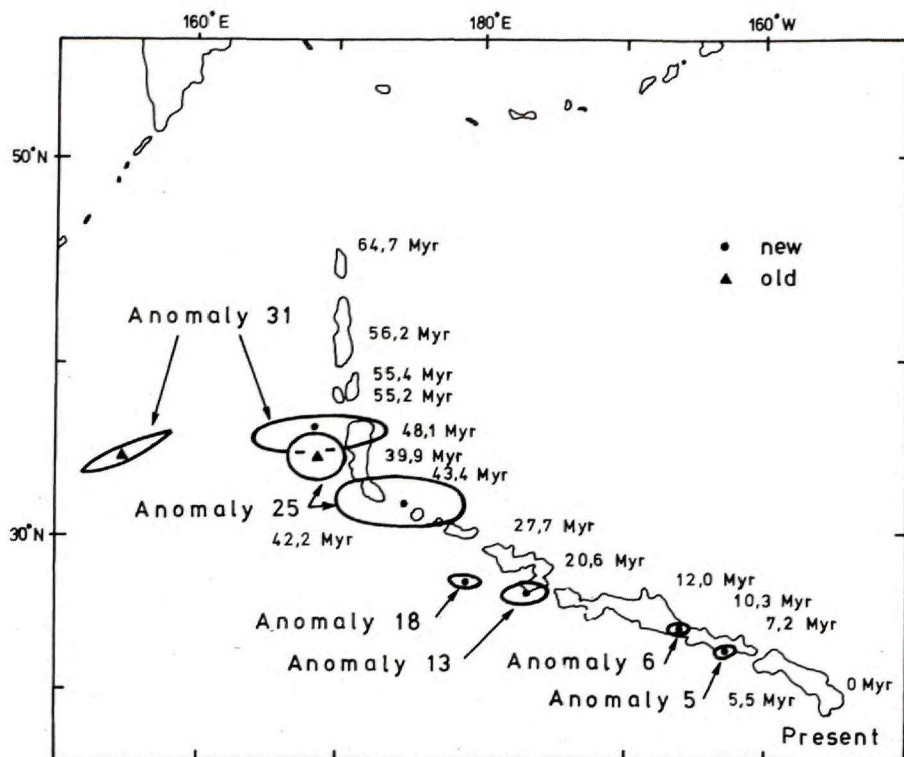
Fig. 8 Map of "the Hawaiian-Emperor hotspot/plume" chain. Movements of the Pacific Plate over the Hawaiian Hotspot/Plume are traced for about 68 million years. The path is marked by little islands and seamounts. The strand of this chain is bent at Anomaly 25 (about 45 MYA). This could mean that the bend was caused by the 30° turn of the Alaskan Orocline which CAREY reported in the Continental Drift Symposium of 1956 and illustrated his opinion again in 1988 (p. 109, Fig. 15). (After MOLNAR - STOCK, 1987, Fig.2)

of the Kilauea volcano of Hawaii is still as hot as the beginning lava outpourings 65 MYA. This is the reason why I differentiate between **superplumes** (the first explosion of the hotspot chain), **hotspot/plumes** and **subduction deduced volcanoes**. At the initial outpouring, at the least, superplumes are **two to three times** hotter than the eruptions of subduction deduced volcanoes and this explains the unusual and terrible destruction of the superplume explosions.
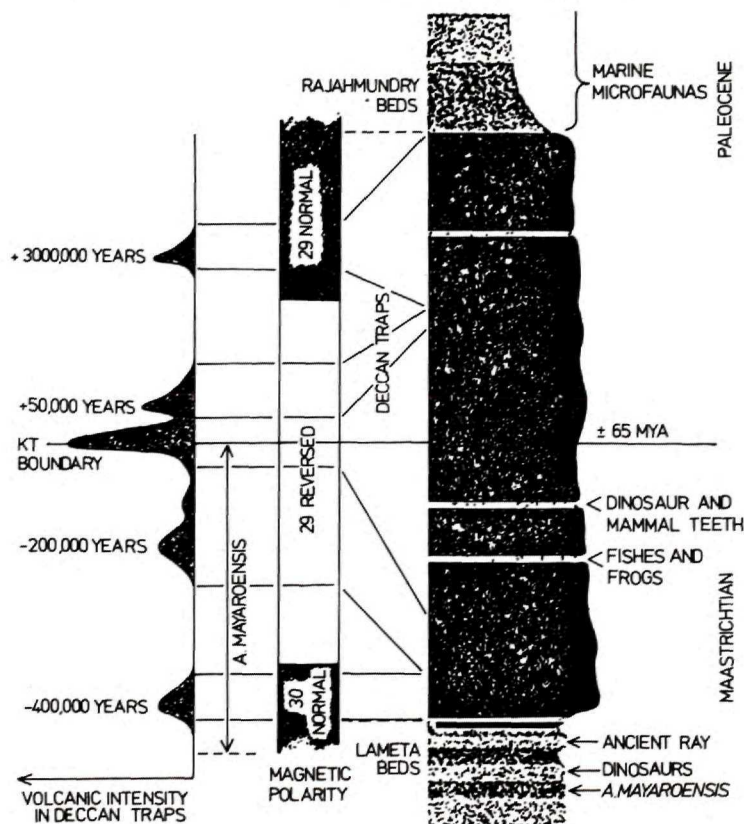
Fig. 9 shows the location of the cataclysmic eruptions of the Reunion Superplume which exploded below India's Deccan Traps at the Cretaceous/Tertiary transition time. The flood basalts of the Deccan Traps originally covered about one third of India and may have been up to 2,000 m thick. They are the largest flood basalts known since the Mesozoic. Much of the original lava coverage has been destroyed by erosion. Since the basalts have been altered extensively over the million of years, it is difficult to obtain accurate age determinations.

According to MOLNAR and STOCK (see Fig. 9A), both the Indochina hotspot chain and the hotspot chain adjacent to Sumatra show the same age as the Deccan Traps hotspot chain. This would indicate that both hotspot plumes erupted about the K/T transition time.

As Fig. 9 shows, the Reunion, St. Paul's and Kerguelen Islands are now all situated in the southern hemisphere. But they are supposed to be the places where those superplumes originally

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exploded the first time. The conclusion would be that not only India but also Indochina and Sumatra were located in the southern hemisphere in the Upper Mesozoic (also perhaps the basalt of the Rajmahal Traps, dated about 115 MYA). This would fit with the construction of VOGEL's terrella models.
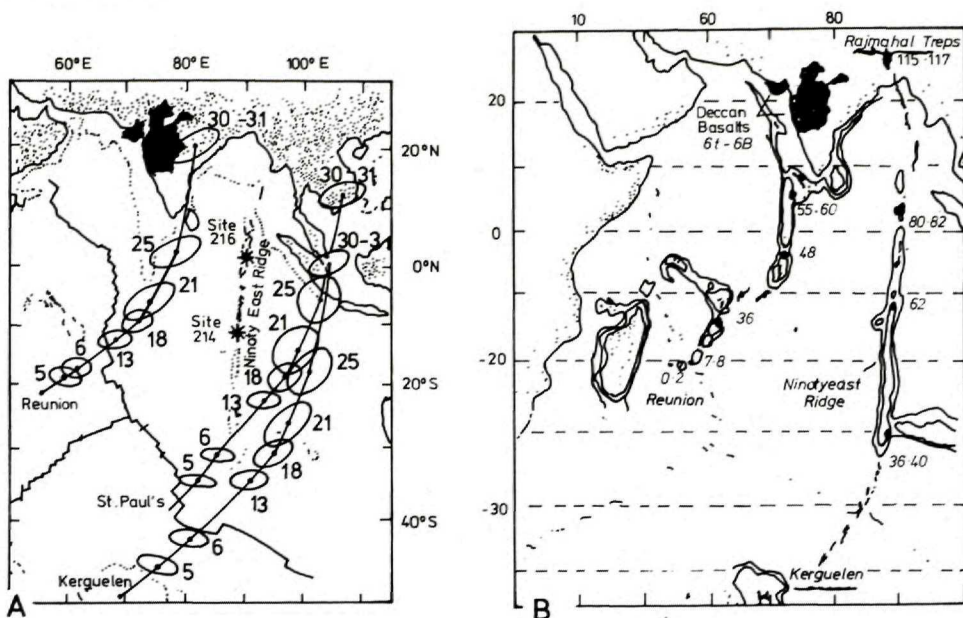
Fig. 9 Part A shows "the assumed chain of the Reunion-Deccan Traps hotspot/plumes and of the St. Paul's Indochina and Sumatra" hotspot/plumes (modified from MOLNAR—STOCK, 1987, Fig. 5) Part B the questionable "Kerguelen-Rajmahal Chain". All numbers represent the assumed ages of the investigated lavas of the seamount and islands of the hotspot chains. The peak eruptions of the Rajmahal Flood basalts occurred about 110 MYA and lasted more than ten million years (RAMPINO—STROTHERS, 1988). (Modified from DUNCAN—PYLE, 1988). (Nature, Vol. 33, p. 841, Fig. 1)

According to his models, India (still connected to Asia) was apparently situated south of the Equator when the Deccan Trap superplume erupted (see Fig. 9A) about 65 MYA from below the Reunion Island. According to VOGEL's terrella photos, in Upper Cretaceous time, the southern tip of India would reach to about 40° southern latitude. As VOGEL's terrella models indicate and also the paleogeographic investigation of AHMAD, CAREY, CHATTERJEE, EHRENSPERGAR, HILGENBERG, KREMP, MEYERHOFF, SMILEY and NOEL (see cited references), India was always connected to Asia. Because in the Paleozoic the Earth was not more than 60 % of its present size, India was also connected to the other Gondwanalands. I certainly hope that interested geologists will start to prepare and to test geologic maps on terrella models. Recently, VOGEL prepared an 80% terrella model which could represent the Earth's size at Reversed Magnetic Polarity #29.

According to the investigations of MOLNAR—STOCK (1987; p. 589, Fig. 3), the volcanism of the Iceland superplume is responsible for the southeasterly trending Iceland-Faeroes Ridge and also for the British Tertiary volcanic province of igneous rocks from a multitude of eruptions at various places with ages between 60 to 50 MYA; the authors conclude that the Iceland superplume apparently underlay Greenland in early Tertiary time.

According to RAMPINO—STROTHERS (1988, p. 665), an isochron age of 65 ± 5 Myrs has been reported of the West Greenland Flood basalts (see Fig. 10) and nearly all the obtained ages of the Brito-Arctic-Basalt-Province span the range between 65 to 50 MYA.
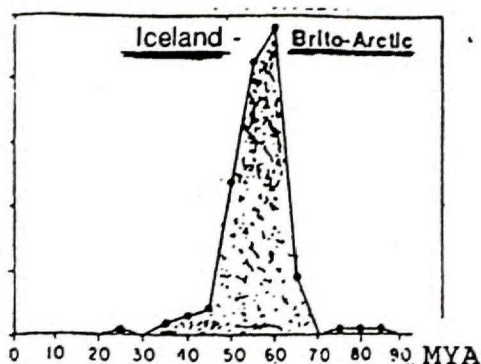
Fig. 10 Histogram "of K-Ar and Ar-Ar ages for the" Iceland-Brito-Arctic superplume at its first cataclysmic eruption. RAMPINO—STROTHERS (1988) gathered and published all potassium-argon and argon-argon ages available from the initial intrusions of this superplume. They write that the Brito-Arctic Basalt Province (including Greenland, Vaffin Island, Faeroe Islands, northern Iceland and northwestern Britain) covered a total area of about 100,000 km^2 but the area was probably much greater before continental rifting and subsequent erosion began. The authors state that accidental and systematic errors for the initiation dates could be some 5 million years. (Simplified from RAMPINO—STROTHERS, 1988. Flood Basalt Volcanism during the Past 250 Million Years. Science. V. 241, 5, August 1988, p. 663—668)

These are mind-boggling statements because the Iceland superplume is located and probably connected with the Reykjane Ridge, a part of the northern Mid-Atlantic Ridge and should be a **stationary** hotspot. This would suggest that the continental crust of Greenland was stationed above the Iceland superplume for a time. The same situation seems to have occurred to other parts of the Brito-Arctic-Basalt Province which seems to have drifted around Iceland during the wild tectonic events at K/T boundary time. (These events are discussed in more detail in Chapter VI.) This would indicate that not only southwestern Asia, but also Greenland, Europe and perhaps North America were situated on more southern latitudes at Mesozoic time.

This was calculated by CAREY (1976; p. 207), who assumed that Europe's latitude was some 19° Lower in Cretaceous time and North America's latitude as well as Siberia's about 4° lower. CAREY's calculations fit with the construction of VOGEL's terrella model.

However, this does not agree with the stubborn assumption that the Earth has never changed its size during the last three or four billion years of its existence.

Recent geophysical interpretations of the outer core's properties

Still, in the seventies apparently no one knew where the hotspot/plume originated. Later, BOSS - SACKS (1985) and YUEN—PELTIER (1990) deduced their origins from the thermal D''-layer at the border of the outer core.

How could seven superplumes cause the terrible mass extinction 65 MYA. Fig. 11 shows the core/mantle border (CMB) from where the superplumes originated.

In recent years, seismologists have discovered that the temperature of the D''-layer at the

core/mantle boundary is at least 800 °C higher than the bottom of the mantle, indicating that the outer core is much hotter than the lowermost part of the mantle. It is impossible for such temperature differences of adjacent layers to have remained constant over four billion years. In this case, the bottom of the mantle would be as hot as the outer core. VOGEL's terrella models tested by the magnetostratigraphic time scale indicate that the outer core began to overheat and to expand in the Paleozoic. Until now, many scientists believed that overheating and expansion of the outer core was technically impossible. But let us consider the Super Novas. Why do they overheat, expand and finally explode? Why is the cosmos expanding? Isn't our planet a part of the cosmos?
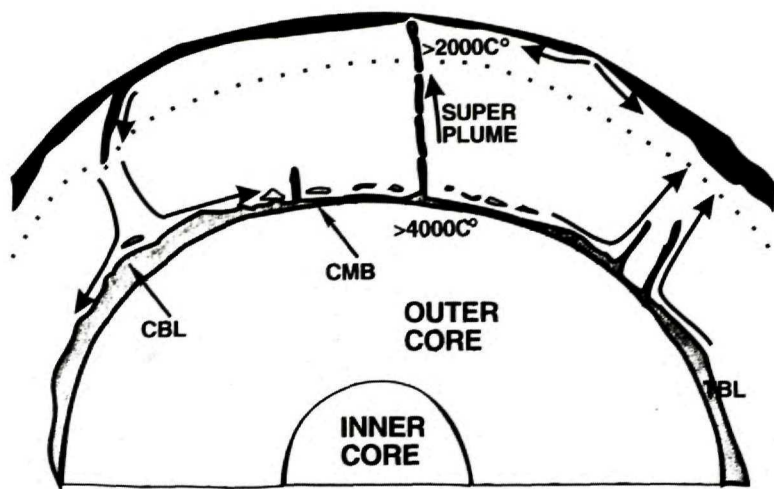
Fig. 11 Assumed temperatures of superplumes arriving at the crust of the Earth. We have to recognize that until recently all calculations were based by necessity on the assumption that the size of the Earth was never changed. We learned in the meantime that the mantle of the Earth was not 2,900 km thick in Lower Cretaceous time. The temperature difference between outer core and mantle may have also been different and consequently, the assumed temperatures of the superplumes which arrived below the crust 65 MYA were also slightly different, possibly hotter than 2,000 °C because the uplift to the crust might not have taken 80 million years. (Modified from LAY, 1989; Structure of the Core-Mantle Transitional Zone: A Chemical and Thermal Boundary Layer /Fig. 7/. American Geophysical Union. EDS, Vol. 70, No. 4, Jan. 24, 1989, p. 49—59). Abbreviates: CMB, Core-Mantle-Boundary; TBL, Thermal-Boundary-Layer; CBL, heterogenous Chemical-Boundary-Layer, embedded in TBL; SPL, Super Plume

Astrophysicists assume that the sun's heat is produced in the core by the fusion of hydrogen into helium and that our sun will explode in several million years.

In the tunnel of The Large Electron-Positron Project near Genf (Suiss), quantum physicists observe how speeding electrons and positrons hit each other and cause microscopic fireballs. JENSEN (1992) calls this "quantum chaos" and GUTZWILLER (1992) also calls this chaotic behavior or "quantum chaos". The question is: Did such quantum chaos start in the outer core of the Earth some 200 million years ago?

In agreement with the concept of the new "quantum chaos theory", the word **chaos** describes a puzzling process which we do not yet understand.

We know that occurrences in the metallic and fluid outer core are causing magnetic reversals. These reversals occurred very irregularly in the last 200 million years as the geologic time scale indicates. It is not possible to assume that such "quantum chaos" is also occurring in the outer core of the Earth, producing millions of microscopic fireballs from the millions of electrons and

positrons crashing against each other? The result would be overheating and expanding of the outer core, expanding of the mushy mantle and crashing of the rigid continental and oceanic plates of the lithosphere, accompanied by more and more numerous catastrophical Earthquakes.

In scientific publications, temperature estimates of the outer core and even of the astenosphere vary greatly. One thing seems to be reasonable. The outer core from where the superplumes are expelled is definitely much hotter than the asthenosphere. Consequently, superplume eruptions are much hotter than those of subduction volcanoes which originate in the uppermost layers of the mantle.

An asteroid impact and the cataclysmic volcanic and tectonic activities 65 MYA

Around 65 MYA, seven or more iridium-rich superplumes erupted. This was during Magnetic Reversal #29, a time period of more than 600,000 years. OFFICER et al. and McLEAN worked out, in detail, the scenario and climatic changes which covered that time span.

Fig. 12 The cataclysmic eruptions of the Reunion Superplume which exploded below India's Deccan Traps at the Cretaceous/Tertiary transition time. The flood basalts of the Deccan Traps originally covered about one third of India and may have been up to 2,000 m thick. They are largest flood basalts known since the Mesozoic. Much of the original lava coverage has been destroyed by erosion. As the basalts have been altered extensively over the million years, it is difficult to obtain accurate age determinations. (Modified from COURTILLOT, 1990; A Volcanic Eruption /p. 90/: Scientific American, October 1990, p. 85—92)

The magma apparently emerged quickly, and the quiet periods between major eruptions may have lasted no more than 10,000 years. The volatile emissions from this volcanism led to acid rain, reduction in the alkalinity and pH of the surface ocean, global atmospheric temperature changes, and ozone layer depletion (OFFICER et al., 1987; McLEAN, 1985, 1988). The acid rain killed the organisms which lived close to the ocean's surface, percolated into the continental soil and leached away fossilized remains. This might explain the up-to-4-meter intervals of barren rock at many sites in the western part of North America responsible for this putative gap of a fossil record.

Also in the oceans, the rapid worldwide volcanic eruptions - as a consequence of the expanding Earth - caused a worldwide hiatus and the loss of the fossil record. During this time of cataclysmic volcanic eruptions, there must have been many wild Earthquakes attributable to the actions caused by the restless expansion of the Earth (see Fig. 13).
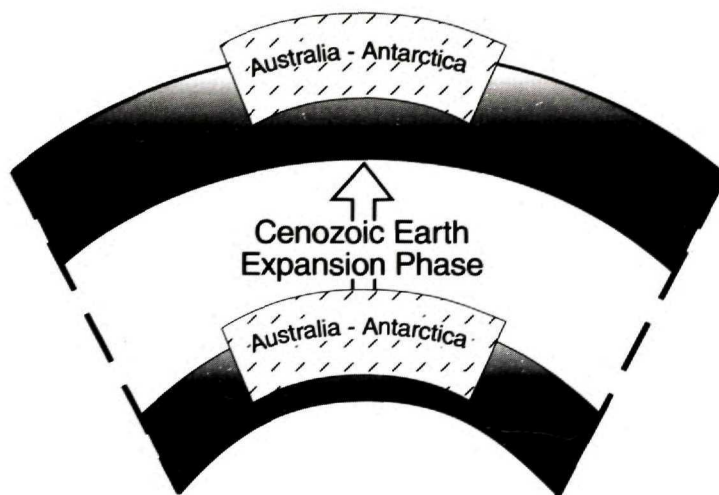
Fig. 13 The break-up the Australo-Antarctica Plate, starting about 65 MYA and ending about 45 MYA in the Eocene. During the first 15 MY period of the Cenozoic Earth Expansion Phase (see Fig. 4), after the expansion lull which ended about 80 MYA, the plate was forced to stretch and adjust to the now more flattened circle of the Earth. The process began cracking up from the underside of the plate. Many more sections of other continental plates are also now under this stress e.g., the Great Rift Valley of Africa and California — geologically speaking. (After EHRENSPERGER's reasoning of 1988)

Perhaps most striking is the break-up of the Australo-Antarctica Plate which was just beginning 65 MYA and ended some 20 million years later. Fig. 13 is not up-to-scale, but it may help to illustrate why the continental plates were forced to stretch and adjust to the now more flattened circle of the Earth — perhaps 15 million years after the Cenozoic Earth Expansion Phase had begun.

About 80 MYA the outer core started expanding again and forced the mantle and the crust to adjust to the new situation. The somewhat mushy layers of the mantle were able to expand too, but not the rigid crust of the Earth, which could only break apart. In the Mesozoic, such event had occurred to the South American-African plate which yielded to the pressure from below by cracking and splitting apart.

Also, 80 MYA, when the Earth began to expand again, the continental plates, fixed to their substratum were pushed outward in a ± radial direction. About 15 million years later, with the now more flattened circle of the Earth, the plates were forced to stretch and adjust to the new situation. This process caused cracking from the underside of the plate. Violent Earthquakes occurred worldwide. Palynological evidence shows (BRINKHUIS —ZACHARIASSE, 1988) that

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three huge and sudden sea level changes occurred in El Haria (Tunisia) at the K/T border time. They are interpreted here as violent Earth-expansion movements accompanied by shocking Earthquakes and tsunamis. At the same time, other areas were also rocked by severe tectonic events, e.g., the Mediterranean, the northwestern Indian Ocean, the area around Greenland and middle America, and the Australo-Antarctica Plate.

While my paper is a criticism of the meteorite theory, it is my wish to acknowledge the merits of the founders of that assumption. A decade ago, the ALVAREZES knew the "only possible" answer; a giant meteorite caused the sudden mass extinctions which left behind strange iridium anomalies. At that time no one knew a better explanation.

By now, more than 2,000 research papers have touched on the exciting aspects of ALVAREZ' proposal. The result is that we now know more about the geologic situation at the K/T transition time than about any other geologic period.

A decade ago, neither the ALVAREZES nor their coworkers had heard about the Earth Expansion Theory nor about the cataclysmic eruptions of some seven superplumes about 65 MYA.

And Iridium? ALVAREZ and ASARO believed that iridium could only be a product of meteorite breakup. But we know now that iridium can come from the Earth's mantle or perhaps the outer core and that it could have been carried to the Earth's surface with ejecting superplumes. Iridium is mind together with gold and platinum.

ALVAREZ and ASARO presented a combined graph of iridium anomalies in the 100 cm thick layers of limestone sediments in Bottacione, Contessa and Goro a Carbara in Italy (1990, p. 10). Yet, they made no mention of the probable sedimentation time of the fallout of these elevated iridium concentrations. They stated their graph was "a clear sign of extraterrestrial impact".

About the same time, COURTILLOT (1990, p. 21) compared his graph of the elevated iridium concentration (in Gubbio, Italy) with graphs obtained from Caravaca (Spain), Bidart (France) and Sterns Klint (Denmark). COURTILLOT (1990, p. 91) stated:

Iridium could have been released either by an asteroid impact or by massive volcanic eruptions. The elevated iridium concentration in strata from the Cretaceous—Tertiary boundary in Italy, Spain, France and Denmark extends over as much as 500,000 years. An asteroid impact would have produced a sudden, well-defined rise in iridium. The Deccan eruptions, in contrast, appear to have persisted for just the right length of time to account for the observed iridium distribution.

As one may recall, ALVAREZ—ASARO (1990, p. 79) reported some one hundred localities worldwide where the iridium anomaly has been found at the K/T boundary. But could one iridium anomaly laden meteorite have caused worldwide mass extinctions of all planctonic organisms with calcareous skeletons — the ammonites, belemnites, planctonic foraminifera, coccolitho-phorids, scleractinina corals, and rudistes? Is it not more likely that the oceans were poisoned by constant outpourings of noxious gases from numerous volcanic eruptions? Could the fallout from one meteorite eliminate all the dinosaurs which managed to survive in North America and Eurasia?

Other phenomena have been found: DAVID CARLISLE from the Environmental Agency in Canada and DENNIS BRAMAN from the Royal Tyrrell Museum of Paleontology in Drumheller, Alberta, discovered diamonds smaller than viruses in a layer of gray clay in Alberta sediments with K/T transition time age. These researchers have assumed that the diamonds in the debris were blown far from the meteorite's impact and settled back to Earth. Another discovery comes from rounded pieces of glass in a Haitian rock layer dating to the time of the K/T boundary. These glass spherules, which range up to about 6 millimeters in diameter, have a crystal-free structure and these researchers believe they could only come from a meteorite impact.

One is inclined to ask what proof is so conclusive as to declare that iridium or microscopic diamonds, etc. came from asteroids. They may have come from the core or lower mantle of the Earth. Meteorites and planets originated in the same cosmos and there is no difference in basic matter.

CHATTERJEE (1992) reported his detailed geologic investigations of the "India-Seychelles continental block", which according to his interpretation was hit at K/T border time by an extremely large asteroid that left behind a crater, perhaps 800 km long and 700 km wide, which he named the "Shiva Crater" (Fig. 14).

I am of the opinion that the evidence supports CHATTERJEE's explanation of the Shiva-Crater asteroid impact. The explanation is reasonable and cannot be excluded. It is very possible that a huge asteroid helped ignite the superplumes which exploded about the same time — geologically speaking — around 65 MYA, yet the wild tectonic events which occurred at K/T boundary time may have been the real and deciding factor.

There is also evidence (PFEUFER, 1981) that fractured zones exist in the Pacific Ocean. Earth expansion induced it. These fractures began through cracking from the underside of the rigid oceanic plate. Heavy Earthquakes and severe tsunamis were and are the consequence.
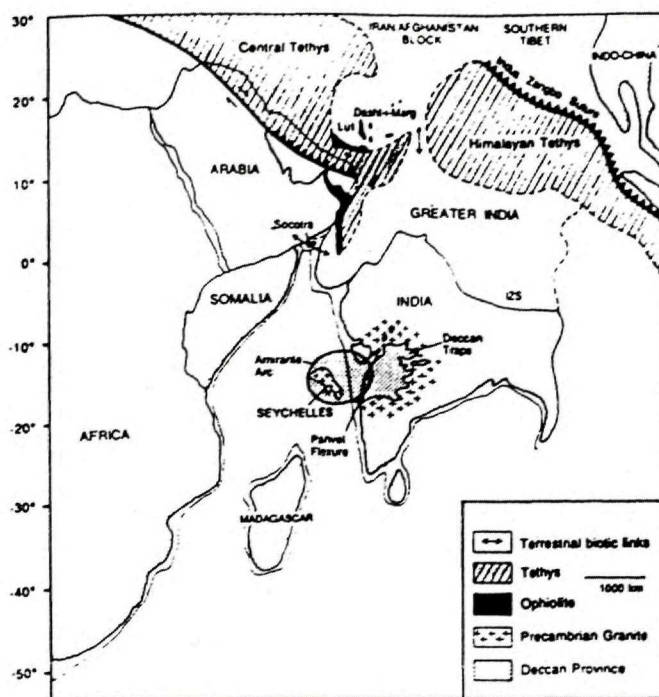
Fig. 14 The India-Seychelles-Continental-Block was apparently hit by an extremely large asteroid at K/T boundary time. The India-Seychelles fit at the K/T boundary time shows the location of the Shiva Crater; possible dispersal routes of land vertebrates between India-Africa and India-Asia are shown by arrow; the Tethys Sea bordering the Indian subcontinent at the K/T boundary time is reconstructed. The morphology of the Shiva Crater exhibits a distinct central uplift in the form of the Seychelles granitic core; an annular trough filled with lava to form a mare; and a slumped outer rim. The crater is somewhat oval shaped because of oblique Impact along southwest-northeast trajectory. The impact simultaneously created the Carlsberg Ridge and the Shiva Crater. (Simplified from CHATTERJEE, 1992; Fig. 7), a kinematic model for the evolution of the Indian plate since the Late Jurassic (in Editors CHATTERJEE—HOTTON III; New Concepts in Global Tectonics, Texas Tech. University Press, Lubbock, 1992; 450 p.)
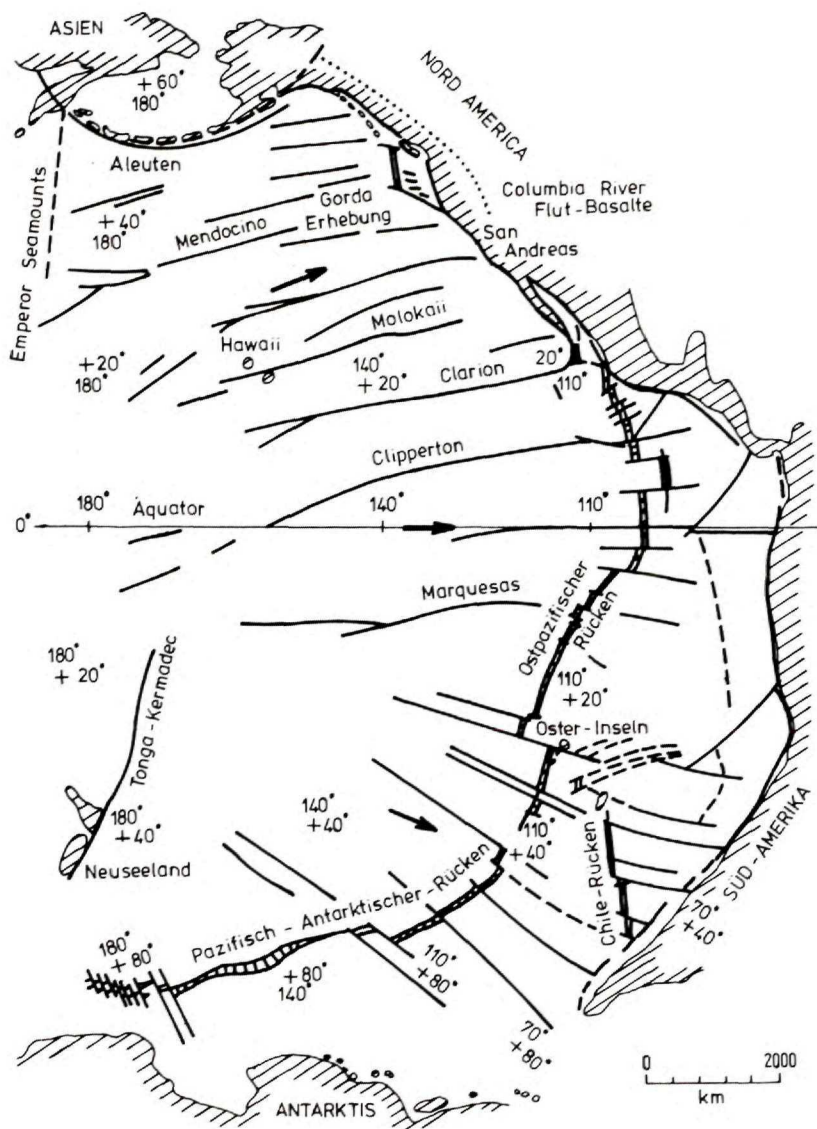
Fig. 15 Fractured zones in the Pacific Ocean. Earth expansion induced fractured zones in the Cenozoic part of the Pacific Ocean. These fractures started through cracking from the underside of the rigid oceanic plates. (Modified from PFEUFER, 1981; Die Gebirgsbildungsprozesse als Folge der Expansion der Erde: Glücksauf-Verlag, Essen, Germany, 125 p.)

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The "Greenhouse Effect" of the "Middle Paleocene"

TAKAHASHI's (1990) draft of the **Aquilapollenites** and Normapolles groups on the northern hemisphere shows their distribution during the late Upper Cretaceous after the Upper Cretaceous Expansion Lull. The climate of the world began to cool during Maastrichtian time, because of the beginning of the Cenozoic Earth Expansion Phase which caused the worldwide uplift of mountain ranges and regression of the continental seas. The continental temperature drop during the Maastrichtian time was followed at the K/T border and during the earliest Paleocene by a climate which we know little about because it still lacks **urgently needed palynological research**. We know that the flora of the **Aquilapollenites** and Normapolles groups of the late Cretaceous was widely destroyed.

Fig. 17 shows the last of the North American dinosaurs survived until the "Middle" Paleocene (RIGBY, 1987), that is, until the mid Paleocene when the "last of the North American dinosaurs" **in Montana** continued to survive. RIGBY calls this "Early" Paleocene time period of 100,000 years or more the event of the "Fern Spore Spike". Perhaps in the future in eastern Europe and in Asia, palynologists will discover more pertinent information about this period.

After the period of acid rain and ozone depletion, in the "middle" Paleocene a huge amount of carbon dioxide remained in the atmosphere (McLEAN, 1988). As documented by numerous paleobotanical and palynological investigations, the climate of the northern hemisphere became warmer. This "greenhouse effect" must have lasted for hundreds of thousands of years and is very well documented in the figures of KRUTZSCH—PACLTOVÁ (1988), concerning the paleophytogeography of the middle Paleocene and the Earlier lower Tertiary. In other words, the "greenhouse" development permitted the origin and advancement of the new Cenozoic life of plants and animals on the surface of the expanding Mother Earth.
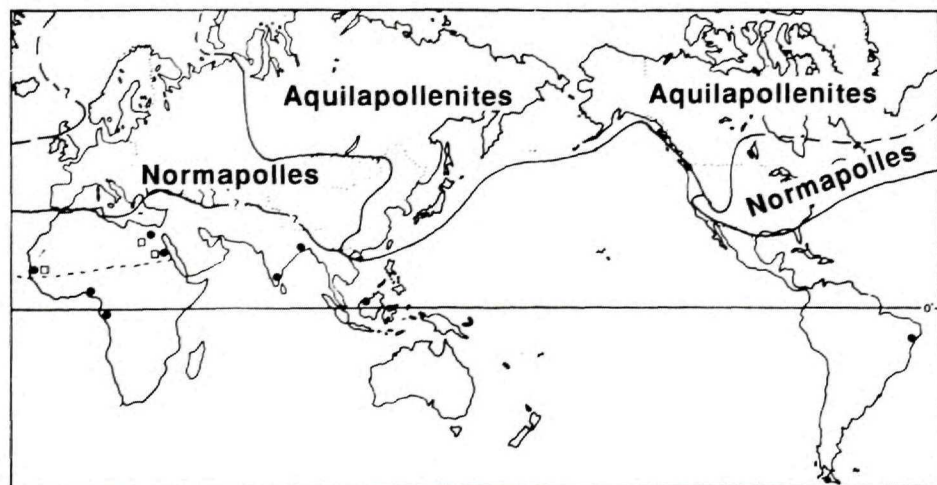
Fig. 16 Distribution of the *Aquilapollenites* and *Normapolles* groups in the Late Cretaceous. The dots represent the sporadic occurrences of *Aquilapollenites* in outside floral provinces and the squares represent the *Normapolles* groups (from TAKAHASHI, 1990)

NORTH AMERICAN DINOSAURS

J. KEITH RIGBY. JR.

Paleocene

Cretaceous

Most Pollen Types

> 64 MYA

~ 65 MYA

TYRANNOSAUR 2000 KG

CERATOPSIAN 2000 KG

Triporopollenites   rugatus

Syncolporites   minimus

Inaperturopollenites sp.

cf. *Fraxinoipollenites variabilis*

cf. *Arecipites tenuiexinous*

cf. *Sigmopollis   hispidus*

cf. *Sigmopollis psilatus*

THE EVENT   "Fern Spore Spike"

Proteacidites retusus

Cranwellia striata

Aquilapollenites delicatus

Gunnera microreticulata

Polycolpites granulatus

TABLE I.   DINOSAUR TOOTH ABUNDANCE IN COLLECTIONS FROM SCREEN - WASHED MATRIX, HELL CREEK FORMATION, MONTANA 1

	Cretaceous					Paleocene	
	CF	KS	Low	High	BCW/SMP	HK	FR
Tyrannosaurid	1	2				1	
Albertosaurid	45	6	1	3	5	1	1
Ceratopsian	45	141	110	35	75	113	59

Fig. 17 The last of the North American Dinosaurs survived in the upper Hell Creek Formation, Montana until the "Middle" Paleocene. The length of the cataclysm event, the "Fern Spore Interval" is not at all understood. Rigby estimates its length between 40,000 to 250,000 years. Others think it could have lasted a little more than one million years. During this event the vegetation of the *Aquilapollenites* and *Normapolles* group was badly destroyed worldwide (e.g., *Proteacidites retusus*, *Aquilapollenites delicatus*, etc.) and a markedly different vegetation appeared (e.g., with *Triporopollenites rugatus*, etc.). Fossils of the last North American dinosaurs (consisting of dinosaur teeth) have been discovered by RIGBY in clay pebble conglomerates. (After KEITH RIGBY, Jr, 1987: The Last of the North American Dinosaurs. In : S . J. CZERKAS —E. C. OLSON (Eds.): Dinosaurs Past and Present, Vol. II, Natural History Museum of Los Angeles Country in association with the University of Washington Press. Seattle, p. 119—135. Printed in Japan)
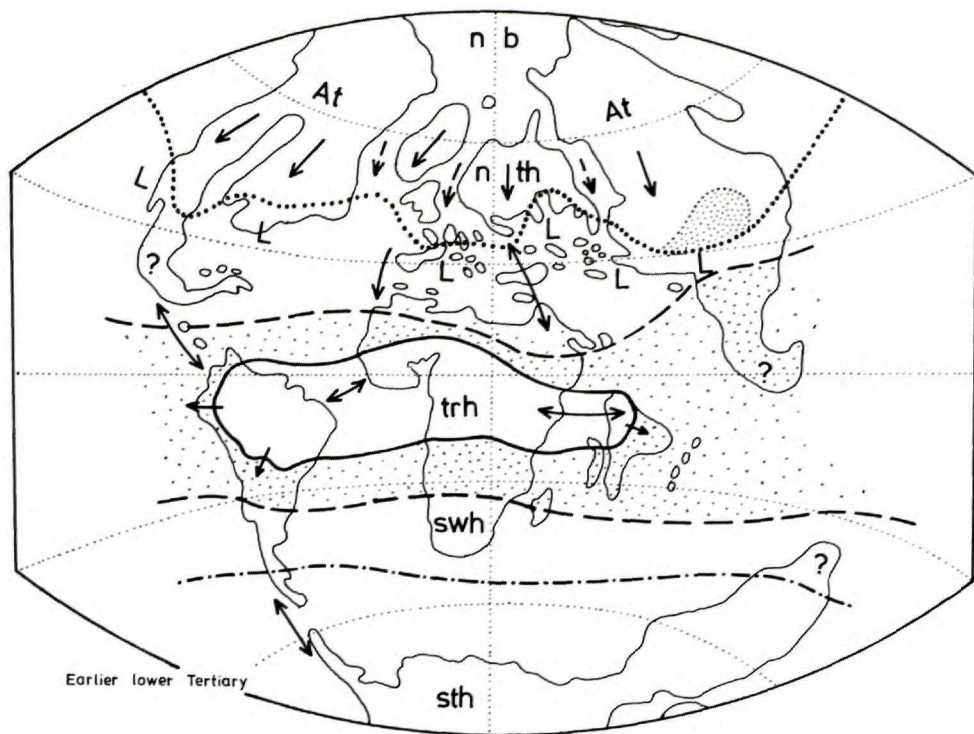
Fig. 18 Paleophytogeography of the Middle Paleocene and the Earlier lower Tertiary (modified from KRUTZSCH - PACLTOVÁ, 1988)
At = deciduous summergreen arctotertiary flora of earlier character in the northern latitudes; nth = northern boreal region; trh = tropical humid; L = evergreen warm humid or occasionally semihumid Lauruslike leaved Zone in the south (north Tethyan region); swh = southern warm humid area; sth = southern temperature humid area.

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GERHARD O. W. KREMP

Zapríčinilo masové vyhynutie niektorých organizmov v prechodnom období krieda —paleogén rozpínanie zeme?

Resumé

Na základe paleobotanických výskumov sa autor v predloženej práci zaoberá významnými klimatickými zónami počas celého geologického obdobia. Osobitnú pozornosť však venuje kriedovým a terciérnym útvarom s aspektom na pohyby kontinentálnej kôry.

PHOTOGRAPHS
I —XLII

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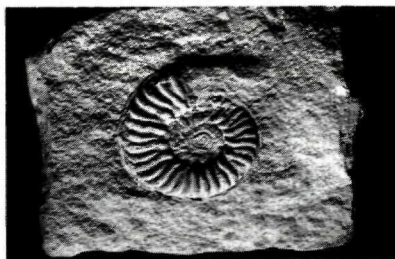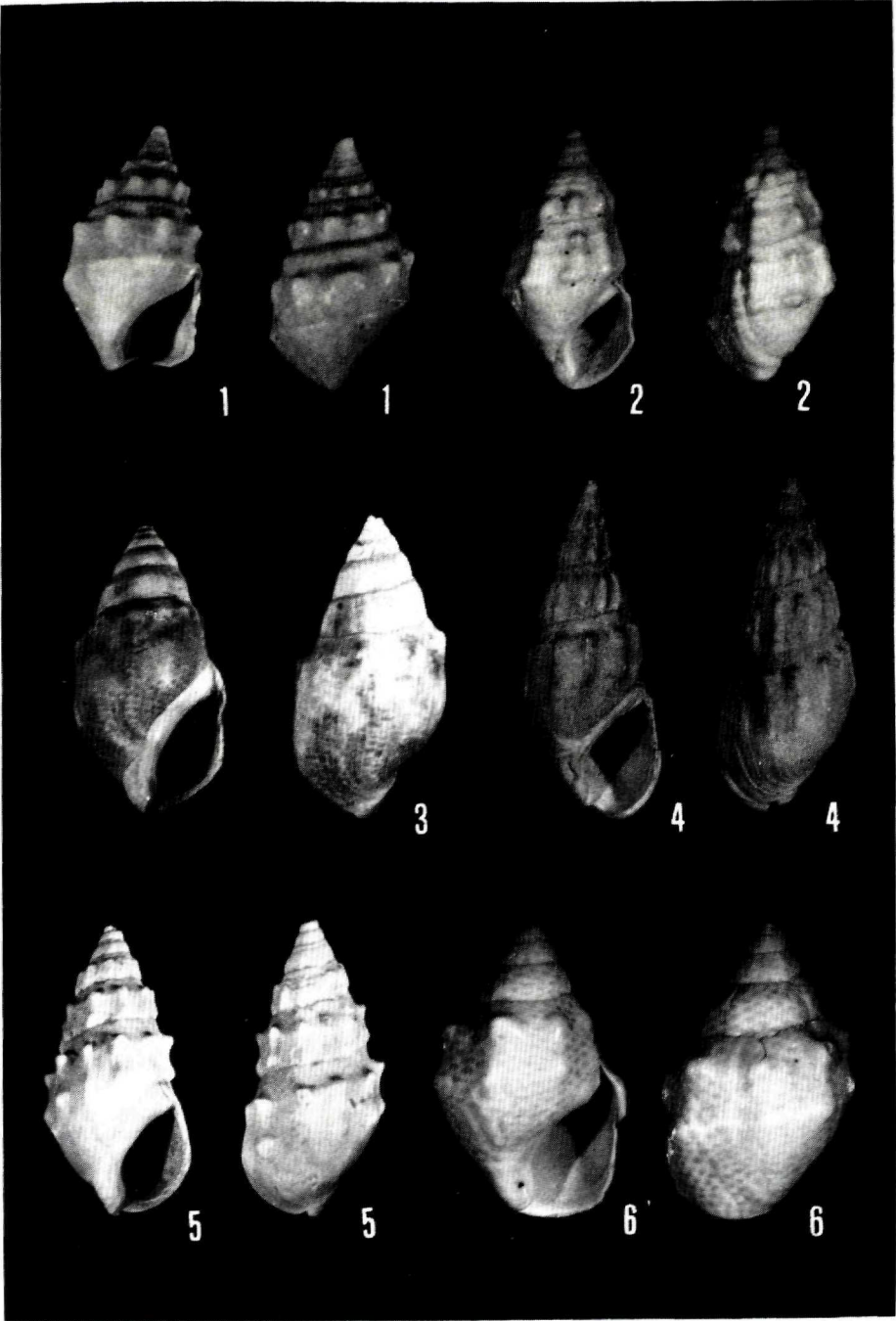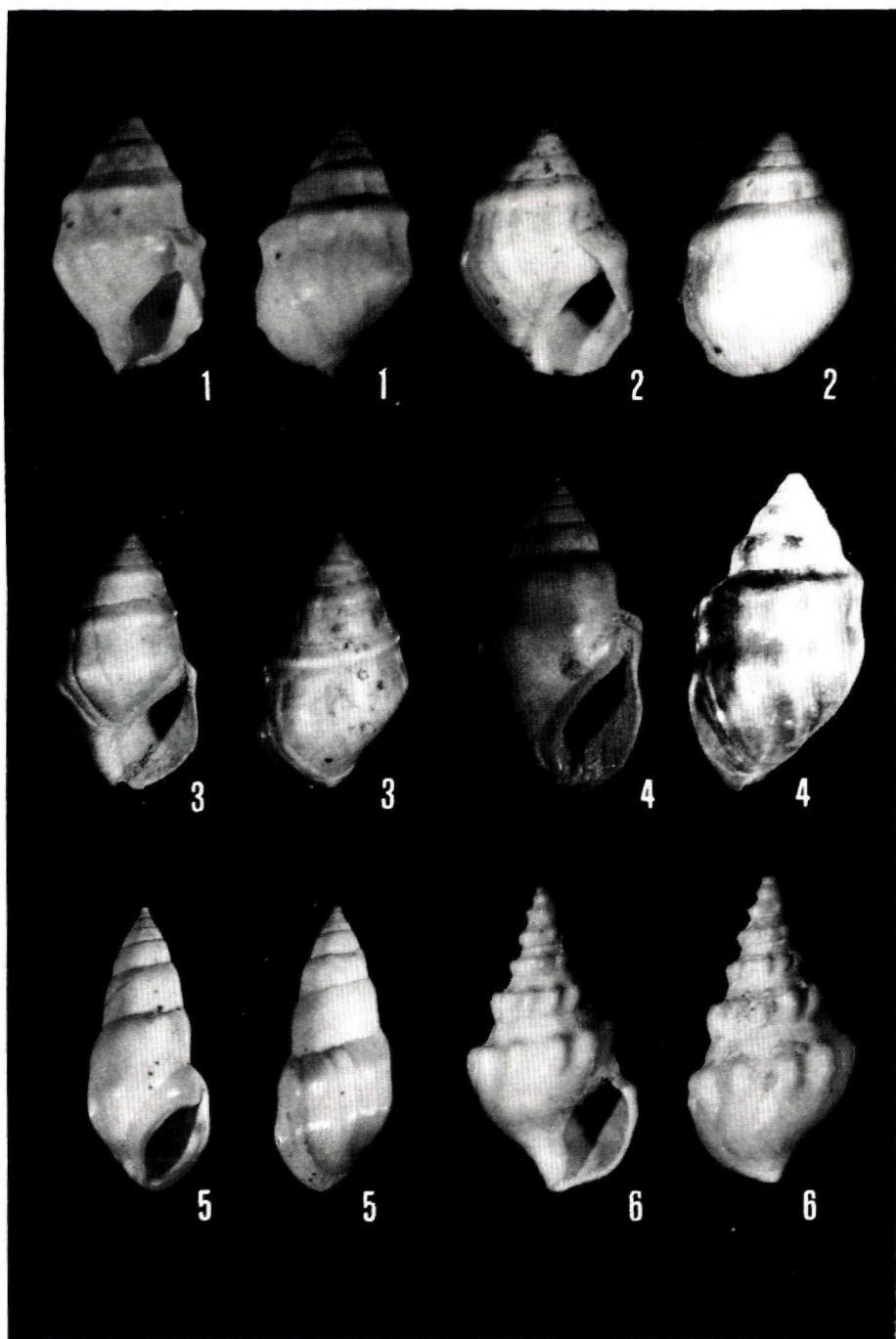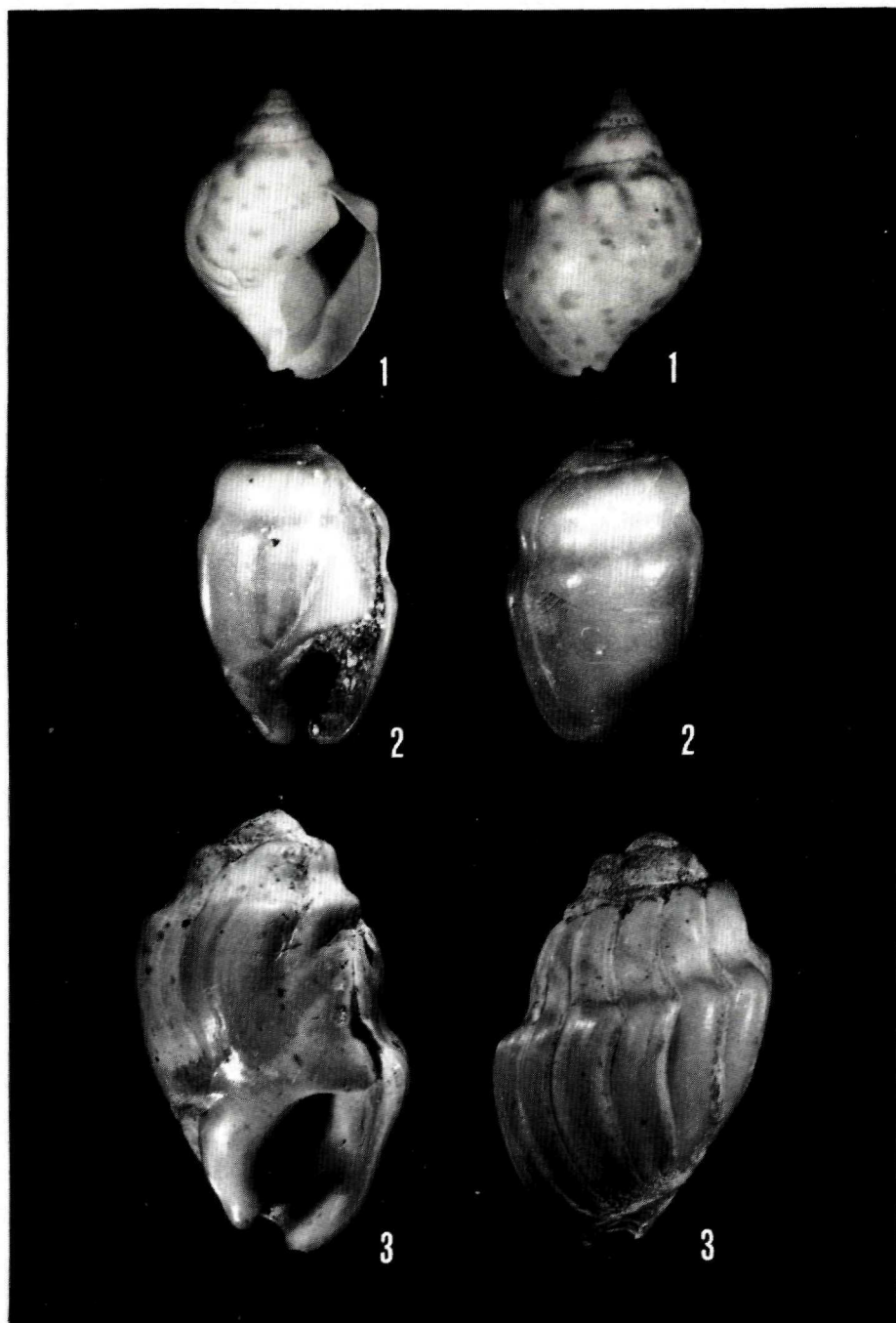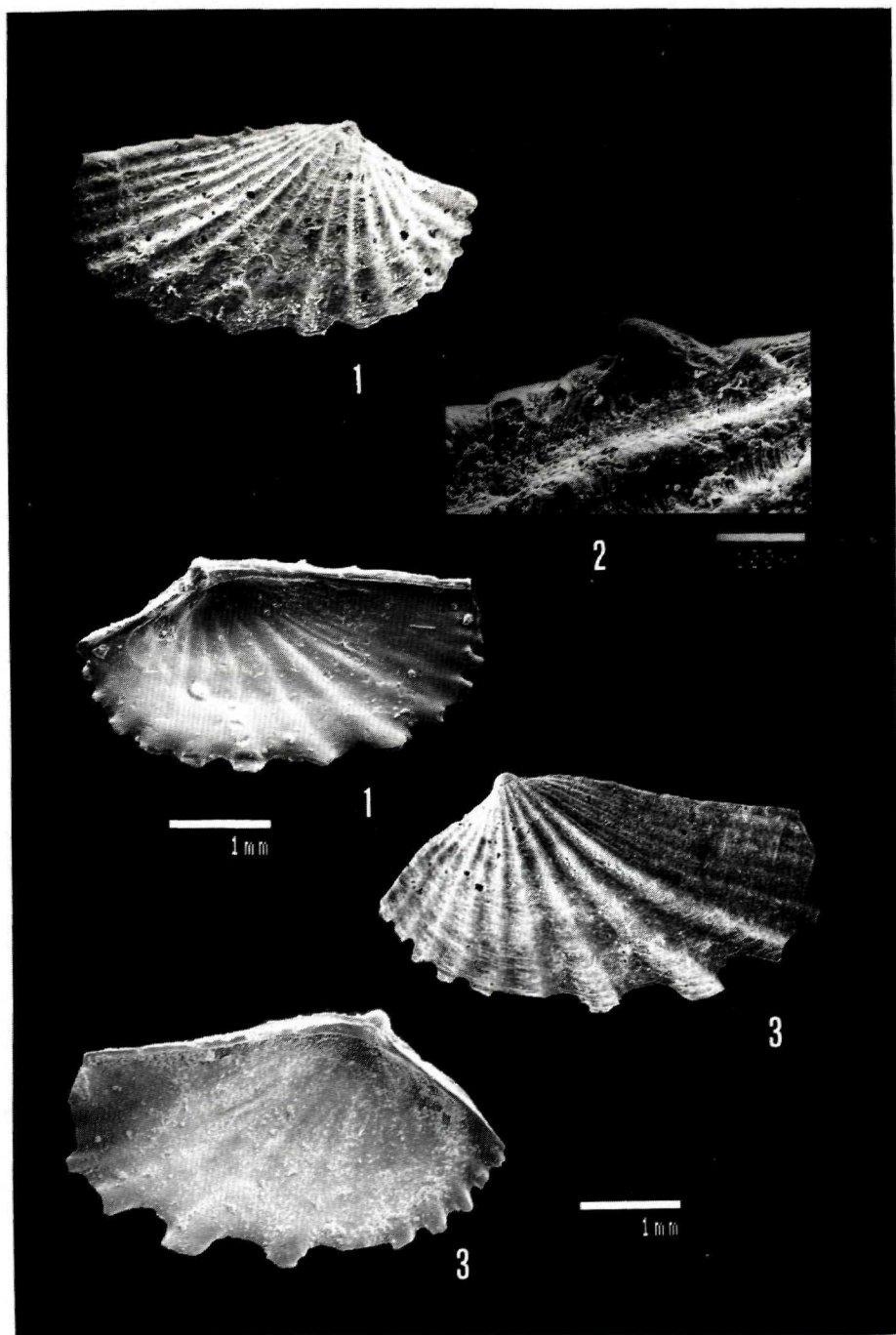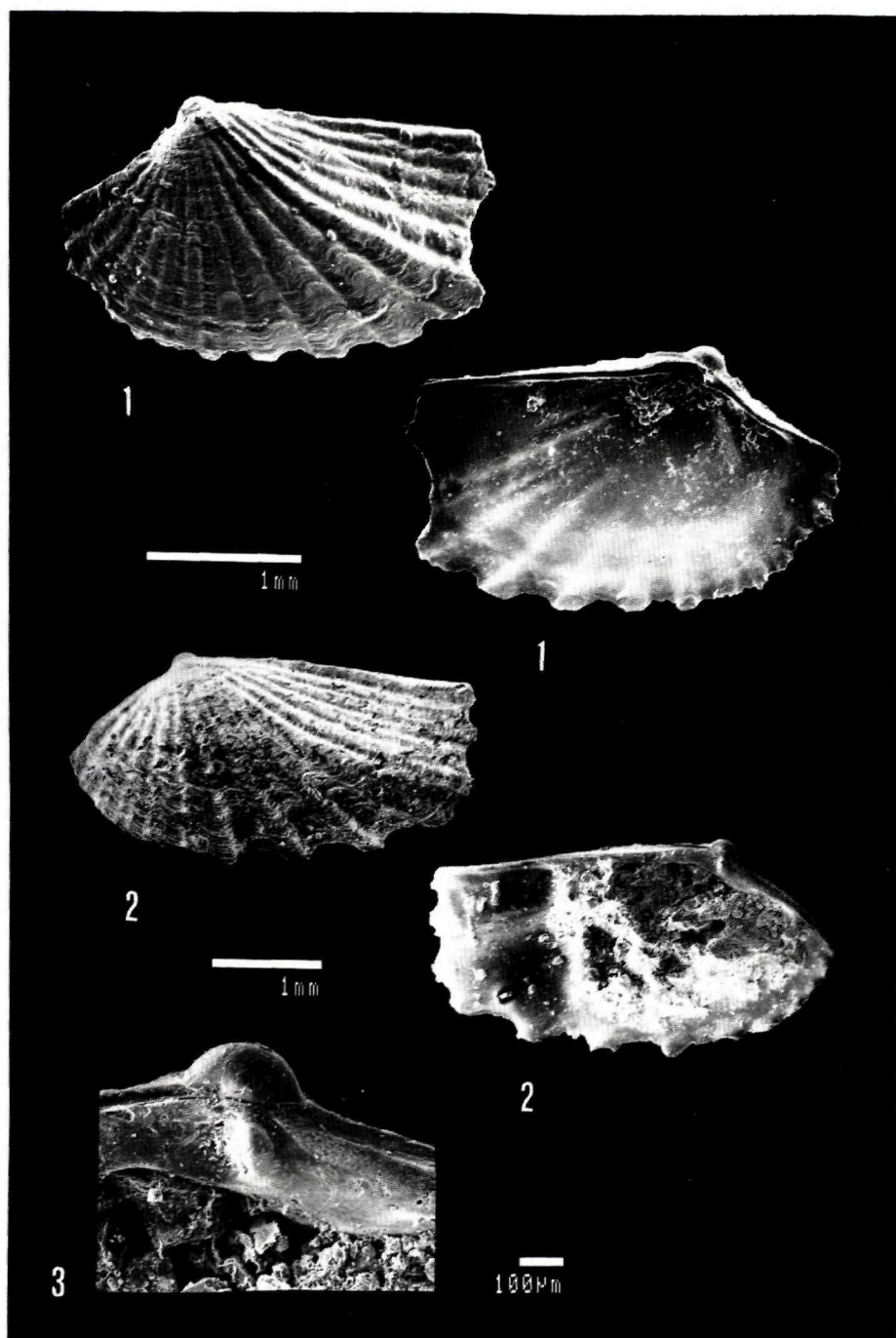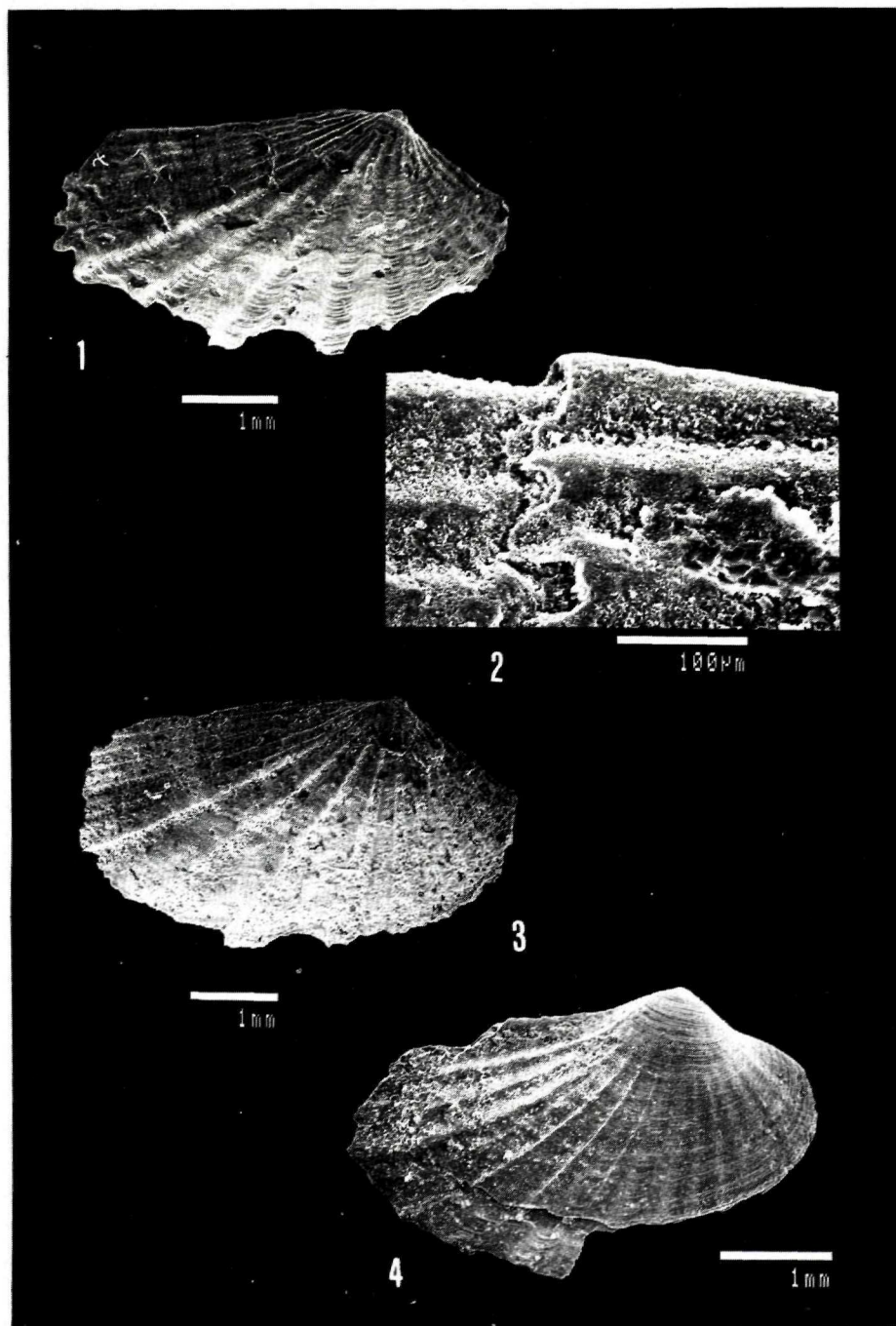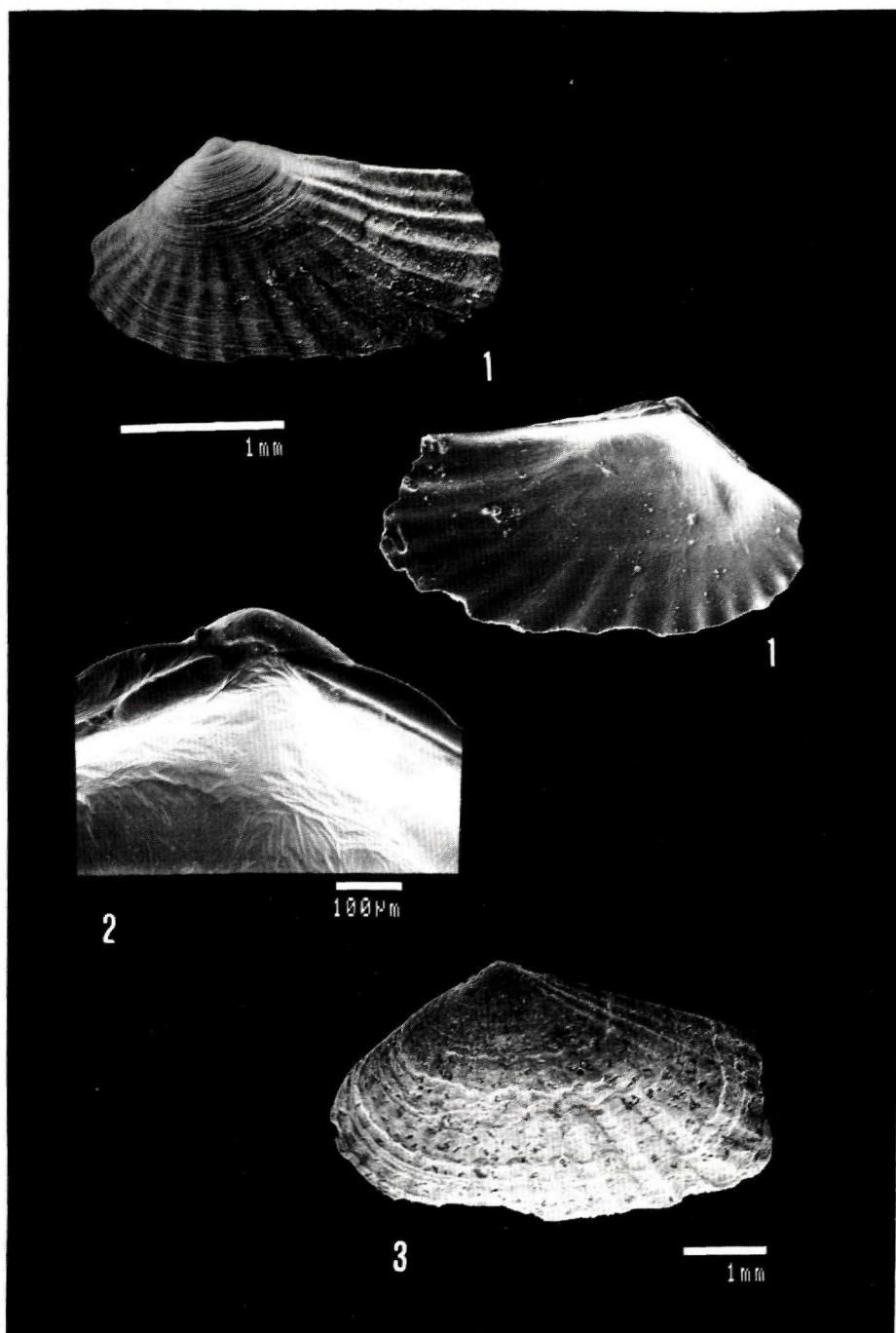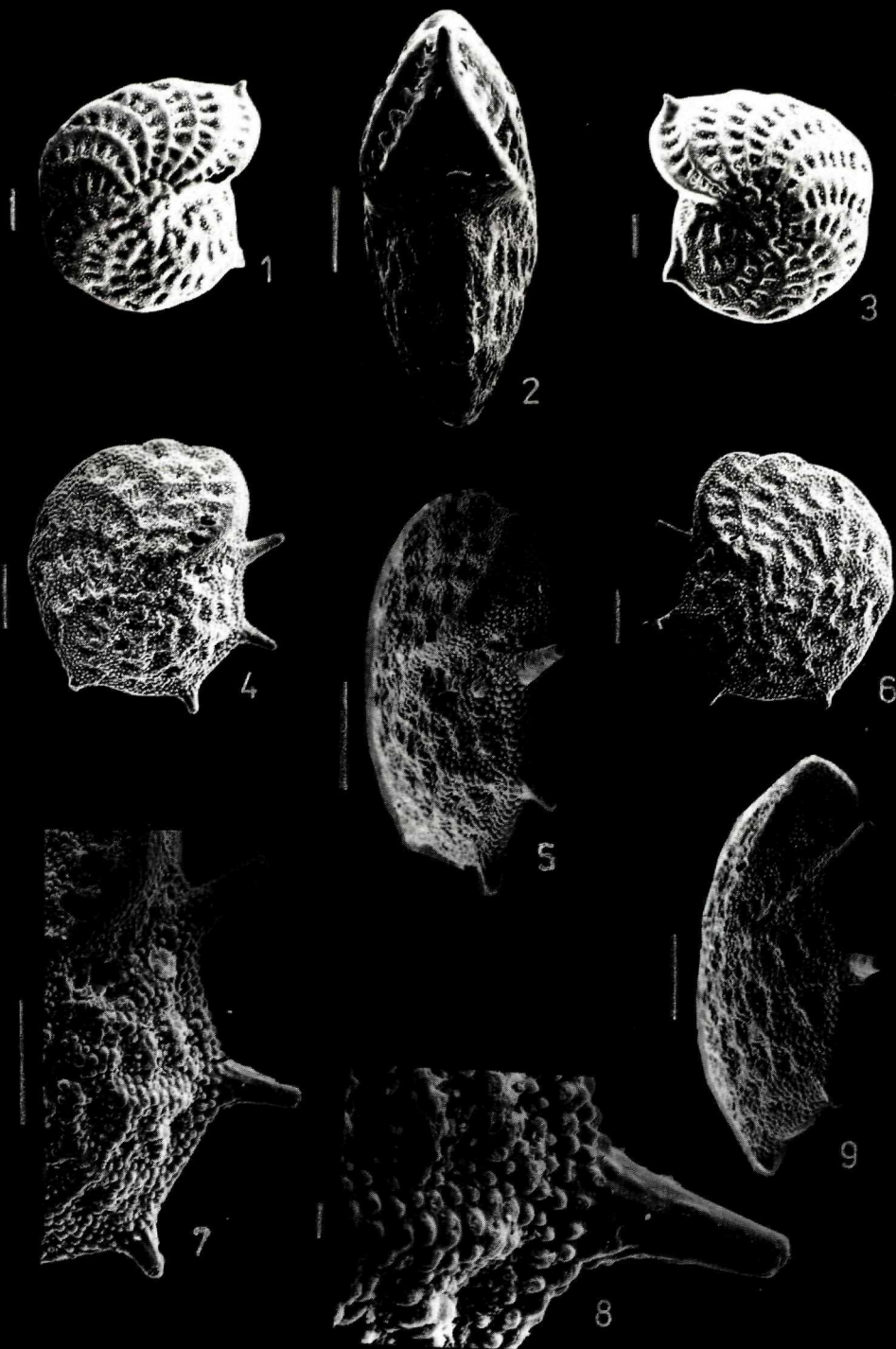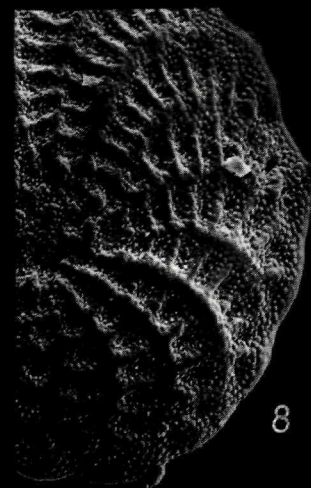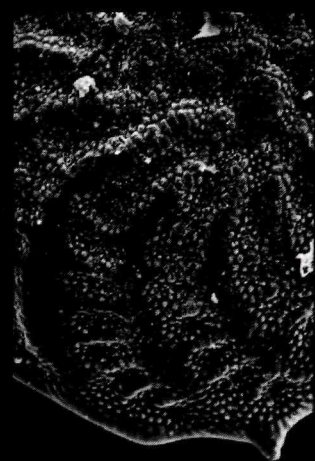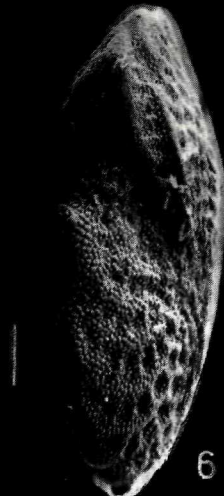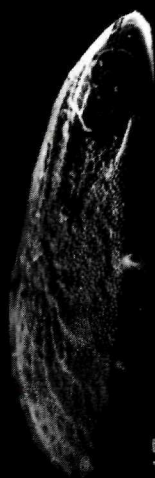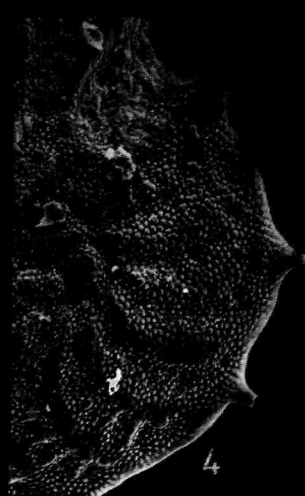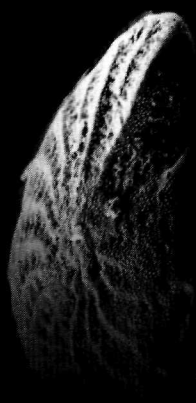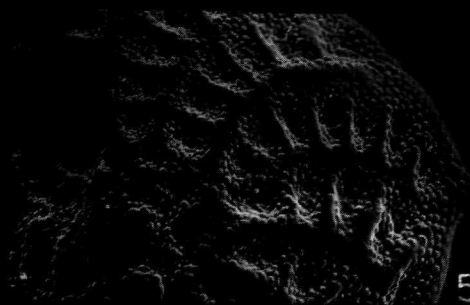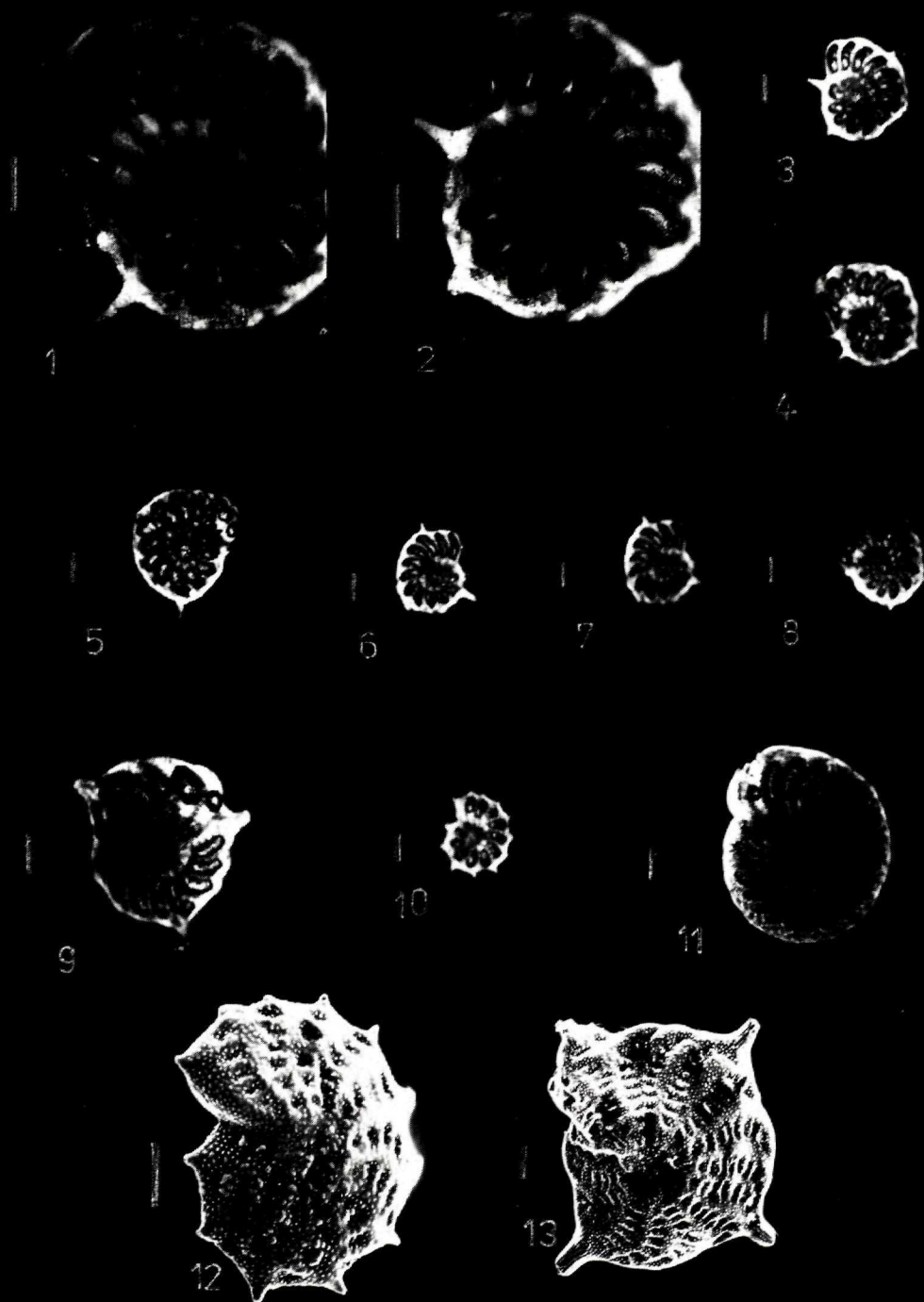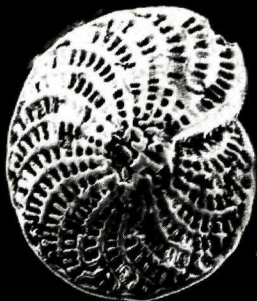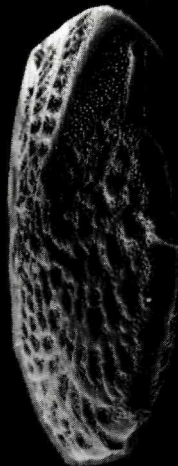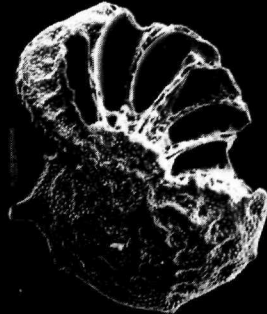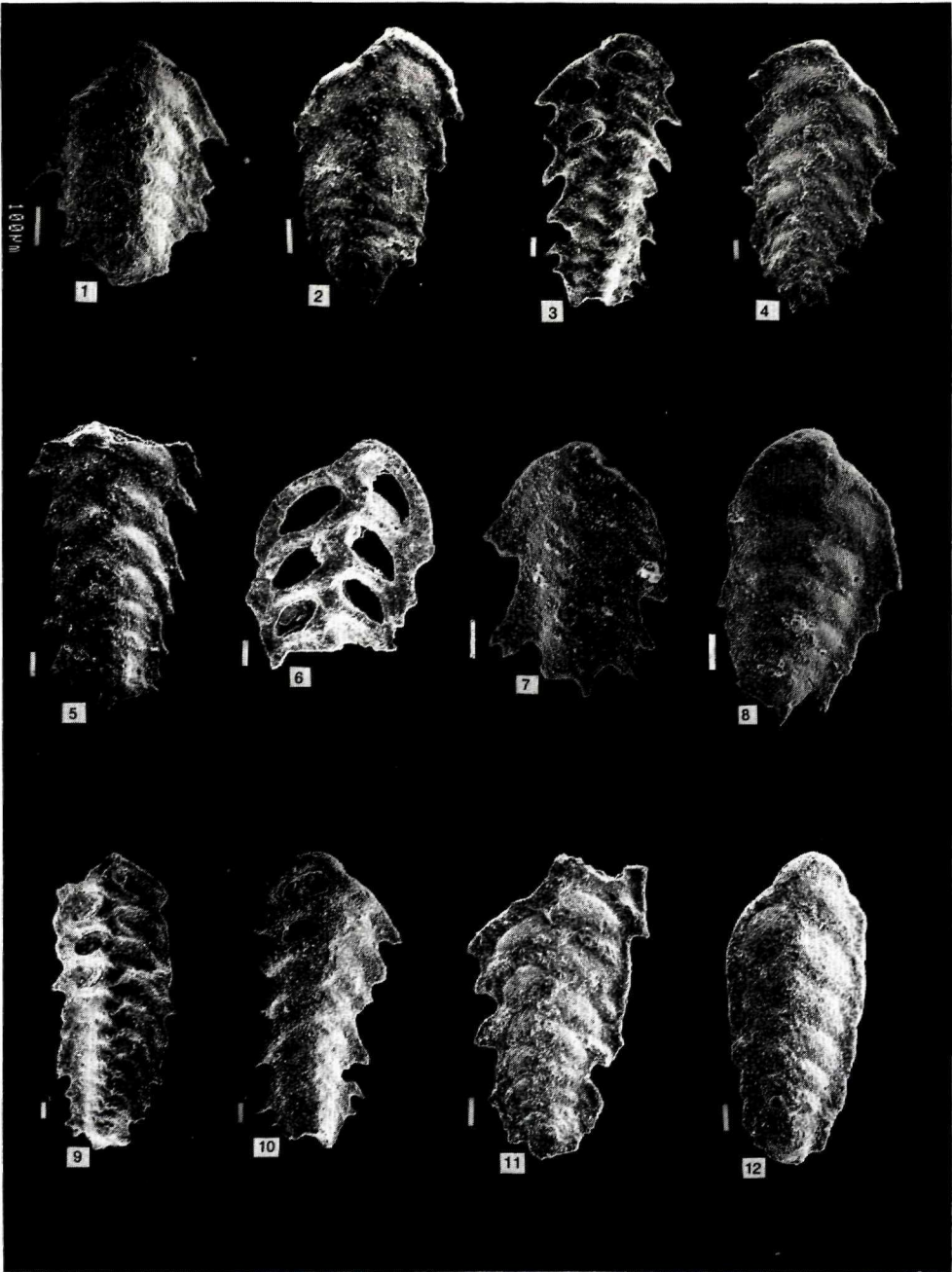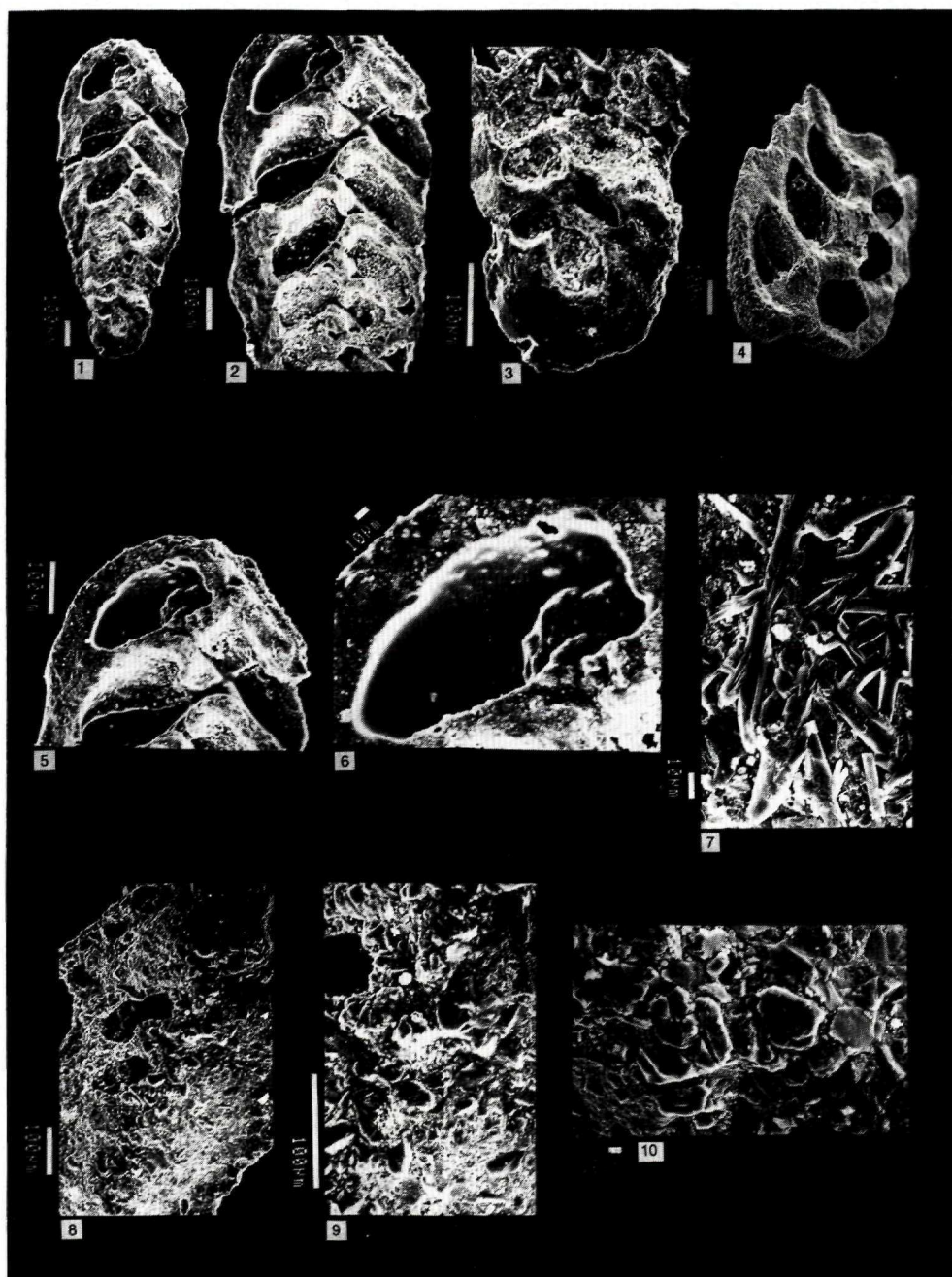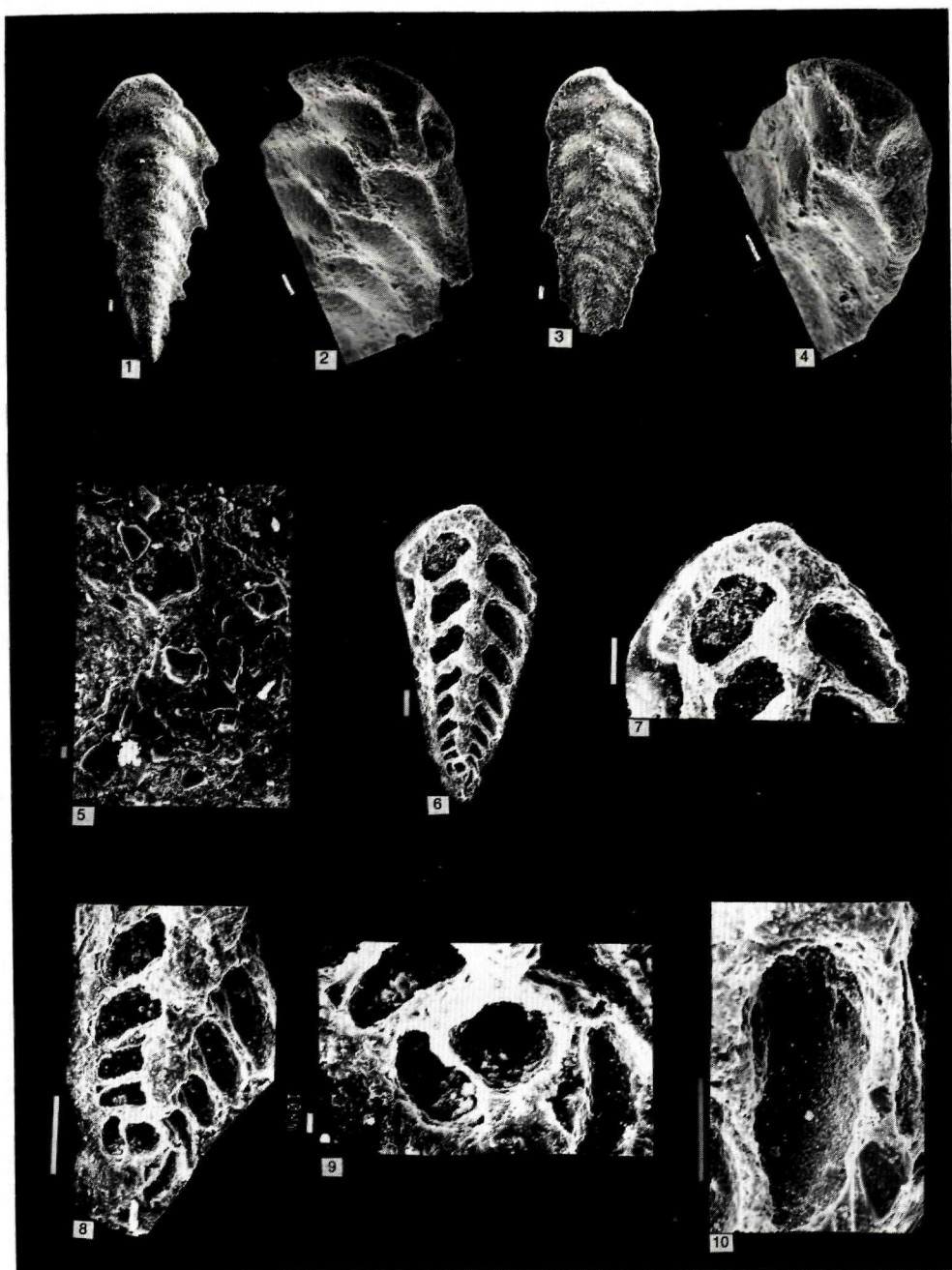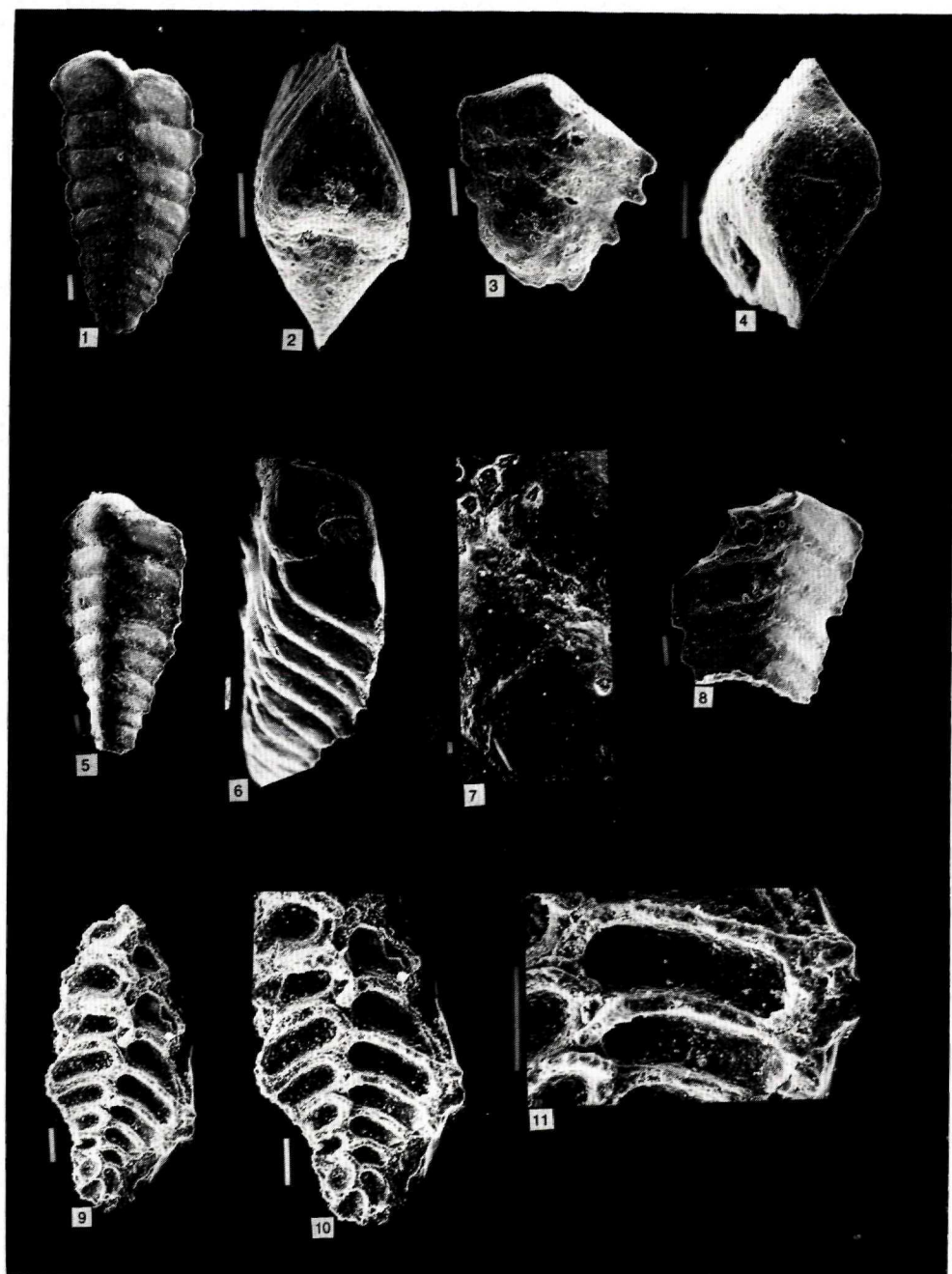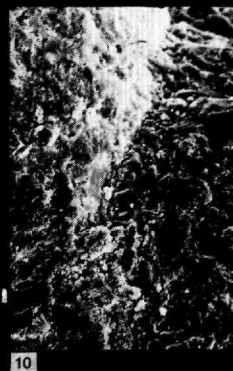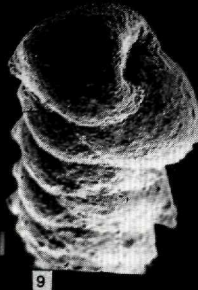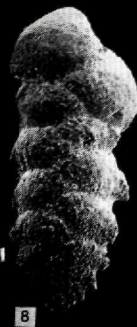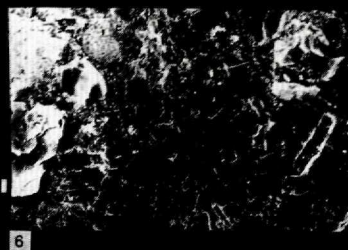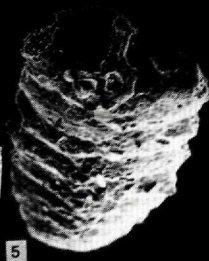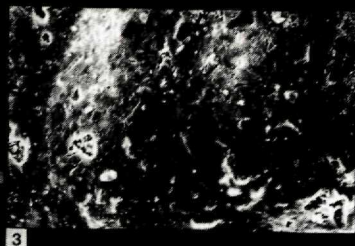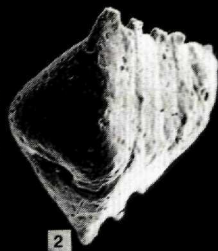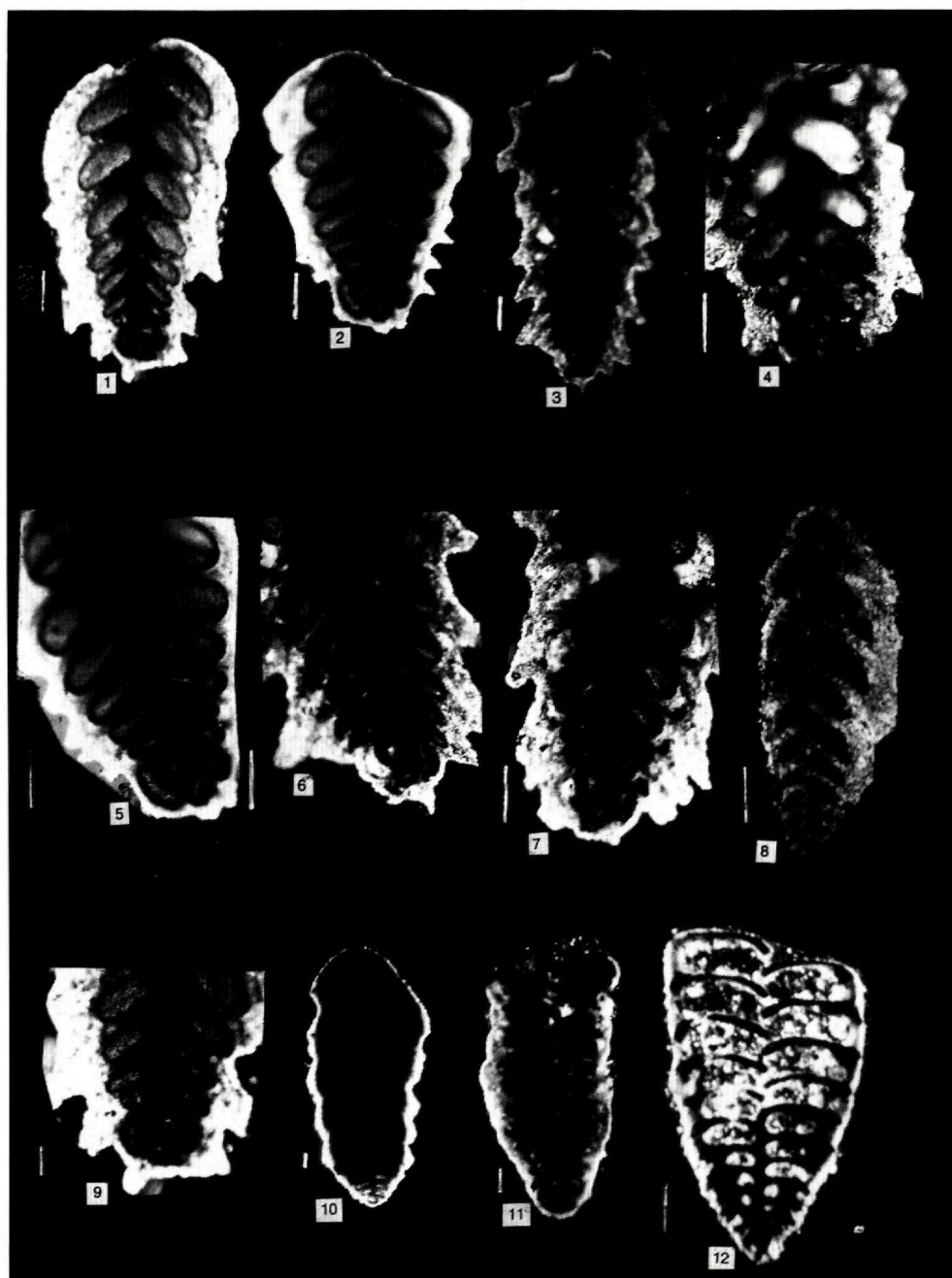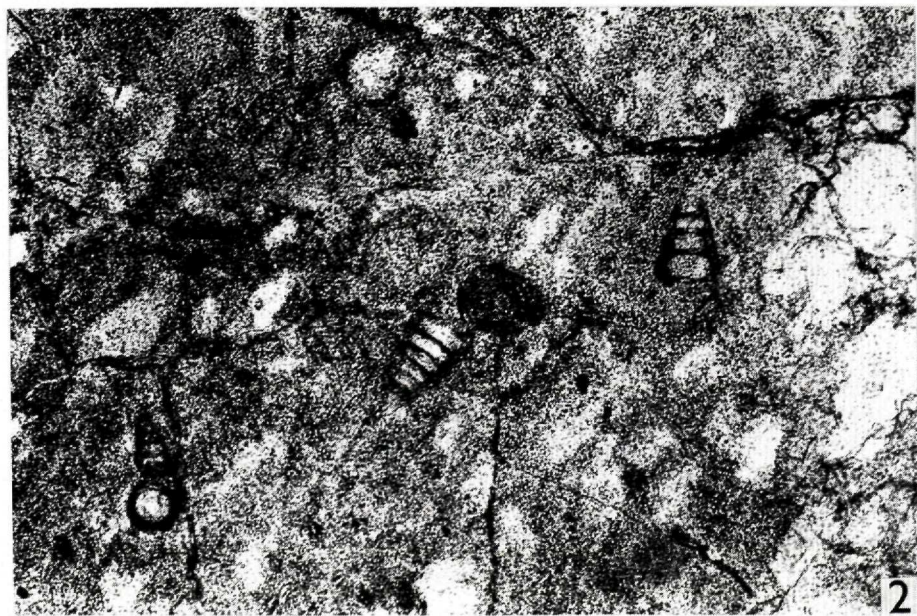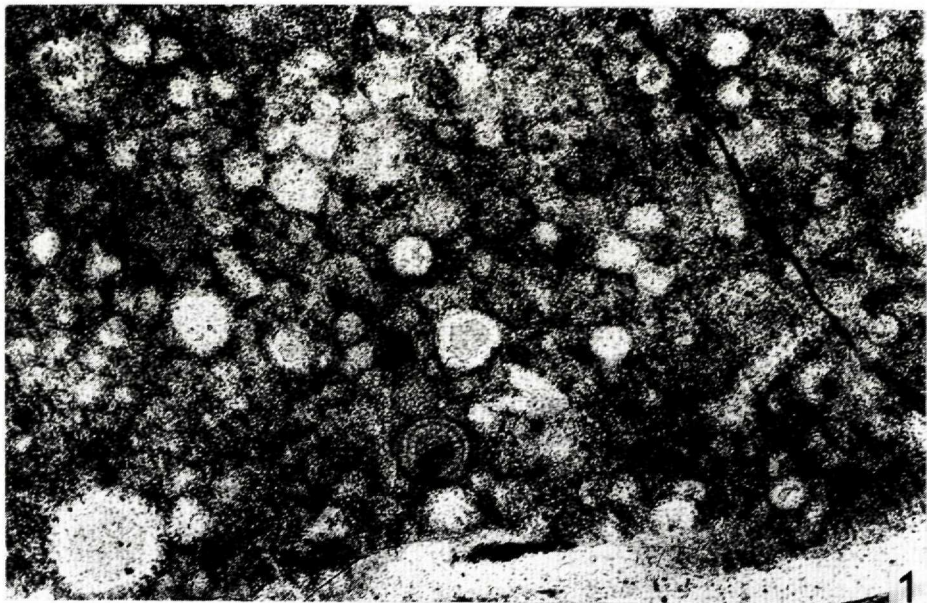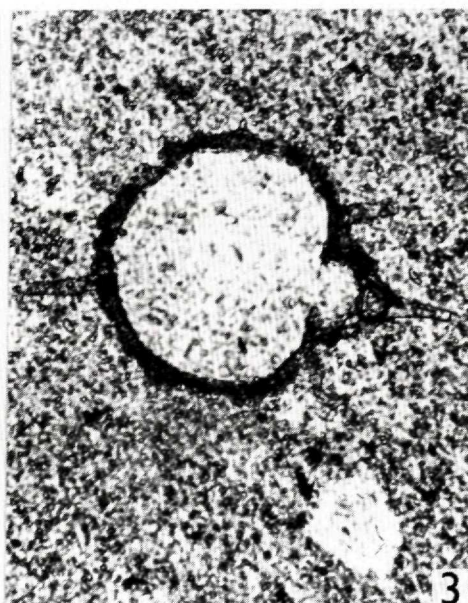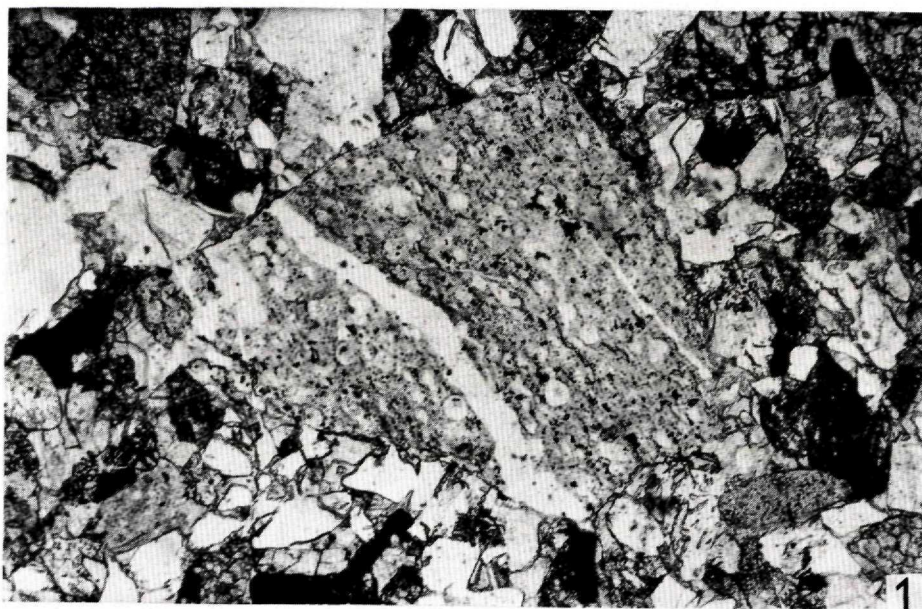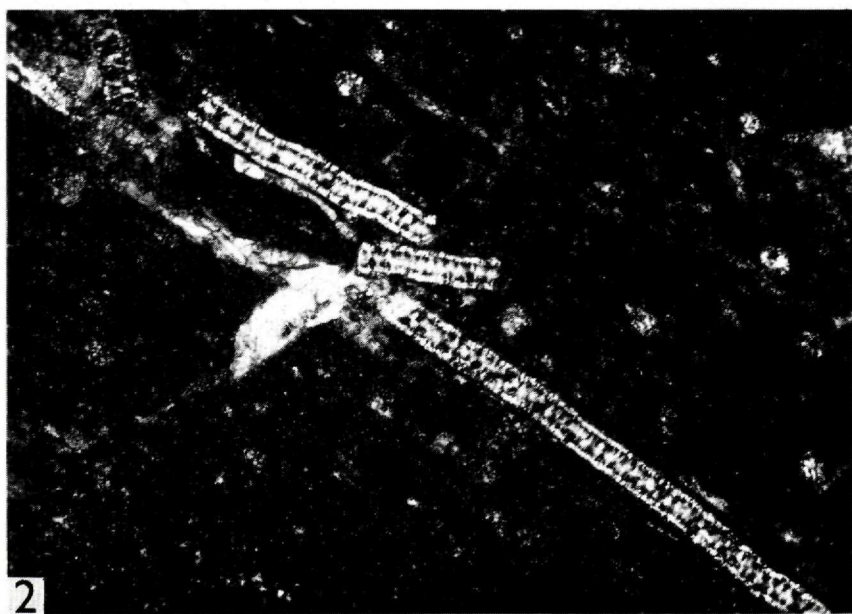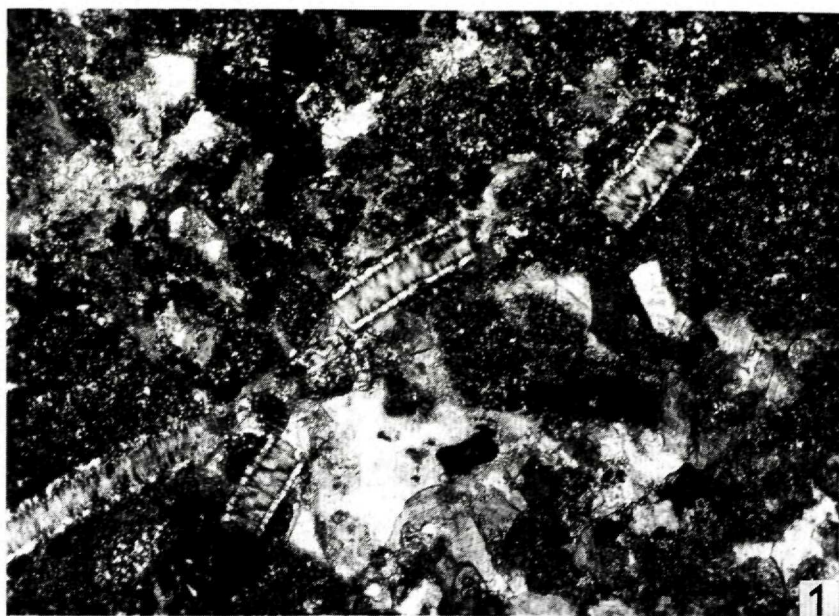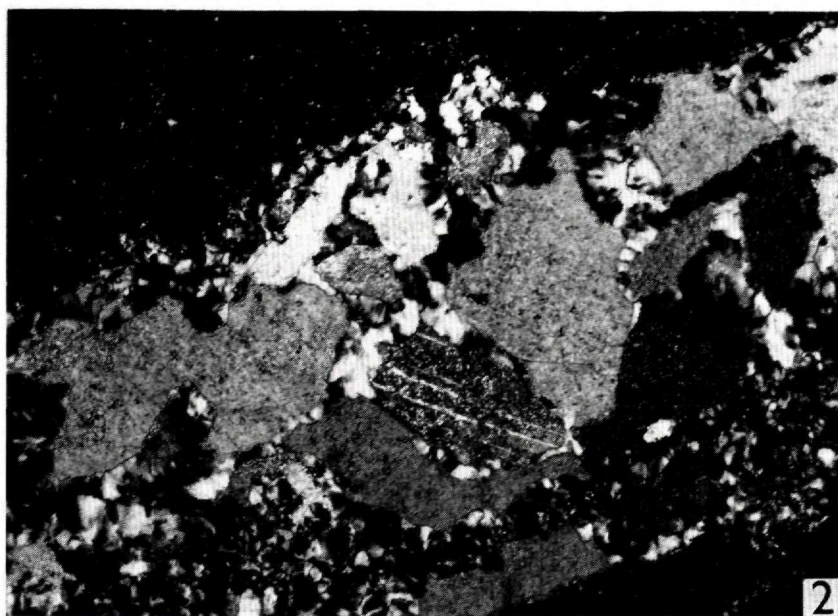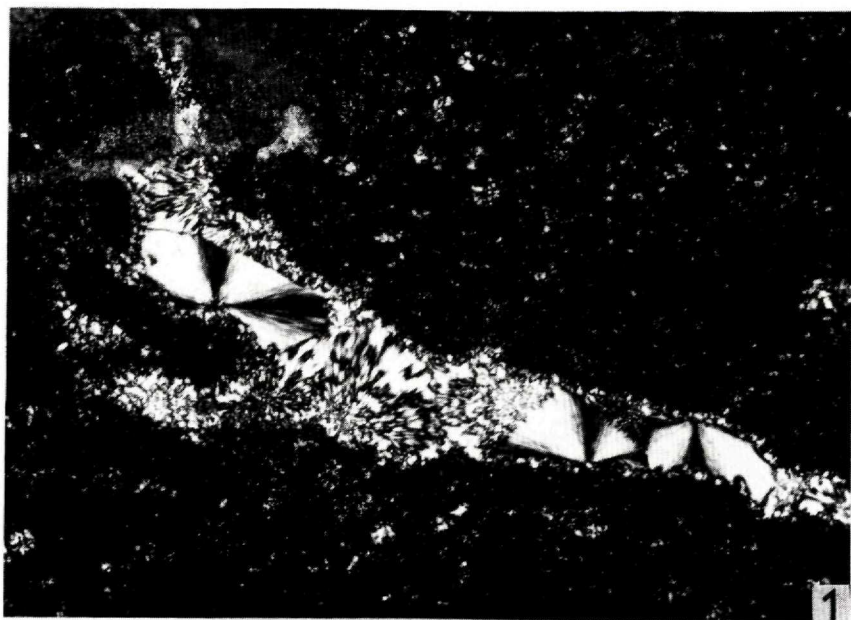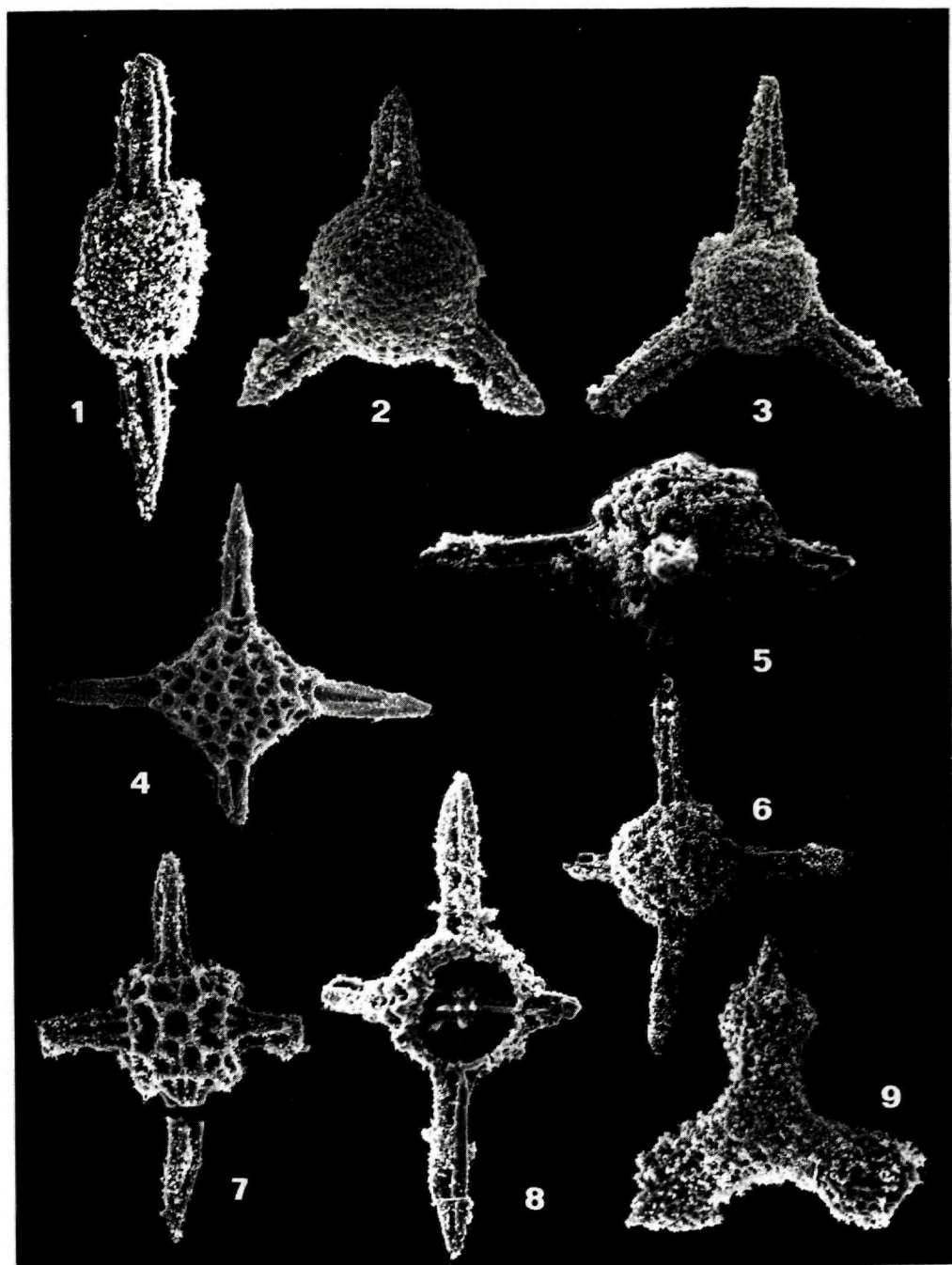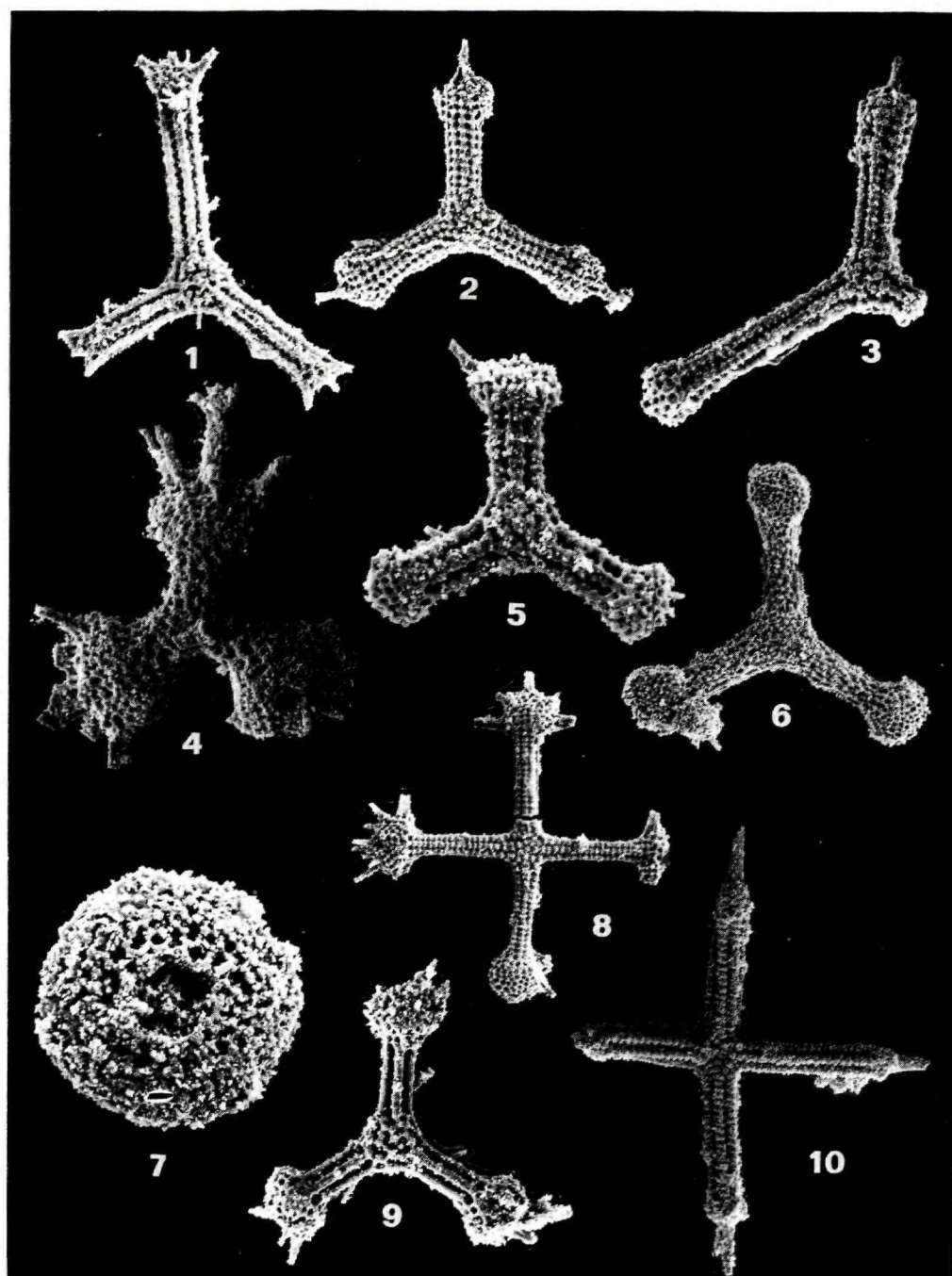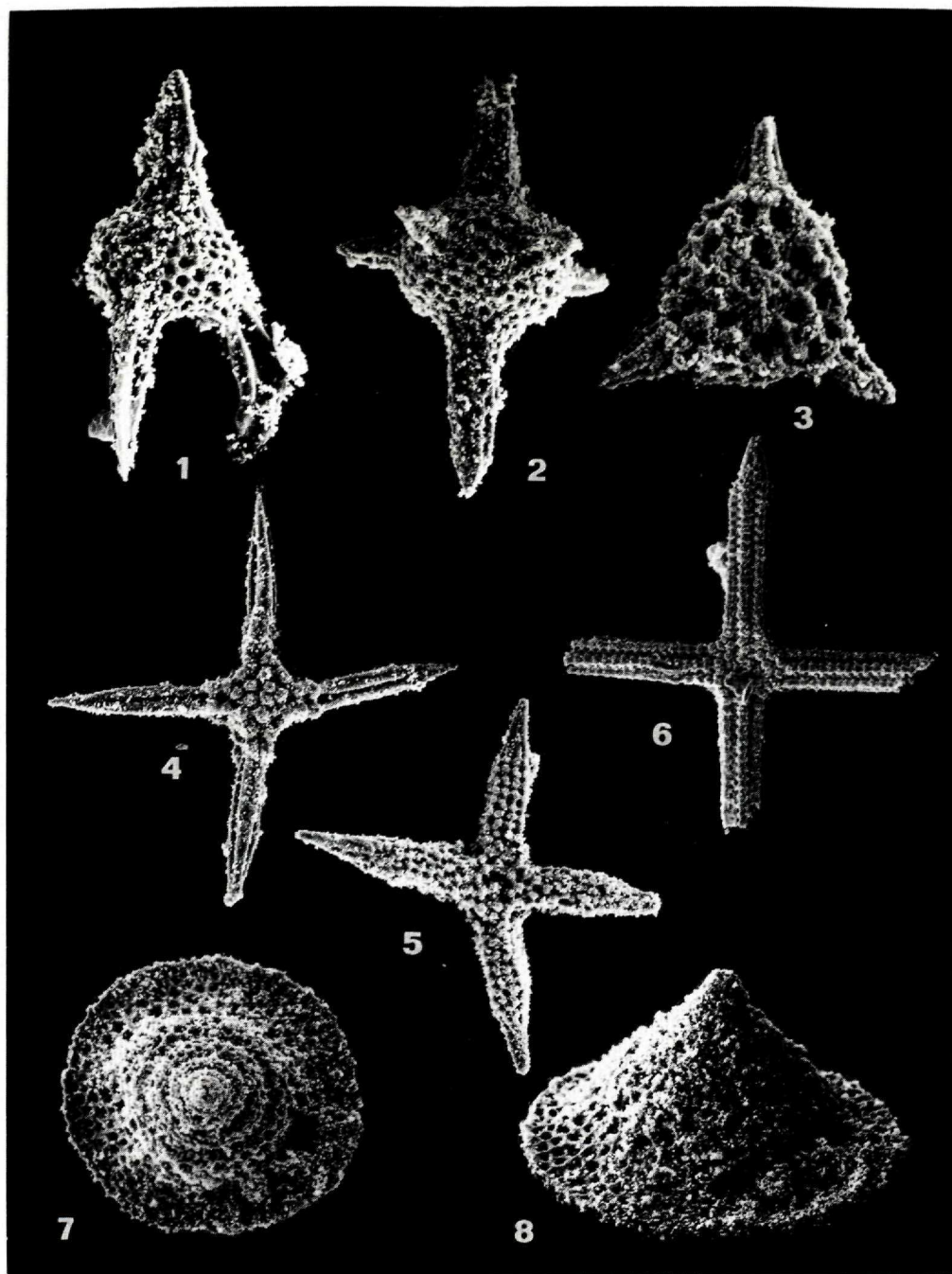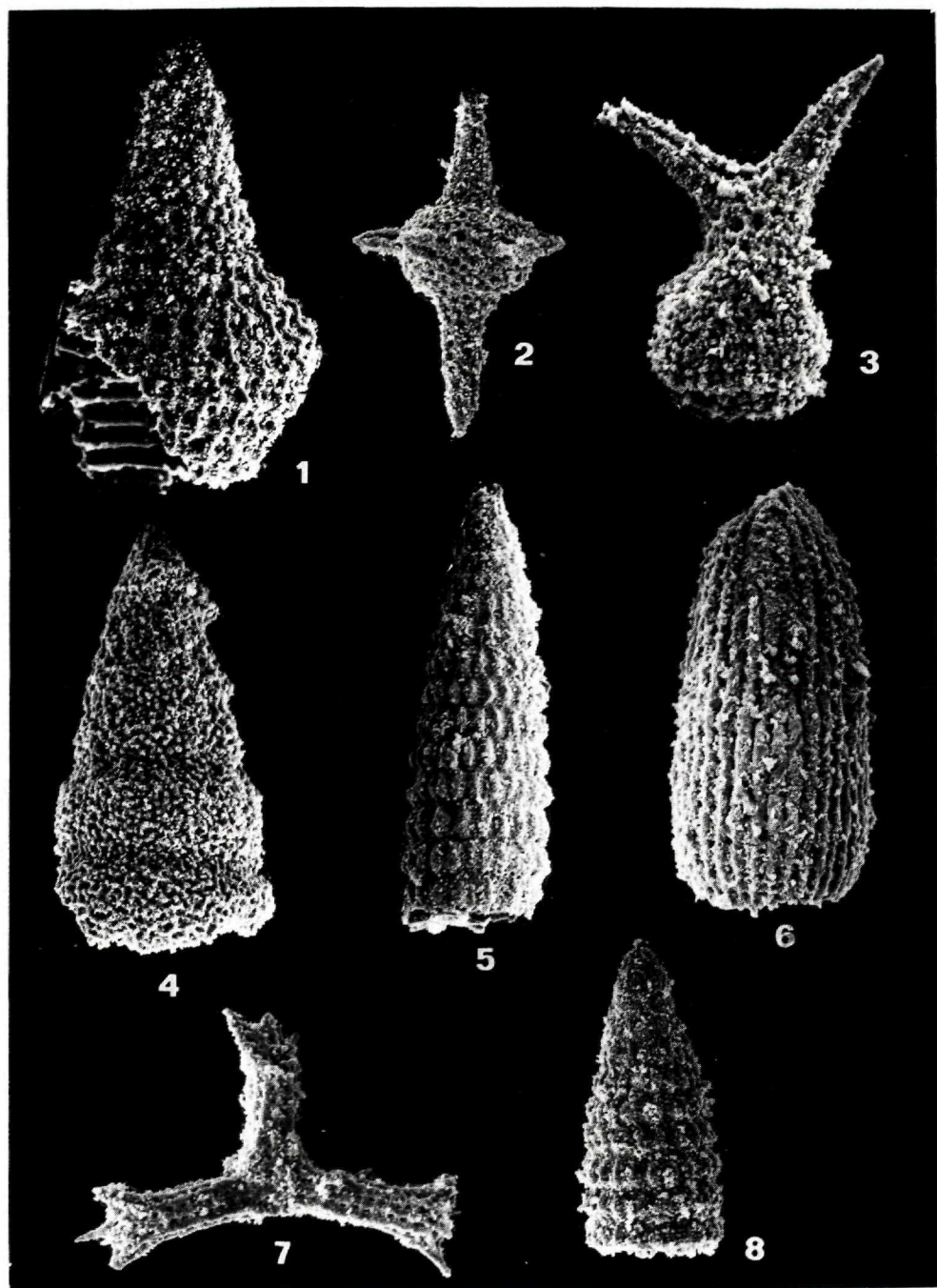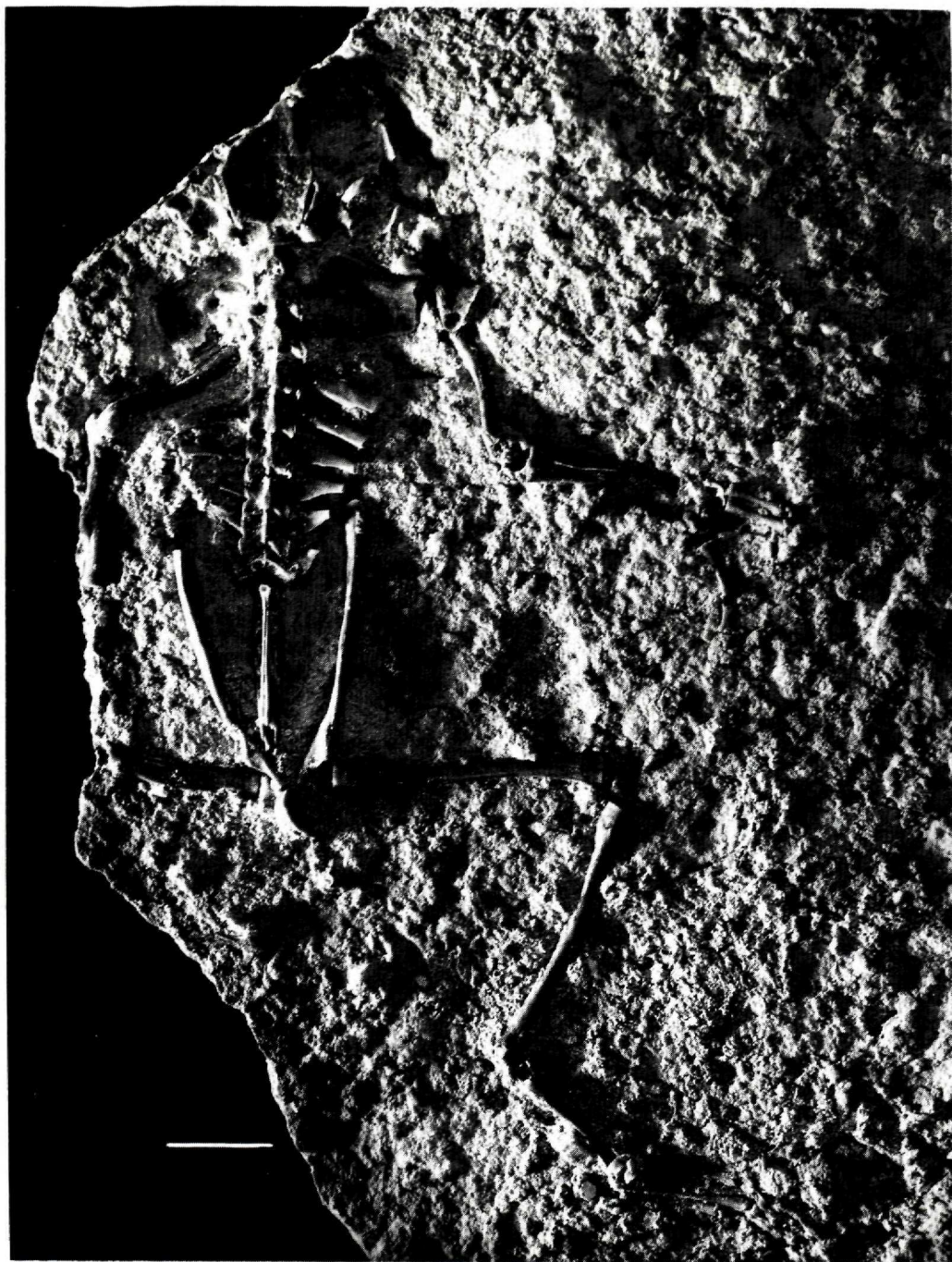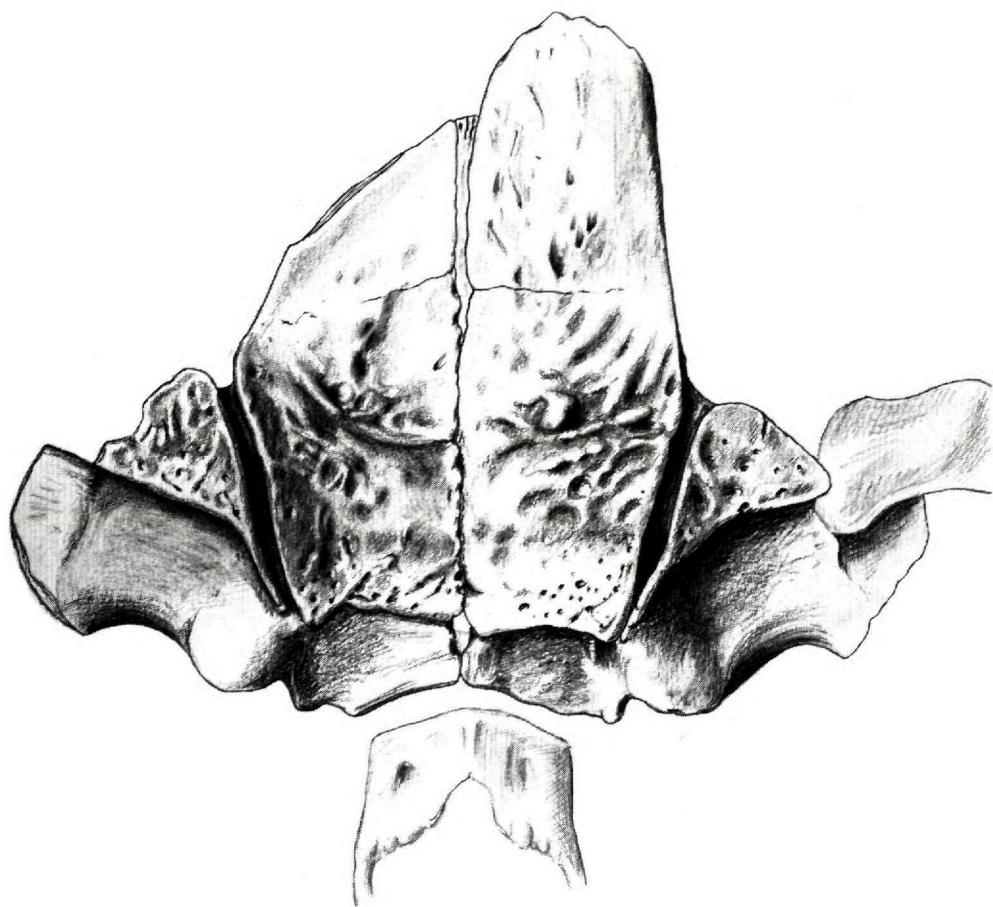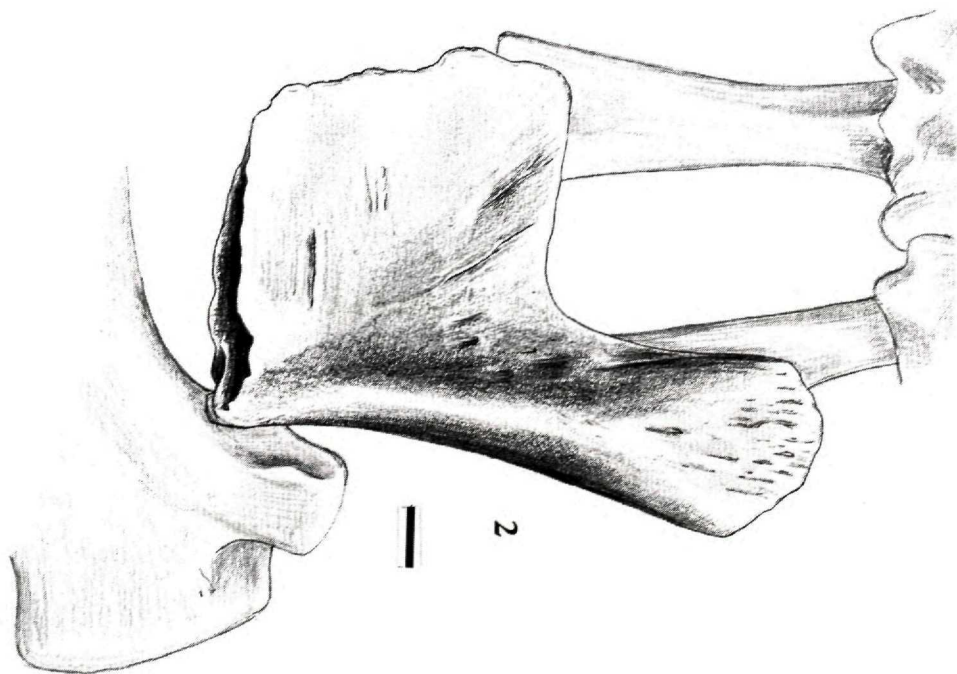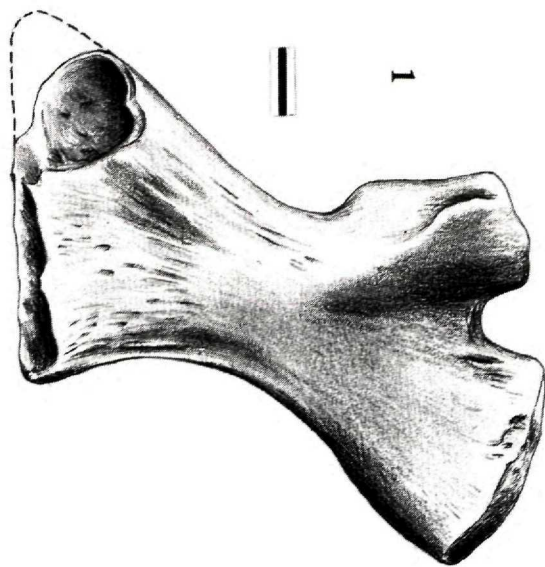
1b

Section: **BABKY** (West Tatra Mts.)

M. SÝKORA, 1987

HETTANGIAN
Planorbis zone

12 m

RHAETIAN

x ♂ Psiloceras (Psiloceras) psilonotum (Qu.)

1 m
0

Section: Mouth of **SOKOL** Valley into Zázrivá Valley (Malá Fatra Mts.)

M. RAKÚS, 1987

HETTANGIAN
Liasicus zone

Planorbis zone

66

• Alsatites liasicus sensu Wähner
• Lima cf. hettangiensis Terquem

• Psiloceras (Caloceras) sp.
• Tutcheria cf. heberti (Terquem)
• Cardinia sp.
• Astarte sp.
• Chlamys sp.
• Gryphaea sp.

• F

1 m
0

Section: **SOKOL** Valley (Malá Fatra Mts.)

M. RAKÚS, 1987

HETTANGIAN

⑦
⑥
⑤
④
③
②
①

20 cm
0

HETTANGIAN
LIASICUS–MEGASTOMA ZONE

3c
3b
3a
2
1

Cardinia sp.
Lima hettangiensis TERQUEM
Cenoceras sp.
Cenoceras molherbii (TERQUEM)
Alsatites sublaqueus (WÄHNER)
Alsatites liasicus sensu WÄHNER
Kammerkarites extracostatus (WÄHNER)
Kammerkarites megastoma (GÜMBEL)
Kammerkarites sokolensis n.sp.
Kammerkarites frigga (WÄHNER)
Kammerkarites cf. frigga (WÄHNER)
Saxoceras langei n.sp.
Schlotheimia taurina WÄHNER
Schlotheimia aff. taurina (WÄHNER)

1 m
0

Section: **BORIŠOV** (Veľká Fatra Mts.)

M. RAKÚS, 1987

LOTHARINGIAN

SINEMURIAN

8a • • ♂ • Coroniceras sp.

7 •

6 •

5 •

4 • • ♂ ✓

3a • • ♂ • Schlotheimia sp.

3 •

HETTANGIAN
Angulata zone
Kopienec fm.

Tatra fm.

2 •

RHAETIAN

1 m
0

Section: **ÚPLAZ pod KRÍŽNOU** (Veľká Fatra Mts.)

M. RAKÚS, 1987

18704 a

SINEMURIAN

40

39 ✓ ⑤ Arnioceras cf. miserabile (Qu.)

38

37
36
35
34

33 • F

32 • F

31

30

HETTANGIAN
Kopienec fm.

29

28

RHAETIAN
Fatra fm.

27

1 m
0

Rakús, M.: **Liassic Ammonites of the West Carpathians,**
part one: Hettangian – supplement

*By mistake of the author the biostratigraphical columns were
omitted from the article. These complete graphically the printed
text and illustrate the lithological character of the Hettangian in
the West Carpathians (Kopieniec Formation).*