GEOLOGICKY ZBORNIK — GEOLOGICA CARPATHICA, 38, 6, BRATISLAVA, DECEMBER 1987, Pp. 651—657

JÁN SOTÁK*

PROTOPENEROPLIDE FORAMINIFERS FROM LOWERMOST CRETACEOUS OF THE ŠTRAMBERK CARBONATE PLATFORM (OUTER WESTERN CARPATHIANS)

(Figs. 4, Pls. 4)

Abstract: The paper brings information on the presence of species *Protopeneroplis trochangulata* SEPTFONTAINE 1974 in the sequences of the Štramberk carbonate platform. Microfacial as well as biofacial characteristics of its occurrence were evaluated into detail. Ephemeral appearance of rich finds of *Protopeneroplis trochangulata* shows the features of acme-zone which is defined as a biostratigraphic unit of benthic foraminifers in the upper carbonate platform-stage of sedimentary area of the Baška cordillera (Lower to Middle Berriasian). The depicted occurrence of *Protopeneroplis trochangulata* brings new biostratigraphic evidences on extension of the Štramberk Limestones to Lower Cretaceous.

Резюме: В статье дается информация о наличии вида *Protopeneroplis trochangulata* SEPTFONTAINE 1974 в толщах штрамберкской карбонатовой платформы. Детально была оценена микрофациальная и биофациальная характеристика его появления. Эфемерный участок обильных находок *Protopeneroplis trochangulata* показывает признаки акме-зоны, определенной как биостратиграфической единицы бентосных фораминифер на верхнекарбонатовой платформенной стадии осадочной области кордильеры Башка (нижний-средний бериас). Описанное появление *Protopeneroplis trochangulata* приносит новые биостратиграфические доказательства о проникании штрамбекских известняков в нижний мел.

Introduction

In the Western Carpathians there have been some incongruities felt for a longer time in biostratigraphic interpretation of Jurassic protopeneroplide foraminifers, and first of all with regard to placing in order of microoncolite limestones with *Protopeneroplis striata* WEYNSCHENK taken from pebbles of Upper Cretaceous conglomerates of the Klippen Belt (Mišík—Sýkora, 1981), Senonian conglomerates of the Silica unit (Mišík—Sýkora, 1980), Jablonica conglomerates Lower Miocene - Mišík, 1986), flysch conglomerates of the Rača unit of the Magura nappe (Soták, 1987) and allodapic Barmstein limestones of the Čachtické pohorie Mts. (Mišík—Sýkora, 1982). The age of these limestones has been dated back to Oxfordian up to Kimmeridgian. On the other hand, however, occurrences of protopeneroplids were stated also in Upper Tithonian up to Lowermost Cretaceous limestones of the Outer Western Carpathians (Eliáš—Eliášová, 1984, 1986; Soták, 1981, 1987) and eastern sector of the Klippen Belt (personal contact with M. Mišík and M. Sýkora) which required a revision of these foraminifers in order to

* RNDr. J. Soták, Geological Institute of the Centre of Geoscience Research, Slovak Academy of Sciences, Horná 15, 974 01 Banská Bystrica.

intercept possible morphogenetic changes of successive species *Protopeneroplis striata* — *Protopeneroplis trochangulata*. This change of protopeneroplide foraminiferal spectra having also considerable biostratigraphic consequences was demonstrated in the Štramberk carbonate platform sequences.

The aim of this work is to clarify vertical distribution of protopeneroplide foraminifers in the Upper Jurassic and Lower Cretaceous of the Western Carpathians and to interpret stratigraphically the presense of species *Protopeneroplis trochangulata* SEPTFONTAINE in the Štramberk Limestones.

Position and facial development of the Štramberk carbonate platform

The Štramberk carbonate platform represents a two-stage cycle of shallow-water carbonate deposition on the Baška elevation in the Silesian sedimentary area (Outer Western Carpathians) dividing by the interphase of the Upper Tithonian biotect of the Štramberk Limestones. The lower stage of the carbonate platform can be seen through sedimentation of biopelmicritic and pelbiomicrosparitic limestones with rare ooids and blue-green algae (Eliáš — Eliášová, 1986). This calpionellid-free stage is dated by the occurrences of *Carpistomiosphaera tithonica* NOWAK for Lower Tithonian (Eliáš — Eliášová, 1985). The Štramberk reef complex itself has its basis fixed in calpionellid zone *Chitinoidella* (uppermost Middle Tithonian and lowermost Upper Tithonian - Houša, 1978) and reaches the climax in calpionellid zone *Crassicollaria* (Eliáš — Eliášová, 1986). The limestones are built up by coral framestones and bindstones with extremely manifold fauna of corals (see Eliášová, 1975, 1978, 1981a, etc.), ammonites, shells of *Diceras*, chaetids, echinoids, bryozoans, hydrozoans, echinoderms, sphinctozoans, serpulid worms, dasycladacean floras (see Steinmann, 1903; Eliáš — Eliášová, 1984, 1986), binding and encrusting microorganisms (see Eliášová, 1981, 1985 etc.), stromatolites, oncoids etc.

On the Jurassic/Cretaceous boundary a change of sedimentation regime was detected and this gradually ended strong reef sedimentation (Štramberk Limestones) which was replaced by that on carbonate platform (Eliáš — Eliášová, 1984). In this developmental stage there was taking place sedimentation of internal carbonate platform facies (wackestones, packestones and grapestones) with bahamite type particles — especially coated grains, micritized grains, pseudoooids, peloids, aggregated lumps etc. — however, the formation of organic buildups on carbonate platform edges and in patch-reefs was still lasting. Considerable changes in biofacial composition can be seen mostly in higher upbuilding of skeletal fragments of echinoderms and other biodetritus as well as in striking appearance of the platform "fusulinids" of *Protopeneroplis trochangulata* type. The type of sedimentation like this had been proceeding to Hauterivian (on the basis of the presence of *Colomisphaera heliosphaera* (according to Eliáš — Eliášová, 1985), but on the other hand, Houša (1978, 1983, etc.) with regard to the rules of calpionellid zonation of Rome division (1970) supposes the Štramberk cycle ending within the boundary of Tithonian/Berriasian. These contraindicatory views suggest complicated processes of the Štramberk carbonate platform dying out within Berriasian to Hauterivian which can be seen in overlying Olivetská hora Formation, strong carbonate platform fracturing with phase separation and fissure filling, brecciation, bio-

erosion of fissures, microbearing processes at the surfaces of *Tubiphytes*-bioclasts, boreal microfauna elements penetration [*Lenticulina nodosa* (REUSS) and other nodosaroid foraminifers], planar corrosion originating hardgrounds up to Hauterivian karstification at the end (see H o u š a 1965, 1974, 1976, 1979, 1981, 1983 and our own observations). Sedimentation of the Olivetská hora cycle took the character of "Spaltenfüllung" and in the form of either neptunic dikes or filled fissures. The sediments from fissures and dikes are formed by clayey, micritic, organodetritic and breccia limestones (H o u š a 1976).

Systematic part

Order *Foraminiferida* EICHWALD, 1830
Sub-order *Fusulina* WEDEKIND, 1937
Super-family *Endothyracea* BRADY, 1884
Family *Endothyridae* BRADY, 1884
Sub-family *Loeblichiinae* CUMMINGS, 1955
emend. FARINACCI, 1964; emend. SEPTFONTAINE, 1974
Protopeneroplis trochangulata SEPTFONTAINE, 1974
Pl. 2, Figs. 1—9; Pl. 3, Figs. 1—9

? 1969 *Protopeneroplis striata* LUPERTO SINNI, Pl. 1, Fig. 1.
? 1972 *Protopeneroplis striata* BRÖNNIMANN, DURAND-DELGA et GRAND-JACQUET, Pl. 1, Figs. 4—5.
1974 *Protopeneroplis trochangulata* SEPTFONTAINE, pp. 608—614, Pl. 1, Figs. 1—18.
1977 *Protopeneroplis trochangulata* AZÉMA, CHABRIER, FOURCADE et JAFFREZO, pp. 126, 130, 132, Pl. 3, Figs. 4—5.
1978 *Protopeneroplis trochangulata* CHIOCCHINI et MANCINELLI, Pl. 10, Figs. 1—2, Pl. 11, Fig. 1.
1979 *Protopeneroplis trochangulata* CHIOCCHINI et MANCINELLI, pp. 22—24, Pl. 1, Figs. 1—12.
1980 *Protopeneroplis trochangulata* SEPTFONTAINE, pp. 190—191, Pl. 3, Fig. 24.
1984 *Protopeneroplis trochangulata* SALVINI-BONNARD, ZANINETTI et CHAROLLAIS, pp. 179—180, Pl. 2, Fig. 12.
non Fig. 1985 *Protopeneroplis trochangulata* BUCUR, pp. 206, 208.
non Fig. 1986 *Protopeneroplis trochangulata* BUCUR, p. 30.

D e s c r i p t i o n : Characteristic morphology of *Protopeneroplis trochangulata* tests was shown mainly in sub-axial sections as the diagnostic values of equatorial sections are limited. However, cross-sections of monoserial type with ventral lamina (ventrolaminide types) were detected most often. The tests are asymmetric, trochospiral and in equatorial sections mostly evolute [according to numerical expresion of spiro-axial relations $\frac{H_1}{D} : \frac{U}{D}$ is the test coiling of *Protopeneroplis trochangulata* evolute (ratio <), in several cases only, it is close to semi-involute type (ratio =)]. The test is formed by $1^1/_2$ up to 2 whorls freely coiling around bud umbilicuses. Early stage of spire coiling with 8—10 chambers passes to trochospiral stage of the last whorl consisting of 10—12 chambers. The chambers consecutively grow in size (expansion rate of chambers reaches the mean value 1.09 from the calculation of D : d correlation) and their septa are rather convex to aperture. In basal parts of septa prosiphon

perforations can be seen. The chambers of trochospiral stage are asymmetric and angular in axial sections. The absence of light and dark striata on spire faces which are typical of *Protopeneroplis striata* is an indirect sign. The presence of calcareous pustules on hyaline layer of spire face is striking. The wall-structure of the tests is heterogenous. In most cases the tests are two-layer formed by inside microgranular and outside hyaline layers, the latter being with fibre-radial habit. Often the microgranular one is missing or appears through slight turning dark of inside contours of chambers. Such appearance of microgranular layer could suggest its recrystallization origin and that is by micritization of hyaline layer (R e i s s, 1958). The hyaline layer is highly developed in bud umbilicuses where it becomes thicker in lateral faces and in coiling plane it is transformed into the form of outside peripheral cordon skirting adult stages of spire. The course of peripheral cordon is interrupted in the places of septa grippings by ribbing thickenings. This new phenomenon of *Protopeneroplis trochangulata* test ornamentation which can be observed also in the illustrations by C h i o c c h i n i — M a n c i n e l l i (1979, Pl. 1, Figs. 1, 3, 10) is considered a valuable diagnostic of the given species in equatorial and subequatorial sections.

Dimensions (in μm):

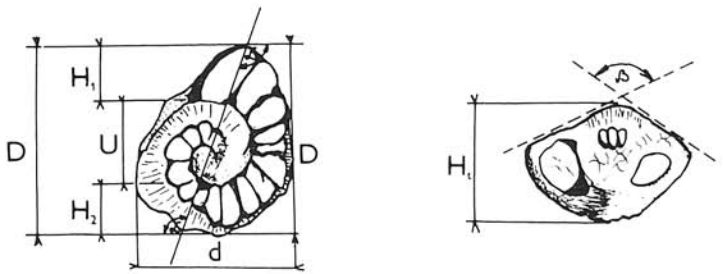


Fig. 1. Measured parameters of *Protopeneroplis trochangulata* test.

D = 474—715	U = 189—282	H_2 = 136—202
d = 435—655	H_1 = 149—231	H_1 = 340—561

mean thickness of septa (the last whorl): 18—20
conical angle $\beta = 120°$
$\alpha = 90—110°$

Microfacies and associated microorganisms accompanying Protopeneroplis trochangulata SEPTFONTAINE occurrences

The occurrences of *Protopeneroplis trochangulata* SEPTFONTAINE were detected in the following patterns of the Štramberk carbonate platform. Their population is the most strikingly adapted to basinal intraplatform niches. Carbonate sediments of this environment are represented by packed biopelmicrites

(wackestones — packestones) with bahamite particles (coated and micritized grains, agglutinated peloids, algal pellets, pseudoooids and superficial ooids, grapestones, etc.). The accompanying microfauna and microflora comprize skeletal segments of echinoderms, echinoid spines, microgastropods, ostracods, algae *Campbelliella striata* (CAROZZI), *Clypeina? solkani* CONRAD et RADOIČIĆ, *Acicularia elongata* CAROZZI, *Acicularia* aff. *endoi* PRATURLON, *Carpathocodium anae* (DRAGASTAN), foraminifers *Neotrocholina valdensis* REICHEL, *Neotrocholina friburgensis* (GUILLAUME et REICHEL), *Trocholina alpina* (LEUPOLD), *Conicospirillina basiliensis* MOHLER, *Valvulina aff. lugeoni* SEPTFONTAINE, *Everticyclammina* sp., *Feurtilia* sp., *miliolids*, textularids, coprolites *Favreina cuvillieri* BRÖNNIMANN and plentiful calpionellid and globochaete plankton. Moreover the occurrences of *Protopeneroplis trochangulata* were detected also in carbonate platform-edge facies. In these limestones it is possible to determine three following subfacies: coral — *Tubiphytes* bindstones, encrusting bindstones and coated grainstones. Their organic assemblages consist of algae *Tubiphytes morronensis* CRESCENTI, *Bacinella irregularis* RADOIČIĆ, *Koscinobullina socialis* CHERCHI et SCHROEDER, *Thaumatoporella parvovesiculifera* (RAINERI), *Muranella parvissima* (DRAGASTAN), *Porostromata*-encrusters, *Salpingoporella pygmaea* (GÜMBEL), *Triploporella remesi* (STEINMANN), *Linoporella capriotica* (OPPENHEIM), *Ethelia-Diversocallis*, serpulide worms, sesile bryozoans, hydrozoans and less the above mentioned neotrocholine and trocholine associations. The proposed microfacial and biofacial characterization suggests that the described limestones still retain typical features of the Upper Tithonian complex of the Štramberk Limestones.

Similar facial control of *Protopeneroplis trochangulata* occurences in environmental zones of carbonate platform was shown also by Septfontaine (1974, 1980); Chiocchini — Mancinelli (1979) and others.

Stratigraphic interpretation of Protopeneroplis trochangulata SEPTFONTAINE in the Štramberk carbonate platform and their broader regional and paleogeographic context

Species *Protopeneroplis trochangulata* SEPTFONTAINE was originally described from the Calcaire de Thoiry Formation in southern Jura (Ain, France) near Geneva which belongs to Berriasian (Septfontaine, 1974). *Protopeneroplis trochangulata* occurs in the same stratigraphic level in near region of High Savoy (Monte Salève, France — Septfontaine, 1974; Salvini-Bonnard — Zaninetti — Charollais, 1984). The assemblages of *Protopeneroplis trochangulata* from the Middle East (Iran) are situated in the superposed layer of horizon with Tithonian calpionellids which is roughly limiting their age to Berriasian (Septfontaine, 1974). Brönnimann et al. (1972 presents redeposed protopeneroplide foraminifers of trochangulata type in association with Neocomian calpionellids in the Galestrino flysch series in southern Italy. The rules of vertical distribution of *Protopeneroplis trochangulata* were used to limit Berriasian—Lower Valanginian biozone in Sardinia (Azéma et al., 1977) and Berriasian—Valanginian subzone in the Gran Sasso region in Italy (Chiocchini — Mancinelli, 1978, 1979). Recently the occurrences of *Protopeneroplis trochangulata* have been detected also in Reşiţa—Moldova Nuovă zone in the Southern Carpathians (Bucur, 1985, 1986) in assemblages

of the terminal part of Marila Limestones (Lower—Middle Berriasian up to Lower Valanginian). The presented data suggest that the interval of the *Protopeneroplis trochangulata* occurrences is in interregional measure limited to Berriasian—Lower Valanginian.

The rules of vertical distribution of protopeneroplide foraminifers in the Štramberk carbonate platform sequences were derived from the known course of calpionellid zones (determinations and data on calpionellid zonation were rendered by V. H o u š a). The occurrences of protopeneroplids were from time to time detected already in *Chitinoidella* and *Crassicollaria* biozones, however these forms in spite of clear tendency to trochospiral coiling still show relics of striae and pustules on the hyaline layer surface, and so they belong to species *Protopeneroplis striata* (Fig. 2, Pl. 3, Figs. 10—12). Clear appearance of *Protopeneroplis trochangulata* falls within *Calpionella alpina* biozone which according to Rome standard zonation corresponds to Uppermost Tithonian and Lower Berriasian (A l l e m a n n et al., 1971). This is connected with the basic problem of stratigraphic interpretation of the Štramberk specimens of *Protopeneroplis trochangulata*. The limestones of Štramberk cycle were for the absence of persuasive Cretaceous fossils, but first of all with regard to Rome position of *Calpionella* Standard Zone, assigned only to Upper Tithonian by H o u š a (1978, 1983, etc.). However, following the latest re-arrangement of biostratigraphic ranges of calpionellid zones in Sümeg 1984 (R e m a n e et al., 1986; N a g y, 1986; P o p, 1986, etc.) the zone of *Calpionella alpina* is assigned to Lower Berriasian and hte boundary Tithonian/Berriasian is identified with that of *Crassicollaria*/*Calpionella* zones. Regarding such a conception of *Calpionella alpina* biozone the occurrences of *Protopeneroplis trochangulata* in limestones of the Štramberk succession appears natural and well-founded. It confirms Berriasian age of a certain part of the Štramberk sequence. Ephemeral appearance of rich finds of *Protopeneroplis trochangulata* in the Štramberk carbonate platform shows however a well-defined acme-zone which has its functional parastratigraphic place in facial developments missing calpionellids. The acme-zone of *Protopeneroplis trochangulata* is defined as a biostratigraphic unit of benthic foraminifers in upper carbonate platform-stage of sedimentary area of the Baška cordillera (sensu E l i á š — E l i á š o v á, 1984, 1986). Its preliminary chronostratigraphic range is Lower to Middle Berriasian.

A survey of known occurrences of *Protopeneroplis trochangulata* (Fig. 3) suggest their spatial distribution in carbonate platforms of Tethyan shelfs along Eurasian margins as well as in the Apulia microplate (Fig. 4). The occurrence of *Protopeneroplis trochangulata* from the Štramberk carbonate platform completes the chain of occurrences of this species along Eurasian margins (Sardinia, Jura Mts., Helvetic — Dauphiné zone of the Western Alps, Getic domain of the Southern Carpathians and Iran) with nearly the same paleogeographic position, time level and tectonofacial setting of its appearance. This parallelization takes a certain concrete expression in views on joining of equivalent zones of Alps and Western Carpathians. Following it the paleogeographic position of the Štramberk carbonate platform (and generally the whole sedimentary area of Silesian unit as well) should corespond to that of the Jura Mts., and or Helvetic—Dauphiné belt of the Western Alps. Corresponding positions of both belts are obvious not only from similar historical sequences and material filling of their pre-Cretaceous cycles of sedimentation (belonging to cratonized massifs

of platform margin which show only epicontinental development of Triassic to Middle Jurassic or they were even an archipelago in this period, Malm downcast with successive or transgressive "superimposing" of shallow-water or at most hemipelagic sediments of Upper Jurassic, late rejuvenation of substrates, similarity of Upper Jurassic biofacies, mixing of Tethyan and boreal fauna elements, etc.) but also from synchronous Late Kimmerian upheaval movements indicated by Purbeck regressions, facial changes or strong development

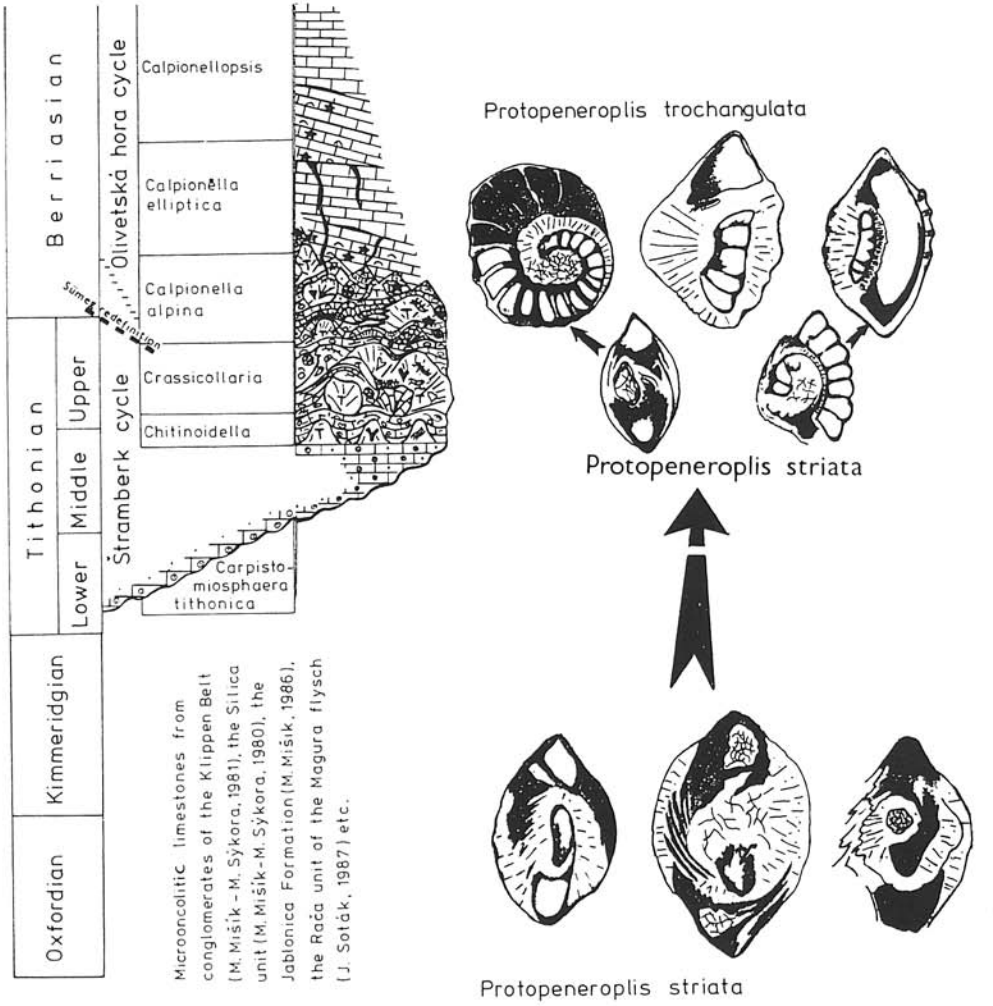


Fig. 2. Evolutionary scheme of successive species of the genus *Protopeneroplis* in Upper Jurassic and Lower Cretaceous of the Western Carpathians. Generalized profile of the Štramberk carbonate platform with the interphase of the Štramberk reef complex and overlying Olivetská hora Formation (type of particles drawn according to the legend by Wilson, 1975).

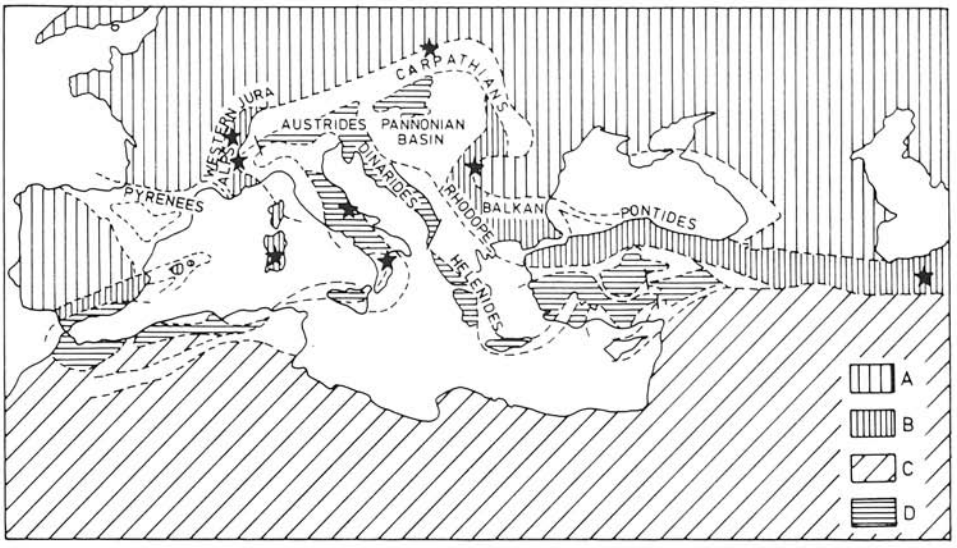


Fig. 3. Geographic distribution of *Protopeneroplis trochangulata* occurrences in Tethyan domain (base map of Mediterranean Tethys adapted according to R i c o u et al., 1986.)

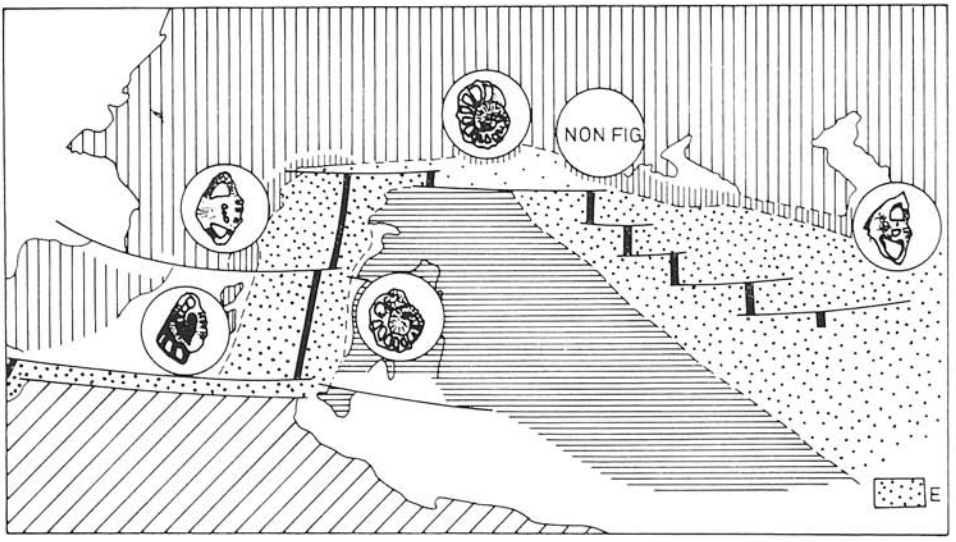


Fig. 4. Distribution of *Protopeneroplis trochangulata* in carbonate platforms of Tethyan shelfs along Eurasian margins and on the Apulia microplate (distribution of continental and oceanic components of Tethyan system in Lower Cretaceous taken from H o m e w o o d, 1983).

Explanations: A. Foreland of European continent; B. Tethyan shelfs of European continent; C. Foreland of African continent; D. Shelf dependences of African continent (Apulia); E. Oceanic basins.

of breccia horizons (e.g. in Helveticum — Furrer, 1950; Mayne, 1938; Trümpy, 1960, 1971, etc.). The outline of the Štramberk carbonate platform development corresponds to this conception. These relations were pointed out by Eliáš—Eliášová (1984) by comparison of "accumulations" of the Štramberk Limestone with Helveticum breccias and were correctly interpreted in syntheses by Lešku—Varga (1980); Prey (1965, 1978); Mahel' (1981) etc.

Other occurrences of Protopeneroplis trochangulata SEPTFONTAINE in the Western Carpathians

In the Western Carpathians region foraminifers of *Protopeneroplis trochangulata* appeared besides the Štramberk carbonate platform in three secondary occurrences. They were found in limestone pebbles with *Triploporella? neocomiensis* RADOIČIĆ, *Salpingoporella aff. melitae* RADOIČIĆ and *Anchispirocyclina lusitanica* (EGGER) in the Milovice locality (conglomerates of Ždánice unit, Outer Western Carpathians), pebbles of algal-foraminiferal limestones in the Beňatina locality (Paleogene conglomerates of the Klippen Belt in Eastern Slovakia — personal contact with M. Mišík and M. Sýkora) and pebbles of algal-foraminiferal limestones in the Mernik conglomerates in Eastern Slovakia (conglomerate formation of indefinite age). All other mentioned limestone clasts are supposed to belong to Berriasian—Lower Valanginian.

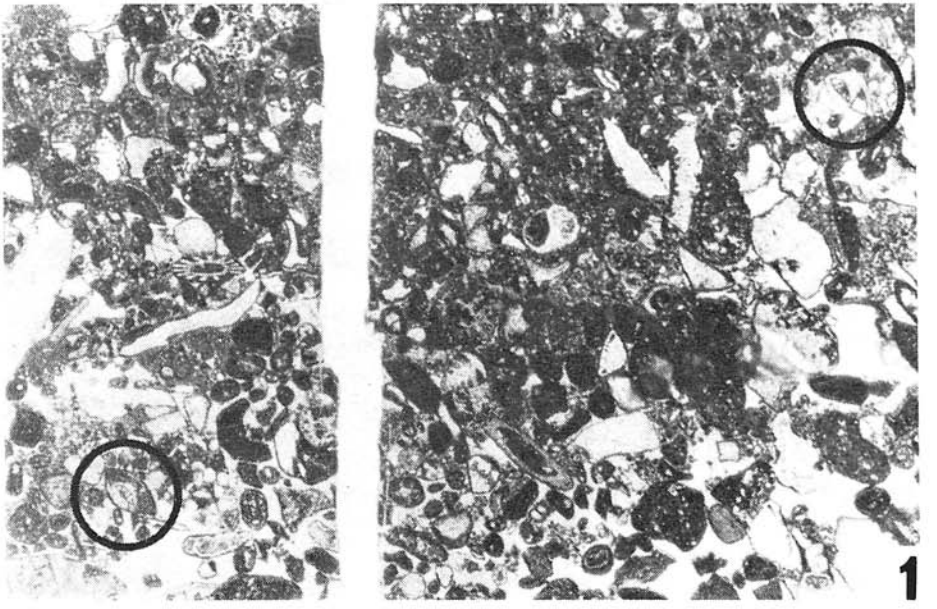
Conclusion

There was traced the change of successive species *Protopeneroplis striata* — *Protopeneroplis trochangulata* in the evolution of protopeneroplide foraminifers of the Štramberk carbonate platform. Temporal breaking of protopeneroplide phylogenetic line arose at the limit of calpionellid zones *Crassicollaria Calpionella* which is according to the meeting in Sümeg (1984) identified with the boundary Tithonian Berriasian. The development of *Protopeneroplis trochangulata* assemblages falls within the biozone *Calpionella alpina* and was supported by a change of paleogeographic regime of sedimentation in the upper platform stage of the Štramberk cycle (preferential bond to basinal intraplatform niches). Stratigraphic evaluation of rich occurrences of *Protopeneroplis trochangulata* in limestones of the Štramberk carbonate platform thus required the need to limit a separate acme-zone of Lower up to Middle Berriasian. The acme-zone of *Protopeneroplis trochangultata* represents the first biostratigraphic unit of benthic microorganisms in shallow-water Lowermost Cretaceous of sedimentary area of the Baška cordillera which seems to be more useful for age identification of limestone clasts from the derived sequences of strata of the other Western Carpathians cordilleras.

Acknowledgement: My acknowledgements are due to RNDr. Václav Houša, CSc. for his rendering thin sections for the study of protopeneroplide foraminifers, precious suggestions, consultation and interest in the problem under study.

Translated by M. Spišiaková

Plate 1



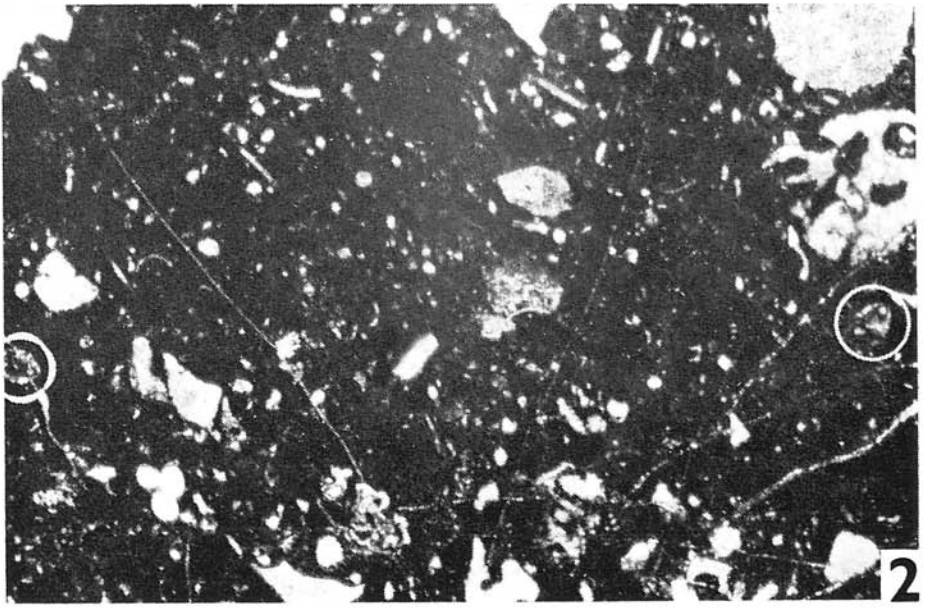


Plate 2

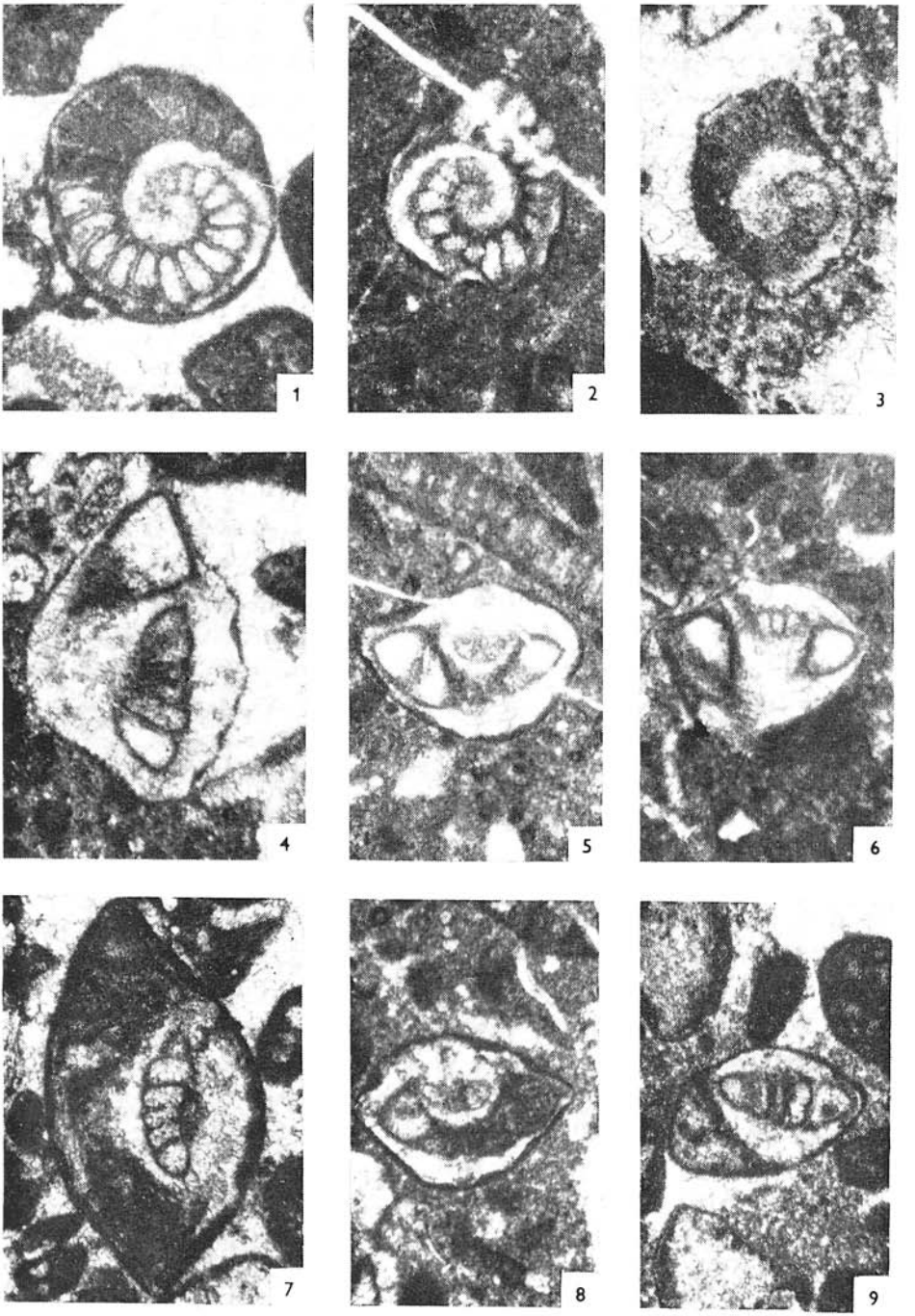


Plate 4

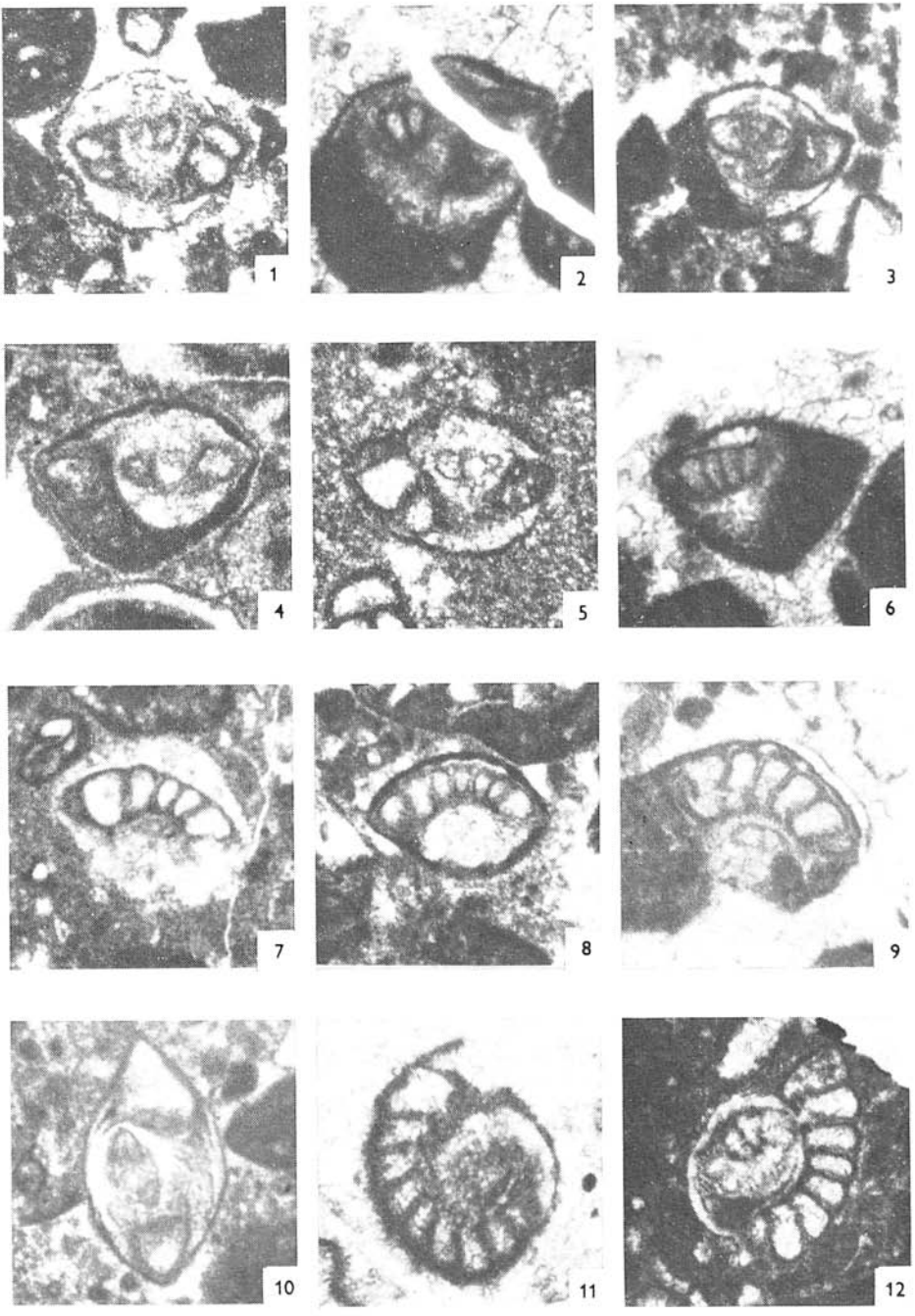


Plate 3

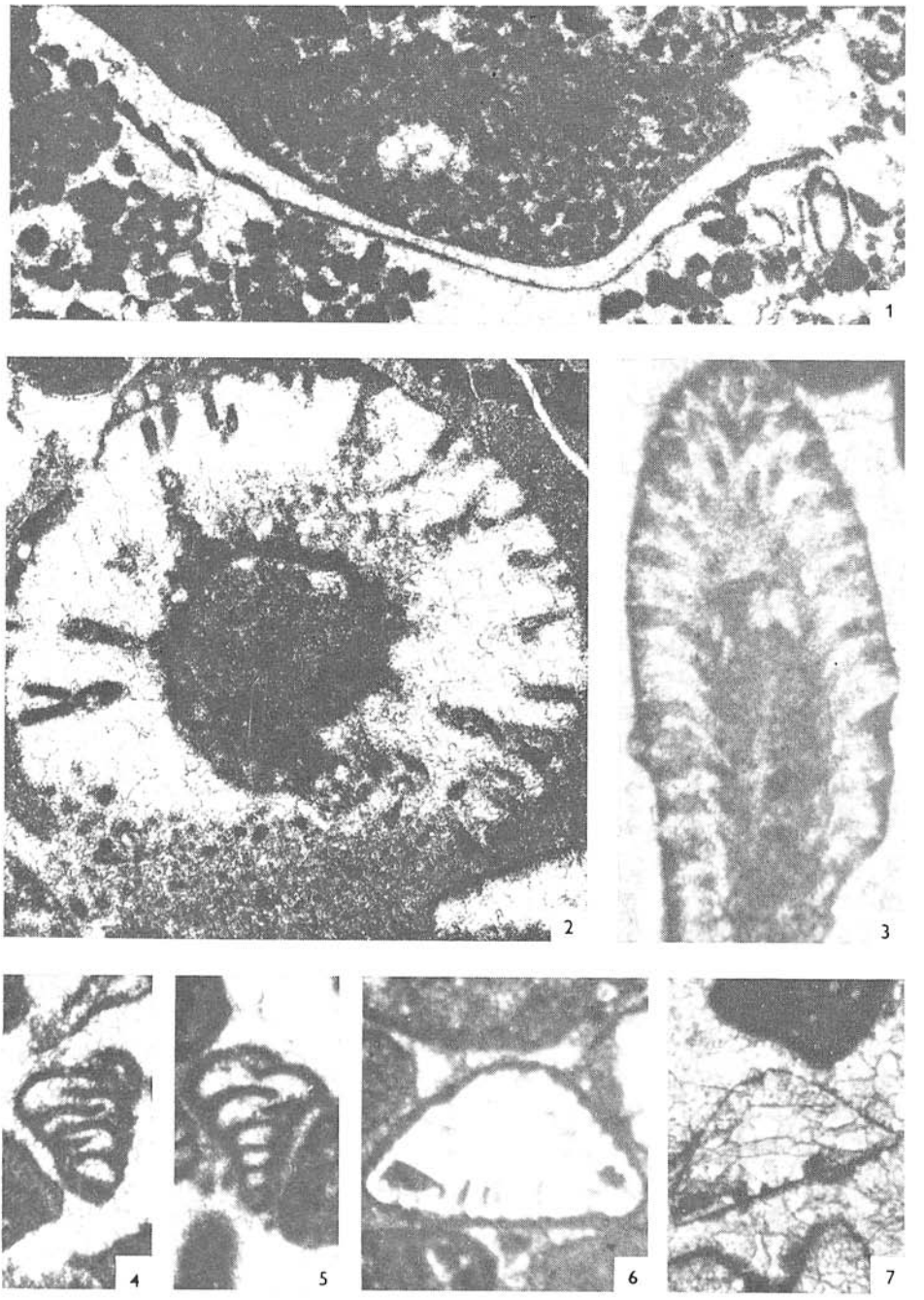


Plate 1

Fig. 1. — Packestone (washed biosparite) with *Protopeneroplis trochangulata* (tests in the middle of black circles), *Neotrocholina valdensis*, *Trocholina alpina*, microgastropods, echinoid spines, etc.; Obecní lom quarry, thin sec. No OV 145, Lower to Middle Berriasian. Magnif. 7 ×.
Fig. 2. — Bioclastic wackestone with *Protopeneroplis trochangulata* (tests in white circles), skeletal segments of echinoderms, hydrozoans fragments, etc.; Obecní lom quarry, thin sec. No OV 73, Lower to Middle Berriasian. Magnif. 14 ×. (Photo by F. Martančík)

Plate 2

Figs. 1–9 — *Protopeneroplis trochangulata* SEPTFONTAINE, 1974 — Štramberk carbonate platform (Outer Western Carpathians), Lower to Middle Berriasian. Magnif. 52 ×.
Figs. 1–3 — equatorial sections; Fig. 1. Obecní lom quarry, thin sec. No OV 70; Fig. 2. Obecní lom quarry, thin sec. No OV 73; Fig. 3. Obecní lom quarry, thin sec. No OV 140.
Figs. 4–9 — subaxial sections; Fig. 4. Obecní lom quarry, thin sec. No OV 145; Fig. 5. Obecní lom quarry, thin sec No OV 73; Fig. 6. Obecní lom quarry, thin sec No OV 145; Fig. 7. Obecní lom quarry, thin sec. No OV 145; Fig. 8. Kotouč quarry, thin sec. No KV 1322; Fig. 9. Kotouč quarry, thin sec. No KV 722.
(Photo by J. Soták)

Plate 3

Figs. 1–9 — *Protopeneroplis trochangulata* SEPTFONTAINE 1974 — Štramberk carbonate platform (Outer Western Carpathians), Lower to Middle Berriasian. Magnif. 52 ×.
Figs. 1–6 — subaxial sections; Fig. 1. Kotouč quarry, thin sec. No KV 907; Fig. 2. Obecní lom quarry, thin sec. No OV 32; Fig. 3. Jurův kámen locality, thin sec. No KV 860; Fig. 4. Dolní Skála locality, thin sec. No SV 29; Fig. 5. Obecní lom quarry, thin sec. No OV 147; Fig. 6. Kotouč quarry, thin sec. No KV 188.
Figs. 7–9 — subtangencial sections (ventrolaminide types); Fig. 7. Obecní lom quarry, thin sec. No OV 40; Fig. 8. Kotouč quarry, thin sec. KV 686; Fig. 9. Dolní Skála locality, thin sec. No SV 65.
Fig. 10. — *Protopeneroplis striata* WEYNSCHENK, 1950 — Štramberk reef complex (Outer Western Carpathians), upper part of Middle Tithonian — lower part of Upper Tithonian (*Chitinoidella* zone), subaxial section; Kotouč quarry, thin sec. No KV 911. Magnif. 52 ×.
Figs. 11–12 — *Protopeneroplis* cf. *striata* WEYNSCHENK, 1950 — Štramberk reef complex (Outer Western Carpathians), Upper Tithonian, equatorial sections; Fig. 11. Kotouč quarry, thin sec. No 832; Fig. 12. Kotouč quarry, thin sec, No KV 908b. Magnif. 52 ×.
(Photo by J. Soták)

Plate 4

Figs. 1–7 — Microfossils accompanying of occurrences of *Protopeneroplis trochangulata* in limestones of Štramberk carbonate platform (Outer Western Carpathians), Lower to Middle Berriasian. Fig. 1. *Campbeliella striata* (CAROZZI), axial section through amphora-like whorl: Obecní lom quarry, thin sec. No OV 73. Magnif. 26 ×; Fig. 2. *Linoporella capriotica* (OPPENHEIM), transversal section through thallus; Dolní Skála locality, thin sec. No SV 56. Magnif. 35 ×; Fig. 3. *Salpingoporella pygmaea* (GÜMBEL), almost axial section through thallus; Obecní lom quarry, thin sec. No OV 44. Magnif. 52 ×; Fig. 4–5. *Valvulina aff. lugeoni* SEPTFONTAINE, axial sections; Kotouč quarry, thin sec. No KV 722, No KV 673. Magnif. 52 ×; Fig. 6. *Neotrocholina valdensis* REICHEL, axial sections; Obecní lom quarry, thin sec. No 145. Magnif. 52 ×; Fig. 7. *Neotrocholina friburgensis* (GUILLAUME et REICHEL), axial section; Jurův kámen locality, thin sec. No KV 860. Magnif. 52 ×.
(Figs. 1–2 photo by F. Martančík; Figs. 3–7 photo by J. Soták.)

REFERENCES

ALLEMANN, F. — CATALANO, R. — FARÈS, F. — REMANE, J., 1971: Standard calpionellid zonation (Upper Tithonian—Valanginian) of the western Mediterranean Province. Proc. II Plankt. Conf., Roma 1970, 2, pp. 1337—1340.

AZÉMA, J. — CHABRIER, G. — FOURCADE, E. — JAFFREZO, M., 1977: Nouvelles données micropaleontologiques, stratigraphiques et paléogeographiques sur le Portlandian et le Néocomien de Sardaine. Rev. Micropaléont. (Paris), 20, 3, pp. 125—139.

BRÖNNIMANN, P. — DURAND-DELGA, M. — GRANDJACQUET, C., 1972: Présence simultanée de Protopeneroplis striata Weynschenk et de Calpionelles neocomiennes dans le Flysch Galestrino de Lucanie (Italie méridionale). Rev. Micropaléont. (Paris), 14, 5, pp. 96—101.

BUCUR, I. I., 1985: Permocalculus dragastani, sp. nov. (Algues Rhodophycees, Gymnocodiacees) dans les du Crétacé inférieur de la zone de Reşiţa-Moldova Nouă (Banat, Roumanie). Rev. Paléobiologie (Genève), 4, 2, pp. 203—209.

BUCUR, I. I., 1986: Les foraminifères du Crétacé inférieur (Berriasien—Hauterivien) de la zone de Reşiţa-Moldova Nouă (Carpathes Méridionales, Roumanie). Remarques biostratigraphiques. 3éme Symposium International sur les Foraminifères Benthiques, Resumes, (Genève), pp. 29—39.

CHIOCCHINI, M. — MANCINELLI, A., 1978: Ricerche geologiche sul Mesozoico del Gran Sasso d'Italia. III. Correlazioni microbiostratigrafiche tra facies di margine della piattaforma carbonatica e facies pelagiche del Giurassico e Cretaceo inferiore. Studi Geologici Camerti, 4, pp. 19—36.

CHIOCCHINI, M. — MANCINELLI, A., 1979: Protopeneroplis trochangulata Septfontaine, 1974 (Foraminiferida) nel Cretaceo inferiore dell'Area del Gran Sasso d'Italia (Abruzzo). Studi Geologici Camerti, 5, pp. 17—37.

ELIÁŠOVÁ, H., 1975: Sous-ordre Amphiastraeina Alloiteau, 1952 (Hexacorallia) des calcaires de Štramberk (Tithionen, Tchécoslovaquie). Čas. Mineral. Geol. (Praha), 20, 1, pp. 1—23.

ELIÁŠOVÁ, H., 1978: La redéfinition de l'ordre Hexanthiniaria Montanaro Gallitelli, 1975 (Zoantharia). Věst. Ústř. Úst. geol. (Praha), 53, 2, pp. 89—101.

ELIÁŠOVÁ, H., 1981a: The Tithionian reef of Štramberk Limestone (Czechoslovakia, West Carpathians). Čas. Mineral. Geol. (Praha), 26, 2, pp. 113—124.

ELIÁŠOVÁ, H., 1981b: Some binding microorganisms of the Štramberk reef limestones (Tithionan, Czechoslovakia). Věst. Ústř. Úst. geol. (Praha), 56, 1, pp. 27—32.

ELIÁŠ, M. — ELIÁŠOVÁ, H., 1984: Facies and palaeogeography of the Jurrasic in the western part of the Outer Flysch Carpathians. Sbor. geol. Věd, Geol. (Praha), 39, pp. 105—170.

ELIÁŠOVÁ, H., 1985: Muranella and Fusanella, algae incertae sedis with spherulitic skeletal microstructure (Tithonian of the Outer Flysch Carpathians, Czechoslovakia). Západ. Karpaty, Sér. Paleont. (Bratislava), 10, pp. 75—84.

ELIÁŠOVÁ, H., 1986: A new binding microorganisms of shallow-water limestones. Věst. Ústř. Úst. geol. (Praha), 61, 2, pp. 109—111.

ELIÁŠ, M. — ELIÁŠOVÁ, H., 1985: New biostratigraphic material from the Mesozoic of the Flysch Carpathians and their foreland. Věst. Ústř. Úst. geol. (Praha), 60, 2, pp. 105—106.

ELIÁŠ, M. — ELIÁŠOVÁ, H., 1986: Elevation facies of the Malm in Moravia. Geol. Zbor. Geol. carpath. (Bratislava), 37, 4, pp. 533—550.

FURRER, H., 1950: Die Tithon-Berriasbreccien vom Hahnenmoospass SW Adelboden (Berner Oberland), Ultrahelvetikum der Sattelzone. Eclogae geol. Helv. (Basel), 43, pp. 160—166.

HOMEWOOD, P., 1983: Palaeography of Alpine flysch. Palaeogr., Palaeoclimatol., Palaeoecol. (Amsterdam), 44, pp. 169—184.

HOUŠA, V., 1965: Výplně rozsedlin ve štramberském vápenci. Čas. Mineral. Geol. (Praha), 10, 4, pp. 381—389.

HOUŠA, V., 1974: Stopy vrtavé činnosti organismů a výskyty epifauny na povrchu štramberských a olivetských vápenců ve Štramberku. Čas. Mineral. Geol. (Praha), 19, 4, pp. 403—414.

HOUŠA, V., 1976: Spodnokřídové formace doprovázející tělesa tithonských vápenců u Štramberka. Čas. Slez. Mus. (Opava), Vědy přír., A, 25, 1, pp. 129—131.

HOUŠA, V., 1978: Kalpionely štramberského tithónu a spodní křídy. Zem. Plyn Nafta (Hodonín), 23, 4a, pp. 525—531.
HOUŠA, V., 1979: Geologická stavba a stratigrafie těles štramberského vápence a geneticky s ním těsně svázaných spodnokřídových hornin v okolí Štramberka. In: Menčík, E. et al., 1983: Geologie Moravskoslezských Beskyd a Podbeskydské pahorkatiny. Ústř. Úst. geol. (Praha), pp. 5—304.
HOUŠA, V., 1981: Společenstva vrtavých organismů a epifauny na stěnách rozsedlin a balvanů ve spodní křídě Štramberka (exkl. Brachiopoda) a jejich význam pro rekonstrukci geologického vývoje bašské elevace. MS, Úst. geol. a geotech. Čs. akad. věd., Praha.
HOUŠA, V., 1983: Vznik těles štramberského vápence u Štramberka. Věst. Ústř. Úst. geol. (Praha), 58, 4, pp. 193—203.
LEŠKO, B. — VARGA, I., 1980: Alpine elements in the West Carpathian structure and their significance. Miner. slov. (Bratislava), 12, 2, pp. 97—130.
LUPERTO SINNI, E., 1969: Presenza di Protopeneroplis striata Weynschenk in alcuni strati di calcari oolitici del Gargano. Boll. Soc. Nat. Napoli (1968), 77, 1, pp. 227—233.
MAHEĽ, M., 1981: Penninikum v Západných Karpatoch z pohľadu globálnej tektoniky. Miner. slov. (Bratislava), 13, 4, pp. 289—306.
MAYNC, W., 1938: Die Grenzschichten von Jura und Kreide in der Titliskette.Eclogae geol. Helv. (Basel), 37, 1, p. 100.
MIŠÍK, M., 1986: Petrographic-microfacial analysis of pebbles and interpretation of sources areas of the Jablonica conglomerates (Lower Miocene of the NW margin of the Malé Karpaty Mts.). Geol. Zbor. Geol. carpath. (Bratislava), 37, 4, pp. 405—443.
MIŠÍK, M. — SÝKORA, M., 1980: Jura der Silica Einheit, rekonstruiert aus Geröllen und oberkretazischen Süsswasserkalke der Gemerikums. Geol. Zbor. Geol. carpath. (Bratislava), 31, 3, pp. 239—261.
MIŠÍK, M. — SÝKORA, M., 1981: Der pieninische exotische Rücken, rekonstruiert aus Geröllen karbonatischer Gesteine kretazischer Konglomerate der Klippenzone und der Manín-Einheit. Západ. Karpaty, Sér. Geol. (Bratislava), 7, pp. 7—111.
MIŠÍK, M. — SÝKORA, M., 1982: Allodaptische Barmsteinkalke in Malm des Gebirges Čachtické Karpaty. Geol. Zbor. Geol. carpath. (Bratislava), 33, 1, pp. 51—78.
NAGY, I., 1986: Investigation of Calpionellides from the Mecsek Mountains (S. Hungary). Acta Geol. Hung. (Budapest), 29, 1—2, pp. 45—64.
POP, Gr., 1986: Calpionellids and correlation of Tithonian — Valanginian formations. Acta Geol. Hung. (Budapest), 29, 1—2, pp. 93—102.
PREY, S., 1965: Vergleichende Beitrachtungen über Westkarpaten und Ostalpen im Anschlussen Exkursionen in die Westkarpaten. Verh. Geol. Bundesanst. (Wien), 1—3, pp. 39—107.
PREY, S., 1978: Rekonstruktionsversuch der alpidischen entwicklung der Ostalpen. Mitt. Österr. geol. Gesell. (Wien), 69, pp. 1—25.
REISS, Z., 1958: Protopeneroplis striata Weynschenk from the Jurassic of Israel. Bull. geol. Surv. Israel (Jerusalem), 17, pp. 8—10.
ŘEMANE, J. — BAKALOVA-IVANOVA, D. — BORZA, K. — KNAUER, J. — NAGY, I. — POP, Gr. — TARDI-FILÁCZ, E., 1986: Agreement on the subdivision of the standard calpionellid zones defined at the II[nd] Planktonic Conference, Roma 1970. Acta Geol. Hung. (Budapest), 29, 1—2, pp. 5—14.
RICOU, L. E. — DERCOURT, J. — GEYSSANT, J. — GRANDJACQUET, C. — LEPVRIER, C. — BIJU-DUVAL, B., 1986: Geological constraints on the Alpine evolution of the Mediterranean Tethys. Tectonophysics (Amsterdam), 123, pp. 83—122.
SALVINI-BONNARD, G. — ZANINETTI, L. — CHAROLLAIS, J., 1984: Les Foraminifères dans le Crétacé inférieur (Berriasien moyen — Valanginien inférieur) de la région de la Corraterie, Grand-Salève (Haute-Savoie, France): Inventaire préliminaire et remarques stratigraphiques. Rev. Paléobiologie (Genève), 3, 2, pp. 175—184.
SEPTFONTAINE, M., 1974: Présence de Protopeneroplis trochangulata sp. nov. (Foraminifére) dans le Crétace inférieur du Jura Méridional et révision de Protopeneroplis Weynschenk, 1950. Eclogae geol. Helv. (Basel), 67, 3, pp. 605—628.
SEPTFONTAINE, M., 1980: Les foraminifères imperforés des milieux de plate-forme au Mésozoique: détermination pratique, interprétation phylogénétique et utilisation biostratigraphiques. Rev. Micropaléont. (Paris), 23, 3/4, pp. 169—203.

SOTÁK, J., 1981: Mikrofaciálny a biofaciálny výskum mezozoika cetechovického sedimentačného priestoru. MS, Katedra geol. a paleont. PF UJEJ, Brno.
SOTÁK, J., 1987: On distribution of Dasycladacean algae in the Jurassic and Lower Cretaceous shallow water limestones from products of the Silesian cordillera (Outer Western Carpathians). Miscellanea Micropalaeontologica, (Hodonín).
STEINMANN, G., 1903: Tetraplorella remesi, eine neue Dasycladacea aus dem Tithon von Stramberg. Beitz. Paläont. Geol. Öster-Ung. Or. (Wien und Leipzig), XV, II—III, pp. 45—54.
TRÜMPY, R., 1969: Paleotectonic evolution of central and western Alps. Bull. Geol. Soc. Amer. (Chicago), 71, pp. 843—908.
TRÜMPY, R., 1971: Sur le Jurassique de la zone helvétique en Suisse. Ann. Inst. Geol. Publ. Hung. (Budapest), LIV, 2, pp. 369—382.
WILSON, J. L., 1975: Carbonate facies in Geologic history. Springer Verlag, Berlin — Heidelberg — New York.

Manuscript received July 6, 1987.