

ZÁPADNÉ KARPATY

CS ISSN 0139—7435

SÉRIA

paleontológia 14

GEOLOGICKÝ ÚSTAV DIONÝZA ŠTÚRA, BRATISLAVA 1990

ZÁPADNÉ KARPATY

Séria

Paleontológia 14

NEPREDAJNÝ VÝTIAČOK

Vedecký redaktor

RNDr. ONDREJ SAMUEL, DrSc.

Redakčný okruh

RNDr. J. GAŠPARIK, CSc., RNDr. A. ONDREJČKOVÁ, CSc., RNDr. EVA PLANDEROVÁ, CSc.,
RNDr. MILOŠ RAKÚS, CSc.

ZÁPADNÉ KARPATY

SÉRIA

paleontológia 14

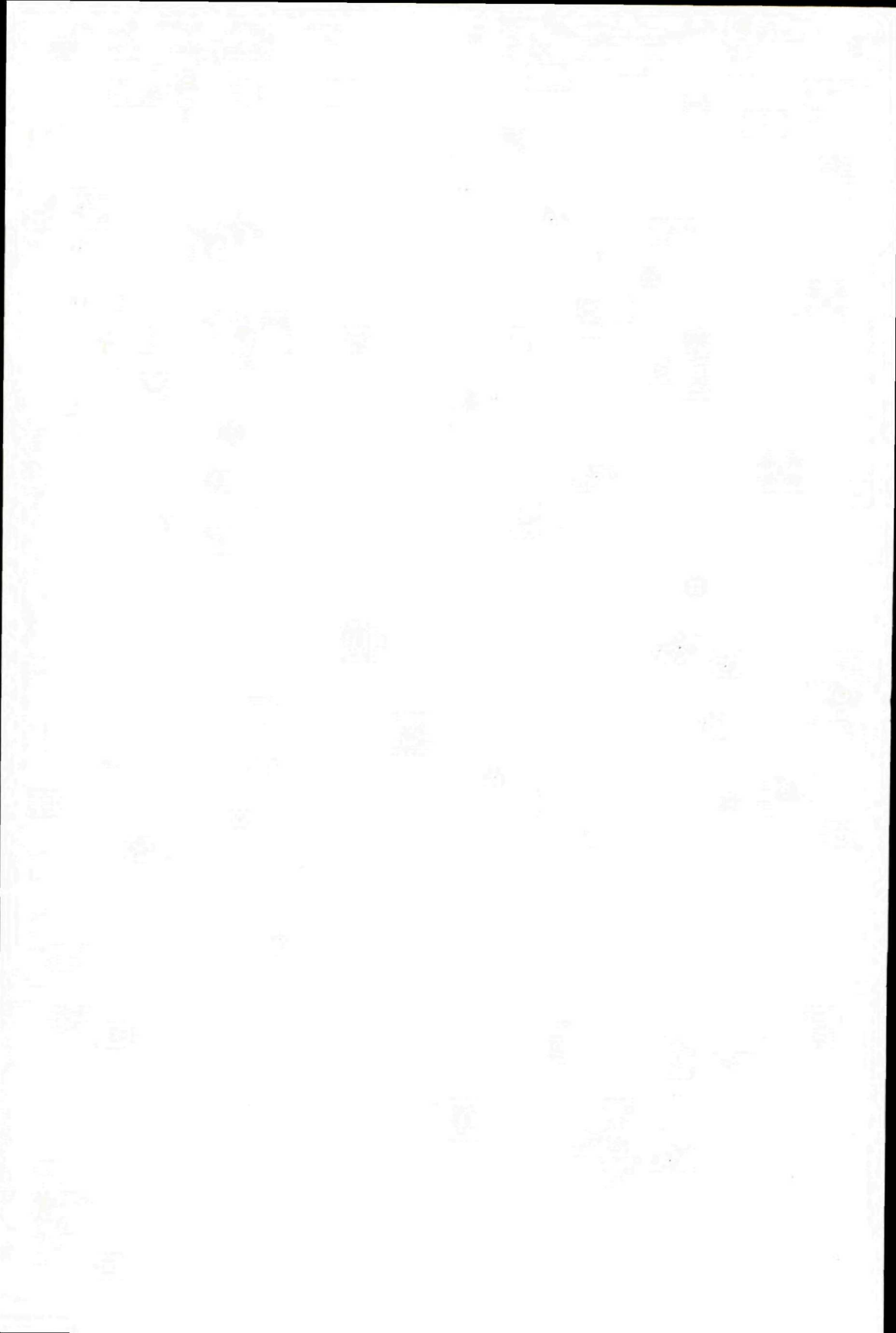
Geologický ústav Dionýza Štúra
ODBOROVÉ INFORMACNÉ STREDISKO
Mlynská dolina 1
817 04 BRATISLAVA

GEOLOGICKÝ ÚSTAV DIONÝZA ŠTÚRA, BRATISLAVA 1990

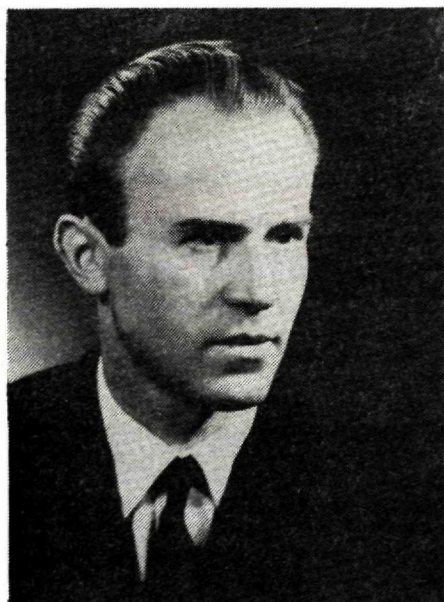
Geologický ústav Dionýza Štúra	
KNIŽNICA, Bratislava	
Signatúra:	1B104 b
kat. čís.:	501/1490
Kčs kúpa:	24.-
vým.:	—
ROP:	—

Content

SAMUEL, O.: Na rozlúčku s akademikom Vladimírom Pokorným	7
SAMUEL, O.: Foraminifers and microbiostratigraphy of Central-Carpathian Paleogene of Bánovská kotlina depression — Foraminifery a mikrobiostratigrafia centrálnokarpatského paleogénu Bánovskej kotliny	11
SALAJ, J.: Problematic age of Lower-Cretaceous foraminiferal zone Leupoldina cabri — Problematika vekového rozsahu spodnokriedovej foraminiferovej zóny Leupoldina cabri	21
VAŇOVÁ, M.—KANAFANI, H.: Paleontological Characteristics of Reticulate Nummulites from the Areas of Damascus and Dmer (Syria) — Paleontologická charakteristika numulitov so sieťovou ozdobou povrchu z okolia Damašku a Dmeru (Sýria)	27
BYSTRICKÁ, H.: The first finding of Rupelian nannoflora in the Turčianska kotlina depression — Vápnitá nanoflóra paleogénu Turčianskej kotliny	47
SUTOVSKÁ, K.: Biometrical characteristics of discoliths Pontosphaera ex gr. multipora Kamptner (Roth) 1970, Egerian of the SE part of the Rimava basin, southern Slovakia; paleoecological (and taxonomical) aspects — Biometrické charakteristiky diskolitov Pontosphaera ex gr. multipora Kamptner (Roth) 1970 z egeru jv. časti Rimavskej kotliny; paleoekologické a taxonomické aspekty	57
KONZALOVÁ, M.: Palynological investigation of the basal Tertiary sediments (Paleogene) in western Bohemia and their correlation with the Carpathian region — Palynologický výzkum bazálních třetihorných sedimentu v západních Čechách a jejich korelace s karpatskou oblastí	73
SIBLIK, M.: New Schwagerispira (Brachiopoda) from the Carnian of the Slovak Karst (SE Slovakia) — Nový druh rodu Schwagerispira (Brachiopoda) z karnu Slovenského krasu (jv. Slovensko)	103
PLÍČKA, M.—NĚMCOVÁ, A.—SIRÁŇOVÁ, Z.: Two New Trace Fossils in the Czechoslovak Carpathian Flysch — Results of the Activity of Eel-like Fish (Anquilliformes) — Dvě nové fosilní stopy v karpatském flyši v Československu — výsledek činnosti mořských úhořovitých ryb (Anquilliformes)	109
PLÍČKA, M.—THOMKA, V.: Halimedaites carpaticus gen. n. sp. n., "Body Fossil" from the Carpathian Flysch of Czechoslovakia — Halimedaites carpaticus gen. n. sp. n., "Body Fossil" from the Carpathian Flysch of Czechoslovakia — Halimedaites carpaticus gen. n. sp. n., "Body Fossil" z karpatského flyše v Československu	125



Na rozlúčku s akademikom Vladimírom Pokorným (12. 6. 1922—21. 7. 1989)



Dňa 21. júla 1989 sme sa rozlúčili s profesorom, akademikom Vladimírom Pokorným, doktorom geologických vied, na jeho poslednej ceste, ktorá ukončila bohatý, čínorodou prácou naplnený, teplom jeho srdca ohrievaný život. Jeho osobnosť, úprimný priateľský vzťah k ľuďom, svojim priateľom, spolupracovníkom a žiakom robí ho nezabudnuteľným, navždy živým v pamäti tých, čo ho poznali.

Akademik Vladimír Pokorný sa narodil 12. júna 1922 v Podivíne na Morave, kde navštevoval obecnú školu. Štátne reformné reálne gymnázium absolvoval v Břeclave a v Hodoníne. Počas celého gymnaziálneho štúdia patril medzi najschopnejších študentov a všetky ročníky i s maturitou absolvoval s vyznamenaním. Po maturite v období ne-

meckej okupácie pracoval v naftových závodoch, kde sa prvýkrát stretol s mikropaleontológiou ako nedeliteľnou súčasťou pri výskume ropy a plynu. Zrejme tieto kontakty ovplyvnili aj jeho ďalšiu voľbu povolania. Hneď po skončení druhej svetovej vojny v roku 1945 sa zapísal na štúdium Prírodovedeckej fakulty Karlovej univerzity (PFUK) v Prahe, ktorú ukončil v roku 1948 s hodnosťou doktora prírodných vied (RNDr.). Už ako študent vzbudil pozornosť u profesorského zboru, ktorý ho odporučil na miesto asistenta PFUK. Už po dvojročnom pôsobení v roku 1950 bol menovaný za odborného asistenta, v roku 1953 sa stal štátnym docentom z odboru mikropaleontológie a v roku 1961 profesorom zoopaleontológie. Po smrti profesora Jozefa Augustu v roku 1968 prevzal vedenie katedry paleontológie a v tejto funkcii zotrval až do odchodu na dôchodok v roku 1986.

Popri pedagogickej činnosti bol vzorom aj vo vedeckej práci. V roku 1957 dosiahol hodnosť kandidáta geologických vied (CSc.) a v roku 1964 hodnosť doktora geologických vied (DrSc.)

Akademik Vladimír Pokorný ako vynikajúci vedec a pedagóg patrí k priekopníckej československej geologickej generácii, ktorá sa zlatými písmenami zapísala do dejín výskumu a rozvoja geologických vied v Československu a položila základy modernej geológie a biostratigrafie. Plodná výskumná činnosť akademika Vladimíra Pokorného, ktorú vykonal v Západných Karpatoch, je a dlho zostane zdrojom základných a trvalých informácií, na ktorých možno rozvíjať ďalší podrobný výskum hlavne v súvisi s riešením mikrobiostratigrafických problémov neogénnych sedimentov Viedenskej panvy, ako aj paleogénu pouzdrianskej, ždánickej a magurskej jednotky v oblasti flyšového pásma južnej Moravy.

Osobitnú pozornosť si zasluhujú taxonomické a stratigrafické výskumy ostrakódov vrchnej kriedy Českého masívu. Tieto práce majú zásadný význam nielen pre interregionálnu koreláciu, ale aj pre paleogeografickú rekonštrukciu kriedových paniev. Významným a na medzinárodnom fóre vyhľadávaným dielom je jeho monografická práca o vrchnojurských (? titón) ostrakódoch južnej Moravy. V tejto práci sa zaoberá predovšetkým taxonomickým a stratigrafickým zhodnotením ostrakódových spoločenstiev zo slieňov klenťníckych vrstiev.

V prácach z oblasti flyšového pásma južnej Moravy okrem biostratigrafie a paleontológie riešil aj batymetrické problémy. Na základe precíznej analýzy foraminiferových i ostrakódových asociácií prikláňal sa k názoru o hlbokomorskom pôvode flyšových sedimentov.

Ďalšiu sféru bádania akademika Vladimíra Pokorného možno charakterizovať ako rýdzo paleontologickú, zameranú predovšetkým na taxonómiu, vývoj a ekológiu mikroorganizmov. O precíznosti jeho výskumu najlepšie svedčí skutočnosť, že validita všetkých ním opísaných taxónov je podnes platná. Dominujúcim objektom jeho záujmu boli lastúrniky (Ostracoda). Ich štúdiu venoval podstatnú časť života. V tejto sfére sa stal medzinárodne uznávanou autoritou. Dielom „Základy zoologickej mikropaleontológie“ (Praha, 1954) sa zapísal medzi najpoprednejších znalcov vo svete v odbore systematiky a taxonómie ostrakódov a foraminifer. O vedeckej hodnote tohto diela najlepšie svedčí skutočnosť, že v prepracovanej a doplnenej verzii vyšlo v Nemeckej demokratickej republike (1958), v Anglicku (1975), v Nemeckej spolkovej republike, pričom určité časti boli uverejnené aj v mikropaleontologických učebniciach v ZSSR a USA. Jednou z osobitných črt uvedeného diela je, že vychádzal z biologickej podstaty fosílií. Práve na základe tohto aspektu umocneného citlivým, až otcovským prístupom pedagóga k mladým adeptom paleontológie položil základy mikropaleontologickej školy, presahujúcej rámec nášho štátu. Najlepším svedectvom toho bola výchova mnohých vynikajúcich mikropaleontológov a návšteva početných zahraničných bádateľov a študentov na katedre paleontológie PFKU.

Akademik Vladimír Pokorný okrem pedagogickej a výskumnej práce bol činný i v iných sférach. S jeho menom je úzko spojená činnosť geologicko-geografického kolégia ČSAV, ktorého bol od roku 1962 členom a v rokoch 1970—1979 jeho predsedom. Od roku 1978 až do roku 1987 zastával funkciu popredsedu prezidia našej vrcholnej vedeckej inštitúcie Československej akadémie vied. V rokoch 1960—1962 pôsobil ako externý riaditeľ novozriadeného Geologického ústavu ČSAV. Pracoval v rôznych komisiách a v redakčných radách našich (Časopis pro mineralogii a geologii) i zahraničných. Okrem už zmienených funkcií bol predsedom štátneho programu základného výskumu II, predseda federálnej komisie pre obhajoby doktorských dizertačných prác z odboru paleontológia a predseda komisie pre obhajoby kandidátskych dizertačných prác z tohože odboru. Až do svojej smrti bol členom komisie expertov pri Ministerstve školstva Českej a Slovenskej socialistickej republiky, ďalej členom viacerých vedeckých rád a rôznych komisií.

Za jeho obsiahlu vedeckú, pedagogickú i organizačnú činnosť bol zvolený v roku 1973 za člena korešpondenta a roku 1977 za akademika Československej akadémie vied. Bol autorom vyše 120 odborných publikácií a monografií; desiatok recenzií a početných populárno-vedeckých článkov.

Vedecká práca akademika Vladimíra Pokorného bola aj spoločensky ocenená štátnym vyznamenaním — cenou Klementa Gottwalda v roku 1960 a v roku 1971 zlatou čestnou plaketou F. Pošepného Československej akadémie vied, ďalej striebornou medailou Karlovej univerzity v roku 1971, Zlatou medailou Jána Evangelistu Purkyně a Radom práce.

Akademik Vladimír Pokorný zasvätil práci celý svoj život, pričom vytvoril veľké dielo, ktoré zostane trvalým pomníkom a bude slúžiť ďalším generáciám ako vzor húževnatej práce vedca a pedagóga, ktorý oddal celý svoj um a srdce vede a výchove. Za to všetko mu patrí naša úprimná vďaka a obdiv. Veľkosť osoby akademika Vladimíra Pokorného sa prejavila v skromnosti, pracovitosti, v zanietenosti o poznanie zákonitostí prírody, ktorú tak miloval a do lona ktorej sa vrátil.

Češť jeho pamiatke!

Ondrej Samuel

ONDREJ SAMUEL

Foraminifers and microbiostratigraphy of Central-Carpathian Paleogene of Bánovská kotlina depression

1 text-fig., 17 Pls. (I—XVII), Slovak summary

Abstract. The author is dealing with microbiostratigraphy of the Paleogene (Central-Carpathian) sedimentation cycle. Mostly planktic foraminifers proved a continuous sedimentation from the biozone P 11 — *Globigerinatheka subconglobata* to the Carpathian biozone *Globigerina postcretacea*, corresponding to biozones P 18 and P 19.

Introduction

The Central-Carpathian Paleogene in the Bánovská kotlina depression mostly crops out in marginal parts of the depression from below Miocene sediments. Paleogene sediments in this area were formerly only studied within the research of earlier mainly Mesozoic formations (MAHEL 1953, GAŠPARIK 1953). During the compilation of the synoptic map of the Sheet Žilina (1 : 200 000) Brestenská precised the stratigraphic range of basal coarse-detrital sediments in the area studied. SAMUEL (1963) and later on SAMUEL-SALAJ (1968) performed biostratigraphic research of flysch sequences and in 1968 presented the first complex picture of the Paleogene history and stratigraphy of the Inner-Carpathian Paleogene of the Bánovská kotlina depression. Further, mostly sedimentological investigations of Paleogene sequences resulted in valuable microbiostratigraphic information enabling the precision of the existing data and detailed division of the Paleogene sedimentary complex of the Inner-Carpathian sedimentation cycle.



Fig. 1. Sketch map of Bánovská kotlina depression.

Lithofacies- and microbiostratigraphical division of Central Carpathian Paleogene

In the Central-Carpathian Paleogene sedimentation cycle and in the adjacent area of Horná Nitra (cf. FRANKO-GROSS-SAMUEL 1970), all four successive lithofacies units may be distinguished on the basis of new data. The lithofacies are distinguished in accordance with their definition by GROSS-KÖHLER-SAMUEL (1984); 1 — *Borové formation*, 2 — *Huta Fm.*, 3 — *Zuberec Fm.*, 4 — *Biely potok Fm.*

1. *The Borové Formation* consists of conglomerates, breccia, and limestones containing alveolines, nummulites, assilines, aperculines and lithotamnians, local pelite intercalations (mainly in upper parts of the formation) with foraminifers. Larger foraminifers are most frequent in limestones in a small quarry near Uhrovec and in smaller exposures along the road from Uhrovec to Jankov Vrch. VAŇOVÁ (in SAMUEL — SALAJ 1968, text table 22, p. 81) found the following nummulite species in the quarry Uhrovec: *Nummulites gallensis* HEIM, *N. millecaput* BOUBÉE, *N. millecaput minor* d'ARCHIAC et HAIME, *Discocyclina marthae* SCHLUMBERGER, *D. daguisi* NEUMANN, *D. sella* (d'ARCHIAC), *D. augustae* WEJDEN, *Alveolina elongata* d'ORBIGNY, *A. cf. pinquis* HOTTINGER, *A. levantina* HOTTINGER, *A. aff. fragilis* HOTTINGER, *A. elliptica* (SOWERBY), *A. vicentina* HOTTINGER, *A. fusiformis* SOWERBY, *A. boscii* (DEFR.), *Lepidocyclina pustulosa* DOUVILLÉ, *Orbitoides complanata minima* HENSON. Small foraminifers were found in claystone intercalations in the upper part of the Borové Fm. They are represented by agglutinated or mixed agglutinated-calcareous assemblages.

The agglutinated assemblages are pretty monotonous, mostly represented by *Rhabdammina*, *Dendrophrya*, *Glomospira*, scarce *Hyperammina*, *Ammodiscus*,

Trochaminoides a. o. Claystone samples from the overlier of the Uhrovec quarry contained the following species: *Rhabdammina* ex gr. *discreta* BRADY, *R. cylindrica* GLAESSNER, *Hyperammina nodata* GRZYBOWSKI, *H. subnodosiformis* GRZYBOWSKI, *Dendrophrya excelsa* GRZYBOWSKI, *Reophax elongata* GRZYBOWSKI, *Ammodiscus polygyrus* REUSS, *Glomospira charoides* (JONES et PARKER), *G. gordialis* (JONES et PARKER), *Trochamminoides* cf. *suborbicularis* (GRZYBOWSKI), *T. variolarius* (GRZYBOWSKI), *Cystammina pauciloculata* (BRADY), *Plectina conversa* (GRZYBOWSKI) and *Cyclammina amplexans* GRZYBOWSKI regarded as the index form of the Middle Eocene. The assemblage of small and larger foraminifers indicates the deposition of the basal Borové Fm. in the Middle Lutetian. Its top border in the Bánovská kotlina depression does not surpass the Upper Lutetian border.

2. *The Huta Formation* is characterized by the pelite component dominant over sandstones. Most part of the formation is covered with younger formations so its range and composition cannot be exactly defined lithofacially. The existing microbiostratigraphical data only concern small exposures. There are quite rich planktic foraminifer assemblages in a profile on the western periphery of the village Kršteňany: *Globigerina eocaena* GÜMBEL, *G. cryptomphala* GLAESSNER, *G. hagni* GOHRBANDT, *G. linaperta* FINLAY, *G. ex gr. yeguaensis* WEINZIERL et APPLIN, "*G.*" *senni* BECKMANN, *Globigerinatheka* ex gr. *subconglobata* CHALILOV, "*Globigerinoides*" *higginsii* BOLLI, *A. spinuloinflata* (BANDY), *A. pentacamerata* SUBBOTINA, *A. simulatilis* (KRAYEVA), *Pseudohastigerina* aff. *mira* (COLE) and *Truncorotaloides topilensis* (CUSHMAN).

A similar assemblage was found in exposures to NW of Skačany. In contrast to the preceding assemblage there is also the species *Morozovella aragonensis* (NUTTALL), *Globigerina boweri* BOLLI and *Hantkenina dumblei* WEINZIERL et APPLIN. Besides planktic there are also benthic foraminifers: *Lagena costata amphora* REUSS, *Nodosaria spinocostata* ORBIGNY, *Margulina subbulata* HANTKEN, *Bulimina aksuatica* MORZOVA, *Gyroidina girardana* (REUSS), *G. soldanii* d'ORBIGNY, *Cibicides* div. sp. According to vertical distribution of planktic foraminifers the assemblages from Kršteňany and Skačany are indicative of the biozone P 11 — *Globigerinatheka subconglobata subconglobata*.

The globigerine species percentage of upper parts of the sequences at the localities mentioned is practically the same. *Morozovella aragonensis* (NUTTALL) disappears and the phylogenetic line *Globigerinatheka subconglobata* and *Turborotalia cerroazulensis* are represented by first appearances of younger descendant forms indicative of the Carpathian biozone *Truncorotaloides rohri*, corresponding to the standard biozone P 12 — P 14.

3. *The Zuberec Formation* crops out in profiles along a road cut between Bánovce nad Bebravou and Nováky, and to NW of Horné Naštice. There the planktic component is dominant. Globigerines are represented like in the above assemblages but there the forms of the group *Globigerina officinalis* SUBBOTINA BLOW and *Globigerina linaperta* FINLAY BLOW et BANNER occur for the first time. Other species were represented by *Turborotalia cerroazulensis* (COLE), *T. cerroazulensis possagnoensis* (TOUMARKINE et BOLLI) and the intermediary form

between *T. cerroazulensis cerroazulensis* (COLE) and *T. cerroazulensis cocoaensis* (CUSHMAN). The lineage *Globigerinatheka* ex gr. *subconglobata* is represented by forms corresponding to the subspecies *Globigerinatheka subconglobata luterbacheri* BOLLI. Occurrences of *Globigerinatheka rubriformis* SUBBOTINA, *Globorotaloides suteri* BOLLI and *Truncorotaloides* ex gr. *rohri* BRÖNNIMANN et BERMÚDEZ are scarce.

Benthic forms are represented by rare *Bolivina antegressa* SUBBOTINA, *Trifarina wilcoxensis* (CUSHMAN et PONTON), *Angulogerina* ex gr. *muralis* (TERQUEM), *Cassidulina subglobosa* BRADY, *Eponides subumbonatus* MYATLYUK, *Gyroidina girardana* (REUSS), *G. soldanii* d'ORBIGNY, *Pullenia quinqueloba* (REUSS), *Cibicides karpaticus* MYATLYUK, *Pararotalia* sp.

Vertical distribution of the above species indicates that the Zuberec Formation outcropping in the vicinity of Horné Naštice belongs to the uppermost part of the Carpathian biozone *Truncorotaloides rohri* also correlable with the standard biozone P 14. This opinion is supported by the simultaneous occurrence of *Truncorotaloides rohri* BRÖNNIMANN which does not surpass P 14, and the transitional forms between *Turborotalia cerroazulensis cerroazulensis* (COLE) and *Turborotalia cerroazulensis cocoaensis* (CUSHMAN). According to TOUMARKINE et LUTERBACHER (1985) first appearance of *Turborotalia cerroazulensis cocoaensis* (CUSHMAN) was in biozone P 14 — *Truncorotaloides rohri*. So the lower part of the Zuberec Formation alternates in age with the upper part of the Huty Formation.

Two assemblages of different ages were found in the profile of a road cut between Bánovce n. B. and Nováky.

In the lower part of the profile the assemblages are mostly represented by "smaller" globigerines. *Globigerina officinalis* SUBBOTINA is dominant. Other forms are represented by *Globigerina* ex gr. *praebulloides* BLOW, *Globigerina tripartita* KOCH, *Globigerina pseudoampliapertura* BLOW et BANNER, *Globigerina danwilensis* HOWE et WALLACE, *Turborotalia cerroazulensis cocoaensis* (CUSHMAN), *Chiloguembelina* aff. *gracillima* (ANDREAE) and ancestral forms of "*Globigerina*" *liverovskae* (BYKOVA). The assemblage is indicative of the Carpathian biozone *Globigerina officinalis*, correlated with the standard biozone P 16 (partial) and P 17, i. e. with the biozone *Turborotalia cerroazulensis* (s. l.).

Biozone P 15 — *Globigerinatheka semiinvoluta* has so far not been proved in the area studied — but it does not mean a break in sedimentation in that time — it is only due to poorly exposed Paleogene sediments.

4. In the top part of the profile the sandstone/calcareous claystone ratio changes quickly in the benefit of the sandstone component. From the lithofacies view it is already the *Biely potok* Formation. The foraminiferal assemblages differ from the former in their composition. The planktonic component represented only by "small" globigerines like *Globigerina officinalis* SUBBOTINA is dominant again. Occurrence of other species is variable: *Globigerina* ex gr. *praebulloides* BLOW, "*Globigerina*" *liverovskae* (BYKOVA), *Globigerina pseudoampliapertura* BLOW et BANNER, *Globigerina ouachitaensis* HOWE et WALLACE, *Pseudohastigerina evoluta* (SUBBOTINA), *Pseudohastigerina micra* (COLE).

The assemblage is indicative of the regional Carpathian biozone *Globigerina postcretacea*, correlated with the standard biozones (in the sense of BOLLI-SAUNDERS 1985) P 18 and P 19 (*Cassigerinella chipolensis*/*Pseudohastigerina micra*). In accordance with the present opinion of many authors we correlate the biozones P 18 and P 19 with the Lower and Middle Oligocene.

Conclusions

The field research and my microbiostratigraphic investigations show that the entire sedimentation cycle of the Central-Carpathian Paleogene has developed in the Bánovská kotlina depression. From the lithofacies viewpoint all the four basal lithostratigraphic units (in the sense of GROSS-KÖHLER-SAMUEL 1984) may be distinguished in the cycle: the *Borové*, *Huty*, *Zuberec* and the *Biely potok* Formations. Their stratigraphical range is from the upper part of the Lower Lutetian to the Middle Oligocene. According to biozonal division the transgression in the Bánovská kotlina depression commenced in biozone P 11 — *Globigerinatheca subconglobata* and continued without breaks in sedimentation at least to biozone P 18/19 — *Cassigerinella chipolensis*/*Pseudohastigerina micra*. The lithostratigraphical units represent formations in superposition (with partly alternating position).

A comparison of the area studied with the adjacent Horná Nitra shows that there are almost no litho- and biofacies differences. So they evidently had a common paleogeographic history. A greater thickness of the Zuberec Member in the area of Horná Nitra indicates a greater subsidence rate than in the Bánovská kotlina depression.

References

- BOLLI, H. M.—SAUNDERS, J. B. 1985: Oligocene to Holocene low latitude planktic foraminifera. — In "Plankton Stratigraphy". (Ed. H. M. Bolli, J. B. Saunders, H. L. Perch Nielsen). — Cambridge Earth. Sc. Ser., Cambridge, 1—1032.
- BRESTENSKÁ, E. 1962; in Vysvetlivky k prehľadnej geologickej mape ČSSR 1 : 200 000; M-34-XXV, list Žilina (Ed. M. Mahef). Vyd. Geol. Úst. D. Štúra, Bratislava, 1—272.
- FRANKO, O.—GROSS, P.—SAMUEL, O. 1970: Geológia centrálneokarpatského paleogénu v okolí bojnických kúpeľov. — Geol. Práce, Správy, 52, Geol. Úst. D. Štúra, Bratislava, 19—34.
- GAŠPARIK, J. 1953: Geológia Bánovskej kotliny. — Geol. Zbor., 4, 1—2, Bratislava, 353—371.
- GROSS, P.—KÖHLER, E.—SAMUEL, O. 1984: Litostratigrafická klasifikácia vnútrokarpatského paleogénneho sedimentačného cyklu. — Geol. Práce, Správy, 81, Geol. Úst. D. Štúra, Bratislava, 103—117.
- MAHEF, M. 1953: K stratigrafii trefohôr bánovskej tabule. — Geol. Zbor., 3, 3—4, Bratislava, 53—69.
- SALAJ, J.—SAMUEL, O. 1984: Microbiostratigraphical division of West Carpathians Mesozoic and Paleogene. — Záp. Karpaty, sér. Paleont., 9, Geol. Úst. D. Štúra, Bratislava, 11—71.
- SAMUEL, O. 1963: Mikrostratigrafia vonkajšieho a vnútorného flyša východného Slovenska, paleogénu bradlového pásma a centrálneokarpatského paleogénu. — Manuskript-archív Geol. Úst. D. Štúra, Bratislava.

- SAMUEL, O. 1965: Zonálne členenie paleogénnych sedimentov Západných Karpát na základe planktonických foraminifer. — Geol. Práce, Správy, 37, Geol. Úst. D. Štúra, Bratislava, 183—198.
- SAMUEL, O.—SALAJ, J. 1968: Microbiostratigraphy and Foraminifera of the Slovak Carpathian Paleogene. — Geol. Úst. D. Štúra, Bratislava, 1—232.
- TOUMARKINE, M.—LUTERBACHER, H. P. 1985: Paleocene and Eocene planktic foraminifera. — In "Plankton stratigraphy" (Ed. H. M. Bolli, J. B. Saunders, H. L. Perch Nielsen). — Cambridge Earth. Sc. Ser., Cambridge, 1—1032.
- VAŇOVÁ, M. 1968; in O. SAMUEL—J. SALAJ 1968: Microbiostratigraphy and Foraminifera of the Slovak Carpathian Paleogene. — Geol. Úst. D. Štúra, Bratislava, 1—232.

ONDREJ SAMUEL

Foraminifery a mikrobiostratigrafia centrálnokarpatského paleogénu Bánovskej kotliny

Resumé anglického textu

Centrálnokarpatský paleogén v Bánovskej kotline väčšinou vystupuje v okrajových častiach kotliny spod miocénnych sedimentov. Paleogénne sedimenty v tejto oblasti boli v minulosti skúmané len okrajovo, v súvisi s výskumom starších, hlavne mezozoických útvarov (M. MAHEL 1953, J. GAŠPARIK 1953). Neskoršie, v rámci zostavovania prehľadnej geologickej mapy listu Žilina (1 : 200 000), paleogénne sedimenty v opisovanej oblasti reambulovala E. Brestenská. Spresnila hlavne stratigrafickú príslušnosť bazálnych hrubodetritických sedimentov. Biostratigrafickým výskumom flyšových sekvencií sa zaoberal O. SAMUEL (1963) a neskoršie O. Samuel—J. Salaj, ktorí v roku 1968 podali prvý ucelenejší pohľad na paleogénny vývoj a stratigrafiu vnútrokarpatského paleogénu Bánovskej kotliny. V súvisi s ďalším, hlavne sedimentologickým výskumom paleogénnych sekvencií sme získali cenné mikrobiostratigrafické poznatky, ktoré nám umožnili nielen spresniť doterajšie poznatky, ale aj podrobnejšie rozčleniť paleogénny komplex sedimentov vnútrokarpatského sedimentačného cyklu.

Na základe nových výskumov možno v centrálnokarpatskom paleogénnom sedimentačnom cykle vyčleniť, podobne ako v priľahlej hornonitrianskej oblasti (porov. O. FRANKO—P. GROSS—O. SAMUEL 1970), všetky štyri sukcesívne litofaciálne jednotky, tak ako ich definoval P. GROSS—E. KÖHLER—O. SAMUEL (1984); 1 — borovské súvrstvie, 2 — hutianske súvrstvie, 3 — zuberské súvrstvie, 4 — bielopotocké súvrstvie.

Borovské súvrstvie sa skladá zo zlepcov, brekcií a vápencov s obsahom alveolín, numulitov, asilín, operkulín a litotamnií. Miestami (hlavne vo vyšších častiach borovského súvrstvia) sa vyskytujú aj vložky pelitov, obsahujúce foraminifery. Zvlášť bohaté na veľké foraminifery sú vápence vystupujúce v malom kameňolome pri Uhrovci a v malých odkryvoch pri ceste vedúcej z Uhrovca na Jankov vrch. Podľa M. Vaňovej (in O. SAMUEL—J. SALAJ 1968, text-tab. 22, str. 81) veľké foraminifery v uhrovskom kameňolome sú zastúpené druhmi indikujúcimi vrchnolutetský vek. Malé foraminifery sme získali z ílovcových vložiek vyskytujúcich sa vo vrchnej časti borovského súvrstvia. Sú zložené buď z aglutinovaných, alebo miešaných aglutinovano-vápnitých asociácií. Aglutinované asociácie sú dosť monotónne a väčšinou ich reprezentujú zástupcovia rodu *Rhabdammina*, *Dendrophrya*, *Glomospira*, zriedkavo *Hyperammina*, *Reophax*, *Ammodiscus*, *Trochaminoides* a iné. Na základe asociácie malých i veľkých foraminifer môžeme konštatovať, že pri trojdielnom členení lutetu bazálne borovské súvrstvie začalo sedimen-

tovať už v strednom lutéte, pričom jeho vrchná hranica v Bánovskej kotline rozhodne neprekračuje hranicu vrchného lutétu.

Hutianske súvrstvie sa vyznačuje prevahou pelitickej zložky nad pieskovcami. Vzhľadom na zakrytosť mladšími útvarmi na povrch vystupuje len vo veľmi obmedzenej miere. Preto po litofaciálnej i mikrobiostratigrafickej stránke jej rozsah i zloženie nie sú dostatočne preskúmané. Mikrobiostratigrafické údaje, ktoré doteraz máme k dispozícii, pochádzajú iba z malých odkryvov. Napr. v profile na západnom okraji dediny Kršteňany a sz. od Skačian sa vyskytujú pomerne bohaté asociácie planktónových foraminifer zodpovedajúce biozónu P 11 — *Globigerinatheka subconglobata* až P 14 — *Truncorotaloides rohri*, t. j. vrchnému lutétu.

Zuberské súvrstvie vystupuje na povrch v profiloch pozdĺž zárezu cesty vedúcej z Bánoviec nad Bebravou do Novák a sz. od Horných Naštíc. V poslednom prípade planktónová zložka tiež má dominujúce postavenie. Zastúpenie globigerín je veľmi podobné, ako sme uviedli u vyššie opísaných asociácií s tým rozdielom, že sa tu prvýkrát vyskytujú formy zo skupiny *Globigerina* ex gr. *praebulloides* BLOW, *Globigerina pseudo-ampliapertura* BLOW et BANNER, ako aj prechodná forma medzi *T. cerroazulensis cerroazulensis* (COLE) a *T. cerroazulensis cocoaensis* (CUSHMAN). Z vývojového radu *Globigerinatheka* ex gr. *subconglobata* sa vyskytujú ešte formy, ktoré dobre zodpovedajú opisu poddruhu *Globigerinatheka subconglobata luterbacheri* BOLLI. Veľmi vzácné sa objavuje i *Globigerinatheka rubriformis* SUBBOTINA, *Globorotaloides suteri* BOLLI a *Truncorotaloides* ex gr. *rohri* BRÖNNIMANN et BERMÚDEZ.

Na základe vertikálneho rozšírenia hlavne druhov vyššie uvedených môžeme konštatovať, že zuberské súvrstvie vystupujúce v okolí Horných Naštíc, patrí do najvyššej časti karpatskej biozóny *Truncorotaloides rohri*, ktorú na druhej strane môžeme korelovať so štandardnou biozónou P 14. V prospech tohto názoru hovorí spoločný výskyt druhu *Truncorotaloides rohri* BRÖNNIMANN, ktorý nepresahuje hranice posledne menovanej biozóny a prechodné formy medzi druhom *Turborotalia cerroazulensis cerroazulensis* (TOUMARKINE et BOLLI) a *Turborotalia cerroazulensis cocoaensis* (COLE). V tejto súvislosti treba poznamenať, že prvé objavenie druhu *Turborotalia cerroazulensis cocoaensis* (COLE) sa podľa údajov M. TOUMARKINE et H. LUTERBACHERA (1985) datuje tiež z biozóny P 14 — *Truncorotaloides rohri*, ktorá, ako sme to už vyššie uviedli, reprezentuje najvyššiu biozónu vrchného lutétu. Z uvedeného vyplýva, že spodná časť zuberského súvrstvia vekovo alternuje s vrchnou časťou hutianskeho súvrstvia.

Z profilu zárezu hlavnej cesty vedúcej z Bánoviec nad Bebravou do Novák sme získali vekove dve rozdielne asociácie.

V spodnej časti profilu sa vyskytujú asociácie reprezentované hlavne „malými“ globigerínami, z ktorých prevláda druh *Globigerina officinalis* SUBBOTINA. Asociácia s dominujúcim druhom *Globigerina officinalis* SUBBOTINA nám indikuje karpatskú biozónu *Globigerina officinalis*, ktorú dávame do vzťahu so štandardnou biozónou P 16 (partien) a P 17, t. j. s biozónou *Turborotalia cerroazulensis* (s. l.).

Biozóna P 15 — *Globigerinatheka semiinvoluta* nebola v skúmanej oblasti doteraz preukázaná. To však neznamená, že v tomto období tu bola prerušená sedimentácia. Jej prítomnosť nebola preukázaná iba v dôsledku nedostatočnej odkrytosti paleogénnych sedimentov.

V najvyšších častiach opísaného profilu sa pomer pieskovcov a vápnitých ílovcov rýchlo menil v prospech pieskovcovej zložky. Z litofaciálneho hľadiska ide už o bielo-potocké súvrstvie. Zloženie asociácií foraminifer sa odlišuje od vyššie opísaných. Opäť dominuje planktónna zložka reprezentovaná výlučne „malými“ globigerínami. Z nich dominujúce postavenie má *Globigerina officinalis* SUBBOTINA. Z ďalších stratigraficky

významných druhov sa premenlivo vyskytujú: *Globigerina* ex gr. *praebulloides* BLOW, „*Globigerina*“ *liverovskae* (BYKOVA), *Globigerina pseudoampliapertura* BLOW et BANNER, *Globigerina ouachitaensis* HOWE et WALLACE, *Pseudohastigerina evoluta* (SUBBOTINA), *Pseudohastigerina micra* (COLE).

Uvedená asociácia indikuje regionálnu karpatskú biozónu *Globigerina postcretacea*, ktorú dávame do vzťahu so štandardnou biozónou (sensu H. M. BOLLI—J. B. SAUNDERS 1985) P 18 a P 19 (*Cassigerinella chipolensis*/*Pseudohastigerina micra*). V súlade so súčasnými názormi početných autorov korelujeme uvedené biozóny (P 18 a P 19) so spodným a stredným oligocénom.

Ak porovnáme skúmanú oblasť so susediacou hornonitrianskou oblasťou (porov. O. FRANKO—P. GROSS—O. SAMUEL 1970), môžeme konštatovať, že po stránke lito- i biofaciálnej sa v podstate neodlišujú. To znamená, že mali spoločný paleogeografický vývoj. Určitý rozdiel je vo väčšej hrúbke zuberských vrstiev v hornonitrianskej oblasti, na základe čoho možno usudzovať, že rýchlosť subsidencie tu bola väčšia ako v Banovskej kotline.

Explanations to Plates I—XVII

Plate I

- 1 *Rhabdammina cylindrica* GLAESSNER, 1937; Magn. 180 ×.
- 2, 3 *Rhabdammina discreta* BRADY, 1884; Magn. 230 ×, 400 ×.
- 4, 5, 6 *Hyperammina subnodosiformis* GRZYBOWSKI, 1897; Magn. 150 ×, 180 ×, 150 ×.
- 7 ?*Bathysiphon* sp. Magn. 120 ×.
- 8 *Ammodiscus polygyrus* REUSS, Magn. 120 ×.
- 9 *Reophax elongatus* GRZYBOWSKI, 1897; Magn. 120 ×.

Plate II

- 1, 2 *Bifarina selseyensis* (HERON-ALLEN et EARLAND, 1909). Magn. 230 ×.
- 3 *Pectina conversa* (GRZYBOWSKI, 1901). Magn. 150 ×.
- 4, 7, 8, 9 *Glomospira charoides* (JONES et PARKER, 1860). Magn. 200 ×, 400 ×.
- 5 *Trochamminoides variolarius* (GRZYBOWSKI, 1898): Magn. 150 ×.
- 6 *Cystamina pauciloculata* (BRADY, 1879). Magn. 100 ×.

All Figures from Borovec formation, Upper Lutetian, near Uhrovec (Pl. I—II).

Plate III

- 1, 2, 3 *Amphycoryna* cf. *scalaris* (BATSCH, 1791). Magn. 180 ×, 1000 ×.
- 4 *Lagena costata amphora* REUSS, 1858. Magn. 180 ×.
- 5, 6 *Dentalina setosa* HANTKEN, 1875. Magn. 150 ×, 800 ×.
- 7, 8, 9 *Marginulina subbulata* HANTKEN, 1975. Magn. 200 ×, 600 ×.

All Figures Zuberec formation, Upper Eocene, Horné Naštice.

Plate IV

- 1—5 *Bulimina aksuatica* MOROZOVA, 1939. Magn. 300 ×, 300 ×, 300 ×, 270 ×, 850 ×.
- 6, 7, 8 *Bolivina aenariensisformis* MJATLIUK, 1960. Magn. 230 ×, 550 ×, 700 ×.

All Figures from Zuberec formation, Upper Priabonian, Horné Naštice.

Plate V

- 1—9 *Angulogerina gracilis germanica* CUSHMAN et EDWARDS, 1938. Magn. 250 ×, 500 ×, 200 ×, 200 ×, 200 ×, 450 ×, 270 ×, 400 ×, 1000 ×.

All Figures from Zuberec formation, Lower Oligocene, near Bánovce nad Bebravou.

Plate VI

1, 2, 3 *Reussella* sp. Magn. 220 ×, 220 ×, 550 ×.

4—9 *Eponides? binominatus* SUBBOTINA, 1960. Magn. 230 ×, 450 ×, 230 ×, 250 ×, 220 ×, 450 ×.

All Figures from Zuberec formation, Lower Oligocene, near Bánovce nad Bebravou.

Plate VII

1—4 *Glabratella hronica* SAMUEL, 1975. Magn. 240 ×, 240 ×, 230 ×, 460 ×.

5, 6 *Gyroidina girardana* (REUSS, 1851). Magn. 200 ×, 200 ×.

7, 8 *Elphidium* cf. *inflatum* (REUSS, 1861). Magn. 170 ×, 350 ×.

9 *Cibicides* cf. *westi* HOWE, 1939. Magn. 180 ×.

All Figures from Zuberec formation, Upper Priabonian, near Bánovce nad Bebravou.

Plate VIII

1, 2 *Cibicides* sp. Magn. 200, 500 ×.

3, 4 *Cibicides* cf. *westi* HOWE, 1939. Magn. 180 ×, 540 ×.

5 *Cibicides lopjanicus* MJATLIUK, 1950. Magn. 190 ×.

6 *Cibicides* sp. (cf. *C. vialovi* BYKOVA, 1939). Magn. 170 ×.

7, 8 *Rosalina quadrata* (TERQUEM, 1882). Magn. 150 ×, 750 ×.

All Figures from Zuberec formation, Lower Oligocene, near Bánovce nad Bebravou.

Plate IX

1, 2 *Elphidiella* aff. *subnodosa* (ROEMER, 1838). Magn. 250 ×, 500 ×.

3, 4 *Elphidiella* aff. *subnodosa* (ROEMER, 1838). Magn. 250 ×, 500 ×.

5, 6 *Elphidiella turgenscens* (CUSHMAN, 1936). Magn. 250 ×, 500 ×.

7, 8, 9 *Elphidiella turgenscens* (CUSHMAN, 1936). Magn. 250 ×, 250 ×, 1200 ×.

All Figures from Zuberec formation, Lower Oligocene, near Bánovce nad Bebravou.

Plate X

1, 2, 3 *Globigerina eocaena* GÜMBEL, 1986. Magn. 160 ×, 160 ×, 160 ×.

4—7 *Globigerina linaperta* FINLAY, 1939. Magn. 170 ×, 170 ×, 170 ×, 430 ×.

8, 9 *Globigerina linaperta* FINLAY, 1939. Magn. 200 ×, 190 ×.

All Figures from Huty formation, Upper Lutetian, Kršteňany.

Plate XI

1—3, 6 *Globigerina pseudoampliapertura* BLOW et BANNER, 1962. Magn. 200 ×, 200 ×, 300 ×, 200 ×.

4, 5, 7 *Globigerina* aff. *galavisi* BERMÚDEZ, 1961. Magn. 180 ×, 450 ×, 180 ×.

8 *Globigerina danvillensis* HOWE et WALLACE, 1932. Magn. 220 ×.

All Figures from Zuberec formation, Upper Priabonian, Horné Naštice.

Plate XII

1—3 *Globigerina boweri* BOLLI, 1956. Magn. 190 ×, 190 ×, 190 ×.

4, 7, 8 *Globigerina boweri* BOLLI, 1956. Magn. 230 ×, 230 ×, 700 ×.

5, 6 *Globigerina boweri* BOLLI, 1956. Magn. 700 ×, 230 ×.

9, 10 *Globigerina compacta* SUBBOTINA, 1953. Magn. 500 ×, 200 ×.

All Figures from Huty formation, Upper Lutetian, Kršteňany.

Plate XIII

1 *Globigerina pseudovenezuelana* BLOW et BANNER, 1962. Magn. 150 ×.

2, 3 *Globigerina pseudovenezuelana* BLOW et BANNER, 1962. Magn. 200 ×, 200 ×.

4, 5 *Globigerina pseudovenezuelana* BLOW et BANNER, 1962. Magn. 170 ×, 370 ×.

6 *Globigerina pseudovenezuelana* BLOW et BANNER, 1962. Magn. 120 ×.

7, 8, 9 *Globigerina cryptomphala* GLAESSNER, 1937. Magn. 110 ×, 170 ×, 220 ×.

Figures 1—6 from Zuberec formation, Upper Priabonian, Horné Naštice; Figures 7—9 from Huty Formation, Upper Lutetian, Kršteňany.

Plate XIV

- 1, 2 *Globigerina eocaena* GÜMBEL, 1868. Magn. 170 ×, 170 ×.
- 3, 6 *Globigerina praebulloides praebulloides* BLOW, 1959. Magn. 400 ×, 370 ×.
- 4, 5 *Globigerina officinalis* SUBBOTINA, 1953. Magn. 500 ×, 500 ×.
- 7, 8, 9 *Globigerina* ex gr. *praebulloides* BLOW, 1959. Magn. 270 ×, 550 ×, 270 ×.

Figures 1—2 from Zuberec formation, Upper Priabonian, Horné Naštice; Figures 3—9 from Zuberec formation, Lower Priabonian, near Bánovce nad Bebravou.

Plate XV

- 1, 2 *Acarinina vicespinuloinflata* (SAMUEL, 1972) = *Acarinina matthewsae* BLOW, 1979. Magn. 270 ×, 230 ×.
- 3, 4 *Acarinina vicespinuloinflata* (SAMUEL, 1972) = *Acarinina matthewsae* BLOW, 1979. Magn. 190 ×, 900 ×.
- 5, 8 *Acarinina bulbrooki* (BOLLI, 1957). Magn. 220 ×, 270 ×.
- 6, 7 *Acarinina bulbrooki* (BOLLI, 1957). Magn. 270 ×, 270 ×.

All figures from Huty formation, Upper Lutetian, Kršteňany.

Plate XVI

- 1—3 *Acarinina* sp. (cf. *A. simulata* KRAYEVA, 1953): Magn. 200 ×, 200 ×, 550 ×.
- 4—6 *Acarinina simulata* KRAYEVA, 1953. Magn. 250 ×, 270 ×, 250 ×.
- 7 *Acarinina rugosoaculeata* SUBBOTINA, 1953. Magn. 400 ×.
- 8, 9 *Acarinina rugosoaculeata* SUBBOTINA, 1953. Magn. 300 ×, 300 ×.

Figures 1—6 from Huty formation, Upper Lutetian, Kršteňany; Figures 7—9 from Zuberec formation, Lower Priabonian, Horné Naštice.

Plate XVII

- 1, 2 *Globigerinatheka* ex gr. *subconglobata* CHALILOV, 1958. Magn. 170 ×, 220 ×.
- 3, 4 *Globigerinatheka* ex gr. *subconglobata* CHALILOV, 1958. Magn. 170 ×, 300 ×.
- 5, 6 *Hantkenina* aff. *dumblei* WEINZIERL et APPLIN, 1929. Magn. 230 ×, 230 ×.
- 7—9 *Pseudohastigerina nagewichiensis* (MYATLYUK, 1950). Magn. 450 ×, 450 ×, 450 ×.

Figures 1—6 from Huty formation, Upper Lutetian, Kršteňany; Figures 7—9 from Zuberec formation, Lower Oligocene, near Bánovce nad Bebravou.

Photographs were made by electron scanning microscope JSM-840 by K. Horák.

JOZEF SALAJ

Problematic age of Lower-Cretaceous foraminiferal zone *Leupoldina cabri*

2 Pls. (XVIII—XIX), Slovak summary

Abstract. Stratigraphical range of the species *Leupoldina pustulans* (BOLLI) and *Leupoldina cabri* (SIGAL) in the Tunisian trough extends from the Upper Barremian of the top part of the zone *Leptoceras puzosianum* with *Leptoceras costidiscus* (d'ORBIGNY) and *Macroscaphites yvani* (PUZOS) to the Upper Gargasian with *Valdedorsella angladei* (SAYN) and *Chelonicerias (C.) martini* (d'ORBIGNY). For this reason the zone *Leupoldina cabri* (J. F. LONGORIA 1974), formerly defined as the zone *Leupoldina protuberans* by H. M. BOLLI (1957), associated only with the Lower Gargasian, is as T. R. Z. ranged to the Uppermost Barremian — Upper Gargasian. The author of the present paper relates it as I. Z. to the Uppermost Barremian.

Introduction

In the Tunisian trough the Uppermost Barremian corresponding to the zone *Leptoceras puzosianum* (L. MEMMI 1981), is represented by black, partly bituminous biomicrite limestones and marlstones with fine cleavage. They had for long been ranged to the Aptian (G. CASTANY 1951).

They were for the first time ranged to the Uppermost Barremian by Z. STRÁNIK—E. MENČÍK—L. MEMMI—J. SALAJ (1974) on the basis of macro- and microfauna. It was later proved by the species *Leptoceras costidiscus* (d'ORBIGNY) determined by J. WIEDMANN (in J. SALAJ 1980), and by the species *Macroscaphites yvani* (PUZOS) (Pl. I), determined by author. Representatives of the genus *Prodeshayesites* have so far not been found in top parts of the formation either.

It is a prominent lithological horizon, easy for mapping (Š. BAJANÍK—A. BIELY—E. MENČÍK—J. SALAJ—Z. STRÁNIK 1977) in the underlier of the Lower-Aptian marls containing *Deshayesites deshayesi* (d'ORBIGNY) and *Pl. (Globigerinelloides) ferreolensis* (MOULLADE). Its significance was also emphasized by P. F. BUROLLET—L. MEMMI—A. M'RABET (1983). The reference profile for the Barremian and Aptian is at the locality Dj. Each Chama with the best defined Barremian/Aptian boundary in Tunisia, which can be suggested as a stratotypical locality (T. BIRKELUND et al. 1984, p. 8).

Microbiostratigraphy

On the basis of microfauna the limestones and marlstones of the Uppermost Barremian were by J. SALAJ (1980) ranged to the zone *Leupoldina pustulans*. The zone is characterized by explosive evolution of the species *Leupoldina pustulans* (BOLLI), *Leupoldina cabri* (SIGAL), *Hastigerinoides alpina* SIGAL, *Planomalina* (*Globigerinelloides*) *blowi* (BOLLI), *Pl.* (*Globigerinelloides*) *duboisii* (CHEVALIER), *Pl.* (*Gl.*) *cepedai* (OBREGON), *Pl.* (*Gl.*) *saundersi* BOLLI, *Hedbergella bollii* (LONGORIA), *Clavihedbergella kuhryi* (LONGORIA) and *Schackoina trifolia* FUCHS. Frequent are also *Hedbergella sigali* MOULLADE, *Clavihedbergella simplex* (MORROW) and *Clavihedbergella simplicissima* (MAGNÉ et SIGAL). Besides J. SALAJ—O. SAMUEL (1966, 1984) also W. FUCHS and J. AUBERT—H. BARTENSTEIN (1976) postulate the presence of most of the species in the Uppermost Barremian — Lower Aptian.

Problem of stratigraphical range

Since most of the species were for the first time found in the lower part of the Upper Aptian (Gargasian) defined by ammonite occurrences (M. MOULLADE 1966, 1974; J. SIGAL 1952, 1967, 1977; J. F. LONGORIA 1974; J. VAN HINTE 1976). M. CARON (1985) ranged the standard zone *Leupoldina cabri* to the Aptian as the third successive zone (*Hedbergella sigali* extending from the Barremian, *Globigerinelloides blowi*, *Schackoina cabri*). According to J. F. LONGORIA (1974, p. 31) the zone *Leupoldina cabri* is correlated with the ammonite zone *Defrenoyia furcata* corresponding to the lowermost part of the Upper Aptian — the Gargasian.

Different opinions about the first appearance of species significant for the stratigraphy of the Uppermost Barremian — Aptian may at the first sight be due to erroneous stratigraphical interpretations concerning the area of the Tunisian trough and the West Carpathians (J. SALAJ—O. SAMUEL 1966, 1984). There is no doubt about the first appearances of various species of the genera *Schackoina*, *Leupoldina*, *Hastigerinoides* and other mentioned species in the Uppermost Barremian of Tunisia so the opinion about the appearance of these species in various stratigraphic horizons within the Uppermost Barremian — Aptian being first of all controlled by the depth and ecological factors.

It is plankton representing the group of oceanic tropical species living in the depth zones I—II of well aerated and heated surficial oceanic water. On the other hand, the black bituminous fine-cleaved limestones and marlstones are indicative of poorly aerated water column associated with the sea floor, which is—besides bituminous matter and dispersed pyrite—also proved by the lack or poor presence of benthic calcareous and agglutinated foraminifers. Well preserved planktic foraminifers might indicate their deposition above the CCD line

and above the foraminiferal lysocline. A comparatively intense transport of organic matter into the sea and the nearness of the Sahara platform may be indicative of the depth 2000—3000 m of the Upper-Barremian sea of the Tunisian trough. It might be the time of its maximum deepening. The turbiditic transport of the aleuritic dispersed grains of quartz forming simple laminae in limestones was proved in thin sections by the author too.

The same foraminiferal assemblages of the zone *Leupoldina cabri* were described by J. F. LONGORIA (1974) from the Lower-Gargasian formation La Peña in Mexico. The delay in the first appearances of these species is due to the fact that the earlier underlying formation, 900 m thick (including the Bedoulian and the Barremian in its upper part), consisting of thick-bedded, massive, compact hard limestones with Rudista, deposited in shallow-water platform environment.

Favourable facies- and depth conditions for the evolution of the genera *Leupoldina* and *Schackoina* were also missing in the Vocontian trough and in the Jura Mts. during the Upper Barremian (Urgonian facies) and Lower Aptian (marls with orbitolines). Representatives of the above genera appear in this area rather late: during the Lower Gargasian or as early as the Uppermost Bedoulian (J. SIGAL 1987). Sporadic specimens of the species *Leupoldina cabri* (SIGAL) were only found in Lower Aptian marls (J. SALAJ—O. SAMUEL 1966) in an assemblage with *Hedbergella delrioensis* (CARSEY) and *Planomalina (Globigerinelloides) gottisi* (CHEVALIER), (Pl. XVIII, Fig. 9, 10).

Conclusion

Different age range of index species of the zone *Leupoldina cabri* (Pls. XVIII—XIX) is due to the lack of favourable conditions of their evolutions. Most areas from which the foraminiferal assemblages of this zone were described, have the platform character and more favourable conditions only commenced since the Lower Gargasian, whereas in the area of Trinidad (H. M. BOLLI 1957) and Tunisian trough the favourable conditions had already commenced in the Uppermost Barremian and lasted up to the Uppermost Gargasian.

References

- AUBERT, J.—BARTENSTEIN, H. 1976: Lenticulina (L.) nodosa additional observations in the world-wide Lower Cretaceous. — Bulletin de Centres de Recherches, Exploration et Production Elf-Aquitaine 10, 1, Pau, 1—33.
- BAJANIĆ, Š.—BIELY, A.—MENČIK, E.—SALAJ, J.—STRÁNÍK, Z. 1977: Carte géologique de la Tunisie à 1/50 000, feuille no 35, Dj. Zaghouan et notice explicative. Serv. Géol. Tunisie, Tunis, 1—70.
- BIRKELUND, T.—HANCOCK, I. M.—HART, M. B.—RAWSON, P. F.—REMANE, J.—ROBASZYSKI, F.—SCHMID, F.—SURLYK, F. 1984: Cretaceous stage boundaries-Proposals. Bull. Geol. Soc. Denmark, Vol. 33, 1—2, Copenhagen, 3—20.
- BOLLI, H. M. 1957: The Foraminiferal Genera Schackoina Thalmann, emended and Leupoldina, n. g. in the Cretaceous of Trinidad B. W. I. Eclogae Geol. Helv., 50, 2, Basel, 271—278.

- BOLLI, H. M. 1959: Planktonic Foraminifera from the Cretaceous of Trinidad, B. W. I. Bull. Amer. Paleont., 39, 179, New York, 257—277.
- BUROLLET, P. F.—MEMMI, L.—M'RABET, A. 1983: Le Crétacé inférieur de Tunisie. Aperçu stratigraphique et sédimentologique. Zitteliana 10, München, 255—264.
- CARON, M. 1985: Plankton Stratigraphy. Cambridge Univ. Press, London—New York—Melbourne—Sydney, 17—86.
- CASTANY, G. 1951: Etude géologique de l'Atlas tunisien oriental. Ann. Mines et Géol., 8, Tunis, 632.
- FUCHS, W. 1971: Eine alpine Foraminiferenfauna des tieferen Mittel-Barreme aus den Drusbergschichten von Ranzenberg bei Hohenems in Vorarlberg. Abh. Geol. Bundesanst., 27, Wien, 1—49.
- HINTE VAN, J. E. 1976: A Cretaceous Time Scale. Amer. Assoc. Petroleum Geologists Bull., 60, 4, Tulsa, 269—287.
- LONGORIA, J. F. 1974: Stratigraphic, morphologic and taxonomic studies on Aptian planktonic foraminifera. Rev. esp. Micropal. Num. Extraordinario, Madrid, 7—107.
- MEMMI, L. 1981: Biostratigraphie du Crétacé inférieur de la Tunisie nord-orientale. Bull. Soc. géol. France 7, t. XXIII, Paris, 175—183.
- MOULLADE, M. 1966: Etude stratigraphique et micropaléontologique du Crétacé inférieur de la "Fosse vocontienne". Document Lab. Géol. Fac. Sci, 15, 2, Lyon, 1—369.
- MOULLADE, M. 1974: Zones des Foraminifères du Crétacé inférieur mésogéen. C. R. Acad. Sci. 278 (D), Paris, 1813—1816.
- SALAJ, J. 1980: Microbiostratigraphie du Crétacé et du Paléogène de la Tunisie septentrionale et orientale (Hypostratotypes tunisiens). Dionýz Štúr Inst. Geol., Bratislava, 1—238.
- SALAJ, J.—SAMUEL, O. 1966: Foraminifera der Westkarpaten-Kreide (Slowakei). Dionýz Štúr Inst. Geol., Bratislava, 1—292.
- SALAJ, J.—SAMUEL, O. 1984: Microbiostratigraphic division of West Carpathian Mesozoic and Paleogene. Západné Karpaty, sér. paleont. 9, Geol. Úst. D. Štúra, Bratislava, 13—73.
- SIGAL, J. 1952: Aperçu stratigraphique sur la micropaléontologie du Crétacé. 19 congr. Geol. Internat., Monographies Régionales, 1^e Série, Algérie, 26, 3—45.
- SIGAL, J. 1966: Contribution à une monographie des Rosalines. I. Le genre *Ticinella* Reichel, couche des Rotalipores. Eclogae geol. Helv., 59, 1, Basel, 185—217.
- SIGAL, J. 1977: Essai de zonation du Crétacé méditerranéen à l'aide des foraminifères planctoniques. Géol. Méditerran., 4, 2, Marseille, 99—108.
- SIGAL, J. 1987: Une échelle zonale du Crétacé méditerranéen et quelques réflexions suscitées par son établissement, particulièrement à propos du Danien. Revue de Micropaleontologie, 30, 1, Paris, 32—51.
- STRÁŇÍK, Z.—MENČÍK, E.—MEMMI, L.—SALAJ, J. 1974: Biostratigraphie du Crétacé inférieur de l'Atlas tunisien oriental. Not. Serv. Géol. Tunisie, 41, Tunis, 65—85.

JOZEF SALAJ

Problematika vekového rozsahu spodnokriedovej foraminiferovej zóny *Leupoldina cabri*

Resumé anglického textu

V tuniskom trógu najvrchnejší barém je reprezentovaný čiernymi, čiastočne bituminóznymi, tenkoštiepateľnými, biotritickými vápencami, zodpovedajúcimi zóne *Leptoceras puzosianum* (Z. STRÁŇÍK, E. MENČÍK, L. MEMMI, J. SALAJ 1974, J. SALAJ 1980, L. MEMMI 1981) s *Leptoceras costidiscus* (d'ORBIGNY) a *Macroscaophites yvani* (PUZOS). V tejto časti barému dochádza aj k prvému objaveniu druhov *Leupoldina pustulans* (BOLLI) a *Leupoldina cabri* (SIGAL), indexových druhov zóny *Leupoldina cabri*, ktorú

definoval J. F. LONGORIA (1974). V Mexiku, rovnako ako aj vo Francúzsku v spodnej časti vrchného aptu prevládajú plytkovodnejšie fácie (rudistové vápence, organogénne urgónske vápence, orbitolínové sliene ai.). Priaznivé podmienky pre rozvoj planktonických foraminifer zóny *Schackoina cabri* v týchto oblastiach v porovnaní s Tuniskom nastali neskoršie, až v priebehu gargasu.

V Tunisku tieto druhy sú svojim stratigrafickým rozsahom viazané od najvrchnejšieho barému do najvrchnejšieho gargasu. *Schackoina cabri*, ako intervalová zóna, je dávaná autorom do vzťahu s najvrchnejším barémom. Jej vrchná hranica je definovaná prvým objavením druhu *Planomalina (Globigerinelloides) ferreolensis* (MOULLADE) spolu s *Deshayesites deshayesi* (d'ORBIGNY).

Referenčný profil v Tunisku pre barém a apt je na lokalite Dj. Ech Chama (oblasť Zaghouanu) s najlepšie definovanou barém — aptskou hranicou. Ako jedna z niekoľkých vhodných lokalít pripadá do úvahy k navrhnutiu za stratotypovú lokalitu pre túto hranicu (T. BIRKELUND et al. 1984, p. 8).

Explanations to Plates XVIII—XIX

Plate XVIII

- 1 *Macroscaphites yvani* (PUZOS) cca 2 ×
- 2 *Clavihedbergella kuhryi* (LONGORIA) × 160
- 3 *Leupoldina pustulans* (BOLLI) × 215
- 4 *Hedbergella bollii* LONGORIA × 120
- 5 *Planomalina (Globigerinelloides) sigali* (LONGORIA) × 160
- 6 *Planomalina (Globigerinelloides) sigali* (LONGORIA) × 120
- 7 *Planomalina (Gl.) maridalensis* (MOLLI) × 120
- 8 *Leupoldina cabri* (SIGAL) × 125
- 9 *Hedbergella bollii* LONGORIA × 160
- 10 *Hedbergella delrioensis* (CARSEY) × 110
- 11 *Planomalina (Gl.) gottisi* (CHEVALIER) × 100

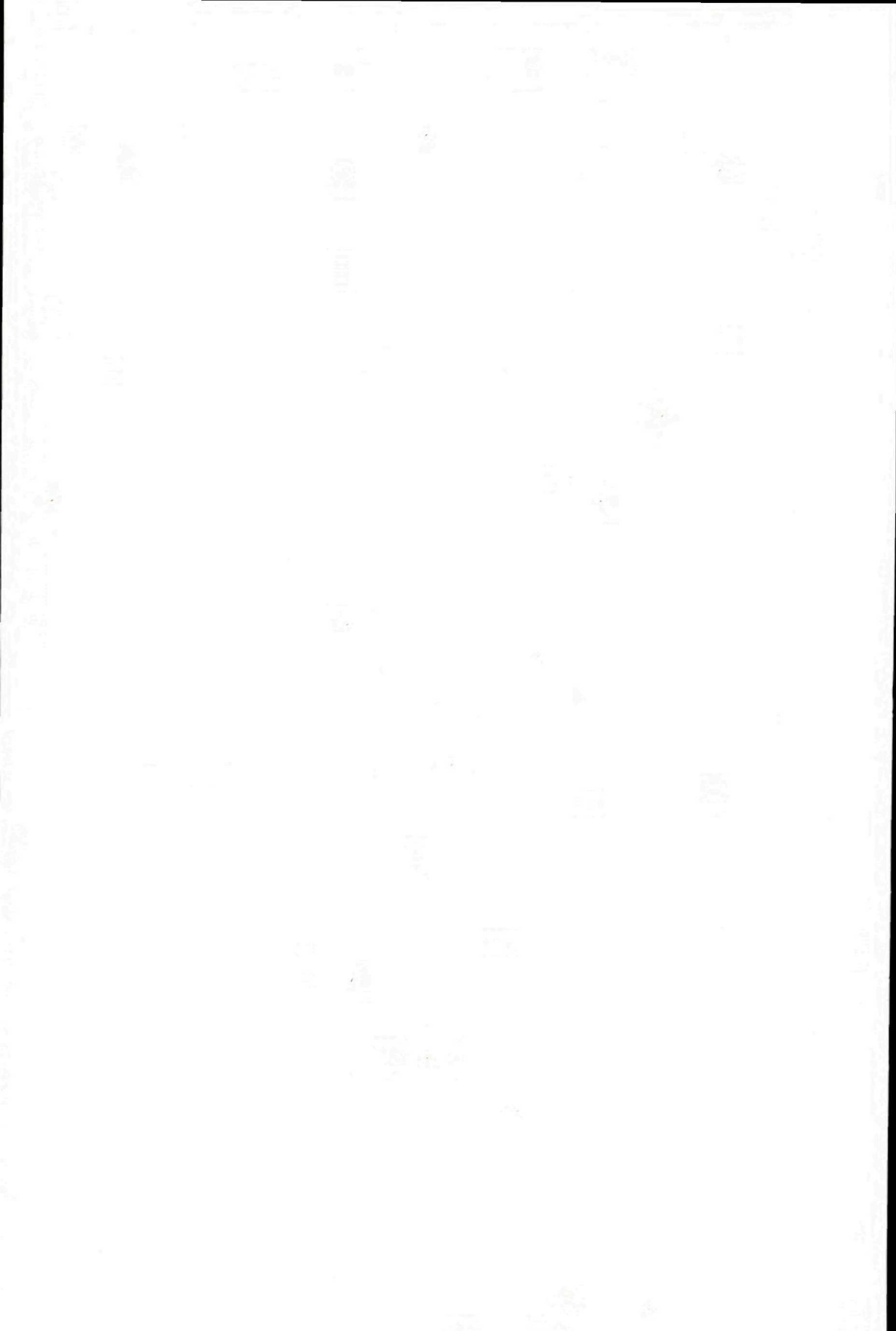
Figs. 1—9. Loc.: Dj. Ech Chama, Uppermost Barremian of Zaghouan area, Eastern Tunisia.

Figs. 10—11. Loc.: Turá Lúka, Marls of the Lower Aptian of the Kysuca sequence. West Carpathians.

Plate XIX

- 1, 2 *Hedbergella labocaensis* LONGORIA × 150, × 175
- 3, 4, 5 *Planomalina (Globigerinelloides) saundersi* BOLLI × 250, × 200, × 200
- 6—9 *Clavihedbergella roblesae* (OBREGÓN) × 185, × 150, × 175, × 150
- 10 *Clavihedbergella kuhryi* (LONGORIA) × 125
- 11—12 *Leupoldina pustulans* (BOLLI) × 165, × 135

1—12 Loc.: Dj. Ech Chama, sample Z-83/1987, Uppermost Barremian of Zaghouan area, Eastern Tunisia.



MARGITA VAŇOVÁ—HIND KANAFANI

Paleontological Characteristics of Reticulate Nummulites from the Areas of Damascus and Dmer (Syria)

3 text. fig., 4 pl. (XX—XXIII), 5 tab., slovak summary

Abstract: This work deals with paleontological characteristics of the specimens *Nummulites fabianii* (PREVER)? *Nummulites fabianii retiatus* ROVEDA, transitional form from *Nummulites fabianii retiatus* ROVEDA to *Nummulites fichteli* MICHELOTTI and *Nummulites fichteli* MICHELOTTI. The first two specimens have been found in the section MS' north of Damascus, whereas the last two occurred in the section AD in the Dmer area in Syria.

Introduction

The Paleogene sediments of Syria are well-known for their abundant and variegated larger foraminifers preserved in various ways in different rock types. Our attention has been attracted by reticulate specimens exposed in the sections MS' north of Damascus and AD in the Dmer area. In the section MS', crumbling foraminifers occurred in weathered limestones. In the samples MS'-50 and MS'-51 they were represented by specimens regarded as *Nummulites fabianii* (PREVER)?, and in the sample MS'-52 by the subspecies *Nummulites fabianii retiatus* ROVEDA. In the section AD, very abundant recrystallized foraminifers occurred in compact nummulite limestones. In the samples AD-9 and AD-9a they were represented by the species *Nummulites fichteli* MICHELOTTI and in the sample AD-13 by a transitional form from *Nummulites fabianii retiatus* ROVEDA to *Nummulites fichteli* MICHELOTTI. The accompanying fauna contains scarce specimens of species with different stratigraphic ranges. Some of them suggest washing of our assemblages, which in the section MS' are assigned to the Priabonian and in the section AD to the Oligocene.

As accompanying species in the section MS' we may mention *Nummulites variolarius* (LAMARCK), *Nummulites discorbinus* (SCHLOTHEIM), *Nummulites*

RNDr. M. VAŇOVÁ, CSc., Geological Institute of Dionýz Štúr, Mlynská dolina 1, 81704 Bratislava, Czechoslovakia

H. KANAFANI, The General Establishment for Geology and Mineral resources, Damascus, P. O. Box 7645 Syria

striatus striatus (BRUGUIÈRE), *Nummulites striatus pannonicus* (ROZLOZSNIK) in the samples MS'-50 and MS'-51. The sample MS'-52 contains none of the last three species but its assemblage is enriched in *Nummulites anomalus anomalus* HARPE, *Nummulites incrassatus ramondiformis* HARPE, *Nummulites pulchellus* HARPE, *Nummulites* cf. *pulchellus* HARPE, *Nummulites chavannesi* HARPE, *Nummulites* cf. *chavannesi* HARPE, *Nummulites* cf. *orbigny* (GALEOTTI), *Nummulites* cf. *anomalus lopuchovensis* VAŇOVÁ, *Nummulites bouillei* HARPE, *Operculina schwageri* SILVESTRI, *Operculina alpina* DOUVILLÉ and *Heterostegina* sp.

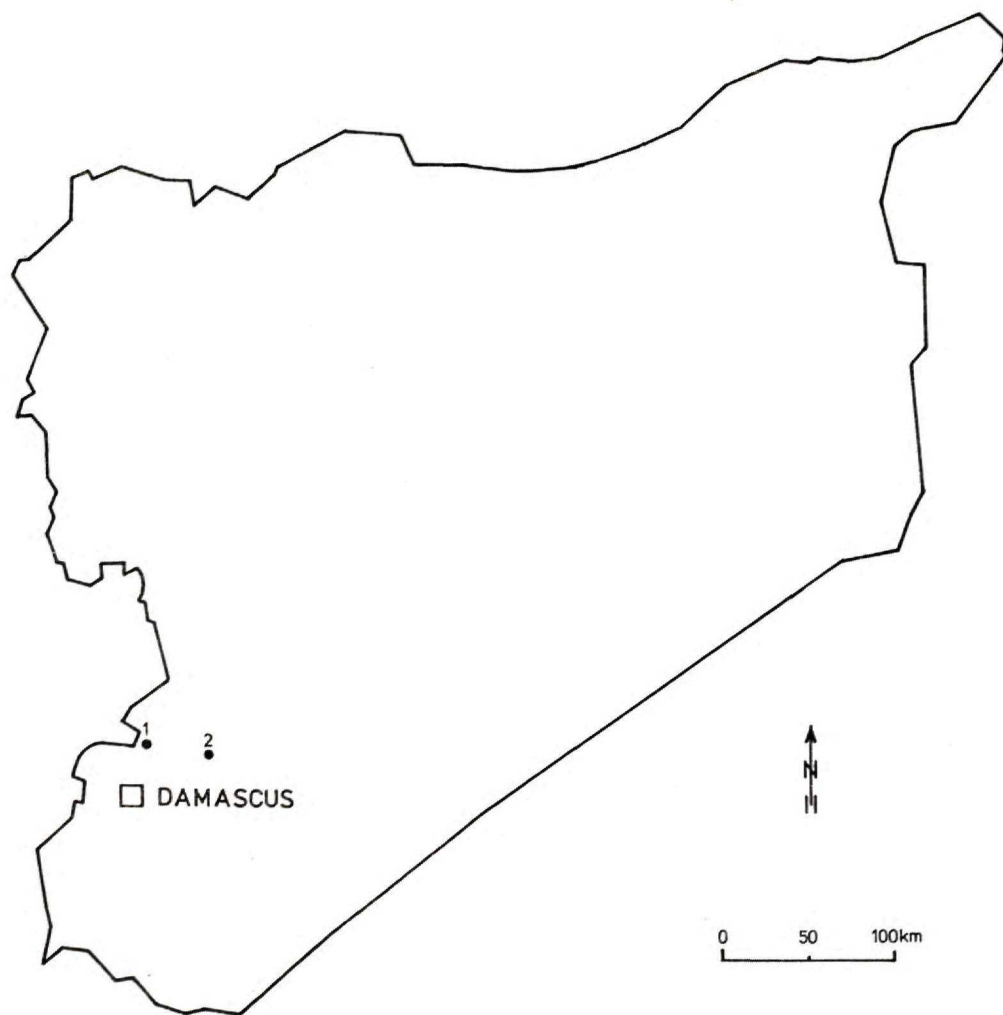


Fig. 1 Sketch map of localities; 1 — profile MS', 2 — profile AD.

Similarly, the section AD contained only a few species. *Nummulites incrassatus incrassatus* HARPE, *Nummulites cf. incrassatus ramondiformis* HARPE and *Operculina* sp. have been found in the sample AD-9. In the sample AD-9a these were replaced by the species *Nummulites anomalus anomalus* HARPE, *Nummulites orbigny* (GALEOTTI), *Nummulites cf. anomalus lopuchovensis* VAŇOVÁ, *Nummulites bouillei* HARPE, *Nummulites cf. vascus* JOLY LEYMERIE and *Planoperculina complanata* (DEFRANCE). The sample AD-13 was strongly recrystallized and although it contained abundant small nummulites only one specimen could have been compared with the species *Nummulites bouillei* HARPE. Of operculinoid foraminifers, only one specimen of heterostegina has been discovered. The shape of its secondary chambers resembles the species *Heterostegina reticulata* RÜTIMEYER, whereas its diagnostic values and the shape of basal chamberlets suggest the species *Heterostegina praecursor* TAN SIN HOK.

Nummulites fabianii (PREVER)?

Form A

Tab. XX, Fig. 7—12

Form of test: Slightly convex tests are considerably affected by weathering. The course of their surface ornamentation is indicated only by fine grooves and small depressions preserved as traces after weathered septal filaments, central pillar, granules and transversal lamina. In the sample MS'-50 the central pillar of some specimens seems to have been indistinct. The septal filaments are undulating. In the specimen No 26 (Tab. XX, Fig. 7), small granules cling to them approximately in the centre of the test. The transversal lamina is indicated near the margin of the tests. Isometric or oblong meshes mark the shape of the chambers of the last two whorls. Apart from specimens with a similar surface character, the sample MS'-51 contains also specimens with distinct concentric granules (Tab. XX, Fig. 9) or conspicuous transversal lamina (Tab. XX, Fig. 10). The septal filaments are undulating. Most specimens have a distinctly visible central pillar. In the polar region, the meshes of the reticulum are elongated radially, in the test's centre they become oblong. Near the margin they again indicate the shape of the chambers of the last two whorls. The test diameter ranges from 1.6 to 3.6 mm, most commonly amounting to 2.0—2.6 mm.

Internal structure of test: In the studied material, specimens with isolepidine-type nucleocoenoch prevail over those with anisolepidine one. Dimensions of the protoconch vary as follows:

	LP*		HP	
	Range	Mean	Range	Mean
MS'-50	0,125—0,200	0,154 mm	0,118—0,288	0,198 mm
MS'-51	0,090—		0,180—	

* LP — length of the protoconch; HP — height of the protoconch, both walls including

Other parts of test: Regular spire grows slightly in the first three whorls, in the fourth whorl its step diminishes a little. In the specimens of the sample MS'-51 it is somewhat more loosely coiled. The L value varies in the range:

MS'-50

Whorl	I	II	III	IV
Range**	0,148—0,190	—0,005—0,120	—0,042—0,100	—0,125—0,052
Mean	0,167	0,038	0,051	—0,014 mm
Range***		0,85—1,82	0,78—1,63	1,56—1,2
Mean		1,25	1,29	0,96

MS'51

Whorl	I	II	III	IV
Range	0,155—0,156	0,016—0,101	—0,017—0,143	0,040— mm
Mean	0,155	0,059	0,063	mm
Range		1,1—1,64	0,093—1,83	1,16—
Mean		1,37	1,38	

The spiral lamina is of variable thickness, in chambers slightly recurved. The P value varies from 1/5 to 1. In the first whorl its mean value is 1/2, in the second 1/3, in the third 2/5 and in the fourth whorl 3/5. The shape of chambers is variable. Besides specimens with longer chambers, both samples contain also specimens with isometric or slightly higher chambers. There occurred also specimens with isometric or a little higher chambers in the internal whorls and longer ones near the test's circumference. Back chamber angles are rounded. The chambers are separated from each other by equilinear or in the upper part slightly bent septa. They usually run diagonally. In the first whorl there are 6—7 septa (Mean 6.2), in the second 10—13 (Mean 11.3), in the third 14—15 (Mean 14.3) and in the fourth 17—18 septa (mean 17.5).

Remark: In our material we failed to find specimens with a perfectly preserved surface nor specimens that could be divided in two and therefore we could not have observed the surface and equatorial section of the same specimen. According to the form of the central part of the test we could divide weathered cores into two types. The first one has a netlike ornamentation throughout its surface, the second only near the circumference. Its central part is decorated with undulating septal filaments with tiny concentric granules. In the sample MS'-50 we have found only specimens without any reticulum in the test's central part (Tab. XX, Fig. 7). The sample MS'-51 contained both types (Tab. XX, Fig. 8, Tab. XX, Fig. 10). Among them there were specimens with distinct concentrically situated granules (Tab. XX, Fig. 9). According to the form of the peripheral part of the test, however, all specimens of both samples

** L — value in the sense of V. DE ZANCHE and R. PAVLOVEC, 1967

*** L — value in the sense of P. ROZLOZNIK, 1924

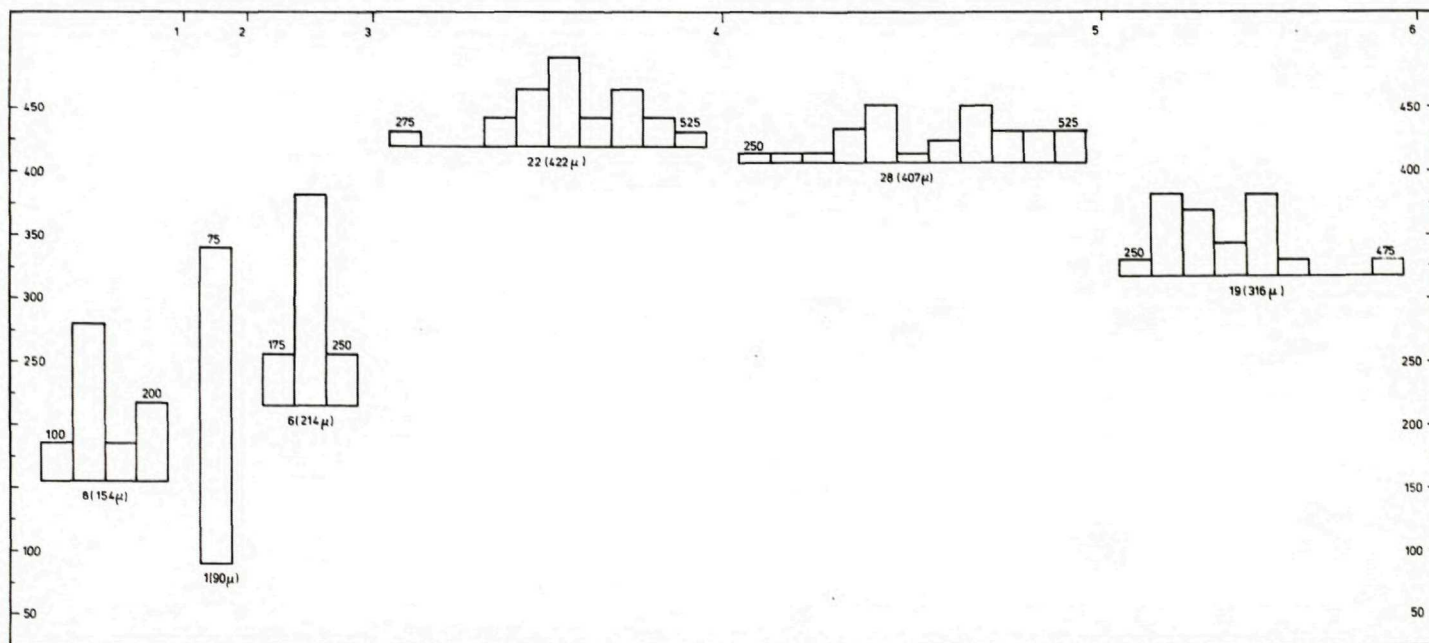


Fig. 2 Percent frequency distributions in length of protoconch of *Nummulites fabianii* (PREVER)?, *Nummulites fabianii retiatus* ROVEDA, Transitional form from *Nummulites fabianii retiatus* ROVEDA to *Nummulites fichteli* MICHELOTTI and *Nummulites fichteli* MICHELOTTI; 1—2 *Nummulites fabianii* (PREVER)?, 1 — sample MS'-50, 2 — sample MS'-51; 3 — *Nummulites fabianii retiatus* ROVEDA, sample MS'-52; 4—5 *Nummulites fichteli* MICHELOTTI, 4 — sample AD-9, 5 — sample AD-9a; 6 Transitional form from *Nummulites fabianii retiatus* ROVEDA to *Nummulites fichteli* MICHELOTTI, sample AD-13.

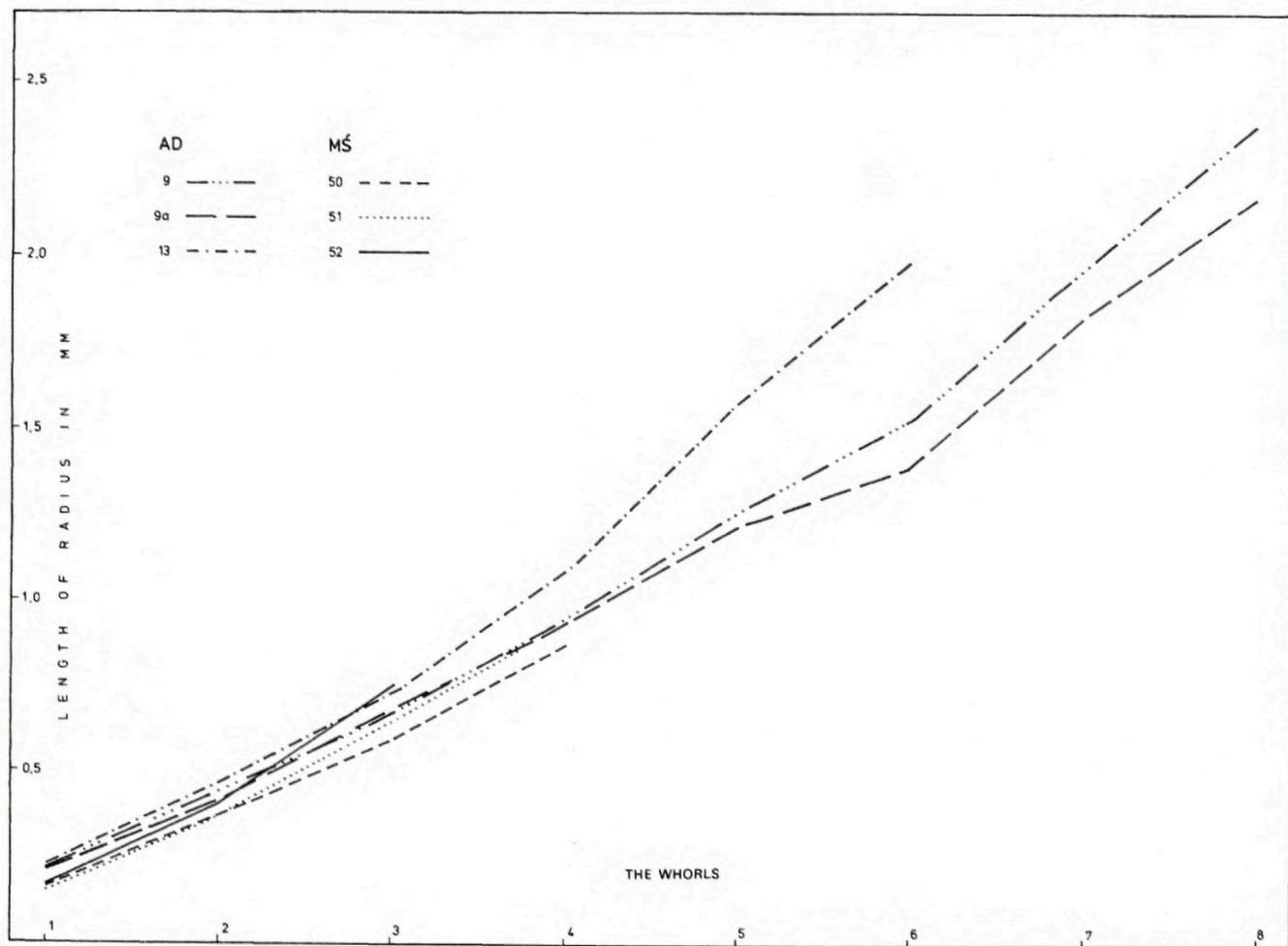


Fig. 3 Coiling diagrams of *Nummulites fabianii* (PREVER)? from samples MS'-50, MS'-51, of *Nummulites fabianii retiatus* ROVEDA from sample MS'-52, of Transitional form from *Nummulites fabianii retiatus* ROVEDA to *Nummulites fichteli* MICHELOTTI from sample AD-13 and of *Nummulites fichteli* MICHELOTTI from samples AD-9 and AD-9a.

can be regarded as one species. On the basis of the character of chambers and coiling of spire of accessible equatorial sections we assign them, with question mark, to the species *Nummulites fabianii* (PREVER). We suppose that the weathered cores provide only an imperfect picture of the test's form. Specimens with no transversal lamina in the central part of the test resemble the species *Nummulites fichteli* MICHELOTTI (V. ROVEDA 1970, p. 246, Fig. 3) and *Nummulites kakhadzei* MREVLISCHVILI (N. I. MREVLISCHVILI 1978, Tab. XII, Fig. 2, 4, Tab. XIII, Fig. 3, 5, 7). From the species *Nummulites fichteli* MICHELOTTI they differ in shorter chambers and more tightly coiled spire, whereas from the species *Nummulites kakhadzei* MREVLISCHVILI our specimens differ in a substantially smaller protoconch.

Our specimens are characterized by a small size and tiny protoconch. Small specimens of the species *Nummulites fabianii* (PREVER) are mentioned by R. HERB and H. HEKEL (1975) from the samples 724 and 728c in the section Val Organa east of Possagno. Our specimens differ from them in the surficial appearance and more tightly coiled spire.

Nummulites fabianii retiatus ROVEDA, 1959

Form A

Tab. XX, Fig. 13—15

1959 *Nummulites retiatus* n.sp. — V. ROVEDA: *Nummulites retiatus* nouvelle espèce etc., p. 201—206, tab. 1, fig. 1—10

1975 *Nummulites fabianii retiatus* ROVEDA—R. HERB—H. HEKEL: *Nummulites* aus dem Obereocaen von Possagno, p. 133—134, tab. 4, fig. 10, 11, tab. 5, fig. 2, 3, 7, 12, text. fig. 39, 40

Form of test: In the sample MS'-52 we failed to find any specimens on which the test surface could be observed.

Internal structure of test: Specimens with isolepidine-type nucleconch dominate in the material studied. The dimensions of the protoconch vary within the range:

	LP		HP	
	Range	Mean	Range	Mean
	0.183—0.228	0.214 mm	0.215—0.250	0.239 mm
Other parts of test:	Equatorial sections contain two or three preserved whorls. To the end of the second whorl the spire grows slowly, in the third it is already more loosely coiled. The L value ranges as follows:			
Whorl	I	II	III	
Range	0.135—0.210	0.020—0.113	0.044—0.155 mm	
Mean	0.171	0.069	0.099 mm	
Range		1.09—1.7	1.16—1.67	
Mean		1.44	1.41	

The spiral lamina is recurved in some whorls. In the first whorl it occupies in average 2/3, in the other ones 4/5 of the chamber height. The chambers are

usually longer already from the first whorl. Back chamber angles are somewhat deeper and rounded. Slightly bent septa are thin, running a little diagonally. In the first whorl there are 6—7 (Mean 6.6), in the second 10—13 (Mean 11.3) septa.

Remark: In comparison with the specimens *Nummulites fabianii* (PREVER)? from the samples MS'-50 and MS'-51, our specimens have a larger protoconch, longer chambers and much more loosely coiled spire from the second whorl, which gives them the character of the subspecies *Nummulites fabianii retiatius* ROVEDA. The general appearance of their equatorial section is equal to that of this subspecies in V. ROVEDA's (1959) work. Our specimens, however, differ from them in a larger length range of the protoconch. In 1973 and 1975 R. HERB—H. HEKEL presented diagrams of spiral coiling and histograms of the protoconch size of specimens of the subspecies *Nummulites fabianii retiatius* ROVEDA from two sections in the vicinity of the locality Possagno. From these, our specimens differ in a smaller protoconch and more tightly coiled spire. Nevertheless, the character itself of the spiral coiling is the same.

**Transitional form from *Nummulites fabianii retiatius* ROVEDA
to *Nummulites fichteti* MICHELOTTI**

FORM A

Tab. XXI, Fig. 1—4

Form of test: Slightly convex lenticular tests have a narrow rounded margin and surficial netlike ornamentation. Some specimens have also a white spot in the polar area. Septal filaments are radial, slightly undulating, only rarely continuous. Transversal lamina is absent. In the last two or three whorls it is indicated by only a fine thickening which does not protrude above the surface and follows the course of the spiral lamina. In the central part of the test, meshes of reticulum are mostly incomplete and irregularly rounded or sometimes radially elongated. In the last third of the test they become angular. Above the last two or three whorls they are two to three times elongated. The test diameter ranges from 2.1 to 3.2 mm and thickness amounts to 1.0—1.2 mm.

Internal structure of test: Specimens with isolepidine-type nucleconch prevail. The dimensions of the protoconch vary within the range:

	LP		HP	
	Range	Mean	Range	Mean
	0.265—0.482	0.316 mm	0.267—0.724	0.383 mm
Other parts of test: The spire grows regularly in the first four whorls, whereas in the last two it is more loosely coiled. The L value ranges as follows:				
Whorl	I	II	III	IV
Range	0.133—0.320	—0.063—0.102	0.091—0.097	0.078—0.131
Mean	0.229	0.009	0.026	0.052

Range		0.75—1.98	0.67—1.4	0.080—1.48
Mean		1.06	1.1	1.15
Whorl	V	VI		
Range	—0.032— —0.002	—0.048 mm		
Mean	—0.018 mm			
Range	0.89—0.95	0.87		
Mean	0.93			

The spiral lamina in chambers is slightly recurved and rather thick. The P value varies from 1/8 to 1/5. In the first whorl its mean value attains 2/5, in the other ones 1/2. The chamber length is larger than the height already from the first whorl. The length is 0.5—2.5 times larger than the height, especially in outer whorls. The chamber angles are rounded. The septa are regularly arranged and run slightly diagonally. They are thin, equilinear or, in the upper part, bent and terminated by a foot. Because of very indistinct visibility of individual parts of the test due to intensive recrystallization, we could have observed the number of septa in only a few specimens. In the first whorl there are 6 septa, in the second 10—12 (Mean 11), in the third 16 and in the fourth whorl 14 of them.

Remark: Specimens with surficial netlike ornamentation from the sample AD-13 cannot be unequivocally assigned to any species of the phylogenic order of the species *Nummulites fabianii* (PREVER). The appearance of their surface most resembles the species *Nummulites fichteli* MICHELOTTI, whereas their equatorial section is similar to that of the subspecies *Nummulites fabianii retiatius* ROVEDA. The similarity to the species *Nummulites fichteli* MICHELOTTI lies in incomplete and irregularly rounded meshes of reticulum in the central part of the test and in two to three times elongated oblong meshes above almost the last three whorls. No element of the netlike ornamentation protrudes above the test surface. As regards the similarity of the equatorial section to that of the subspecies *Nummulites fabianii retiatius* ROVEDA, it lies in the shape of the chambers and the way in which the spire is coiled. In the first three whorls the course of the spire resembles that of the species *Nummulites fabianii* (PREVER) and *Nummulites fichteli* MICHELOTTI, in the other whorls it becomes much looser. In this sign it most resembles the subspecies *Nummulites fabianii retiatius* ROVEDA, though our specimens are more loosely coiled.

M. CIZANCOURT (1943) described in page 755 and illustrated in Tab. XLV, Fig. 6, 7 the species *Nummulites fichteli* MICHELOTTI. According to this author it resembles, at the first look, the species *Nummulites subfabianii*, i. e. form A of the species *Nummulites fabianii* (PREVER). The surface appearance of the specimen from the locality Seba Biar (Tab. XLV, Fig. 6) is similar to our transitional form from *Nummulites fabianii retiatius* ROVEDA to *Nummulites fichteli* MICHELOTTI. The specimen from the locality Tarag el Allag differs from it in a thinner, in chambers unrecurved, spiral lamina and smaller height of the chambers in the peripheral part of the test.

Nummulites fichteli MICHELOTTI, 1841

Form A

Tab. XXI, Fig. 5, 6, Tab. XXII, Fig. 1—7, Tab. XXIII, Fig. 1—4

1841 *Nummulites fichteli* MICHELOTTI, p. 44, Pl. 3, Fig. 7 (non vidi), (fide V. ROVEDA, 1970)

1970 *Nummulites fichteli* MICHELOTTI, Form A — V. ROVEDA: Revision of the *Nummulites* etc., p. 245—249, Pl. 22, Fig. 1—3

1981 *Nummulites fichteli* MICHELOTTI, 1841, Form A — H. SCHAUB: *Nummulites et Assilines* etc., p. 128—130, Pl. 50, Fig. 6, 9, 10, 13, 15, 17, Tab. 15:1

Form of test: Slightly convex test rapidly flattens into a narrow rounded margin. From the test there protrude undulating irregular septa which join together thus forming a fine, variegatedly shaped surface ornamentation. In some specimens, in the beginning the meshes of reticulum are elongated in radial sense, then passing into irregularly rounded (Tab. XXII, Fig. 1), or more or less oblong ones still elongated in radial sense (Tab. XXII, Fig. 4). Above the last rarely and also above the next to the last whorl, the meshes become two to three times elongated oblongs. In some specimens the radial course of septa disappears. All their surface is covered with irregularly rounded meshes beginning in the immediate vicinity of the white spot. Only above the last whorl, oblong, in average three times elongated meshes can be seen (Tab. XXIII, Fig. 1, 3). In the sample AD-9 the mean test diameter attains 5.0 mm and thickness amounts to 1.6 mm. In the sample AD-9a the test diameter mostly varies from 3.4 to 4.5 mm and thickness from 1.5 to 1.8 mm.

Internal structure of test: In the samples AD-9 and AD-9a, most specimens have an anisolepidine nucleocoach. The dimensions of the protoconch vary as follows:

	L		H	
	Range	Mean	Range	Mean
AD-9	0.290—0.523	0.422 mm	0.360—0.628	0.496 mm
AD-9a	0.258—0.525	0.408 mm	0.318—0.604	0.472 mm

Other parts of test: The spire is regularly coiled up to the last whorl. In the specimens from the sample AD-9 it is slightly looser already from the first whorls and from the sixth whorl this difference becomes more distinct. The L value varies within the range:

AD-9				
Whorl	I	II	III	IV
Range	0.156—0.280	—0.077—0.062	—0.069—0.116	—0.050—0.157
Mean	0.220	0.005	0.016	0.054
Range		0.72—1.51	0.7—1.6	0.8—1.93
Mean		0.99	1.18	1.24
Whorl	V	VI	VII	VIII
Range	—0.069—0.170	—0.109—0.168	0.004—0.087	0.027 mm
Mean	0.028	—0.002	0.042	mm
Range	0.76—1.85	0.63—1.61	0.73—1.29	
Mean	1.1	1.01	0.98	

AD-9a

Whorl	I	II	III	IV
Range	0.120—0.295	—0.075—0.112	—0.054—0.096	—0.063—0.095
Mean	214	0.013	0.013	0.026
Range		0.58—1.85	0.78—1.44	0.95—1.47
Mean		1.09	1.08	1.12
Whorl	V	VI	VII	VIII
Range	—0.091—0.108	—0.096—0.134	—0.070—0.61	—0.058—0.031 mm
Mean	0.023	0.007	—0.013	—0.013 mm
Range	0.65—1.55	0.75—1.76	0.77—1.3	0.78—1.08
Mean	1.05	1.07	0.96	0.93

In chambers the spiral lamina is slightly recurved or equilinear and irregularly thick. The P value varies from 1/7 to 1 1/3. The mean P value of the specimens from both samples ranges from 2/5 to 1/2 the end of the sixth whorl. Specimens from the sample AD-9 have a thicker spiral lamina (3/4) in the last whorl than those from the sample AD-9a (1/3). From the test centre toward the periphery, the chambers gradually become longer. In the first whorls the chambers are 1 1/2 times and in the last whorls 3—4 times longer. The back chamber angles are slightly deepened, mostly pointed. The septa are short, equilinear or slightly bent and run somewhat diagonally. As regards the number of the septa, there are differences between the specimens of both samples:

AD-9

Whorl	I	II	III	IV
Range	6—8	9—15	15—21	6—24
Mean	6.6	11.6	16.9	20.5
Whorl	V	VI	VII	VIII
Range	17—24	22—23	24—25	
Mean	21.1	22.6	24.5	

AD-9a

Whorl	I	II	III	IV
Range	5—8	11—16	13—19	16—23
Mean	6	12.6	15.7	17.8
Whorl	V	VI	VII	VIII
Range	16—22	16—21	19—28	19
Mean	18.8	19.3	23.8	

Remark: According to the character of the reticulum, the specimens from the sample AD-9a could be divided in two types. The first type would comprise the specimens with more or less visible septal filaments (Tab. XXII, Fig. 1, 4) whereas the second type includes specimens whose septal filaments are so undulating that they cannot be observed (Tab. XXIII, Fig. 1, 3). The latter

Table of statistical data of Transitional form from *Nummulites fabianii retiatus* ROVEDA to *Nummulites fichteli* MICHELOTTI from the sample AD-13

Number of the specimen	Protoconch		Length of the radius in whorls						L value	
	Length	Height	1	2	3	4	5	6	in the sense of V.	
									1	2
21	0.265	0.284	0.185	0.394	0.598				0.185	0.024
1	0.282	0.312	0.22	0.439	0.707	1.105	1.505		0.224	-0.009
35	0.286	0.325	0.243	0.464	0.714				0.243	-0.022
17	0.290	0.338	0.237	0.469	0.690	0.927			0.237	-0.005
16	0.297	0.338	0.241	0.480	0.693	0.984			0.241	-0.002
32	0.297	0.267	0.133	0.368	0.570				0.133	0.102
18	0.303	0.346	0.215	0.439	0.690	1.060			0.215	0.009
36	0.323	0.533	0.215	0.497	0.688	0.882			0.215	0.067
23	0.323	0.391	0.247	0.529	0.860	1.269	1.654	1.991	0.247	0.035
31	0.325		0.228	0.439	0.684	0.963			0.228	0.017
27	0.357		0.215	0.471	0.789	1.221	1.641		0.215	0.041
34	0.357	0.232	0.307	0.585	0.899	1.344			0.307	-0.029
30	0.366	0.437	0.263	0.546	0.860				0.263	0.020
38	0.372		0.183	0.402	0.645	0.925			0.183	0.036
37	0.374	0.361	0.252	0.441	0.707	1.041			0.252	-0.063
33	0.389	0.472	0.194	0.344	0.591				0.194	-0.044
22	0.482	0.724	0.320	0.590	0.943	1.250	1.525		0.320	-0.050
20			0.228	0.496	0.783	1.137			0.228	0.040

have the entire surface of their test covered with small irregular rounded meshes. The first-type specimens resemble the species *Nummulites fichteli* MICHELOTTI from the locality Migiurtinia in the northern part of former Italian Somalia that was illustrated by E. MARCHESINI and G. C. FACCA (1941—1942, Tab. VIII (II), Fig. 15—20). The appearance of the second-type specimens is similar to that of the species *Nummulites garansianus* JOLY-LEYMERIE that was assigned to the species *Nummulites fichteli* MICHELOTTI by the authors Ph. DE LA HARPE (1881, p. 8), G. BOMBITA (1975, p. 65) and H. SCHAUB (1981, p. 129). There are no differences in the equatorial section character of specimens of both our types, which confirms the supposition of the above-mentioned authors about the identity of these species.

In comparison with M. CIZANCOURT'S (1934) specimens of the species *Nummulites fichteli* MICHELOTTI, the specimen from the locality Seba Biar has a different shape of its peripheral part and specimen from Tarag el Allag has a thinner spiral lamina and therefore also higher and sorter chambers. Its character most resembles the specimens from the sample AD-13, which we consider a

in whorls									Number of septa in whorls			
de Zanche and R. Pavlovec (1967)				in the sense of P. Rozloznsnik (1924)					1	2	3	4
3	4	5	6	2	3	4	5	6				
-0.005				1.12	0.97							
0.053	0.130	-0.002		0.96	1.25	1.48			6	10		14
0.029				0.91	1.13							
0.011	0.016			0.98	0.95	1.07			6	12		
-0.026	-0.078			0.99	0.89	1.36			6	11	16	
-0.033					1.75	0.86						
0.027	0.119			1.04	1.12	1.47						
-0.091	0.033			1.3	0.67	1						
0.049	0.078	-0.024	-0.048	1.14	1.17	1.23	0.94	0.87				
0.034	0.034			0.92	1.16	1.14					14	
0.062	0.114	-0.012		1.2	1.2	1.41	0.95					
0.036	0.131			0.9	1.13							
0.031				1.98	1.1							
0.024	0.037			1.2	1.1	1.15						
0.077	0.068			0.75	1.4	1.25						
0.097				0.77	1.35							
0.083	-0.046	-0.032		0.90	1.27	0.80	0.89					
0.019	0.067			1.18	1.08	1.23						

transitional form from *Nummulites fabianii retiatius* ROVEDA to *Nummulites fichteli* MICHELOTTI.

Form B

Tab. XXIII, Fig. 5—7

1846 *Nummulites intermedia* D'ARCHIAC, p. 199 (non vidi) (fide V. ROVEDA, 1970)

1970 *Nummulites intermedia*, 1846, Form B — V. ROVEDA: Revision of the *Nummulites* etc., p. 249—252, Tab. 22, Fig. 9, Tab. 24, Fig. 1, 2, text. fig. 27—34

1981 *Nummulites fichteli* MICHELOTTI, Forme B — H. SCHAUB: *Nummulites et Assilines* etc., p. 128—129, P. 50, Fig. 5—8, 11, 12, 16, 18 Tab. 15:k

Form of test: Slightly convex test rapidly flattens toward a narrow rounded margin. On the surface there is a fine, rather indistinct netlike ornamentation formed of small irregular rounded meshes. The test diameter ranges from 11.0 to 13.0 mm and thickness from 2.0 to 2.3 mm.

Table of statistical data of *Nummulites fabianii* (PREVER)? and *Nummulites fabianii retiatus* ROVEDA

Sample	Number of the specimen	Nucleoconch		Length of the radius in whorls*				L value in whorls							Number of septa in whorls				Species
		Length	Height	1	2	3	4	in the sense of V. de Zanche and R. Pavlovec (1967)				in the sense of P. Rozložník (1924)			1	2	3	4	
								1	2	3	4	2	3	4					
MS'-50	8	0.125	0.288	0.148	0.370	0.655	0.815	0.148	0.074	0.063	−0.125	1.5	1.28	0.56		11	14		Nummulites fabianii (PREVER)?
	40	0.135	0.130	0.190	0.375	0.633	0.943	0.190	−0.005	0.073	0.052	0.97	1.39	1.2					
	42	0.138	0.118	0.158	0.350	0.500		0.158	0.034	−0.042		1.21	0.78		6	12	14	18	
	9	0.143	0.183	0.168	0.345	0.585	0.855	0.168	0.009	0.063	0.030	1.05	1.35	1.12	6	12	15	17	
	39	0.143		0.183	0.340	0.597		0.183	−0.026	0.100		0.85	1.63						
	6	0.160	0.250	0.170				0.170											
	7	0.190	0.198	0.173	0.410			0.173	0.064			1.36			7	10	14		
	12	0.200	0.220	0.145	0.410			0.145	0.120			1.82			6	13	15		
MS'-51	7	0.090		0.155	0.326	0.640		0.155	0.016	0.143		1.10	1.83		6	10	14		
	1			0.156	0.413	0.653	0.933	0.156	0.101	−0.017	0.040	1.64	0.93	1.16					
MS'-52	8	0.183	0.230	0.135	0.365	0.750		0.135	0.095	0.155		1.7	1.67						Nummulites fabianii retiatius ROVEDA
	42	0.213	0.215	0.163	0.375			0.163	0.049			1.3							
	9	0.220	0.250	0.160	0.433	0.750		0.160	0.113	0.044		1.7	1.16		7	10			
	43	0.225	0.250	0.210	0.440			0.210	0.020			1.09			6	11			
	41	0.228	0.250	0.188				0.188							7	13			

* The length of the radius was measured from the beginning of the first whorl

Table of statistical data of *Nummulites fichteli* MICHELOTTI from the sample AD-9a

Number of the specimen	Protoconch		Length of the radius in whorls								L value in whorls																Number of septa in whorls							
	Length	Height	1	2	3	4	5	6	7	8	in the sense of V. de Zanche and R. Pavlovec (1967)								in the sense of P. Rozloznsnik (1924)								1	2	3	4	5	6	7	8
											1	2	3	4	5	6	7	8	2	3	4	5	6	7	8									
10	0.258	0.365	0.181	0.430	0.626	0.860	1.112	1.410			0.181	0.068	−0.053	0.038	0.018	0.046			1.38	0.78	1.19	1.07	1.18			6	12	14	17	17	16			
12	0.293	0.318	0.215	0.430	0.645	0.948	1.329	1.707	2.062		0.215	0.000	0.000	0.088	0.078	−0.003	−0.023		1	1	1.41	1.25	0.99	0.93		6	13	15	19	18	21			
42	0.308	0.430	0.202	0.392	0.624	0.860	1.092	1.359	1.632	1.847	0.202	−0.012	0.042	0.004	−0.004	0.035	0.006	−0.058	0.94	1.22	1.01	0.98	1.15	1.02		7	13	16	16	16	19	19		
50	0.329	0.466	0.204	0.385	0.645	0.931	1.270	1.557			0.204	−0.023	0.079	0.026	0.053	−0.052			0.88	1.44	1.1					6	11	17	16	19				
21	0.335	0.406	0.157	0.360	0.597	0.897	1.195	1.593			0.157	0.046	0.034	−0.063	0.002	0.100			1.29	1.17	1.27	0.99	1.33			5	13	15	17	19				
23	0.335	0.378	0.215	0.387	0.606	0.832	1.120	1.419	1.649		0.215	−0.043	0.047	0.007	0.062	0.011	−0.069		0.8	1.27	1.03	1.27	1.03	0.77		6	16	16	18					
11	0.351	0.450	0.219	0.447	0.673	0.972	1.303				0.219	0.009	−0.003	0.075	0.031				1.04	0.99	1.33	1.1				6	11	15	19	16	17	22		
20	0.355	0.394	0.146	0.353	0.645	0.931	1.230	1.548			0.146	0.061	0.085	−0.006	0.013	0.019			1.41	1.41	0.97	1.04	1.06			6	14	13	16	16				
40	0.359		0.120	0.342	0.557	0.847	1.125	1.370	1.632		0.120	0.102	−0.007	0.075	−0.012	−0.033	0.017		1.85	0.96	1.35	0.95	0.88	1.06		5	14	13	18	21	21	28		
18	0.361	0.443	0.215	0.430	0.684	0.948	1.275				0.215	0.000	0.039	0.010	0.064				1	1.18	1.03	1.23				6	14	16	16	18	20			
19	0.363	0.430	0.215	0.458	0.755	1.075	1.462	1.753	2.105	2.488	0.215	0.028	0.054	0.023	0.067	−0.096	0.061	0.031	1.13	1.22	1.07	1.2	0.75	1.3	1.08	6	11	15	18	16	19	22	19	
53	0.400	0.430	0.224	0.443	0.695	0.888	1.189	1.443			0.224	−0.005	0.033	−0.059	0.108	−0.047			0.58	1.15	0.77	1.55	0.84			5	12	16	17	19				
17	0.409	0.443	0.226	0.466	0.716	0.974					0.226	0.014	0.010	0.008					1.06	1.04	1.03					8	10	16						
24	0.430	0.512	0.215	0.449	0.562	0.950	1.264	1.544			0.215	0.019	−0.031	0.095	0.016	−0.034			1.09	0.86	1.47	1.05	0.89			6	13	16	18	20				
25	0.430	0.452	0.267	0.548	0.796						0.267	0.014	−0.033						1.05	0.88						5	11	16						
47	0.430	0.527	0.185	0.482	0.725	0.959					0.185	0.112	−0.054	0.009					1.6	0.81	0.86					7	13	17	23					
44	0.447	0.447	0.215	0.449	0.667	0.916	1.178	1.415			0.215	0.019	−0.016	0.031	0.013	−0.025			1.09	0.93	1.14	1.05	0.9			6	11	15	17	19	20			
51	0.447	0.437	0.249	0.480	0.697	0.955					0.249	−0.018	−0.014	0.041					0.92	0.94	1.18					5	12							
16	0.454	0.559	0.215	0.430	0.675	0.942	1.118	1.428			0.215	0.010	0.020	0.022	−0.091	0.134			1.07	1.08	1.1	1.65	1.76											
9	0.456	0.550	0.248	0.510							0.248	0.014							1.06							6	16							
52	0.460	0.540	0.226	0.484	0.736	0.976					0.226	0.032	−0.006	−0.012					1.14	0.98	0.95					7	12	18						
46	0.477	0.574	0.290	0.510	0.813						0.290	−0.070	0.083						0.75	1.38						5	12	18	19	22				
45	0.488	0.593	0.258	0.441	0.720	1.002	1.316				0.258	−0.075	0.096	0.003	0.032				0.7	1.52	1.01	1.11				6	12	16	17	22				
41	0.490		0.178	0.404	0.618	0.860	1.097	1.361			0.178	0.048	−0.012	0.028	−0.005	0.027			1.26	0.94	1.13	0.97	1.11			5	14	13	18	21	21	28		
26	0.503	0.600	0.224	0.452	0.650						0.224	0.004	−0.030						1.01	0.86														
43	0.510	0.604	0.173	0.406	0.609	0.875	1.118	1.387	1.576		0.173	0.060	−0.030	0.063	−0.023	0.026	−0.070		1.34	0.87	1.31	0.91	1.1	0.70	0.78	7	14	19	21	22				
54	0.525		0.295	0.535	0.860	1.174	1.505				0.295	−0.055	0.085	−0.011	0.017				0.81	1.35	0.97	1.05				5	12	17						

Geologický ústav Dionýza Štúra
GEOL. INFORM. STREDISKO
Mlynská dolina 1
817 04 BRATISLAVA

Table of mean statistical data of *Nummulites fabianii* (PREVER)? (1), *Nummulites fabianii retiatus* ROVEDA (2), Transitional form from *Nummulites fabianii retiatus* ROVEDA to *Nummulites fichteli* MICHELOTTI (3) and *Nummulites fichteli* MICHELOTTI (4)

Sample	Protoconch		Length of the radius in whorls								L value								in whorls								Number of septa in whorls								Species or subspecies
	Length	Height	1	2	3	4	5	6	7	8	in the sense of V. de Zanche and R. Pavlovec (1967)								in the sense of P. Rozloznsnik (1924)								1	2	3	4	5	6	7	8	
											1	2	3	4	5	6	7	8	2	3	4	5	6	7	8										
MS'-50	0.154	0.198	0.167	0.371	0.594	0.871					0.167	0.038	0.051	−0.014					1.25	1.29	0.96					6.2	11.3	14.3	17.5					1	
MS'-51			0.155	0.369	0.646	0.933					0.155	0.059	0.063						1.37	1.38															
MS'-52	0.214	0.239	0.171	0.403	0.750						0.171	0.069	0.099						1.44	1.41						6.6	11.3							2	
AD-13	0.316	0.383	0.229	0.466	0.728	1.085	1.581	1.991			0.229	0.009	0.026	0.052	−0.018				1.06	1.1	1.15	0.93				6	11							3	
AD-9	0.422	0.496	0.220	0.443	0.670	0.950	1.267	1.537	1.978	2.380	0.220	0.005	0.016	0.054	0.028	−0.002	0.042		0.99	1.18	1.24	1.1	1.01	0.98		6.6	11.6	16.9	20.5	21.1	22.6	24.5		4	
AD-9a	0.408	0.472	0.214	0.410	0.680	0.937	1.226	1.399	1.832	2.167	0.214	0.013	0.013	0.026	0.023	−0.007	−0.013	−0.013	1.09	1.08	1.12	1.07	1.07	0.96	0.93	6	12.6	15.7	17.8	18.8	19.3	23.8			

Table of statistical data of *Nummulites fichteli* MICHELOTTI from the sample AD-9

Number of the specimen	Protoconch		Length of the radius in whorls								L value in whorls																Number of septa in whorls						
	Length	Height	1	2	3	4	5	6	7	8	in the sense of V. de Zanche and R. Pavlovec (1967)								in the sense of P. Rozloznsnik (1924)								1	2	3	4	5	6	7
											1	2	3	4	5	6	7	8	2	3	4	5	6	7	8								
2	0.290	0.360	0.168	0.373	0.608	0.865					0.168	0.037	0.025	0.022					1.2	1.14	1.09					7	13	17	13	23			
12	0.355	0.433			0.553	0.858	1.113	1.570						-0.045	0.168								0.83	1.61		6	11	15	16	17			
21	0.360	0.500	0.176	0.370	0.598	0.890	1.115	1.358			0.176	0.018	0.032	0.068	-0.069	0.018			1.08	1.18	1.28	0.76	1.07			7	14	21	23	20	23		
15	0.380		0.208	0.473	0.726	1.020	1.280				0.208	0.057	-0.012	0.041	-0.034				1.27	0.96	1.14	0.88				7	12	16	23	24			
1	0.383		0.233	0.420	0.723		1.198				0.233	-0.046	0.116						0.8	1.6						7	12	19	22				
13	0.390	0.440	0.250	0.500	0.750	0.950	1.320				0.250	0.000	0.000	-0.050	0.170				1	1		0.8	1.85						22				
11	0.398	0.460	0.250	0.440	0.475	0.960	1.195	1.500			0.250	-0.060	0.035	0.060	-0.050	0.070			0.76	1.18	1.26	0.82	1.29			7	13	18	20	24			
8	0.403	0.500	0.250	0.513	0.750	1.085	1.458				0.250	0.013	-0.026	0.098	0.038				1	0.90	1.41	1.11							22				
9	0.405	0.500	0.258	0.500	0.733		1.478	1.933	2.353		0.258	0.016	0.031				0.035		0.94	1.12				0.92		6	11	17	24	22	23	24	
17	0.405	0.470	0.188	0.405	0.623	0.923	1.250				0.188	0.029	0.001	0.082	0.027				1.16	1	1.37	1.09				7	15	18	21	20			
28	0.418	0.475	0.255	0.460							0.255	-0.050							0.8							7	12						
25	0.423	0.500	0.220	0.453		0.972	1.250	1.523			0.220	0.013				0.005			1.05				1.01			6	9	10	18	21			
29	0.423	0.520	0.250		0.653	0.897	1.250	1.500			0.250				0.109	-0.104						1.44	0.70			6							
4	0.435	0.532	0.156	0.393	0.560	0.885	1.250				0.156	0.081	-0.069	0.157	0.040				1.51	0.71	1.93	1.12				5	14	17					
3	0.440	0.540	0.168	0.328	0.588	0.865	1.128	1.423	1.805		0.168	-0.008	0.100	0.017	0.086	-0.068	0.087		0.95	1.6	1	1.13	0.81	1.29		7	11	17					
26	0.463		0.250	0.455	0.675						0.250	-0.045	0.015						0.8	1.07						8	13						
22	0.465	0.513	0.205	0.410	0.618	0.888	1.170	1.468	1.685		0.205	0.010	0.007	0.062	0.012	0.016			1	1	1.3	1.04	1.05	0.73		7							
16	0.470	0.515		0.500		1.068	1.365	1.553								-0.109							0.63			6	11	15					
23	0.475		0.250	0.500	0.685						0.250	0.000	-0.065						1	0.7													
24	0.482		0.168	0.385	0.650	0.975					0.168	0.049	0.048	0.060					1.29	1.2	1.22												
7	0.500	0.548	0.250	0.510	0.750	1.055	1.400	1.733	2.070	2.380	0.250	0.010	-0.020	0.045	0.040	-0.012	0.004	0.027	1	0.92	1.17	1.13	0.96	1	0.91	6	11	17	18	20	22	25	
14	0.523	0.628	0.193	0.448	0.735						0.193	0.062	0.032						1.3	1.1						7	13	20					
5			0.280	0.483	0.720	1.000	1.320				0.280	-0.077	0.034	0.043	0.040				0.72	1.17	1.17	1.14							19	20			

Internal structure of the test: According to the spiral coiling and chamber shape we distinguish three parts in the equatorial section. The first seven whorls are tightly coiled. The chambers are isometric with a recurved spiral lamina. The septa are slightly bent and diagonal, the back chamber angles are rounded. In the 8th to 17th whorl the spire is loosely coiled, in chambers slightly recurved. The length of the chambers is $1\frac{1}{2}$ to $3\frac{1}{2}$ larger than their height. Also here the septa are slightly bent and diagonal. In the chambers they form rounded or a little pointed back angles. The outer, very tightly coiled stretch begins in the 18th whorl. Here the chambers are three to four times larger. The septa are equilinear, run diagonally and in chambers form a deeper pointed back angle. The thickness of the spiral lamina varies from $\frac{2}{5}$ to 1, near the test margin it exceeds the height of chambers. In a radius of 6.3 there are 20 whorls.

Remark: A characteristic sign of our specimens is that in their netlike ornamentation there are only small meshes and the course of the septal filaments cannot be observed. Their ornamentation equals that of specimens of the species *Nummulites garansianus* YOLY—LEYMERIE, which, as has been mentioned above, was assigned to the species *Nummulites fichteli* MICHELOTTI by PH. DE LA HARPE (1881, p. 8), G. BOMBITA (1975, p. 65) and H. SCHAUB (1981, p. 129). The narrow coiling of the spire in the inner and outer whorls and fairly regular arrangement of chambers are conspicuous, too. These characteristics of our specimens most resemble a specimen from Biarritz illustrated in Tab. 50, Fig. 5 in the work of H. SCHAUB (1981).

Translated by L. Böhmer

Reference

- ABDULRACHIM, A. Ch. 1970: Nummulity Damasskoj oblasti Sirii. Izv. vys. učeb. zaved., Geol. Razv., 8, Baku, 23—25.
- D'ARCHIAC, A. 1846: Description des fossiles recueillis par M. Thorent dans les couches à Nummulines des environs de Bayonne. Mém. Soc. géol. France, 2, 2, Paris, 189—217.
- BIEDA, F. 1963: Duże otwornice eocenu tatrzańskiego. Institut geologiczny. Prace, 37, Warszawa, 1—215.
- BOMBITA, G. 1975: Remarques sur le groupe de Nummulites fabianii. Rev. esp. Micropaleont., 7, 1, Empresa nacional "Adaro", Madrid, 63—90.
- BOUSSAC, J. 1911: Études paléontologiques sur le nummulitique alpin. Mém. Ct. géol. dét. France, Paris, 1—122.
- DE CIZANCOURT, M. 1934: Matériaux pour la Stratigraphie du Nummulitique dans le Désert de Syrie. C. R. sommaire et Bull. Soc. géol. France, 5, 4, Société géologique de France, Paris, 737—758.
- FERRER, F. 1971: El Paleoceno y Eoceno del borde sur-oriental de la depresión del Ebro (Cataluña). Schweiz. paläont. Abh., 90, Kommission der Schweiz. Naturforsch. Gesell., Basel, 1—70.
- GRIGORIAN, S. M. 1961: Novyje podvidy nummulitov iz verchneocenovych otloženij Armenii. Dokl. Arm. Akad. Nauk, 32, Jerevan, 105—112.
- HARPE, DE LA PH. 1881: Étude des Nummulites de la Suisse et révision des espèces éocènes des genres Nummulites et Assilina. 1. Mém. Soc. Pal. Suisse, 7, Genève, 1—123.
- HERB, R.—HEKEL, H. 1973: Biostratigraphy, Variability and Facies Relations of some Upper Eocene Nummulites from Northern Italy. Eclogae geol. Helv., 66, 2, Schweiz. geol. Gesell., Basel, 419—445.

- HERB, R.—HEKEL, H. 1975: Nummulites aus dem obereocaen von Possagno. Schweiz. paläont. Abh., 97, Kommission der Schweiz. Naturforsch. Gesell., Basel, 113—135.
- JOLY, N.—LEYMERIE, A. 1848: Mémoire sur les nummulites considérées zoologiquement et géologiquement. Mém. Acad. roy. Inscrit. Bell.-Lett. Toulouse, 3 sér., t. 4, Toulouse, 149—218.
- KAČARAVA, Z. D. 1969: O filogenetičeskom riade gruppy Nummulites fabianii. Soobšč. Akad. Nauk Gruz. SSR 55, 2, Akad. Nauk Gruzinskoj SSR, Tbilisi, 497—500.
- MARCHESINI, E.—FACCA, G. C. 1941—1942: Sulla variabilità di Nummulites fichteli Michelotti. Paleontographica italica, 40 (n. ser. 10), Pisa, 39—65 (1—27).
- MREVLISVILI, M. J. 1971: Nummulites praefabianii Var. et Menn. v paleogene Gruzii. Soobšč. Akad. Nauk Gruz. SSR, 62, 1, Akad. Nauk Gruzinskoj SSR, Tbilisi, 109—112.
- MREVLISVILI, N. J. 1978: Nummulity Gruzii i ich stratigrafičeskoje značenie. Izd. Tbiliskovo Univ., Tbilisi, 241 p.
- NEMKOV, G. I. 1967: Nummulitidy Sovetskogo sojuza i ich biostratigrafičeskoje značenie. Materialy k poznaniu geologičeskogo strojenija SSSR, izdavyanje moskov. obšč. ispyt. prirody, N. S. V. 16(20), Moskva, 1—318.
- PAVLOVEC, R. 1961: K poznavanju eocenskih in oligocenskih numulitov Jugoslavije. Razprave Sloven. Akad. Znan. Umetn., 6, Ljubljana, 399—416.
- PTUCHIAN, A. E. 1964: O fylogenii gruppy Nummulites partschi. Vopr. geol. Kavkaza. Izd. AN Armjan. SSR, Jerevan, 49—55.
- ROVEDA, V. 1959: Nummulites retiatius nouvelle espèce de Nummulite réticulée des Abrusses (Italie). Rev. Micropaléont. 4, Laboratoire de Micropaléont. de l'Université, Paris, 201—207.
- ROVEDA, V. 1970: Revision of Nummulites (Foraminiferida) of the N. fabianii — fichteli group. Riv. ital. Paleont. Stratigr., 76, 2, Milano, 235—324.
- ROZLOSNIK, P. 1927: Bevezetés a Nummulinák és Assilinák tanulmányozásába. Magy. kir. földt. Intéz. Évk., 26, Budapest, 1—136.
- ROZLOSNIK, P. 1929: Studien über Nummulinen. Geologica Hungarica ser. paleont., 2, Edit. Institutum Regni Hungariae Geol., Budapestini, 89 (5) — 248 (164).
- SCHAUB, H. 1981: Nummulites et Assilines de la Téthys paléogène. Taxinomie, phylogénèse et biostratigraphie. Schweiz. paläont. Abh., 104—106, Kommission der Schweiz. Naturforsch. Gesell., Basel, 1—238, Pl. 1—97.
- VAŇOVÁ, M. 1972: Nummulites from the area of Bojnice, the Upper Hron Depression, and the Budín Paleogene around Štúrovo. Západ. Karpaty, 17, Geol. Úst. D. Štúra, Bratislava, 5—104.
- VAŇOVÁ, M. 1981: On transitional forms from Nummulites fabianii (Prever) to Nummulites fichteli Michelotti from boreholes LU-2 and P-16 in Horehronská kotlina (depression). Západ. Karpaty, sér. paleontol., 6, Geol. Úst. D. Štúra, Bratislava, 49—63.
- DE ZANCHE, V.—PAVLOVEC, R. 1967: Mikrofavna in Microfacies iz eocenskih flišnih plasti pri Ustju v Vipavski dolini JZ Slovenija. Razpr. Sloven. Akad. Znan. Umetn., 10/5 Slovenska Akademia znanosti in umetnosti, Ljubljana, 206—263.

MARGITA VAŇOVÁ—HIND KANAFANI

Paleontologická charakteristika numulitov so sieťovou ozdobou povrchu z okolia Damašku a Dmeru (Sýria)

Resumé anglického textu

V spoločenstvách veľkých foraminifer s prevládajúcim zastúpením numulitov sa severne od Damašku a v oblasti Dmeru našli zaujímavé numulity so sieťovou ozdobou povrchu. V profile AD s. od Damašku boli väčšie, avšak veľmi prekryštalizované.

V profile MS' vo vzorkách MS'-50 a MS'-51 ich môžeme podľa vzhľadu povrchu rozdeliť do dvoch typov. Prvý typ má sieťovú ozdobu na celom povrchu, druhý iba pri obvode schránky. Na základe charakteru komôrok a vinutia špirály ich zaraďujeme s otáznikom k druhu *Nummulites fabianii* (PREVER). Exempláre bez transverzálnej laminy

v centrálnej časti schránky pripomínajú druhy *Nummulites fichteli* MICHELOTTI (V. ROVEDA, 1970, p. 246. fig. 3) a *Nummulites kakhadzei* MREVLISCHVILI (N. I. MREVLISVILI 1978, tab. XII, fig. 2, 4, tab. XIII, fig. 3, 5, 7). Od druhu *Nummulites fichteli* MICHELOTTI sa líšia kratšími komôrkami a užším vinutím špirály, od druhu *Nummulites kakhadzei* MREVLISCHVILI podstatne menšou protokonchou. Naše exempláre sú charakteristické malým vzrastom a malou protokonchou. Malé exempláre druhu *Nummulites fabianii* (PREVER) uvádzajú R. HERB a H. HEKEL (1975) vo vzorkách 724 a 728 c v profile Val Organa východne od Possagna. Naše exempláre sa od týchto odlišujú užšie vinutou špirálou.

Exempláre poddruhu *Nummulites fabianii retiatius* ROVEDA zo vzorky MS'-52 majú v porovnaní s exemplármi *Nummulites fabianii* (PREVER)? zo vzoriek MS'-50 a MS'-51 väčšiu protokonchu a dlhšie komôrky a podstatne voľnejšie vinutú špirálu od druhého závitú. V porovnaní s exemplármi *Nummulites fabianii retiatius* ROVEDA na tab. 1 v práci V. ROVEDA (1959) majú zhodný celkový vzhľad ekvatoriálneho rezu. Odlišujú sa od nich väčším rozpätím dĺžky protokonchy. R. HERB—H. HEKEL (1973 a 1975) uviedli diagramy vinutia špirály a histogramy veľkosti protokonch exemplárov poddruhu *Nummulites fabianii retiatius* ROVEDA z dvoch profilov z okolia lokality Possagno. Od týchto exemplárov sa naše líšia menšou protokonchou a užšie vinutou špirálou. Samotný charakter vinutia špirály majú však rovnaký.

V profile AD vo vzorke AD-13 exempláre so sieťovou ozdobou povrchu považujeme za prechodnú formu od *Nummulites fabianii retiatius* ROVEDA k *Nummulites fichteli* MICHELOTTI. Vzhľadom povrchu schránky najviac pripomínajú druh *Nummulites fichteli* MICHELOTTI, ekvatoriálnym rezom poddruh *Nummulites fabianii retiatius* ROVEDA. Podobnosť s druhom *Nummulites fichteli* MICHELOTTI spočíva v neúplných a nepravidelne zaoblených okách siete v centrálnej časti schránky a v dva až tri razy predĺžených obdĺžnikových okách nad poslednými necelými tromi závitmi. Ani jeden prvok sieťovej ozdoby neprečnieva nad povrch schránky. Podobnosť ekvatoriálneho rezu s poddruhom *Nummulites fabianii retiatius* ROVEDA sa javí v tvare komôrok a v spôsobe vinutia špirály. V prvých troch závitoch špirála má podobný priebeh ako u druhov *Nummulites fabianii* (PREVER) a *Nummulites fichteli* MICHELOTTI, potom začína byť podstatne voľnejšia. Týmto znakom stojí bližšie k poddruhu *Nummulites fabianii retiatius* ROVEDA i keď je od neho voľnejšie vinutá.

M. CIZANCOURTOVÁ (1934) opísala na str. 755 a vyobrazila na tab. XLV, obr. 6, 7 druh *Nummulites fichteli* MICHELOTTI, ktorý podľa autorky na prvý pohľad pripomína druh *Nummulites subfabianii*, teda formu A druhu *Nummulites fabianii* (PREVER). Exemplár z lokality Seba Biar (Tab. XLV, obr. 6) vzhľadom povrchu pripomína našu prechodnú formu od *Nummulites fabianii retiatius* ROVEDA ku *Nummulites fichteli* MICHELOTTI. Exemplár z lokality Tarag el Allag sa od nej líši tenšou, v komôrkach nevykrojenou špirálnou laminou a menšou výškou komôrok v obvodovej časti schránky.

Vo vzorke AD-9 a AD-9a vystupuje druh *Nummulites fichteli* MICHELOTTI. V diagnostických hodnotách sa exempláre oboch vzoriek od seba trochu odlišujú (pozri tabuľku priemerných štatistických hodnôt, histogramy dĺžky protokonch — obr. 2 a diagramy vinutia špirál — obr. 3).

Podľa charakteru siete by sme mohli exempláre zo vzorky AD-9a rozdeliť do dvoch typov. Do prvého by sme mohli zaradiť exemplár s viac-menej sledovateľnými septálnymi čiarami (Tab. XXII, obr. 1, 4), do druhého exempláre s natoľko vlnitým priebehom septálnych čiar, že ich až nemožno sledovať (Tab. XXIII, obr. 1, 2). Tieto majú celý povrch schránky pokrytý malými nepravidelným zaoblenými okami. Exempláre prvého typu pripomínajú exempláre druhu *Nummulites fichteli* MICHELOTTI z lokality Migiur-

tinia v severnej časti bývalého Talianskeho Somálska, ktoré E. MARCHESINI a G. C. FACCA (1941—1942) vyobrazili na obr. 15—20 na tabuľke VIII(II). Exempláre druhého typu sú vzhľadom zhodné s druhom *Nummulites garansianus* JOLY—LEYMERIE, ktorý PH. DE LA HARPE (1881, p. 8), G. BOMBITA (1975, p. 65) a H. SCHAUB (1981, p. 129) zahrnuli ku druhu *Nummulites fichteli* MICHELOTTI. V charaktere ekvatoriálneho rezu exemplárov oboch našich typov nepozorujeme žiadne rozdiely, čo potvrdzuje mienku vyššie uvedených autorov o totožnosti oboch druhov.

Ak porovnáme M. CIZANCOURTOVEJ (1934) exempláre druhu *Nummulites fichteli* MICHELOTTI s týmito našimi, zistíme, že exemplár z lokality Seba Biar má odlišný vzhľad obvodovej časti a exemplár z lokality Tarag el Allag má tenšiu špirálnu laminu, a tým i vyššie a kratšie komôrky. Svojím charakterom je bližší exemplárom zo vzorky AD-13, ktoré uvádzame ako prechodnú formu od *Nummulites fabianii retiatius* ROVEDA k *Nummulites fichteli* MICHELOTTI.

Charakteristickým znakom formy B druhu *Nummulites fichteli* MICHELOTTI zo vzorky AD-9a je, že v jemnej sieťovej ozdobe pozorujeme iba malé oká a priebeh septálnych čiar nie je sledovateľný. Týmto typom ozdoby sa zhodujú s exemplármi druhu *Nummulites garansianus* JOLY—LEYMERIE, ktorý ako už bolo vyššie uvedené PH. DE LA HARPE (1881, p. 8), G. BOMBITA (1975, p. 65) a H. SCHAUB (1981) začlenili ku druhu *Nummulites fichteli* MICHELOTTI. Nápadné je tiež užšie vinutie špirály vo vnútorných a vonkajších závitoch a pomerne pravidelné usporiadanie komôrok. Týmto znakmi naše exempláre najviac pripomínajú exemplár z Biarritzu vyobrazený na tab. 50, obr. 5 v práci H. SCHAUBA (1981).

Explanations to plates XX—XXIII

Plate XX

- 1 *Nummulites variolarius* (LAMARCK), A form; profile MS', sample MS'-52, number of the specimen 31, $\times 15$.
- 2—3 *Nummulites striatus pannonicus* (ROZLOSZNIK), A form; profile MS', 2 — sample MS'-50, number of the specimen 16, $\times 10$; 3 — sample MS'-51, number of the specimen 6, $\times 10$.
- 4 *Nummulites discorbinus* (SCHLOTHEIM), A form; profile MS', sample MS'-50, number of the specimen 3, $\times 10$.
- 5—6 *Nummulites incrassatus ramondiformis* HARPE, A. form; profile MS', sample MS'-52, 5 — number of the specimen 14, $\times 10$; 6 — number of the specimen 16, $\times 11.5$.
- 7—12 *Nummulites fabianii* (PREVER)?, A form; profile MS', sample MS'-50, 7 — number of the specimen 26, $\times 10$; 12 — number of the specimen 12, $\times 10$; sample MS'-51, 8 — number of the specimen 10, $\times 11$; 9 — number of the specimen 5, $\times 8.5$; 10 — number of the specimen, 19, $\times 10$; 11 — number of the specimen 7, $\times 17.3$.
- 13—15 *Nummulites fabianii retiatius* ROVEDA, A form; profile MS', sample MS'-52, 13 — number of the specimen 9, $\times 10$; 14 — number of the specimen 41, $\times 10$; 15 — number of the specimen 43, $\times 10$.
- 16 *Sphaerogypsina globulus* (REUSS); profile MS', sample MS'-50, number of the specimen 5, $\times 16.5$.

Plate XXI

- 1—4 Transitional form from *Nummulites fabianii retiatius* ROVEDA to *Nummulites fichteli* MICHELOTTI, A form; profile AD, sample AD-13, 1—2 — number of the specimen 52, 1 — $\times 11$, 2 — $\times 5$; 3 — number of the specimen 23, $\times 11$; 4 — number of the specimen 27, $\times 11$.
- 5—6 *Nummulites fichteli* MICHELOTTI, A form; profile AD, sample AD-9, 5 — number of the specimen 9, $\times 11$; 6 — number of the specimen 7, $\times 11$.

7—8 *Nummulites cf. anomalus lopuchovensis* VAŇOVÁ, A form; profile AD, sample AD-9a, number of the specimen 4, $\times 16.5$.

Plate XXII

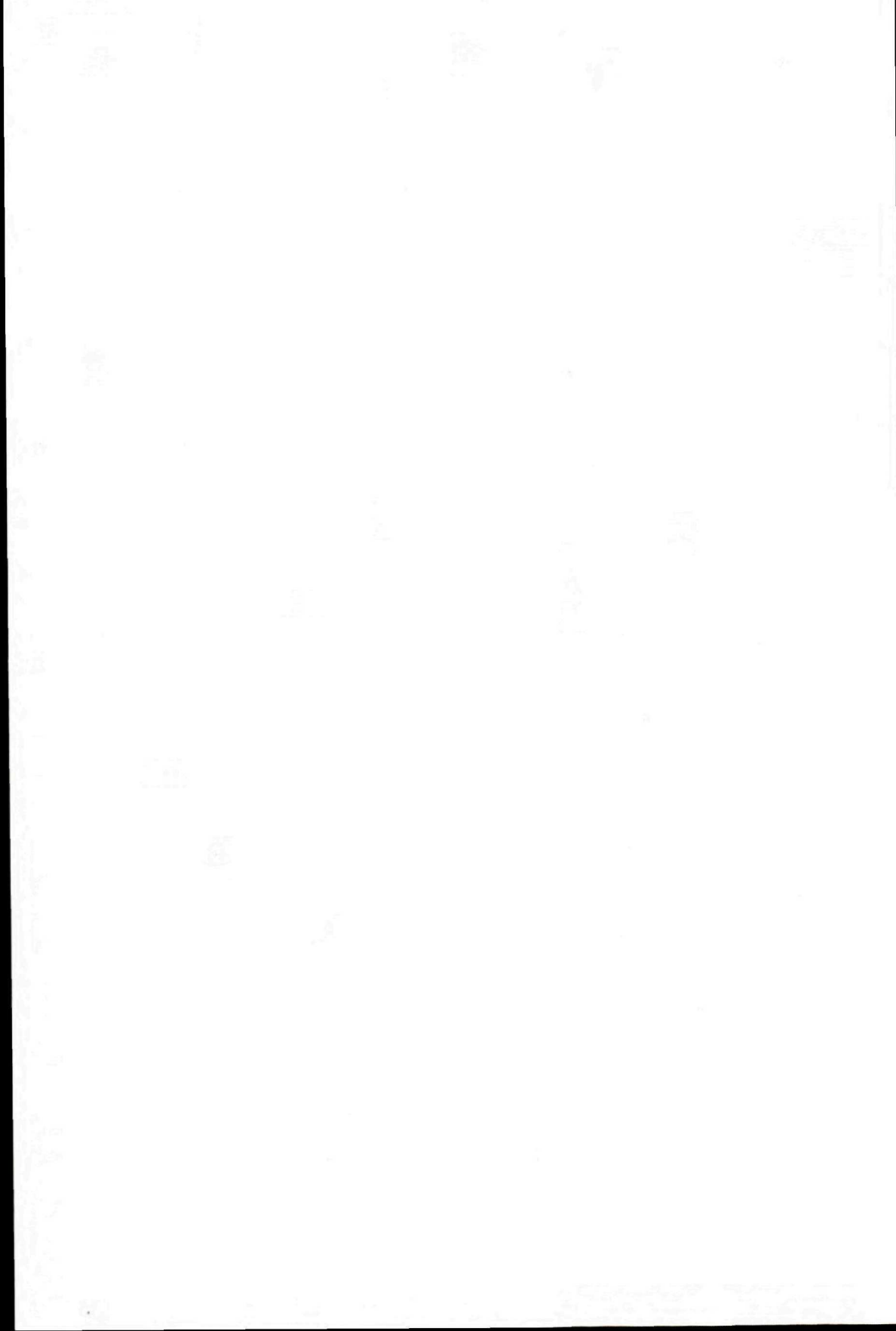
1—7 *Nummulites fichteli* MICHELOTTI, A form; profile AD, sample AD-9a, 1—3 number of the specimen 42, 1 — $\times 10$, 2 — $\times 5.75$, 3 — $\times 9$; 4—5 — number of the specimen 10, 4 — $\times 10$, 5 — $\times 11$; 6—7 number of the specimen 19, 6 — $\times 10$, 7 — $\times 11$.

8—9 *Nummulites orbigny* (GALEOTTI), A form; profile AD, sample AD-9a, number of the specimen 2, 8 — $\times 11$, 9 — $\times 14$.

Plate XXIII

1—7 *Nummulites fichteli* MICHELOTTI, 1—4 A form, 5—7 B form; profile AD, sample AD-9a, 1—2 — number of the specimen 24, 1 — $\times 5.7$, 2 — $\times 12$; 3—4 — number of the specimen 18, 3 — $\times 5$, 4 — $\times 10.3$; 5—6 — number of the specimen 14, $\times 4.7$; 7 — number of the specimen 15, $\times 9$.

Photo by M. Vaňová



HEDVIGA BYSTRICKÁ

The first finding of Rupelian nannoflora in the Turčianska kotlina depression

1 Text-fig., 8 Pls. (XXIV—XXXI), Slovak summary

Abstract. The paper deals with biostratigraphic knowledge gained by a study of Paleogene calcareous nannoflora in the Turčianska kotlina basin. Nannoplanktonic biozones NP 19/20 and NP 23 were found there. The Oligocene — i. e. the Rupelian (= Kišcelian) was evidenced for the first time in the Turčianska kotlina basin by finding the biozone NP 23. The paper is supplied with a brief ecological characteristic of the paleobiotores.

Introduction

Although the oldest notes on the Turčianska kotlina basin Paleogene are already in the work of D. ŠTÚR (1860), its fauna has not been worked out in a complex, yet. Large foraminifers worked out in detail by E. KÖHLER (1966, 1967) are an exception. He defined 4 faunal zones of large foraminifers in the range of the Middle Eocene upper part and the Upper Eocene, viz.:

the zone with *Nummulites perforatus* = the Upper Lutetian

the zone with a mixed assemblage = the lower Upper Eocene

the zone with *Nummulites chavannesi* = the middle Upper Eocene

the zone with *Nummulites problematicus* = the upper Upper Eocene.

He found no Oligocene large foraminifers here, but he assumes that the sandy developments overlying the flysch bed sequence are of the Oligocene age. Similar opinions were published by several authors — e. g. A. MATEJKA (1924), J. ILAVSKÝ, Ž. ČERVEŇOVÁ (1952), J. GAŠPARIK (1975) — however, without stratigraphic evidence. Small foraminifers of this region were mentioned only sporadically. E. BENEŠOVÁ (1959) mentioned a Middle Eocene microfauna from the basal beds near Krpeľany, O. SAMUEL (in J. GAŠPARIK 1975) found an abundant microfauna near Dolný Kalník, and Upper Eocene assemblages with *Globigerina officinalis* in several places. However, no data on Oligocene foraminifers are known to me.

Doc. RNDr. H. BYSTRICKÁ, CSc., Katedra geológie a paleontológie PFUK, Mlynská dolina, pavilón G, 842 15 Bratislava



Situation sketch

Calcareous Nannoplankton

No data have been published on the Paleogene calcareous nannoplankton of the Turčianska kotlina basin so far. The samples collected from surfacial exposures contained a rich calcareous nannoplankton which helped to make the Paleogene bed sequence stratigraphy more exact. To make taxonomic determinations and biostratigraphic results more evident, I used the Scan method in three of the samples worked out by optical microscopy. The samples are as follows:

Sample P. 234 — Horné Jaseno, marls overlying biogenic fine conglomerates, exposed at the road to Turčianska Belá. The sample contained a very rich coccolith thanatocoenosis composed by the species:

Zygrhablithus bijugatus (DEFL.) DEFL.

Coccolithus pelagicus (WALL.) SCHILL.

Coccolithus eopelagicus (BRAM. et RIED.) BRAM. et SULL.

Cyclococcolithus formosus KAMPT.

Chiasmolithus grandis (BRAM. et RIED.) HAY, MOH. et WADE

Chiasmolithus oamaruensis (DEFL.) HAY, MOH. et WADE

Cyclococcolithus cf. *protoanula* GART.

Helicosphaera compacta BRAM. et WILC.

Pontosphaera multipora (KAMPT.) ROTH
Cyclicargolithus floridanus (ROTH et HAY) BUK.
Dictyococcites bisectus (HAY, MOH. et WADE) BUK. et PERC.
Dictyococcites cf. *danicus* BLACK
Dictyococcites cf. *lockeri* (MÜLL.) ROM.
Dictyococcites daviesi (HAQ) PERCH-NIEL.
Cribozentrum reticulatum (GART. et SMITH) PERCH-NIEL.
Cribozentrum cf. *foveolatum* (REIN.) PERCH-NIEL.
Cribozentrum coenurum (REIN.) PERCH-NIEL.
Cribozentrum sp.
Reticulofenestra umbilica (LEV.) MART. et RITZ.
Isthmolithus recurvus DEFL.
Sphenolithus moriformis (BRÖNN. et STRAD.) BRAM. et WILC.
Discoaster barbadiensis T. S. H.
Discoaster deflandrei BRAM. et RIED.
Discoaster saipanensis BRAM. et RIED.
Discoaster tani nodifer BRAM. et RIED.

The assemblage abounds in *Coccolithus pelagicus*, *Dictyococcites bisectus*, *Reticulofenestra umbilica* and *Cyclococcolithus formosus*. Less frequent, yet plentiful are *Isthmolithus recurvus* and *Cyclicargolithus floridanus*.

Biostratigraphy

The nannoplankton thanatocoenosis is formed mostly by autochthonous species in which redeponated Eocene ones are mixed. The autochthonous taxa are mostly represented by specimens persisting from the Middle or Upper Eocene to the Oligocene. Established limitation criteria could not be used in including the nannoflora in a biozone because no index sphenoliths occurred in the material studied and because the taxa applied to determination of the upper boundaries of biozones had been usually redeponated into younger beds in Carpathian flysch thanatocoenoses.

That is why in stratigraphic interpretations, I took into consideration species having the shortest stratigraphic diapazone and belonging to the youngest in the assemblage. Such are:

Chiasmolithus oamaruensis — strat. range NP 18 — NP 23
Helicosphaera compacta — strat. range NP 17 — NP 24
Cyclicargolithus floridanus — strat. range NP 20 — NN
Cribozentrum reticulatum — strat. range NP 17 — NP 20
Isthmolithus recurvus — strat. range NP 19 — NP 22
Discoaster barbadiensis — strat. range NP 10 — NP 20
Discoaster saipanensis — strat. range NP 16 — NP 20

It is evident from the above stratigraphic ranges that the nannoflora cannot belong to a biozone older than the NP 19 — *Isthmolithus recurvus* and to a

biozone younger than the NP 20 — *Sphenolithus pseudoradians*. *Sphenolithus pseudoradians*, the appearance of which determines the biozone NP 20 lower boundary, was not found in the assemblage. In spite of that, a very abundant representation of *Isthmolithus recurvus* indicates rather the biozone NP 20 than the biozone NP 19. The biozone NP 20 can be according to the currently accepted stratigraphic scale (C. CAVELIER 1978) correlated with the Middle Priabonian.

Sample P 236 — Horné Jaseno, marls overlying reefs. The marls contained a relatively poor, but diverse in species thanatocoenosis, in which the following species were identified:

Zygrhablithus bijugatus (DEFL.) DEFL.
Orthozygus aureus (STRAD.) BRAM. et WILC.
Coccolithus eopelagicus (BRAM. et RIED.) BRAM. et SULL.
Coccolithus pelagicus (WALL.) SCHILL.
Cyclococcolithus formosus KAMPT.
Pontosphaera multipora (KAMPT.) ROTH.
Pontosphaera sp. 1
Pontosphaera sp. 2
Transversopontis obliquipons (DEFL.) HAY et al.
Transversopontis sp.
Cyclicargolithus floridanus (ROTH. et HAY) BUK.
Dictyococcites bisectus (HAY, MOH. et WADE) BUK. et PERC.
Dictyococcites daviesi (HAQ) PERCH-NIEL.
Dictyococcites hesslandii (HAQ) HAQ et LOH.
Cribocentrum reticulatum (GART. et SMITH) PERCH-NIEL.
Reticulofenestra umbilica (LEV.) MART. et RITZ.
Reticulofenestra dictyoda (DEFL.) STRAD.
Isthmolithus recurvus DEFL.
Blackites spinosus (DEFL. et FERT) HAY et TOVE
Sphenolithus moriformis (BRÖNN. et STRAD.) BRAM. et WILC.
Discoaster barbadiensis T. S. H.
Discoaster tani nodifer BRAM. et RIED.

Coccolithus pelagicus and *Dictyococcites bisectus* are the most abundant in the thanatocoenosis. Taxonomic representation is similar as in the previous locality. Of stratigraphically significant species, *Orthozygus aureus* acceded, with its stratigraphic diapazone of NP 18 — NP 20, i. e. the upper part of the Lower Priabonian and the Middle Priabonian.

Biostratigraphy

Composition of the species neither in this assemblage allows its unambiguous inclusion in the biozone NP 19 or NP 20.

Samples P 1657 and 1658 — the road between Podhradie and Konské.

Two samples were collected from an exposure near the road between the villages Podhradie and Kónské, from its highest part (in the saddle); they were collected from light brown marls, separated from each other by a ca. 3 cm thick layer of rusty brown marls without fossils. A very rich and well preserved nannoflora was gained from the underlying bed — the sample 1657. The following species were determined in it:

Zygrhablithus bijugatus (DEFL.) DEFL.
Coccolithus eopelagicus (BRAM. et RIED.) BRAM. et SULL.
Coccolithus pelagicus (WALL.) SCHILL.
Cyclococcolithus formosus KAMPT.
Chiasmolithus solitus (BRAM. et SULL.) LOCK.
Helicosphaera cf. *reticulata* BRAM. et WILC.
Pontosphaera multipora (KAMPT.) ROTH.
Cyclicargolithus floridanus (ROTH. et HAY) BUK.
Coronocyclus prionion (DEFL. et FERT) STRAD.
Dictyococcites bisectus (HAY, MOH. et WADE) BUK. et PERC.
Dictyococcites lockeri (MÜLL.) ROM.
Cribocentrum reticulatum (GART. et SMITH) PERCH-NIEL.
Reticulofenestra umbilica (LEV.) MART. et RITZ.
Sphenolithus moriformis (BRÖNN. et STRAD.) BRAM. et WILC.
Discoaster barbadiensis T. S. H.
Discoaster deflandrei BRAM. et RIED.
Discoaster multiradiatus BRAM. et RIED.
Discoaster saipaniensis BRAM. et RIED.
Discoaster tani nodifer BRAM. et RIED.

The overlying bed — P 1658 — contained a substantially poorer nannoplankton in which only the following species were found:

Coccolithus pelagicus (WALL.) Schill.
Pontosphaera multipora (KAMPT.) ROTH
Cyclicargolithus floridanus (ROTH et HAY) BUK.
Dictyococcites bisectus (HAY, MOH. et WADE) BUK. et PERC.
Dictyococcites lockeri (MÜLL.) ROM.
Discoaster lodoensis BRAM. et RIED.

Dictyococcites lockeri of a very variable development dominates in both samples. The size of placoliths and the size of central areas with a grill vary mainly. In the underlying sample (P 1657) also *Zygrhablithus bijugatus* and *Dictyococcites bisectus* are frequent. Other taxa are rare, even sporadic. They are mostly persisting species of a wide stratigraphic diapazone.

Biostratigraphy

Dictyococcites lockeri is stratigraphically the most significant species which restricts the range of these beds to the biozones NP 23 — *Sphenolithus predisten-*

tus and NP 24 — *Sphenolithus distentus*. The species is mentioned in literature as very frequent in boreal developments of these biozones (M. BALDI-BEKE 1979, 1982, Hungary, C. MÜLLER 1970, the Bavarian Molasse, H. BYSTRICKÁ 1979, 1982, the West Carpathians mts.). J. KRHOVSKÝ (1978) adjoining to this species specimens with a small central grill described as a new species called *Reticulofenestra pseudolockeri* by F. JURÁŠOVÁ (1974) from menilitic beds near Dolné Tešice, shifts the base of this species occurrence into the biozone NP 21 — *Ericsonia subdisticha*.

None of the species with the first appearance from the biozone NP 24 *Sphenolithus distentus* occurred among the taxa found, so it is evident that the nannoplankton of the both samples belongs to the biozone NP 23.

The nannoplankton biozone NP 23 can be correlated with the upper part of the foraminiferal biozone P 19 and the biozone P 20 representing the Rupelian (= Kišcelian).

J. SALAJ and O. SAMUEL (1984), in their work on the microbiostratigraphic division of the West Carpathians mts. Mesozoic and Paleogene, assume completion of the Paleogene sedimentation in the Innercarpathian basins and the Magura Unit by the foraminiferal biozone P 18 *Globigerina postcretacia*. They explain the absence of the foraminiferal biozone P 19 and P 20 by a probable interruption of the sedimentation during this stratigraphic interval. Finding the nannoplankton biozone in the region studied is evidence of the Oligocene sedimentation in the Turčianska kotlina basin continuing into the Middle Oligocene (in the Banskobystrická kotlina basin even in the interval of the biozone NP 24, H. BYSTRICKÁ 1982). The absence of the foraminiferal biozones P 19 and P 20 may be of an ecological cause; however, it cannot be excluded that they will be found after more detailed paleontological studies or in more suitable localities.

Notes on the ecology

I made ecological interpretations by the classical method, i.e. by applying known ecological demands of certain occurring taxa. I considered also their quantitative relations and state of preservation. According to these criteria, the thanatocoenoses of the samples P 234 and P 236 can be taken for an assemblage of a not too deep near-shore sea, relatively cold, connected with the ocean. The shallow-water environment is evidenced by occurrences of well preserved or only slightly etched specimens of the holococcolith *Zygrhablithus bijugatus* which due to its microstructure does not bear sedimentation into greater depths. Neritic to near-shore are furthermore *Isthmolithus recurvus*, *Pontosphaera*s, representatives of *Transversopontis* and *Orthozigus aureus*. The rich occurrence of *Reticulofenestrads*, *Coccolithus pelagicus* and *Cyclococcolithus formosus* gives evidence of connection with the open ocean. The abundant occurrence of *Reticulofenestra umbilica*, *Coccolithus pelagicus* and *Isthmolithus recurvus* suggests a progressive cooling in this time interval. Our deductions on the cooling agree with findings gained by studies of benthic populations of the Paleogene

epicontinental seas, according to which a gradual cooling occurred at the beginning of the Upper Lutetian, culminating at the turn of the Eocene to the Oligocene, after which a gradual warming began (C. CAVELIER 1979).

The calcareous nannoflora of the marls from Podhradie (P 1657, 1658) can be included in the type of the assemblage determined as the Reticulofenestrid Assemblage and *Reticulonestra dictyoda* by B. U. HAQ and G. P. LOHMAN (1976). It is typical for higher latitudes in the Oligocene, i. e. for cooler marine waters. Occurrence of *Zygrhablithus bijugatus* and the *Pontosphaera*s, as well as the mass representation of *Dictyococcites lockeri* indicate a shallow-water near-shore marine environment.

Conclusion

Occurrence of the biozones NP 19/20 and NP 23 was found by studying the calcareous nannoflora of younger Paleogene beds in the Turčianska kotlina basin. This is evidence of the Paleogene sedimentation not ending here in the Lower Oligocene, but continuing into the Middle Oligocene — the Rupelian or Kišcelian.

The nannoflora species composition, the quantitative relations of occurring species and the state of preservation of placoliths in the biozone NP 19/20 assemblages indicate a near-shore shallow-water relatively cool biotope, connected with the open sea. The biozone NP 23 nannoplankton also suggests a shallow-water near-shore environment of the boreal bioprovince, where an imperceptible decrease of the sea water salinity cannot be, due to the dominant representation of *Dictyococcites lockeri*, excluded.

References

- CAVELIER, C. 1979: La limite éocène — oligocène en Europe occidentale. Sciences Géolog. ULP, Mém. 54 Strassbourg, 1—280.
- BALDI-BEKE, M. 1984: Dunántúli paleogén képződmények nannoplanktonja. Geol. Hungarica, ser. Paleont. 43, Budapest, 1—307.
- BALDI-BÉKE, M. 1977: A budai oligocén rétegtani és faciestani tákolódása nannoplankton alapján. Föld. Közlöny, 107, Budapest, 50—89.
- BYSTRICKÁ, H. 1982: Výskyt stredného oligocénu v paleogénnych sedimentoch Horehronia. Geol. Práce, Správy 87, Geol. Úst. D. Štúra, Bratislava, 123—129.
- BYSTRICKÁ, H. 1982: Findings of Oligocene Beds near Banská Bystrica. Geol. Zborník — Geol. Carpathica, 33, 4, Bratislava, 509—529.
- GAŠPARIK, J. 1975: Stratigrafické a litologické štúdium terciérnych sedimentov v s. časti Turčianskej kotliny. Čiastková záverečná správa č. 35932, Geofond, Bratislava.
- HAQ, B. U.—LOHMAN, G. P. 1976: Early Cenozoic calcareous nannoplankton biogeography of the Atlantic Ocean. Marine Micropaleontology 1, Amsterdam, 119—194.
- ILAVSKÝ, J.—ČERVEŇOVÁ, Ž. 1952: Geologické štúdiá na západnom svahu Veľkej Fatry. Geol. Práce, 30, Geol. Úst. D. Štúra, Bratislava.
- JURÁŠOVÁ, F. 1974: Nannoplankton from the Menilitic Formation (Lower Oligocene) at Dolní Tešice. Věstník ÚUG, 49, Praha, 91—96.

- KÖHLER, E. 1966: Stratigrafia paleogénu Rajeckej a Turčianskej kotliny na základe veľkých foraminifer. Geol. práce, 52, Geol. Úst. D. Štúra, Bratislava, 55—63.
- KÖHLER, E. 1967: Grossforaminiferen und Stratigraphie des Paläogens des Rajec und Turiec—Kessels (Westkarpaten). Nauka o Zemi, Geol. 5, Bratislava, 1—89.
- KRHOVSKÝ, J. 1978: Calcareous nannoplankton from the Eocene (Oligocene boundary of some localities of the Pouzdřany and Ždánice Units (The West Carpathians, Czechoslovakia). Paleontologická konference 77, Univerzita Karlova, Praha, 75—94.
- MÜLLER, C. 1970: Nannoplankton — Zonen der Unteren Meeresmolasse Bayerns. Geol. Bavar 63, München, 107—118.
- SALAJ, J.—SAMUEL, O. 1984: Microbiostratigraphical division of West Carpathians Mesozoic and Paleogene. Záp. Karpaty, sér. Paleont., 9, Bratislava, Geol. Úst. D. Štúra, 11—71.

HEDVIGA BYSTRICKÁ

Vápnitá nanoflóra paleogénu Turčianskej kotliny

Resumé anglického textu

Práca prináša prvé údaje o paleogénnej vápnitej nanoflóre Turčianskej kotliny. Súvrstvia mladšieho paleogénu poskytli prevažne bohatý vápnitý nanoplanktón, ktorý pomohol spresniť ich stratigrafiu. Aby taxonomické určenie a stratigrafické interpretácie boli preukazateľnejšie, zo vzoriek spracovaných pomocou optického mikroskopu bola u troch použitá metóda riadkovacieho elektrónového mikroskopu. Podrobné výsledky sú uvedené v anglickom texte. Z dvoch vzoriek od Horného Jasena bola získaná vrchnoeocénna nanoflóra biozóny NP 19/20 (*Isthmolithus recurvus*/*Sphenolithus pseudoradians*). Vzorky odobraté pri ceste medzi Podhradím a Konským obsahovali mladšie spoločensvo, ktoré bolo možné zaradiť do biozóny NP 23 *Sphenolithus predistentus*.

Podľa súčasne uznávanej biostratigrafickej škály možno nanoplanktónovú biozónu NP 23 korelovať s dvoma foraminiferovými biozónami, a to P 19 a P 20, ktoré reprezentujú rupel (= kišcel). Zistením biozóny NP 23 bol aj v Turčianskej kotline dokázaný stredný oligocén. Po Horehróni a Zvolenskej kotline je to tretia vnútrokarpatská kotlina, kde pomocou vápniteho nanoplanktónu bolo dokázané, že paleogénna sedimentácia zasahovala do stredného až vrchného oligocénu (H. BYSTRICKÁ 1982 a, b).

Práca je doplnená ekologickou rekonštrukciou paleoprostredí. U asociácii biozón NP 19/20 možno predpokladať príbrežný, plytkovodný, relatívne studený biotop, spojený s otvoreným morom. Nanoplanktón biozóny NP 23 poukazuje tiež na plytkovodné príbrežné prostredie boreálnej provincie, kde vzhľadom na dominantné postavenie druhu *Dictyococcites lockeri* nie je vylúčené nepatrné zníženie salinity morskej vody.

Explanations of Plates XXIV—XXXI

Sample P 234 Pl. XXIV

- 1 *Helicosphaera compacta* BRAM. et WILC. Magn. 4 300 ×
- 2 *Cribocentrum reticulatum* (GART. et SMITH) PERCH-NIEL. Magn. 7 700 ×
- 3 *Pontosphaera multipora* (KAMPT.) ROTH. Magn. 7 000 ×
- 4 *Zygrhablithus bijugatus* (DEFL.) DEFL. Magn. 6 300 ×
- 5 *Discoaster* sp., corroded asterolith. Magn. 4 300 ×
- 6 *Cyclococcolithus protoanula* GART. Magn. 7 600 ×
- 7 *Discoaster saipanensis* BRAM. et RIED. Magn. 6 600 ×
- 8 *Pontosphaera* sp. 1. Magn. 8 000 ×

Sample P 234 Pl. XXV

- 1 *Dictyococcites* cf. *danicus* BLACK. Magn. 7 300 ×
- 2, 4 *Cribrocentrum* sp. Magn. 7 000 ×, 10 000 ×
- 3, 5 *Cribrocentrum* cf. *foveolatum* (REIN.) PERCH-NIEL. Magn. 8 000 ×, 6 700 ×
- 6 *Reticulofenestra umbilica* (LEV.) MART. et RITZ. Magn. 6 700 ×
- 7 *Coccolithus pelagicus* (WALL.) SCHILL. Magn. 9 000 ×

Sample P 234 Pl. XXVI

- 1, 3 *Dictyococcites daviesi* (HAQ) PERCH-NIEL. Magn. 9 700 ×, 7 700 ×
- 2 *Dictyococcites* cf. *lockeri* (MÜLL.) ROM. Magn. 10 000 ×
- 4 *Dictyococcites bisectus* (HAY, MOH. et WADE) BUK. et PERC. Magn. 4 300 ×
- 5, 6, 7 *Cyclicargolithus floridanus* (ROTH et HAY) BUK. Magn. 10 700 ×, 9 300 ×, 10 000 ×

Sample P 236 Pl. XXVII

- 1, 3 *Pontosphaera* sp. 2. Magn. 8 500 ×, 7 000 ×
- 2 *Isthmolithus recurvus* DEFL. Magn. 8 300 ×
- 4 *Orthozygus aureus* (STRAD.) BRAM. et WILC. Magn. 10 000 ×
- 5 *Pontosphaera* sp. 1. Magn. 6 000 ×
- 6 *Discoaster deflandrei* BRAM. et RIED. Magn. 6 000 ×
- 7 *Transversopontis obliquipons* (DEFL.) HAY et al. Magn. 7 700 ×
- 8 *Transversopontis* sp. Magn. 8 000 ×

Sample P 236 Pl. XXVIII

- 1 *Cyclicargolithus floridanus* (ROTH et HAY) BUK. Magn. 9 700 ×
- 2, 3 *Dictyococcites* cf. *hesslandii* (HAQ) HAQ et LOH. Magn. 6 000 ×, 6 000 ×
- 4 *Blackites spinosus* (DEFL. et FERT) HAY et TOWE. Magn. 9 000 ×
- 5 *Coccolithus pelagicus* (WALL.) SCHILL. Magn. 7 000 ×
- 6 *Reticulofenestra dictyoda* (DEFL.) STRAD. Magn. 7 000 ×
- 7 *Zygrhablithus bijugatus* (DEFL.) DEFL. Magn. 4 000 ×
- 8 *Reticulofenestra* sp. Magn. 5 000 ×

Sample P 1657 Pl. XXIX

- 1—8 *Dictyococcites lockeri* (MÜLL.) ROM. Figs. 1—7 distal view, fig. 8 prox. view.

Sample P 1657 Pl. XXX

- 1, 2, 5, 6 *Dictyococcites lockeri* (MÜLL.) ROM., prox. view.
- 3 *Coronocyclus prionion* (DEFL. et FERT) STRAD.
- 4 *Discoaster tani nodifer* BRAM. et RIED.
- 7 *Coccolithus pelagicus* (WALL.) SCHILL.
- 8 *Discoaster deflandrei* BRAM. et RIED.

Sample P 1657 Pl. XXXI

- 1 *Chiasmolithus solitus* (BRAM. et SULL.) LOCK.
- 2 *Dictyococcites bisectus* (HAY, MOH. et WADE) BUK. et PERC.
- 3 *Dictyococcites bisectus* (HAY, MOH. et WADE) BUK. et PERC., prox. view
- 4 *Cyclococcolithus formosus* KAMPT.
- 5 *Helicosphaera* cf. *reticulata* BRAM. et WILC.
- 6 *Pontosphaera multipora* (KAMPT.) ROTH
- 7 *Cyclicargolithus floridanus* (ROTH et HAY) BUK.
- 8 *Sphenolithus* sp.

Scanning — electron micrographs in Pls. 1—5 were made by RNDr. I. Holický in Geological Institute of the Slovak Academy of Sciences, those in Pls. 6—8 by K. Horák in Dionýz Štúr Institute of Geology.

KATARÍNA ŠUTOVSKÁ

Biometrical characteristics of discoliths *Pontosphaera* ex gr. *multi-pora* Kamptner (Roth) 1970, Egerian of the SE part of the Rimava basin, southern Slovakia; paleoecological (and taxonomical) aspects

9 text-figs., Slovak summary

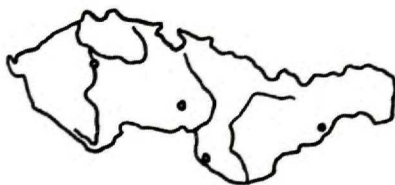
Abstract. In the Egerian of LR-9 and LR-9 sections there were found 2 types of variability of discoliths *Pontosphaera* ex gr. *multi-pora*:

1. variability of the general shape of the discoliths that can represent a variability within the coccosphere;

2. variability of the number and relative size of the perforations and width of the peripheral rim, that based the division of discoliths into 2 groups. Group I represents an assemblage that invaded the isolated Parathethys basin due to the sea level rise; group II appears during the period of basin isolation.

Introduction

Samples from boreholes LR-9 near Chanava and LR-10 near Číž in the SE part of the Rimava basin have been studied. The samples have been supplied by Geological Survey (Geologický prieskum), Banská Bystrica. Approximately each 50 m of the borehole were sampled. Slides and residuum are filed by the Department of geology and paleontology, Faculty of Science, Komenský University, Bratislava.



In the studied samples, assemblages of foraminifers and nannoplankton were evaluated, as well as some sedimentological characteristics of the monotonous "schlier formation": portion of sand-silt-clay fraction, CaCO_3 content (determined by Dr. Kúšik), content of glauconite and pyrite in the residuum, abrasion of quartz grains.

Methodology

Nannoplankton has been microscopally studied ($600\times$ and $800\times$ enlargement). Slides have been made from centrifugally separated samples (2000 turns per min., for 2 minutes), and from non-separated testing samples. The photographs have been made by ordinary methods using direct light, non-polarized with crossed nicols, in a biological microscope (projective No. 10, immersion objective 100).

The diversity of nannoplankton assemblages has been calculated for 500 specimens from each sample according to the Simpson formula:

$$D = \frac{\sum n_i(n_i - 1)}{n(n - 1)}$$

where D = diversity, n = total number of specimens (500), n_i = number of specimens of the i taxon. The diversity does not express a real diversity of individuals, but only the coccoliths diversity. Redeposited Cretaceous and Eocene microfossils have not been taken into consideration. Similarity of assemblages has been calculated for each 2 adjacent samples in the section, using the Hazel formula:

$$S = \frac{C}{\sqrt{N1N2}}$$

where S = similarity, C = number of taxa occurring in both samples, $N1, N2$ = total numbers of taxa in the compared samples (500 coccoliths from each sample).

Because the studied sections are situated close to each other in one sedimentary basin, it is possible to correlate them in detail, using a plot (fig. 1). The individual plotted points show the depth of maximal and minimal occurrence of foraminifera and nannoplankton or maximal and minimal values of studied parameters (D, S , sedimentological characteristics). The points from a straight or broken line, expressing relative changes in sedimentation rate between the two sections, or even a sedimentation break in one of them. In case of a great diffusion of the points, the accuracy of the correlation decreases. Coordinates of the points laying in the straight or broken line mark and isochronous horizon in the correlated sections.

This method represents a modified correlation method introduced by SHOW (1964, ex MILLER 1977), which used the first and last occurrence of the taxa. For

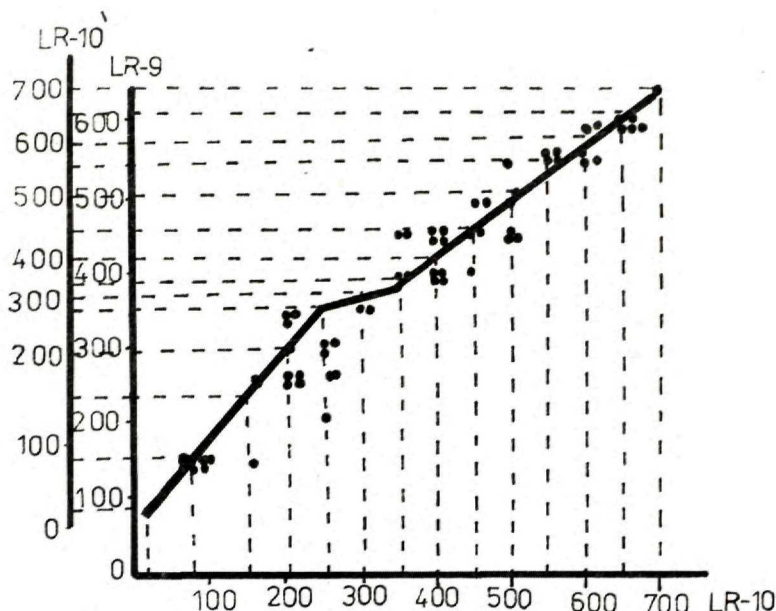


Fig. 1 Graphic correlation of LR-9 and LR-10 sections based on the layers with max. and min. values of biometrical variables and max. or min. occurrence of selected taxa (for details see text). The thick line marks the correllable horizons, LR-10 is the LR-10 section correlated to LR-9 (for simplification a constant sedimentation rate supposed for LR-9).

the sections that represent a relatively short time span and steady sedimentation conditions, however, application of maximal and minimal occurrence proved to be more accurate.

Characteristic of the nannoplankton assemblages and the stratigraphic evaluation of the sections

In the nannoplankton assemblages the species *Coccolithus pelagicus* predominates, forming more than 40 % of the assemblages. Exceptional are samples from 650 m depth (LR-9) and 700 and 740 m (LR-10), where *Cyclicargolithus floridanus* forms 30—40 % of the assemblage, and sample from 762 m (LR-10) with prevailing *Pontosphaera* ex gr. *multiopora* (40 %). Other common species are *Cyclicargolithus abisectus*, *Reticulofenestra daviesi*, *Reticulofenestra bisecta*, *Discolithina latelliptica*, *Helicosphaera euphratis*, *Sphenolithus moriformis* and in the upper parts of the sections also *Helicosphaera carteri*. Cretaceous (up to 6 % of the assemblage) and Eocene (up to 3 %) allochthonous elements occur. The former predominate in the lower parts, the latter are distributed equally throughout in the sections. Changes in diversity and similarity of the assemblages or show by fig. 9b.

The assemblages do not comprise index forms of the biozones from the studied interval NP 24-NN 1. The stratigraphic classification is complicated also by discordant conception of stratigraphic range of particular species in the literature. The classification of parts of the sections into particular biochrones is based on the data of BÁLDI-BÉKE (1984), PERCH-NIELSEN (1986) and the conception of biochrones in the studied area by LEHOTAYOVÁ (1982).

The boundary of NP 24 and NP 25 biochrones can be situated into the interval 500—550 m (LR-9) and 450—500 m (LR-10). The occurrence of *Discolithina latelliptica*, *Reticulofenestra bisecta* and *Zygrhabdulus bijugatus* in the whole sections probably excluded the existence of NN 1 biochrone. On the contrary, there were found some features typical of the Oligocene/Miocene boundary event: increase in planktonic foraminifers diversity (KENNETT and SRINIVASAN 1983), increase in diversity of nannoplankton (LEHOTAYOVÁ 1982), marks of sea level rise transgression for O/M boundary event especially in the studied area noted by Báldi 1986). This concerns the 100 m depth in the LR-9 section and 12 m for LR-10.

Selection and definition of biometrical features of *Pontosphaera discoliths*

The selection of features (suitable for statistical evaluation) was conditioned by several factors:

1. the way of distinguishing of particular *Pontosphaera* species, based on various number of perforations, various perforation size, width of the peripheral rim, presence of ornamentation (BRAMLETTE-SULLIVAN 1961, HAY, MOHLER, WADE 1966, STRADNER-EDWARDS 1968, ROTH 1970, PERCH-NIELSEN 1971, HAQ 1971, PERCH-NIELSEN 1976);

2. the quality of photography enabled by the light microscope, that does not allow a detailed study of the structure of discoliths.

The following features have been selected for the biometrical study of discoliths:

1. *General shape.* Because the shape of the discoliths is not exactly elliptic, the length of longer and the shorter semi-axes is not sufficient for the shape definition. Thus, for more accuracy I have used dimensions a_1 and a_2 , i. e. diameters of the discolith in the $a/3$ and $a/6$ distance from the rim, perpendicular to b (see fig. 2a). As the length of the b semi-axis is directly proportional to a (fig. 3a, correlation coefficient 0,91), the coccolith can be sufficiently characterized by one of these dimensions.

The above dimensions may be deformed by different focussation of measured specimens on the microphotographs. Magnitude of such error has been identified by measuring of one specimen photographed with crossed nicols and in transmitted light, that is usually differently focused. The error for 25 studied specimens was not statistically significant — it took only 1—5 % of the measured dimension.

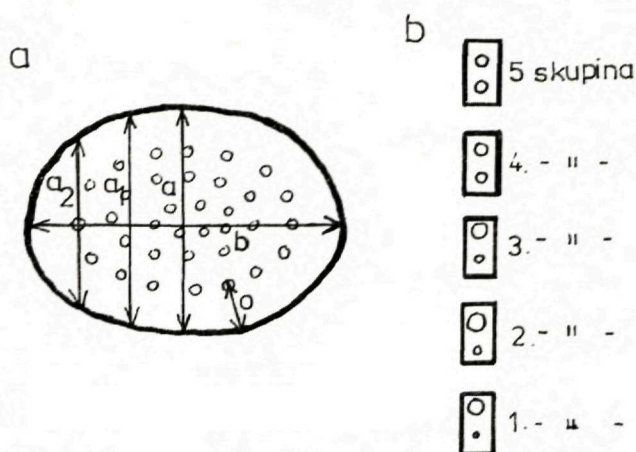


Fig. 2a Measured dimensions of *Pontosphaera* ex gr. *multiplora* discoliths

Fig. 2b Semi-quantitative scale expressing the ratio between the sizes of the last and the preceding cycles.

2. *Width of the rim.* This means the perpendicular distance between the rim and the centre of perforation of the last cycle (fig. 2a).

3. *Number of perforations.* Because it was not possible to estimate exactly the total number of perforations, I present only the number of perforations in the last cycle.

4. *The ratio of the magnitude of perforations of the last cycle to that other perforations.* The perforation diameter is a small dimension that could not be exactly measured in the used enlargement (the diameter took 1—3 bars of the scale, that deform the measurement up to 50 % error). Thus, the ratio perforation magnitudes has been expressed semiquantitatively, referred to one of 5 groups (fig. 2b).

There has not been proved any correlation between the rim width or number of perforations and the coccolith diameter (correlation indexes 0.30 and 0.61, for details see figs. 3b, c).

Characteristics of the variability of discoliths

Variability of coccolith shapes expressed by the plot of a_1/a and a_2/a correlation. The relationship between these parameters can be most accurately expressed by a hyperbolic function. There appeared 4 groups in the plot; changes in discolith shape in particular groups are demonstrated by fig. 4b.

In the plot of correlation between the rim width and the number perforations in the last cycle there can be observed 2 groups; they can be distinguished also by the different ratio of perforation size in the last cycle and the preceding ones (fig. 5a, demonstrated by different marks).

The groups can be biometrically characterized as follows:

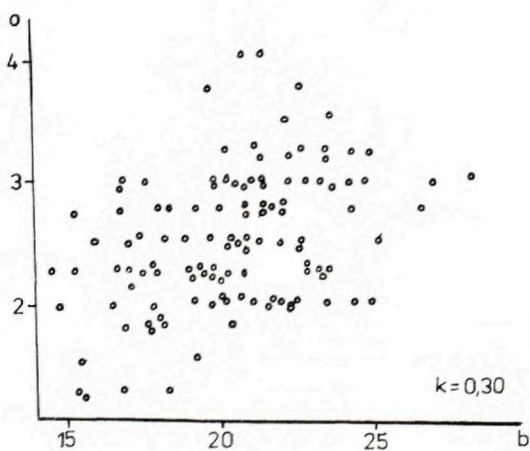
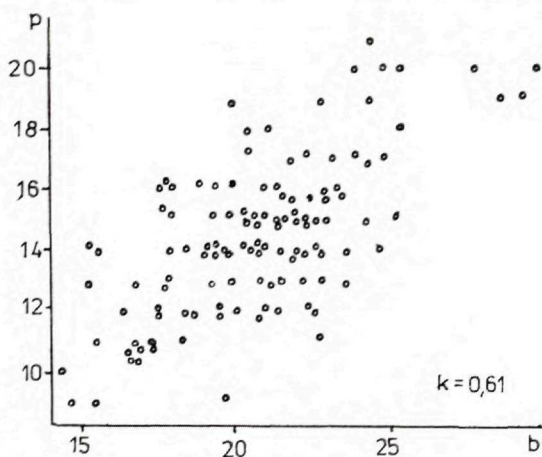
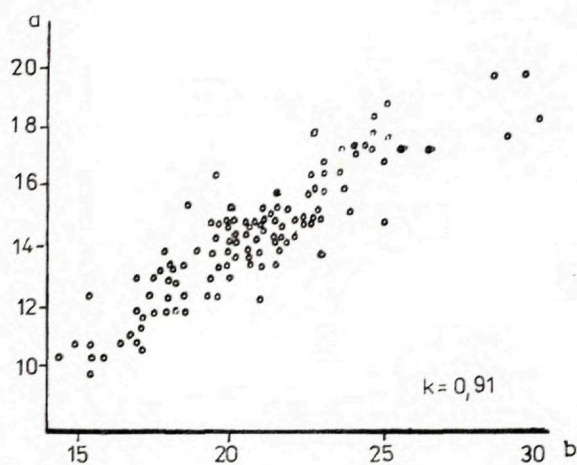


Fig. 3 Dependence of the shortes diameter (a), number of perforations in the last cycle (p), width of the peripheral rim (o) on the longer diameter (b) of discoliths *Pontosphaera* ex gr. *multipora* in the LR-9 section. (k = correlation index for each couple of studied variables).

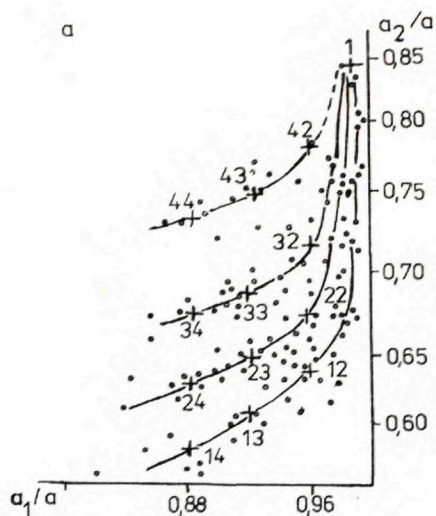
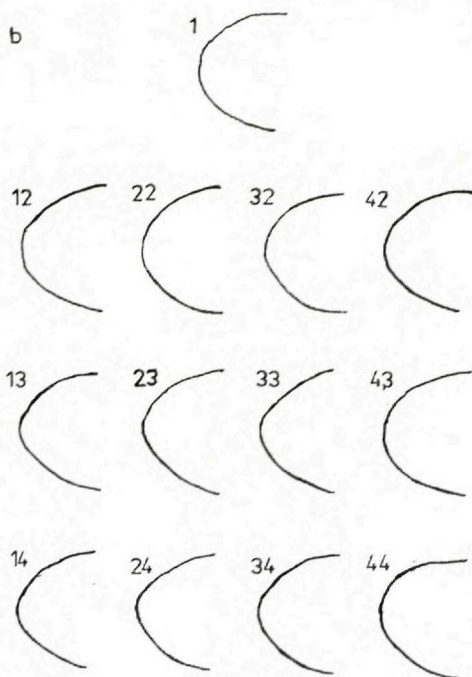


Fig. 4a Morphological variability of *Pontosphaera* ex gr. *multipora* expressed by ratios a_1/a and a_2/a (dimensions shown by fig. 2a). Rising groups are concentrated close to the curves.

Fig. 4b Various shapes of discoliths corresponding to the points plotted by fig. 4a (points labelled by daggers and numbered).



Group I (fig. 5b)

Elliptic discoliths with 11—23 perforations in the last cycle (ave. 13.5, mode 14). Rim width greater than that of group II, between 1.5—2.3 μm (average 1.89, mode 9 μm). Small differences in the perforation size of the last and the preceding cycles (2nd—5th group, in the 3rd group 38 %, 4th 64 % of specimens). No ornamentation visible in a light microscope.

Group II (fig. 5b)

Elliptic discoliths with the number of last perforations smaller than the group I (10—18, ave. 18, mode 15). Rim width less than 0.6—1.3 μm , ave. 1.2, mode 1. Size of last cycle perforations and that of the preceding cycles shows considerable differences; they belong to 1-st—3rd groups, 87 % to the 2nd group. No indications of ornamentation visible in a light microscope.

Approximately 10 % of specimens can not be unambiguously referred to one of the above groups. The occurrence of particular groups throughout the section is demonstrated by fig. 9a.

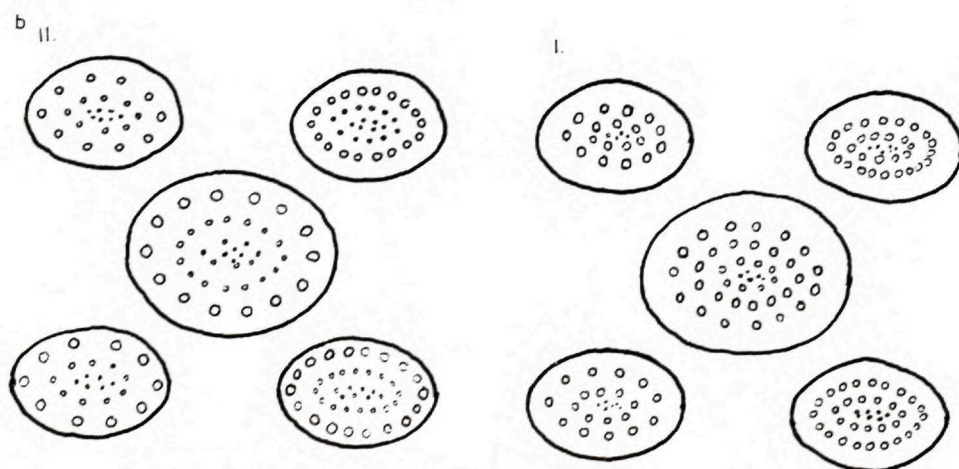
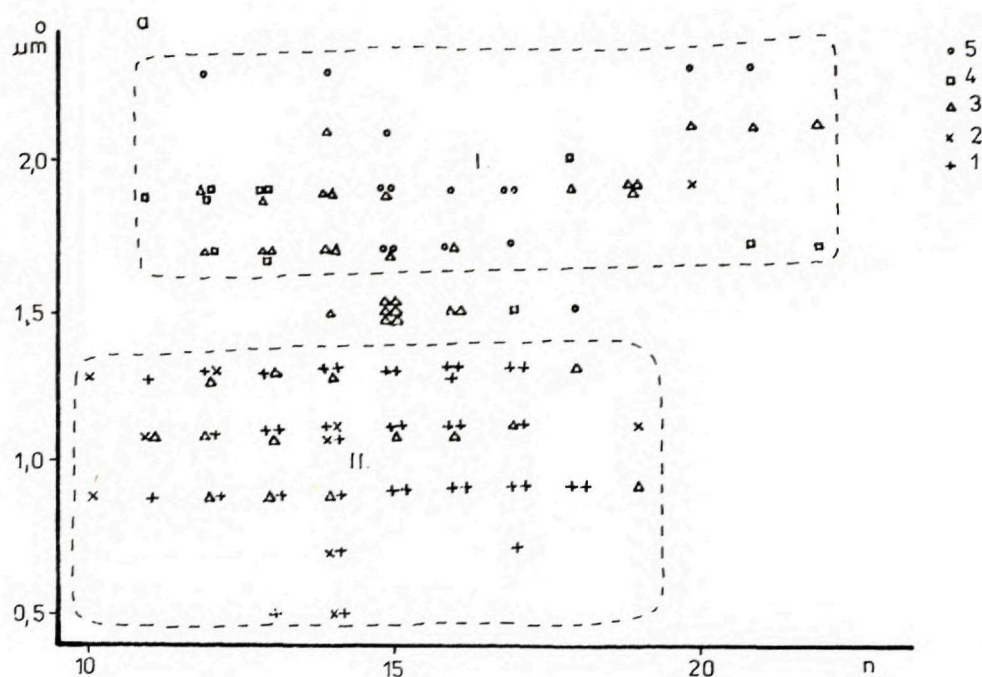


Fig. 5a Dependence of the number of perforations in the last cycle (n) on the width the peripheral rim (o) of *Pontosphaera* ex gr. *multipora*. Various signs express the ratio of size of the last and the preceding cycles. Numbers point at the number of group in the semi-quantitative scale (fig. 2b). Field of groups I and II is marked. Out of it is situated specimens of the transitional group.

Fig. 5b Discoliths belonging to the I and II groups. In the middle is figured a specimen with average values of o , p and $d1/d2$, surrounded by individuals with extreme values.

Possible reasons of discoliths variability

The biometrical variability of discoliths may be due to the following reason:

- common intraspecific variability
- differences between the distal and proximal side of the discolith
- changes during ontogeny
- coccosphere variability
- variability within the reproduction cycle
- reaction to the changed environmental conditions (seasonal or long-term changes); the groups represent ecoforms
- phylogenic development; the groups represent species
- growth of elements during diagenetic processes.

The intraspecific variability is documented in literature by diagnoses of species (BRAMLETTE—SULLIVAN 1961, HAY, MOHLER, WADE 1966, STRADNER—EDWARDS 1968, ROTH 1970, HAQ 1971). The notes on variability concern above all the variable number of perforations.

STRADNER and EDWARDS (1968) described differences between the distal and proximal side. They appear in the general structure of the elements, that influences perforation size and rim shape. In the light microscope I have observed extinction of a thin stripe in the central area of the discolith and partial extinction in the rim area. However, the differences between the distal and proximal side should not influence the biometrical characteristics.

MC INTYRE and BÉ (1967) as well as OKADA and ONJO (1970, ex TAPPAN) describe macro- and micrococcoliths differing in size, which should have originated in different stages of ontogeny. Size differences should not influence the studied characteristics. The variability of coccosphere so far has not been described. The procurable figures of *Pontosphaera coccospheres* did not allow a more detailed study of coccolith variability.

The variability within the reproduction cycle should be expressed by 2 distinctively different forms (TAPPAN 1980). In this case the focus of the problem rather is the right classification of different reproduction stages of 1 taxon.

Environmental variability has not yet been described. Changes caused by diagenetic growth can not be distinguished from other types of variability using the light microscope.

A possible way to determine the causes of observed variability is the comparison of the character of changes in 2 correlative sections or a comparison with changes of other characteristics in the same section. Possibilities of identification of particular types of variability by the above ways are tabulated demonstrated by fig. 7.

From the fig. 7 and the appended plots (figs. 6, 9) it follows that:

1. Variability in coccoliths shape can be an expression of the variability within the coccosphere; the common intraspecific variability should not lead to the rise of distinct groups. Changes of this characteristic show no correlation with changes of other variables. Thus, the discoliths may belong to various parts of the coccosphere.

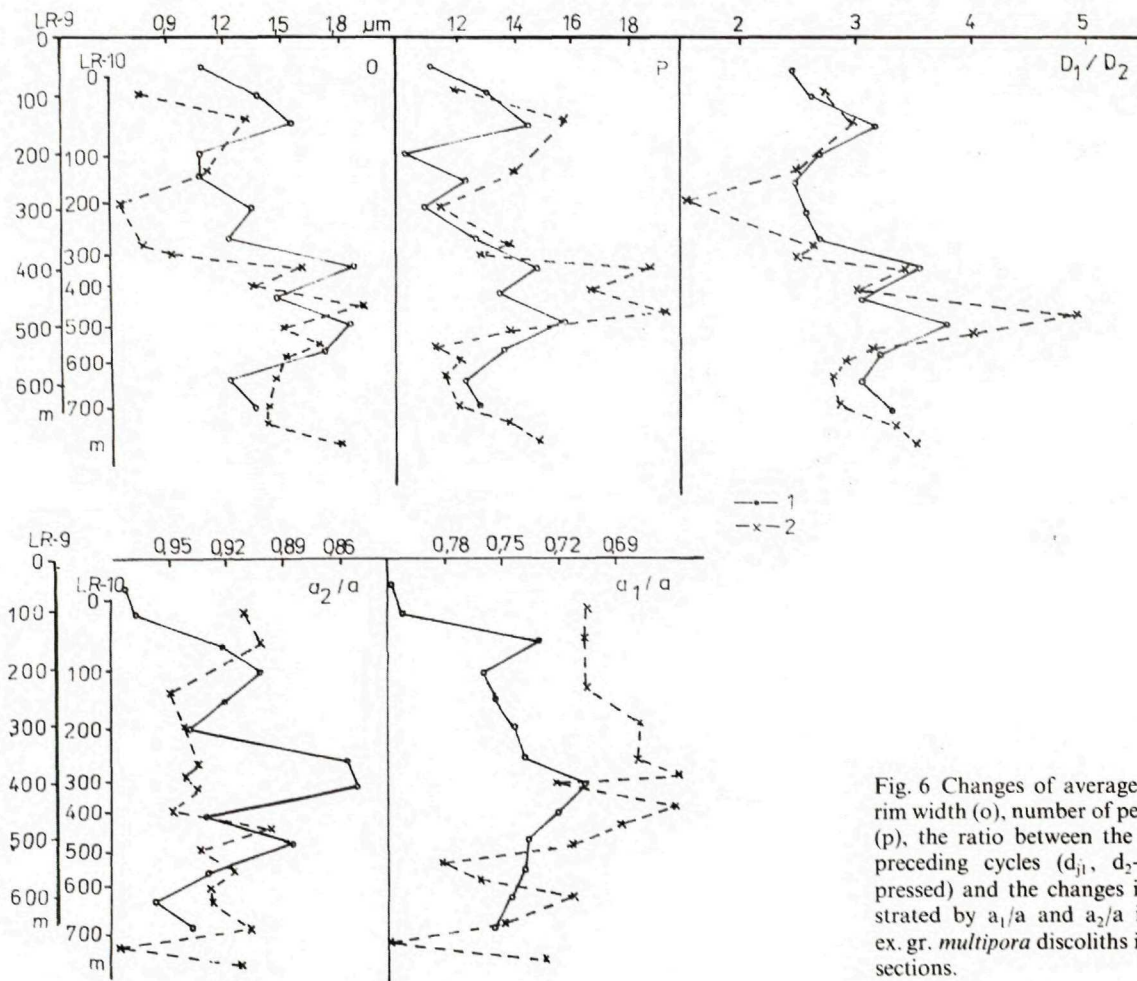


Fig. 6 Changes of average values of the peripheral rim width (o), number of perforations in the last cycle (p), the ratio between the sizes of the last and the preceding cycles (d_{11} , d_2 - semi-quantitatively expressed) and the changes in general shape (demonstrated by a_1/a and a_2/a indexes) of *Pontosphaera ex. gr. multipora discoliths* in LR-9 (1) and LR-10 (2) sections.

changes of studied variable correlate reasons of variability	with changes of the same variable in other sections	with changes of other variables in the same section	remarks
common variability	-	-	no groups are formed
differences between the distal and proximal sides	-	-	two distinctively separated groups definable differences
ontogenetic stages	-	-	← correlation possible in the case of dependence between generation exchange (or ontogenetic stages) and the ecological conditions
variability within the coccosphere	-	-	↓
stage of reproduction cycle	-	-	distinctively separated groups
short-term ecological changes	+	±	
long-term ecological changes	+	+	
changes during phylogeny	+	-	
diagenetic changes	-	-	may depend on the CaCO_3 content in the rocks

Explonation: + correlation found
- no correlation found

The correlated sections must conform to the condition of similar ecological development (identical facies development etc.)

Fig. 7 Possibility of correlation between the variables of thanatocoenoses in the studied sections and the morphological changes of pontospheres in dependence on various reasons of discoliths variability.

2. Variability in the number of perforations, their proportional size, width of the peripheral rim may be due to long-term ecological changes. The following environmental parameters (variables) may have played role:

- temperature
- salinity
- content of O_2 , CO_2 , N_2
- changes connected with the sea level variations
- nutrient supply
- relations between the zoo- and phytoplankton

The fig. 8 serves as a model of reaction of some variables studied in the boreholes on the above environmental changes.

The possibility of changes in salinity is excluded due to the varied foraminiferal assemblages and the presence of stenohaline forms.

The other characteristics of foraminiferal assemblages, nannoplankton and the sedimentological characteristics suggest 2 trends in the sections:

1. The "oxygen trend"; because of the presence of foraminifers resistant at oxygen-depleted environment (*Bolivina*, *Uvigerina*, less *Praeglobobulimina*), and the increased portion of pyrite I suppose a diminished O_2 content during the Kiscelian and in the uppermost Egerian;

2. The "depth trend"; due to the changes in diversity of benthic foraminifers, representation of deep-water and shallow-water taxa portion of planktonic foraminifers and grain-size changes of the deposits I suppose changes of basin depth as shown by the fig. 9d.

The change of the ratio between *Pontosphaera* groups I and II is similar to the depth trend. In my opinion, the influence of O_2 content changes at the morphological changes of discoliths should be excluded.

From the above discussion, as well as from the fig. 9, it follows that the appearance and disappearance of groups I and II in the sections may have been caused by alternating isolation and communication with the open sea. According to this hypothesis, the group I may represent an assemblage that invaded from the open sea (during the period of deepening of the basin). Later, transitional forms began to appear, and in the period of basin isolation the group II gradually prevailed. (fig. 9a). In this case the change of ratio between the above groups could be significant for local stratigraphy of the basin and for paleontographic interpretations.

LEHOTAYOVÁ 1975 figured a specimen of *Pontosphaera* belonging to the group II, from 96 m dept of Š 1 borehole near Štúrovo, where shallow-water fauna is present and in the upper parts even freshening of the environment is documented (BRESTENSKÁ 1975); thus in this depth the isolation of the basin can be supposed).

This hypothesis may be evidenced by the increase of diversity of nannoplankton and of planktonic foraminifers, as well as by the general change in the assemblages of planktonic foraminifers (expressed by low values of the similarity index), connected with the occurrence of an assemblage diversified in shape

in the time of appearance of group II (fig. 9). This can also explain the correlation between the morphological changes of *Pontosphaera* and the depth trend.

Occurrence of malformed coccoliths in closed basin is described by OKADA-BUKRY (ex TAPPAN 1980).

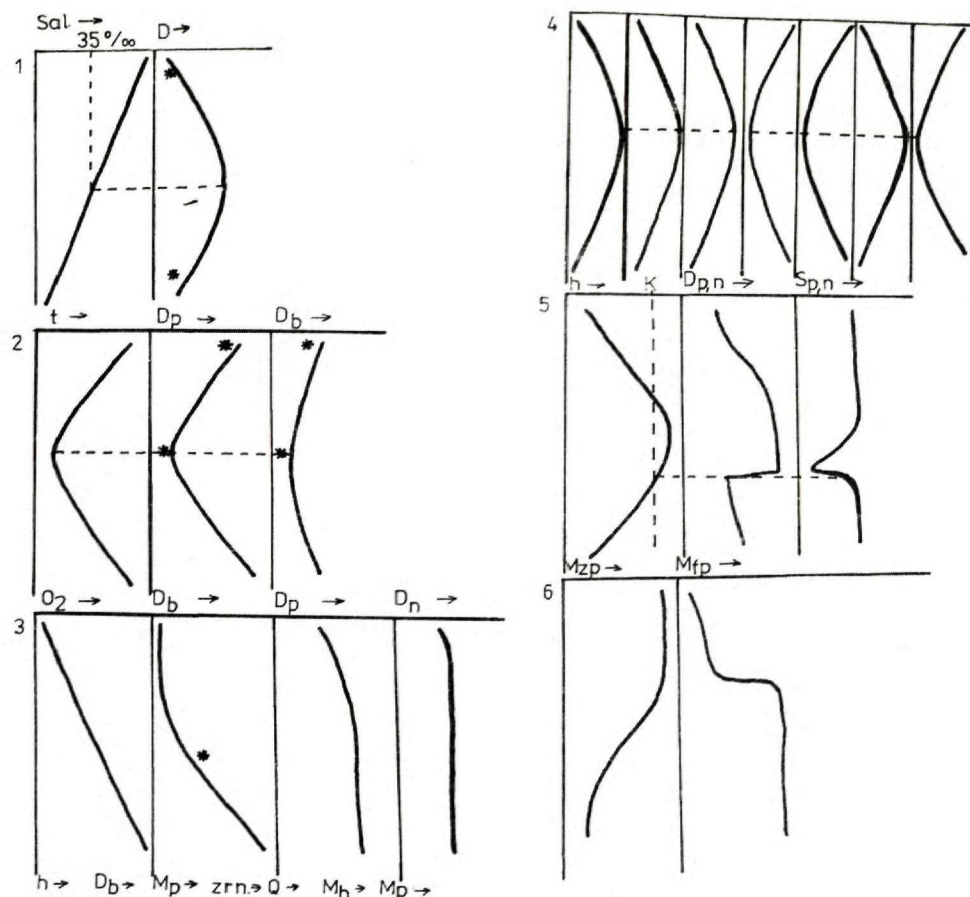


Fig. 8 A model expression of changes in some numerical characteristics of the thanatocoenoses related to the changes on some environmental variables. The arrow points at the increase of the observed values.

1 — diversity (D) changes related to salinity variations. 35 ‰ is normal salinity, 2 — changes in plankton (Dp) and benthos (Db) diversity dependent on temperature changes (t), 3 — dependence of Dp, Db, and nannoplankton diversity (Dn) changes on the variations of O₂ content, 4 — changes in Dp, amount of plankton (Mp), deep-water (Mhv) and shallow-water (Mpv) benthonic species, grain size and abrasion of quartz grains (Q) in relation to the depth changes, 5 — changes of Dp, Dn and similarity of adjacent plankton (Sp) and nannoplankton (Sn) thanatocoenoses during a restored communication of the isolated basin with the open sea (K). Index h expresses changes in the depth of the basin dependent only on global sea level oscillations, 6 — correlation between the total amount of zoo- (Mzp) and phytoplankton (Mfp). A star marks the appearance of species typical of changed ecological conditions. Compiled from various sources.

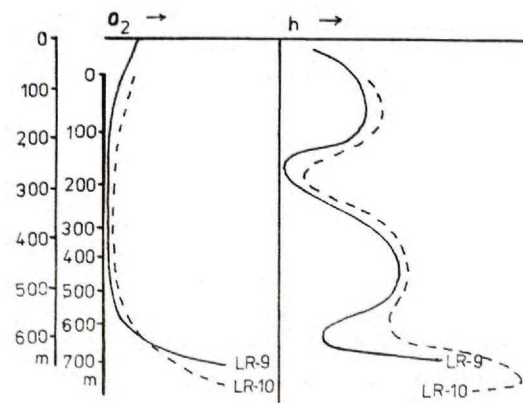
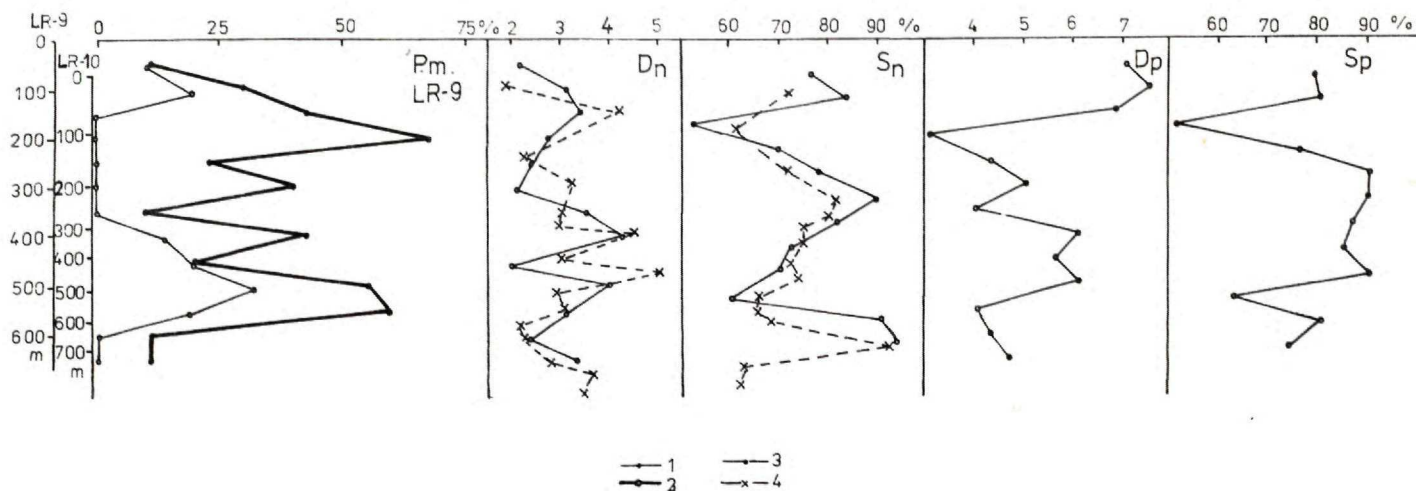


Fig. 9 Changes in diversity of nannoplankton (Dn), similarity of nannoplankton thanatocoenoses (Sn), diversity of plankton (Dp) and similarity of adjacent thanatocoenoses of planktonic foraminifers (Sp) compared to the changes in ratio of groups I and II (morphotypes of *Pontosphaera* ex gr. *multi-pora*) and to the "oxygen" and "depth" (h) trends in the LR-9 and LR-10 sections. The arrows point at the increase of O_2 content and deepening of basin depth.

A remark on the taxonomical significance of the morphotypic groups

In my opinion, so far it is not useful to give the groups a new specific or subspecific name. Both groups can be incorporated into the framework of intraspecific variability of *Pontosphaera multipora* species. As this species is relatively widely conceived, I used the name *Pontosphaera* ex. gr. *multipora*.

A further division of the species into minor species on subspecies, or the solution of position of *Pontosphaera rothi* HAQ 1971, connected to them by transitional forms reminding the group II would be rightful only through knowledge of the detailed structure of elements of particular forms, which I suppose to be a crucial systematic feature.

Summary

There were observed 2 types of variability of discoliths of *Pontosphaera* ex gr. *multipora* from NP 24 and NP 25 zones of the SE part of the Rimava Basin. The first type — variability of the discolith shape — may represent the variability within the coccosphere. The second type, variability of the number and relative size of perforations and of the peripheral rim width, enabled to separate 2 morphotypic groups; their representation in the sections varied in time. Group I may represent an open-sea assemblage that invaded the isolated Paratethys basin during a sea level rise. During the interval of basin isolation the assemblage of group II began to appear.

Because the detailed structure of discoliths is not known, the groups are labelled only by numbers I and II, without any taxonomical significance.

The hypothesis of reasons of the alternation of two morphotypes should be verified by further studies; then the changes in representation of morphotypical groups could be used for solution of some paleogeographic problems and more detailed stratigraphy of the basin.

References

- BÁLDI, T. 1986: Mid-tertiary stratigraphy and paleogeographic evolution of Hungary. — Akadémiai Kiadó, Budapest, 1—201.
- BÁLDI-BÉKE, M. 1984: A dunántúli paleogén képződmények nannoplanktonja. — Geol. Hung., Ser. Pal., 43, 1—307.
- BRAMLETTE, M. M.—SULIVAN, F. R. 1961: Coccolithoporida and related nannoplankton of the early Tertiary in California. — Micropaleontology, 7, 2, New York, 129—188.
- HAQ, U. Z. B. 1971: Paleogene calcareous nannoflora Part II: Oligocene of Western Germany. — Stockholm Contrib. Geol. 25, 57—97.
- HAY, W. W.—MOHLER, H.—WADY, M. A. 1966: Calcareous nannofossils from Naľčik (Nordwest Caucasus). — Eclogae geol. helv., 59, 1, Basel, 374—399.
- KIDWELL, S. M.—AIGNER, T. 1985: Sedimentary dynamics of complex shell beds: implications for ecologic and evolutionary patterns. — In: Bayer, N.—Seilacher, A. (eds.): Sedimentary and evolutionary cycles. — Springer-Verlag, Berlin—Heidelberg, 320—341.

- LEHOTAYOVÁ, R. 1977: Vápenná nanoflóra na liste Chanava.—Čiast. záverečná správa, MS Geofond, Bratislava.
- LEHOTAYOVÁ, R.—BÁLDI-BÉKE, M. 1975: Kalkige Nannoflora der Sedimente des Egerien. — In: Báldi, T.—Seneš, J. et al.: Chronostratigraphie und Neostatotypen 5, Egerien.—Veda, Bratislava, 479—530.
- MILLER, F. X. 1977: The graphic correlation in biostratigraphy. — In: Kauffman, E. G.—Hazel, J. E.: Concepts and methods of biostratigraphy. — Dowden, Hutchinson and Ross, Inc. Stroudsburg, 165—186.
- PERCH-NIELSEN, K. 1971: Elektronenmikroskopische Untersuchungen und Coccolithen and verwandten Formen aus dem Eozän von Danemark. — K. Danske Vid. Selskab, Biol. Skr. 18/3, København 1—76.
- PERCH-NIELSEN, K. 1986: Cenozoic calcareous nannofossils. In: Bolli, H. M.—Saunders, J. B.—Perch-Nielsen, K.: Planctonic stratigraphy.—Cambridge Univ. Press, 426—554.
- REYMENT, R. A. 1971: Introduction to quantitative paleoecology.—Elsevier Publish. Comp. Amsterdam—London—New York, 1—226.
- ROTH, H. P. 1970: Oligocene calcareous nannoplankton biostratigraphy — Eclogae geol. Helv. 63, 3, Basle, 799—881.
- SRINIVASAN, M. S.—KENNETT, J. P. 1983: The Oligocene — Miocene boundary in the South Pacific. — Bull. Geol. Soc. Amer., 94, 6, New York, 798—812.
- STRADNER, H.—EDWARDS, A. R. 1968: Electron microscopic studies on Upper Eocene Coccoliths from the Oamaru diatomite, New Zeland. — Jahr. der Geologischen Bundesanstalt, 13, Wien.
- TAPPAN, H. 1980: Haptophyta, Coccolithophores and other calcareous nannoplankton. — In: Tappan, H.: The paleobiology of plant Protists. — W. H. Freeman and comp., San Francisco.

KATARÍNA ŠUTOVSKÁ

Biometrické charakteristiky diskolitov *Pontosphaera* ex. gr. *multiplora* Kamptner (Roth) 1970 z egeru jv. časti Rimavskej kotliny; paleoekologické a taxonomické aspekty

Resumé anglického textu

V jv. časti Rimavskej kotliny, vo vrtoch LR-9 a LR-10 boli študované spoločenstvá nanoplanktónu. Stratigraficky boli zaradené do zón NP-24 a NP-25. Zastúpenie jednotlivých druhov nanoplanktónu bolo kvantitatívne vyhodnotené a vypočítaná diverzita spoločenstiev.

Na základe fotografií z optického mikroskopu boli biometricky charakterizované kokolity *Pontosphaera* ex gr. *multiplora*. Boli pozorované dva typy variability.

1. Tvar (resp. obrys) diskolitov sa mení kontinuálne. Môže ísť o variabilitu v rámci kokosféry.

2. Variabilita v počte otvorov posledného cyklu, relatívnej veľkosti otvorov v poslednom a predchádzajúcich cykloch a v šírke okrajových lemov umožnili vyčleniť dve skupiny: Skupina I s veľkým počtom otvorov, približne rovnako veľkých a úzkym obvodovým lemom by mohla predstavovať spoločenstvo otvoreného mora, ktoré preniklo v čase stúpnutia morskej hladiny do ináč izolovaného priestoru Paratetedy (stúpnutie morskej hladiny indikujú zmeny v spoločenstve foraminifer a litológie). V období izolácie sa postupne objavuje skupina II, charakterizovaná širokým lemom a malým počtom otvorov v poslednom závite, ktoré sú výrazne väčšie ako ostatné.

Pretože nie je známa detailnejšia stavba diskolitov, ponechávam skupinám len číselné označenie (skupina I a II) a neprisudzujem im žiadny taxonomický význam.

Zmeny v zastúpení morfortypov by bolo možné využiť na detailnejšiu stratigrafiu panvy a na niektoré paleoekologické a paleogeografické interpretácie.

MAGDA KONZALOVÁ

Palynological investigation of the basal Tertiary sediments (Paleogene) in western Bohemia and their correlation with the Carpathian region

6 text-fig., 8 plates (XXXIV—XLI), 1 table

Abstract. The basal Tertiary sediments, the Staré Sedlo Formation and the basal strata in the Cheb Basin, western Bohemia, have been palynologically evaluated. The comparison with the Central European Paleogene and with the Paleogene of the West Carpathians in Slovakia is given. The Eocene spectra of plant microfossils are evidenced.

Introduction

During the last years, micropaleontological data brought many essential findings and information on the basal sedimentation of the Tertiary deposits in western Bohemia (text-fig. 1) in the Sokolov Basin and in the Cheb area (Cheb Basin and its periphery, text-figs. 2, 3). It has been evidenced that basal sediments in some parts of the Cheb Basin belong to the Eocene and Eocene/Oligocene sedimentations, analogously to the Sokolov Basin, to the Staré Sedlo (Grasseth) Formation, where Paleogene (the Upper Eocene) assemblages have been identified together with the index pollen taxa.

The present paper shows in a rather wide context the comparison of the data from the Sokolov and Cheb Basins with those of the central European Paleogene basins and their zones, and especially with the region of the Western Carpathians where the sedimentary complexes are well dated on the basis of fauna and radiometric data.

The comparison is based on the associations of preserved and identified taxa of plant microfossils. The comparison includes the correlation between continental and marine associations.

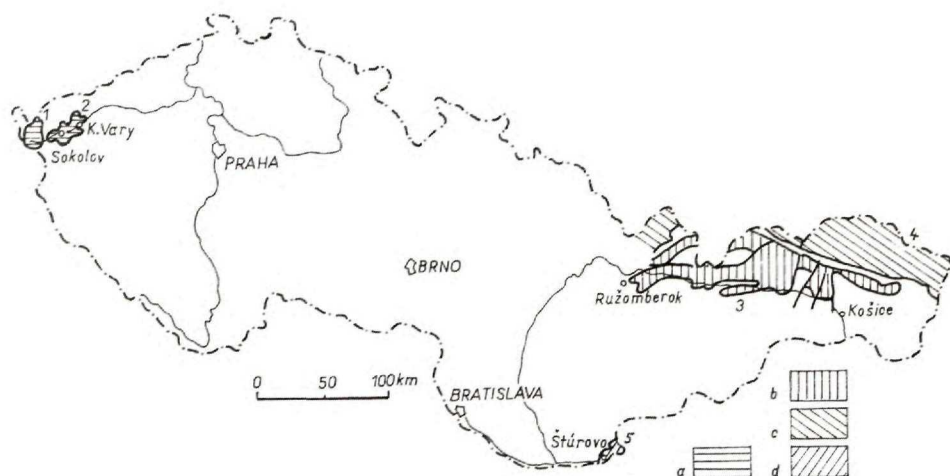


Fig. 1 Map of Czechoslovakia where the correlated Bohemian and Slovakian Paleogene formations are indicated. 1, 2. Western Bohemian Basins — Cheb Basin (1a) and Sokolov Basin (2a), Central Carpathian Paleogene (3b), Paleogene of Magura and Dukla units (4c), Paleogene of Buda facies, Danube Lowland (5d), Slovakia.

Systematic part

The identified taxa of pollen, spores and algal remains are given on Table 1 which also shows their relative distribution. Some significant taxa are discussed below.

Systematic notes on some botanically or stratigraphically significant taxa

Bombacaceae

Bombacacidites kettigensis (PF.) W. KR. *gracilis* W. KR.

(Pl. XXXVII, Figs. 1—3)

Bombacacidites geiseltalensis W. KR.

Bombacacidites palaeogenis W. KR.

The species of the genus *Bombacacidites* comprise significant index microfossils (see text-fig. 4). In the Tertiary of Bohemia, they have for the first time been

identified from the basal Tertiary sediments in the Sokolov Basin (Staré Sedlo Formation) and at the Velký Luh locality (KONZALOVÁ 1972, 1976). Together with the other index pollen and on the basis of the evaluation of their accompanying association, the sediments of the Staré Sedlo Formation could be correlated with the Eocene deposits of the Saxon-Thuringian region in the Leipzig district. The stratigraphic range of the *Bombacacidites* species in pollen assemblages is seen in text-fig. 4. The species *B. kettigensis* (Pf.) W. KR. found in the Sokolov Basin in the bore Je 49, at the Jehličná locality appears in the Middle and the Upper Eocene, and is e. g. the typical element of the Geiseltal pollen spectrum, similarly as *B. geiseltalensis* and *B. palaeogenis*. According to BOULTER's (1984) statistical analysis of palynological data, it also represents an element of an Early Paleogene paratropical forest.

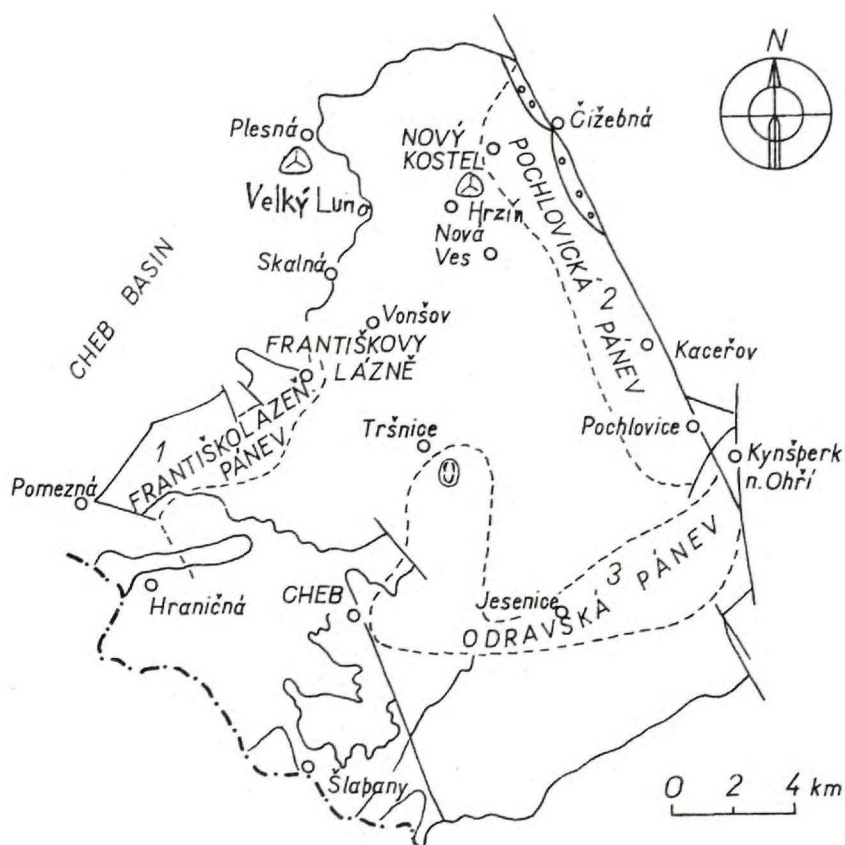


Fig. 2 Sketch of the Cheb Basin in western Bohemia. 1, 2, 3 parts of the Cheb Basin (Františkovy Lázně 1-, Pochlovice 2-, Odrava 3-parts of the basin). Palynologically evidenced Eocene sedimentation designated by symbol of spore, recently evidenced Oligocene sediments designated by symbol of pollen (assemblages with index pollen *Boehlensipollis* W. KR.).

Occurrence: Jehličná, Sokolov Basin, Velký Luh, Nový Kostel, Cheb Basin. (Bore Je 49, depth 209, 7—209.9 m, bore 4359, depth 63 m, bore HV 17, depth 138.6—138.8 m.)

Botanical relationship: Mostly *Bombacaceae*, partly *Sterculiaceae* (*Fremontodendron*)

Distribution: In the present-day tropical regions (pantropical distribution).

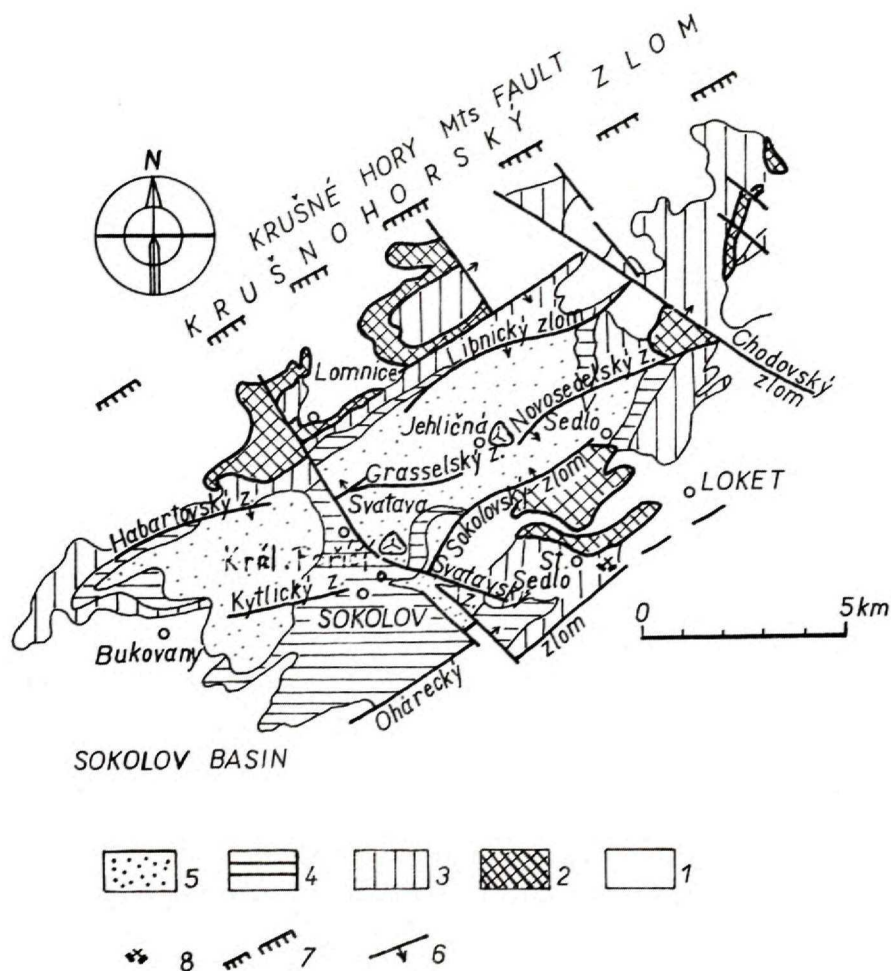


Fig. 3 Sketch of the Sokolov Basin in western Bohemia. 1 — Crystalline bedrock and granite, volcanics in the eastern part of the basin. 2 — Staré Sedlo Formation, Paleogene. 3 — Volcanic Complex. 4, 5 — Main Coal and Cypris Formation, Neogene. The area of evidenced Eocene pollen spectra designated by symbol of spore.

Localities of characteristic assemblages of microfossils in the Central Europe							
Helmstedt (Lower seam)	Helmstedt (Upper seam)	Borken	Elzdorf	Zeitz	Heskem	Calau	
14	15	16	17	18	19	Pg 20	Paleogene zones (Sporopollen zones)
—	—	—	—				<i>Bombacacidites geiseltalensis</i> W. Kr.
—	—	—	—				<i>Bombacacidites kettigensis</i> (Pf.) W. Kr.
—	—	—	—	—			<i>Pompeckjoidaepollenites subhercynicus</i> (W. Kr.) W. Kr.
—	—	—	—	—			<i>Alangiopollis eocaenicus</i> W. Kr.
—	—	—	—	—			<i>Duplopollis myrtoides</i> W. Kr.
—	—	—	—	—	?		<i>Spinaepollis spinosus</i> (R. Pot.) W. Kr.
?	—	—	—	—	—	—	<i>Tricolporopollenites staresedloensis</i> W. Kr. et Paclt.
				—	?	—	<i>Tsuga</i> (tsugoid types)
				—	?	—	<i>Carya</i> (<i>S. simplex</i> type)
				—	—	—	<i>Ulmaceae</i> (ulmoid types)

Fig. 4 Sporopollen zones and stratigraphic range of some significant pollen taxa in the Central European Paleogene (after KRUTZSCH 1967, 1970a, b and l.c.) The zones Pg-14 up to Pg-18, partly Pg-19: Eocene, Pg-19 and Pg-20: Oligocene.

? *Betulaceae* (*Prae-Betulaceae*)

Plicapollis pseudoexcelsus (W. KR.) W. KR.

Triporate pollen representing the ancient types probably affiliated with the family *Betulaceae* (*Betula*). A typical element of Paleogene floras, distributed especially in Eocene spectra in continental as well as marine sediments.

Occurrence: Jehličná—Královské Poříčí, Sokolov Basin, Velký Luh, Nový Kostel, Cheb Basin (bore H 11, depth 261.8 m, bore 4359, depth 75 m, HV 17, depth 138.6—138.8 m.)

aff. *Salicaceae*

Tricolporopollenites staresedloensis W. KR. et PACLT.

(Pl. XXXVI, Figs. 4—6, Pl. XL, Figs. 5, 6)

Baculate tricolporates described from the Staré Sedlo Formation in Bohemia and Calau beds in the GDR (KRUTZSCH 1969), are commonly distributed in the Paleogene sediments of W. Bohemian basins and in the Oligocene sediments of the Volcanic Complex in the České středohoří Mts. The localities Lochočice — Rovný near Stadice and Roudníky near Modlany at the northern margin of the České středohoří Mts, Mradice near Louny at the southern margin and at the locality Tršnice in the Cheb Basin may serve as examples. These microfossils often are assembled with the Oligocene index pollen *Boehlensipollis hohli* W. KR., e.g. at the localities Lochočice — Rovný and Tršnice (text-fig. 2), comparable with the zones Pg-19 and Pg-20 in the GDR. (Oligocene assemblages see KONZALOVÁ 1981).

Botanical relationship: The comparison with the family *Salicaceae*, given by Krutzsch, is only very approximative.

Occurrence: Jehličná, Sokolov Basin, Velký Luh, Nový Kostel, Cheb Basin. (Bores Je 50, depth 244.3 m, H 11, depth 272.8 m, bore 4359, depth 63 m and 67 m, bore HV 17, depth 138.6 m—138.8 m and other boreholes).

Rhizophoraceae

Tricolporopollenites mansfeldensis W. KR.

Tricolporate or tetracolporate types comparable with the above mentioned species, suggesting smooth sapotoid grains, have been found in the Sokolov Basin, at the Jehličná locality. An earlier element of Paleogene, i. e. Eocene and Paleocene floras is involved.

Occurrence: Jehličná—Královské Poříčí, Sokolov Basin. (Bore H 11, depth 261.8 m)

Juglandaceae

***Plicatopollis plicatus* (R. POT.) W. KR.**

***Momipites quietus* (R. POT.) W. KR.**

Juglandaceae represent typical elements of the Eocene accompanying microfloras distributed especially in the Paleogene zone Pg-18 of Central Europe (KRUTZSCH-LENK 1973), e. g. in the Eocene of the Geiseltal locality and of the Weissester Basin in the GDR. They occur in the Paleogene of both W. Bohemian basins and have also been found in the Eocene sediments of the Dukla and Magura units of the Slovakian Paleogene, in the Buda facies of the Eocene in southern Slovakia (SNOPKOVÁ 1977; text-fig. 1,6 in the present paper) in the Paleogene of the Dorog Basin and in the Eocene of Bakony Mts in Hungary, and elsewhere. Both types are fairly widespread. They also occur in the Paleogene pollen spectra known from the southern part of the USA (Mississippi region). From the phylogenetic point of view they are assumed to be the descendents of Cretaceous floras.

Occurrence: Jehličná, Sokolov Basin; Velký Luh, Nový Kostel, Cheb Basin. (Bores Je 49, depth 209.7—209.9 m, Je 50, depth 255.3 m—255.65 m, HV 17, depth 138.6—138.8 m and other bores.)

***Myrtaceae* (*Loranthaceae* according to some authors)**

***Duplopollis myrtoides* W. KR.**

Typical syncolporate pollen known e. g. from Geiseltal (from the Lutetian and overlying seams) have been found in the northern part of the Cheb Basin, at the Nový Kostel locality (KONZALOVÁ 1987). They represent the significant element of the zones Pg 15 up to Pg 18 of the central European Paleogene (KRUTZSCH 1970a), and probably belong to the blossom of rhodomyrtophyllous leaves. *D. myrtoides* has also been recorded in the Paleogene of Hungary, from the Lower Eocene at the Halimba locality (KEDVES 1969) as well as in the Eocene of North American continent, e. g. Gulf region (TSCHUDY and VAN LOENEN 1970).

Occurrence: Nový Kostel, Velký Luh, Cheb Basin. (Bore HV 17, depth 138.6—138.8 m, bore 4359, depth 63 m).

Myrtaceae* vel *Sapindaceae

***Cupanieidites eucalyptoides* W. KR.**

***Cupanieidites minimus* W. KR.**

Further myrtoid pollen, which occur in Paleogene spectra in both basins. It also is regularly present in the Oligocene sediments of the Volcanic Complex (KONZALOVÁ 1981). It is an element also spread in the Upper Eocene sediments of the Mississippi region of the USA (TSCHUDY and VAN LOENEN 1970).

Occurrence: Jehličná, Sokolov Basin; Velký Luh, Nový Kostel, Cheb Basin. (Bore Je 50, depth 255.30—255.65 m, bore 4359, depth 63 m, bore HV 17, depth 138.6—138.8 m).

Euphorbiaceae

***Spinaepollis spinosus* (R. POT.) W. KR.**

Low-spinate pollen with characteristic pattern of the exine are the typical element occurring from the Paleogene to the Middle Oligocene. It is especially striking in the deposits of the Cheb Basin. (The evidence of the *Euphorbiaceae* distribution is furnished by their seeds *Euphorbiospermum* e. g. from Geiseltal or London clay). The pollen have been recorded in the spectra of the Eocene and Oligocene sediments of the Saxon-Thuringian and Baltic regions (GRABOVSKA 1974), in the Eocene basins in Hungary, and elsewhere. According to KRUTZSCH (1970a) they are a rare element in the Paleocene, but are frequent in the sediments of the Middle and Upper Eocene. SNOPOKOVÁ (1980) gives *S. spinosus* (sensu cf. *Lauraceae*) as occurring in the Upper Eocene (claystone lithofacies) in the inner Carpathian depressions (Liptovská kotlina depression, Šariš hilly land a. o.).

Occurrence: Velký Luh, Cheb Basin. (Bore 4359, depth 63 m and 67 m, KONZALOVÁ 1976).

Hamamelidaceae (Altingiaceae)

***Periporopollenites steinhaueraoides* W. KR.**

(Pl. XXXV, Figs. 11, 12)

Rare periporate pollen assigned by Krutzsch to the extinct Paleogene genus *Steinhauera* have been found in the Velký Luh sediments and recently also in the Nový Kostel area. They evidence an earlier Paleogene zone Pg-14 up to the lower part of the zone Pg-18, i. e. the sediments of the upper Lower Eocene to the lower part of the Upper Eocene.

Occurrence: Velký Luh, Nový Kostel, Cheb Basin. (Bore 4359, depth 77 m, bore HV 17, depth 138.6—138.8 m.)

Incertae sedis

***Tricolporopollenites cognitus* (R. POT.) W. KR.**

Tricolporate pollen of similar distribution as in *P. steinhaueraoides*, but occurring as early as in the sediments of the deeper Lower Eocene, in the zone Pg-11.

(*T. cognitus* and other significant taxa of both basins see in Table 1 and in KONZALOVÁ 1972, 1976, 1987).

Occurrence: Velký Luh. (Bore 4359, depth 63 m).

Brief floristic characterization of the Paleogene of the Sokolov and Cheb Basins

The sporopollen spectra display the high portion of triporate and tricolporate grains of a cingulate type, partly related to *Fagaceae*, and tricolporate or tetracolporate, often sculptured grains which represent unknown or extinct taxa of Paleogene woody plants. Part of the tetracolporates comprises the *Sapotaceae* family, part of the tricolporates and tetracolporates the leguminous plants (*Fabaceae*) whose identification is mostly very uncertain. The *Fagaceae* family, in addition to the groups *cingulum* — *fuscus* — *oviformis*, is also represented by quercoid pollen, *Tricolporopollenites quercioides* (designated by some authors as *Protoquercus* BOLCH). In observing recent pollen of the genus *Trigonobalanus excelsus* under LM and SEM, Plate XXXVIII, a close resemblance has been found between both types but more detailed study would be needed.

Triporate pollen grains are mostly derived from the Early Tertiary catkin plants related to *Juglandaceae*, *Betulaceae* and *Myricaceae*. *Momipites quietus* suggests engelhardtoid types, and its mother plants formed probably part of laurel forests. This assumption follows from analogous experience with the floras of Volcanic Complex and their correlation between the pollen spectra and plant macrofossil remains.

As variable elements of the W. Bohemian Paleogene (pre-Rupelian) spectra, edaphic and environment-dependent *Cupressineae* and *Pteridophytes* are represented. The assembled *Pteridophyte* taxa are common in the Eocene sediments, as it is visible from the comparison with Paleogene spectra from various region, areas and lithofacies. They testify to the rich fern vegetation comprising especially fern lianas growing on favourable habitats, the thermophile ferns of the *Schizaeaceae*, *Pteridaceae* and *Polypodiaceae* families, as well as to a minor extent *Gleicheniaceae* family. According to the sporangial fragments (microsporangial tissues) of *Azollaceae-Salviniaceae* stagnant waters were settled by water ferns, flooded habitats by *Nyssa* and representatives of *Hamamelidaceae* and swampy habitats (probably very restricted in W. Bohemian Basins) by *Taxodiaceae* and *Cupressaceae*.

Comparison of the Paleogene of western Bohemia with that of Central Europe

On the basis of pollen stratigraphy, the Paleogene in Central Europe has been divided by German paleobotanists (especially W. Krutzsch) into 20 zones in dependence on presumed climatic phases controlling the composition of forest

Table 1 Occurrences and frequency of the single taxa in the Bohemian Paleogene (basal Tertiary strata)

A B			A Cheb Basin, B Sokolov Basin	
1	2	3	Localities: 1 — Velký Luh, 2 — Nový Kostel, Hrzín (A) 3 — Jehličná, Královské Poříčí (B)	
•		<i>Algae</i>	<i>Botryococcus braunii</i> KÜTZ., <i>Pediastrum</i> (rests)	
		<i>Pteridophytes</i>		
v	v	<i>Azollaceae, Salviniaceae</i>	rests of microsporangia (without glochidia)	
○	○	• <i>Schizaeaceae</i> (smooth <i>Lygodium</i> types)	<i>Leiotriletes</i> sp. div.- <i>Triplanosporites</i> PF.	
x	v	○ <i>Schizaeaceae, Lygodium</i>	<i>Leiotriletes adriennis</i> (R. POT. et VEN.) W. KR.	
		○ <i>Schizaeaceae, Lygodium</i>	<i>Leiotriletes maxoides</i> W. KR.	
v	x	○ <i>Schizaeaceae, Lygodium</i>	<i>Leiotriletes microadriennis</i> W. KR. var. <i>triplan</i> KDS.	
		○ <i>Schizaeaceae, Lygodium</i>	<i>Leiotriletes</i> asp. <i>sinusoides</i> W. KR.	
	x	○ <i>Schizaeaceae, Lygodium</i>	<i>Triplanosporites sinomaxoides</i> W. KR.	
		v cf. <i>Gleicheniaceae</i>	<i>Toroisporis irregularis</i> (PF.) W. KR.	
v		cf. <i>Gleicheniaceae</i>	aff. <i>Toroisporis eocaenicus</i> KDS.	
	x	cf. <i>Gleicheniaceae</i>	<i>Toripunctisporis punctinedeni</i> W. KR.	
v		○ cf. <i>Gleicheniaceae, Cyatheaceae, Dicksoniaceae</i>	cf. <i>Cyathidites</i> sp.	
v	x	○ <i>Gleicheniaceae</i>	<i>Gleicheniidites</i> sp. div.	
		v <i>Gleicheniaceae</i>	<i>Neogenisporis</i> sp.	
		x <i>Gleicheniaceae</i>	<i>Concavisporites obtusangulus</i> (R. POT.) W. KR.	
•	•	<i>Selaginellaceae, Selaginella</i>	<i>Echinatisporis longechinus</i> W. KR.	
v	x	x <i>Selaginellaceae, Selaginella</i>	<i>Echinatisporis</i> sp. div.	
x	v	○ <i>Osmundaceae, Osmunda</i>	<i>Baculatisporites quintus</i> (TH. et PF.) W. KR.	
		•	<i>Tegumentisporis</i> cf. <i>tegumentis</i> (W. KR.) W. KR.	
○	•	○ <i>Schizaeaceae, Lygodium</i> (ornamented types)	<i>Trilites multivallatus</i> (PF.) W. KR.	
		○ <i>Schizaeaceae, Lygodium</i>	<i>Trilites paravallatus</i> W. KR.	
	v	v <i>Schizaeaceae, cf. Lygodium</i>	<i>Ischyosporites asolidus</i> (W. KR.) W. KR.	
v	○	○ <i>Schizaeaceae, Ruffordia, Aneimia</i>	<i>Cicatricosisporites dorogensis</i> R. POT. et GELL.	
	○	○ <i>Schizaeaceae, Ruffordia, Aneimia, ?Mohria</i>	<i>Cicatricosisporites paradorogensis</i> W. KR.	
	v	<i>Schizaeaceae, Ruffordia, Aneimia, ?Mohria</i>	<i>Cicatricosisporites cicatricosoides</i> W. KR.	
	v	○ <i>Schizaeaceae</i>	<i>Cicatricosisporites</i> sp. div.	
v	v	v <i>Pteridaceae</i>	<i>Polypodiaceoisporites</i> cf. <i>marxheimensis</i> (PFL.) W. KR.	
○	○	○ <i>Pteridaceae</i>	<i>Polypodiaceoisporites</i> sp. div.	
x	x	? <i>Pteridaceae</i>	<i>Verrucingulatisporites</i> sp.	
	v	v <i>Lycopodiaceae</i>	<i>Camazonosporites (Hamulatisporis) heskemensis</i> (PFL.) W. KR.	
v		○ <i>Polypodiaceae</i>	<i>Laevigatosporites discordatus</i> PF.	
v	v	○ <i>Polypodiaceae</i>	<i>Polypodiites secundus</i> (R. POT.) W. KR.	
•		? <i>Polypodiaceae</i>	<i>Reticuloidosporites poriacus</i> W. KR.	
		• <i>Polypodiaceae, Asplenium, Athyrium</i>	<i>Perimonoletes</i> sp.	
		• <i>Polypodiaceae, aff. Lastrea</i>	<i>Extrapunctatosporites extrapunctoides</i> W. KR.	
		<i>Gymnospermophyta</i>		
•		<i>Pinaceae</i>	<i>Pityosporites cedrisacciformis</i> W. KR.	
x	x	x <i>Pinaceae, Pinus</i> types	<i>Pityosporites</i> sp. div. (<i>labdacus</i> types)	
v	x	v <i>Pinaceae, Cathaya</i>	<i>Pityosporites microalatus</i> (R. POT.) TH. et PF.	

A B			A Cheb Basin, B Sokolov Basin	
1	2	3	Localities: 1 — Velký Luh, 2 — Nový Kostel, Hrzín (A) 3 — Jehličná, Královské Poříčí (B)	
x	v	x	<i>Pinaceae, Cathaya</i>	<i>Pityosporites alatus</i> (R. POT.) TH. et PF.
x	x	x	<i>Podocarpaceae, Podocarpus</i>	<i>Podocarpidites podocarpoides</i> (THG.) W. KR.
		•	<i>Taxodiaceae, Sciadopitys</i>	<i>Sciadopityspollenites quintus</i> W. KR.
		•	cf. <i>Araucariaceae</i>	cf. <i>Araucariacidites eocenicus</i> W. KR.
v	v	v	<i>Taxodiaceae, Taxodium, Glyptostrobus</i>	<i>Inaperturopollenites hiatus</i> (R. POT.) TH. et PF.
	x	v	<i>Taxodiaceae, Taxodium, Glyptostrobus</i>	<i>Inaperturopollenites concedipites</i> (WDH.) W. KR.
x	x	x	<i>Cupressaceae</i>	<i>Cupressacites</i> cf. <i>insulapillatus</i> (TREV.) W. KR.
	x	x	<i>Taxodiaceae, Sequoia type Ephedropsida</i>	<i>Sequoiapollenites</i> cf. <i>gracilis</i> W. KR.
•			<i>Ephedraceae, Ephedra</i>	<i>Ephedripites</i> sp. (non <i>Distachyapites</i>)
			<i>Angiospermophyta</i>	
•	•	•	<i>Gramineae</i>	<i>Graminidites</i> sp.
•	x	•	<i>Restionaceae</i>	<i>Milfordia incerta</i> (TH. et PF.) W. KR.
		•		<i>Aglaoreidia cyclops</i> ERDT.
		x		<i>Cycadopites</i> sp.
v	v	○	<i>Arecaceae (Palmae), Phoenix</i>	<i>Monocolpopollenites tranquillus</i> (R. POT.) TH. et PF.
x	x	x	<i>Arecaceae (Palmae), cf. Phoenix</i>	<i>Monocolpopollenites tranquillus</i> (R. POT.) TH. et PF.
				<i>verrucatus</i> W. KR.
v			<i>Arecaceae (Palmae)</i>	<i>Monocolpopollenites</i> sp. div.
x	x	x	<i>Arecaceae (Palmae), cf. Phoenix</i>	<i>Arecipites wiesaensis</i> W. KR.
		•	<i>Arecaceae (Palmae)</i>	<i>Arecipites</i> sp. G type
v	x	v	<i>Arecaceae (Palmae), Sabal</i>	<i>Arecipites parareolatus</i> (W. KR.) W. KR. — (<i>Sabalpollenites granulatus</i> sensu KEDVES)
v	v	v	<i>Arecaceae (Palmae)</i>	<i>Arecipites</i> sp. div.
v	•	v	<i>Arecaceae (Palmae), Calamoidae, Calamus</i>	<i>Dicolpopollis kockeli</i> PFLANZL
		•		cf. <i>Pompeckjoidapollenites subhercynicus</i> (W. KR.) W. KR.
		•		<i>Basopollis</i> sp.
		•		cf. <i>Nudopollis thiergarti</i> — <i>endangulatus</i> type
•	•	•	<i>?Betulaceae</i>	<i>Plicapollis pseudoexcelsus</i> (W. KR.) W. KR.
•			<i>Ulmaceae, ?Celtis</i>	<i>Subtriporopollenites intrastructurus</i> W. KR. et VANH.
v	x	v	<i>Juglandaceae</i>	<i>Subtriporopollenites anulatus</i> — <i>constans</i> group
		•		<i>Subtriporopollenites reticulatus</i> W. KR. et VANH.
		•	<i>Juglandaceae</i>	<i>Subtriporopollenites subporatus</i> W. KR.
x	x	x	<i>Juglandaceae</i>	<i>Subtriporopollenites</i> sp. div.
v	•	x	<i>Ulmaceae</i>	<i>Subtriporopollenites ulmoides</i> CHTNF.
x		•	<i>Juglandaceae</i>	<i>Caryapollenites</i> sp.
x		v	<i>Myricaceae</i>	<i>Triatriopollenites rurensis</i> PF. et TH.
x	x	○	<i>Myricaceae</i>	<i>Triatriopollenites</i> sp. div.
•	x	v	<i>Myricaceae</i>	<i>Triatriopollenites bituitus</i> (R. POT.) TH. et PF.
•	•	•		<i>Triatriopollenites roboratus</i> — <i>aroboratus</i> group
v	v	v	<i>Juglandaceae</i>	<i>Momipites punctatus</i> — <i>coryphaeus</i> group
v	x	v	<i>Juglandaceae</i>	<i>Momipites quietus</i> (R. POT.) Nichols
•	•	•	<i>Juglandaceae</i>	<i>Mimopites cycloquietus</i> (W. KR.) W. KR.
		•		<i>Momipites coryloides</i> WDH.
x	x	v		<i>Labrapollis labraferus</i> (R. POT.) W. KR.
x	x	x	<i>Juglandaceae</i>	<i>Plicatopollis plicatus</i> (R. POT.) W. KR.

A B			A Cheb Basin, B Sokolov Basin	
1	2	3	Localities: 1 — Velký Luh, 2 — Nový Kostel, Hrzín (A) 3 — Jehličná, Královské Poříčí (B)	
• •		<i>Juglandaceae, Platycarya</i>	cf. <i>Platycaryapollenites trisolutionis</i> W. KR. et VANH.	
x • x		<i>Juglandaceae, Platycarya</i>	<i>Platycaryapollenites flagellus</i> type	
x x x		<i>Juglandaceae, Platycarya</i>	<i>Platycaryapollenites</i> sp. div.	
v v v		<i>Juglandaceae, Engelhardtia</i>	<i>Engelhardtoidites microcoryphaeus</i> (R. POT.) R. POT.	
x v x		<i>Juglandaceae,</i> cf. <i>Engelhardtia</i>	cf. <i>Engelhardtoidites microcoryphaeus</i> (R. POT.) R. POT. (thin-walled forms)	
• • •		? <i>Betulaceae, ?Myricaceae</i>	<i>Triplopollenites palaeobetuloides</i> W. KR. et VANH.	
•		<i>Tiliaceae</i>	<i>Intratriplopollenites ceciliensis</i> W. KR.	
x		<i>Tiliaceae</i>	<i>Intratriplopollenites microreticulatus</i> MAI	
•		<i>Tiliaceae</i>	<i>Intratriplopollenites schliebenensis</i> W. KR.	
x		<i>Bombacaceae, Sterculiaceae,</i> <i>Fremontodendron</i>	<i>Bombacacidites palaeogenis</i> W. KR.	
x		<i>Bombacaceae, Bombax</i> (pro parte)	<i>Bombacacidites geiseltalensis</i> W. KR.	
v v		<i>Bombacaceae, Bombax</i> sp.	<i>Bombacacidites kettigensis</i> (PF.) W. KR. <i>gracilis</i> W. KR.	
•			cf. <i>Brosipollis maximus</i> W. KR. et VANH.	
•		<i>Loranthaceae</i>	<i>Gothanipollis</i> sp.	
x		<i>Myrtaceae</i> vel <i>Loranthaceae</i>	<i>Duplopollis myrtilloides</i> W. KR.	
x x v		<i>Myrtaceae</i> vel <i>Sapindaceae</i>	<i>Cupanieidites minimus</i> W. KR. — <i>C. eucalyptoides</i> W. KR.	
•			aff. <i>Pentapollenites</i> sp.	
• •			<i>Pentapollenites</i> sp. C type sensu KEDVES	
x		<i>Euphorbiaceae</i>	<i>Spinaepollis spinosus</i> (R. POT.) W. KR.	
•			aff. <i>Compositoipollenites</i> sp. — small sized types	
v x		<i>Ulmaceae</i>	<i>Polyporopollenites undulosus</i> (WOLFF) TH. et PF.	
• •		<i>Betulaceae, Carpinus</i>	<i>Carpinuspollenites carpinoides</i> (TH. et PF.) NAGY	
x x x		<i>Betulaceae, Alnus</i>	<i>Alnipollenites verus</i> (R. POT.) R. POT.	
•		<i>Hamamelidaceae, (Altingiaceae)</i>	<i>Periporopollenites steinhaueraoides</i> W. KR.	
•		<i>Thymelaeaceae</i>	<i>Pseudospinaepollis pseudospinosus</i> W. KR.	
• • x			<i>Dicolporopollis middendorfi</i> (R. POT.) W. KR.	
v x v		<i>Symplocaceae</i>	<i>Porocolpopollenites calauensis</i> W. KR.	
v v v		<i>Symplocaceae</i>	<i>Porocolpopollenites vestibulum</i> (R. POT.) TH. et PF.	
v v		<i>Symplocaceae</i>	<i>Porocolpopollenites</i> sp. div.	
x			<i>Tricolporopollenites cognitus</i> (R. POT.) W. KR.	
•			<i>Tricolporopollenites abbreviatus</i> (R. POT.) W. KR.	
v x v		<i>Vitaceae, Parthenocissus</i>	<i>Tricolporopollenites marcodurensis</i> TH. et PF.	
•		<i>Convolvulaceae, cf. Merremia</i>	<i>Perforicolpites digitatus</i> GONZALES	
v v		aff. <i>Salicaceae</i>	<i>Tricolporopollenites staresedloensis</i> W. KR. et PACLT.	
•		? <i>Rhizophoraceae</i>	<i>Tricolporopollenites mansfeldensis</i> W. KR.	
•			<i>Tricolporopollenites</i> cf. <i>spinus</i> W. KR.	
x x		cf. <i>Cyrillaceae</i>	<i>Tricolporopollenites megaexactus</i> (R. POT.) TH. et PF., T type	
x x v		<i>Cyrillaceae</i>	<i>Tricolporopollenites megaexactus</i> (R. POT.) TH. et PF.	
x v		<i>Anacardiaceae</i>	<i>Tricolporopollenites pseudocingulum</i> (R. POT.) TH. et PF.	

A B			A Cheb Basin, B Sokolov Basin	
1	2	3	Localities: 1 — Velký Luh, 2 — Nový Kostel, Hrzín (A) 3 — Jehličná, Královské Poříčí (B)	
v	x	v	<i>Araliaceae</i>	<i>Araliaceipollenites</i> sp. div.
		v		<i>Tricolporopollenites irregularatus</i> NAKOMAN
v	v	v	<i>Fagaceae</i>	<i>Tricolporopollenites microhenrici</i> (R. POT.) TH. et PF.
●	●	x	<i>Fagaceae</i>	<i>Tricolporopollenites quercoides</i> W. KR. et VANH.
v	v	○	<i>Fagaceae, Leguminosae</i> (pro parte)	<i>Tricolporopollenites liblarensis-quisqualis-</i> <i>-graniquisqualis</i> group
x	v	v	<i>Fagaceae</i>	<i>Tricolporopollenites cingulum</i> (R. POT.) TH. et PF. <i>oviformis</i>
	v	v	<i>Fagaceae</i>	<i>Tricolporopollenites cingulum</i> (R. POT.) TH. et PF. T type
		x	? <i>Fagaceae</i> vel <i>Leguminosae</i>	<i>Tricolporopollenites cingulum</i> (R. POT.) TH. et PF., P type
v	v	○	cf. <i>Fagaceae</i>	<i>Fususpollenites fusus</i> (R. POT.) KDS.
●			<i>Fagaceae</i> ?	<i>Faguspollenites</i> sp.
x	x	x	<i>Fagaceae</i> (pro parte)	<i>Tricolporopollenites</i> sp.
○	x	v	<i>Aquifoliaceae, Ilex</i>	<i>Ilexpollenites iliacus</i> (R. POT.) R. POT.
x	v	v	<i>Aquifoliaceae, Ilex</i>	<i>Ilexpollenites margaritatus</i> (R. POT.) R. POT.
x	x	x	<i>Aquifoliaceae, Ilex</i>	<i>Ilexpollenites</i> sp. div.
v	x	v	<i>Nyssaceae</i>	<i>Nyssapollenites kruschi</i> (R. POT.) NAGY
		●	<i>Alangiaceae</i>	<i>Alangiopollis eocaenicus</i> W. KR.
	x	v	<i>Theaceae</i>	<i>Verrutricolporites magnotectatus</i> ROCHE et SCHULER
x		v		<i>Verrutricolporites</i> aff. <i>irregularis</i> ROCHE et SCHULER
	x	v	? <i>Araliaceae, Leguminosae</i>	<i>Scabratricolporites scheffleroides</i> ROCHE et SCHULER
		x	<i>Umbeliferae</i> ?	<i>Tricolporopollenites</i> sp. — <i>Heteromorpha</i> type
		●	cf. <i>Sapotaceae</i>	? <i>Psilastephanocolporites mimusopsoides</i> ROCHE et SCHULER
x	v	v	<i>Sapotaceae</i>	<i>Tetracolporopollenites sapotoides</i> TH. et PF.
x	v	v	<i>Sapotaceae</i>	<i>Tetracolporopollenites</i> div. sp.
x	●	x	<i>Meliaceae</i>	<i>Tetracolporopollenites</i> sp., M type
		x		cf. <i>Eocaenipollis pentacolpatus</i> W. KR.
		●		<i>Striatricolpites</i> cf. <i>catatumbus</i> GONZL.
		x	<i>Ericaceae</i>	<i>Ericipites ericius</i> (R. POT.) TH. et PF.

(Occurrences and frequencies: samples of bores — Je 49, Je 50, Je 61, P 21 B, H 11, HV 17, 4359, NK 56)

Remarks:

Occurrences: ● very rare, x single specimens, v more than single specimens
○ regularly, abundant in some horizons
● very abundant

communities. In the Paleogene spectra, preserved in most complete profiles on the territory of the GDR, three prominent moments in their composition have been observed: representation of Cretaceous elements overlapping from the Upper Cretaceous into the Early Paleogene, their gradual disappearing and replacing by new Eocene-paleotropical elements and the gradual expansion of the elements of deciduous forests, most probably from the holarctic area (Arctotertiary elements). Their cyclical representation in time and space, connected with the extinction of ancient groups and the onset of modern ones, has shown the general trend toward cooling, which, however, took place during alternating climatic fluctuations and oscillations. The alternation of warm and cool phases, designated by the predominance of the warm-like or Arctotertiary elements, became the basis for the multiphase development of the Early Tertiary Flora in the Central European space, suggested by German specialists (KRUTZSCH 1967, 1970 a, MAI-WALTHER 1985).

Even this conception is criticized by some authors (BOULTER 1984), and ecological requirement and climatic tolerancy remain unknown for many taxa, the characteristic Paleogene assemblages, reflecting floristic alteration, are recognizable and correlable. For the Central European Tertiary the zone-assemblages are — for the present time — the only possibility of short-distance correlation of the terrestrial sedimentary sequences, comprising brown coal seams.

The palynological investigations on Bohemian territory have shown that the basal Tertiary sediments in the basinal areas may be successfully correlated with the Paleogene sediments of Central Europe. The correlation is based on the average pollen spectra corroborated by index taxa. In this way, the Paleogene sediments of the Sokolov Basin and the basal sediments in the Cheb Basin, considered as Miocene in age, have been determined as Eocene and Eocene-Oligocene (and the assemblages of the main volcanic phase of the Volcanic Complex as Rupelian up to Egerian/Chattian), analogously to the Saxon-Thuringian and Lusatian regions (KONZALOVÁ—MAZANCOVÁ in BŮŽEK et al. 1969, KONZALOVÁ 1969, 1972, 1976, 1977, 1981, 1987).

From the sporopaleontological view, the beginning of the Paleogene is characterized by rather poor (so-called minimal) Paleocene floras whereas the Middle Paleocene and Eocene represent the time spans of the development of rich floras, rich in number of taxa and specimens. The warm and humid climate of the subtropics or tropical regions have been supposed for them. For the Early Tertiary, KRUTZSCH (1967) differentiated two expansions of the Cretaceous elements in the Tertiary flora. In the $\pm$ Montian and in the Lower Eocene (Ypressian, Sparnacian). In the Middle Eocene and especially in the Upper Eocene (Pg-18, Zeitz) disappear their last specimens. In the Tertiary of Bohemia, their representatives (*Basopollis* sp., cf. *Nudopollis thiergarti endangulatus* and cf. *Pompeckjoidaepollenites subhercynicus* [W. KR./W. KR.]) have been found in single finds (three specimens) in the Sokolov Basin (*Basopollis* and *Nudopollis* in the lower part of the Paleogene sedimentary sequence). They represent the descendents of Cretaceous flora, the *Normapolles* group. So-called post- *Nor-*

mapolles, e. g. *Plicapollis pseudoexcelsus* (W. KR.) W. KR. occurs in the Sokolov and Cheb Basins in the sediments corresponding mainly to the Staré Sedlo Formation. The genus *Thomsonipollis* W. KR. has not been reconfirmed at the Velký Luh locality.

It is most probable that a new similar pollen species was concerned, which later has been described as *Subtriporopollenites intrastructurus* W. KR. et VANH. from the Upper Landenian of Belgium. This species is comparable with *Celtis* type (*Ulmaceae*) and is not included in the stratigraphically significant taxa of the zone Pg-11.

In both basins of western Bohemia, the Eocene paleotropical elements are fairly represented, similarly as they are on the territory of the GDR. As far they may be assigned to the taxa of the recent systematic botany, the representatives of the following families are involved: *Restionaceae*, *Juglandaceae* (*constans*, *anulatus*, *subporatus* types etc, Table 1), *Euphorbiaceae*, *Arecaceae* (*Palmae*), *Bombacaceae*, *Sterculiaceae*, *Meliaceae*, *Tiliaceae*, *Myrtaceae*, *Loranthaceae*, *Symplocaceae* (mainly baculate types), *Sapotaceae*, *Hamamelidaceae* (*Altingiaceae*, *Steinhauera* type), in addition to the taxa of uncertain systematic position, i. e. *Tricolporopollenites cognitus* (R. POT.) W. KR., *Labrapollis labraferus* (R. POT.) W. KR., *Striatricolpites* cf. *catatumbus* GONZL., *Eocaenipollis* and others (Table 1).

These associations characterize in the GDR the zone Pg-17 and especially Pg-18 (Etzdorf and Zeitz) but involve also the typical elements of the Geiseltal main seam. They represent the Eocene paleotropical elements corresponding to the laurophyllous elements of mastixoid floras in the megaflores (KRUTZSCH 1967). In other regions, similar microflora elements appear e. g. in the Eocene London clay. In the Central Europe they are ranged to the Middle and Upper Eocene, i. e. in the zones Pg-14 up to Pg-18, defined by the assemblages of the Helmstedt seams (HU and HO), by Geiseltal seams and of localities Borken, Etzdorf and Zeitz (KRUTZSCH 1967), more recently by the Roszbach, Geiseltal, Profen and Zeitz localities. The zone Pg-19, former the Heskem, newly Lochau localities, already overlaps into Oligocene floras (of the transitional character to Neogene floras), and is striking by the relatively rich representation of deciduous woody plants, so-called Arctotertiary elements, in pollen spectra.

The Middle and Upper Eocene microfloristic assemblages in the GDR (Geiseltal—the main coal seam and the overlying seams, Profen and Zeitz localities) and the assemblage of western Bohemian basins have e. g. the following more significant elements in common:

- Alangiopollis eocaenicus* (Jehličná—Sokolov Basin)
- Bombacacidites kettigensis* (Jehličná—S. B., Nový Kostel—Cheb Basin)
- Bombacacidites geiseltalensis* (Nový Kostel—Ch. B.)
- Bombacacidites palaeogenis* (Velký Luh—Ch. B.)
- Pompeckjoidapollenites subhercynicus* (Jehličná—S. B.)
- cf. *Eocaenipollis pentacolpatus* (Jehličná—S. B.)
- Periporopollenites steinhaueroides* (Velký Luh, Nový Kostel—Ch. B.)
- Subtriporopollenites constans-anulatus* (Jehličná—S. B., Velký Luh, Nový Kostel, Hrzín—Ch. B.)

Subtriporopollenites subporatus (Jehličná—S. B.)
Intratriporopollenites ceciliensis (Nový Kostel—Ch. B.)
Tricolporopollenites mansfeldensis (Královské Poříčí—Jehličná—S. B.)
Cicatricosisporites cicatricosoides (Nový Kostel—Ch. B.)
Milfordia incerta (Jehličná—S. B., Velký Luh—Ch. B.)
Spinaepollis spinosus (Velký Luh—Ch. B., Jehličná—S. B.)
Pseudospinaepollis pseudospinosus (Velký Luh—Ch. p.)
Duplopollis myrtoides (Nový Kostel—Ch. p.)
Monocolpopollenites tranquillus (Jehličná, Královské Poříčí—S. B., Velký Luh, Nový Kostel, Hrzín—Ch. B.)
Plicapollis pseudoexcelsus (Jehličná—S. B., Velký Luh, Nový Kostel—Hrzín, Ch. B.)
 aff. *Pentapollenites* sp. (Jehličná—S. B., Nový Kostel—Ch. B.)
Plicatopollis plicatus (Jehličná S. B., Nový Kostel, Velký Luh—Ch. p.)
Labrapollis labraferus (Jehličná—S. B., Velký Luh, Nový Kostel—Ch. B.)
Momipites quietus (Jehličná, S. B., Velký Luh, Nový Kostel, Hrzín—Ch. B.)
Cupanieidites minimus (Nový Kostel—Ch. B.)
Porocolpopollenites calauensis (Jehličná—S. B., Velký Luh, Hrzín, Nový Kostel—Ch. B.)
Tricolporopollenites cognitus (Velký Luh—Ch. B.)
Dicolporopollis middendorfi (Jehličná—S. B., Velký Luh, Nový Kostel—Ch. B.)

The above taxa occur in Bohemia mostly as accessories or, in lower numbers (except palms and "salicoid" types) associated with many tricolporates and ancient types of *Myricaceae* and *Juglandaceae*. The nearest equivalent of these associations may be seen in those of the Etzdorf (Profen) and Zeitz assemblages, representing the zones Pg-17 and Pg-18 in the GDR in the regions of the Geiseltal and Weissenfelster Basins. They reflect the Eocene associations existing before the onset of the richer development of the Arctotertiary elements at the close of the Eocene (e.g. *Pinaceae*, *Ulmaceae-Ulmus* types, *Carpinus*, *Tiliaceae* of the *insculptus* type, *Sciadopitys*, *Tsuga*, *Juglandaceae*). In the Bohemian sedimentary sequence, the above microfossils and the accompanying assemblages characterize the Staré Sedlo (Grasseth) Formation in the Sokolov Basin, and the sediments underlying the seams in the Cheb Basin in the area Nový Kostel and Hrzín (text.-figs 2). A relic of the Paleogene sediments near Velký Luh may be compared (as far possible according to the finds) with the earlier associations of the Staré Sedlo Formation (KONZALOVÁ 1976). The more detailed comparison is in progress now with respect to further Paleogene associations from the northeastern part of the Cheb Basin.

Comparison of the Paleogene of western Bohemia with the Paleogene of the Western Carpathians

Comparison with the Central Carpathian Paleogene of Slovakia

The Paleogene, especially the Eocene, sediments on the territory of Slovakia are abundantly represented in the Carpathian Flysch and in the basins (depressions) within the Carpathians. Their palynological investigation is being carried out by SNOPOKOVÁ (1977, 1980, SAMUEL and SNOPOKOVÁ 1962, PLANDEROVÁ and SNOPOKOVÁ 1970, SNOPOKOVÁ in GROSS-KÖHLER et al. 1980). In her partial contributions, Planderová deals with the Paleogene.

The Paleogene deposits in Slovakian basins are mostly completely treated, and their stratigraphy is evidenced by fauna, especially microfauna and nannoplankton. With respect to it, the comparison of western Bohemian Paleogene (of continental development) with that of Carpathian region is involved, as far possible. The comparison has been concentrated especially on Eocene deposits which, being the closest, may be taken into consideration.

The sediments of the central Carpathian Paleogene in the inner-Carpathian depressions, of the outer Flysch in eastern Slovakia and of epicontinental development of Buda facies in southern Slovakia were investigated in full detail. The palynological content (plankton, sporomorphs) of all these sediments was studied by Snopková. The sediments involved e. g. the deposits in the depressions of the Upper Nitra region (PLANDEROVÁ and SNOPOKOVÁ 1970), in the Spiš and Šariš depressions (SNOPOKOVÁ 1977, 1980, SAMUEL and SNOPOKOVÁ 1962), the Liptov basin (SNOPOKOVÁ 1980, SNOPOKOVÁ in GROSS-KÖHLER et al. 1980), the Paleogene of the Levoča Hills and southern Slovakia region near Štúrovo (SNOPOKOVÁ 1977, 1980).

The Paleogene of the Liptov basin has been elaborated in most comprehensive way, the investigation having been based on lithology, biostratigraphy — microfauna, macrofauna, nannoplankton, palynology — and on radiometric data. The results of palynological investigation of this basin and those of the Paleogene of Buda development in southern Slovakia have been taken as the basis of the comparison between the Carpathian region and the Paleogene of western Bohemia. Beside them, the spectra of sediments of the central Carpathian Paleogene in the Upper Hron region were involved, as they comprise rather differentiated conifers and permit the correlation with the rich Bohemian spectra.

The age of these sediments have been determined as Upper Eocene, Priabonian, according to the large forams and nummulites (VÁŇOVÁ 1969 ex PLANDEROVÁ 1973). PLANDEROVÁ (1973) studied these sediments palynologically and points out the varied pattern of the conifer taxa; she and SNOPOKOVÁ also report on frequent conifers from the Middle Eocene and Upper Eocene/Lower Oligocene from the Bojnice—Nováky area (PLANDEROVÁ—SNOPOKOVÁ 1970). The conifers of the western Bohemian region are mostly analogous as to taxa, although their frequencies are much lower in the average spectra than in the Carpathian material, where the transgressive character of the sediments is reflected. (In contrast to it, the abundance and diversity of the taxa of ferns are equivalent in both compared regions.)

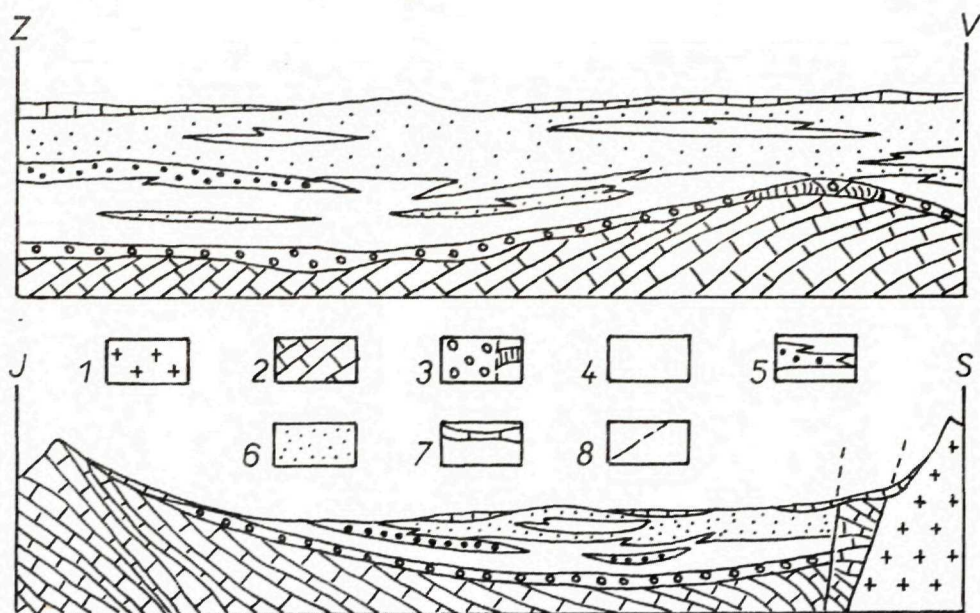


Fig. 5 Paleogene sedimentary sequence of the Liptov depression, inner-Carpathian Paleogene. Lithological and stratigraphic section. 1 — crystalline rock, 2 — Mesozoic, 3 — basal lithofacies (Upper Lutetian — Priabonian), 4 — claystone lithofacies (Priabonian), 5 — sandstones and conglomerates (Priabonian), 6 — flysch lithofacies (Priabonian — Lower Oligocene), 7 — Quaternary, 8 — faults (ex GROSS-KÖHLER et al. 1980).

Among conifers, the occurrence of the genus *Tsuga* (*Tsugaepollenites igniculus*) in the Priabonian sediments of the Upper Hron area is noteworthy, similarly as the presence of the further species of *Tsuga*, the *Zonalapollenites maximus*, in the Priabonian of the Liptov basin (SNOPKOVÁ in GROSS-KÖHLER et al. 1980). The genus *Tsuga* has so far not been recorded in the basal Tertiary sediments of the western Bohemian basins, i.e. neither in the Staré Sedlo Formation of the Sokolov Basin nor in the Cheb Basin. "*Tsuga maxima*" [*Zonalapoll. maximus* (RAATZ) W. KR.] is closely related to the present day species *Tsuga canadensis* from the Atlantic region of North America (zone of boreal conifer forests).

Also, KRUTZSCH (1971, Atlas VI, p. 31) gives the first finds of this conifer, representing the temperate element, from the Upper Eocene; it occurs at the beginning of the zone Pg-19 (Heskem, Lochau). At the time when the earlier non-spinate forms appear. The initial, quite sporadic finds from the Tertiary of central Europe are evidenced from the Lower and Middle Eocene, from the zone Pg-15 C (KRUTZSCH 1971). In so far as it is known, they represent the first occurrences of *tsuga* pollen in Europe. The zone Pg-15 is characterized by the pollen spectrum of the Helmstedt Upper Seam, rich in species and specimens, and by that of the Geiseltal Seams (KRUTZSCH 1967, pp. 18 and 29). Very far transport from the parent communities is presumed for these *Tsuga* pollen, whereas the local communities may be considered for their regular occurrences in the Upper Eocene/Lower Oligocene spectra.

The regular representation of *Tsuga* pollen in the Carpathian Paleogene, in

the Upper Priabonian/Lower Oligocene sediments, is demonstrated in the spectra of the inner Carpathian basins (SNOPOKOVÁ 1980, fig. 2), in the flysch lithofacies of the Liptov basin (Liptovská kotlina depression — SNOPOKOVÁ in GROSS-KÖHLER et al. 1980). The Upper Priabonian or Lower Oligocene age has been evidenced there by foraminifers, GROSS-KÖHLER et al. 1980). Their occurrence in the assemblage of other conifers (*Pinus* subgen. *Diploxylon*, *Pinus* subgen. *Haploxylon*, *Sciadopitys*, *Cedripites*, *Piceapollis*) probably corresponds not only to a dissected relief but also to the approaching climatic alteration, manifested by cooling and changes in plant and fauna communities at the Eocene/Oligocene boundary (Stehlin's rupture). In the continuous profiles of the so far investigated Tertiary basal sediments of the Staré Sedlo Formation in western Bohemia, this event, well recognizable in the pollen spectra, has not hitherto been ascertained. It is reflected in the overlying sediments and their spectra.

From the biostratigraphic comparisons of the main plant groups of the Paleogene sedimentary sequences in the territory of Slovakia and those of western Bohemia, the following relations may be deduced.

The Paleogene sediments of the Dukla unit, the Cisniansky beds (Upper Senonian and Paleocene), contain significant, although corroded Cretaceous elements of the *Normapolles* Group, which globally characterize these sediments. With respect to the in general poor Paleocene palynofloras and to the fairly poor and scarce palynomorphs in flysch facies, the finds and identification of the single taxa are important (see SNOPOKOVÁ 1977, 1980). The following *Normapolles* are characteristic here: *Pseudooculopollis* (*P. principalis*), *Oculopollis* (*O. minoris*, *O. fsp.*), *Plicapollis* (*P. sarta*, *P. conserta*), *Trudopollis* (*T. hemiperfectus*, *T. fsp.*), besides the Paleocene species *Laeviporopollis laevigatus* (W. KR.) W. KR. and *Polyporopollenites* TH. et PF. (*P. microreticulatus*). They are assembled with *Triatriopollenites hannoverensis* W. KR., *Triatriopollenites roboratus* PF., *Pompeckjoidaepollenites cf. subhercynicus* (W. KR.) W. KR., *Compositoipollenites fsp.*, *Interpollis microsupplingensis*, W. KR., *Interpollis velum* W. KR., *Subtriporopollenites* TH. et PF. (*S. scissus*, *vadosus*, *constans*), *M. quietus* (R. POT.) W. KR., *Arecipites granulatus* (KDS.) KDS., *Monocolpopollenites tranquillus* (R. POT.) TH. et PF., *Ischyosporites asolidus* W. KR., *Trilites multivallatus* (PF.) W. KR., *Trilites paravallatus* W. KR., *Cicatricosisporites dorogensis* R. POT. et GELL., *Cicatricosisporites paradorogensis* W. KR. The Paleocene index taxa *Stephanoporopollenites* TH. et PF. and *Menatipollenites* KDS. have not been encountered here. The above mentioned characteristic taxa of *Normapolles* are lacking in the western Bohemian basins. In contrary to them, the pre-Arctotertiary and Arctotertiary elements (*Plicapollis pseudoexcelsus*, *Alnipollenites*, *ulmoid* types) occur in all Paleogene sediments in western Bohemia.

Eocene spectra are closer comparable with the western Bohemian sediments. In Eocene spectra, the considerable decrease of the Cretaceous *Normapolles* element and, in contrast, an intense advancement of Eocene paleotropical elements is characteristic. Both these features are documented in the Lower Eocene of the Dukla and Magura units (SNOPOKOVÁ 1980, p. 52, fig. 2). The genera *Basopollis* PF. and *Interpollis* W. KR. (*Normapolles* Group) persist here,

the species of *Interpollis* pass into the Middle Eocene. Of the significant elements of Angiospermae the *robustus* and *subhercynicus* types as well as ?*Compositoipollenites* occur here, similarly as in the underlying Upper Senonian/Paleocene sedimentary cycle, associated with *Spinizonocolpites prominatus* (McINTYRE) KDS., *Plicatopollis hungaricus* KDS., *Plicatopollis plicatus* (R. POT.) W. KR., *Plicapollis pseudoexcelsus* (W. KR.) W. KR., *Minorpollis* W. KR., *Triatriopollenites* cf. *intermedius* (GLADK.) KDS., *Triporopollenites pflugii* KDS., *Pentapollenites* cf. *laevigatus* W. KR., *Platycaryapollenites* fsp., *Engelhardtoidites microcoryphaeus* (R. POT.) R. POT., *Subtriporopollenites* div. sp. (*scissus*, *vadosus*, *constans*), *Momipites quietus* (R. POT.) W. KR., *Fususpollenites fusus* (R. POT.) KDS., tricolporate pollen (*megaexactus*, *kruschi*, *retiformis*, *pusillus*, *oviformis*, *microhenrici*, *liblarensis*), *Tetracolporopollenites* fsp., *Polycolporopollenites doregensis* KDS., *Monocolpopollenites tranquillus* (R. POT.) TH. et PF., *Arecipites granulatus* (KDS.) KDS., *Ischyosporites asolidus* W. KR., *Trilites* (*multivallatus*, *paravallatus*), *Leiotriletes* (*microadriennis*) and *Triatriopollenites coryphaeus* (R. POT.) TH. et PF. are abundantly present. (For the taxa and their frequency see Snopková 1980, fig. 2, submenilitic and Beloveža beds). The Lower Eocene palynofloras of the Dukla and Magura units are characterized by the absence of Arctotertiary elements as well as the so-called intermediate elements e.g. *Rhus* (*R. pseudocingulum*), *Alnus* (*A. verus*), *Carya* (*S. simplex*) and *Pterocarya* (*P. stellatus*).

The Middle Eocene spectra in the Paleogene of Slovakia have been evidenced in different lithological units and in the wide areas: In the Dukla and Magura units of the outer Flysch (submenilitic beds, lower Zlín beds), in the central Carpathians (inner-Carpathians depressions, the basal transgressive lithofacies) and the freshwater brackish and turrilous marls of Buda facies in the Danube Lowland. Their typical feature consists in the fairly wide distribution of the genera: *Plicatopollis* W. KR. (*Pl. plicatus*), *Minorpollis* W. KR., *Fususpollenites* KDS. (*T. cingulum fusus* type), *Engelhardtoidites* R. POT. [*E. microcoryphaeus* R. POT. (R. POT.)], triporate pollen of *coryphaeus-punctatus* types, tricolporate pollen of *pusillus* and *oviformis* types (very abundant), *T. microhenrici* (R. POT.) TH. et PF., *C. liblarensis* — *fallax* types, *Monocolpopollenites tranquillus* (R. POT.) TH. et PF. and *Arecipites granulatus* (KDS.) KDS. (*Palmae*, very abundant, especially the *tranquillus* type). *Interpollis microsupplingensis* W. KR. and *Interpollis velum* W. KR. are present as accessories, the genera *Alnus*, *Carya* and *Pterocarya* appear here for the first time (SNOPKOVÁ 1980, p. 56). The Cretaceous floral elements are already fully suppressed (with exception of *Minorpollis* that also ranges within the zone Pg-18 — Upper Eocene, see KRUTZSCH 1970a, and *Interpollis*). The corresponding zones of microfauna are given in GROSS-KÖHLER et al. 1980. The characteristics of spectra given by Snopková corresponds to the accompanying assemblages of the spectra of the pre-Rupelian Paleogene sediments in western Bohemia. SNOPKOVÁ (1980) designated this assemblages as pollen spectrum 4, corresponding to the zone of *Cyclammina amplexans* (zone of agglutinated foraminifers) and to the zone of *Truncorotaloides rohri* (planktonic zone in inner Carpathian Paleogene and Paleo-

gene of the Danube Lowland). It is noteworthy, that the spectrum of basal lithofacies (Vyšné Matiašovce — Podmešťtrová locality) already display Upper Eocene features, whereas the large foraminifers evidenced Middle Eocene, upper Lutetian.

The Upper Eocene pollen spectra were derived from the same units and areas as Middle Eocene assemblages. They comprise the Papín beds of Dukla unit, upper Zlín beds of Magura unit, the claystone lithofacies of the inner Carpathian depressions and sandy marls and marine sandstones of the Buda facies in the Danube Lowland. They contain abundant well preserved plankton (*Dephlandrea phosphoritica* EIS., *D. spinulosa* ALB., *Thalasiphora pelagica* (EIS.) EIS. et GOCHT, *Pleurozonaria concinna* COOKSON et MANUM a. o.) and an accompanying spectrum also characterizing the Middle Eocene sediments. *Normapolles* elements have not been recorded (*P. subhercynicus* either). Insofar as they occur, they are secondary, redeposited from Upper Cretaceous deposits. The taxa assignable to the elements of a deciduous forest appear as a more stable element although occurring as accessories or in low frequency; they are not yet a current component of forest communities. The isolated occurrences of *Faguspollenites*, *Carpinuspollenites*, *Multiporopollenites* cf. *maculosus* (R. POT.) TH. et PF., *Piceapollis*, *Sciadopityspollenites* appear, *Carya* (*S. simplex*) and *Pterocarya* (*P. stellatus*) are more frequent. *Interpollis* species were no more encountered, e. g. *Minorpollis*, *Momipites quietus*, *Subtriporopollenites* (*S. vadosus*, *scissus*, *constans*) occur only rarely, *Plicatopollis plicatus*, *Plicapollis pseudoexcelsus*, *Fususpollenites fusus* are more reduced, *Rhoipites pseudocingulum* (*Rhus* types) and *Alnipollenites* are more frequent. Regularly occur *Cyrillaceae* pollen (*T. megaexactus*) and spores of *Cicatricosisporites* types, *T. microhenrici* a *C. liblarensis* are abundant, and very frequent are *Pinaceae* (both types, *labdacus* and *microalatus*). Of the accompanying elements remain *Palmae* (*M. tranquillus* especially), *Ischyosporites asolidus*, *Trilites multivallatus*, *T. coryphaeus*, *Engelhardtoidites microcoryphaeus*, *Tetracolporopollenites* (*Sapotaceae*), *Fagaceae* of the *oviformis* type and others (see SNOPOKOVÁ in GROSS-KÖHLER 1980, the Upper Eocene spectra of Liptov basin at the localities Ružomberok and Liptovská Štiavnica). These assemblages are designated as pollen spectrum 5 corresponding to the zones of planktonic foraminifers *Globigerapsis index* and partly to *Globigerina officinalis* (SNOPOKOVÁ 1980, SAMUEL and SNOPOKOVÁ 1962). The characteristics or index pollen taxa of the German zone Pg-18 (Upper Eocene) are missing here in contrary to the W. Bohemian Paleogene in Sokolov and Cheb Basins. The Bohemian spectra comprise numerous 'Eocene paleotropical' elements and *Tsuga*, *Picea*, *Juglans*, *Pterocarya* were not yet encountered there. The Bohemian basal spectra are mostly comparable with those of the earlier Priabonian spectra in the Carpathian region, i. e. those existing before the rather cool climatic event at the Upper Eocene/Lower Oligocene boundary, demonstrated in the Upper Priabonian/Lower Oligocene assemblages. At some levels, the earlier assemblages comparable with Lutetian/Priabonian spectra were recognized in both Sokolov and Cheb Basins (deeper levels at the Jehličná and Nový Kostel localities) Je 61, H 11, 21 P and probably NK 56 bores).

Fig. 6

The Paleogene of the northern region of the Bavarian Alps (The western part of the Central Paratethys)

The palynological investigation of the Alpine regions of Bavaria and in Austria have been carried out by HOCHULI (1978). On the basis of molasse (at the locality Kohleck between Linz and Regensburg) he distinguished the Upper Eocene zone Pg-18 and characterizes it by the last occurrence of *Bombacacidites* (*B. palaeogenis* W. KR.), ranging up to the zone Pg-18 (Zeitz) in the central European Paleogene. The spectrum comprises thermophile ferns of schizaeaceous types, *Cicatricosisporites cicatricosoides* W. KR., *Trilites paravallatus* W. KR. and other taxa of ferns which are constant elements of Paleogene spectra in continental as well as in marine sediments (Paleogene of western Bohemian basins and of Saxon-Thuringian region, the Anglo-Parisian Basin, the Slovakian Paleogene, and the Paleogene of the Bakony Mts).

Hochuli points to the fact that in the spectrum the taxa representing so-called intermediate elements (sensu KRUTZSCH and MAJEWSKI 1967) are lacking. Of the Arctotertiary representatives, Hochuli gives only single finds of *Aceripollenites* NAGY (of a younger, Neogene, type).

In both these above mentioned features as well as in the average spectrum, the molasse assemblage closely resembles the associations of the western Bohemian Paleogene, correlable mostly with the zones Pg-17 and Pg-18 in the GDR. The Zeitz (the zone Pg-18) assemblage represents the warm phase of the Upper Eocene. Hochuli identifies this spectrum in the deepest part of the molasse and provides the first evidence of it in the mentioned region.

In addition to the total spectrum and index taxa, the close resemblance between the western Bohemian basins and the Bavarian region as to facies elements, is striking. The spores of the smooth type of *Lygodium* (*Leiotriletes discordatus* type), conifers of the *Cupressacites*, *Sequoia* and *Pityosporites* sp. div., the facies with *Ilex* (*Ilexpollenites iliacus*) — relatively abundant element in the Sokolov and Cheb Basins, and the occurrence of *Alnus* are striking. *Alnus* is probably edaphic-controlled element of sandy banks and shores.

The microfossils of the western Bohemian Paleogene equal to those of the Eocene of North America

The microfossils, significant for the relative age of sediments in the western Bohemian basins (Sokolov and Cheb Basins), evidenced the pre-Rupelian, mostly Eocene sedimentary complex, correspond to many taxa of the Eocene of North America, and have some features in common with their spectra. The resemblance witnesses the uniform character of flora on both continents (the Euro-American flora) and permits the rough comparison. (The correlation with the W. European Paleogene will be carried out separately).

The Middle Eocene pollen spectra from the northwestern region of the State of Wyoming or the Eocene spectra from the Gulf region display a great number

of the elements which they have in common with those of the Paleogene of Central Europe inclusive of the western Bohemian region.

The Middle Eocene assemblages of the Hominy Peak Formation (northwestern part of Wyoming, Love-Leopold-Love 1978) contain index pollen taxa also known from the Middle Eocene of Central Europe, e.g. *Pistillipollenites mcgregorii* or *Bombacaceae*. Of rather current Paleogene taxa overlapping into the Upper Eocene, the following are common to both continents: *Alangium*, "*Betulapollenites*" *plicatus*, *Aneimia* (i.e. cicatricose spore types) smooth or corrugate spores of *Lygodium* ("*Lygodium kaulfusii* type" and *Corrugatisporites*), *cingulate* spores of *Pteris* type, gleichenoid spores, *Hammulatisporites* div. sp. The pollen of woody plants common to both continents, also passing to the younger Paleogene (Oligocene) sediments (in great part) are the following: identical ulmoid types, *Platanus* pollen, *Fagaceae* (*fusus* type), *Aceraceae* (*Acer palmatum* type), large granulate-reticulate tricolporates, lacking modern analogues, and tetracolporates of various morphological types — *Sapotaceae* etc. (LOVE-LEOPOLD-LOVE 1978). *Pistillipollenites*, the typical element of the Paleocene and Early Eocene sediments of Europe (e. g. GDR, Poland), is absent in the Paleogene of western Bohemia.

Likewise, in the Eocene of the southern USA, in the Mexico Gulf region (Louisiana, Alabama and Mississippi) there are many forms, known from the Jackson Group, Mississippi, that are identical with the European taxa (compare TSCHUDY 1973 and TSCHUDY—VAN LEONEN 1970). To these belong e. g. *Juglandaceae* of the *quietus* type (*Momipites quietus*), *Plicatopollis*, *Spinaepollis*, *Gothanipollis*, *Symplocos* of the *calauensis* type (i. e. the representatives of the families *Juglandaceae*, *Euphorbiaceae*-*Spinaepollis*, *Loranthaceae*-*Gothanipollis*, *Symplocaceae* — *S. cf. calauensis* type), further *Bombacaceae*, *Cyrillaceae*-*Clethraceae*, *Fagaceae*, tricolporates of *cingulum* type, baculate tricolporates etc. The difference is discernible in the earlier extinction or disappearance of some taxa in the American Eocene, according to data given by TSCHUDY (1973). For example, *Spinaepollis spinosus* (*Euphorbiaceae*) occurring in the Central European Paleogene (Bohemia, GDR, Poland, Hungary and elsewhere) in the Eocene and Oligocene spectra, in the south of the USA does not reach farther than into the lower Middle Eocene. Common pollen types differently distributed in the time span Eocene-Oligocene are *M. quietus*, *robustus* types, *Symplocos* and others. However the index pollen taxa also display the same distribution as that in Europe, e. g. *Pistillipollenites* ROUSE, *Thomsonipollis* W. KR., and *Nudopollis* PF. [*N. thiergarti* (TH. et PF.) PF., *Nudopollis* sp.] and other taxa of *Normapolles* types. The occurrences of *Pistillipollenites* and *Thomsonipollis* in the American as well as the European Eocene spectra are known from the Lower Eocene (and earlier, from Paleocene spectra) and from the lower part of the Middle Eocene (compare Reklaw Formation, Clairborne Group, TSCHUDY 1973). A low number of *Nudopollis* specimens still occurs in Upper Eocene sediments (Jackson Group, Mississippi). In the Central European Eocene, *Nudopollis* types range especially within the Lower and Middle Eocene, mainly in the transgressive sediments. In the Upper Eocene their occurrence becomes quite exceptional, in

single specimens, and they practically disappear at the close of Middle Eocene.

The Upper Eocene is represented in the respective region of the USA by marine sediments (Jackson Group, Yazoo Clay), well evidenced on the basis of fauna and microfauna. The pollen assemblages contain elements common to European spectra, i.e. *Fagaceae* (*fusus* type) and *Cupuliferoipollenites* (*quisqualis-liblarensis-fallax* group), occurring in masses, taxa of the family *Juglandaceae* and *Myricaceae* (*quietus*, *microcoryphaeus*, *punctatus*, *Triatriopollenites* sp.), *Myrtaceae* (*Duplopollis*, sp., *Cupanieidites* sp.), *Aquifoliaceae* (*Ilex-Ilex-pollenites* sp.), *Symplocaceae* (*Symplocoipollenites* sp.), *Tiliaceae* (*Tiliaepollenites* sp.), *Sterculiaceae* and *Sapotaceae* (*Sapotaceoidaepollenites* sp.). The occurrence of the family *Bombacaceae* (*Bombacacidites* sp.), comprising the Paleogene index pollen is also common to both continents. (All the taxa are derived from the Yazoo Clay, investigated by TSCHUDY and VAN LOENEN 1970).

Striking is the higher frequency of *Alnus*, *Carya*, *Juglans* and *Ulmus* in the Eocene spectra (TSCHUDY 1973), in comparison with the European Eocene. It could be interpreted as a reflection of the vertical differentiation of climate and vegetation with regard to extensive basalt effusions in the Eocene (Oregon, North California), and to the great distances of pollen transport of anemophilous plants by wind or water to marine sediments. On the other hand, this difference also indicates the distribution and occurrence of endemic species.

The taxonomic assignment of the Upper Eocene sporomorphs is only tentative in the paper of TSCHUDY and VAN LOENEN (1970), but the perfect documentation makes them available for the comparison. They evident the close resemblance with the European, and Central European Upper Eocene spectra respectively.

Notes on the sociological evaluation of Paleogene associations

Eocene flora is characterized by a paratropical evergreen forest. As an example of this forest communities e. g. the well known Geiseltal flora was earlier given, which recently has been the subject of intensive paleontological investigation (inclusive of paleobotanical studies of micro- and macrofossils). A number of authors (RÜFFLE 1975, MAI and WALTHER 1985) conclude, according to preserved remains of leaves and seeds, that in these Eocene floras a vegetation of a rather subtropical character the vegetation of warm subtropics, was represented. The latter authors assume that in the set of macroflora the typical elements of a tropical East Asian type are lacking (*Dipterocarpaceae*, *Guttiferae*, *Combretaceae* etc.) i.e. the highly thermophile ones. According to their conclusion, the European and American zonal floras of the Eocene correspond to a higher degree to a subtropical flora of the montane type (over 1000 m) in the Indo-Malayan region, and only exceptionally its elements are represented in tropical forests (RÜFFLE 1975, p. 501). These opinions are still new and may be proved there where sets of flora in leaved, carpological and spore-pollen records are elaborated, taxonomically or morphologically, in detail. The fact is well known that Paleogene floras contain in all the above mentioned sets greatest amount

of undetermined elements among which a number of hitherto taxonomically unknown groups or elements may exist or have not been thoroughly studied, and hence their ecological requirements are so far unknown as well.

Eocene pollen spectra of Europe and America contain elements which in macroremains have not been known at all (or known with doubt), and belong to present-day pantropical floras. The distribution of the family *Bombacaceae* may serve as an example. Among tricolporate pollen grains a number of not very well known or completely unknown systematic groups are concealed, which have not yet been sufficiently studied and compared with recent materials. Palynologists are obliged, with regard to practical tasks, to consider rather the system of pure morphology than to study in detail morphology and possibilities of taxonomical assignment that would lead to botanical separation of some groups. Where the pollen morphology of some distinct recent plant taxa is known enough, it also leads to the isolation of some significant taxonomical groups or species in the fossil assemblages. (They then often represent index taxa having stratigraphically limited ranges). An example may be seen in the representation of a paleotropical element of the modern family *Lecythidaceae* (*Barringtonia* type) in the European Tertiary (Paleogene) pollen assemblages. Thus, in pollen spectra the record of many important groups is concealed, i. e. those which are not preserved or have not been distinguished and identified among other records. It is evident that in the deliberation on the Paleogene forest communities, the full set of fossil records must be taken into consideration.

Conclusion

1. The present paper brings the first taxonomical evaluation of spores and pollen taxa of the pre-Rupelian Paleogene sediments of Bohemia. The rarely preserved spectra of the predominantly sandstone formation called Staré Sedlo Formation in the Sokolov Basin and the basal sediments of the Cheb Basin demonstrate the great diversity of the microflora (Table 1, Plates XXXIV—XXXVII, XXXIX—XLI) with overwhelming prevalence of Eocene paleotropical elements of an angiosperm type. The identified microfossils comprise abundant ferns and angiosperms, prevailing over conifers. Within the framework of the recent botanical system, they represent about sixty taxonomical groups.

2. With respect to the continental development, the basal Paleogene of western Bohemia was compared and correlated with the most closely related deposits of an analogous type in the Saxon-Thuringian region, with the Middle and Upper Eocene seams of Geiseltal and Upper Eocene seams of Weisshelster Basin in the GDR and their Paleogene zones. It has been stated that the Paleogene of western Bohemia encompasses horizons already comparable with the zone earlier than the zone 17, probably at the Velký Luh locality and in the rather deep parts of the Staré Sedlo Formation near Jehličná (Grasseth)—Královské Poříčí and in some boreholes at the Nový Kostel locality. The prevailing associations are correlative with the zone Pg-17 and Pg-18 in both

basins. In the sporopollen parachronology they are represented by the Etzdorf (Profen) and Zeitz assemblages. This correlation is of a regional character and is valid only for the Paleogene sediments of Central European region.

3. Continental deposits can be classified as to age only with difficulty on a regionally wide or internationally valid scale, and thus they were correlated, as far possible, with the marine or brackish Paleogene of near regions where the sedimentary sequences are biostratigraphically well determined. By correlation of western Bohemian pollen spectra with those of the Carpathian Paleogene (and the Paleogene of southern Slovakia respectively), it has been found that in the main features the western Bohemian Paleogene is conform to the Priabonian sequences of the Upper Eocene of the Carpathian region, i. e. to the Priabonian spectra earlier than the onset and development of elements of deciduous forest at the close of Priabonian.

4. Index pollen, analogous facies elements and the comparable main features of pollen spectra of the western Bohemian region and those at the base of Bavarian molasse have been found. The pollen spectrum of molasse, analogous to that of some horizons in the western Bohemian basins, has also been correlated with the zone Pg-18 (Zeitz assemblages) of the GDR.

5. Elements common to the Paleogene of Central Europe, inclusive Bohemia, and to the American Paleogene, especially of the Upper Eocene of the Gulf region, are striking. Furthermore, the assemblages of these marine sediments are excellently preserved in contrast to those of the marine sediments of the Carpathian region. The correlable spectra already lack the Normapolles elements and comprise the index pollen common in Central Europe. They testify to the same paleofloristic province.

6. For the Early Tertiary sediments of the Bohemian Massif, an Oligocene age was assumed, still in the sixties. The beginning of the Oligocene sedimentation has been considered after the Paleocene and Eocene gaps, and the origin of Tertiary basins in western Bohemia was ranged into the Middle Oligocene. Paleontological investigation has proved an age higher than Middle Oligocene, i. e. Eocene up to Eocene/Oligocene. The main sedimentary cycle of the Staré Sedlo Formation and its proved equivalents in the Cheb Basin falls within the time span of the Upper Eocene, most probably Priabonian, on the basis of palynological evidence.

The Upper Eocene/Lower Oligocene assemblages, recognizable at the Nový Kostel locality, will be discussed separately.

Literatura

- BOULTER, M. 1984: Palaeobotanical evidence for land-surface temperature in the European Palaeogene.- *Ex Fossils and Climate*, Ed. P. Brenchley, London, 35—37.
- BŮŽEK, Č. et al. 1969: Zprávy o nálezích rostlinných zbytků ve vrtu 4359 Velký Luh v chebské pánvi.- *Zpr. geol. Výzk.*, 1968, Praha, 172—173.
- GRABOWSKA, I. 1974: Stratygrafia osadów paleogeńskich na Niżu Polskim w świetle badań mikroflorystycznych. *Biul. Inst. Geol.*, Warszawa, 281.

- GROSS, P.—KÖHLER, E. a kol. 1980: Geológia Liptovskej kotliny.- Geol. Úst. D. Štúra, Bratislava, 242.
- HOCHULI, A. 1978: Palynologische Untersuchung im Oligozän und Untermiozän der Zentralen und westlichen Paratethys.- Beitr. z. Paläontologie von Österreich. Inst. d. Paläontologie d. Univ. Wien, 4, Wien, 1—132.
- KEDVES, M. 1969: Palynological studies on Hungarian Early Tertiary deposits.- Akadémiai Kiadó, Budapest, 85.
- KEDVES, M. 1978: Paleogene fossil sporomorphs of the Bakony Mountains. Part III.- Akad. Kiadó, Budapest, 166.
- KONZALOVÁ, M. 1969: Paleontologicko-stratigrafický posudek k úkolu "Hydrogeologie Sokolovska — kóta 310".- Archiv Geoindustria, MS. Praha.
- KONZALOVÁ, M. 1972: Paläotropische und stratigraphisch wichtige Pflanzenreste (Sporen und Pollen) aus dem Alttertiär NW-Böhmens.- Věst. Ústř. úst. geol., 47, Praha, 239—242.
- KONZALOVÁ, M. 1976: Paläobotanisch und stratigraphisch wichtige Sporomorphen aus dem Alttertiär NW-Böhmens.- Čas. min. geol., 21, 1, Praha, 71—75.
- KONZALOVÁ, M. 1977: Mikropaleontologický výzkum v západočeských pánvích.- Sbor. 8. paleont. konf., Sokolov 1977: Sokolov, 12—16.
- KONZALOVÁ, M. 1981: Boehlensipollis und andere Mikrofossiles des böhmischen Tertiärs (vulkanogene Schichtenfolge).- Sbor. geol. věd 24, Praha, 135—162.
- KONZALOVÁ, M. 1987: Palaeogene plant microfossils from the basal strata of the Cheb Basin (Tertiary, Czechoslovakia).- Věst. Ústř. úst. geol., 62, 5, Praha, 297—301.
- KONZALOVÁ, M. 1989: Mikropaleontologický (palynologický) výzkum vulkanického komplexu na jižním okraji severočeské pánve u Modlan (02-32 Teplice).- Zpr. geol. výzk. za rok 1987, Praha, 72—74.
- KRUTZSCH, W. 1961: Beitrag zur Sporenpaläontologie der präoberoligozänen kontinentalen und marinen Tertiärlagerungen Brandenburgs.- Berichte d. Geol. Gesellschaft, 4, Berlin, 290—343.
- KRUTZSCH, W. 1967: Die Florenwechsel im Alttertiär Mitteleuropas auf Grund von sporenpaläontologischen Untersuchungen.- Abh. zentr. geol. Inst., 10, Berlin, 17—37.
- KRUTZSCH, W. 1969: Über einige stratigraphisch wichtige neue Longaxoner-Pollen aus dem mitteleuropäischen Alttertiär.- Geologie, 18, 4, Berlin, 472—487.
- KRUTZSCH, W. 1970a: Die stratigraphisch verwertbaren Sporen- und Pollenformen des mitteleuropäischen Alttertiärs.- Geol. Jb., 3, Berlin, 309—379.
- KRUTZSCH, W. 1970b: Einige neue Pollenformen aus den Familien der Tiliaceen, Bombacaceen und Sterculiaceen aus dem mitteleuropäischen Alttertiär.- Jb. Geol., 3, 2, Berlin, 275—307.
- KRUTZSCH, W. 1971: Atlas der mittel- und jungtertiären dispersen Sporen und Pollen- sowie der Mikropflanzkonformen des nördlichen Mitteleuropas.- Jena, 234.
- KRUTZSCH, W.—LENK, G. 1973: Sporenpaläontologische Untersuchungen im Alttertiär des Weissester Beckens.- Abh. zentr. geol. Inst., Berlin, 59—76.
- KRUTZSCH, W.—MAJEWSKI, J. 1967: Zur Methodik der pollenstratigraphischen Zonengliederung im Jungtertiär Mitteleuropas.- Abh. zentr. geol. Inst., 10, Berlin, 83—98.
- LOVE, J. D.—LEOPOLD, E. B.—LOVE, D. W. 1978: Eocene Rocks, Fossils and Geologic History, Teton Range, Northwestern Wyoming.- Geol. Surv., Pap. 932 B, Washington, 1—40.
- MAI, H. D.—WALTHER, H. 1985: Die obereozänen Floren des Weissester-Beckens und seiner Randgebiete.- Abh. St. Mus. f. Min. Geol., 33, Dresden, Leipzig, 5—176.
- PLANDEROVÁ, E. 1973: Nové poznatky o veku centrálnokarpatského paleogénu Horehronia.- Geol. práce, 61, Geol. Úst. D. Štúra, Bratislava, 259—272.
- PLANDEROVÁ, E.—SNOPKOVÁ, P. 1970: Mikropaleobotanický výzkum terciéru Bojnisko-Nováckej oblasti.- Geologické práce, Správy 52, Geol. Úst. D. Štúra, Bratislava, 301—343.
- SAMUEL, O.—SNOPKOVÁ, P. 1962: Mikrobiostatigrafické a palynologické korelačné štúdiá centrálnokarpatského paleogénu. — Geol. Práce, Zoš. 63, Geol. Úst. D. Štúra, Bratislava, 69—84.
- SNOPKOVÁ, P. 1977: Mikrostratigrafie východoslovenského flyša, vnútrokarpatského a budinského paleogénu Slovenska na základe spór a pelových zrn.- Archiv Geol. Úst. D. Štúra, Bratislava.
- SNOPKOVÁ, P. 1980: Paleogene Sporomorphs from West Carpathians.- Západné Karpaty, sér. paleont. 5, Geol. Úst. D. Štúra, Bratislava, 7—74.

- PACLTOVÁ, B.—ŽERT, B. 1961: Palynologický výzkum v Sokolovské páňvi. Zpr. geol. Výzk., 1959, Praha, 94—95.
- TSCHUDY, R. H.—VAN LOENEN, S. D. 1970: Illustrations of Plant Microfossils from the Yazoo Clay (Jackson Group, Upper Eocene) Mississippi.- Geol. Surv. Pap., 643-E, 1—5 pls. Washington.
- TSCHUDY, R. H. 1973: Stratigraphic distribution of significant Eocene palynomorphs of the Mississippi embayment.- Geol. Surv. Paper, 743-B, Washington, 1—24.
- RÜFFLE, R. 1975: Pflanzenformationen und -gesellschaften im Eozän, besonders des Geiseltales.- Wiss. Zeitschrift, Mat.-Nat., 24, 4, Berlin, 501—509.
- VACHRAMEJEV, V. A.—ZAKLINSKAJA, E. D. et al. 1970: Paleozojskie i mesozojskie flory Evrazii i fytogeografija etogo vremeni.- Trudy Geol. Inst. AN SSSR, 208, Moskva, 426.

Explanation of Plates XXXIV—XLI

Plate XXXIV

- 1, 2 *Gleicheniidites* sp. — *Gleicheniaceae*, bore H 11, depth 272.8 m.
- 3 *Polypodiaceoisporites* cf. *marxheimensis* (PFL.) W. KR. — *Pteridaceae*, bore Je 49, depth 207.0—208.0 m.
- 4 *Triplanosporites sinomaxoides* W. KR. — *Schizaeaceae*, *Lygodium* type, bore Je 49, depth 209—210 m, $\times 450$.
- 5, 6 *Dicolporopollis middendorfi* (R. POT.) W. KR., bore H 11, depth 272.8 m.
- 7 *Baculatisporites quintus* (TH. et PF.) W. KR. — *Osmundaceae*, *Osmunda*, bore Je 49, depth 209—210 m.
- 8 *Verrucingulatisporites* sp. — ?*Pteridaceae*, bore H 11, depth 272.8 m.
- 9 *Pityosporites alatus* (R. POT.) TH. et PF. — *Pinaceae*, *Cathaya*, bore H 11, depth 272.8 m.
- 10 *Sciadopityspollenites quintus* W. KR. — *Taxodiaceae*, *Sciadopitys*, bore H 11, depth 272.8 m. $\times 900$ when not otherwise mentioned

Plate XXXV

- 1—3 *Triatriopollenites rurensis* TH. et PF. — *Myricaceae*, bore H 11, depth 272.8 m.
- 4 *Triatriopollenites* sp. — ?*Myricaceae*, bore H 11, depth 272.8 m.
- 5 cf. *Cyathidites* sp. — cf. *Gleicheniaceae*, *Cyatheaceae*, *Dicksoniaceae*, bore H 11, depth 272.8 m.
- 6, 7 *Arecipites wiesaensis* W. KR. — *Arecaceae* (*Palmae*), cf. *Phoenix*, bore Je 49, depth 209.7—209.9 m.
- 8, 9 *Verrutricolporites magnotectatus* ROCHE et SCHULER — *Theaceae*, bore H 11, depth 272.8 m.
- 10 *Tricolporopollenites* cf. *spinus* W. KR., bore H 11, depth 272.8 m.
- 11, 12 *Periporopollenites steinhaueraoides* W. KR. — *Hamamelidaceae* (*Altingiaceae*), *Steinhauera* typ, bore 4359 (Velký Luh—Plesná), depth 77 m.
- 13 *Tricolporopollenites* sp. — cf. *Fagaceae*, bore H 11, depth 272.8 m.

Plate XXXVI

- 1 *Dicolpopollis kockeli* PFL. — *Arecaceae* (*Palmae*), *Calamoidae*, *Calamus*, bore Je 50, depth 255.30—255.65 m.
- 2 *Monocolpopollenites tranquillus* (R. POT.) Th. et Pf. *Arecaceae* (*Palmae*), *Phoenix*, bore Je 50, depth 255.3—255.65 m. $\times 1300$
- 3 *Subtriporopollenites anulatus* TH. et PF. (*anulatus-constans* group) — *Juglandaceae*, bore Je 61, depth 184.0—184.3 m. $\times 1300$.
- 4—6 *Tricolporopollenites staresedloensis* W. KR. et PACLT. — aff. *Salicaceae*, bores Je 50, depth 244.3 m, H 11, depth 272.8 m (fig. 6).
- 7, 8 *Tricolporopollenites* sp. Bore H 11, depth 272.8 m.
- 9 *Pentapollenites* sp. (C type sensu Kedves), bore H 11, depth 272.8 m.
- 10, 11 *Ericipites ericius* (R. POT.) W. KR. — *Ericaceae*, bore H 11, depth 272.8 m.

Plate XXXVII

- 1—3 *Bombacacidites kettigensis* (PF.) W. KR. subsp. *gracilis*. *Bombacaceae*, *Bombax* sp., bore Je 49, depth 209.7—209.9 m. $\times 450$.

- 4 *Tricolporopollenites cingulum* (R. POT.) TH. et PF. subsp. *oviformis* — *Fagaceae*, bore H 11, depth 272.8 m.
- 5, 6 ?*Psilastephanocolporites mimusopsoides* ROCHE et SCHULER. — cf. *Sapotaceae*, bore H 11, depth 272.8 m.
- 7, 8 *Tricolporopollenites graniquisqualis* W. KR. et VANH. — *Fagaceae* vel *Leguminosae*, bore H 11, depth 272.8 m.
- 9, 10 *Tricolporopollenites* sp. — *Heteromorpha* type, *Umbeliferae* — bore H 11, depth 272.8 m.
- 11, 12, 14—16 *Tricolporopollenites irregulatus* NAKOMAN. bore H 11, depth 272.8 m.
- 13 *Fususpollenites fusus* (R. POT.) KDS. — cf. *Fagaceae*, bore H 11, depth 272.8 m.
- 17, 18 aff. *Scabratricolporites scheffleroides* ROCHE et SCHULER — ?*Araliaceae*, *Leguminosae*, bore H 11, depth 272.8 m. × 900

Plate XXXVIII

- 1, 2 *Trigonobalanus excelsa* LOZANO et al., *Fagaceae*. SEM. × 4000. Herbarium material, Recent, South America, Colombia.

Plate XXXIX

- 1, 2 *Porocolpopollenites calauensis* W. KR. — *Symplocaceae*, bore HV 17, depth 138.6—138.8 m.
- 3 *Ischyosporites asolidus* (W. KR.) W. KR. — *Schizaeaceae*, cf. *Lygodium*, bore HV 17, depth 138.6—138.8 m.
- 4, 5 *Cicatricosisporites cicatricosoides* W. KR. — *Schizaeaceae*, *Ruffordia* or *Mohria* types, bore HV 17, depth 138.6—138.8 m. × 1000

Plate XL

- 1, 2 *Inaperturopollenites concedipites* (WODEH.) W. KR. — *Taxodiaceae*, *Taxodium*, *Glyptostrobus*, bore Je 61, depth 182.5—182.6 m.
- 3 *Leiotriletes* asp. *sinusoides* W. KR. — *Schizaeaceae* (smooth *Lygodium* types), bore Je 61, depth 178.05 m.
- 4 Fragment of tracheid. × 400.
- 5, 6 *Tricolporopollenites staresedloensis* W. KR. et PACLT. — aff. *Salicaceae*, bore Je 61, depth 182.5—182.6 m. × 2000

Plate XLI

- 1 *Tricolporopollenites cingulum* (R. POT.) TH. et PF., T type (of very thick exine), *Fagaceae*, bore Je 61, depth 186.0—187.0 m.
- 2—4 *Tricolporopollenites cingulum* (R. POT.) TH. et PF., P type.- aff. *Fagaceae* or *Leguminosae*, bore Je 61, depth 186.0—187.0 m.
- 5, 6 cf. *Brosipollis maximus* W. KR. et VANH., bore Je 61, depth 184.0—184.3 m.
- 7 *Arecipites* sp., G type — ?*Arecaceae* (*Palmae*), bore Je 61, depth 182.5—182.6 m.
- 8 cf. *Engelhardtoidites microcoryphaeus* (R. POT.) R. POT. — cf. *Juglandaceae*, *Engelhardtia*, bore Je 61, depth 182.5—182.6 m.
- 9, 10 *Tricolporopollenites mégaexactus* (R. POT.) TH. et PF., T type (the forms with a thick exine) — cf. *Cyrillaceae*, bore Je 61, depth 182.5—182.6 m.
- 11 cf. *Subtriporopollenites reticulatus* W. KR. et VANH. Bore 61, depth 184.0—184.3 m. × 1300

Translated: J. Košáková

MILOŠ SIBLÍK

New *Schwagerispira* (Brachiopoda) from the Carnian of the Slovak Karst (SE Slovakia)

2 text-figs., 2 pls. (XLII—XLIII), Czech summary

Abstract. A new retzioid brachiopod *Schwagerispira bystrickyi* sp.n. is described from the Carnian of the Slovak Karst and its relations to some similar Upper Triassic species are discussed.

Upper Triassic retzioid brachiopods occur relatively rarely both in the Northern Alps and in the Carpathians. There have been only scarce notations of them in faunal lists since BITTNER's epoch, and I know of only few specimens illustrated in the last decades from mentioned areas (e. g. M. MAHEL 1957, M. SIBLÍK 1967, D. A. B. PEARSON 1977).

New findings of retzioid genus *Schwagerispira* DAGYS, 1972 were made in the Carnian at the former BALOGH's locality I. (1940) and its surroundings, SW of the village Silická Brezová in the Slovak Karst. The geological situation of this locality was summarized by M. SIBLÍK (1986). Most retzioid specimens found there belong to a new species the description of which follows.

I am indebted to the staffs of the Geologische Bundesanstalt-Museum, of the Palaeontological Department of the Natural History Museum, and of the Palaeontological Institute of the University- all in Vienna, for access to the collections and for their kind assistance.

Description

Retziidina BOUCOT, JOHNSON et STATON, 1964

Retziacea WAAGEN, 1883

Neoretziidae DAGYS, 1972

Schwagerispira DAGYS, 1972

Type-species: *Retzia Schwageri* BITTNER, 1890 — Anisian of Austria and Hungary.

***Schwagerispira bystrickyi* sp. n.**

(Pl. XLII, figs. 1—3; pl. XLIII, fig. 1; text-figs. 1—2)

Holotype: The specimen figured on the plate XLII, fig. 2 and deposited in the collections of the Slovak National Museum in Bratislava under number SNM Z 20023.

Stratum typicum and locus typicus: Tuvalian, *Subbulatus* and *Anatropites* (?) Zone; Silická Brezová.

Derivatio nominis: In honour of the late RNDr. J. BYSTRICKÝ, DrSc. who did so much for the geology and palaeontology of the Slovak Karst.

Material: 35 more or less fragmentary internal moulds. The dimensions in mm of the figured specimens are as follows: $10.4 \times 8.6 \times 8.0$ (pl. XLII, fig. 2; holotype); $7.9 \times 6.2 \times 4.6$ (pl. XLII, fig. 3), $7.0 \times 6.3 \times 4.9$ (pl. XLIII, fig. 1); $6.1 \times 5.3 \times 4.6$ (pl. XLII, fig. 1).

Description: Small shells of subtrigonal outline, subequally biconvex in profile, up to 10.5 mm long, 8.6 mm wide and 8.0 mm thick, with length apparently exceeding width. Maximum width situated near the anterior margin of shell. Very short, straight hinge line present. Anterior margin of shell straight on dorsal view, in some specimens gently concave. Shallow sulci developed in the anterior half of both valves. Valves sloping steeply to lateral commissures in most specimens, giving rise to flank "planareas". Anterior commissure straight or broadly sulcate (pl. XLII, fig. 3). Beak low and narrow, apical angle ranging between 50—60 degrees. Apsacline area well divided from lateral slopes and slightly recurved in profile. Exact position of pedicle opening not visible on the material studied. Both valves with between 5—14 (most frequently 10—11) subangular ribs extending to the umbones. Branching common in ribs on flanks. Central interspace on pedicle valve deeper than the others and the only one reaching distinctly the umbo. Corresponding median rib on brachial valve slightly wider than flank ribs, its neighbouring interspaces deeper if compared with the others. Radial grooving of the interspaces sometimes hardly perceptible.

Pedicle collar not ascertained. Dental lamellae lacking. Cardinal process massive and smooth, in some specimens club-like in shape. Crural plates strongly developed, extending into umbonal cavity of pedicle valve. Simple spiralia with few turns supported by high, thin dorsal septum reaching mid-length of valve.

Remarks: The material was not enough suitably preserved for sectioning, being much recrystallized, but it nevertheless shows essential internal features of *Schwagerispira* DAGYS, 1972 that associates a series of species externally similar to *S. bystrickyi* sp. n. which is referred here to *Schwagerispira* without greater hesitation. Specific independence of our specimens is based above all on their subtrigonal outline and steep flanks. When establishing the new species, it was necessary to make comparisons with some already existing, externally similar Upper Triassic species, and to examine relevant museum collections.

Some specimens of the new species show considerable resemblances to *Schwagerispira pretiosa* (BITTNER, 1890) described from the Hallstatt Limestone of Nassköhr near Neuberg/Mürz, and of Salzkammergut. That species, however, differs in having well-rounded, subpentagonal outline with nearly isometric brachial valve, in the absence of steep flanks, in having longer hinge line and weaker ribs, and in having the maximum width situated in the mid-length. It was confirmed both in the lectotype of *S. pretiosa* from Nassköhr (BITTNER, 1890, pl. 15, fig. 2-housed in the collection of the Geologische Bundesanstalt in Vienna), and in the little collection of "*Retzia pretiosa*" coming from Siriuskogel near Ischl (coll. E. KITTL in the Natural History Museum in Vienna).

The specimen figured here on the plate XLIII, fig. 2 under the name *Schwagerispira* aff. *pretiosa* (BITTNER, 1890) deriving from the same locality of Silická Brezová (old collection of dr. J. BYSTRICKÝ) differs from "*pretiosa*" in

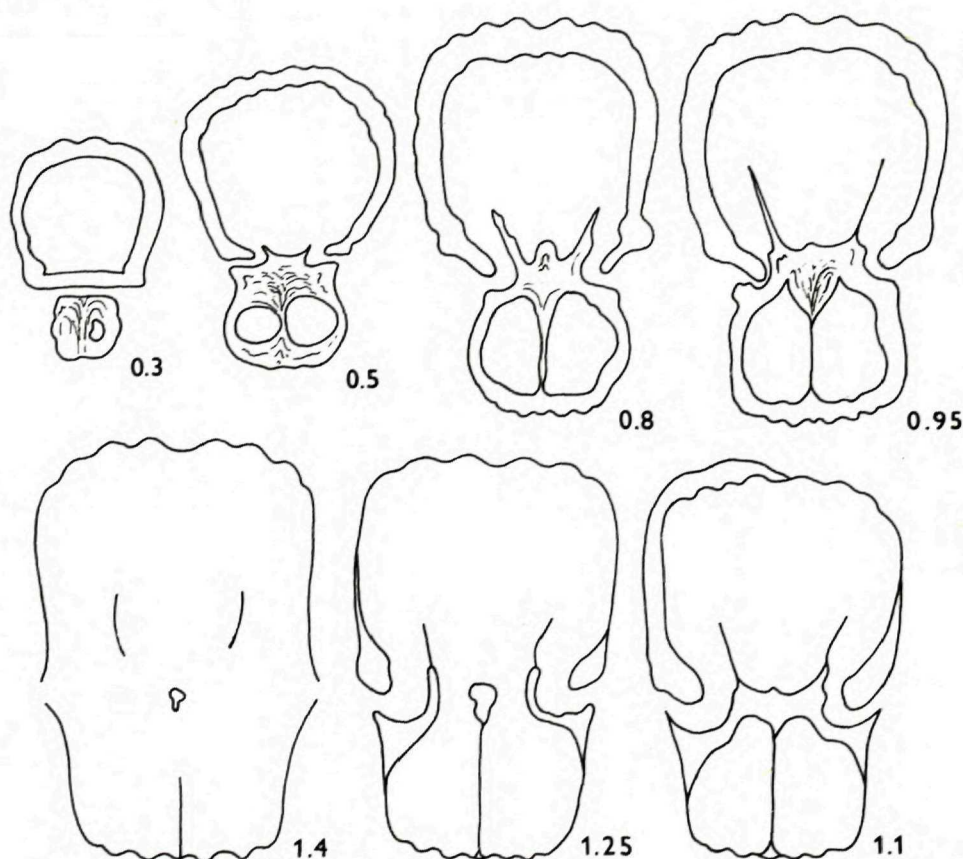


Fig. 1 *Schwagerispira bystrickyi* sp. n. Serial transverse sections through the posterior part of shell. Other internal characters not ascertainable due to the secondary calcite infilling. Total length of specimen 8.6 mm. Silická Brezová, upper part of BALOGH's locality. Enlarged.

being longer and narrower, in having very short hinge line, and in more outstanding pedicle beak. This specimen differs, on the other side, from *Schwagerispira bystrickyi* sp. n. notably in having a different outline, and in lacking steep flanks.

The occurrence of *Retzia pretiosa* mentioned by J. PEVNÝ (1979) in the faunal list from the environs of Silická Brezová could not be confirmed by my newer collections and it is also not present in the large material of J. BYSTRICKÝ and his collaborators from this locality (incorrect determination?).

Schwagerispira bystrickyi sp. n. can be distinguished on the grounds of its different outline, steep lateral sloping, and its narrow area accompanied with poorly developed hinge line from *Schwagerispira fastosa* (BITTNER, 1890). This species (referred to *Neoretzia* by Y. K. JIN—B. X. FANG, 1977) derives from Dachsteinkalk of the Tristlwand and Dürrnberg near Hallein, Salzburg, and was also reported by M. MAHEE (1957) from the Stratenská hornatina Mts.

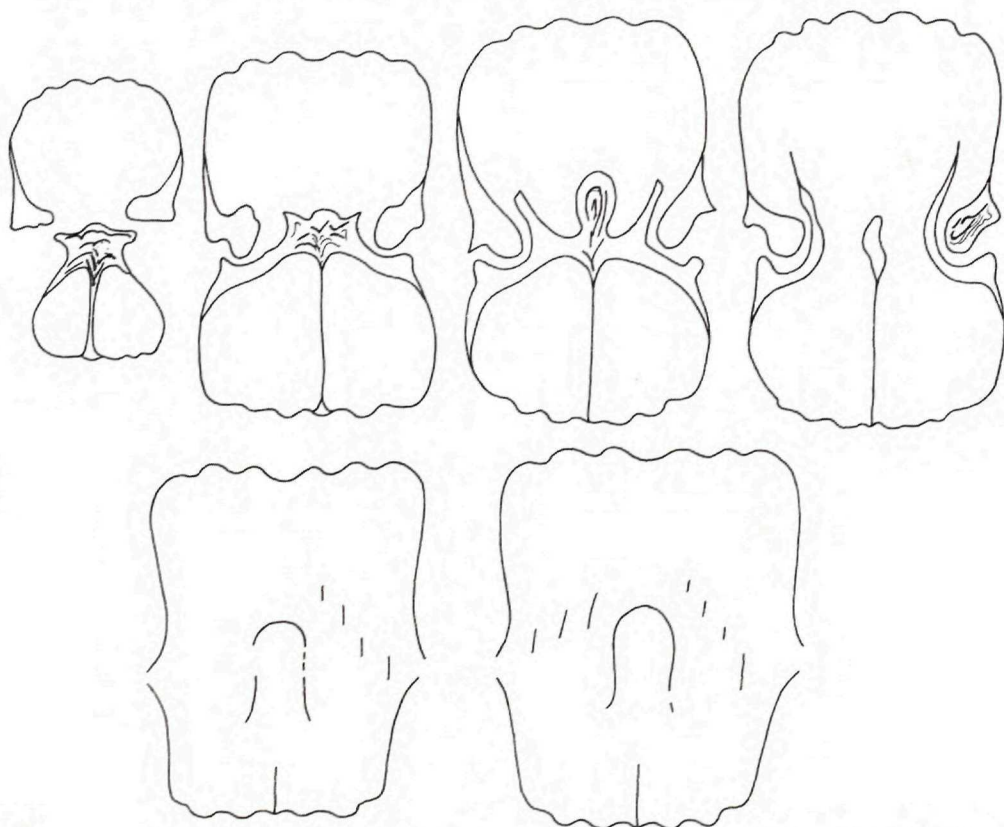


Fig. 2 *Schwagerispira bystrickyi* sp. n. Four transverse sections through the posterior part of shell. Length of specimen 8.0 mm (above).- Two sections showing uncomplete jugum and spiralia of another specimen. Original length of specimen 7.4 mm (bottom). Silická Brezová, upper part of BALOGH's locality. Enlarged.

More serious differences are to be seen in the specimen from the Lower Norian Hallstatt Limestone of Balbersteine/Miesenbach, Lower Austria (pl. XLIII, fig. 3) if compared with *Schwagerispira bystrickyi* sp. n. This specimen (coll. B. GRUBER in the Palaeontological Institute of the University, Vienna) differs in having subrounded, isometric outline, more numerous and weaker ribs, and in the absence of lateral „planareas” and of any sulcation in the brachial valve. It might be rather compared with *Schwagerispira pretiosa* (BITTNER) or still better with *Retzia* [= *Schwagerispira*?] *modesta* BITTNER, 1890.

Occurrence: Tisovec Limestone—Tuvalian, Silická Brezová: lower and upper part of BALOGH's locality I (K. BALOGH, 1940) and locality M 47 in MOCK's section (R. MOCK in M. MIŠÍK—K. BORZA, 1976). Interestingly, not a specimen has been yet found in the faunistically comparable locality of the Ostré vršky Hill on the Plešivec Karst Plateau.

References

- BALOGH, K. 1940: Daten zur geologischen Kenntnis der Umgebung von Pelsőcardó. Abh. miner.-geol. Inst. St. Tisza-Univ., 19, Debrecen, 151—200.
- BITTNER, A. 1890: Brachiopoden der alpinen Trias. Abh. k. k. geol. Reichsanst., 14, Wien, 1—320.
- BYSTRICKÝ, J. 1964: Slovenský kras. ÚÚG, Bratislava, 1—197.
- DAGYS, A. S. 1972: Morphology and systematics of the Mesozoic retzioid brachiopods. Transact. Inst. Geol. Geoph. Acad. Sci., 112, Novosibirsk, 94—105 (in Russ.).
- DAGYS, A. S. 1974: Triassic Brachiopods. Trans. Inst. Geol. Geoph. Acad. Sci. USSR, Siber. branch, 214, Novosibirsk, 1—322 (in Russ.).
- JIN, Y. K.—FANG, B. X. 1977: Upper Triassic brachiopod fauna from the area in the east of the Hengduan Mountains, Western Yunnan. Mesozoic Fossils from Yunnan, China, 2, Peking, 39—66 (in Chin.).
- MAHEL, M. 1957: Geológia Stratsenskej hornatiny. Geol. Práce, Zošit 48a, Geol. Úst. D. Štúra, Bratislava, 1—199.
- MIŠÍK, M.—BORZA, K. 1976: Obere Trias bei Silická Brezová. Acta geol. geogr. Univ. Comen., 30, Bratislava, 5—49.
- PEARSON, D. A. B. 1977: Rhaetian Brachiopods of Europe. N. Denkschr. Naturhist. Mus., 1, Wien, 1—70.
- PEVNÝ, J. 1979: Brachiopoda of the genus *Aulacothyris* from the Carnian of the West Carpathians. Záp. Karpaty, sér. paleont., 4, Geol. Úst. D. Štúra, Bratislava, 65—80.
- SIBLÍK, M. 1967: Ramenonožci noru z lokality Drnava (Slovenský kras). Geol. Práce, Správy, 43, Geol. Úst. D. Štúra, Bratislava, 81—97.
- SIBLÍK, M. 1986: Carnian rhynchonellid brachiopods from the Slovak Karst area. Záp. Karpaty, sér. paleont., 11, Geol. Úst. D. Štúra, Bratislava, 7—33.

MILOŠ SIBLÍK

Nový druh rodu *Schwagerispira* (Brachiopoda) z karnu Slovenského krasu (jv. Slovensko)

Resumé anglického textu

V článku je popsán nový druh retzioidních brachiopodů *Schwagerispira bystrickyi* sp. n., který byl zjištěn v karnu jz. od obce Silická Brezová ve Slovenském krasu. Vyznačuje se

výrazným trojbokým obrysem s přímým předním okrajem a vysokými, někdy až zploštělými laterálními partiemi. Nový taxon je dále srovnáván s podobnými svrchnotriasovými druhy.

Vysvětlivky k tabulím XLII—XLIII

Všichni jedinci byli před fotografováním poběleni chloridem amonným. Jsou uloženi ve sbírkách Slovenského národního muzea v Bratislavě (SNM), kromě jedince na tab. XLIII, obr. 3. Nevýobrazený další materiál je uložen v Ústavu geologie a geotechniky ČSAV v Praze. Foto J. BROŽEK a M. PÁRALOVÁ

Tab. XLII

- 1 *Schwagerispira bystrickyi* sp. n. Silická Brezová, svrchní část Baloghovy lokality, tuval. SNM Z 20022, zvětš. $\times 4$.
- 2 Jako obr. 1. Holotyp. SNM Z 20023, $\times 4$.
- 3 Jako obr. 1. SNM Z 20024, $\times 4$.

Tab. XLIII

- 1 *Schwagerispira bystrickyi* sp. n. Silická Brezová, svrchní část Baloghovy lokality, tuval. SNM Z 20025, $\times 4$.
- 2 *Schwagerispira* aff. *pretiosa* (BITTNER, 1890). Silická Brezová, spodní část Baloghovy lokality, tuval. Nález J. BYSTRICKÉHO. SNM Z 20026, $\times 3$.
- 3 *Schwagerispira* (?) ex gr. *modesta* (BITTNER, 1890). Balbersteine/Miesenbach v Dolním Rakousku, lac. Sběrka GRUBER, Paleontologický ústav univerzity ve Vídni, $\times 3$.

Explanations of Plates XLII—XLIII

All specimens were coated with ammonium chloride before photographing. Photographs by Mrs. M. PÁRALOVÁ and Mr. J. BROŽEK. Figured specimens are deposited in the collections of the Slovak National Museum in Bratislava (SNM), except the specimen on Pl. XLIII, fig. 3. The other, unfigured material is housed in the Institute of Geology and Geotechnics, Czech. Academy of Sciences, Prague

Plate XLII

- 1 *Schwagerispira bystrickyi* sp. n. Silická Brezová, upper part of BALOGH's locality, Tuvanian. SNM Z 20022, $\times 4$.
- 2 As fig. 1. Holotype. SNM Z 20023, $\times 4$.
- 3 As fig. 1. SNM Z 20024, $\times 4$.

Plate XLIII

- 1 *Schwagerispira bystrickyi* sp. n. Silická Brezová, upper part of BALOGH's locality, Tuvanian. SNM Z 20025, $\times 4$.
- 2 *Schwagerispira* aff. *pretiosa* (BITTNER, 1890). Silická Brezová, lower part of BALOGH's locality, Tuvanian. Collected by J. BYSTRICKÝ. SNM Z 20026, $\times 3$.
- 3 *Schwagerispira* (?) ex gr. *modesta* (BITTNER, 1890). Balbersteine/Miesenbach in Lower Austria, Lacian. Coll. GRUBER, Palaeontological Institute of the University, Vienna, $\times 3$.

Translated by the author.

MIROSLAV PLIČKA—ALENA NĚMCOVÁ—ZUZANA SIRÁŇOVÁ

Two New Trace Fossils in the Czechoslovak Carpathian Flysch — Result of the Activity of Eel-like Fish (Anquilliformes)

8 text-figs., 4 Pls. (XLIV—XLVII), Czech summary

Abstract: The authors describe a new trace fossil *Anquilliformisichnium andrusovi* n. ichnogen. n. sp. from the Inner as well as Outer Carpathian flysch (Cretaceous, Paleogene) in Czechoslovakia. The other trace fossil (?“Body Fossil”) *Heterocongeridopsisichnium casteri* n. ichnogen n. sp. has also been discovered in the Cretaceous and Paleogene of the Carpathian flysch. Both the trace fossils are likely to have originated by the activity of eel-like fish of the group *Anquilliformes* (families: *Congeridae*, *Anquillidae*, *Murenidae*, *Heterocongeridae*).

Introduction

By rock jointing study in the Outer Carpathian flysch on the Czechoslovak territory in 1960—1965 (M. PLIČKA 1968), also trace fossils were occasionally observed at the localities. Later, during a systematic research of trace fossils in the Inner Carpathian Paleogene area in Slovakia (M. PLIČKA, 1987) the study has been extended into all the Carpathian flysch area in our territory. A. NĚMCOVÁ's (1973) work, focused exclusively on trace fossil study in the western part of the Carpathian flysch, has brought a lot of knowledge on the topic.

Geologists of the Geological Institute of Dionýz Štúr in Bratislava (Dr. T. ĎURKOVIČ CSc., Dr. P. GROSS CSc., Dr. T. KORÁB CSc., Dr. J. NEMČOK CSc. and others) did not pay special attention to this problem, but in the course of their geological researches of the Slovak territory they observed also trace fossils, some of which are deposited and exhibited in the above-mentioned institute in Bratislava. They informed us of their discoveries (M. PLIČKA 1968, 1987) and allowed us to evaluate them. This was the case e. g. by the evaluation of the trace fossils *Anquilliformisichnium andrusovi* n. ichnogen n. sp. from eastern Slovakian flysch, that had been discovered by Dr. T. KORÁB CSc. and we chose it as a holotype.

Dr. M. PLIČKA, Central Geological Survey, Leitnerova 22, Brno

Dr. A. NĚMCOVÁ, Moravian Petroleum Mines, Úprkova 5, Hodonín

Dr. Z. SIRÁŇOVÁ, Geological Institute of Dionýz Štúr, Mlynská dolina 1, Bratislava

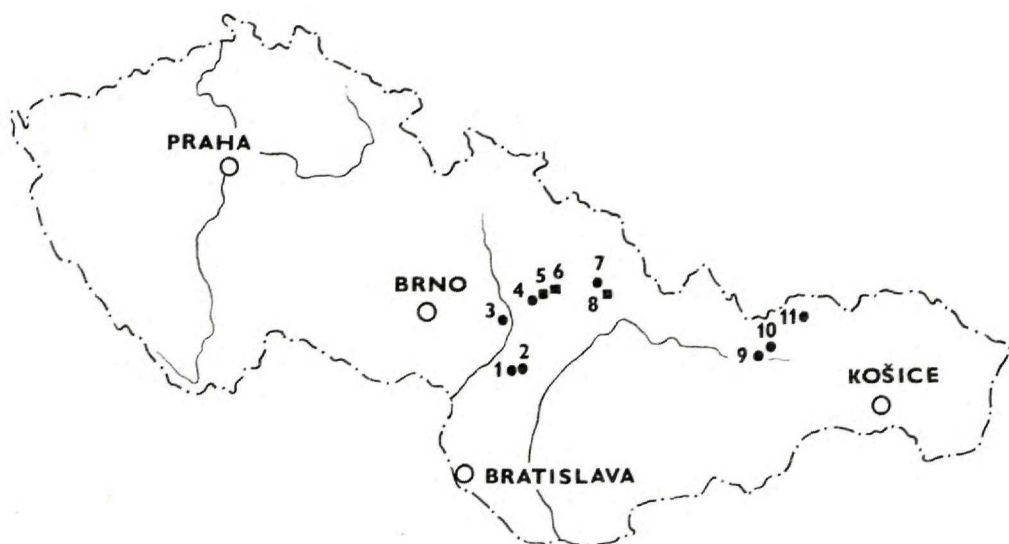


Fig. 1 Schematic map of localities with new trace fossils occurrences (● — *Anquilliformisichnium andrusovi* n. ichnogen. n. sp., ■ — *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp.). Localities: 1 — Javorník, 2 — Nová Lhota, 3 — Kostelany, 4 — Chvalčov, 5 — Hostýn, 6 — Oznice, 7 — Pustevny, 8 — Horní Bečva, 9 — Liptovský Peter, 10 — Podbanské, 11 — Valentovice.

The trace fossil study in the Carpathian flysch of Central Europe is supplemented by recent researches in Poland where the neighbouring area of the Carpathian flysch has been investigated in this way (M. KSIĄZKIEWICZ 1977). An extensive part of the Outer Carpathian flysch on our territory, including eastern Slovakia, will also be investigated in this manner (M. PLÍČKA, preparatory work for press).

Systematical description

Ichnogenus: *Anquilliformisichnium* n. ichnogen.

Type species: *Anquilliformisichnium andrusovi* n. sp.

Denomination: According to the designation of eel-like fish belonging to the group *Anquilliformes* (W. LUTHER—K. FIEDLER 1962, p. 34, R. RIEDL 1963, p. 517).

Diagnosis: Cylindrical trace, even or arched, on the lower or upper bedding plane of sandstones, 2—4 cm wide, rising up to 10 mm over the bedding plane.

***Anquilliformisichnium andrusovi* n. ichnosp.**

Pl. XLIV, XLV, text-fig. 2, 3

Holotype: Excellent sample exhibited on the corridor of the Geological Institute of Dionýz Štúr in Bratislava, leg. Dr. T. KORÁB CSc. in 1960, Pl. I, text-fig. 2a₁, 2a₂

Type locality: Valentovice, eastern Slovakia

Type level: Bela veža beds of the Magura nappe, Paleocene, sandstones.

Denomination: In the honour of late Czechoslovak geologist univ. Prof. Dr. DIMITRIJ ANDRUSOV DrSc.

Material: 10 fragments of fine-grained, tabular sandstones.

Diagnosis: Even or arched trace, cylindrical, 2—4 cm wide (most often 3—3.5 cm), mostly as positive hyporelief, rising up to 10 mm over the bedding plane. In one or both directions it may end in a blunt point.

Description: On the lower and upper bedding plane of fine-tabular sandstones there are even or arched traces, cylindrical (positive hyporelief, negative epirelief) that are often terminated by a blunt point in one or two directions. Their width varies from 2 to 4 cm. They penetrate up to 10 mm under the lower bedding plane, whereas on the upper bedding plane the trace depth is considerably smaller (see text-fig. 3k). The holotype sample (Pl. XLIV) contains two traces on the lower bedding plane of greenish-gray, fine-grained, quartzylcalcareous, finely micaceous sandstone. One of them is even, only slightly arched, 4 cm wide, whereas the other is 3.5 cm wide and arched. In the place of the maximum arching the trace is partly deformed.

Remark: The new trace fossil *Anquilliformisichnium andrusovi* n. ichnogen n. sp. is represented by a cylindrical depression on clayey or sandy seafloor surface that occurs on the lower bedding plane of sandstone as positive hyporelief or on its upper bedding plane as negative hyporelief. Even or only slightly arched traces resemble in their appearance a current mechanoglyph. That is probably the reason why the trace fossil was not noticed sooner. The blunt termination of the trace in one or both ends means detachment of a cylindrical sea organism from the sea floor or, on the contrary, its landing (see Pl. XLV, Fig. 1 and text-figs 2e, 2g₁, 2g₂, 2j, 2k, 2l).

Sediment: The holotype is on the lower bedding plane of greenish-gray, fine-grained, finely tabular, quartzylcalcareous, finely micaceous sandstone (Paleocene, Bela veža beds). These traces in the quarry pod Pustevnami (Godula beds of the Silesian nappe, Cretaceous) occur in green-gray, calcareous, strongly fine-micaceous, tabular to finely tabular sandstones. As regards the findings in the Inner Carpathian Paleogene, the sandstones are yellowish-gray, fine- to medium-grained, calcareous, micaceous, tabular.

Association: *Planolites* sp., *Taprhelminthopsis auricularis*, *Scolicia* sp., *Subphyllochorda* sp., *Capodistria vettersi*, *Zoophycos* sp., *Godulaichnium tenue*, *Saportia* sp., *Gyrichnites* sp., *Helminthopsis granulata*, *Paleodictyon miocenicum*.

Origin: Probably traces of sea eel-like fish of the group *Anquilliformes*.

Stratigraphical range: Outer Carpathian as well as Inner Carpathian

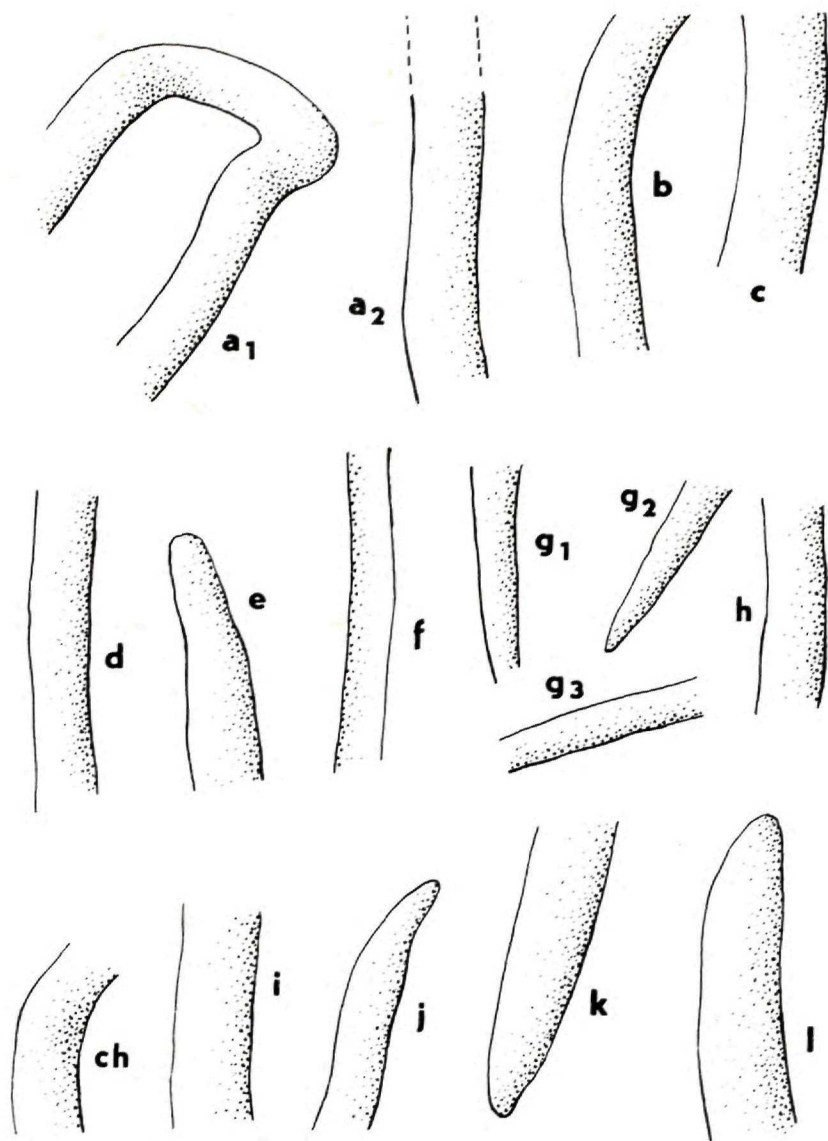


Fig. 2 *Anquilliformisichnium andrusovi* n. ichnogen. n. sp., schematic sketches of occurrences at individual localities: a₁, a₂ — Valentovice (Bela veža beds, Paleocene), holotype, $\times 0.35$. b — quarry pod Pustevnami (Godula beds, Cretaceous), $\times 0.4$. c — do, $\times 0.4$. d — do, $\times 0.6$. e — do, $\times 0.6$. f — do, upper bedding plane of sandstone (negative epirelief), $\times 0.5$. g₁—g₃ — Javorník (Eocene, Bílé Karpaty unit), $\times 0.2$. h — Chvalčov (Solán beds, Paleocene), $\times 0.5$. ch — quarry pod Pustevnami (Godula beds, Cretaceous), $\times 0.25$. i — Kostelany (Zlín beds, Eocene), $\times 0.5$. j — Nová Lhota (Eocene, Bílé Karpaty unit), $\times 0.3$. k — Liptovský Peter (Eocene, Inner Carpathian Paleogene), $\times 0.3$. l — Podbanské (do), $\times 0.5$. All the occurrences represent positive hyporelief with the exception of the quarry pod Pustevnami (f), where the organism moved on the sandy surface of the sea floor.

flysch. Outer Carpathian flysch: Godula beds of the Silesian nappe (Cretaceous), locality quarry pod Pustevnami; Magura nappe (western part) — Rača unit, Zlín Formation (Eocene), locality Kostelany; Bílé Karpaty unit (Eocene), localities Javorník, Nová Lhota. Magura nappe (eastern part), Bela veža beds (Paleocene), locality Valentovice. Inner Carpathian flysch: Intra Carpathian Paleogene (Eocene), localities Liptovský Peter, Podbanské (M. PLÍČKA, 1987).

Ichnogenus: **Heterocongeridopsisichnium n. ichnogen.**

Type species: *Heterocongeridopsisichnium casteri* n. sp.

Denomination: According to the designation of a sea eel-like fish that lives in tubes on the sea floor and belongs to the family *Heterocongeridae* (K. DECKERT 1967, p. 126).

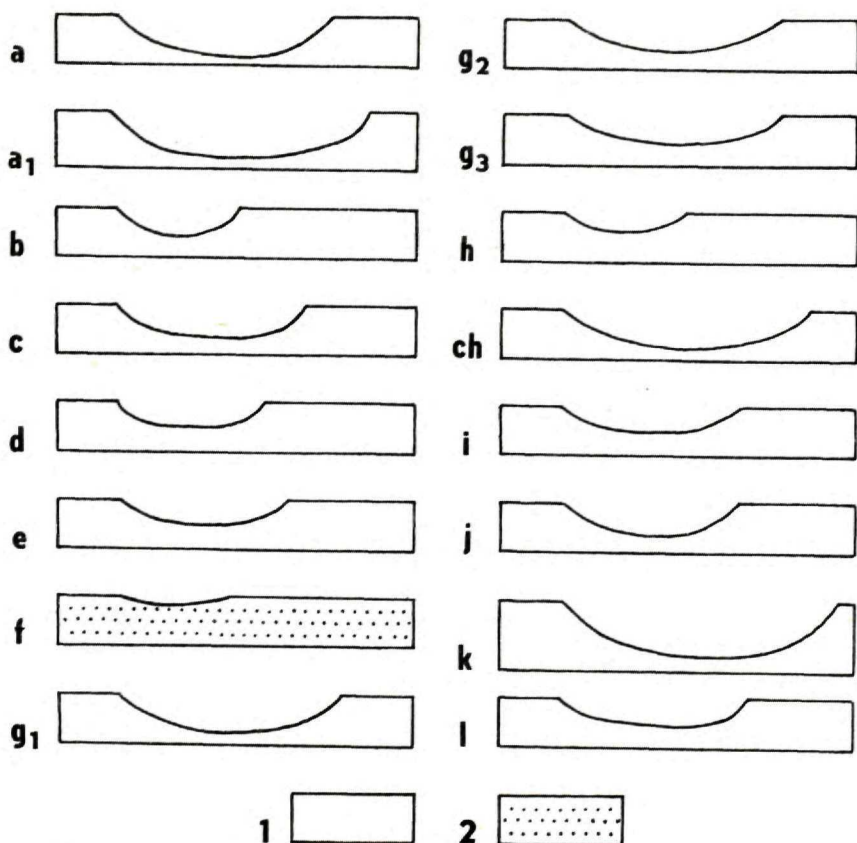


Fig. 3 Transversal section of the trace fossil *Anquilliformisichnium andrusovi* n. ichnogen. n. sp. in the original clayey seafloor surface, except for the letter "f" where the sea floor is sandy. The trace in the clayey sea floor was formerly deeper (diminishing of the sediment volume). Localities: Valentovice (a), quarry pod Pustevnami (b — f, ch), Javorník (g₁ — g₃), Chvalčov (h), Kostelany (l), Nová Lhota (j), Liptovský Peter (k), Podbanské (l). The seafloor surface is clayey (1), sandy (2). × 0.75.

Diagnosis: Circular trace on the lower or upper bedding plane of sandstones, in the central part tubal, perpendicular at bedding, with a diameter of 1.2—6 cm. The central part of the trace is dark with a fringe on its circumference — fossil remain of a tube.

***Heterocongeridopsisichnium casteri* n. ichnosp.**

Pl. XLVI/2, XLVII, text-figs 4, 5, 6

Holotype: Individual on the lower bedding plane of sandstone in a quarry by a road SSE of Oznice, shown in photography (Pl. XLVI/2 in the centre). The sample could not have been taken.

Type locality: Oznice near Valašské Meziříčí, quarry by the road.

Type level: Zlín beds of the Rača unit of the Magura flysch, sandstones, Eocene.

Denomination: In the honour of famous american paleontologist univ. Prof. Dr. KENNETH E. CASTER.

Material: 35 individuals on bedding planes of sandstones of the Zlín, Soláň and Istebné beds at the localities: Oznice, Hostýn, Horní Bečva (Pl. XLVI/2, XLVII/1, 2, text-figs. 4, 5, 6).

Diagnosis: Circular trace on the lower and upper bedding plane of sandstones, tubal in the central part, perpendicular at bedding, 1.2—6 cm in diameter. The central part of the trace is dark with a distinct fringe on its circumference — fossil remain of a tube. Around the central dark part with the fringe there is a wall forming about one third of the total trace circumference. Exceptionally, up to three circular fringed forms may occur inside the wall — see text-fig. 4ch.

Description: At the locality Oznice, circular forms, 3—6 cm in diameter, occur on the lower bedding plane of tabular, greenish-gray sandstone. They consist of three parts: Central, which is much darker than the surrounding rock, and is formed of fine, clayey-sandy material. On its circumference is a fringe 0.5—2 mm wide — depending on the size of the trace. The third — outer part is of the same grain-size and colour as the surrounding wall rock which forms a certain wall around the central part. This is the case on the lower bedding plane of sandstone. As seen in text-fig. 4, the outer part of the trace has a variable size in comparison with the central part, though its diameter is mostly two times larger than the central dark part, see e. g. Fig. 4i, j, k, l, o. The central part, however, is sometimes much smaller (Fig. 4d, g). In one instance, an oval trace 4 × 6 cm in diameter has the outer part as much as 10 mm wide. Inside are three central parts 1 cm in diameters, in places with a distinct fringe (text-fig. 4ch).

In the quarry by the summit of Hostýn Mt. there is a similar development of these trace fossils, which occur in sandstones of the Soláň Formation (Paleocene).

Trace fossils in the quarry in the wood SE of Oznice (Zlín beds, Eocene) are of partly different development. Only their central part with a fringe 2 mm wide

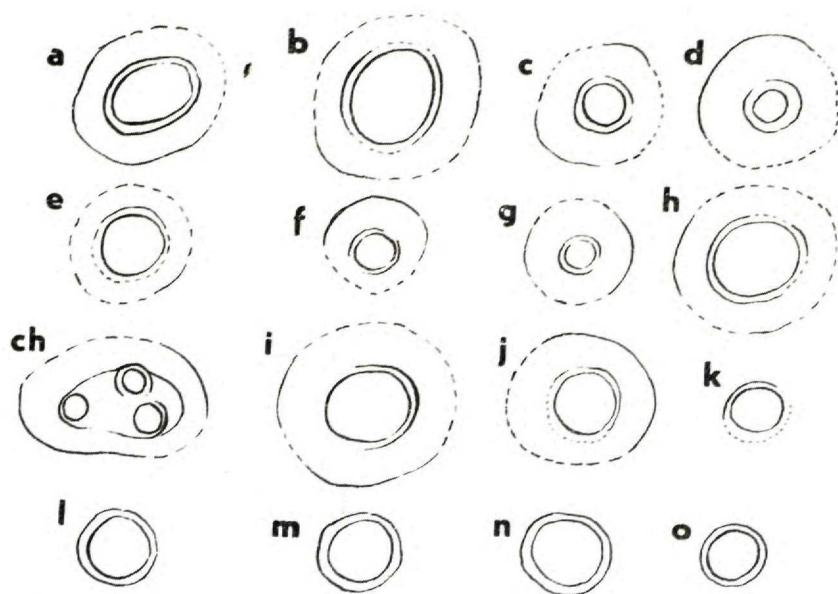


Fig. 4 Schematic sketches of individual trace fossils *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp. at the localities: Oznice, quarry by a road SE of the village (a — k). Oznice, quarry in the wood SSE of the village (l, m). Hostýn, quarry by the road to Hostýn (n, o). Almost all sketches are diminished: a, b — $\times 0.4$, c—j — $\times 0.5$, j — $\times 0.4$, k, l — $\times 0.5$, m, n — $\times 1$, o — $\times 0.6$. The outer circumference of the trace is a wall caused probably by the movement of the eel sliding out of the tube (lateral pressure on the sediment) as well as by the erosion by the streaming water in the place of the obstacle. The fringe around the dark central part is probably the remainder of the eel's tube.

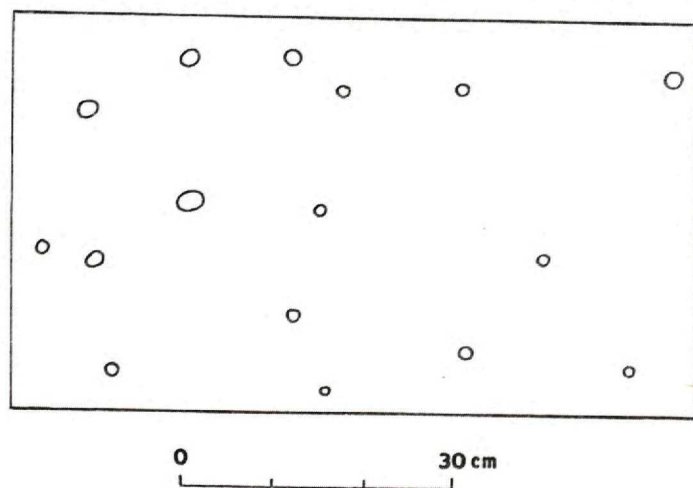


Fig. 5 Scheme of the areal distribution of the trace fossils *Heterocongeridopsisichnium casteri* ichnogen. n. sp. n. visible on the lower bedding plane of sandstone of the Zlin beds in a road-side quarry SSE of Oznice. In this case the eels lived on a clayey sea floor and were suddenly buried by sandy material.

is preserved. This is probably due to the fact that only a part of the tube deeper under the surface is exposed on the bedding joint and the outer margin is therefore missing. The outer wall is likely to originate in the place near the seafloor surface where there is a lateral pressure in all directions because of the eel's sliding in and out of the tube. Moreover, sea water movement may operate

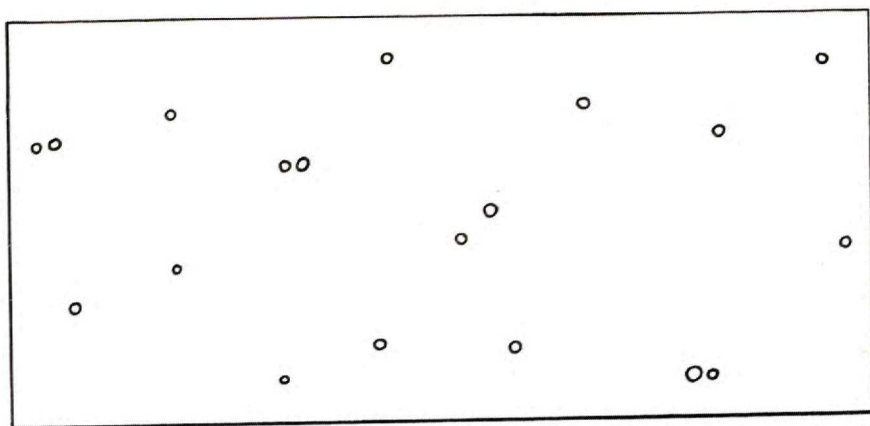


Fig. 6 Scheme of areal distribution of trace fossils of smaller individuals *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp. on the bedding plane (? bedding joint) of a sandstone block of the Istebné beds (Cretaceous, Silesian nappe) in the quarry near the Horní Bečva church.

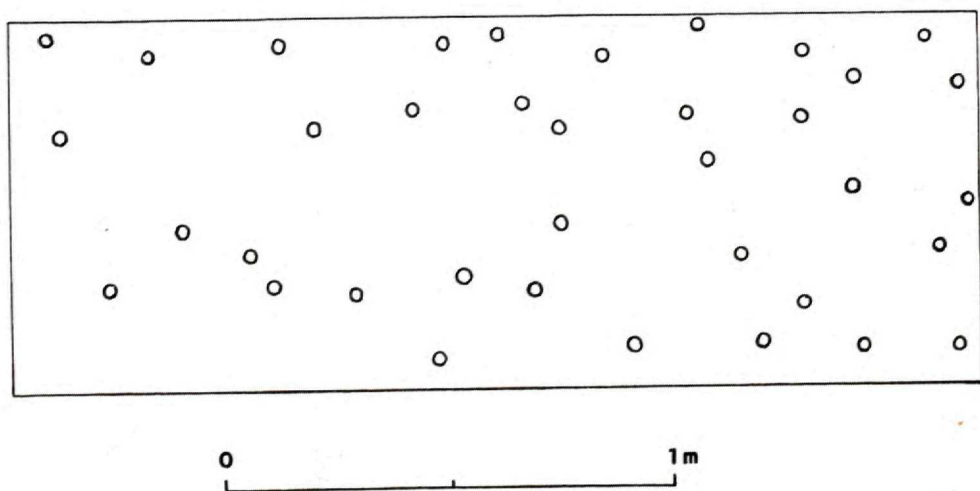


Fig. 7 Location of areal distribution of recent sea eels *Xarifania hassi* on the sandy floor of the Red Sea at a depth of 8 metres. Reconstruction according to a photography (K. DECKERT 1967, p. 127). The eels attain the length of over 40 cm, their width is 1.5—2 cm. The areal distribution of recent eels is similar to that of the fossil ones. Nowadays, eels of the family *Heterocongeridae* live on sandy as well as clayey sea floor (K. DECKERT 1967).

here, too. In the vicinity of the protruding eel the current scours the surface sediment in place where the fish forms an obstacle (see schematic sketch in text-fig. 8).

As regards findings of these traces on the bedding joint of sandstone of the Istebné beds (Cretaceous) in the quarry at Horní Bečva, the situation is similar. Also here the outer part of the trace is missing. In this case only the dark central part with a marginal fringe, secondarily filled with a dark, clayey-sandy substance is exposed on the bedding joint.

Remarkk: The shape of the newly described trace, especially that of smaller forms, is very similar to sea worm tubes (e. g. *Planolites* sp., *Granularia* sp.). The similarity is especially conspicuous if the surrounding sandstone is separated by a bedding joint in place where the eel was bored into the sediment. The outer part of the trace — wall, which is visible only on the surficial part of the sea floor, is missing. In our case this can be well observed on the lower bedding plane of the Zlín beds sandstone in the quarry SE of Oznice (Pl. XLIV/2, XLV).

Eels living in tubes on the sea floor slide out into the height of up to 40 cm. Only recently were they discovered at a small depth on the floor of the Red Sea. That is probably why the possibility that these traces originate by the activity of the fish of this species has not so far been speculated on.

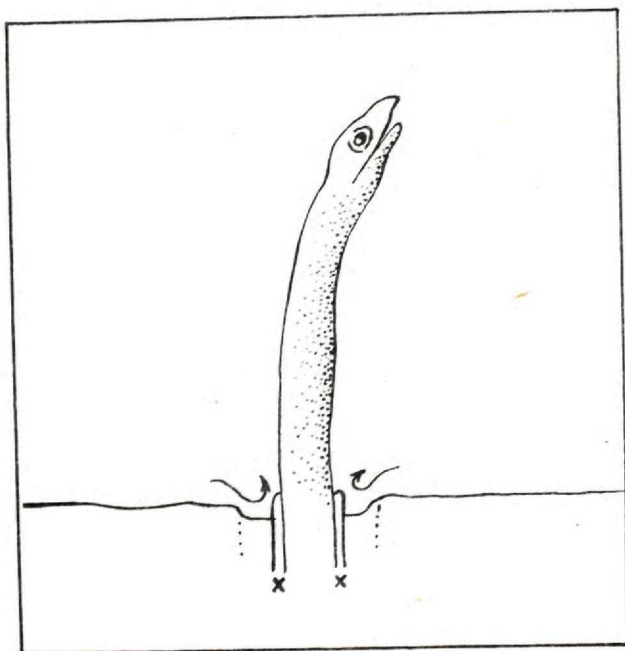


Fig. 8 Schematic sketch and reconstruction of a sessile sea eel of the family *Heterocongeridae* on clayey seafloor surface. The letter x marks the tube formed by the fish.

Sediment: At the locality Oznice (Zlín beds) there is greenish-gray, fine-grained, calcareous, micaceous, tabular sandstone. In the quarry at Hostýn, greenish-gray, noncalcareous, fine- to medium-grained, micaceous, tabular sandstone (Solán beds) occurs. At Horní Bečva is gray, greenish, tabular, noncalcareous, micaceous, medium-grained sandstone with rare small quartz pebbles (Istebné beds).

Association: *Planolites* sp., *Belonidopsisichnium carpaticum*, *Scolicia prisca*, *Zoophycos* sp., and plant remains of considerable size with a distinct structure.

Origin: The trace fossil *Heterocongeridopsisichnium casteri* n. ichnogen. n.sp. (in places also "Body Fossil" — see tube protecting the fish in the sediment) was formed by the activity of sessile sea eels living in tubes on sandy or clayey sea floor. This fish belongs to the family *Heterocongeridae* and has been discovered only recently.

Stratigraphical range: Istebné beds of the Silesian nappe (Upper Cretaceous) — Horní Bečva; Solán beds (Paleocene) — Hostýn; Zlín beds (Eocene) — Oznice, Magura nappe.

Ecology and Paleoecology

Both the trace fossils were created by sea eel fishes (*Anquilliformes*). One fish, which gave rise to the new trace fossil *Anquilliformisichnium andrusovi* n. ichnogen. n.sp., moved freely in the water, whereas the other fish (*Heterocongeridae*) was sessile and gave rise to the trace *Heterocongeridopsisichnium casteri* n. ichnogen. n.sp. All this group of eel fishes has one thing in common, i.e. they live in a relatively shallow-water environment. As regards the origin of the trace *Anquilliformisichnium andrusovi* n. ichnogen. n.sp., though it is known that during their reproduction process eels (also fresh-water ones, i.e. *Anquilla anquilla* /L/) move into larger depths (400—600 m), e.g. into the Sargasso Sea off the Central American coast and some even descend into a depth of 1000 m, e.g. the eel *Conger conger* /L/ (R. RIEDL 1963), but this happens exclusively in these cases. Otherwise eels live in a shallower water environment where they look for food on the sea floor (crabs, molluscs, worms etc) but they devour also fish. Some eels quickly bury the tip of their tail into sand or mud on the sea floor where they wait for pray, others, e.g. snake-like eels in tropical seas, slowly crawl on the sea floor catching molluscs and worms (Golden Press, Inc. 1964).

The other trace fossil (maybe partially also "Body Fossil") was caused by an eel fish living in tubes on the clayey or sandy surface of the sea floor at small depths. This fish was discovered for the first time during the recent expedition Xarifa in the Red Sea at a depth of 15 m. It was denominated *Xarifania hassi* (Pl. XLVI/1). The fish slid out of its tube waves its body to and for in the streaming water and catches small animals. Similarly, other newly found eel fishes, such as *Gargasias maculata* and *Gargasias sillneri*, were discovered at as small depth (30 metres) near the sea shore.

Conclusions

As regards the origin of trace fossils, they are often supposed to have been created by the activity of sea worms, molluscs etc. The activity of sea fishes is omitted, although they are undoubtedly very significant representatives of marine fauna. The trace fossil *Belonidopsisichnium carpaticum* PLIČKA, 1962 has so far been identified in Eocene sandstones of the Magura flysch in eastern Slovakia, Czechoslovakia. This trace fossil comes from the beak-like jaws of the fish of the family *Belonidae* which looks for food on the seafloor surface (M. PLIČKA 1982). Similarly, the trace fossil *Saerichnites beskidensis* PLIČKA, 1974 probably originated by the activity of sea fishes (M. PLIČKA 1974). In other cases, holes and traces on the seafloor surface may be caused by the protuberances on the lower side of the head of fishes which enables them to move more safely close to the seafloor surface, e.g. the sea fish *Trigla hirundo* or even fish of the family *Bunocephalidae* whose one spike on the head's lower side leaves conspicuous holes on the seafloor surface (K. DECKERT 1969, p. 123). That is why the explanation for the origin of all trace fossils still has to be looked for, which requires good knowledge on the recent marine fauna and mainly knowledge on the way of life of marine organisms. This will contribute considerably to the knowledge on the sedimentary environment.

Translated by L. Böhmer

References

- DECKERT, K. et al. 1967: Urania Tierreich, Fische-Lurche-Kriechtiere. Urania Verlag, Jena, Leipzig, 1—534.
- FRICKE, H. W. 1976: Bericht aus dem Riff. R. Piper and CO. Verlag., München.
- GOLDEN PRESS, Inc., 1964: Editions des Deux Coqs d'Or.
- KSIAŻKIEWICZ, M. 1977: Trace Fossils in the Flysch of the Polish Carpathians. *Palaeontologia polonica*, Polska ak. nauk, Warszawa-Kraków, 1—208.
- LUTHER, W.—FIEDLER, K. 1962: Die Unterwasserfauna der Mittelmeerküsten. Verlag Paul Parey, Hamburg, Berlin, 1—253.
- NĚMCOVÁ, A. 1973: Klasifikace a význam bioglyfů při výzkumu sedimentů karpatského flyše. Rigorosní práce, Přírodovědecká fakulta UJEP, Brno, 1—124.
- PLIČKA, M. 1968: Joint zones in the flysch of the Czechoslovak Carpathians and in the Paleozoic of the SE border of the Czech Massif. *Geol. Práce, Správy* 44—45, Geol. Úst. D. Štúra, Bratislava, 119—227.
- PLIČKA, M. 1974: *Saerichnites beskidensis* n. sp., a new trace fossil from the Carpathian Flysch of Czechoslovakia. *Věst. Ústř. úst. Geol.*, 49, Praha, 75—82.
- PLIČKA, M. 1982: *Belonidopsisichnium carpaticum* n. ichnogen. n. sp. from the Outer Carpathian Flysch of East Slovakia, Czechoslovakia. *Záp. Karpaty, sér. Paleont.*, 8, Geol. Úst. D. Štúra, Bratislava, 149—158.
- PLIČKA, M. 1987: Fossil Traces in the Inner — Carpathian Paleogene of Slovakia, Czechoslovakia. *Záp. Karpaty, sér. Paleont.* 12, Bratislava, 125—196.
- RIEDL, R. 1963: Fauna und Flora der Adria. Verlag Paul Parey, Hamburg und Berlin, 1—640.

Dvě nové fosilní stopy v karpatském flyši v Československu — výsledek činnosti mořských úhořovitých ryb (*Anquilliformes*)

Resumé anglického textu

V letech 1960—1965 byly ve vněkarpatském flyši na území Československa sledované fosilní stopy jen příležitostně při studiu puklinatosti hornin (M. PLIČKA 1968). Později při systematickém studiu fosilních stop, rozšířeném i o oblast vnitrokarpatského paleogénu na Slovensku (M. PLIČKA, 1987) bylo tak studium rozšířené na celé území karpatského flyše u nás. Rovněž práce A. NĚMCOVÉ (1973), zaměřené čistě na studium fosilních stop v západní oblasti karpatského flyše, byly v tomto směru velkým přínosem.

Pracovníci Geologického ústavu Dionýza Štúra v Bratislavě (Dr. T. ĎURKOVÍČ CSc., Dr. P. GROSS CSc., Dr. T. KORÁB CSc., Dr. J. NEMČOK CSc. a další) se sice touto otázkou podrobněji nezabývali, sledovali však při geologických pracích na území Slovenska i fosilní stopy a poskytli nám ochotně některé vzorky případně údaje o fosilních stopách. Tak tomu bylo například při hodnocení fosilní stopy *Anquilliformisichnium andrusovi* n. ichnogen. n. sp. z belovežských vrstev magurského flyše na východním Slovensku, kterou v r. 1960 našel Dr. T. KORÁB CSc. a kterou jsme zvolili za holotyp. Vzorek je vystaven na Geologickém ústavu Dionýza Štúra v Bratislavě.

Uvedená fosilní stopa dostala název dle úhořovitých ryb náležejících do skupiny *Anquilliformes* (W. LUTHER—K. FIEDLER, 1962, p. 34; R. RIEDL, 1963, p. 517) — *Anquilliformisichnium andrusovi* n. ichnogen. n. sp. (Pl. XLIV, XLII obr. 2, 3 v textu). Fosilní stopa je válcovitého tvaru, rovná nebo prohnutá, většinou na spodní vrstevní ploše pískovců jako pozitivní hyporelief. Je široká 2—4 cm a přechází nad spodní vrstevní plochu až 10 mm. Jedním nebo oběma směry se může uzavírat v podobě tupé špičky. U holotypu (Tab. XLIV, obr. 2a₁, 2a₂ v textu, je stopa výrazně prohnutá a je na spodní vrstevní ploše zelenavěšedého, jemnozrnného pískovce, křemitovápenného, jemně slídnatého, deskovitého. Stopa je v místě maximálního prohnutí poněkud deformovaná. Válcovitá stopa vlastně představuje protáhlé korytko na převážně jílovitém povrchu mořského dna. Korytko vzniklo po úhořích, kteří se po něm pohybovali nebo se jej jen dotkli svým válcovitým tělem. Proto vzniká ukončení fosilní stopy v podobě špičky (viz obr. 2e, 2g₁, 2g₂, 2j, 2k, 2l). V případě holotypu se jedná patrně o otisk prohnutého těla úhoře v místě, kde zahynul.

Fosilní stopa *Anquilliformisichnium andrusovi* n. ichnogen. n. sp. byla u nás zjištěna v sedimentech vněkarpatského i vnitrokarpatského flyše. Vněkarpatský flyš: godulské vrstvy slezského příkrovu (křída), lokalita lom pod Pustevnami; magurský příkrov (západní oblast) — račanská jednotka, zlínské souvrství (eocén), lokalita Kostelany; — bělokarpatská jednotka (eocén), lokalita Javorník a Nová Lhota. Magurský příkrov (východní oblast) — račanská jednotka, belovežské vrstvy (paleocén), lokalita Valentovice. Vnitrokarpatský flyš: vnitrokarpatský paleogén (eocén), lokality Liptovský Peter a Podbánské (M. PLIČKA 1987).

V asociaci popisované fosilní stopy byly zjištěny: *Planolites* sp., *Taprhelminthopsis auricularis*, *Scolicia* sp., *Subphyllochora* sp., *Capodistria vettersi*, *Zoophycos* sp., *Godulaichnium tenue*, *Saportia* sp., *Gyrichnites* sp., *Helminthopsis granulata*, *Paleodictyon miocenicum*.

Další fosilní stopa *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp. pochází také od mořských úhořovitých ryb, ale přisedlých, žijících na mořském dně v trubicích (čeleď *Heterocongeridae*). Stopa je kruhovitěho tvaru, je na spodní nebo svrchní vrstevní ploše

pískovce a je k ní kolmá. Má celkový průměr 1,2—6 cm. Středová část stopy je tmavá, na jejím obvodu je znatelný lem (fosilní zbytek trubičky — „Body Fossil“). Okolo středové tmavé části s lemem je val, tvořící asi jednu třetinu průměru stopy (viz obr. 4 v textu). V ojedinělých případech mohou být uvnitř valu i tři kruhovitě tvary s lemem — viz. Obr. 4ch v textu. Lem okolo tmavé středové části je široký 0,5—2 mm, dle velikosti stopy. Jak je patrné na obr. 4 v textu, má vnější část stopy (val) proměnlivý rozměr vzhledem ke středové části. Vnější val zřejmě vzniká v místě, kde při povrchu mořského dna dochází k bočnímu tlaku všemi směry vlivem vysouvání a zasouvání se úhoře do trubičky a kromě toho zde může působit i pohyb mořské vody, který způsobuje v blízkosti vysunuté ryby vymílání povrchu sedimentu na mořském dně (vysunutá ryba je překážkou proudící vodě).

Fosilní stopa *Heterocongeridopsisichnium casteri* n. ichnogen n. sp. (Tab. XLVI/2, XLVII, obr. 4 v textu) byla u nás zjištěná v ístebnanských vrstvách slezského příkrovu (svrchní křída) na lokalitě Horní Bečva (lom u kostela). Dále byla zjištěná v solánských vrstvách (paleocén) v lomu na Hostýně a zlínských vrstvách (eocén) v lomu u silnice jv. od Oznice u Valašského Meziříčí (magurský příkrov).

V asociaci s nově popsanou fosilní stopou byly zjištěny tyto stopy: *Planolites* sp., *Belonidopsisichnium carpaticum*, *Scolicia prisca*, *Zoophycos* sp. a rostlinné zbytky se zřetelnou strukturou stavby.

Vzhledem k tomu, obě dvě popisované nové fosilní stopy pocházejí pravděpodobně od úhořovitých ryb, je možné uvažovat spíše o prostředí mělkovodnějším, vzhledem k současným znalostem o způsobu života recentních ryb ze skupiny *Anquilliformes*.

Při úvaze o původcích fosilních stop je běžně jejich vznik přisuzován například činnosti mořských červů, měkkýšů a podobně. Činnost mořských ryb je v tomto směru opomíjena, přestože ryby patří bezesporu k velmi významným zástupcům mořské fauny. Prozatím byla identifikovaná fosilní stopa *Belonidopsisichnium carpaticum* PLÍČKA, 1982, zjištěná v eocéních a paleocéních pískovcích magurského flyše v Československu (M. PLÍČKA, 1982). Rovněž fosilní stopa *Saerichnites beskidensis* PLÍČKA, 1974 vznikla zřejmě činností mořských ryb (M. PLÍČKA, 1974). Rovněž některé vpichy do povrchu mořského dna mohou způsobit mořské ryby, pohybující se v jeho těsné blízkosti a mající výrůstky na spodní straně hlavy, umožňující jejich pohyb těsně při povrchu mořského dna. Sem patří například ryby z čeledi *Bunocephalidae* nebo například ryba *Trigla hirundo* a podobně. Rozšíření těchto poznatků a hlavně dobrá znalost způsobu života veškeré mořské fauny přispěje značnou měrou k přesnějšímu poznání sedimentačního prostředí.

Vysvětlivky k obrázkům v textu

Obr. 1 Schematická mapa lokalit s výskyty nových fosilních stop (● — *Anquilliformisichnium andrusovi* n. ichnogen. n. sp., ■ — *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp.). Lokality: 1 — Javorník; 2 — Nová Lhota; 3 — Kostelany; 4 — Chvalčov; 5 — Hostýn; 6 — Oznice; 7 — Pustevny; 8 — Horní Bečva; 9 — Liptovský Peter; 10 — Podbánské; 11 — Valentovice.

Obr. 2 *Anquilliformisichnium andrusovi* n. ichnogen. n. sp., schematické nákresy výskytů na jednotlivých lokalitách: a₁, a₂ — Valentovice (belovežské vrstvy, paleocén), holotyp, × 0,35; b — lom pod Pustevnami (godulské vrstvy, křída), × 0,4; c — dtto, × 0,4; d — dtto, × 0,6; e — dtto, × 0,6; f — dtto, svrchní vrstevní plocha pískovce (negativní epirelief), × 0,5; g₁—g₃ — Javorník (eocén, bělokarpatká jednotka), × 0,2; h — Chvalčov (solánské vrstvy, paleocén), × 0,5; ch — lom pod Pustevnami (godulské vrstvy, křída), × 0,25; i — Kostelany (zlínské vrstvy, eocén), × 0,5; j — Nová Lhota (eocén, bělokarpatká jednotka), × 0,3; k — Liptovský Peter (eocén, vnitrokarpatký paleogén), × 0,3; l — Podbánské (dtto), × 0,5. Všechny výskyty představují pozitivní hyporelief s výjimkou výskytu v lomu pod Pustevnami (f), kdy organizmus se pohyboval na povrchu písčitého mořského dna.

Obr. 3 Příčné řezy fosilní stopou *Anquilliformisichnium andrusovi* n. ichnogen. n. sp. v původním jílovitém povrchu mořského dna s výjimkou písmene „f“, kdy dno bylo písčité. Stopa v jílovitém mořském dně byla původně hlubší (zmenšování objemu sedimentu). Lokality: Valentovice (a); lom pod Pustevnami (b—f, ch); Javorník (g₁—g₃); Chvalčov (h); Kostelany (l); Nová Lhota (j); Liptovský Peter (k); Podbánské (l). Povrch mořského dna je jílovitý (1), písčitý (2). $\times 0,75$.

Obr. 4 Schematické nákresy jednotlivých fosilních stop *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp. na lokalitách: Oznice, lom u silnice jv. od obce (a—k); Oznice, lom v lese jv. od obce (l, m); Hostýn, lom u silnice na Hostýnu (n, o). Skoro všechny nákresy jsou zmenšené: a, b — $\times 0,4$; c — $\times 0,5$; j — $\times 0,4$; k, l — $\times 0,5$; m, n — $\times 1$; o — $\times 0,6$. Vnější obvod stopy je val, vzniklý pravděpodobně jednak pohybem vysunujícího se úhoře z trubičky (boční tlak na okolní sediment), jednak pravděpodobně erozí proudící vody v místě překážky. Lem okolo tmavé středové části je zřejmě zbytek trubičky úhoře.

Obr. 5 Schéma plošného rozmístění fosilních stop *Heterocongeridopsisichnium casteri* n. sp. n., patrně na spodní vrstevní ploše pískovce zlínských vrstev v lomu u silnice jv. od Oznice. Úhoři v tomto případě žili na jílovitém mořském dně a byli náhle zasedimentováni písčitém materiálem.

Obr. 6 Schéma plošného rozmístění fosilních stop menších jedinců *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp. na vrstevní ploše (vrstevní spáře?) bloku pískovce ístebnanských vrstev (křída, slazský příkrov) v lomu u kostela na Horní Bečvě.

Obr. 7 Situace plošného rozmístění recentních mořských úhořů *Xarifania hassi* na písčitém dně Rudého moře v hloubce 8 metrů. Rekonstrukce dle fotografie na str. 127 v práci K. DECKERTA (1967). Úhoři dosahují délky přes 40 cm, jejich šíře je 1,5—2 cm. Plošné rozmístění recentních úhořů je obdobné jako u fosilních nálezů. V současné době žijí úhoři z čeledi *Heterocongeridae* také jak na písčitém, tak na jílovitém mořském dně (K. DECKERT, 1967).

Obr. 8 Schematický nákres a rekonstrukce přisedlého mořského úhoře z čeledi *Heterocongeridae* na jílovitém povrchu mořského dna. Písmenem x je označena trubička, kterou si ryba vytvořila.

Vysvětlivky k tabulkám XLIV—XLVII

(Foto K. Horák, tab. XLIV, M. Plička, tab. XLV, V. Mlýnek, tab. XLVI/2, XLVII)

Tab. XLIV

Anquilliformisichnium andrusovi n. ichnogen. n. sp. na spodní vrstevní ploše pískovce belovežských vrstev račanské jednotky magurského flyše (paleocén). Valentovice, východní Slovensko. $\times 0,4$.

Tab. XLV

- 1 *Anquilliformisichnium andrusovi* n. ichnogen. n. sp. na spodní vrstevní ploše pískovce jednotky bělokarpatké magurského flyše, sv. od obce Javorník. $\times 0,25$.
- 2 *Anquilliformisichnium andrusovi* n. ichnogen. n. sp. na spodní vrstevní ploše pískovce godulských vrstev slezského příkrovu, lom pod Pustevnami. $\times 0,8$.

Tab. XLVI

- 1 *Xarifania hassi*, mořská úhořovitá ryba žijící přisedle v trubicích na písčitém dně Rudého moře. Na obrázku byly zastíženy ryby v hloubce 8 metrů. Jejich tělo vyčnívá až 40 cm nad povrch mořského dna (K. DECKERT, 1967, p. 127).
- 2 *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp. na spodní vrstevní ploše pískovce zlínských vrstev v lomu jv. od Oznice (eocén). Račanská jednotka magurského flyše, těsně podloží belovežských vrstev. Na spodní vrstevní ploše jsou také stopy *Planolites* sp.

Tab. XLVII

- 1 *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp., lom jv. od Oznice, spodní vrstevní plocha pískovce zlínských vrstev (eocén).

- 2 *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp. a četné fosilní stopy *Planolites* sp. na spodní vrstevní ploše pískovce. Táž lokalita.

Explanations to Plates XLIV—XLVIII

(Photo K. Horák, Pl. XLIV, M. Plička Pl. XLV, V. Mlýnek, Pl. XLVI/2, XLVII)

Pl. XLIV

Anquilliformisichnium andrusovi n. ichnogen n. sp. on the lower bedding plane of sandstone of the Bela veža beds of the Rača unit of the Magura flysch (Paleocene). Valentovice, eastern Slovakia. $\times 0.4$.

Pl. XLV

- 1 *Anquilliformisichnium andrusovi* n. ichnogen. n. sp. on the lower bedding plane of sandstone. Bílé Karpaty unit, Magura flysch, NE of the village Javorník. $\times 0.25$.
- 2 *Anquilliformisichnium andrusovi* n. ichnogen. n. sp. on the lower bedding plane of sandstone. Godula beds, Silesian nappe, quarry pod Pustevnami. $\times 0.8$.

Pl. XLVI

- 1 *Xarifania hassi*, sessile sea eel fish living in tubes on the sandy floor of the Red Sea. The plate shows the fish at a depth of 8 m. Their bodies rise up to 40 cm over the seafloor surface (K. DECKERT 1967, p. 127).
- 2 *Heterocongeridopsisichnium casteri* n. ichnogen n. sp. on the lower bedding plane of sandstone of the Zlín beds in a quarry SE of Oznice (Eocene). Rača unit, Magura flysch, immediate underlier of the Bela veža beds. On the lower bedding plane are also the traces *Planolites* sp.

Pl. XLVII

- 1 *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp., quarry SE of Oznice, lower bedding plane of sandstone of the Zlín beds (Eocene).
- 2 *Heterocongeridopsisichnium casteri* n. ichnogen. n. sp. and numerous trace fossils *Planolites* sp. on the lower bedding plane of sandstone. The same locality.



MIROSLAV PLIČKA—VLADIMÍR THOMKA

Halimedaites carpaticus gen. n. sp. n., “Body Fossil” from the Carpathian Flysch of Czechoslovakia

5 text-figs., 2 Pls (XLVIII—XLIX), Czech summary

Abstract: In the paper we introduce a new problematic fossil from the Outer Carpathian flysch in eastern Slovakia. It has been found in light gray, calcareous claystones near Nová Sedlica (Lupkov beds, Cenomanian-Senonian, Dukla unit). The problematic fossil is of an oblong shape with a marked lobed division, very similar to the body of the sea alga *Halimeda tuna* (*Chlorophyta*). That is why it has been denominated *Halimedaites carpaticus* gen. n. sp. n.

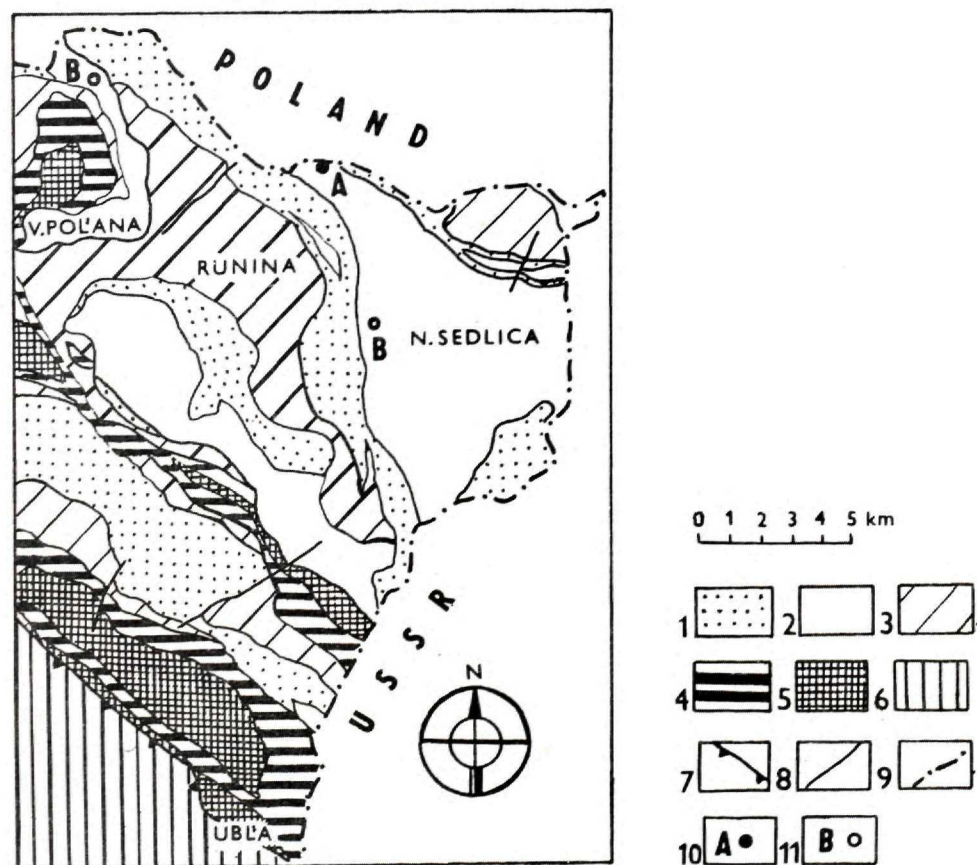
Introduction

In order to know the geology of the Protected Landscape Area (PLA) East Carpathians and Vihorlat Mts. in the region Krajná Poľana—Nižná Jablonka—Remetské Hámre—Nová Sedlica, the Centre of State Protection of Nature — Management of the PLA East Carpathians and Vihorlat at Humenné carries out field researches of this area (Eng. V. THOMKA). These field works include also the collecting of type rocks occurring on the territory concerned. Moreover, mechanoglyphs, bioglyphs and/or macrofossils are paid attention, too. The geological study of T. KORÁB—T. ĎURKOVIČ (1978) that had recently re-investigated the geology of the Dukla unit, served us as a basis for these works.

In the course of the researches, dark organic remains have been discovered in light gray, calcareous claystones of the Lupkov beds at the locality Riaba skala (Nová Sedlice). At first these remains resembled fossil remains of sea worms e.g. *Maldanidopsis maeandriiformis* PLIČKA 1979 (M. PLIČKA 1979). Detailed study of the collected samples and their comparison to the recent sea flora, however, revealed that they are fossil remains of sea algal bodies — green algae (*Chlorophyta*) of the order *Siphonales*, family *Codiaceae*. The fossil remain most resembles the recent sea green alga *Halimeda tuna* (ELLIS et SOL) LAM. (R. RIEDL 1963). W. HÄNTZSCHEL (1975) refers to these exactly undeterminate organic remains as “Body Fossil” and we also accept this denomination.



Fig. 1 Schematic map of localities with fossil ?*Halimeda* sp. occurrences (empty circles) and fossil remains of the sea green alga *Halimedaites carpaticus* gen. n. sp. n. (full circle.).



Systematic description

Genus: *Halimeda* gen. n.

Type species: *Halimeda carpaticus* sp. n. (Fig. 3, Pl. XLVIII).

Derivation of name: Because its shape and dimensions are similar to the recent sea green alga *Halimeda tuna* (ELLIS et SOL) LAM. (*Chlorophyta*, *Siphonales*, *Codiaceae*), (R. RIEDL 1963).

Diagnosis: Oblong, dark-coloured, lobed, widening forms up to 3.7 cm long and up to 3 mm wide. In places there is an indistinct lighter-coloured boundary between individual lobes.

Halimeda carpaticus sp. n.

Pl. XLVIII, Fig. 3

Holotype: Sample is kept in the collections of the Moravian Museum in Brno under the inventory No. Ge 23742 (Pl. XLVIII, Fig. 3).

Type locality: rock Riaba skala, landslide on a slope, 60 m from the state boundary, 1250 m WNW of the hill Čolo, elevation point 1159.

Type level: Lupkov beds, Cenomanian-Senonian, Dukla unit, Outer Carpathian flysch.

Denomination: According to the place of its occurrence, Carpathians.

Material: 5 calcareous claystone fragments. Holotype (sample 23742) has dimensions $7 \times 6.5 \times 0.8$ cm.

Diagnosis: Oblong, dark-coloured, lobed forms, up to 3.7 cm long and up to 3 mm wide, in places with an indistinct boundary between individual lobes. The dimensions of individual lobed, protruding segments are sometimes different. Their size abruptly diminishes in one direction.

Description: On the upper bedding plane of light-coloured, calcareous, strongly fine-sandy claystone there are dark, oblong, lobed protruding forms, with distinct contours in the surrounding rock, up to 3.7 cm long and up to 3 mm wide. In places there is an indistinct boundary between individual lobed protruding parts. The size of the individual lobed protruding segments is sometimes different. Their dimension abruptly diminishes in one direction. In the close vicinity of the holotype sample of the new problematic fossil there are dark (?) chondrites. They are branched, 0.3–0.7 mm wide.



Fig. 2 Geological map of the area with occurrences of the new problematic fossil *Halimeda carpaticus* gen. n. sp. n. and a fossil sea green alga. Section of geological map. T. KORÁB—T. ĐURKOVIČ (1978). 1—5 Dukla unit: 1 — Lupkov beds, 2 — Cisniansky beds, 3 — Submenilite and variegated beds, 4 — Menilite beds, 5 — Cergow beds. 6 — Magura nappe, 7 — Magura overthrust, 8 — fault, 9 — state boundary, 10 — location of *Halimeda carpaticus* gen. n. sp. n. occurrence, 11 — location of fossil ?*Halimeda* sp. occurrence.

Remarks: In its overall shape and dimensions the new problematic fossil resembles fossil remains of a sea green alga very close to the recent sea green alga *Halimeda tuna* (ELLIS et SOL) LAM. Dark, fine, branched "chondrites" in the close vicinity of the studied fossil remain have, on detailed observation, darker and lighter division in their course. In places there is an indistinct regular widening and narrowing of the chondrites. A question arises whether these finely branched forms are trace fossils, as it is generally accepted at present (W. HÄNTZSCHEL 1975), or fossil plant remains. In this case there is a conspicuous shape similarity to the bodies of the sea red alga *Cerarium rubrum* (HUDS.), (*Rhodophyta*, *Ceramiales*), (R. RIEDL 1963).

The new problematic fossil is partly similar to *Halimedes fuggeri* (W. HÄNTZSCHEL 1975, Fig. 42, p. W 68) which is of a different shape and much larger size. Unlike the fossil remain *Halimedaites carpaticus* gen. n. sp. n., the shape of which is very similar to the recent sea green alga *Halimeda tuna* (ELLIS et SOL) LAM., the problematic fossil *Halimedes fuggeri* has cudgel-shaped protuberances arranged in pairs oblique to the long axis. W. HÄNTZSCHEL (1975, p. W 65, 68, 69) places it among trace fossils.

The supposition that *Halimedaites carpaticus* gen. n. sp. n. is fossil remains of a sea green alga similar to the recent sea alga *Halimeda tuna* (ELLIS et SOL) LAM. may be supported by further findings of fossils on the bedding planes of sandstones of the Lupkov beds at the localities Ruské (left streambank, 600 m E of the upper end of the village), Zboj (3 km NNW of the village), valley of the brook Dlhé (Lacková Žalobina) and Palota (1.5 km E of the village) (see Pl. XLIX). It is probably also a fossil sea green alga, the systematic assignation of which is currently under study (Fig. 4, 5).

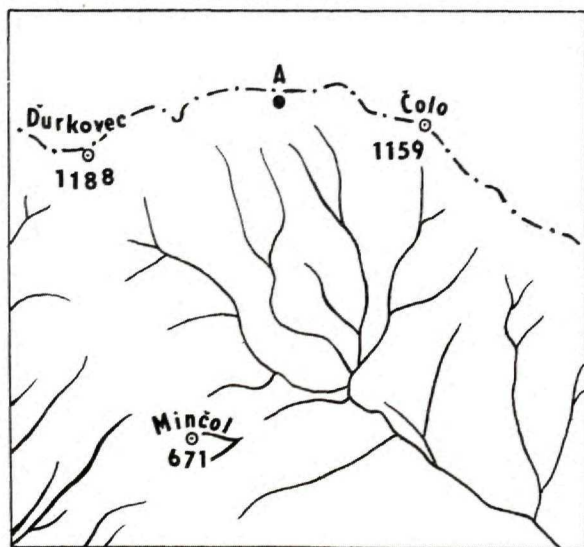


Fig. 3 Schematic sketch of the new problematic fossil *Halimedaites carpaticus* gen. n. sp. n. occurrence (A). Scale 1: 50 000, leg. V. THOMKA

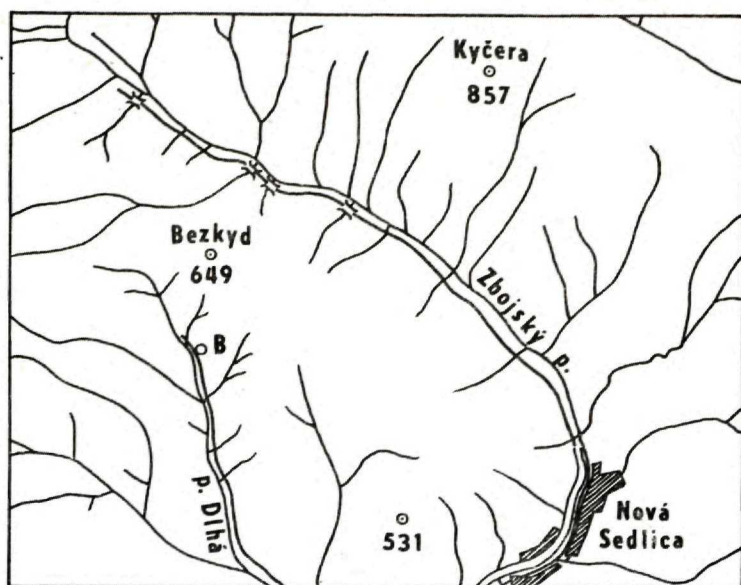


Fig. 4 Location of the fossil *?Halimeda* sp. occurrence near Nová Sedlica (leg. V. THOMKA).

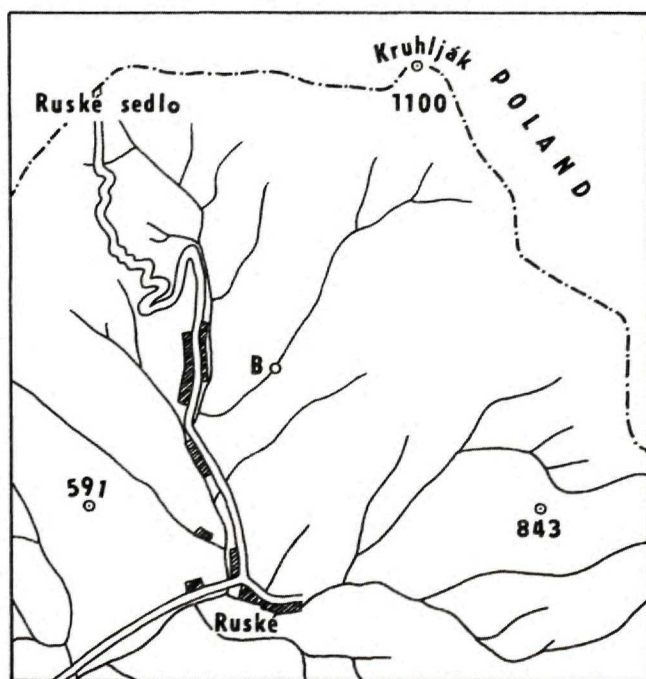


Fig. 5 Location of the fossil *?Halimeda* sp. occurrence near the village Ruské (leg. V. THOMKA).

Sediment: Light-gray, greenish, calcareous claystone, in places with thin tabular jointing.

Origin: Probably organic remains of a sea green alga of the genus *Halimeda*.

Distribution: Lupkov beds, their uppermost part in the immediate underlier of the Cisňany beds, Dukla unit, Outer Carpathian flysch.

Conclusion

The finding of fossil remains of plant origin in the Cretaceous of the Carpathian flysch in eastern Slovakia enriches our knowledge on macroflora distribution in the basin's sedimentary area. In their shape, overall appearance and characteristics the fossil remains are very similar to the body of the sea green alga *Halimeda tuna* (*Chlorophyta*). This fact is supported by further findings of well preserved fossils of plant origin which also come from the Lupkov beds of the Dukla unit in eastern Slovakia. The fossils are present in close vicinity of *Halimeda* *carpaticus* gen. n. sp. n. occurrences. They are fossil sea green algae probably of the genus *Halimeda* (Pl. XLIX). The discovery of sea green algae in eastern Slovakia belongs among the first findings of this kind in the Carpathian flysch of Czechoslovakia.

Moreover, the provability of the origin and the fact that the holotype sample of *Halimeda* *carpaticus* gen. n. sp. n. contains in close vicinity of the sea algal bodies also fine, bush-shaped forms ("chondrites") suggest also another explanation for the origin of some "chondrites" than that accepted so far (see W. HÄNTZSCHEL 1975, p. W. 49—52).

The supposition that they are channels of sea organisms may be in this case undermined by the fact that the "channels" regularly slightly widen and narrow, and are distinctly transversally segmented into darker and lighter parts. In this the structure of these fine branched forms resembles the fossil remains of sea red algae (*Rhodophyta*). By comparison there is a conspicuous resemblance to the shape of the red alga *Ceramium rubrum* (HUDS.) (R. RIEDL 1963).

The study of these small forms as *Halimeda* *carpaticus* gen. n. sp. n., that were not paid attention in the past, again emphasizes the necessity of a detailed study during geological and paleontological researches as early as in the field stage. This experience has been gained already by the trace fossil study in the Carpathian flysch sediments on our territory. This way of studies has resulted in very good results also as far as trace fossils are concerned (M. PLÍČKA 1984, M. PLÍČKA 1986).

Translated by L. Böhmer

References

- HÄNTZSCHEL, W. 1975: Trace fossils and problematica. In R. C. MOORE—C. TEICHERT (eds): Treatise on Invertebrate Paleontology, p. W, Miscellanea, 1, Boulder, Lawrence, W 1—269.
KORÁB, T.—ĐURKOVIČ, T. 1978: Geológia dukelskej jednotky (Flyš východného Slovenska). Geol. Úst. of D. Štúra, Bratislava, 1—194.

- PLIČKA, M. 1979: *Maldanidopsis maeandriiformis* (Müller) (Annelida, Sedentaria) from the Lower Carboniferous of Moravia (Czechoslovakia). Čas. slez. Muz. Opava, A, 28, Opava, 37—48.
- PLIČKA, M. 1984: *Eulalites obscurus* gen. n. sp. n., "Body Fossil" of the Eocene flysch of Slovakia. Věst. Ústř. Úst. geol., 59, 3, Praha, 183—186.
- PLIČKA, M. 1986: A new "Body Fossil" and a new trace fossil from the Outer Carpathian Flysch of Moravia (Czechoslovakia). Západné Karpaty, Ser. paleontológia 11, Geol. Úst. D. Štúra, Bratislava, 77—88.

MIROSLAV PLIČKA—VLADIMÍR THOMKA

Halimedaites carpaticus gen. n. sp. n., "Body Fossil" **z karpatského flyše v Československu** Resumé anglického textu

Za účelem poznání geologie území chráněné krajinné oblasti Východné Karpaty a Vihorlat zjistil ing. V. THOMKA (Správa CHKO Východné Karpaty a Vihorlat v Humennom) při terénních výzkumech ve světlešedých vápnitých jílovcích lupkovských vrstev (křída) na lokalitě Riaba skala (Nová Sedlice) tmavé zbytky organismů, které svou segmentací a tmavým zbarvením připomínaly zpočátku fosilní zbytky mořských červů jako je například *Maldanidopsis maeandriiformis* PLIČKA 1979 (PLIČKA 1979). Při podrobnějším prostudování nasbíraných vzorků a po srovnání s recentní mořskou florou se však ukázalo, že se jedná o fosilní zbytky stélek mořských řas a to řas zelených (*Chlorophyta*), řádu *Siphonales*, čeledi *Codiaceae*. Fosilnímu zbytku se nejvíce podobá recentní mořská zelená řasa *Halimeda tuna* (ELLIS et SOL) LAM. (R. RIEDL 1963). W. HÄNTZSCHEL (1975) uvádí tyto zbytky organismů blíže neurčitelné jako „Body Fossil“. Přidružujeme se proto také tohoto označení.

Nález pochází z úlomků hornin (cenoman-senon) v sesuvu ve svahu ve vzdálenosti 60 m od státní hranice, 1250 m zsz. od kopce Čolo, k. 1159. Místo výskytu náleží vrstvám dukelské jednotky vněkarpatského flyše.

Při podrobnějším studiu byly zjištěny na svrchní vrstevní ploše (spáře) světlého, vápnitého jílovce, silně jemně písčitého, tmavé, protáhlé, laločnaté vybihající tvary, ostře ohraničené oproti hornině, dlouhé až 3,7 cm a široké až 3 mm. Místy je slabě znatelná hranice mezi jednotlivými, laločnaté vybihajícími částmi. Rozměr jednotlivých laločnaté vybihajících dílů je místy odlišný. Jedním směrem se jejich rozměr náhle zmenšuje. U vzorku holotypu jsou v těsné blízkosti nové problematické fosilie tmavé (?) chondrity. Jsou rozvětvené, široké 0,3, 0,7 mm.

Nové problematické fosilie se poněkud podobá *Halimedes fuggeri* (W. HÄNTZSCHEL, 1975, Fig. 42, p. W 68) která je odlišného tvaru a mnohem větších rozměrů. Na rozdíl od fosilního zbytku *Halimedaites carpaticus* gen. n. sp. n., která se tvarově velmi blíží recentní mořské zelené řase *Halimeda tuna* (ELLIS et SOL.) LAM., problematická fosilie *Halimedes fuggeri* má kyjovité výběžky párovitě uspořádané šikmo k podélné ose. W. HÄNTZSCHEL (1975, p. 65, 68, 69) ji uvádí mezi fosilními stopami.

Pro to, že se jedná v případě *Halimedaites carpaticus* gen. n. sp. n. o fosilní zbytky zelené mořské řasy podobné recentní mořské řase *Halimeda tuna* (ELLIS et SOL) LAM. by mohly svědčit nálezy fosilií na vrstevní ploše pískovců lupkovských vrstev na lokalitách Ruské a Zboj (viz B na obr. 2 v textu), vyskytujících se v těsném okolí *Halimedaites carpaticus* gen. n. sp. n. Rovněž nález této fosilie v. od obce Palota je toho dokladem. Jedná se zřejmě také o fosilní zelenou mořskou řasu, jejíž podrobnější systematické zařazení se doposud zpracovává.

Kromě toho průkaznost původu a skutečnost, že u vzorku holotypu s *Halimeda* *carpaticus* gen. n. sp. n. jsou v těsné blízkosti zbytků stélek mořských řas i jemné, keříčkovité tvary („chondrity“), dává možnost vysvětlení i jiného původu některých „chondritů“ než se dosud uvažuje (viz W. HÄNTZSCHEL 1975, p. W 49—52). Proti názoru, že se jedná o chodby po mořských organizmech by mohla v tomto případě svědčit skutečnost, že „chodbičky“ se ve svém průběhu mírně rozšiřují a zužují a s tím současně je znatelná i příčná segmentace, projevující se tmavším a světlejším zbarvením. Tím se struktura těchto jemných větviček se tvarů v našem případě blíží spíše fosilním zbytkům stélek mořských řas červených (*Rhodophyta*) než chodbičkám po mořských organizmech.

Vysvětlivky k obrázkům v textu

Obr. 1 Schematická mapa lokalit s výskytem fosilní ?*Halimeda* sp. (prázdná kolečka), fosilního zbytku zelené mořské řasy *Halimeda* *carpaticus* gen. n. sp. n. (plně kolečko).

Obr. 2 Geologická mapa území s výskyty nové problematické fosilie *Halimeda* *carpaticus* gen. n. sp. n. a fosilní mořské zelené řasy. Výsek z geologické mapy T. KORÁB—T. ŽURKOVIC (1978). 1—5 dukelská jednotka: 1 — lupkovské vrstvy; 2 — cisňanské vrstvy; 3 — podmenilitové a pestré vrstvy; 4 — menilitové vrstvy; 5 — cergovské vrstvy; 6 — magurský příkrov; 7 — magurské nasunutí; 8 — zlom; 9 — státní hranice; 10 — místo výskytu *Halimeda* *carpaticus* gen. n. sp. n.; 11 — místo výskytu fosilní ?*Halimeda* sp.

Obr. 3 Schematický náčrt místa výskytu (A) nové problematické fosilie *Halimeda* *carpaticus* gen. n. sp. n. Měřítko 1 : 50 000, leg. V. Thomka.

Obr. 4 Situace místa výskytu fosilní ?*Halimeda* sp. u Nové Sedlice (leg. V. Thomka).

Obr. 5 Situace místa výskytu fosilní ?*Halimeda* sp. u obce Ruské (leg. V. Thomka).

Vysvětlivky k tabulkám XLVIII—XLIX (Foto V. Thomka)

Plate XLVIII

Halimeda *carpaticus* gen. n. sp. n. na vestevní ploše vápnatého jílovce v nejvyšší poloze lupkovských vrstev (křída) v těsném podloží cisňanských vrstev (dukelská jednotka). Lokalita Riaba skála, při státní hranici, 1250 m zsz. od kopce Čolo, sz. od obce Nová Sedlica. Vzorek je uložen ve sbírkách Moravského muzea v Brně pod inventárním číslem Ge 23742. × 3,5.

Plate XLIX

Fosilní zelená mořská řasa na svrchní vrstevní ploše pískovce lupkovských vrstev (křída), dukelská jednotka. Lokalita Ruské, zářez levého břehu potoka, 600 m v. od horního konce obce. × 4.

Explanations to Plates XLVIII—XLIX (Photo V. Thomka)

Plate XLVIII

Halimeda *carpaticus* gen. n. sp. n. on the bedding plane of calcareous claystone in the uppermost layer of the Lupkov beds (Cretaceous) in the close underlier of the Cisňany beds (Dukla unit). Locality Riaba skála, near the state border, 1250 m WNW of the hill Čolo, NW of the village Nová Sedlica. Sample is deposited in the collections of the Moravian Museum in Brno under the inventory No. Ge 23742, × 3.5

Plate XLIX

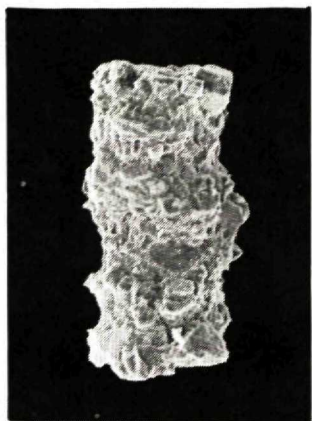
Fossil sea green alga on the upper bedding plane of sandstone of the Lupkov beds (Cretaceous), Dukla unit. Locality Ruské, left streambank, 600 m E of the upper end of the village. × 4



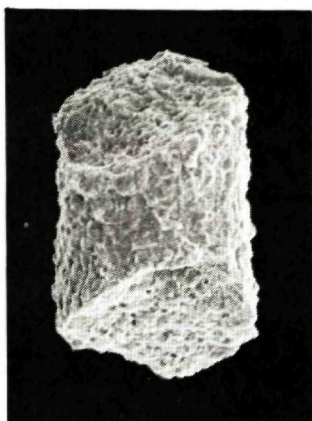


PHOTOGRAPHS
FOTOGRAFICKÁ PRÍLOHA
I—XLIX

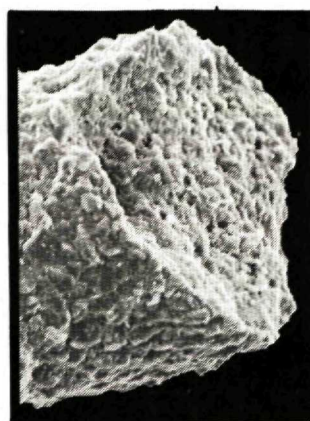




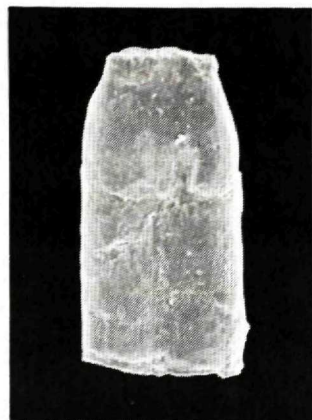
1



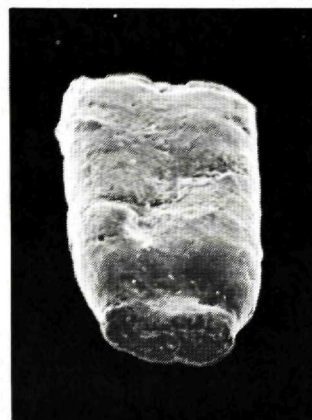
2



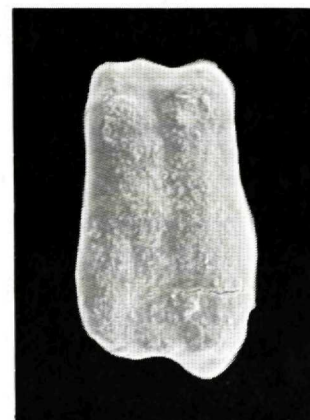
3



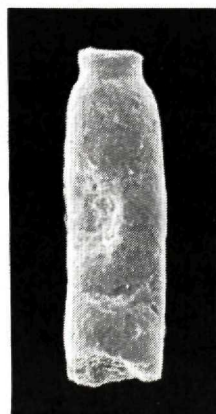
4



5



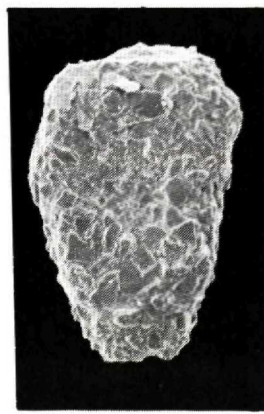
6



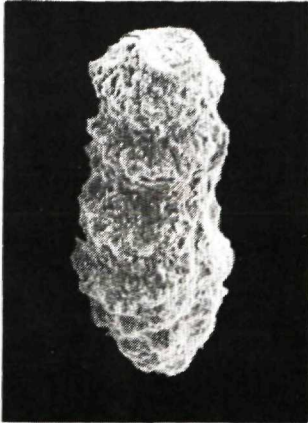
7



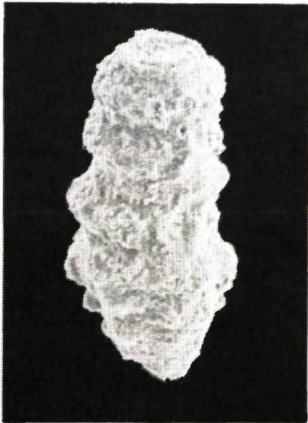
8



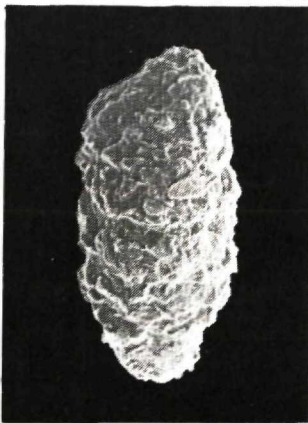
9



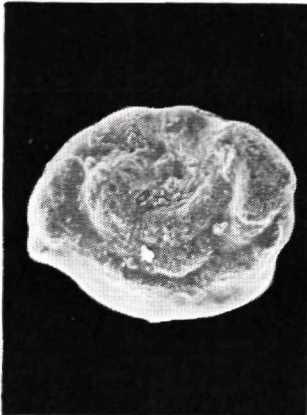
1



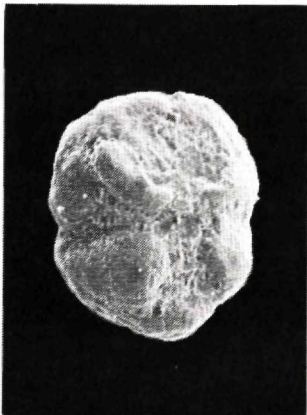
2



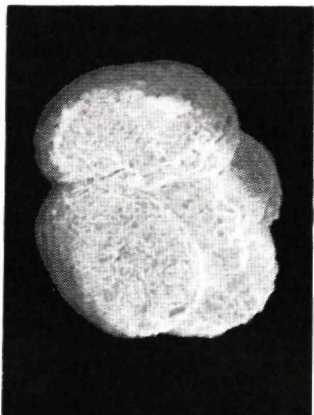
3



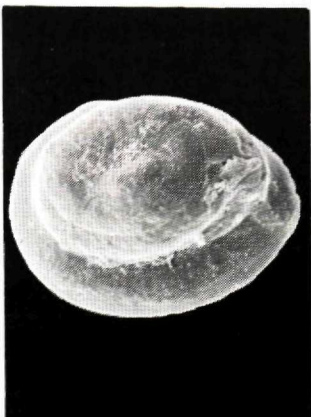
4



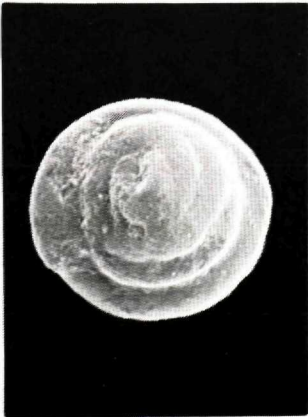
5



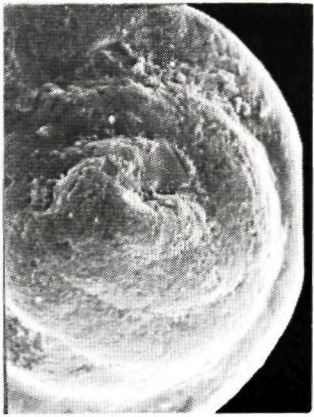
6



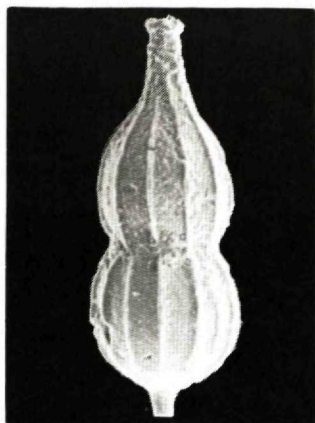
7



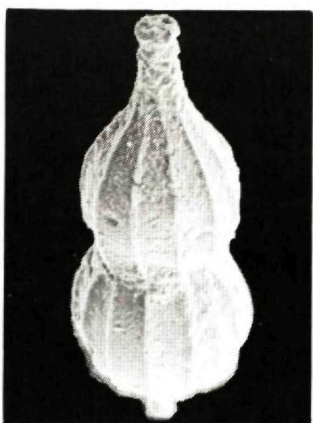
8



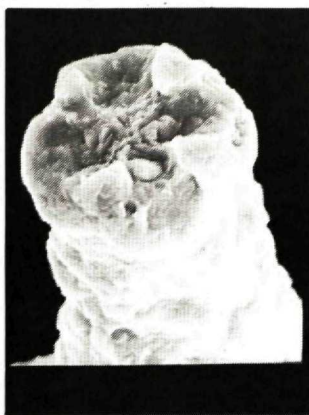
9



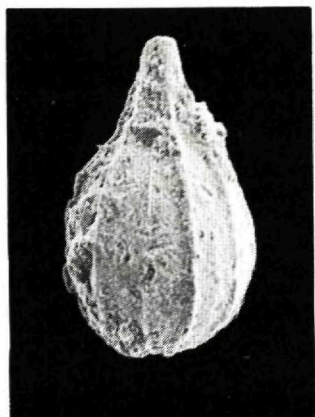
1



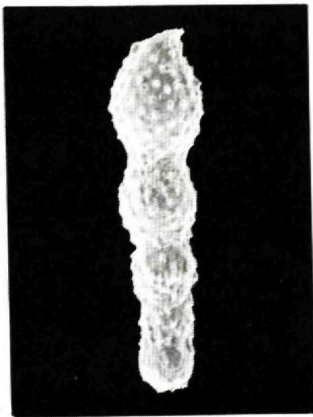
2



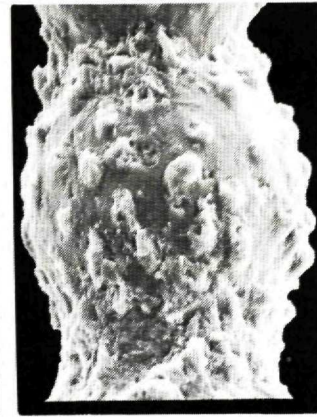
3



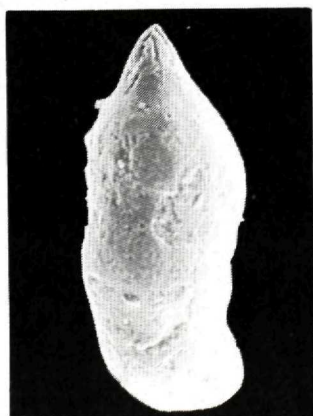
4



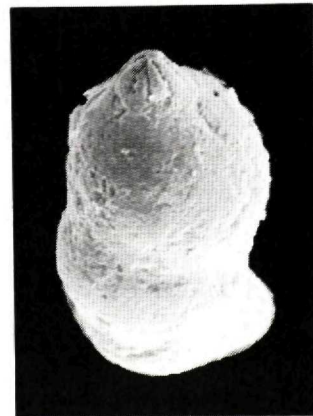
5



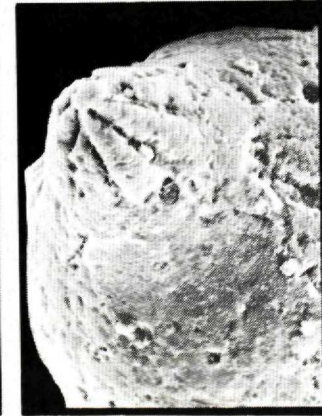
6



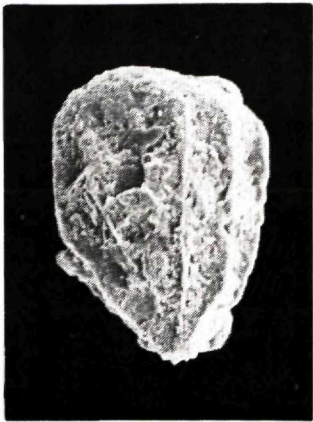
7



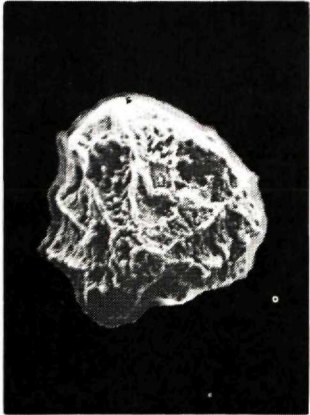
8



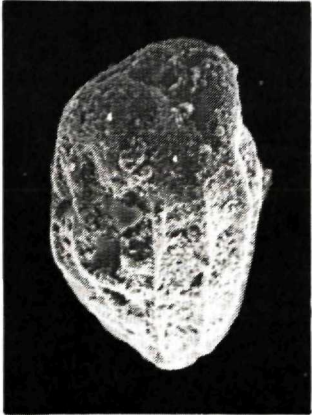
9



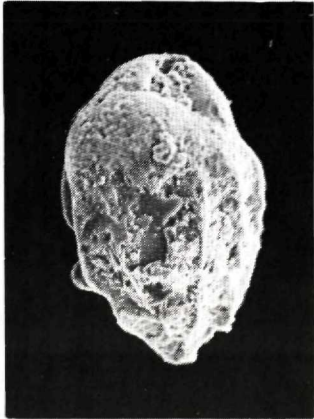
1



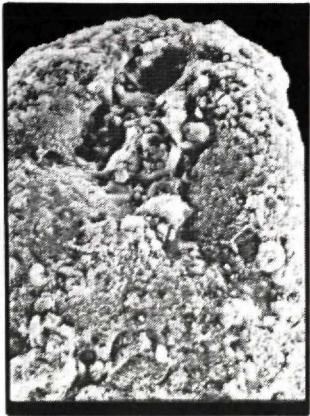
2



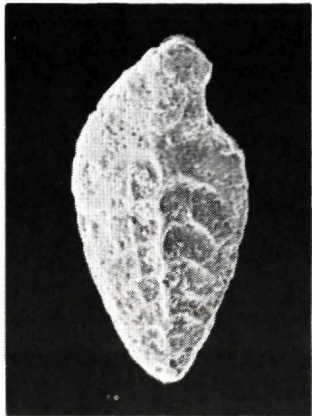
3



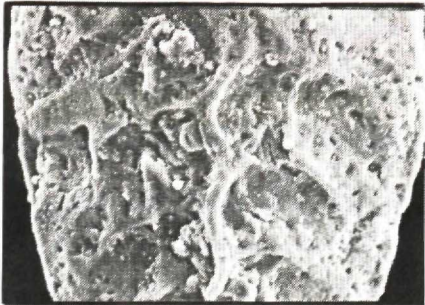
4



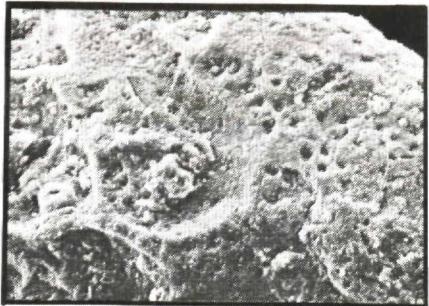
5



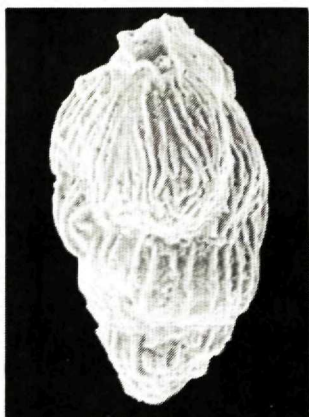
6



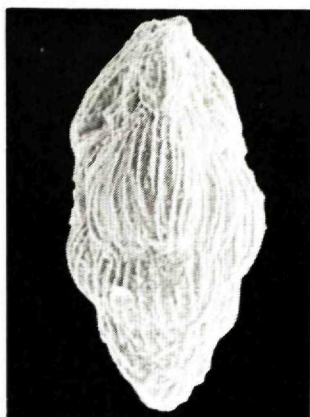
7



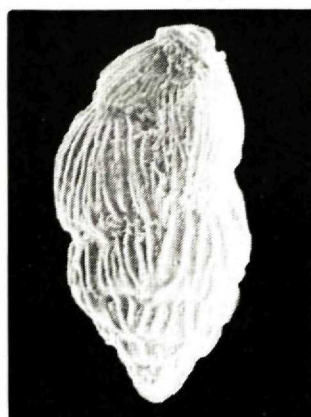
8



1



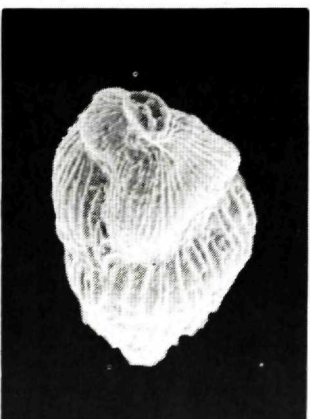
3



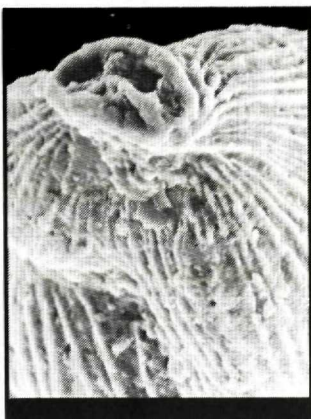
4



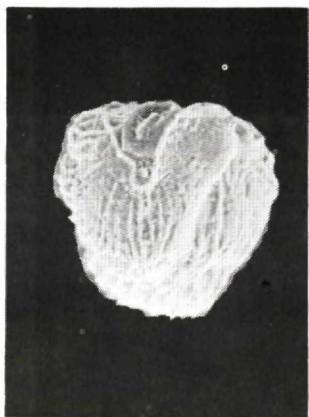
2



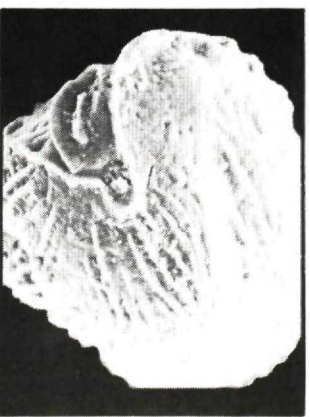
5



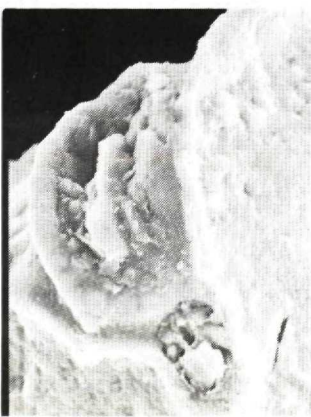
6



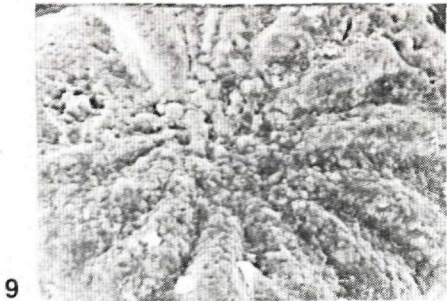
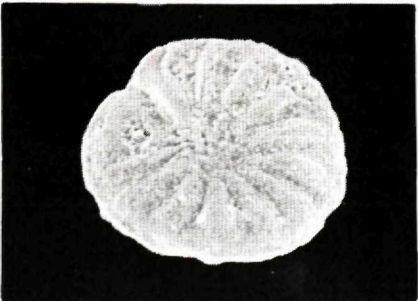
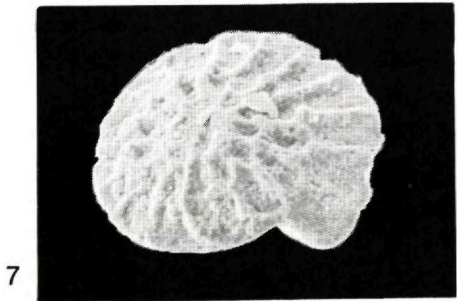
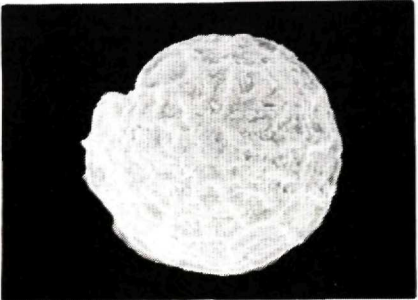
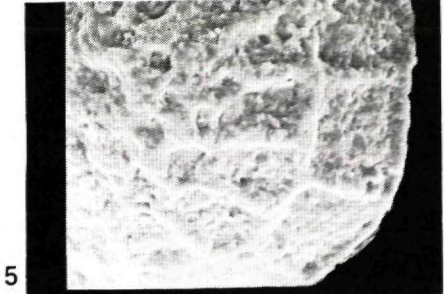
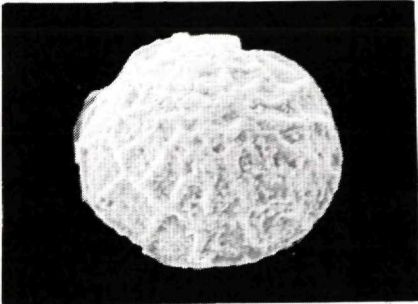
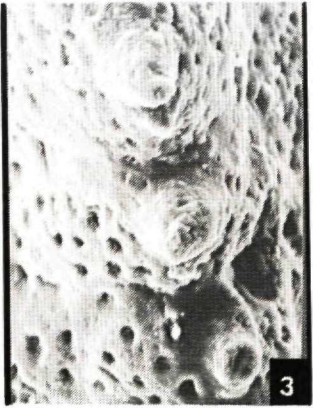
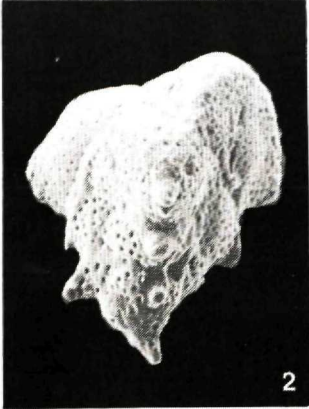
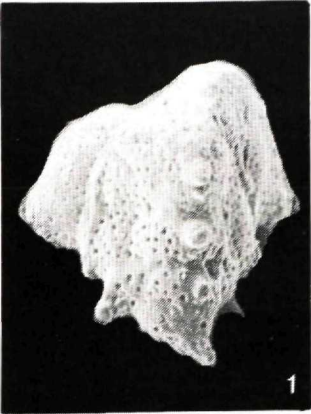
7

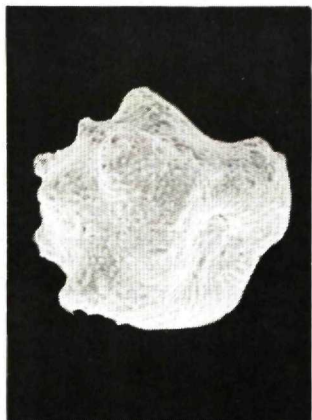


8

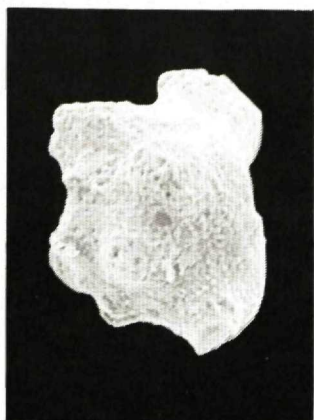


9

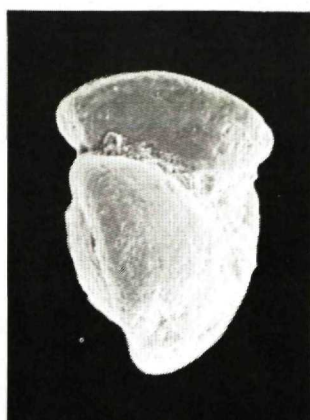




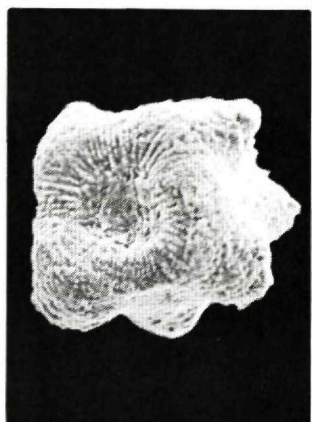
1



2



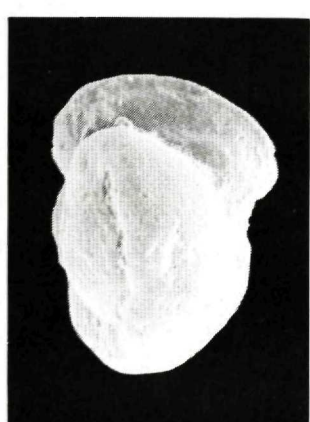
5



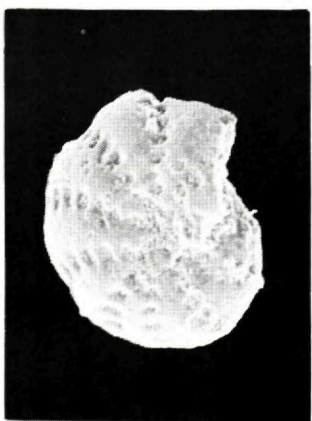
3



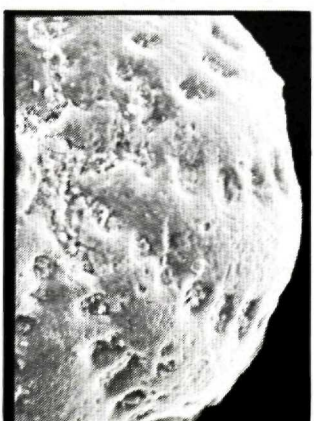
4



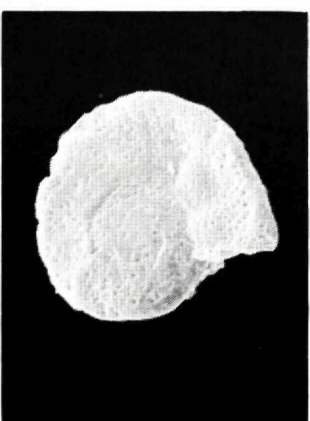
6



7



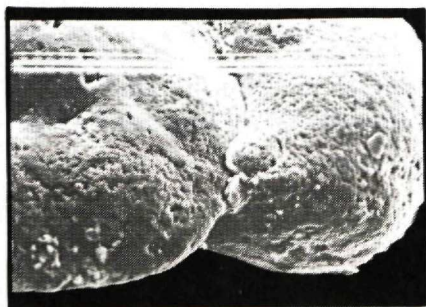
8



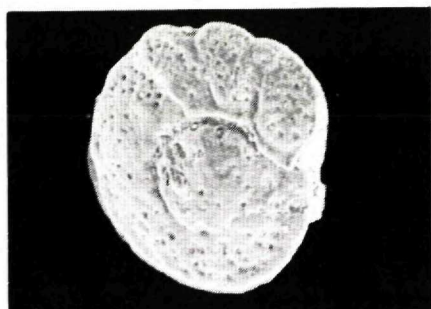
9



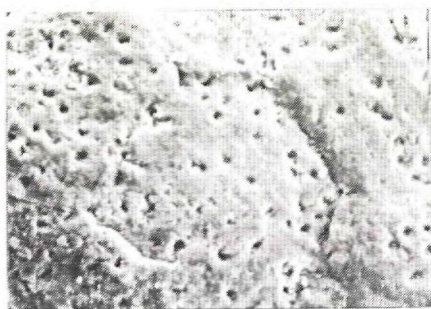
1



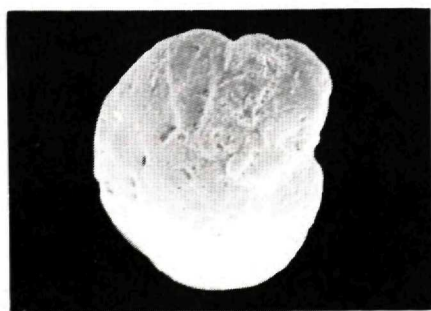
2



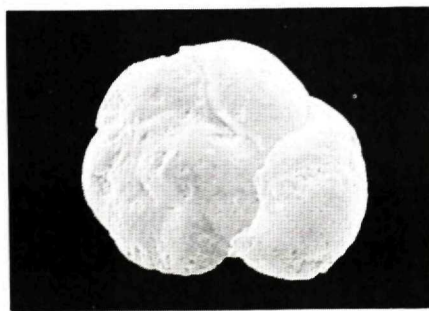
3



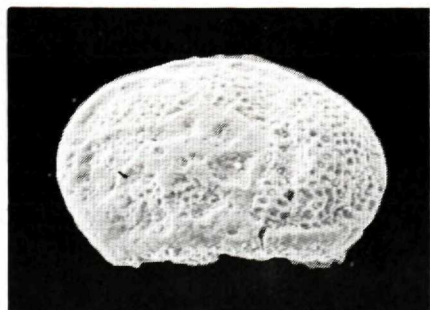
4



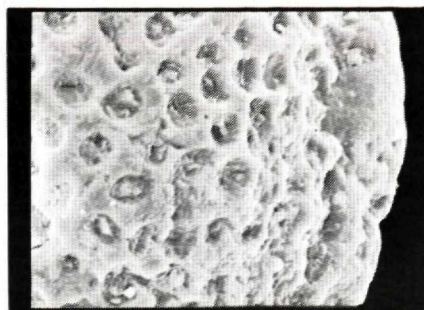
5



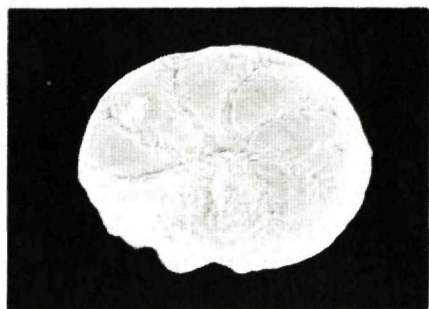
6



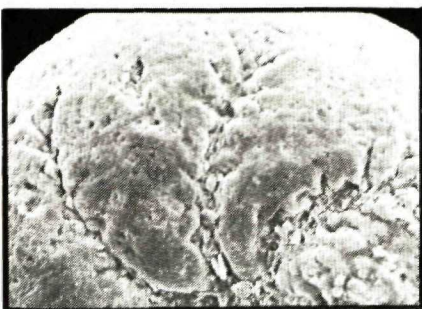
7



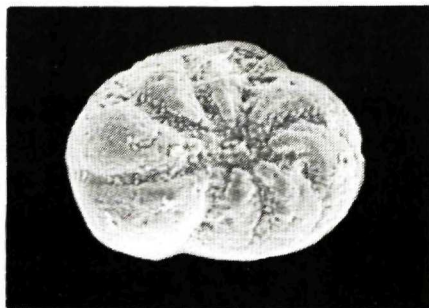
8



1



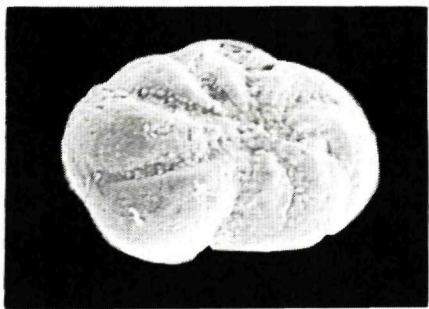
2



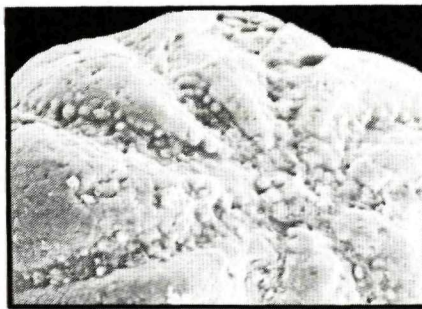
3



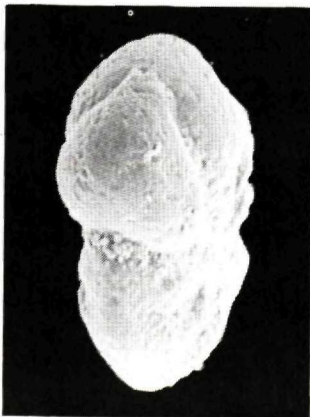
4



5



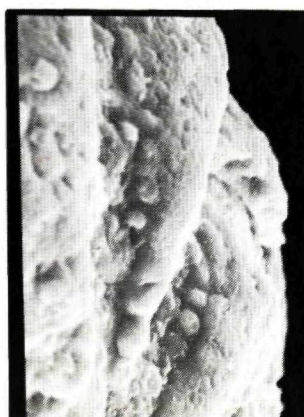
6



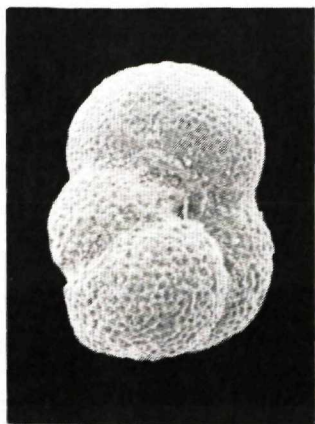
7



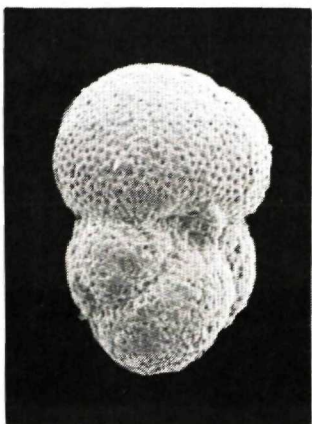
8



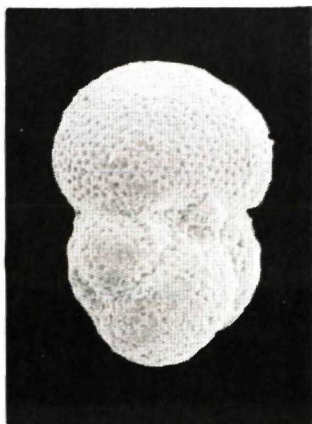
9



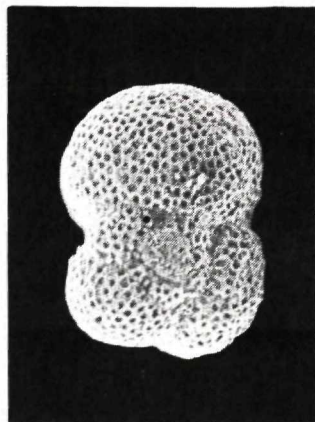
1



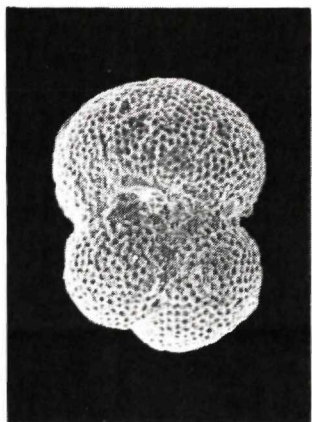
2



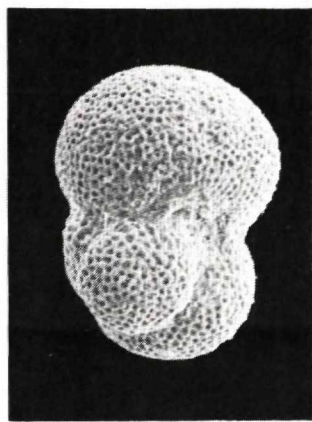
3



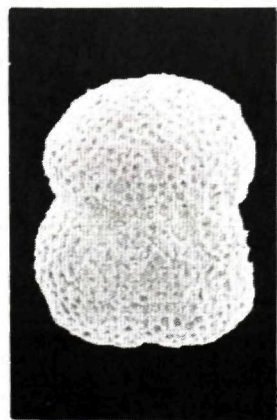
4



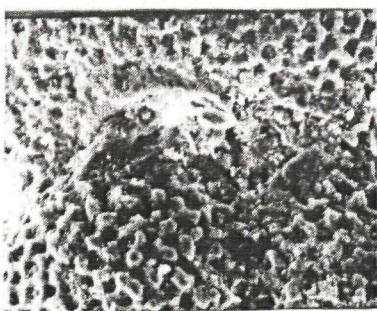
5



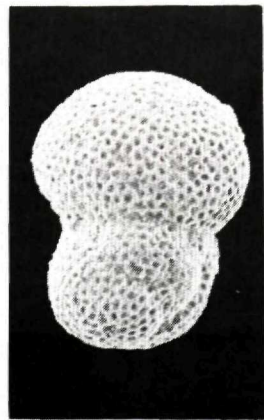
6



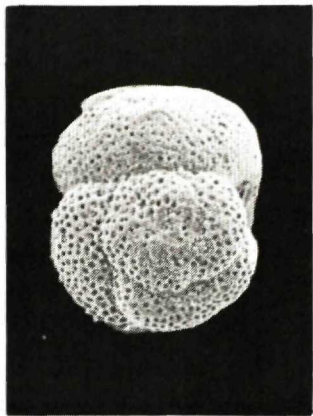
8



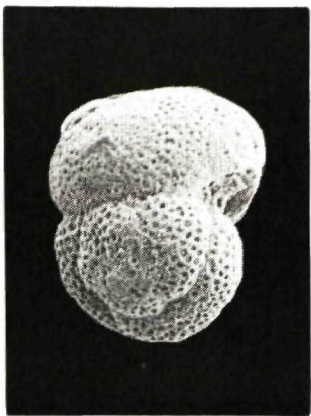
7



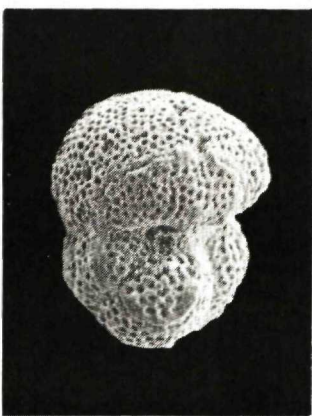
9



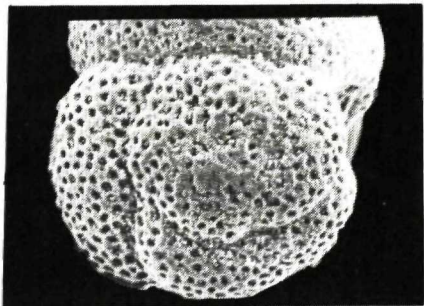
1



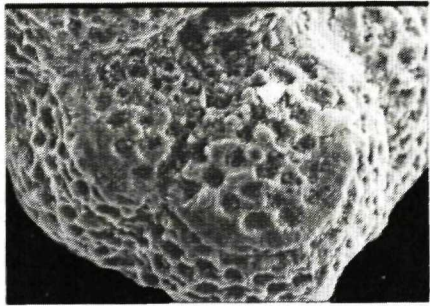
2



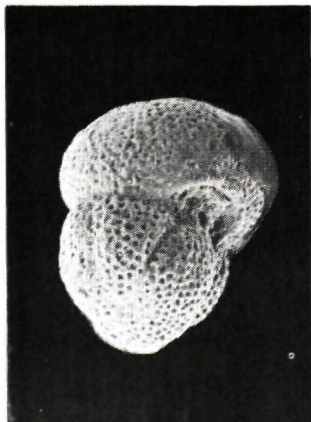
4



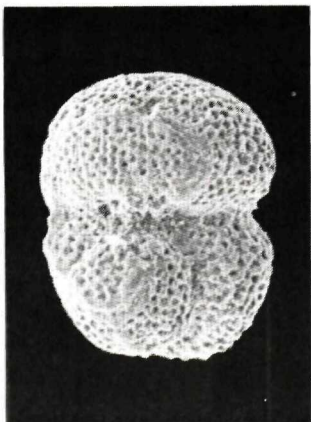
3



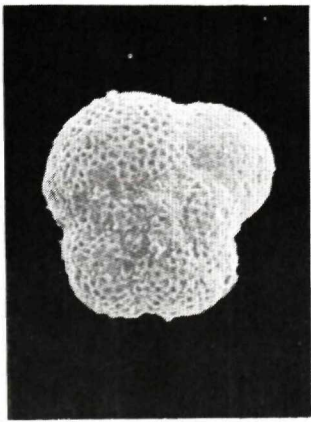
5



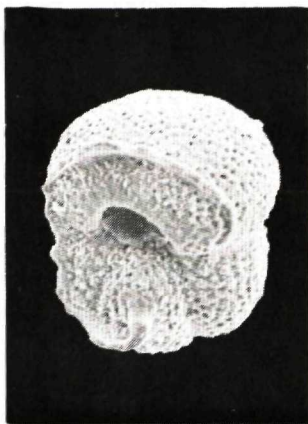
6



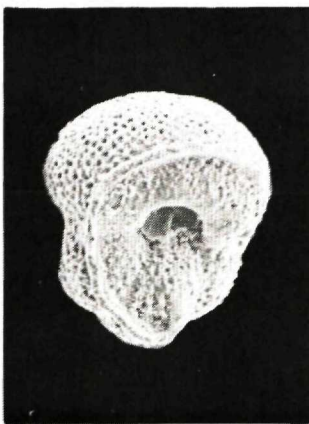
7



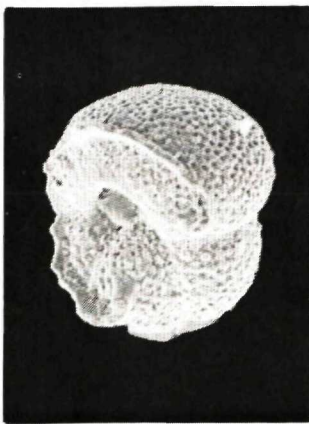
8



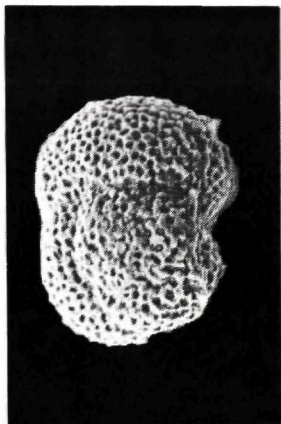
1



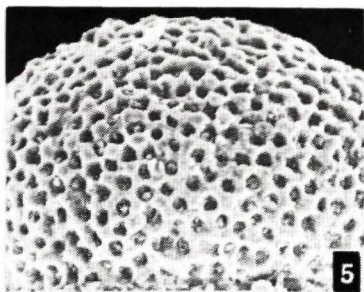
2



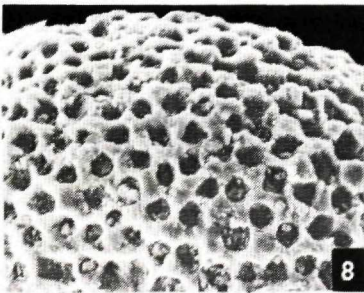
3



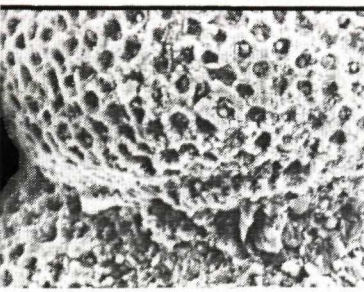
4



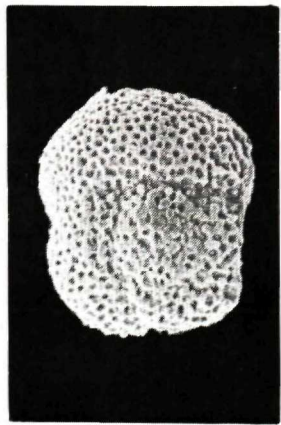
5



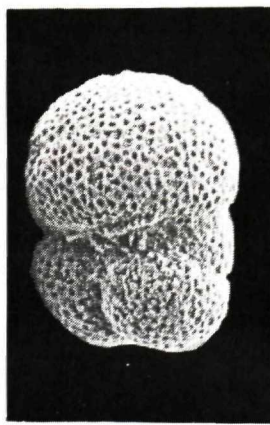
6



7



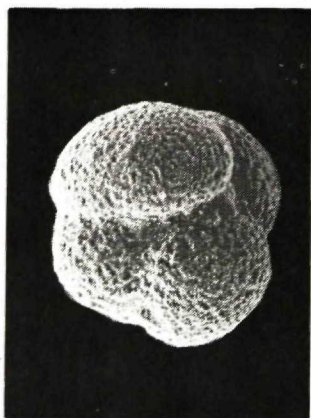
8



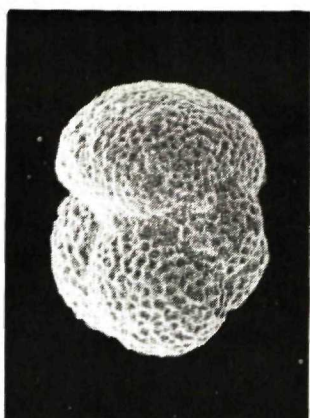
9



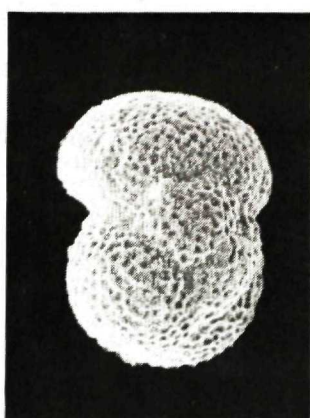
10



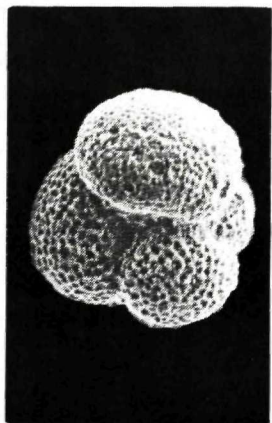
1



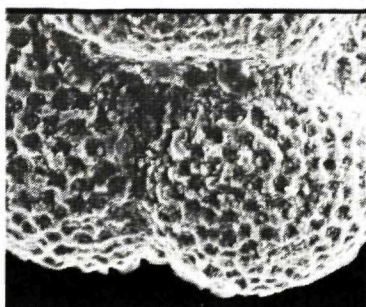
2



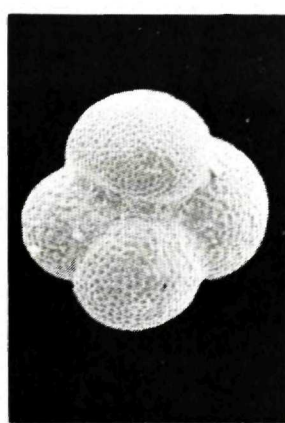
3



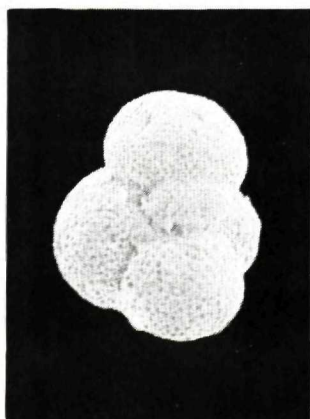
4



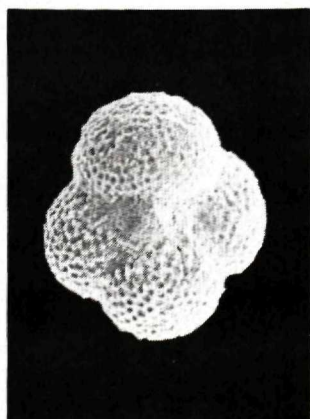
5



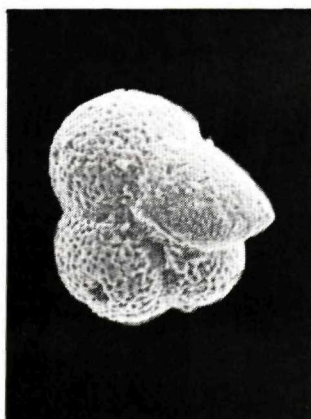
6



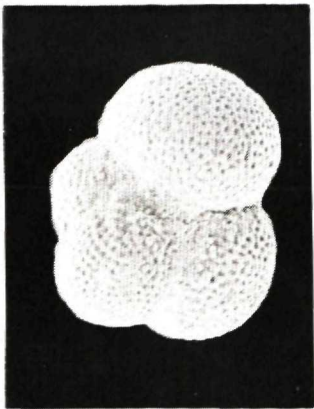
7



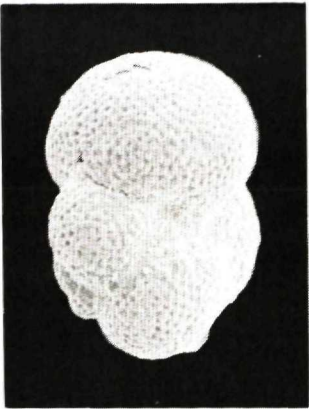
8



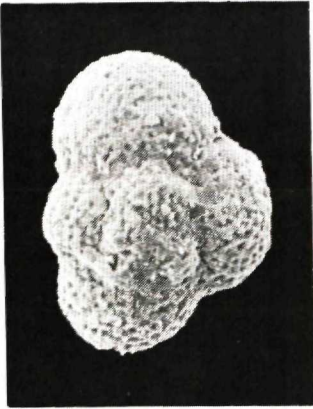
9



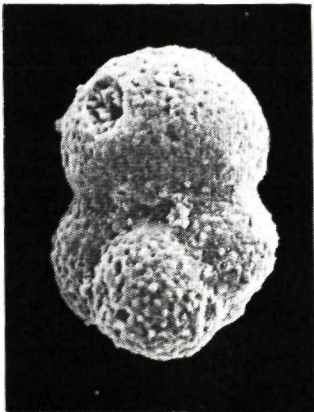
1



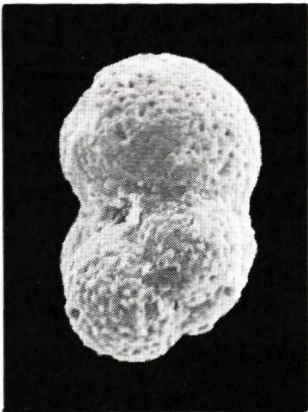
2



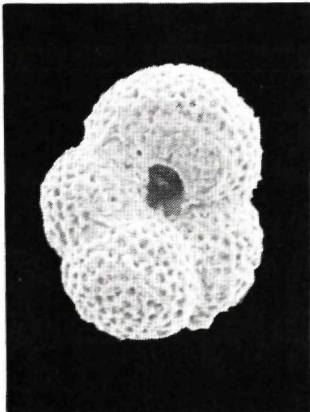
3



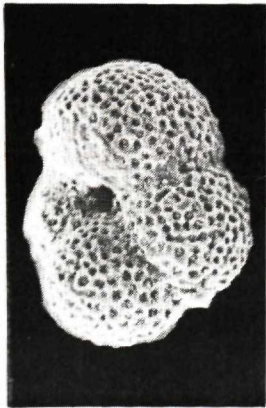
4



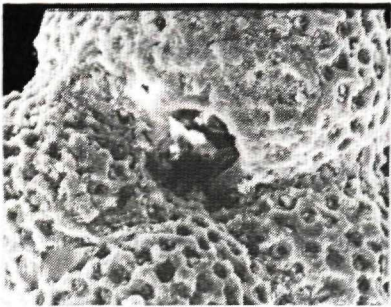
5



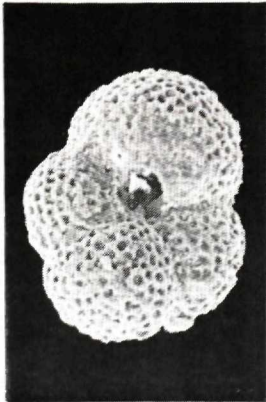
6



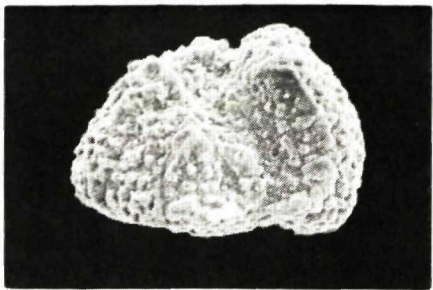
7



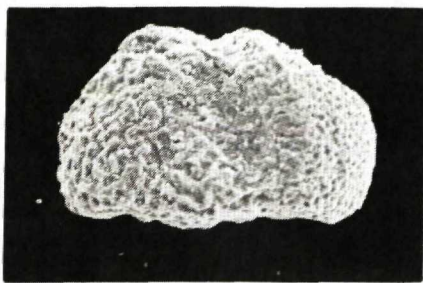
8



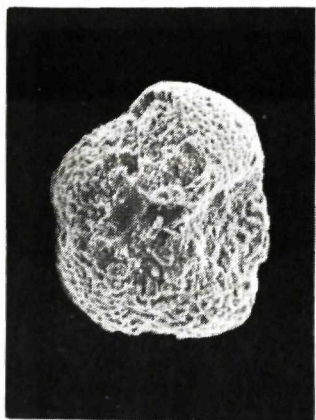
9



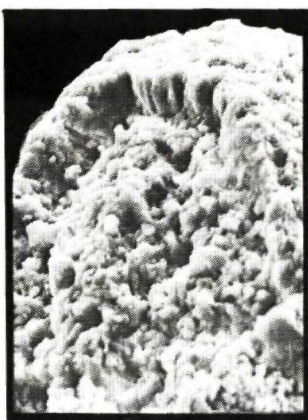
1



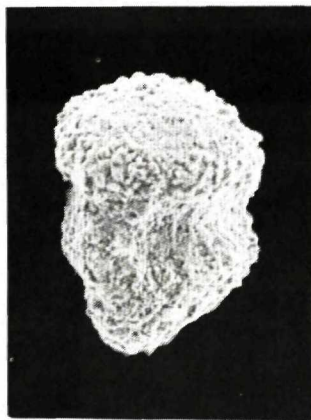
2



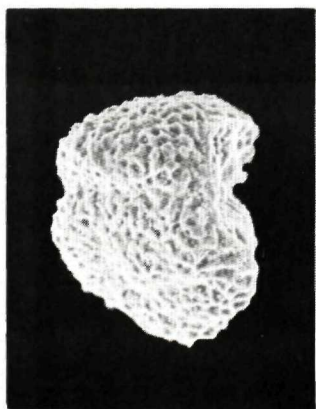
3



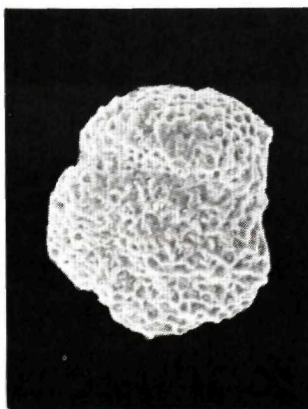
4



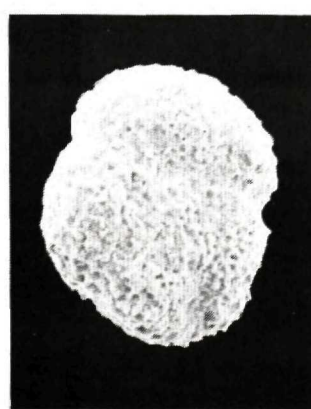
5



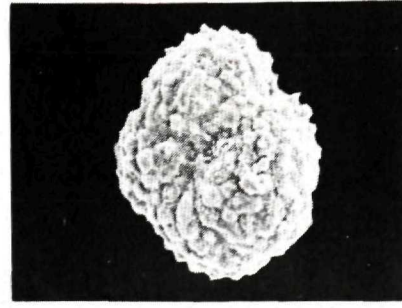
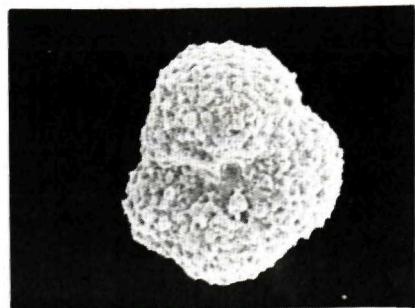
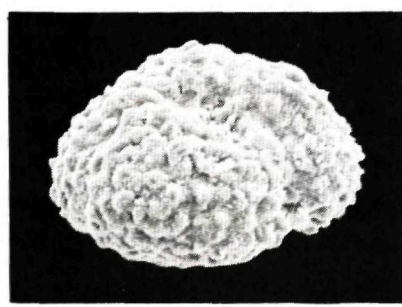
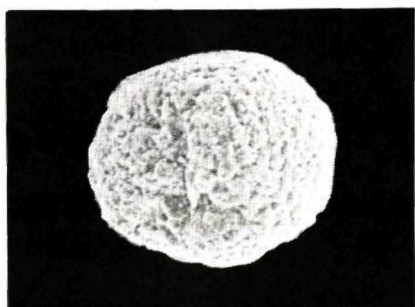
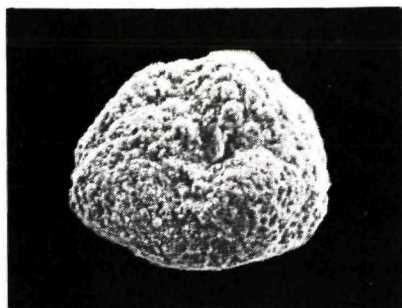
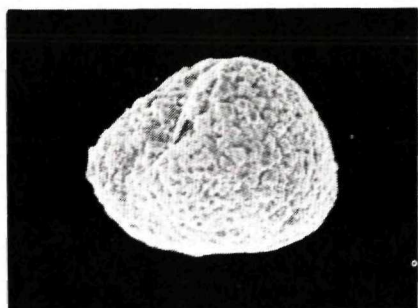
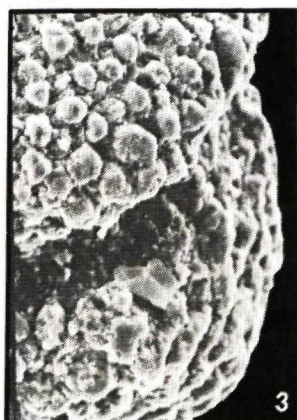
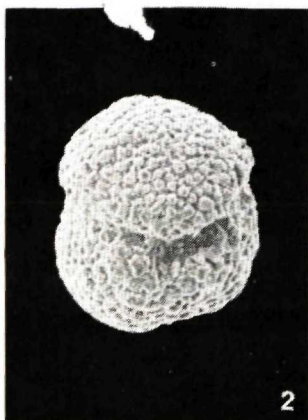
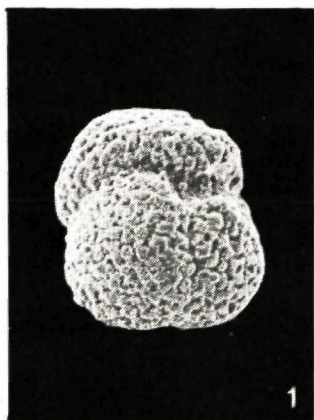
6

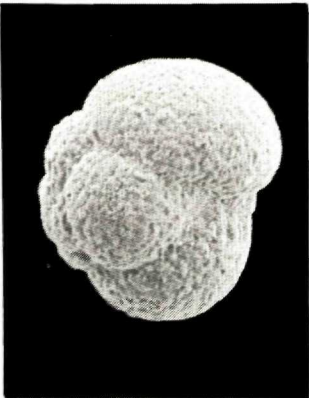


7

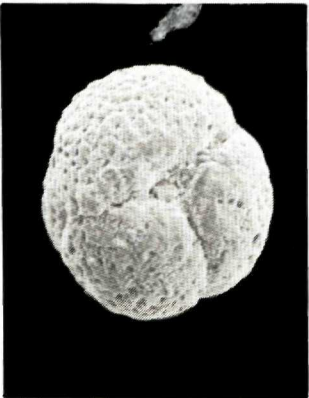


8

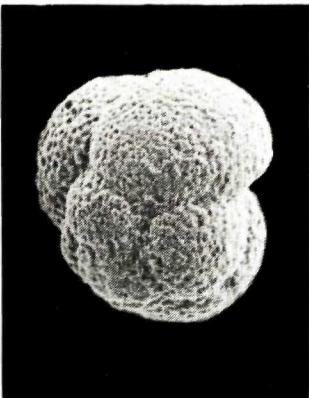




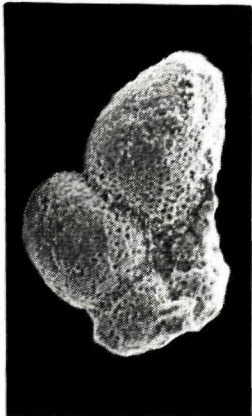
1



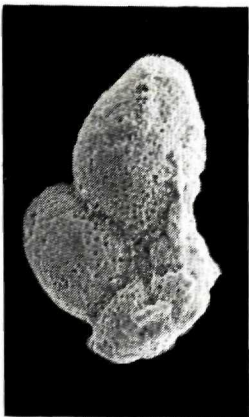
2



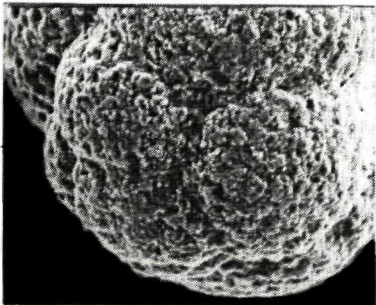
3



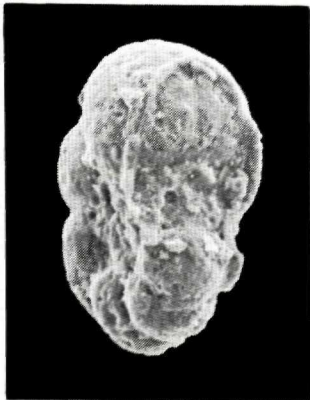
5



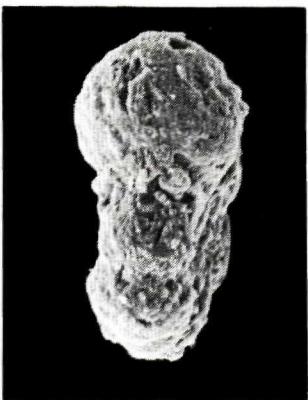
6



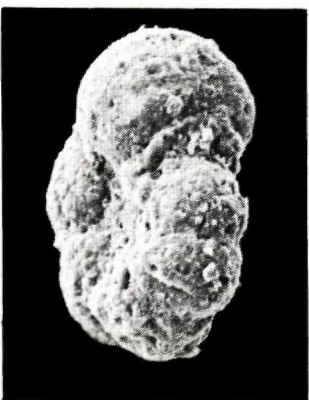
4



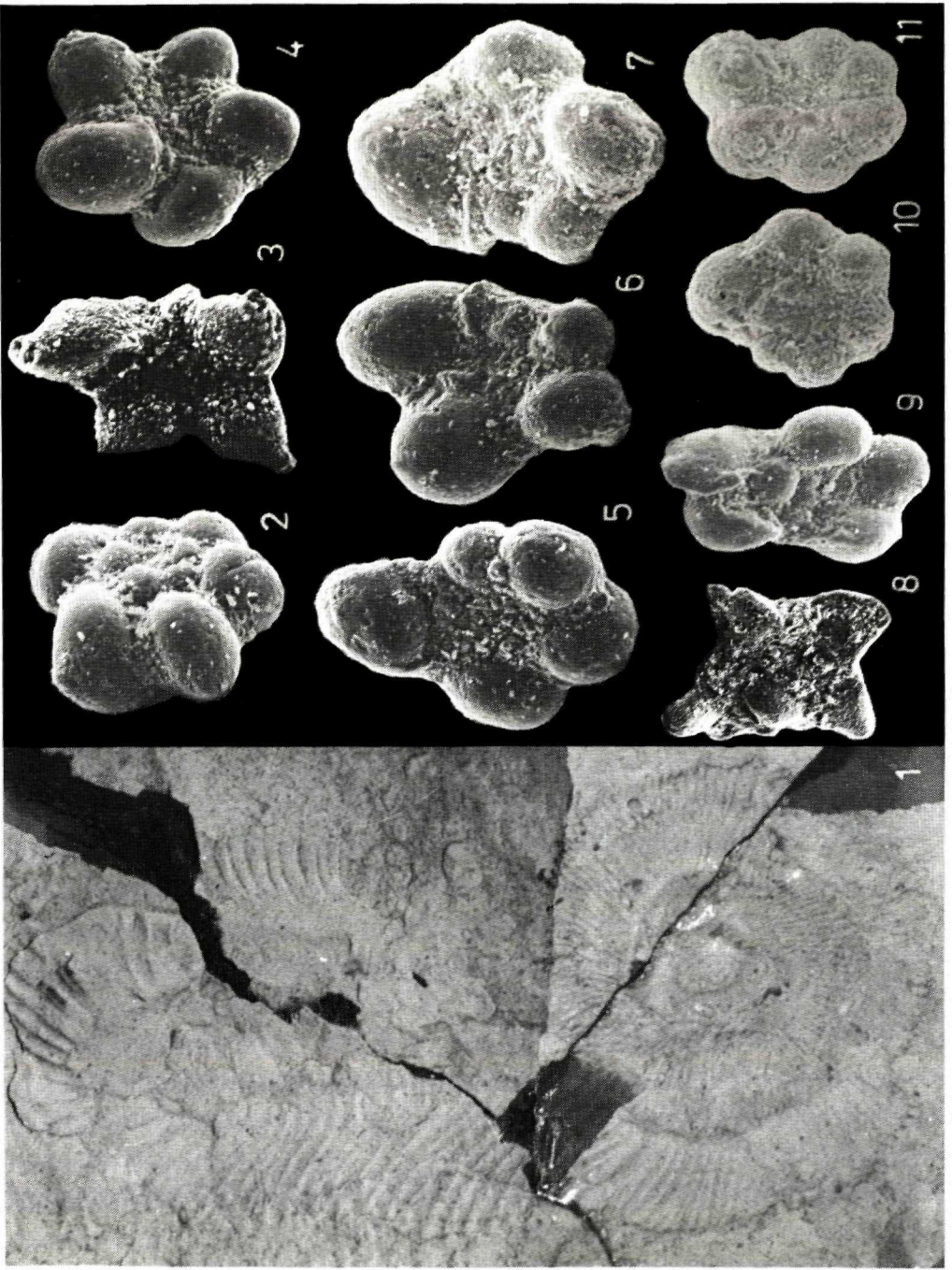
7

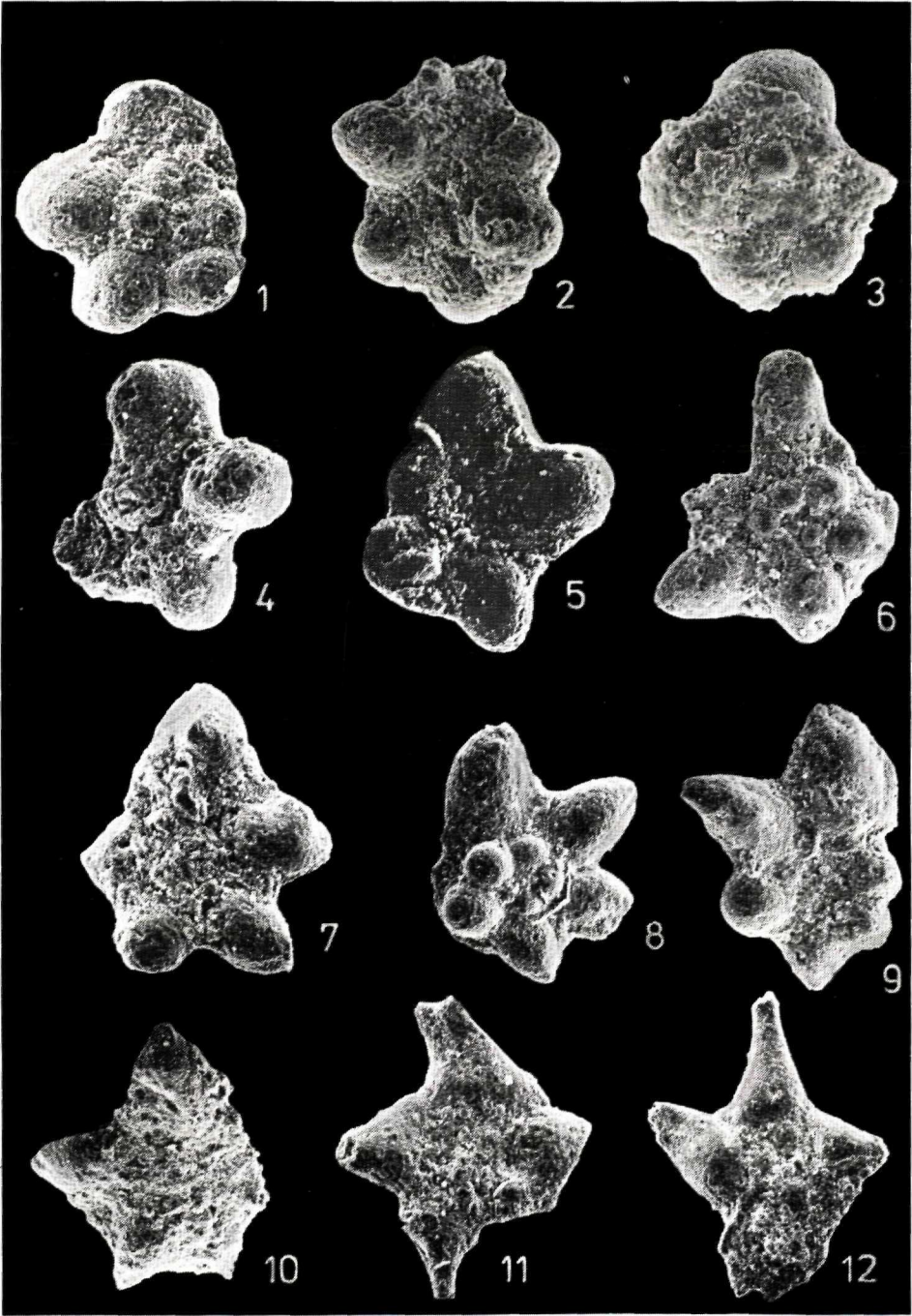


8



9



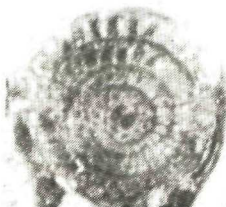




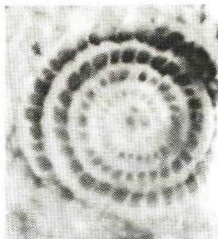
1



2



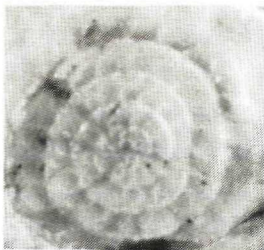
3



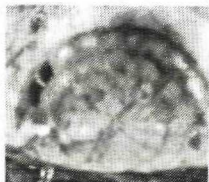
4



5



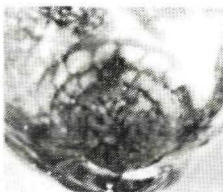
6



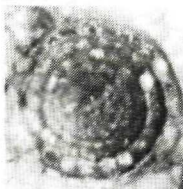
7



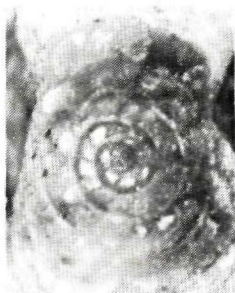
8



9



10



11



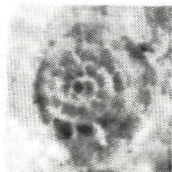
12



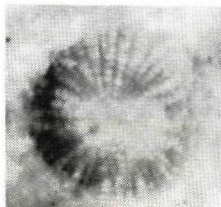
13



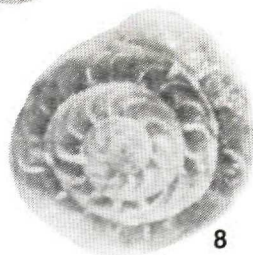
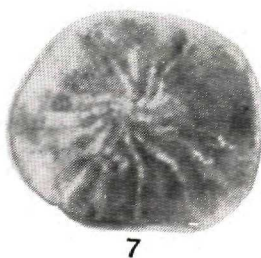
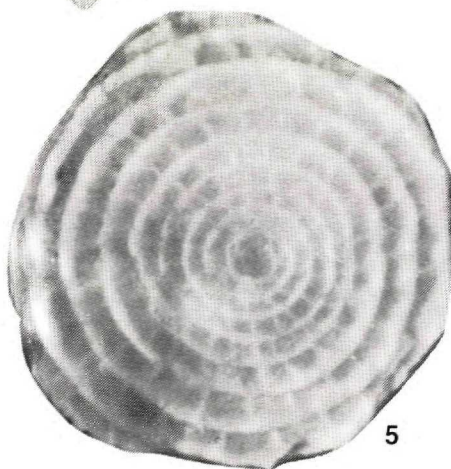
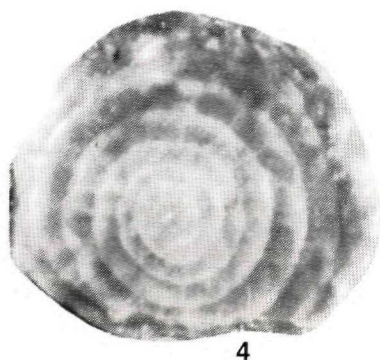
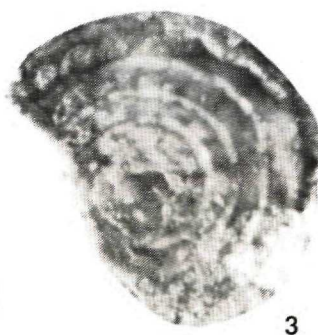
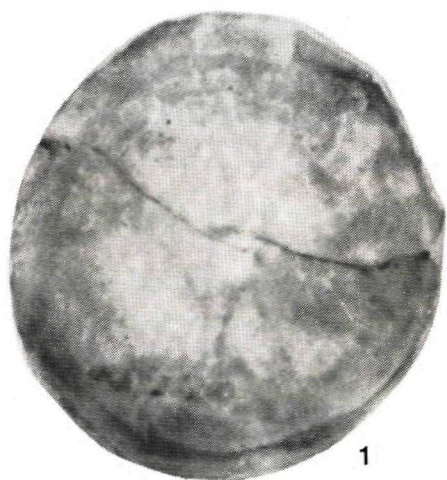
14

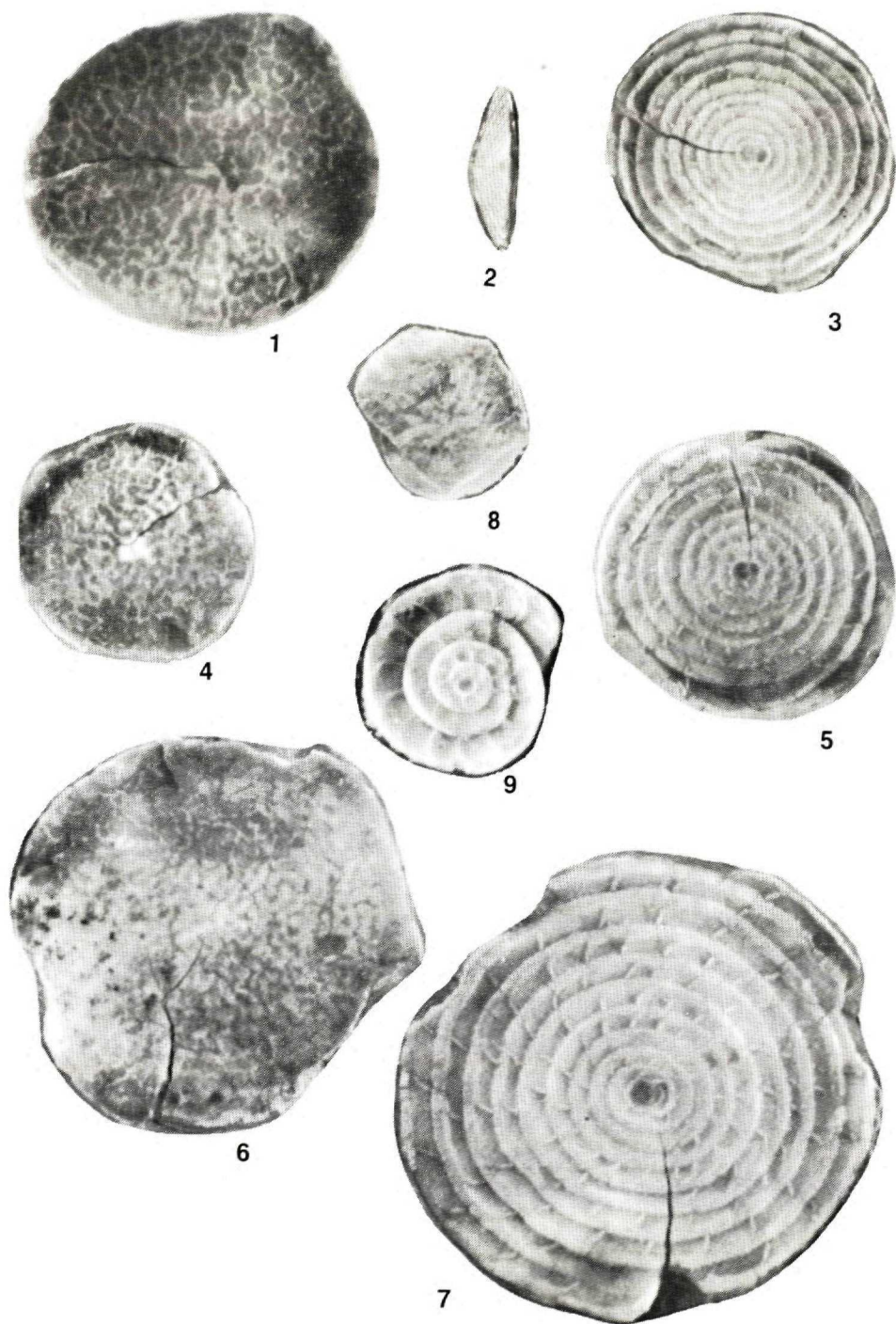


15



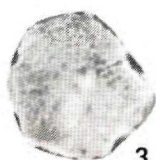
16



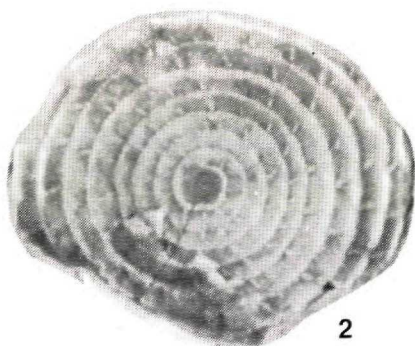




1



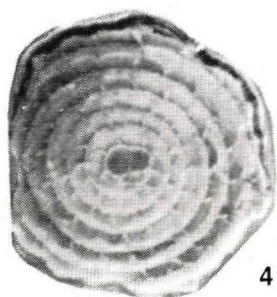
3



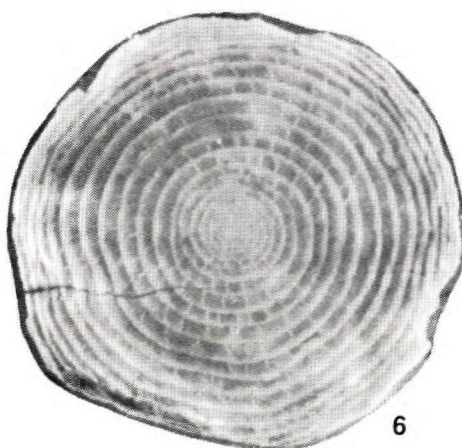
2



5



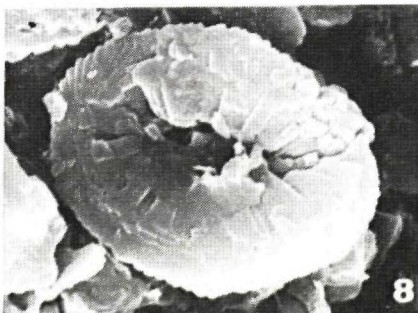
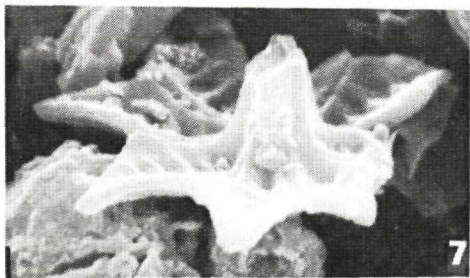
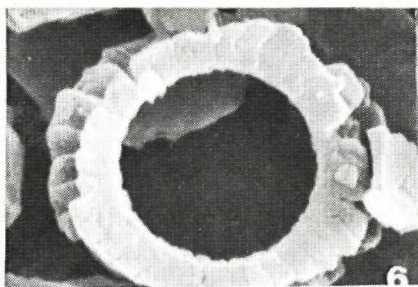
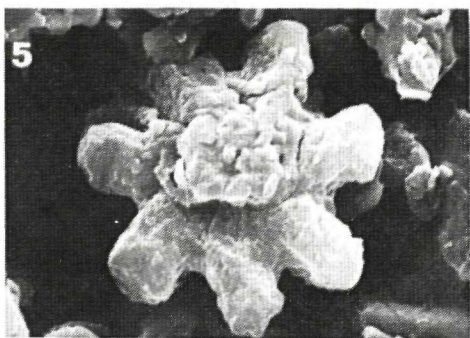
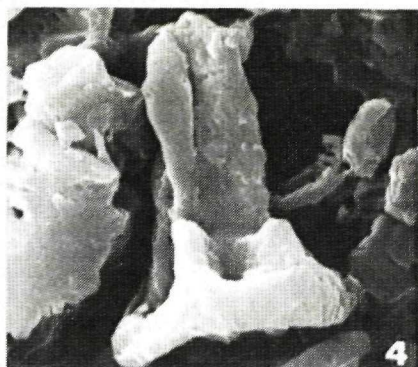
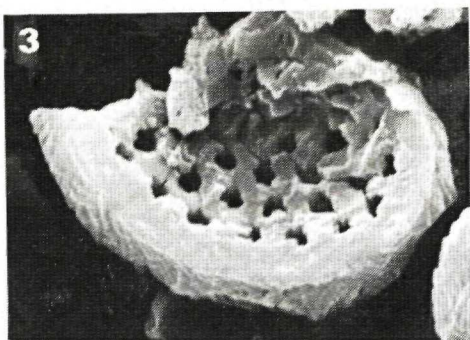
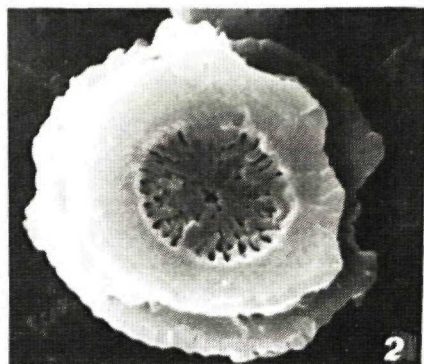
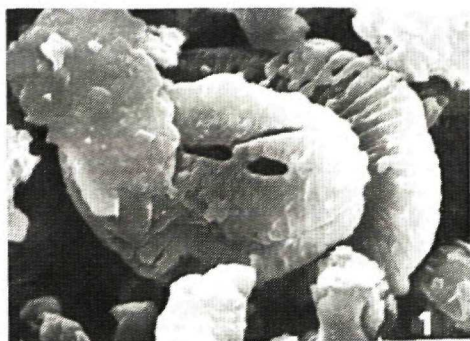
4

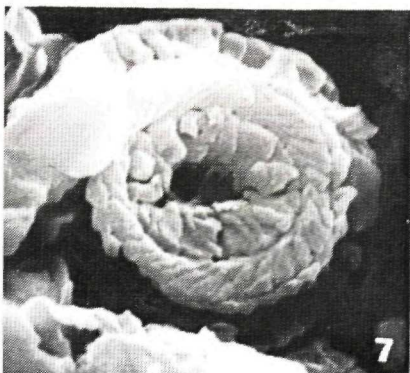
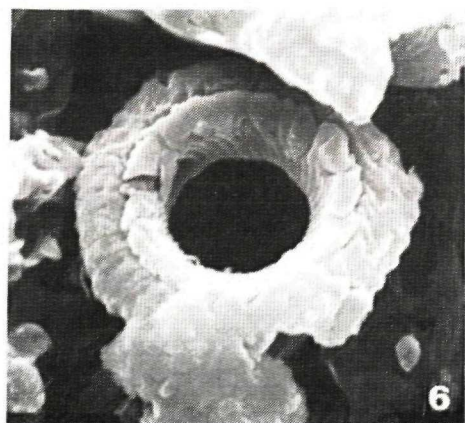
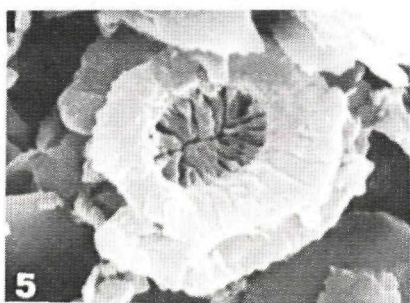
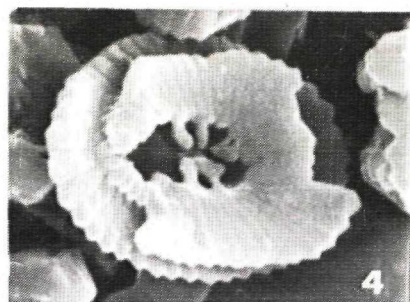
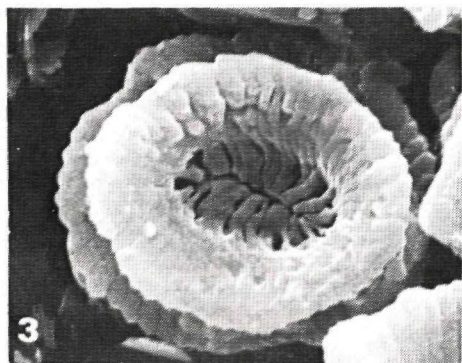
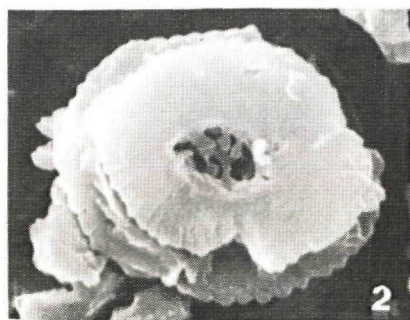
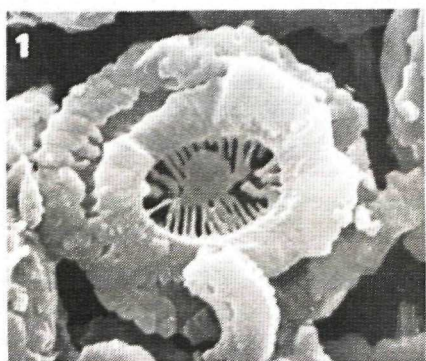


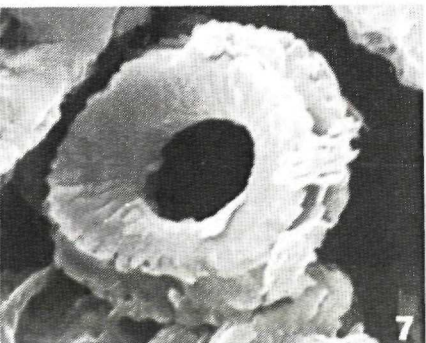
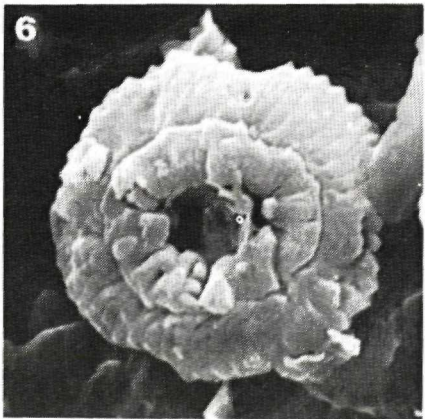
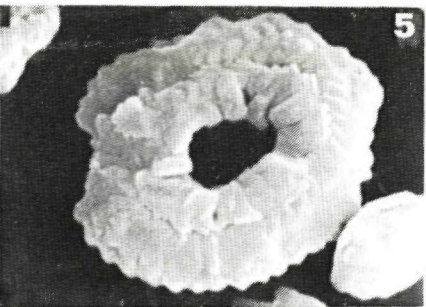
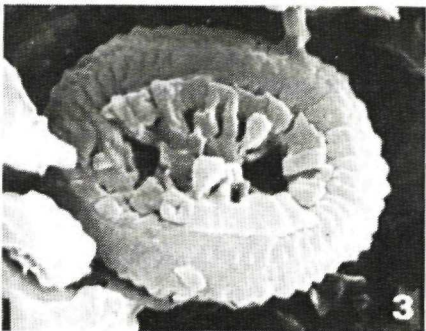
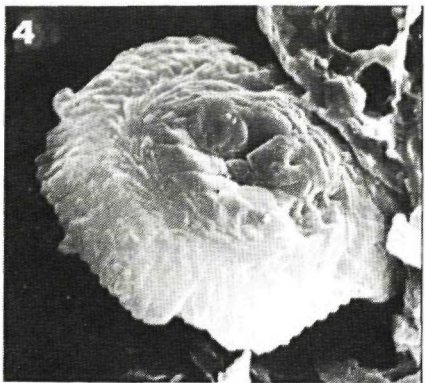
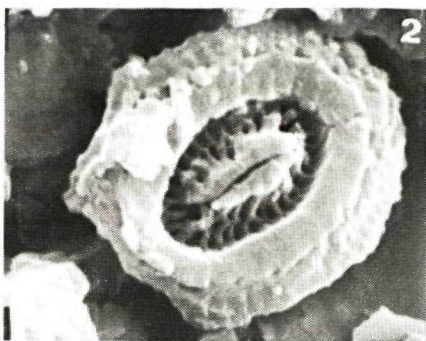
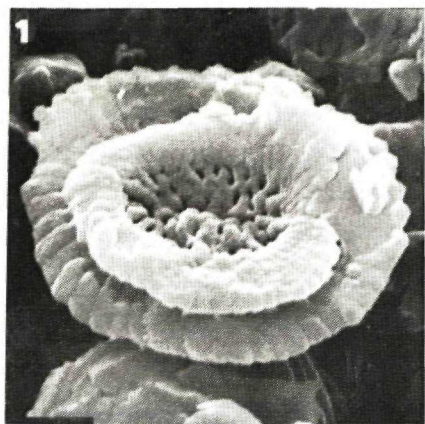
6

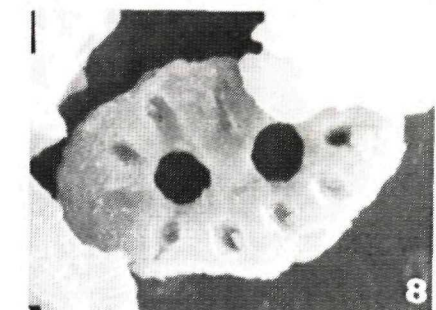
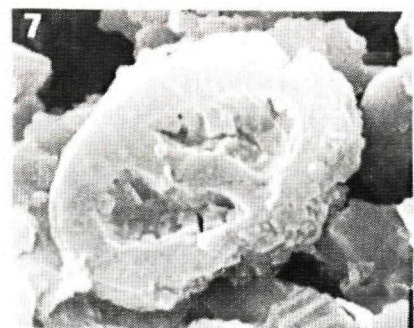
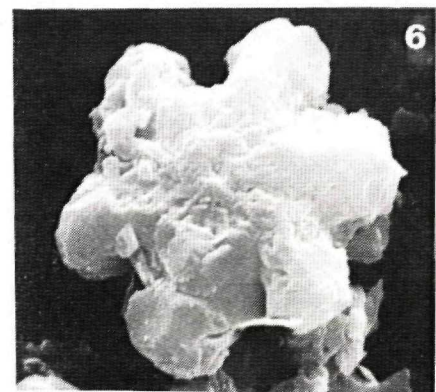
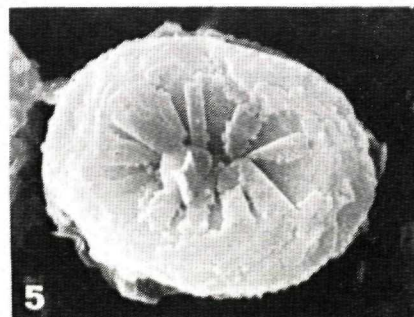
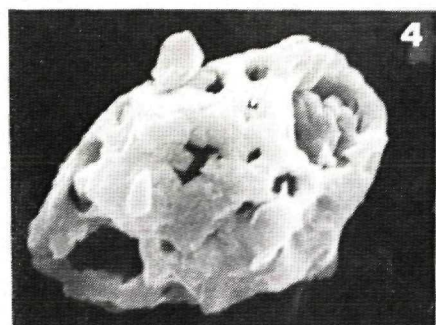
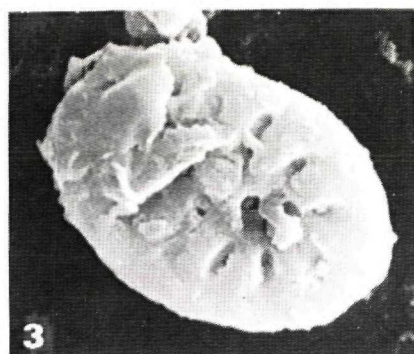
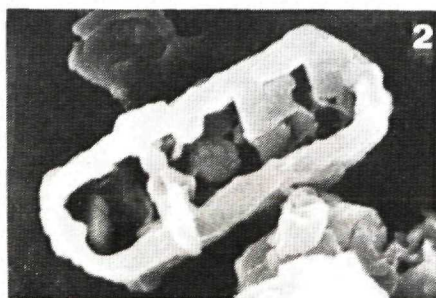
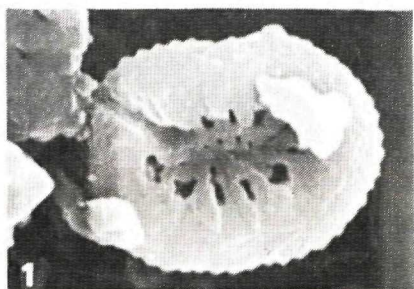


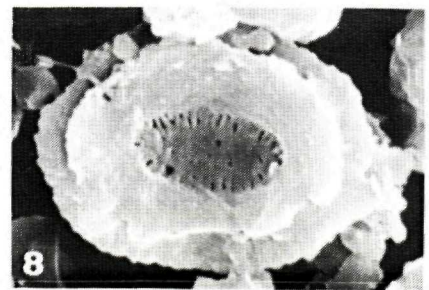
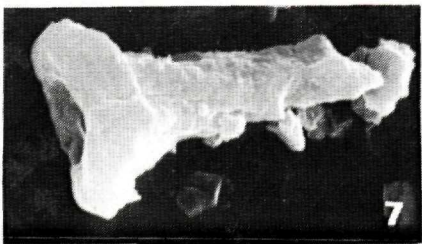
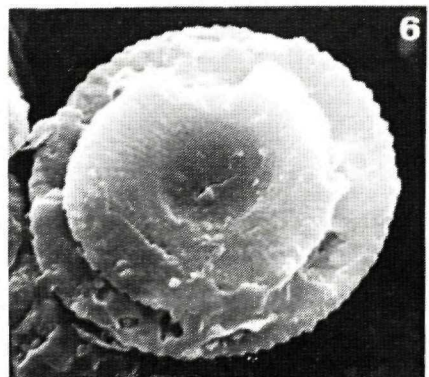
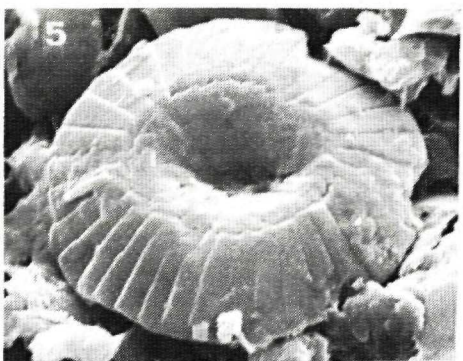
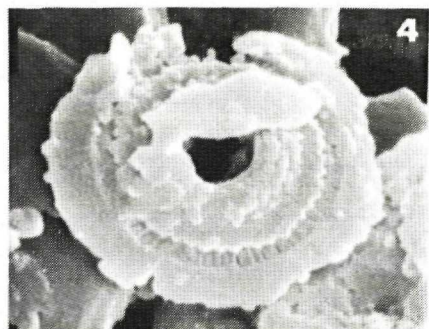
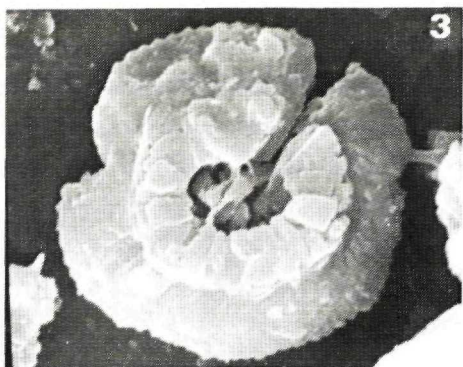
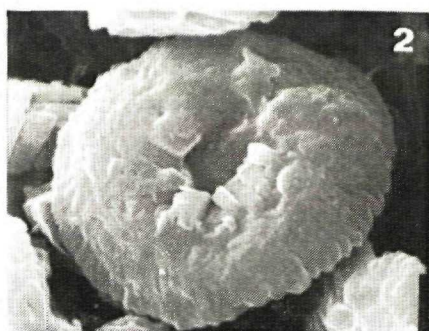
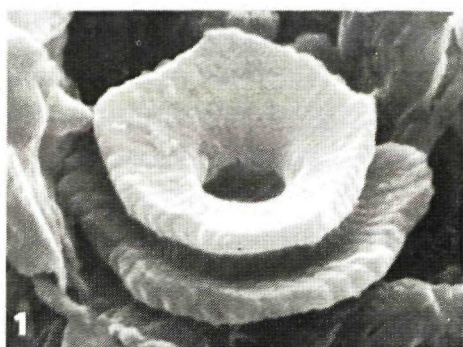
7

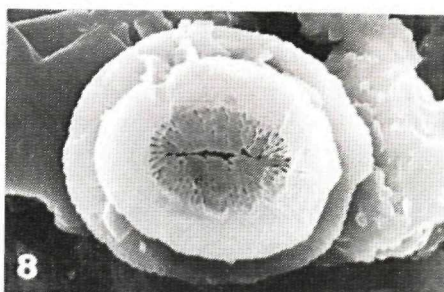
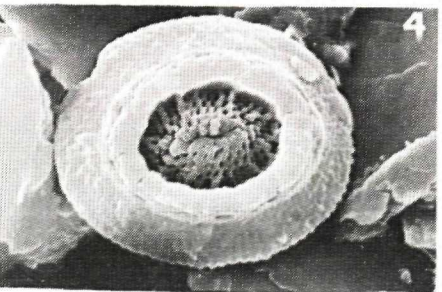
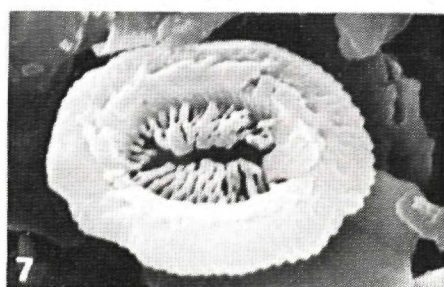
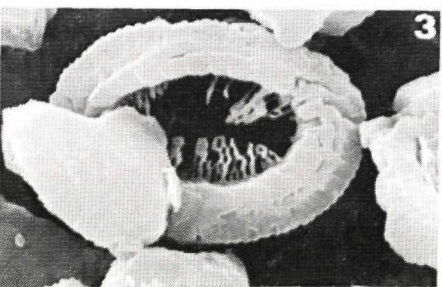
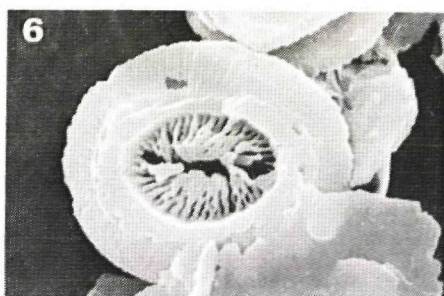
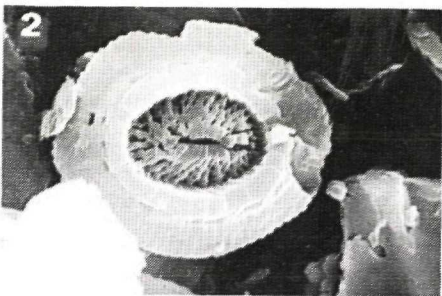
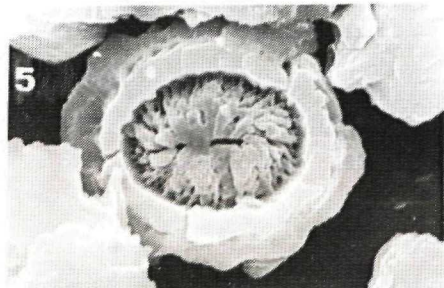
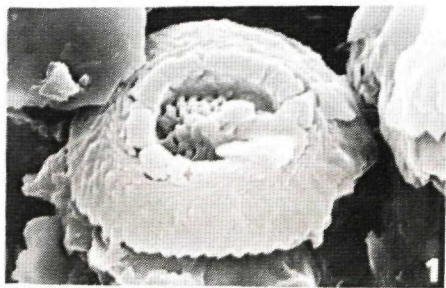


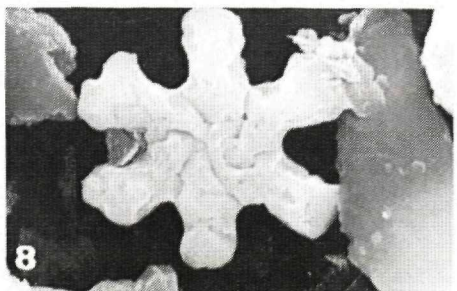
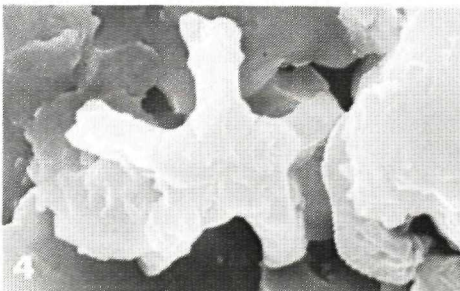
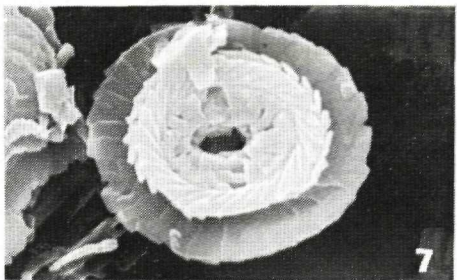
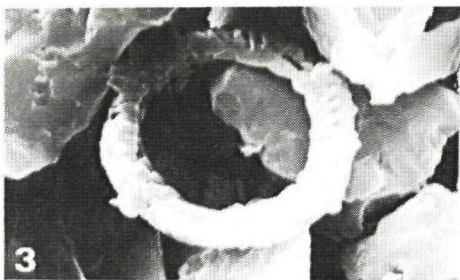
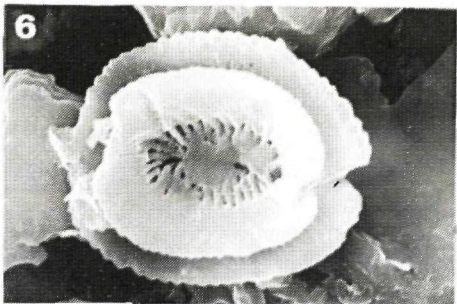
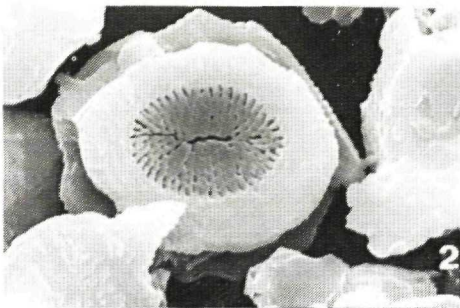
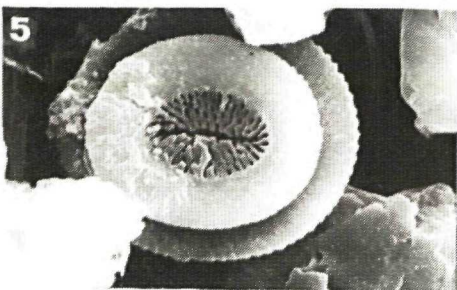
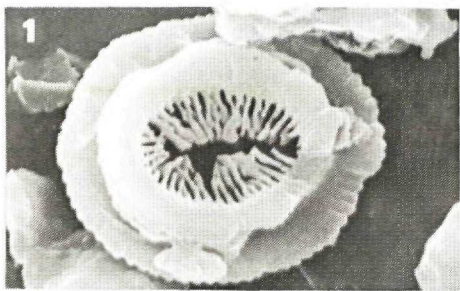


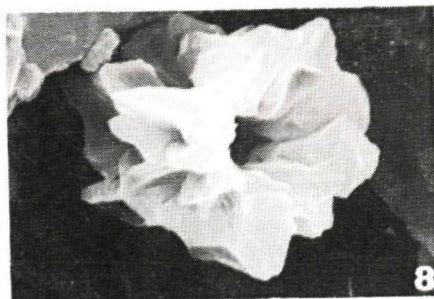
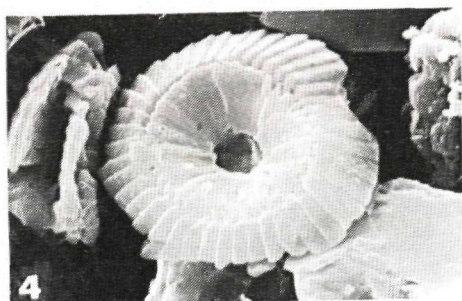
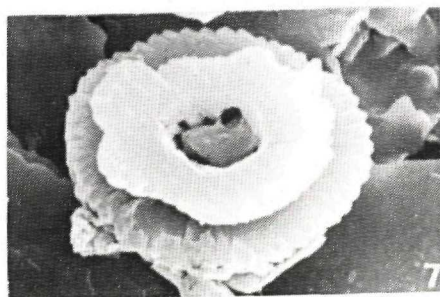
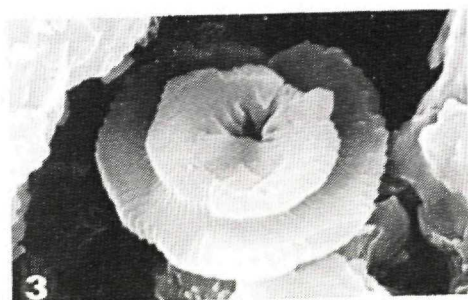
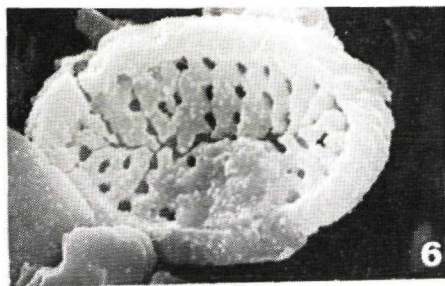
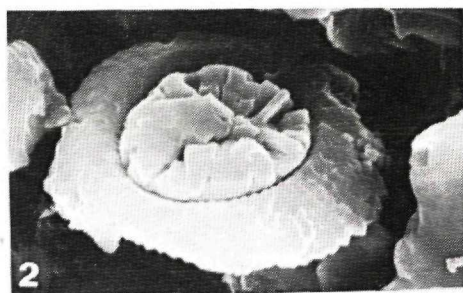
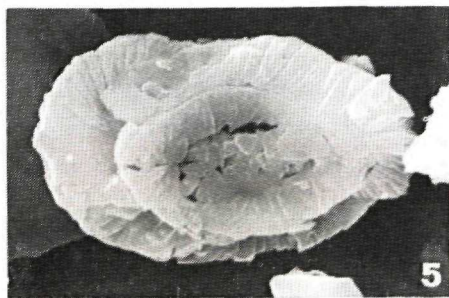
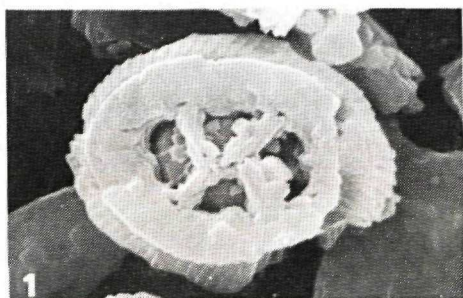


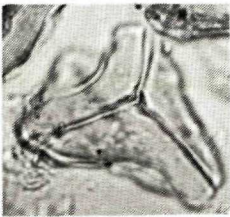




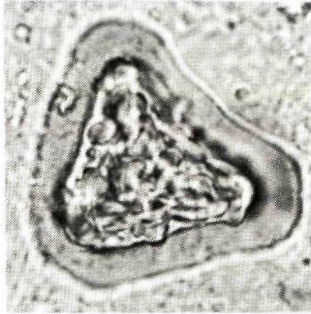




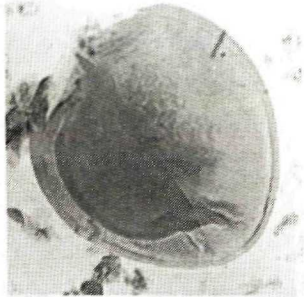




1



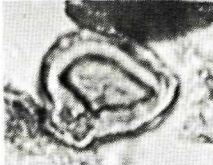
3



4



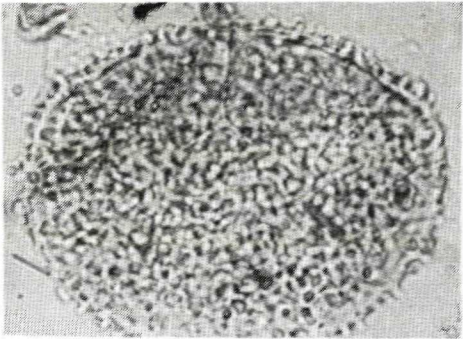
2



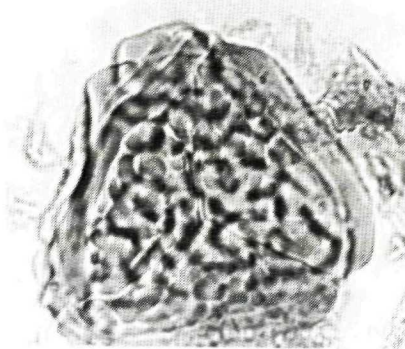
5



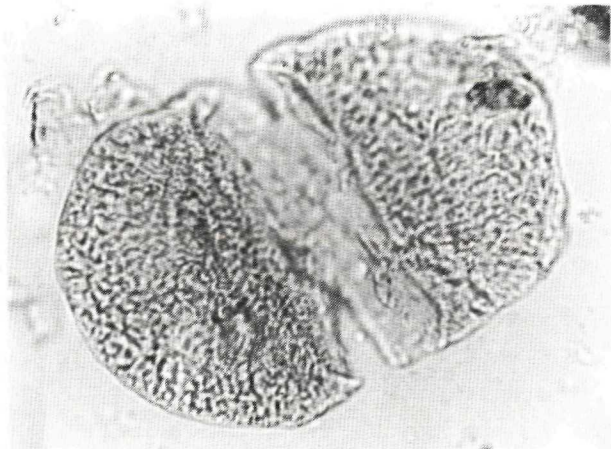
6



7



8



9



10



1



2



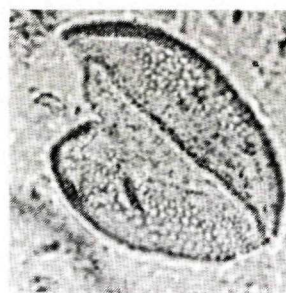
3



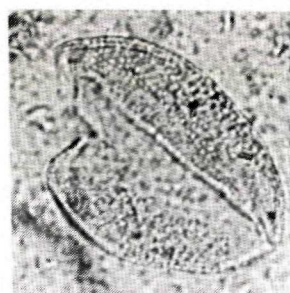
4



5



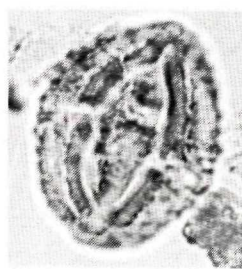
6



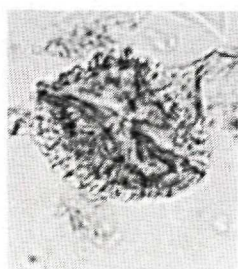
7



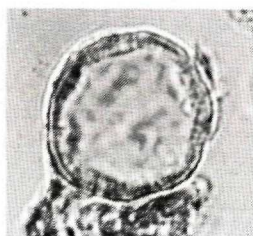
8



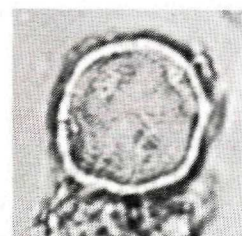
9



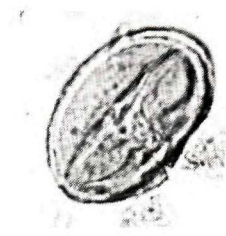
10



11



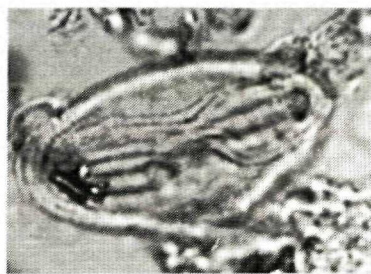
12



13



1



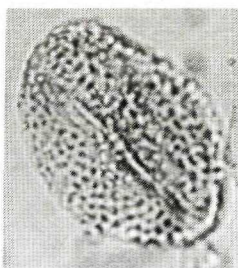
2



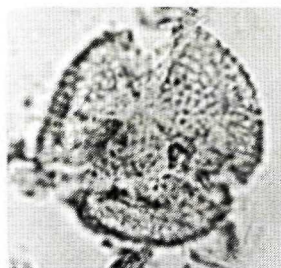
3



4



5



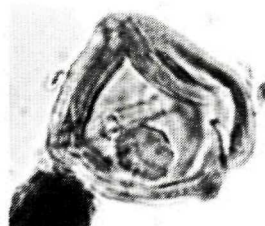
6



7

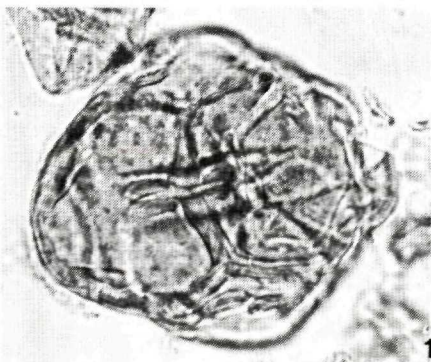


8

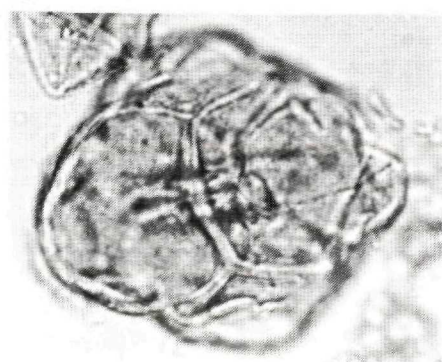


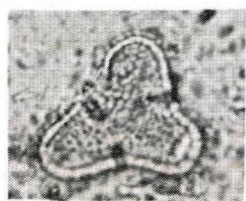
9

11



10

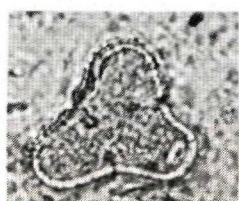




1



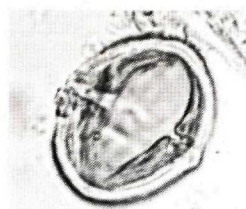
2



3



4



5



6



7



8



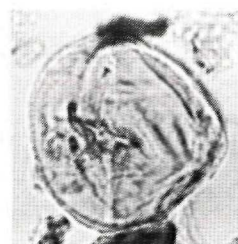
9



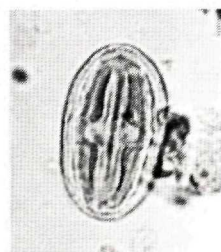
10



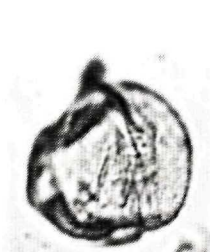
11



12



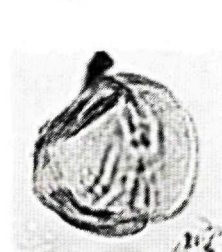
13



14



15



16



17



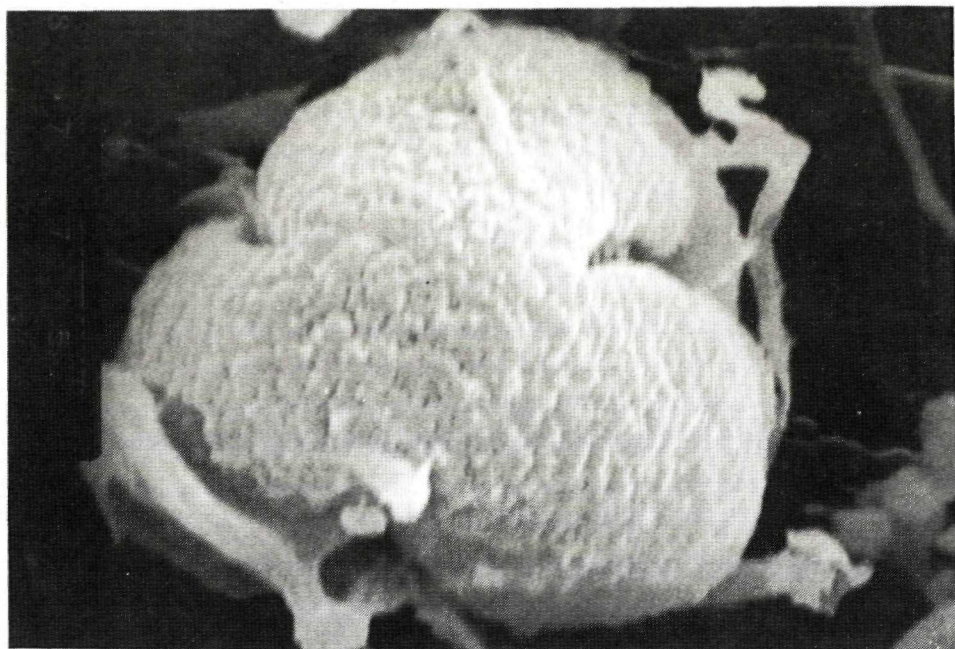
18



19

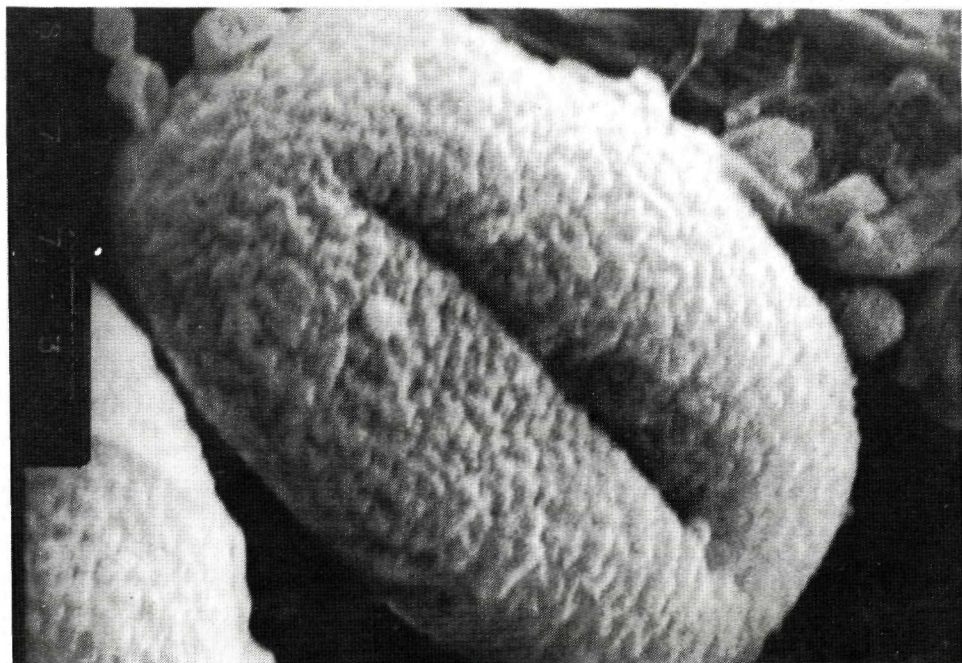


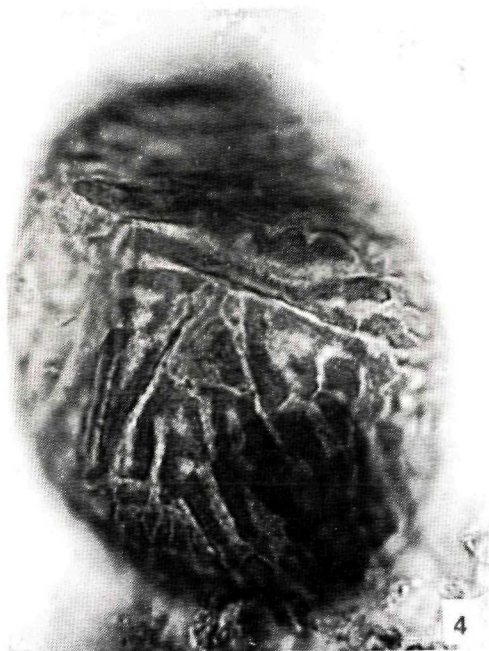
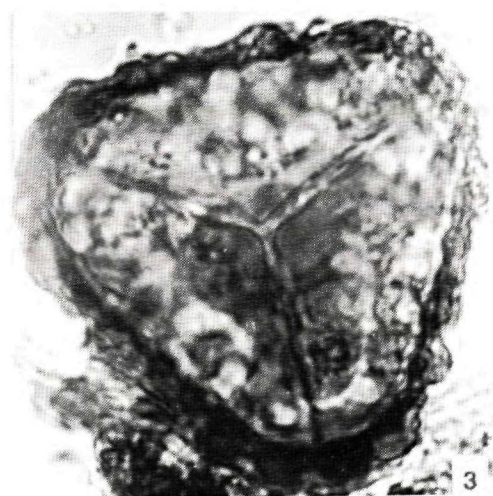
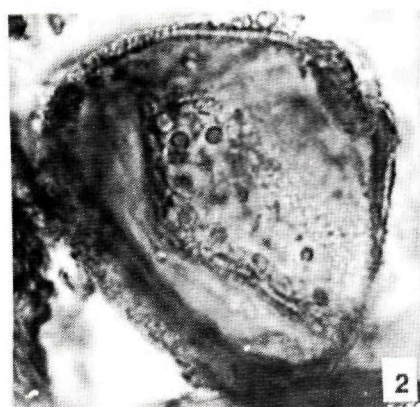
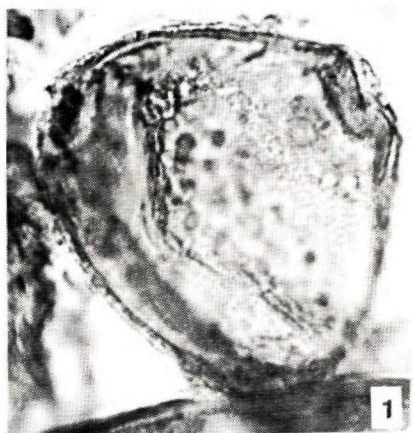
20

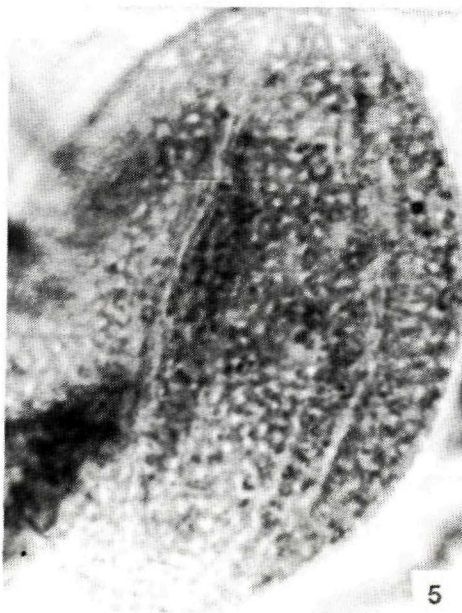
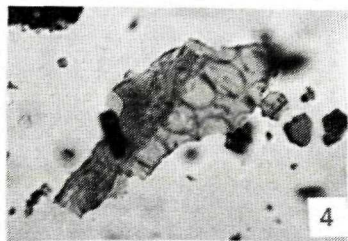
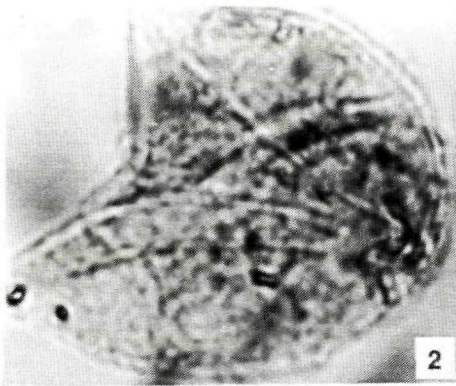
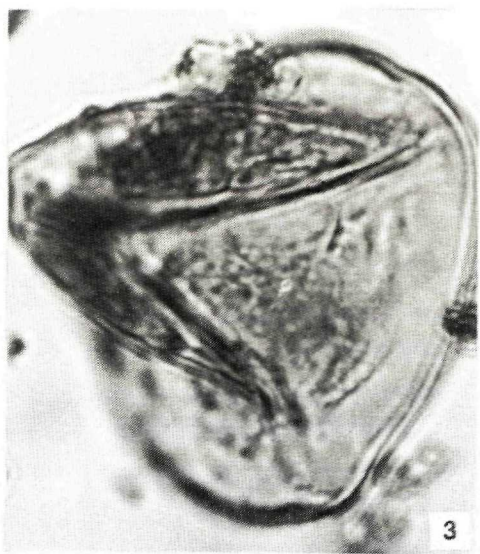
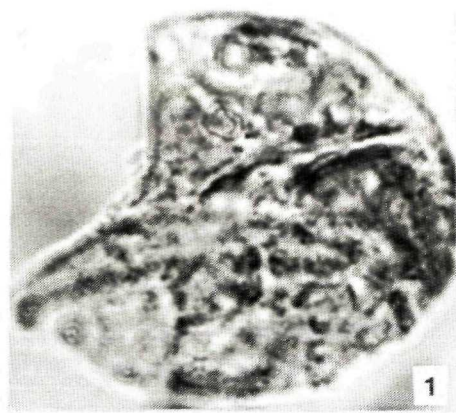


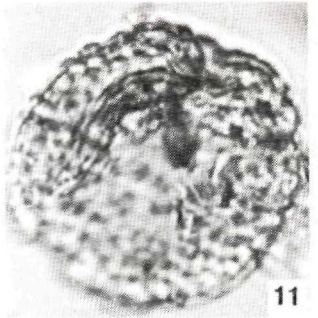
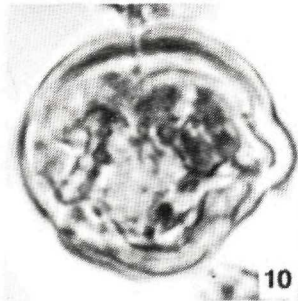
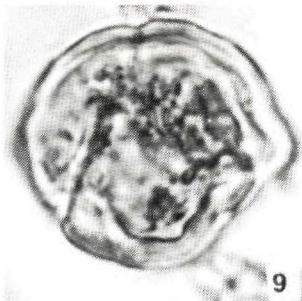
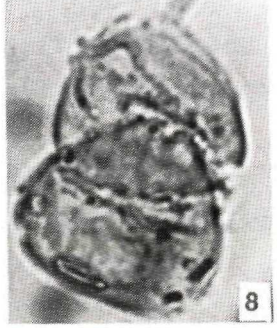
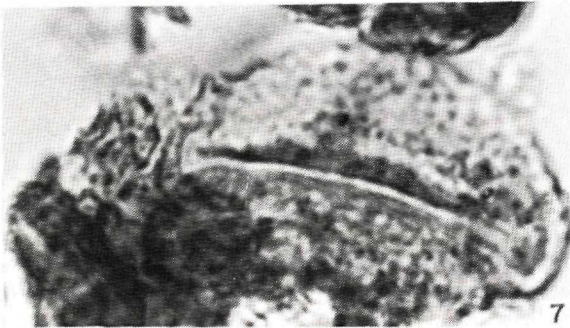
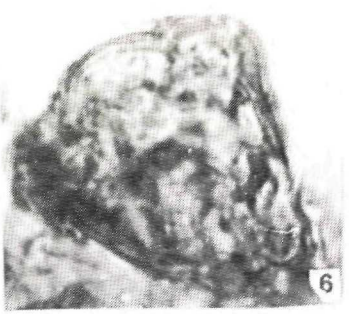
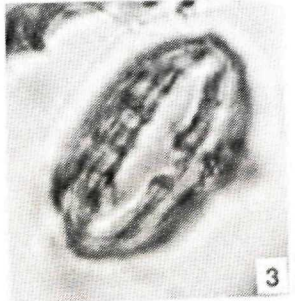
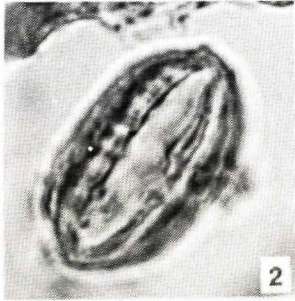
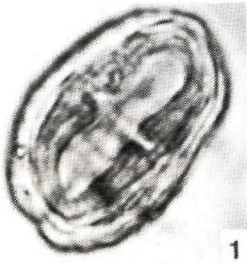
1

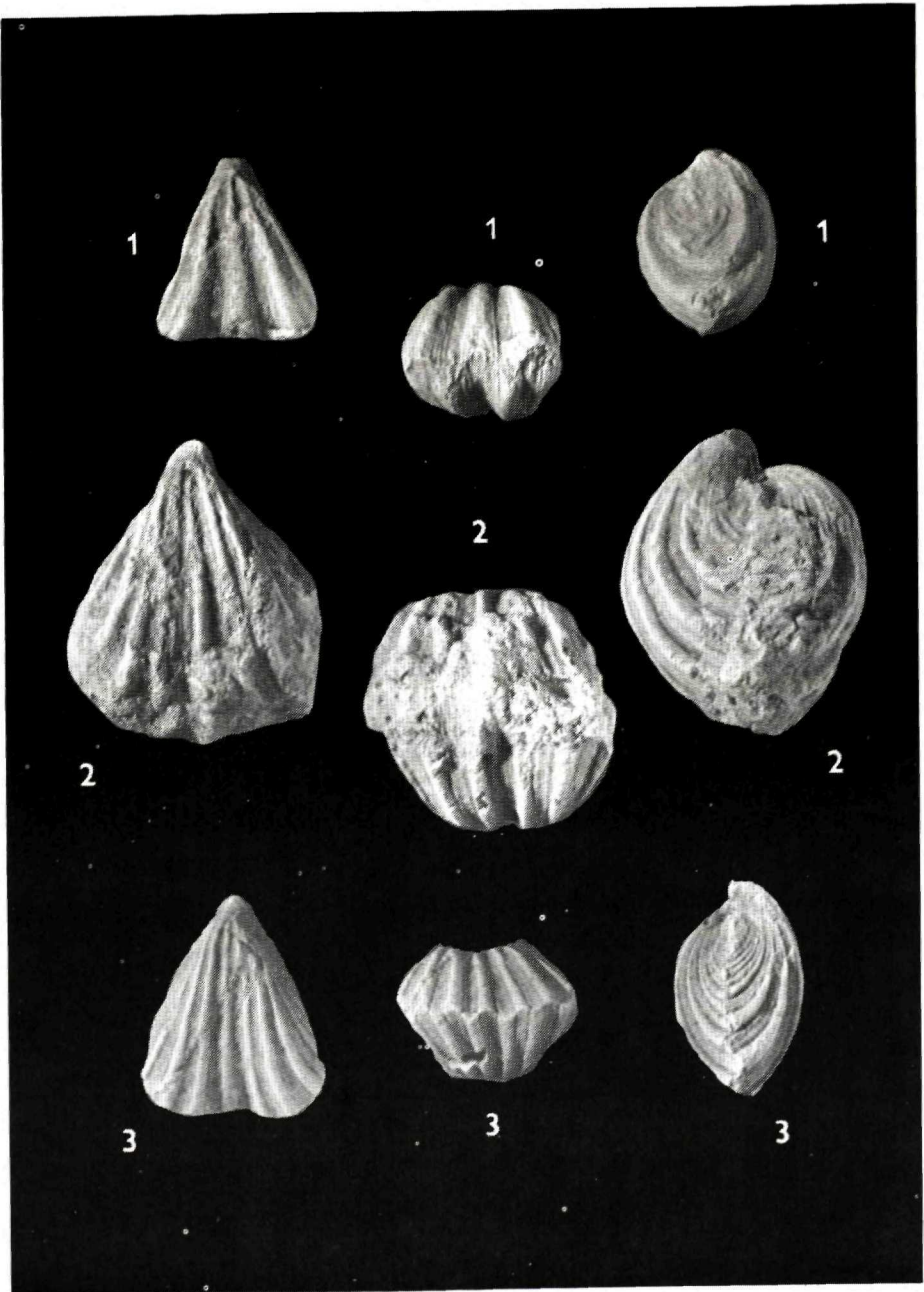
2

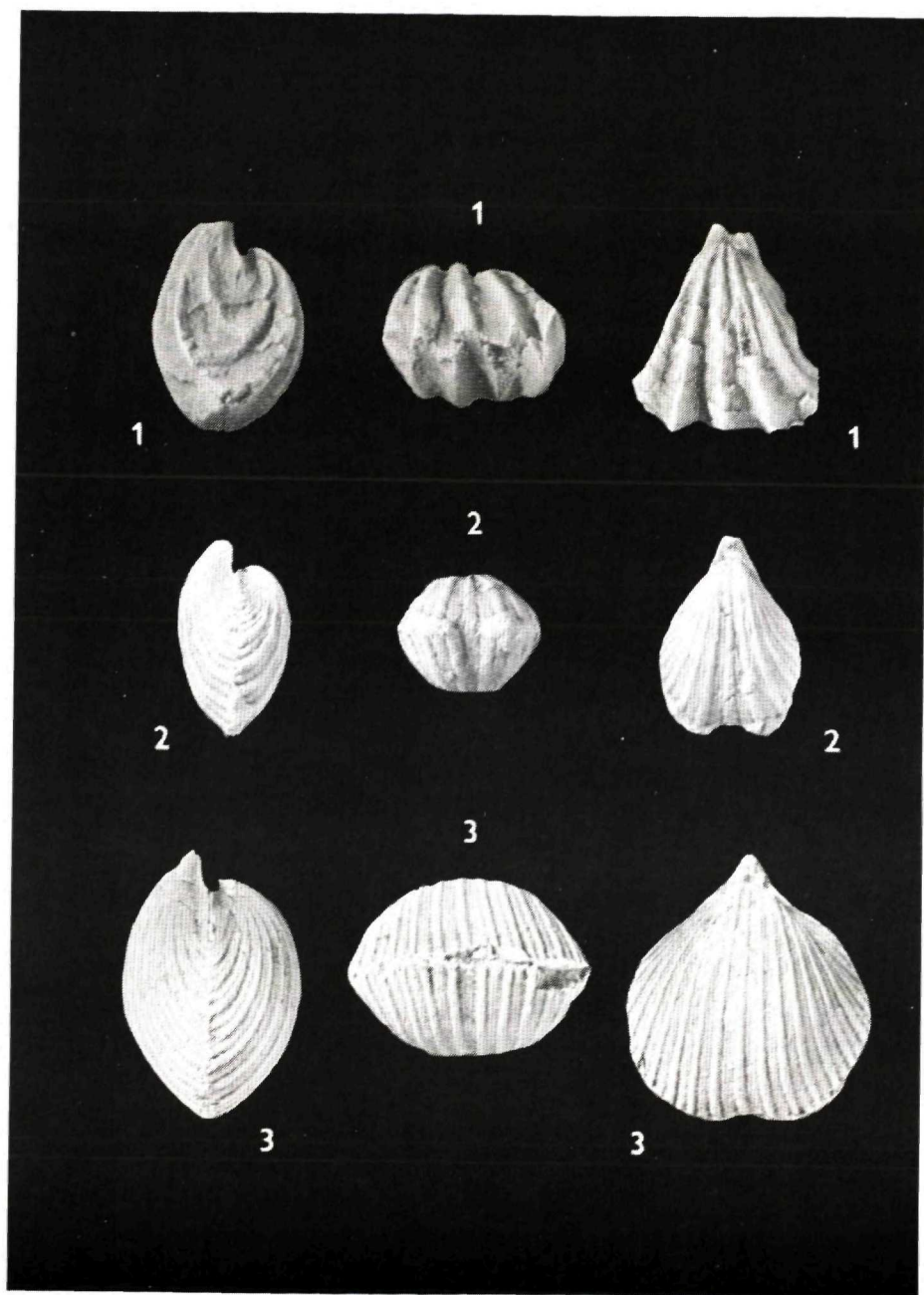








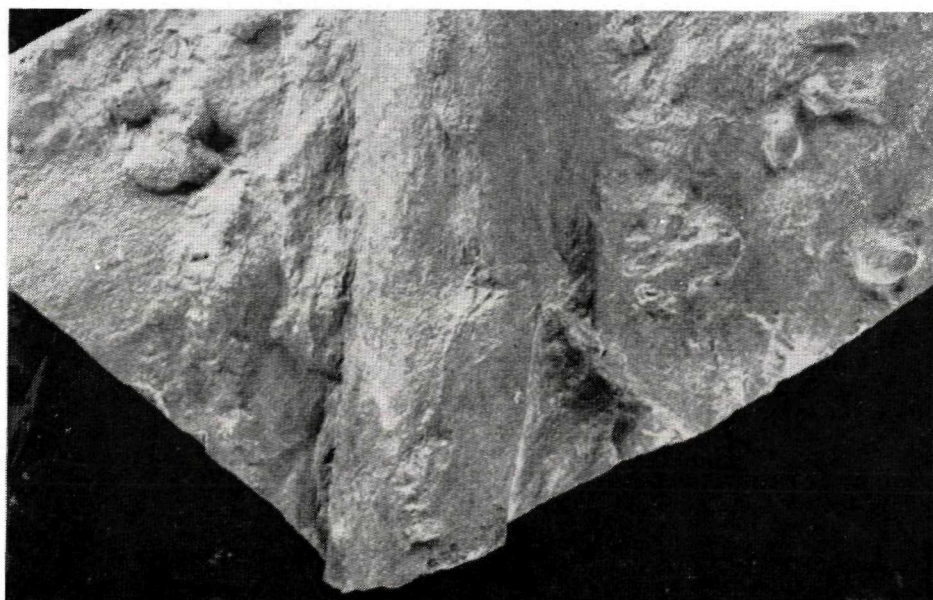




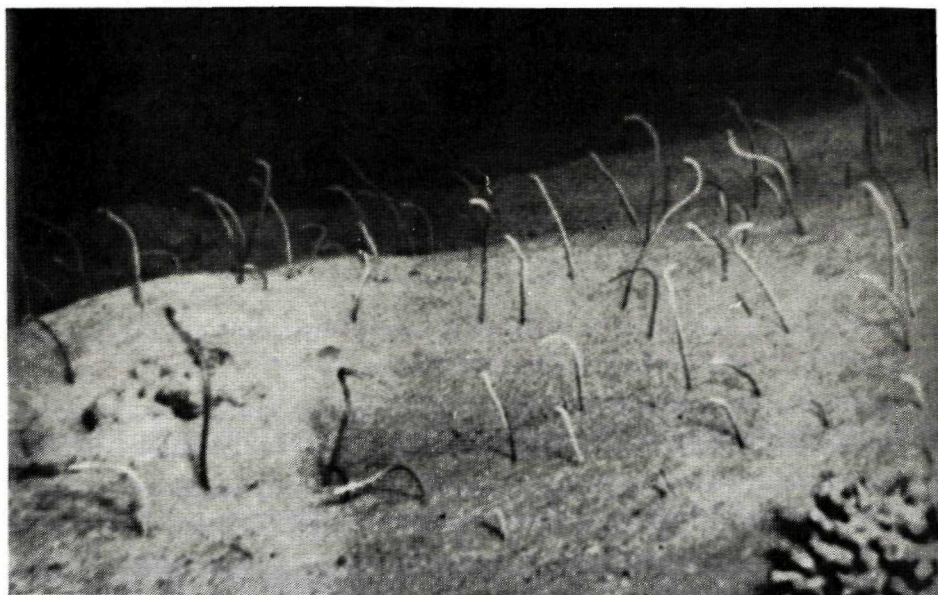




1



2



1



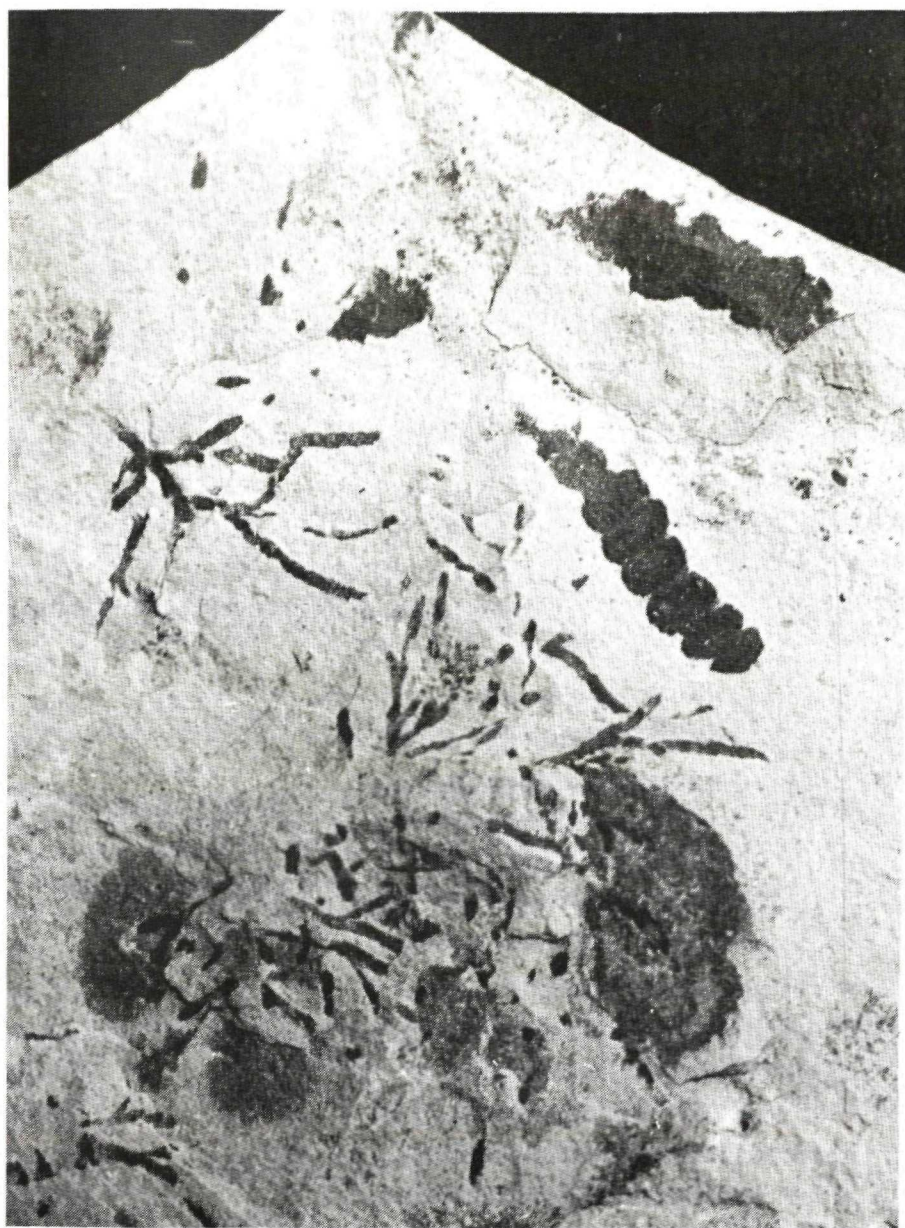
2

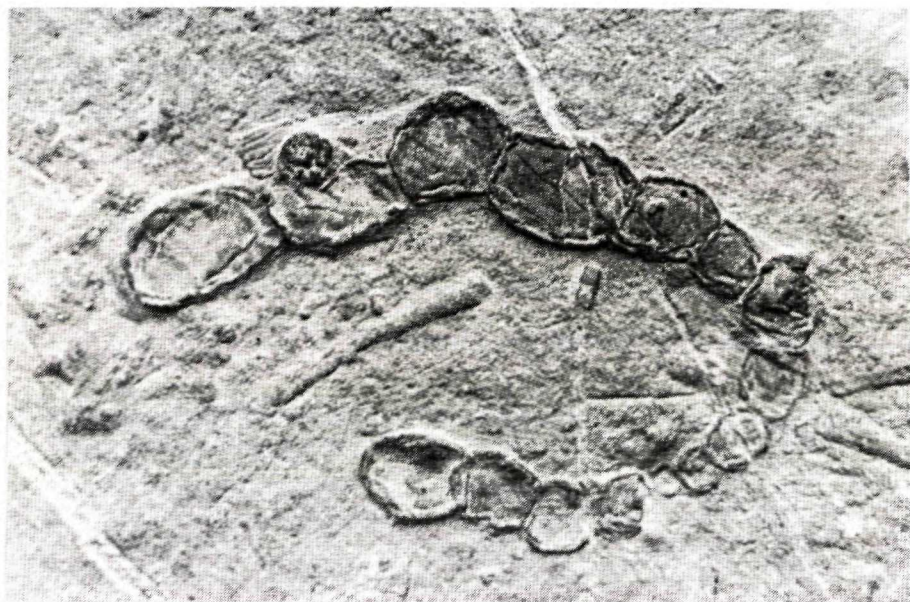


1



2





1



2

Geologický ústav Dionýza Štúra
ODBOROVÉ INFORMAČNÉ STREDISKO
Mlynská dolina 1
817 04 BRATISLAVA