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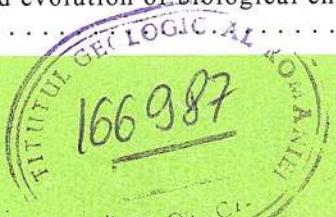
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SPHENOBAIERA CRASSA n.sp., UNE NOUVELLE SPHENOBAIERA DU LIAS INFÉRIEUR D'ANINA, ROUMANIE

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Key words: Early Liassic. Anina. Romania. *Sphenobaiera crassa* n.sp.

Abstract: *Sphenobaiera crassa* n.sp. a new *Sphenobaiera* from the Lower Liassic at Anina, Romania. A new species of *Sphenobaiera* is described. From the morphological point of view the material is characterised by an almost rounded basis, by the short branched (2-4 times) lobes and by the general plump form.

Introduction

Grâce à l'amabilité de la Direction du Laboratoire de Géologie et Paléontologie et celle du Jardin Botanique de l'Université de Cluj-Napoca, Roumanie, nous avons eu la possibilité d'étudier les belles collections de plantes fossiles jurassiques, provenant du Lias inférieur, à savoir Hettangien-Sinémurien d'Anina (ante Steierdorf). Les résultats ont été publiés dans plusieurs notes (Givulescu 1990, 1992, 1993; Givulescu et Czier, 1990). Il en ressort que la flore d'Anina est l'une des plus belles et plus riches flores du Lias inférieur européen. La liste présentée récemment par Givulescu (1997) comprend 54 taxons, mais on doit y ajouter encore le matériel cité par Czier (1995), Barbu (1995), Givulescu (1990), et surtout celui cité par Popa (1997, 1997 a). Au total, 70 taxons révisées, sans compter les données plus anciennes, non révisées.

Description paléontologique

Nous allons présenter dans cette note un bel échantillon de *Sphenobaiera*, que nous considérons comme représentant d'une nouvelle espèce.

Matériel: deux feuilles au numéro d'inventaire 11873, conservées sur la même plaque de schiste. L'épiderme est parfaitement conservé, il a été donc possible de le préparer, cela par la méthodologie classique au réactif Schulze.

Description macroscopique: feuille à base très courte et rétrécie, qui s'élargit subitement et se ramifie en deux lobes. Le sinus respectif est linéaire. Les deux lobes se ramifient de nouveau à 20 mm en

dessus de la base, ainsi que l'on ait affaire à quatre lobes rétrécis égaux et longs, séparés par deux sinus profonds, rétrécis et arrondis à la base. Une nouvelle ramifications à 45 ou 50mm de la base peut ou non intervenir. La nervation est formée dans les lobes par de nervures égales, parallèles: sur 0,5mm, on compte 7 nervures qui présentent une dichotomie accentuée surtout en base.

Aspect microscopique: la feuille est amphistomatiqe, les deux épidermes sont semblables, la différence dérive du nombre quelque peu plus réduit de stomates sur l'épiderme supérieur. Les épidermes sont formés de cellules plus ou moins rectangulaires, polygonales ou carrées, disposées en rangées relativement régulières interrompues sur l'épiderme supérieur par de rares stomates. Les parois anticliniales des cellules sont droites, d'épaisseur égale; les parois péricliniales sont caractérisées par de papilles rondes, cutinisées. Sur l'épiderme inférieur, les stomates sont disposés en rangées larges de 275-385 m μ , alternant avec d'autres rangées de la même largeur, mais sans stomates. Les stomates disposées en fils irréguliers sont petits, d'orientation différente. Il y a deux cellules de garde non colorées, petites, semi-lunaires, dont le contour général est ovalaire. Les parois extérieures sont cutinisées et épaissies. Ces cellules sont entourées par un nombre de cellules annexes, pourvues de papilles rondes fortement cutinisées, papilles qui recouvrent le plus souvent les cellules de garde. L'ostiole a l'aspect d'une fente, quelquefois aux marges épaissies.

Dimensions: hauteur 33,30-39,96 m μ -46,62 m μ , ostiole 23,21 m μ .

Discussion. D'après Florin (1936), le genre *Sphenobaiera* est défini de la manière suivante: "leaves



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without a distinctly set-off petiole narrowing wedge-wise toward the base ± narrowly triangular in outline, further divided ± deeply into 2-3 primary segments, which are arranged in two groups each segment being cut into lobes once or repeatedly and ± deeply. Venation fan-shaped as a whole". Il va sans dire que le matériel que nous avons présenté correspond complètement à cette description.

Le nombre des *Sphenobaiera* avec ou sans épiderme décrites dans la littérature paléobotanique est considérable. Nous en avons recensé 44 espèces décrites dans l'espace euro-asiatique dans l'intervalle Trias-Crétacé inférieur. Dix-sept proviennent de la Sibérie. Les autres se répartissent entre 14 pays et provinces. Trois proviennent du Crétacé inférieur, onze du Jurassique inférieur, les autres du Jurassique supérieur et du Trias. L'épiderme des 22 espèces est connu, les autres sont décrits sur la base de leur morphologie (voir annexe). Une synthèse des espèces à épiderme conservé et étudié a été donnée par Samylina (1956), puis par Lundblad (1957). Nous avons eu la possibilité d'examiner tout ce matériel à épiderme préservé, ainsi qu'une grande partie de l'autre catégorie (à remarquer que la majorité sont des endémiques sibériennes). Si l'on considère seulement le matériel à cuticule au point de vue morphologique, on constate la présence de deux types morphologiques fondamentaux, à savoir: 1, types sveltes à ramifications multiples, *S. paucipartita*, *angustiloba*, *uninervis*, *flabelata*; 2, types trapus à ramification réduite, *S. pulchella*, *biloba*, *grandis*, *paragrandis*. En ce qui concerne notre matériel, celui-ci appartient au second groupe. En ce qui concerne la ramification, mais non le type de base, nous avons trouvé, dans la littérature consultée deux figures plus ou moins semblables. Il s'agit de *Sphenobaiera ophioglossum*, la figure présentée dans Harris et al., 1974, figure 17 B, et celle figurée par Tatsuaki et al., 1984, texte figures 4 a, b. La conclusion de cette discussion est qu'aucune des espèces de *Sphenobaiera* examinées dans la littérature paléo-botanique ne peut pas être comparée au point de vue macro- ou microscopique à notre matériel. Par conséquent, nous sommes d'avis qu'on est en présence d'une espèce nouvelle de *Sphenobaiera*, pour laquelle nous proposons la dénomination "crassa".

Sphenobaiera crassa n. sp.

(Pl. II, Fig. 2)

Holotypus: numéro d'inventaire 11873, Laboratoire de Géologie et Paléontologie de l'Université de Cluj-Napoca.

Derivatio nominis: crassus-solide, gras.

Locus typicus: Anina(ante Steierdorf), Roumanie.

Stratum typicum: Lias inférieur.

Description. Leaves with short and rounded base divided 3-4 times. Lobes small and linear, sinuses despersed and narrowed. Nervation branched, dichotomous. Amphistomatique leaves. Lower epidermis is formed of cells arranged in rows. There are rows with stomata and without stomata. All cells are provided with rounded papillae. Stomata irregularly disposed. Guard cells small non coloured, subsidiary cells (5-6) provided with strongly cutinised rounded papillae which cover partly the guard cells.

Conclusions

Sphenobaiera crassa est la deuxième nouvelle espèce de *Sphenobaiera* que l'on décrit de cette région. C'est Semaka (1962) qui a décrit de Doman, puis d'Anina, la *S. rarefurcata*, matériel dont nous avons eu la possibilité d'examiner la structure épidermique et de confirmer ainsi qu'il s'agissait d'une nouvelle espèce. *Sphenobaiera crassa* vient s'ajouter ainsi aux autres espèces citées d'Anina, à savoir: *S. colchica* (PRYN.) DELLE, *S. furcata* (HEER) FLORIN, *S. rarefurcata* SEMAKA em. GIV., *S. ex gr. longifolia* (POMEL) FLORIN, *S. ex gr. pulchella* (HEER) FLORIN. A l'exception de la première, toutes les autres on pu être examinées au point de vue cuticulaire.

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Annexe
Les *Sphaenobaiera* de l'espace euro-asiatique:

AGE	OCURRENCE	NOM DU TAXON
		1. A épiderme décrit
J1	Siberie	<i>angustiloba</i> (HEER) FLORIN, 1936, épid. SAMYLINA, 1955
C1	Siberie	<i>biloba</i> PRYNADA, 1938
J1	Groenland	<i>boeggildiana</i> HARRIS, 1935
T	Suisse	<i>furcinervis</i> (HEER) FLORIN, 1936, épid. KRÄUSEL, 1940
C1	Siberie	<i>flabellata</i> VASSILEVSKAIA, 1963
J1	Iran	<i>grandis</i> KILPER, 1971
J1	Yorkshire	<i>gyron</i> HARRIS, MILLINGTON, 1974
C1	Franz-Jos. Land	<i>horniana</i> FLORIN, 1936
C1	Groenland	<i>ikorfatensis</i> (SEWARD) FLORIN, 1936, épid. SAMYLINA, 1956
Js	Kazachstan	<i>kazachstanika</i> DOLUDENKO, 1976
J1	Groenland	<i>leptophylla</i> (HARRIS) FLORIN, 1936
Js, C1	France, Siberie	<i>longifolia</i> (POMEL) FLORIN 1936, épid. SAMYLINA, 1956
J	Yorkshire	<i>ophioglossum</i> HARRIS et al., 1974
C1	Franz-Jos. Land	<i>paucinervis</i> FLORIN, 1936
J1	Scanie	<i>paucipartita</i> (NATHORST) FLORIN, 1936
J	Yorkshire	<i>pecten</i> HARRIS, 1945
J1	Iran	<i>paragrandis</i> KILPPER, 1971
C1	Siberie	* <i>pulchella</i> (HEER) FLORIN, 1936
J1	Roumanie	* <i>rarefurcata</i> SEMAKA, 1962
J1	Scanie	<i>spectabilis</i> (NATHORST) FLORIN, 1936
C1	Spitzber	<i>spetbergensis</i> (NATHORST) FLORIN, 1936
C1	Siberie	<i>uninervis</i> SAMYLINA, 1956
Js	Gruzie	<i>samylinae</i> DOLUDENKO et SVANIDZE, 1969
		2. Sans épiderme décrit
Js	Gruzie	<i>colchica</i> (PRINADA) DELLE, 1959
J1	Siberie	<i>czekanovskiana</i> (HEER) FLORIN, 1936
J1	Siberie	<i>dzergaianensis</i> GENKINA, 1966
J1	Chine	<i>eurybasis</i> SZE, 1959
Js	Chine	<i>huangi</i> STE, HSU, 1964
J	Kaukase	<i>magnifolia</i> AKSARIN, 1955
Js	Japan	<i>nipponica</i> KIMURA, TSUJII 1984
J1	Siberie	<i>orientalis</i> VACHRAMEEV, LEBEDEEV, 1974
C2	Siberie	<i>paraangustiloba</i> LEBEDEEV, 1974
Ts	Siberie	<i>petsorica</i> CHRAMOV, 1977
T1	Siberie	<i>orrecta</i> MOGUTSCHEV, 1972
C1	Siberie	<i>pseudolongifolia</i> ABRAMOVA, 1970
Ts	Donbas	<i>stenoloba</i> STANISLAVSKY, 1976
T	Siberie	<i>suluktensis</i> BRICKSIXTEL, 1960
T1	Taimire	<i>taymirensis</i> SCHVEDOV, 1960
Js	Gruzie	<i>tsagarelli</i> SVANIDZE, 1973
J1	Siberie	<i>turkestanuka</i> (PRYNADA, 1931) KIRITCHKOVA, SAMYLINA, 1984
Js	Siberie	<i>umaltensis</i> KRASSILOV, 1972
J1	Siberie	<i>urgalica</i> KRASSILOV, 1972
T1	Siberie	<i>vittaeformis</i> MOGUTSCHEVA, 1977
P	Ferghana	<i>zalesskui</i> KRYSHTOFOVICI, 1912

Note: les synonymes n'ont pas été pris en considération;

* - épiderme sous presse.



Planche I

Fig. 1 – La plaque de schiste aux feuilles de *Sphenobaiera crassa*. 1:1; voir Pl. II, fig. 1.

Figs. 2, 3 – Les deux feuilles séparées et reconstituées; 1:1.

Figs. 4, 5, 6 – Stomates et cellules épidermiques sur l'épiderme inférieur; 320 x; voir aussi Pl. II, figs. 4, 5.



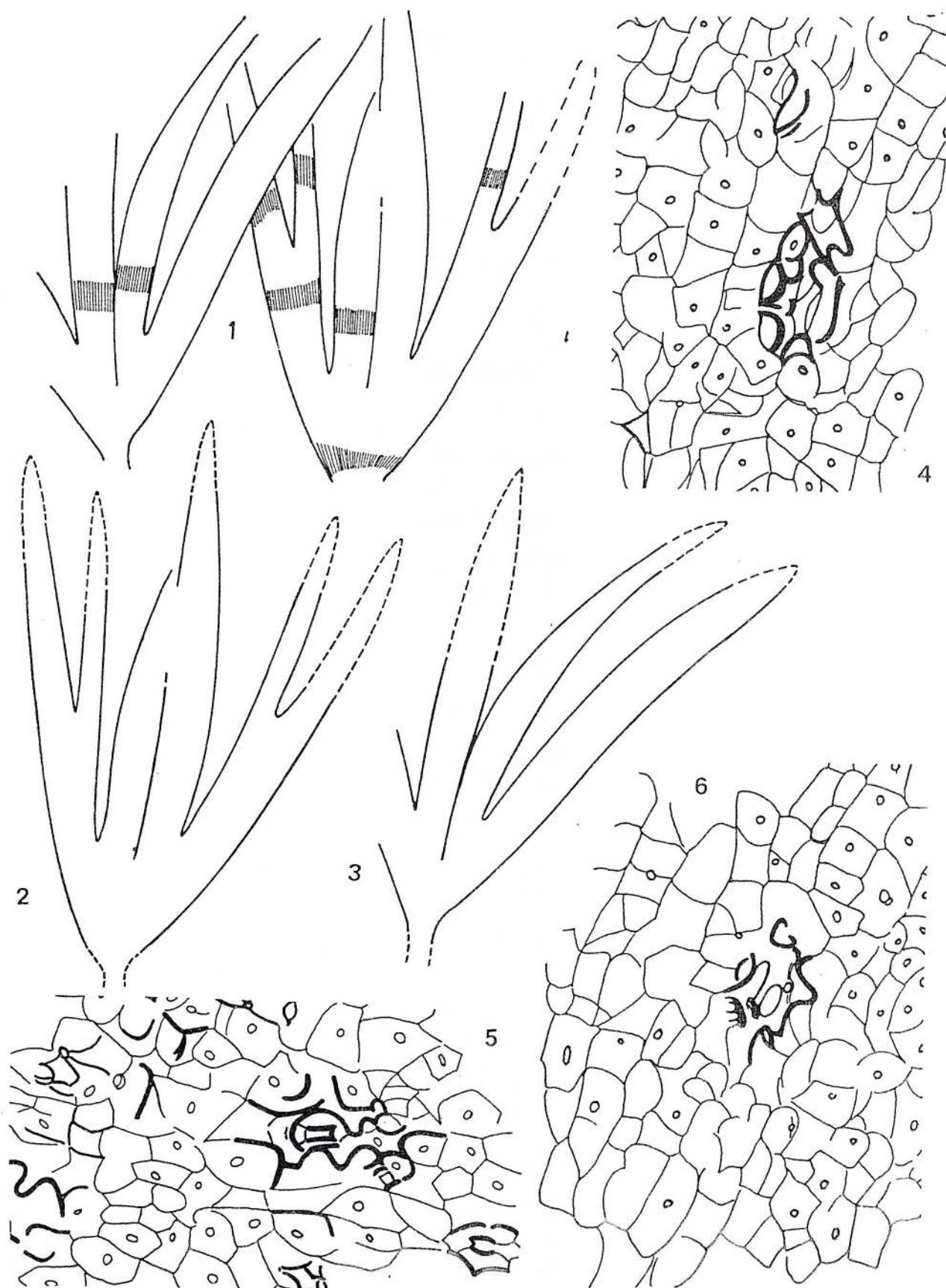


Planche II

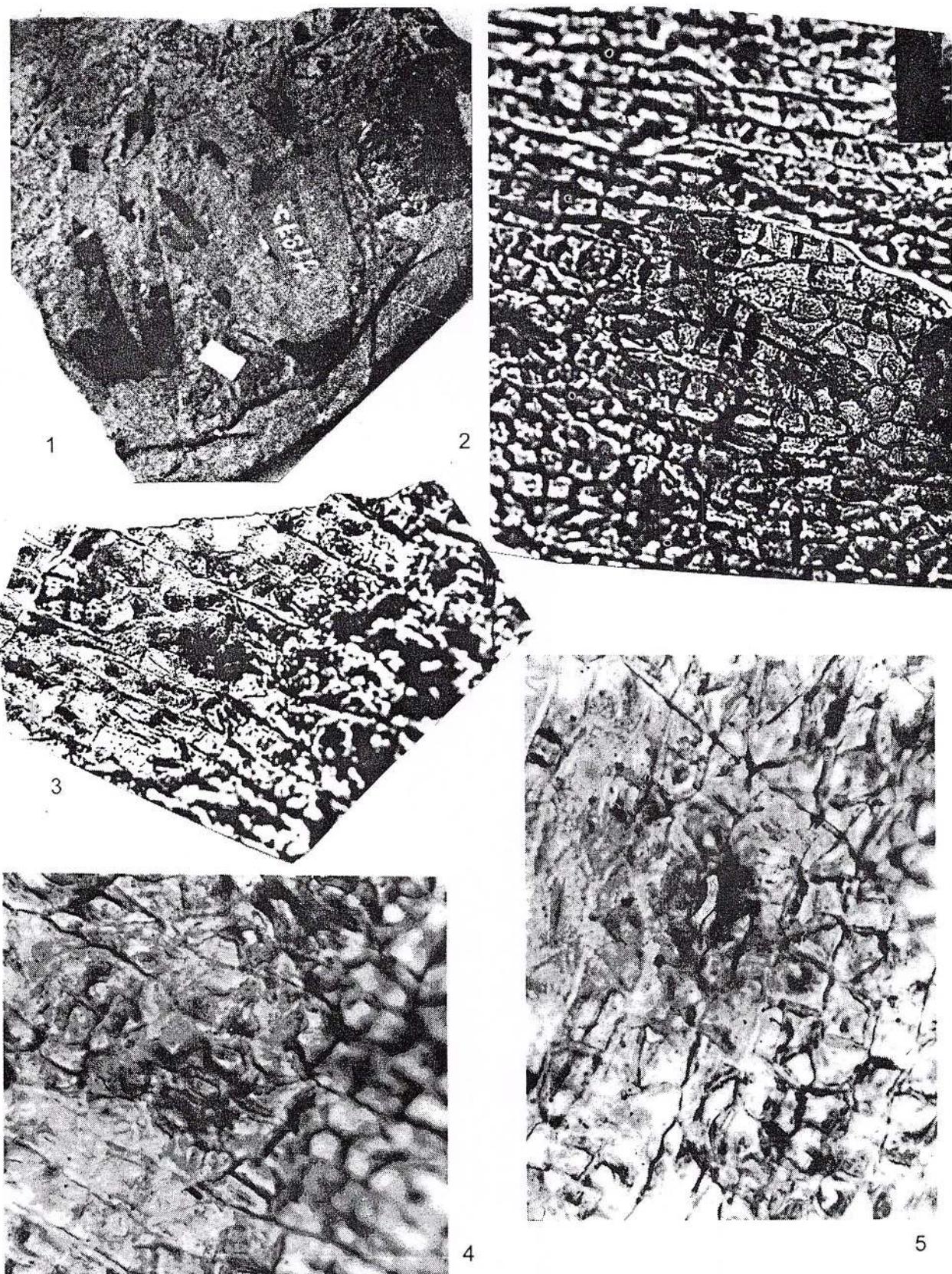
Fig. 1 – Echantillon original 1:0,7.

Fig. 2 – *Sphenobaiera crassa*; épiderme inférieur, 280 x. En bas de la photo, cellule à rangées stomatiques, en haut sans stomates.

Fig. 3 – Epiderme inférieur, stomates et cellules à papilles; 300 x.

Figs. 4, 5 – Stomates sur l'épiderme inférieur; 320 x.





LATE ALBIAN AND CENOMANIAN PLANKTONIC FORAMINIFERA IN THE ROMANIAN BLACK SEA OFFSHORE AND THE AGE OF THE CORRESPONDING FORMATIONS

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Key words: Planktonic foraminifera. Late Albian-Cenomanian. Western Black Sea. Romanian offshore.



Abstract: Eighteen species of planktonic foraminifera coming from the Late Albian and Cenomanian deposits of the Romanian Black Sea offshore are reported. Four planktonic foraminiferal zones and two subzones are recognized within the above-mentioned time interval: Rotalipora apenninica Zone, R. brotzeni Zone, R. reicheli Zone and R. cushmani Zone (with R. cushmani and Whiteinella paradubia subzones). The age of the two lithostratigraphical units which yielded this fauna, namely Lebăda and Tomis formations, are assigned to the Late Albian-Cenomanian and the Cenomanian, respectively.

Introduction

The exploration of hydrocarbons by wells in the Romanian Black Sea offshore started in 1976. The drilled wells are distributed in an area situated between $43^{\circ}55'$ and $44^{\circ}41'$ northern latitude and $28^{\circ}38'$ and $29^{\circ}54'$ eastern longitude. Despite this long activity, no paleontological data are published.

The geological setting of the study zone shows numerous similarities with the adjacent onshore Dobrogea region (Fig. 1). Late Albian to Cenomanian strata are known only from the Histria and northern offshore blocks situated in the offshore extension of the North Dobrogea structural unit (Babadag Basin inclusive).

The fossil material presented here is deposited in the PETROMAR Collection (PC); analysed samples consist of core fragments, about eight centimetres in diameter and two to ten centimetres in height.

Lithostratigraphy

The Late Albian and Cenomanian deposits from the Romanian Black Sea offshore have been assigned to the Lebăda and Tomis formations (Georgescu, 1993).

Lebăda Formation. Within this lithostratigraphical unit both outer shelf and slope turbidites are recorded. The deposits consist mainly of conglomerates, microconglomerates and quartzitic and lithic

sandstones; dark coloured marlstones and clays are present as intercalations whose thickness does not exceed twenty centimetres. The Lebăda Formation disconformably overlies the Upper Jurassic and Lower Cretaceous (Late Oxfordian throughout Valanginian) dominant carbonate deposits. According to planktonic foraminifera (Fig. 2) the age of this formation in the southern part of the Histria block is Late Albian, while in the northern part it comprises the entire Late Albian-Cenomanian interval.

Tomis Formation. This lithostratigraphical unit consists of dark marlstones and clays with thin sandy interbeds. It was recorded in the south-western part of the Histria block, pointing out an outer shelf sedimentation facies. Its Cenomanian age is proved by the three planktonic foraminiferal biozones recognized: Rotalipora brotzeni Zone, R. reicheli Zone and R.-cushmani Zone. The relationship of the Tomis Formation with the Lebăda Formation is presented in Figure 2.

Both Lebăda and Tomis formations are overlain either by the Lebăda West Formation [Turonian(?) Coniacian] or Unirea Formation (Late Santonian-Maastrichtian).

Biostratigraphy

A zonation based on planktonic foraminifera is proposed for the Late Albian and Cenomanian deposits of the Romanian Western Black Sea offshore (Fig. 3).



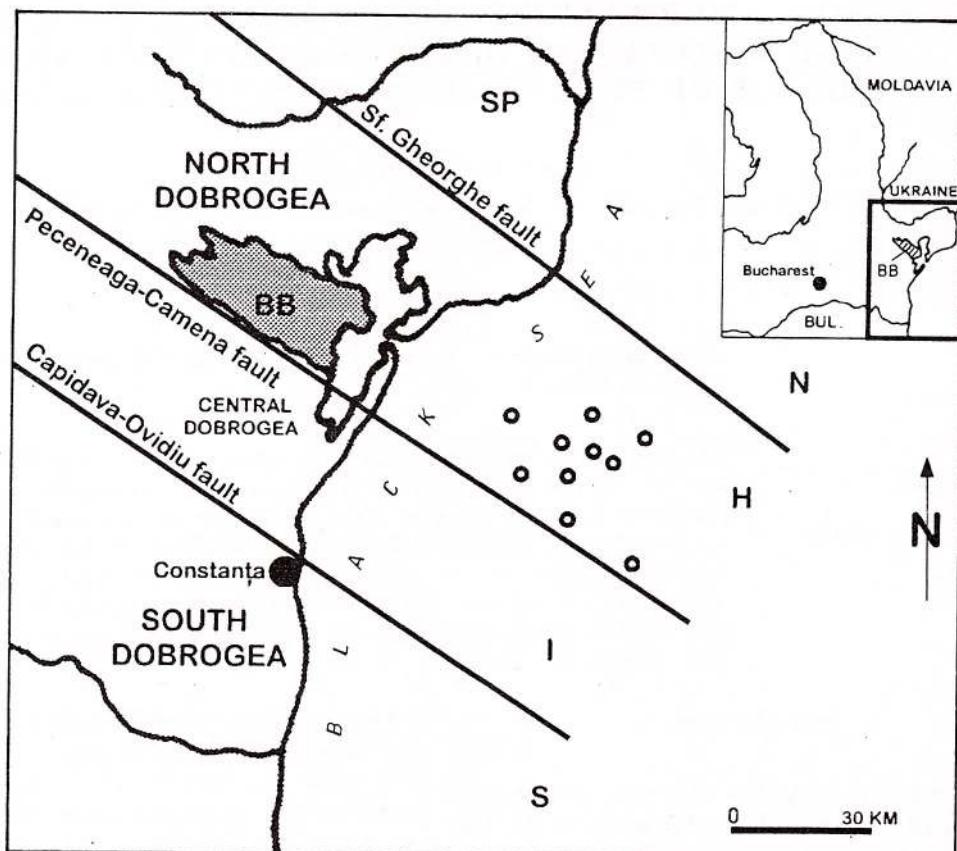


Fig. 1 – Romanian Black Sea offshore with the wells yielding Late Albian and Cenomanian deposits. BB-Babadag Basin, H-Histria Block, I-Intermediate Block, N-Northern Block, S-Southern Block, SP-Scythian Platform.

It is a combination of the biozonation previously proposed by Robaszynski et al. (1979) for the Tethyan Realm, those established in Romania (East and South Carpathians as well as North Dobrogea) by Ion (Ion, 1976, 1983, 1993, Ion in Ion & Szasz 1988, Ion in Szasz & Ion 1994) and our emendations (see Rotalipora cushmani Subzone). The age of the biostratigraphic units is according to those established by Ion, in Romania, by direct correlations with the ammonite and for inoceramid faunas.

Remarks: The upper limit of this biozone is well defined in the study area as in certain parts (northern part of Histria block) a continuity in sedimentation between Late Albian and Cenomanian is known. The lower limit of this biozone in the Romanian sector of the western Black Sea offshore is not known; its deposits unconformably overlie Triassic, Jurassic and Cretaceous rocks. The planktonic foraminiferal content of these strata indicates (Fig. 4) a Late Albian age, proved by Rotalipora apenninica Zone.

Rotalipora apenninica Zone

Author: Bronnimann (1952).

Definition: According to Bronnimann (1952) this biozone comprises the interval between the first occurrence (FO) of *Rotalipora apenninica* (RENZ) and FO of *R. brotzeni* (SIGAL).

Age: Late Albian.

Rotalipora brotzeni Zone

Author: Lehman (1966).

Definition: This biozone comprises the interval between FO of *Rotalipora brotzeni* (SIGAL) and FO of *R. reicheli* (MORNOD).

Age: Latest Albian-Early Cenomanian.

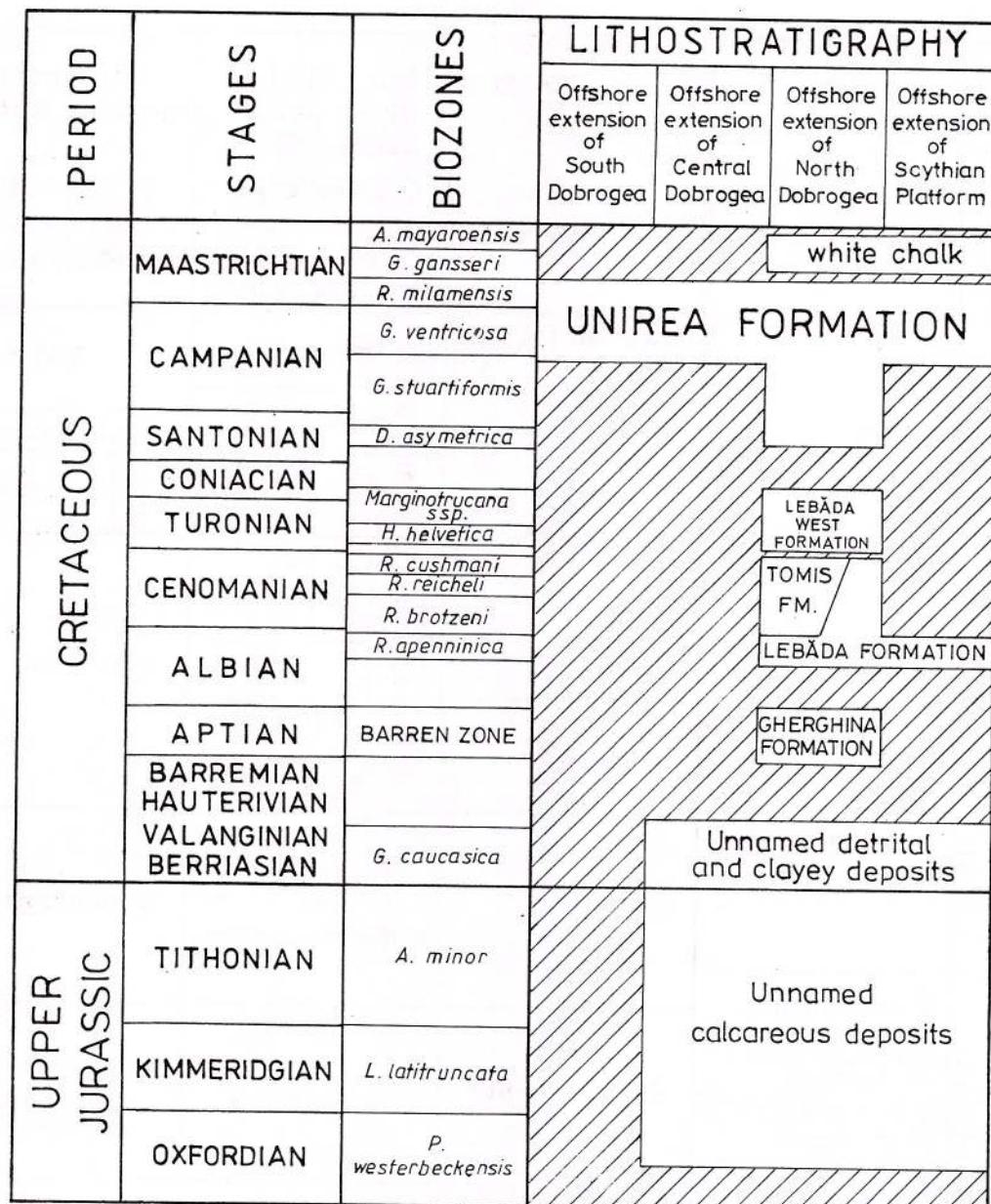


Fig. 2 - Laté Albian and Cenomanian lithostratigraphical units in the Romanian Black Sea offshore and their relationship with the adjacent deposits. No scale implied.

Rotalipora reicheli Zone

Author: Bolli (1966).

Definition: The interval between FO of *Rotalipora reicheli* (MORNOD) and FO of *R. cushmani* (MORROW).

Age: Latest Lower Cenomanian-Middle Cenomanian.

Rotalipora cushmani Zone

Author: Borsetti (1962), but with definition emend. (in this paper?)

Definition: The interval between the FO of *Rotalipora cushmani* (MORROW including *R. turonica* BROTZEN as junior synonym) and FO of *Whiteinella archaeocretacea* PESSAGNO.

Age: Upper Cenomanian (excepting its topmost).

Remarks: Despite the fact that the lower limit of this zone is easily recognizable in the Romanian Black Sea offshore, the upper limit is considered at the discordance between the Lebăda and Tomis formations and Lebăda west Formation (Turonian-(?) Coniacian). As its faunal content differs very much between the basal and upper parts of this zone, two

STAGES		Vonders (1980) WESTERN MEDITERRANE	Robaszynski et al. (1979) TETHYAN REALM	Ion (1993) Ion in Ion & Szász (1994) CONTINENTAL ROMANIA (CARPATHIANS and DOBROGEA)	Georgescu (present study) BLACK SEA ROMANIA OFFSHORE
LATE	CENOMANIAN				
	MIDDLE	<i>R. cushmani</i>	<i>R. cushmani</i>	<i>W. archaeocretacea</i> <i>D. imbricata</i> <i>W. paradubia</i> <i>R. gr. cushmani - turonica</i>	GAP
	EARLY	<i>R. globotruncanoides</i>	<i>R. reicheli</i>	<i>Th. deeckeii</i> <i>Th. reicheli</i> <i>Th. porthaulti</i>	<i>R. cushmani</i> <i>W. paradubia</i> <i>R. cushmani</i>
LATE ALBIAN		<i>R. appenninica</i> <i>R. appenninica / Pl. buxtorfi</i> <i>R. ticinensis / Pl. buxtorfi</i> <i>R. ticinensis</i> <i>R. subticinensis</i>	<i>R. brotzeni</i> <i>R. appenninica</i> <i>R. ticinensis / R. subticinensis</i>	<i>Th. brotzeni / Th. globotruncanoides</i> <i>Th. appenninica</i>	<i>R. reicheli</i> <i>R. brotzeni</i> <i>Th. appenninica</i>
					GAP

Fig. 3 – Late Albian-Cenomanian planktonic foraminiferal zonation in the Romanian Black Sea offshore and its relationship with other planktonic foraminiferal scales.

subzones are considered within it: Rotalipora cushmani Subzone and Whiteinella paradubia Subzone.

Rotalipora cushmani Subzone

Author: according to definition, Ion (1978), renamed in this paper.

Definition: Interval between FO of *Rotalipora cushmani* (MORROW) and FO of *Whiteinella paradubia* (SIGAL).

Age: Late Cenomanian.

Remarks: With this definition, Ion (1978) erected the Rotalipora gr. cushmani-turonica Zone for the lower part of the Upper Cenomanian in Romania. As far as *Rotalipora turonica* BROTHZEN is accepted by some micropaleontologists to be a junior synonym of *R. cushmani* (MORROW), we preferred to maintain it as a subzone, named Rotalipora cushmani Subzone, at the base of *R. cushmani* Zone.



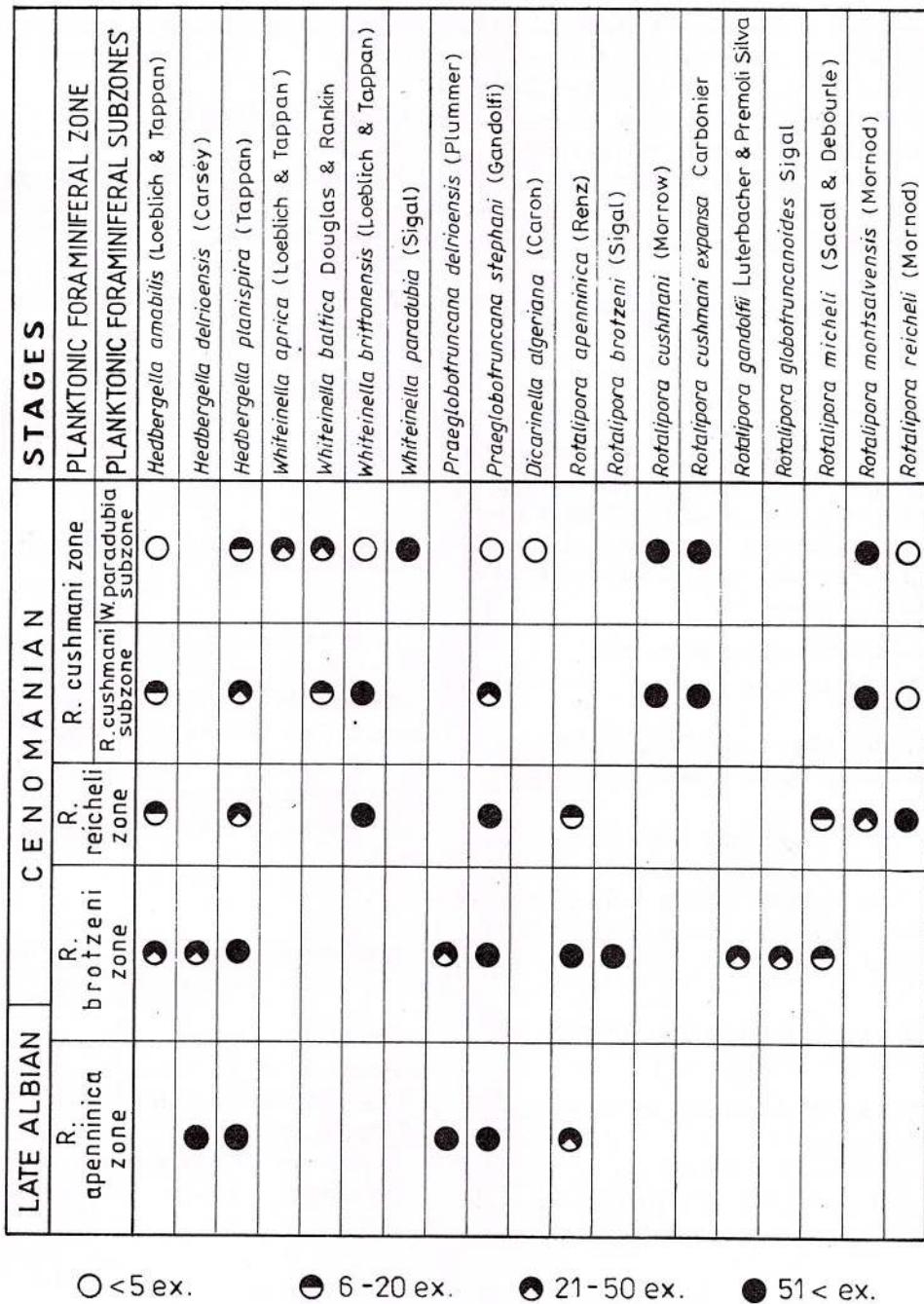


Fig. 4 – Stratigraphical distribution and frequency of the Late Albian-Cenomanian planktonic foraminiferal species in the corresponding formation of Romanian Black Sea offshore.

Whiteinella paradubia Subzone

Author: Ion (1978), emended by Ion in Szasz & Ion, 1984 (fide pl. I)

Definition: The interval between the FO of *Whiteinella paradubia* (SIGAL) and FO of *Dicarinella imbricata* (MORNOD).

Age: Late Cenomanian.

Remarks: This subzone (Ion, 1978) has initially been defined as Hedbergella paradubia Subzone for the interval from the FO of *H. paradubia* to the FO of *Dicarinella imbricata* and *D. indica* (=*D. hagni*); subsequently (Ion in Szasz & Ion, see pl. I) it is reported as Whiteinella paradubia Subzone representing the interval from the FO of *W. paradubia* to the FO of *D. imbricata*. In the Black Sea offshore de-

posites the lower limit of this zone is well defined either within the Tomis Formation or the Lebăda Formation by the FO of the index species. The upper limit is considered with the sharp discordance between the already mentioned two lithostratigraphical units and the overlying Lebăda West Formation; the gap between them comprises the latest Cenomanian-earliest Turonian time interval. Within this subzone, the proliferation of *Whiteinella* and the first occurrences of *Helvetoglobotruncana* and *Dicarinella* genera are to be noted.

Systematics

The suprageneric classification is considered after Loeblich & Tappan (1988). The definition of the genera and of some species are according to Rovaszynski et al. (1979). *Rotalipora* s.s. is separated as *R. cushmani morpha* FYPICA and *R. turonica expansa* as *R. cushmani morpha expansa*

Order Foraminifera EICHWALD, 1830

Suborder Globigerinina DELAGE & HEROUARD, 1896

Superfamily Rotaliporacea SIGAL, 1859

Family Hedbergellidae LOEBLICH & TAPPAN, 1961

Subfamily Hedbergellinae LOEBLICH & TAPPAN, 1961

Genus *Hedbergella* BRONNIMANN & BROWN, 1958

Type species: *Anomalina lorneiana* var. *trocoides* GANDOLFI, 1942

Hedbergella amabilis LOEBLICH & TAPPAN, 1961

(Pl. I, figs. 2 a-b)

Hedbergella amabilis LOEBLICH & TAPPAN, 1961, p. 274, pl. 3, figs. 2, 3, 5.

Dimensions: D max = 0.32-0.38 mm.

Occurrence: Latest Albian-Early Cenomanian (R. brotzeni Zone) to Late Cenomanian (W. paradubia Subzone).

Hedbergella delrioensis (CARSEY), 1926

(Pl. I, figs. 3 a-b)

Globigerina cretacea D'ORBIGNY var. *delrioensis* CARSEY, 1926, p. 43.

Globigerina infracretacea GLAESSNER, 1937, p. 28, text-fig. 1.

Hedbergella delrioensis (CARSEY), Loeblich & Tappan, 1961, p. 275, pl. 2, figs. 11-13; Leckie, 1984, p. 598, pl. 1, fig. 12, pl. 9, figs. 1-4, 8.

Dimensions: D max = 0.40-0.46 mm.

Occurrence: Late Albian (R. apenninica Zone) to Latest Albian-Early Cenomanian (R. brotzeni Zone).

Hedbergella planispira (TAPPAN), 1940

(Pl. I, figs. 1 a-c)

Globigerina planispira TAPPAN, 1940, p. 122, pl. 19, fig. 12.

Hedbergella planispira (TAPPAN), Loeblich & Tappan, 1961, p. 276, pl. 5, figs. 4-11; Leckie, 1984, p. 599, pl. 9, figs. 6-7.

Dimensions: D max = 0.25-0.36 mm.

Occurrence: Late Albian (R. apenninica Zone) to Late Cenomanian (W. paradubia Subzone).

Genus *Whiteinella* PESSAGNO, 1967

Type species: *Whiteinella archaeocretacea* PESSAGNO, 1967

Whiteinella aprica (LOEBLICH & TAPPAN), 1961

(Pl. I, figs. 4 a-b)

Ticinella aprica LOEBLICH & TAPPAN, 1961, p. 292, pl. 4, figs. 14-16.

Whiteinella aprica (LOEBLICH & TAPPAN), Porthault (in Donze et al.), 1970, p. 66, pl. 9, fig. 16; Robaszynski et al., 1990, pl. 27, figs. 4, 6, 7.

Dimensions: D max = 0.30-0.44 mm.

Occurrence: Late Cenomanian (R. cushmani Zone).

Whiteinella baltica DOUGLAS & RANKIN, 1969

(Pl. II, figs. 1 b-c)

Whiteinella baltica DOUGLAS & RANKIN, Robaszynski et al., 1979, p. 165, pl. 35, figs. 1-5, pl. 36, figs. 1-2; Robaszynski et al., 1990, pl. 27, figs. 1, ?(2, 3), 8.

Dimensions: D max = 0.46-0.53 mm.

Occurrence: Late Cenomanian (R. cushmani Zone).

Whiteinella brittonensis (LOEBLICH & TAPPAN), 1961

(Pl. I, figs. 5 a-c)

Hedbergella brittonensis LOEBLICH & TAPPAN, 1961, p. 274, pl. 4, figs. 1-8.

Hedbergella brittonensis (LOEBLICH & TAPPAN), Neagu, 1969, p. 139, pl. 13, figs 7-12 (non fig. 13 = *W. paradubia*), pl. 4, figs. 1-6, 16-18, pl. 15, figs. 1-2.

Dimensions: D max = 0.34-0.42 mm.

Occurrence: "Middle" Cenomanian (R. reicheli Zone) to Late Cenomanian (R. cushmani Zone).



Whiteinella paradubia (SIGAL), 1952
(Pl. I, figs. 6 a-c)

Globigerina paradubia SIGAL, 1952, text-fig. 28.
Hedbergella paradubia (SIGAL), Porthault (in Donze et al.), 1970, p. 64, pl. 9, figs. 13-15; Ion (in Szasz & Ion), 1988, pl. 24, fig. 8, pl. 27, figs. 1-3; Robaszynski et al., 1990, pl. 27, fig. 9

Dimensions: D max = 0.36-0.43 mm.

Occurrence: Late Cenomanian (W. paradubia Sub-zone).

Subfamily **Rotundininae** SAMUEL & SALAJ, 1977
Genus *Praeglobotruncana* BERMUDEZ, 1952
Type species: *Globorotalia delrioensis* PLUMMER, 1931

Praeglobotruncana delrioensis (PLUMMER), 1931
(Pl. II, figs. 2 a-c)

Globorotalia delrioensis PLUMMER, 1931, p. 199, pl. 13, fig. 2.

Praeglobotruncana delrioensis (PLUMMER, Loeblich & Tappan, 1961, p. 280, pl. 6, figs. 9-12; Caron, 1966, p. 722, pl. 2, fig. 1; Ion, 1983, p. 101, pl. 35, fig. 1, pl. 36, fig. 1; Leckie, 1984, p. 600, pl. 12, fig. 1.

Dimensions: D max = 0.35-0.42 mm.

Occurrence: Late Albian (R. apenninica Zone) to Latest Albian-Early Cenomanian (R. brotzeni Zone).

Praeglobotruncana stephani (GANDOLFI), 1942
(Pl. II, figs. 3 a-c)

Globotruncana stephani GANDOLFI, 1942, p. 130, pl. 3, figs. 4-5, pl. 4, figs. 36-37, 41-42, pl. 9, figs. 5, 8, pl. 14, fig. 2.

Praeglobotruncana stephani (GANDOLFI), Bolli et al., 1957, p. 39, pl. 9, fig. 2; Loeblich & Tappan, 1961, p. 284, pl. 12, figs. 9-12; Ion, 1983, p. 104, pl. 35, fig. 2; Leckie, 1984, p. 600, pl. 2, figs. 9-12.

Dimensions: D max = 0.35-0.43 mm.

Occurrence: Late Albian (R. apenninica Zone) throughout Late Cenomanian (R. cushmani Zone).

Subfamily **Helvetoglobotrunciniae** LAMOLDA, 1970

Genus *Dicarinella* PORTHAULT, 1970
Type species: *Dicarinella indica* JACOB & SASTRY, 1966

Dicarinella algeriana (CARON) 1966
(Pl. II, figs. 4 a-c)

Praeglobotruncana algeriana CARON, 1966, p. 74, pl. 2, fig. 5.

Dicarinella algeriana (CARON), Ion, 1983, p. 111, pl. 35, fig. 4, pl. 36, fig. 5; Ion (in Szasz & Ion), 1988, pl. 27, fig. 9.

Dimensions: D max = 0.40-0.45 mm.

Occurrence: Late Cenomanian (W. paradubia Sub-zone).

Family **Rotaliporinae** SIGAL, 1958

Subfamily **Rotaliporinae** SIGAL, 1958

Genus *Rotalipora* BROTZEN 1942

Type species: *Globorotalia cushmani* MORROW, 1934

Rotalipora apenninica (RENZ), 1936
(Pl. II, figs. 5 a-c)

Globotruncana appenninica RENZ, 1936, p. 14; fig. 2.

Rotalipora appenninica appenninica (RENZ; Luterbacher & Premoli Silva, 1962, p. 266, pl. 19, figs. 1-2, pl. 20, figs. 1-4, pl. 21, figs. 1-4).

Rotalipora apenninica (RENZ), Caron & Luterbacher, 1969, p. 26, pl. 8, fig. 8; Robaszynski et al., 1979, p. 59, pl. 4, figs. 1-3, pl. 5, figs. 1-3.

Thalmanninella appenninica (RENZ), Wonders, 1978, p. 130, pl. 1, figs. 5-6.

Dimensions: D max = 0.35-0.43 mm.

Occurrence: Late Albian (R. apenninica Zone) throughout "Middle" Cenomanian (R. reicheli Zone).

Rotalipora brotzeni (SIGAL), 1948
(Pl. II, figs. 6 b, c)

Thalmanninella brotzeni SIGAL, 1948, p. 26, text-fig. 25; Ion, 1983, p. 87, pl. 16, fig. 1; Ion (in Szasz & Ion), 1988, pl. 22, fig. 1.

Rotalipora brotzeni (SIGAL), Bolli et al., 1957, p. 41, pl. 9, fig. 7; Robaszynski et al., 1979, p. 63, pl. 6, figs. 1-3.

Dimensions: D max = 0.44-0.51 mm.

Occurrence: Latest Albian-Early Cenomanian (R. brotzeni Zone).

Rotalipora cushmani (MORROW), 1934 morpha typica
(Pl. III, figs. 1 a-b)

Globorotalia cushmani MORROW, 1934, pl. 31, figs. 2, 4.

Rotalipora cushmani (MORROW), Loeblich & Tappan, 1961, p. 297, pl. 8, figs. 1-10; Robaszynski et



al., 1979, p. 69, pl. 7, fig. 1, pl. 8, figs. 1-2; Ion, 1983, p. 97, pl. 9, fig. 1; Ion (in Szasz & Ion), 1988, pl. 24, fig. 8.

Dimensions: D max = 0.53-0.65 mm.

Occurrence: Late Cenomanian (R. cushmani Zone).

Rotalipora cushmani (MORROW) *morpha expansa* CARBONIER, 1952
(Pl. III, figs. 2 a, c)

Globotruncana (Rotalipora) turonica (BROTZEN) *expansa* CARBONIER, 1952, p. 118, pl. 6, fig. 4.

Rotadipora cushmani expansa CARBONIER, Neagu, 1969, p. 146, pl. 28, figs. 7-9, pl. 29, figs. 1-5.

Rotalipora turonica expansa CARBONIER, Ion, 1983, p. 98, pl. 11, figs. 1-4, pl. 12, fig. 4, pl. 15, fig. 3; Ion (in Szasz & Ion) 1988, pl. 24, fig. 6.

Dimensions: D max = 0.55-0.60 mm.

Occurrence: Late Cenomanian (R. cushmani Zone).

Rotalipora gandolfii LUTERBACHER & PREMOLI SILVA, 1962

Rotalipora appenninica gandolfii LUTERBACHER & PREMOLI SILVA, 1962, p. 267, pl. 19, fig. 3.

Rotalipora gandolfii LUTERBACHER & PREMOLI SILVA, Caron & Luterbacher, 1969, p. 26, pl. 9, fig. 3; Robaszynski et al., 1979, p. 81, pl. 11, figs. 1-2; Leckie, 1984, p. 601, pl. 15, figs. 5-12.

Thalmanninella appenninica (RENY), Ion, 1983, p. 84, pl. 2, fig. 1.

Dimensions: D max = 0.45-0.53 mm.

Occurrence: Latest Albian-Early Cenomanian (R. brotzeni Zone).

Rotalipora globotruncanoides SIGAL, 1948
(Pl. III, figs. 4 a-c)

Rotalipora globotruncanoides SIGAL, 1948, p. 100, pl. 1, fig. 4, pl. 2, figs. 3-5.

Thalmanninella globotruncanoides (SIGAL), Wonders, 1978, p. 132, pl. 2, figs. 1-2; Ion, 1983, p. 90, pl. 16, fig. 5; Ion (in Szasz & Ion) 1988, pl. 22, fig. 3.

Dimensions: D max = 0.56-0.63 mm.

Occurrence: Latest Albian-Early Cenomanian (R. brotzeni Zone).

Rotalipora micheli (SACAL & DEBOURLE), 1957
(Pl. III, figs. 6 a-c)

Globotruncana (Rotalipora) micheli SACAL & DEBOURLE, 1957, p. 58, pl. 25, figs. 4-5, 12.

Rotalipora micheli (SACAL & DEBOURLE), Robaszynski et al., 1979, p. 91, pl. 14, figs. 1-3; Leckie, 1984, p. 601, pl. 17, figs. 3-7.

Thalmanninella micheli (SACAL & DEBOURLE), Ion, 1983, p. 88, pl. 23, fig. 4, pl. 24, fig. 1.

Dimensions: D max = 0.55-0.60 mm.

Occurrence: Latest Albian-Early Cenomanian (R. brotzeni Zone) to "Middle" Cenomanian (R. reicheli Zone).

Rotalipora montsalvensis (MORNOD), 1950
(Pl. III, figs. 5 a-c)

Globotruncana (Rotalipora) montsalvensis MORNOD, 1950, p. 584, text-figs. 4 (1), 7 (1-2).

Rotalipora (Rotalipora) montsalvensis (MORNOD), Klaus, 1959, p. 813, pl. 5, fig. 1

Rotalipora montsalvensis (MORNOD), Wonders, 1978, p. 135, pl. 4, figs. 1-2; Ion, 1983, p. 99, pl. 4, figs. 1-3, pl. 5, figs. 1-2, pl. 6, fig. 1; Ion (in Szasz & Ion) 1988, pl. 23, fig. 5.

Dimensions: D max = 0.54-0.62 mm.

Occurrence: "Middle" Cenomanian (R. reicheli Zone) to Late Cenomanian (W. paradubia Subzone).

Rotalipora reicheli (MORNOD), 1950
(Pl. III, figs. 3 a, c)

Globotruncana (Rotalipora) reicheli MORNOD, 1950, p. 583, text-figs. 5 (4), 6 (1-6), pl. 25, figs. 3-4.

Rotalipora reicheli (MORNOD), Caron & Luterbacher, 1969, p. 27, pl. 9, fig. 10; Robaszynski et al., 1979, p. 99, pl. 16, fig. 1, pl. 17, fig. 1, pl. 18, figs. 1-2; Leckie, 1984, p. 601, pl. 17, figs. 1-2.

Thalmanninella reicheli (MORNOD), Ion, 1983, p. 93, pl. 23, fig. 2, pl. 28, fig. 4; Ion (in Szasz & Ion) 1988, pl. 22, fig. 5, pl. 23, fig. 2.

Dimensions: D max = 0.55-0.64 mm.

Occurrence: "Middle" Cenomanian (R. reicheli Zone) to Late Cenomanian (R. cushmani Zone).

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Plate I

- Figs. 1 a-c — *Hedbergella planispira* TAPPAN. Late Albian (R. apenninica Zone). Specimen PC-ss001-56, x 350.
- Figs. 2 a, b — *Hedbergella amabilis* LOEBLICH & TAPPAN. "Middle" Cenomanian (R. reicheli Zone). Specimen PC-ss 002-11, x 200.
- Figs. 3 a, b — *Hedbergella delrioensis* (CARSEY). Latest Albian-Early Cenomanian (R. brotzeni Zone). Specimen PC-ss 001-9a, x 200.
- Figs. 4 a, b — *Whiteinella aprica* (LOEBLICH & TAPPAN). Late Cenomanian (R. cushmani zone). Specimen PC-ss 001-44a, x 350.
- Figs. 5 a-c — *Whiteinella brittonensis* (LOEBLICH & TAPPAN). Late Cenomanian (R. cushmani Zone). Specimen PC-ss 001-44a, x 200.
- Figs. 6 a-c — *Whiteinella paradubia* (SIGAL). Late Cenomanian (W. paradubia Subzone). Specimen PC-ss 001-44b, x 200.



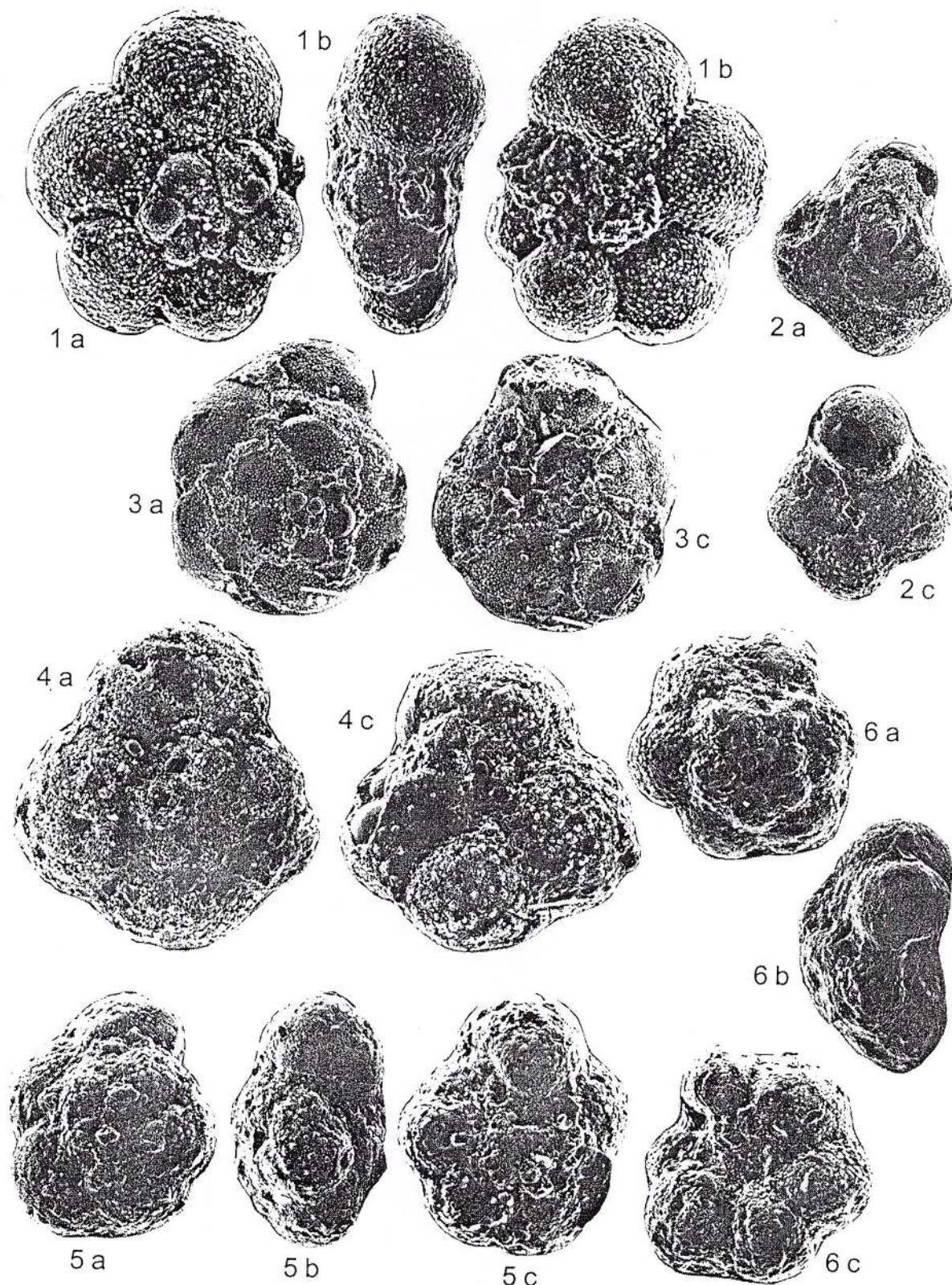
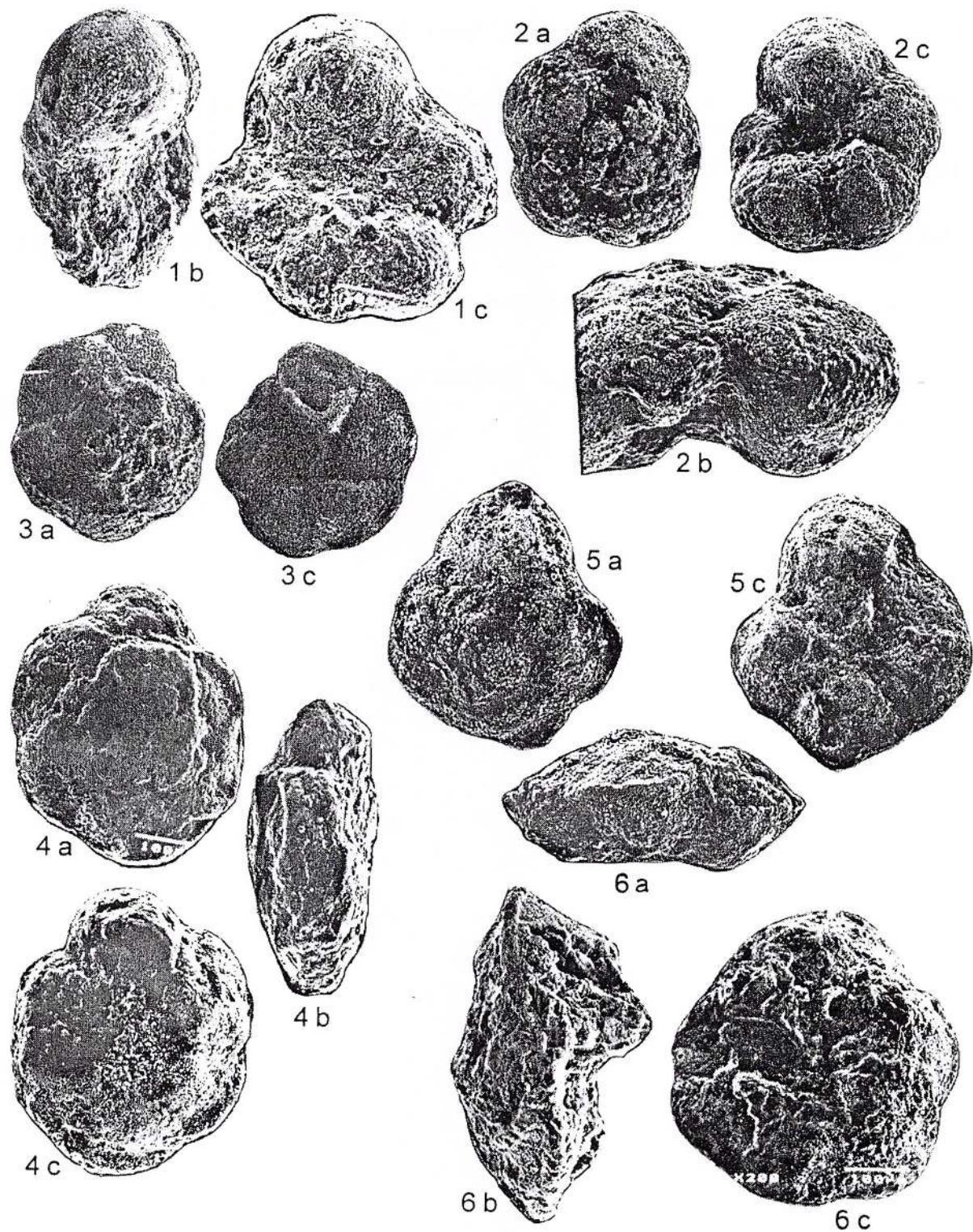


Plate II

- Figs. 1 b, c — *Whiteinella baltica* DOUGLAS & RANKIN. Late Cenomanian (R. cushmani Subzone). Specimen PC-ss 001-28b, x 200.
- Figs. 2 a-c — *Praeglobotruncana delrioensis* (PLUMMER). Late Albian (R. apenninica Zone). Specimen PC-ss 001-2b, 4 A, C (x 150), 4B (x 200).
- Figs. 3 a, c — *Praeglobotruncana stephani* (GANDOLFI). Late Albian (R. apenninica Zone). Specimen PC-ss 001-38a, x 150.
- Figs. 4 a-c — *Dicarinella algeriana* (CARON). Late Cenomanian (W. paradubia Subzone). Specimen PC-ss 002-36, x 200.
- Figs. 5 a-c — *Rotalipora apenninica* (RENZ). Late Albian (R. apenninica Zone). Specimen PC-ss 002-8, x 150.
- Figs. 6 b, c — *Rotalipora brotzeni* (SIGAL). Latest Albian-Early Cenomanian (R. brotzeni Zone). Specimen PC-ss 001-3b, x 150.



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Plate III

Figs. 1 a, b — *Rotalipora cushmani* (MORROW) typica. Late Cenomanian (R. cushmani Subzone). Specimen PC-ss 001-52, x 150.

Figs. 2 a, c — *Rotalipora cushmani* (MORROW) morpha *expansa* CARBONIER. Late Cenomanian (R. cushmani Subzone). Specimen PC-ss 001-45b, x 150.

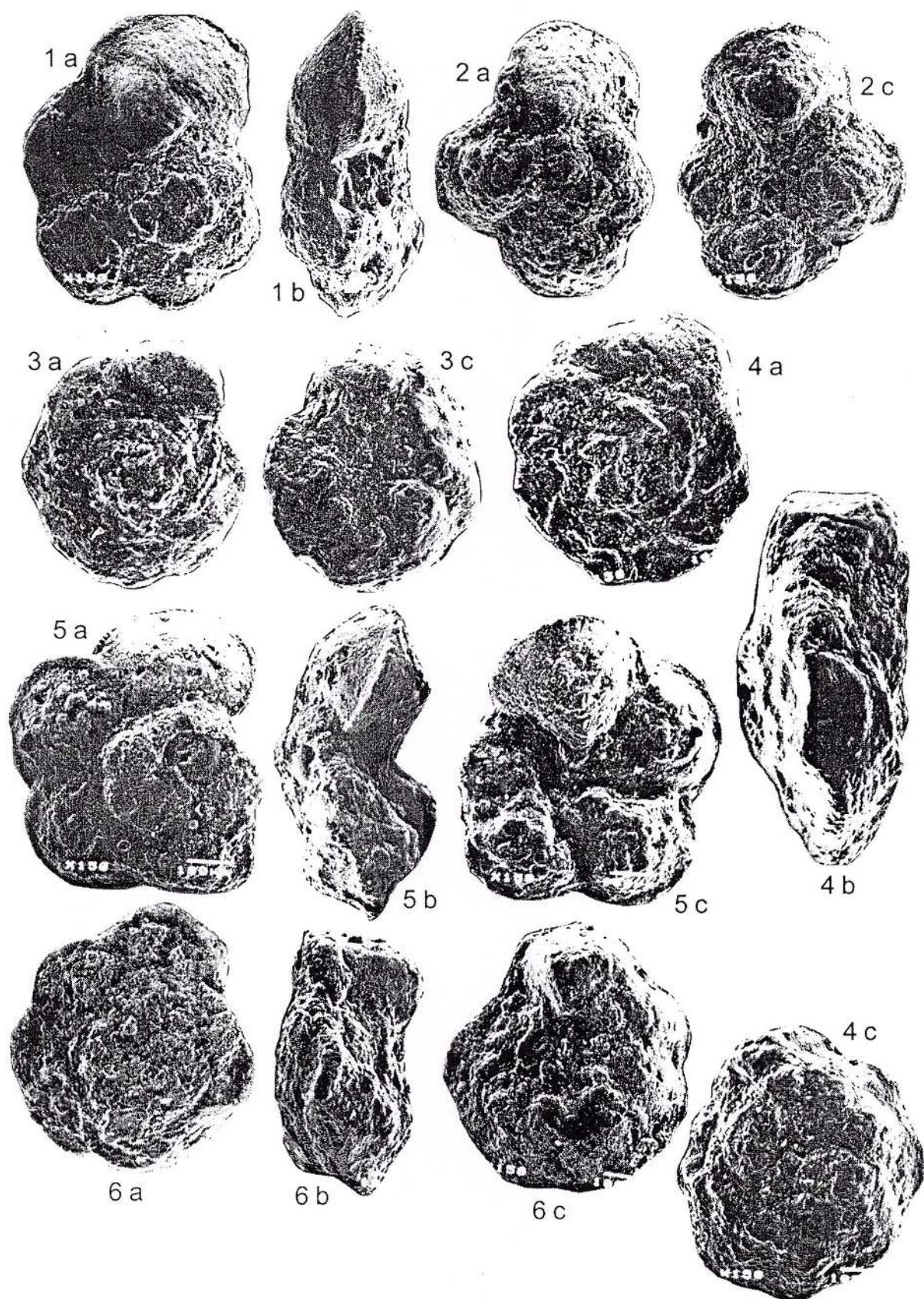
Figs. 3 a, c — *Rotalipora reicheli* (MORNOD). "Middle" Cenomanian (R. reicheli Zone). Specimen PC-ss 001-45b, x 150.

Figs. 4 a, c — *Rotalipora globotruncanoides* (SIGAL). Late Cenomanian (R. cushmani Subzone). Specimen PC-ss 001-40a, 4 A, C (x 150), 4 B (x 200).

Figs. 5 a-c — *Rotalipora montsalvensis* (MORNOD). Late Cenomanian (R. cushmani Subzone). Specimen PC-ss 001-51, x 150.

Figs. 6 a-c — *Rotalipora micheli* (SACAL & DEBOURLE). "Middle" Cenomanian (R. reicheli Zone). Specimen PC-ss 001-12b, x 150.

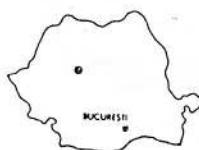




EVOLUTION AND DISTRIBUTION OF THE SENONIAN RUDISTS IN THE APUSENI MOUNTAINS ACCORDING TO PALEOGEOGRAPHIC CHANGES

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Key words: Senonian. Hippuritidae. Radiolitidae. Caprinidae. Chiapassellidae. Paleogeography. Apuseni Mountains. Romania.

Abstract: The Apuseni Mountains (Romanian West Carpathians) constitute a geological unit where during the Senonian paleogeographic evolution gave rise to two distinct zones - northern and southern with a different composition and distribution of the rudists faunas. During the Coniacian - (Lower and Middle) Maastrichtian, access ways linked the southern part to the Internal Dinarids and the northern part to the Sumeg area from Hungary, the Slovak Carpathians and the East and South Alps. In the South Apusenids the rudists deposits occur start with the Coniacian. In the northern part of the Apuseni Mts, the Senonian transgression starts with a lacustrine facies. In the Upper Santonian the transgression reaches the maximum point in both sectors, the rudists faunas well illustrated by the families Hippuritidae, Radiolitidae, Caprinidae and Chiapassellidae. In the Northern Apuseni Mountains the Santonian-Maastrichtian are exclusively constituted of rudists facies, whereas in the southern part they are partially substituted by flysch formations, that in the Maastrichtian settled exclusively. It is assumed that during the Maastrichtian there were connections with the Alpine and Apenninic regions, as well as with the south and southeastern Tethyan area.

1. Introduction

According to their composition, the Senonian rudist associations of the Apuseni Mountains provide sources belonging to various areas of the Tethyan realm. This fact is accountable by the nature of the paleogeographic connexions of the mentioned area.

The rudist bearing carbonate deposits feature, in most cases, lense shapes in tens of meters length-thickets, coppices, clusters or a combination of these three bioconstructing types (Philip, 1972; Kauffmann & Sohl, 1974; Bilotte, 1985).

In the North Apuseni Mountains (Fig. 1) the Senonian deposits are transgressive and offer significant similitudes with the Gossau facies in the Eastern Alps. In both cases the Senonian deposits constitute a post-tectogenetic cover succeeding the pre-Gosau tectogenesis responsible for the setting up of the Austro-Alpine nappes in the Eastern Alps and of the Codru Nappes System in the North Apuseni Mountains (Fig. 2).



Fig. 1 – Location of the study area.

In the South Apuseni Mountains (Fig. 1) although the pre- Gosau tectogenesis is unknown, the Senonian transgression starts in the northern flank with a rudists-bearing formation-(mostly Hippuritidae) while in the middle of the sedimentary basin flysch deposits are replacing them.



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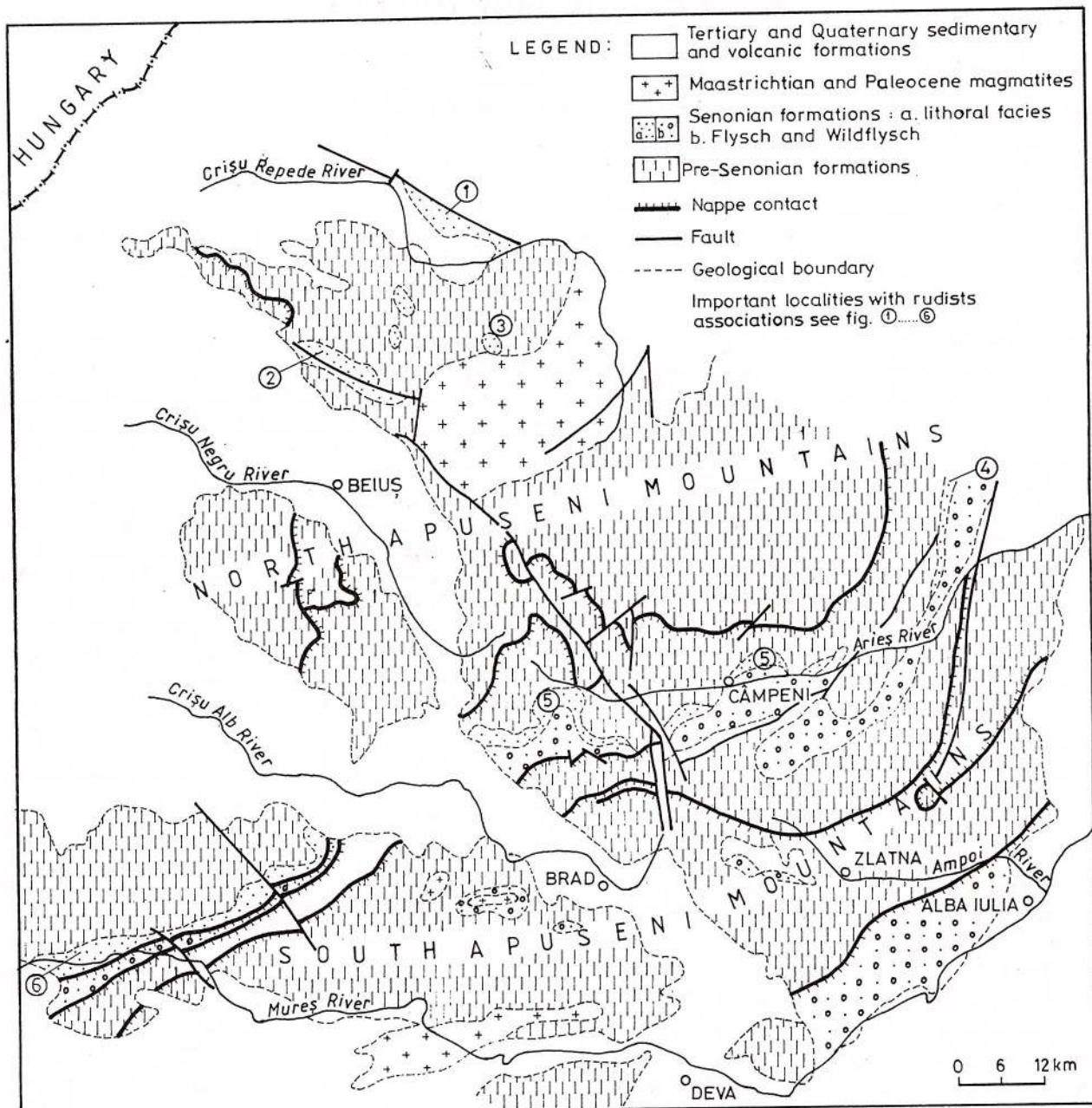


Fig. 2 – Simplified structural sketch of the Apuseni Mountains.

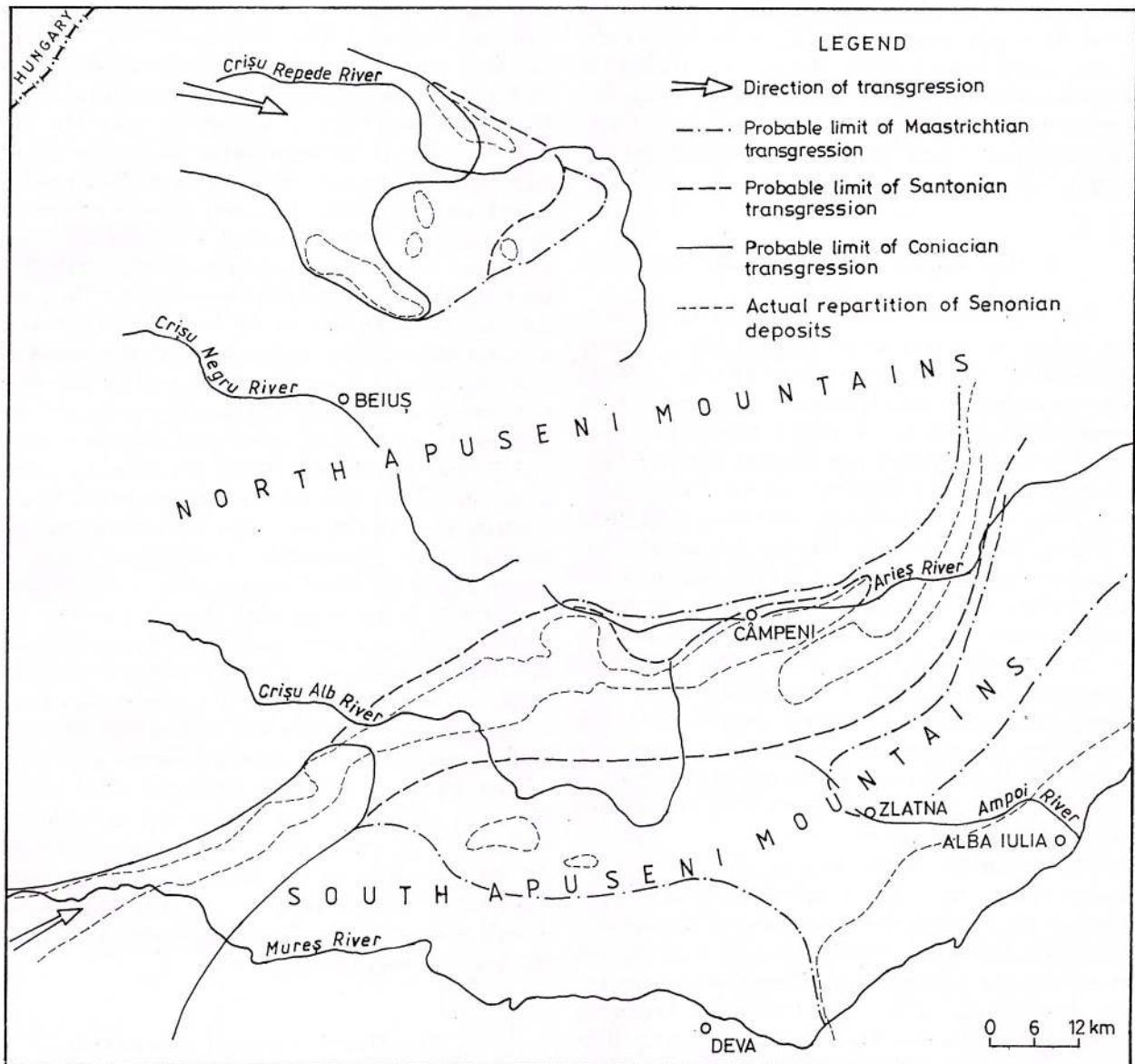


Fig. 3 – The evolution of Senonian transgression in the Apuseni Mountains.

In the North Apuseni Mountains as well as in the South Apuseni Mountains the Senonian transgression advances from W-SW towards E. The littoral areas of this Tethyan segment formed almost probably several gulfs, progressively filled by terrigenous supply, the come back of the sea often yielding after deltaic interludes with **Actaeonellides**, as it results from the study of several *in situ* rudist-bearing deposits (Valea Neagră-Borod, Roșia, etc.). During the Senonian the central part of the Apuseni Mountains constituted an uplifted area, source of detrital supply, being partly invaded by the sea starting with the Upper Santonian-Lower Campanian.

2. The South Apuseni Mountains

The Coniacian transgression started from the western extremity of the South Apuseni Mts. (Drocea Mountains). The sequence has at its base polymictic conglomerates with fragments of the underlying metamorphic rocks, followed by marly sandstones in which 3m calcarenitic lenses appear. Relatively numerous specimens of *Hippurites socialis* DOUV., *Vaccinites oppeli felixi* KUHN., *V. giganteus* d'HOMBRE FIRMAS, *H. praerenensis* TOUCAS are present. It is noteworthy the presence of taxa identified in the Eastern Alps (*V. oppeli felixi*, *V. giganteus*) as well as taxa known in the biopalaeogeographical assemblages of the western and central Mediterranean area (*H. praerenensis*, *H. socialis*, *V. giganteus*). Within the marly sandstones, which include calcarenitic lenses, the rudist *Plagiptychus arnaudi* DOUV. and the ammonite *Reesideoceras* were identified. During the Santonian the advancing of the sea from SW towards NE is obvious (Fig. 3).

The amplitude of the transgression reaches an apogee during the Upper Santonian-Lower Campanian, partly occupying the central area of the Apuseni Mountains, as well. The configuration of the sea shore and the palaeoecological conditions favoured the development of a rich association belonging to the **Hippuritidae**, **Radiolitidae**, **Caprinidae**. Among the representatives of the **Hippuritidae**: *Vaccinites sulcatus* DEFRE., *V. gosavioensis* DOUV., *V. praesulcatus* DOUV., *V. chalmasi* DOUV., *V. opelli santoniensis* KUHN, *V. arenensis* KUHN, *V. zurcheri* DOUV., *V. braciensis* SLADIC-TRIFUNOVIC, *V. carinthiacus recivalis* KUHN & ANDRUSOV, *H. nabresinensis* FUTT., *H. colliciatus* WOODW., *Hippuritella maestrei* VIDAL. The following taxa have been identified only in the Campanian: *Vaccinites inaequicostatus* MUNSTER, *V. archiaci* MUN-CHALW., *V. opelli* DOUV., *V. opelli pironaeiformis* LUPU, *V. boehmi* DOUV., *Pironaea* sp. have to be noticed (see Table).

The **Radiolitidae** family is represented during the Santonian-Lower Campanian by the following taxa: *Medeela* sp., *Fossulites* sp., *Sphaerulites boreai* TOUCAS, *Sph. aff. boreai* TOUCAS, *Sphaerulites* sp. The Radiolitids which have been identified only from the Campanian deposits and prolongate also during the Lower Maastrichtian are: *Praeradiolites hoeninghausi* (DES MOULINS), *Pr. aristidis* (MUNIER-CHALMAS). The above-mentioned limestones and calcarenites with rudists interfinger sometimes with sandstones of lumachelic character constituted either of **Actaeonelidae**, in the case of former palaeodeltaic environments, or of **Nerineidae** in paleoestuaric areas. In other cases interfingering with polymictic breccias or with marly deposits with inocerams and ammonites which directly overlie the metamorphic basement, can be remarked. The presence at the lower part of the Santonian succession in the southern part of the Apuseni Mountains of coaly sandstones, of some bauxites, and the fact that the rudists and *Actaeonella* bearing sequences are followed by marls with *Inoceramus balticus* BOEHM and *Echinocorys vulgaris* BREYNIUS represent significant similitudes with the Gosau Formation in the Eastern Alps. During the Upper Campanian the advancing of the sea recorded a stagnation being resumed during the Maastrichtian when a new advancing brought a flysch deposits lapping over the underlying Senonian ones and overlying directly the metamorphic basement. Until the Maastrichtian the Senonian developed in littoral facies in which the rudist bearing limestones and calcarenites, the gastropods sandstones, the coaly sandstones and bauxites are replaced with flysch formation developed in the center of the sedimentary basin; during the Maastrichtian the flysch facies is represented exclusively. At the uppermost part of the flysch deposits some wildflysch sequences announce the Laramian tectogenesis which built up the major structural frame of the South Apuseni Mountains.

3. The North Apuseni Mountains

In this realm the Senonian transgression starts with a slow advance marked by lacustrine coaly schists and sandstones (Fig. 4) facies as well as sandy sequences which maintain until the Lower Santonian. The coaly schists and sandstones contain Lammellibranchiata as *Corbula*, *Cardium* and Gastropoda as *Turitella*, *Melanopsis*. With sandy limestones, sometimes bituminous with Chara, ends the lower part of the sequence. Upwards the first marine terms follow, which are represented by limestones with *Parabouronia* sp. and *Nerineids* (*Plesiptygmatis*). The extent of this level is relatively restricted. The



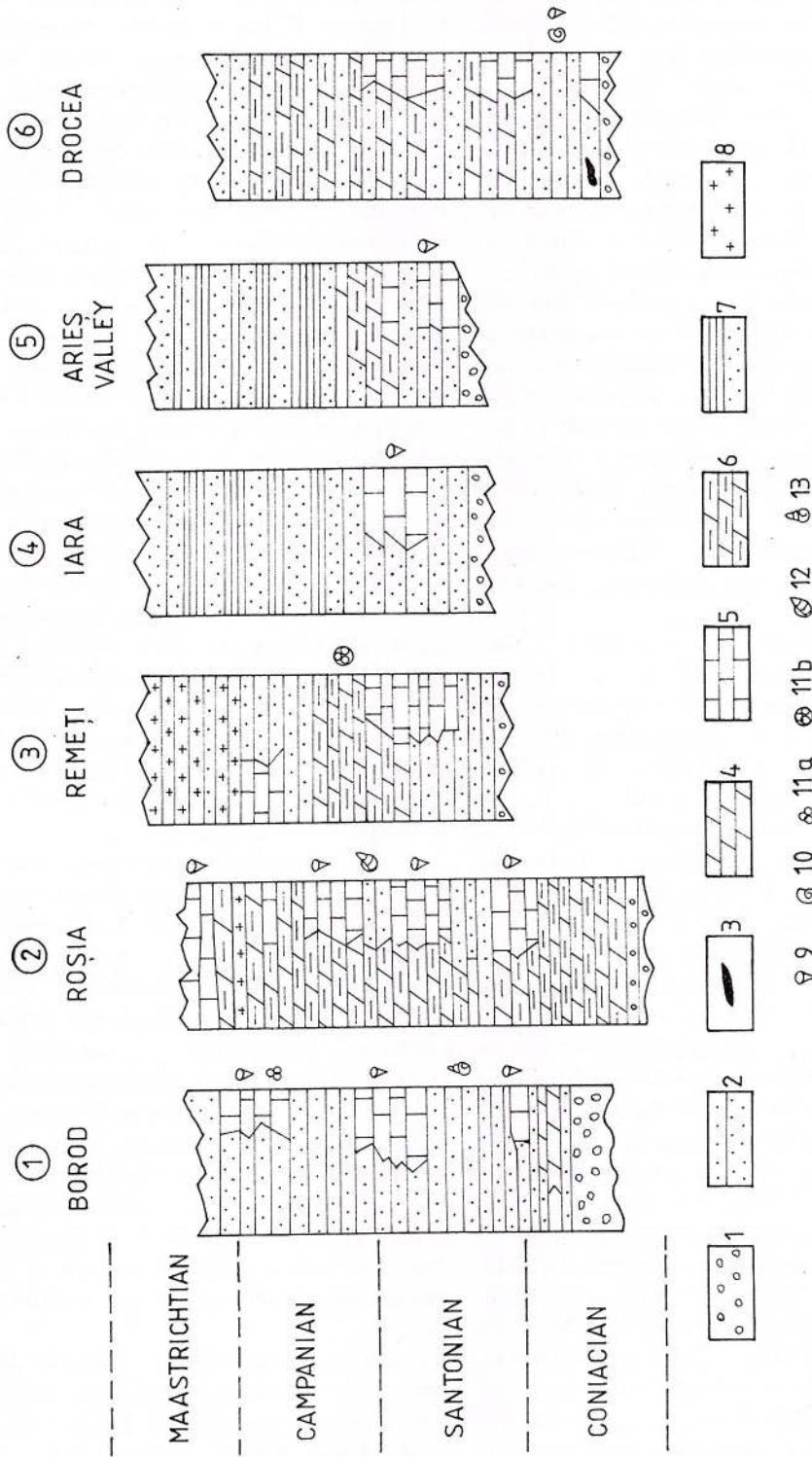


Fig. 4 – Correlation scheme of the Gosau formation in the Apuseni Mountains: 1, conglomerates; 2, sandstones; 3, coals; 4, lacustrine limestones; 5, rudist limestones; 6, marls; 7, flysch; 8, tuffs; 9, rudists; 10, ammonites; 11, microfauna, a - big foraminifera, b - globotruncanids; 12, inocerams; 13, gastropods.

next cycle represents a maximal spreading of the Senonian transgression and the rudist facies are characterised by a generic and specific diversity within the families **Hippuritidae**, **Radiolitidae** and **Caprinidae**. The rudist taxa, common with those of the Eastern Alps, appear at different levels associated with taxa proceeding from the Mediterranean biogeographic area. The abundance of the rudist fauna in the Santonian-Campanian deposits of the North Apuseni Mountains consists not only in the diversity of species, but also in the number of specimens compared to those of the Southern Apusenids. This fact can be explained by more favourable palaeoecological and palaeogeographical conditions existing in the North Apuseni Mountains. Among the **Hippuritidae** mentioned in the South Apuseni Mountains, *Vaccinites vredenburgi* KUHN, *V. cornuvaccinum* BRONN., *Hippurites matheroni* DOUV., *H. nabresinensis acuticostatus* LUPU, *H. praecessor* DOUV., *Hippuritella sartacensis peroni* DOUV., *H. praebioculatus* TOUCAS, *H. bioculatus* LAMARCK, *H. heberti* MUN-CHALM have been also found. In the Lower-possibly Middle-Maastrichtian, *Hippuritella costroi* VIDAL and *Hippuritella lapeirousei* GOLDFUSS have been evidenced.

In the same biostratigraphic sequence the **Radiolitidae** family is represented by the following taxa: *Radiolites mammilaris* MATHERON, *R. angeiodes* (LAPEIROUSE), *R. gastaldianus* PIRONA, *R. aff. aurigerensis* MUNIER-CHALMAS, *R. squamosus* D'ORBIGNY, *R. subsquamosus* TOUCAS, *R. aff. stopanianus* (PIRONA), *Biradiolites alatus* LUPU, *B. biplicatus* LUPU, *Neoradiolites matheroni* (TOUCAS), *Praeradiolites caderensis* TOUCAS, *P. plicatus* LAJ. NEGR. TOUL., *P. toucasianus* (D'ORB.), *Praeradiolites sinuatus* (D'ORB.), *Distefanella* sp., *Gorjanovicia paronai* (WIONTZEK), *G. polsaki* LUPU, *Lapeirousea pervinquierei* (TOUCAS), *L. zitelli* (DOUV.), *L. lascarevi* MILOVANOVIC, *Sauvagesia tenuicostata* POLSAK, *Durania aff. major* KUHN. Some **Radiolitidae** have been identified only in the Campanian-Lower (possibly also Middle) Maastrichtian, as follows: *Praeradiolites soubtoucasi* TOUCAS, *Bournonia aff. africana* DOUV., *B. bournoni* DES MOULINS, *Klinghardtites musculus* (KLINGHARDT), *K. submusculus* (MILOVANOVIC). In the same littoral deposits of the North Apuseni Mountains there have been identified the genera *Miseia* (*Miseia costulata* PATRULIU, *M. vadensis* PATR.), *Colveraia* (*Colveraia secunda* LUPU) and *Joufia* (*Joufia cappadociensis* (Cox), *J. silvaeregis* LUPU which, as a result of the presence of canals in their upper valve, indicate their appartenence to the family **Chiapassellidae** (Alecaster, 1971). It is noteworthy that the association with *Joufia*, *Colveraia*, *Sabinia* and *Pseudopoly-*

conites from Bulgaria have recently been dated as Campanian-Middle Maastrichtian based on Sr isotope analysis (Swinburne et al., 1992).

The family **Caprinidae** is represented by taxa belonging to the genus *Plagioptychus* (*P. paradoxus* MATHERON, *P. toucasi* MATH., *P. maestrei* LUPU, *P. borodense* LUPU, *Sabinia* sp.). In the North Apuseni Mountains the Maastrichtian is partly ingressive, a fact which is evidenced, in some areas, by calcarenites with *Joufia*, *Colveraia*, *Sabinia* associated with big foraminifera as *Clypeorbis mamillata* (SCHLUMBERGER), *Lepidorbites minor* (SCHLUMBERGER), *Simplorbites gensacicus* (LEYMEIRE), *Siderolites* sp., which overlie directly the Triassic and Jurassic limestones. The presence of this last rudist level in the North Apuseni Mountains constitutes a difference in comparison with the situation existing in the Eastern Alps. This fact leads to the conclusion that the biopalaeogeographic littoral conditions perpetuated only in the North Apuseni Mountains. Thus, the marine level may built up paleogeographic barriers as Masse and Philip are supposing in their "Evolution of rudists" (1986), most probably in a more western area so that in the North Apuseni Mountains the more or less similar conditions have been maintained during the whole Senonian. It is to note that some specimens belonging to the **Radiolitidae** - known in the Upper Campanian-Maastrichtian of the Sumeg area (Hungary) mentioned by Csabalay (1982), have been identified: *Lapeirouseia jouanneti* (DES MOULINS), *Praeradiolites maximus* ASTRE, *Pr. hoeninghausi* (DES MOULINS).

In the Slovakian Carpathians the littoral deposits of Lower Campanian-Maastrichtian age contain: *Bystrickaia andrusovi* LUPU and *Pseudopolyconites* sp. (LUPU, 1976) together with *Globotruncanita stuarti* (DE LAPPARENT), *Gl. linneana* (D'ORB.), *Globotruncanita elevata* (BROTZEN), *Rzechakina* sp., *Miliammina* sp. The rudist associations belonging to this chronobiostratigraphic sequence in the North Apuseni Mountains, Hungary and the Slovakian Carpathians emphasize the community with the specimens proceeding from the western palaeobiogeographical provinces - central and eastern Mediterranean (sensu Philip, 1985). In this sense it is possible that this area might become a biopalaeogeographic subassemblage in the middle area of the Tethys.

It can be presumed that during the Maastrichtian there existed connections with the Alpine and Apenninic regions, illustrated by the presence of the genera *Joufia*, *Sabinia*, *Klinghardtites*, *Colveraia*, as well as with the South and Southeastern Tethyan areal (East and West Serbia, Bulgaria, Greece, Turkey). The common genera of this last area with the



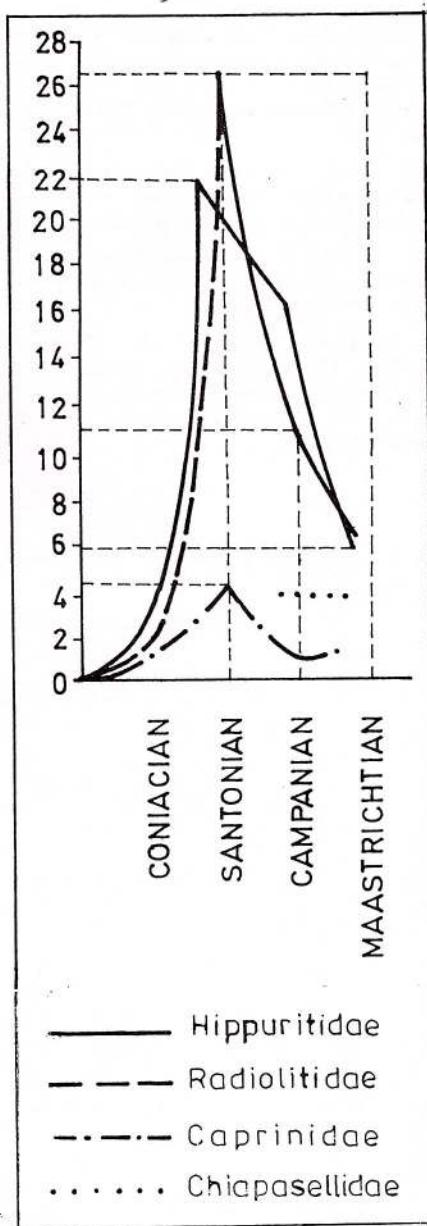


Fig. 5 - Frequency diagram of the *Hippuritidae*, *Radiolitidae*, *Caprinidae* and *Chiapasellidae* in the Apuseni Mountains.

North Apuseni Mountains are *Miseia*, *Joufia*, *Klinghardtites*, *Mitrocaprina*, *Pseudopolyconites* and *Pironaea*.

4. Concluding remarks

From the palaeogeographical point of view in the Apuseni Mountains the Senonian formations with rudists have been deposited in two palaeogeographic environments. In the North Apuseni Mountains as a consequence of the Pregosau tectogenesis a stable shelf area was established, which favoured, during almost the entire Senonian including the Lower-

Middle Maastrichtian, conditions for the rudists development.

In the South Apuseni Mountains the deposits which include rudists develop only in the northern flank of a sedimentary basin in which flysch deposits are characteristic. Here, no rudist facies occurs in the Maastrichtian.

The diachronism of the Senonian transgression from W to E in the North Apuseni Mountains and from SW to NE in the South Apuseni Mountains is obvious.

The maximal abundancy of the rudist assemblages took place during the Santonian-Lower Campanian (Fig. 5) as a consequence of the maximal development of the littoral facies in this biopalaeogeographic subassemblage of the central Mediterranean area.

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CHRONO - STRATIGRAPHIC AND REGIONAL DISTRIBUTION OF THE RUDISTS IN THE SENONIAN OF THE APUSENI MOUNTAINS

	HIPPURITIDAE	RADIOLITIDAE	CAPRINIDAE	CHIAPASELLIDAE	CONIACIAN	SANTONIAN	CAMPAÑIAN	MAASTRICHTIAN	NORTHERN APUSENI MTS	SOUTHERN APUSENI MTS	SOUTH CARPATHIANS	EAST CARPATHIANS	SLOVAC CARPATHIANS	APENNINS	YUGOSLAVIA	BULGARIA	TURKEY	HUNGARY	CAUCASUS	FRANCE	SPAIN	NORTH AFRICA	EASTERN ALPS	SOUTHERN ALPS	GRÈCE	SW ASIA	IRAN
<i>Vaccinites sulcatus</i> Defrance																											
<i>Vaccinites inaequicostatus</i> Münster																											
<i>Vaccinites gosaviensis</i> Douville																											
<i>Vaccinites gosaviensis acicularis</i> Lupu																											
<i>Vaccinites vredenburgi</i> Kühn																											
<i>Vaccinites cornuvaccinum</i> Brönn																											
<i>Vaccinites cornuvaccinum gaudryi</i> Munier - Chalmas																											
<i>Vaccinites braciensis</i> Sladić - Trifunović																											
<i>Vaccinites praesulcatus</i> Douville																											
<i>Vaccinites chalmasi</i> Douville																											
<i>Vaccinites archiaci</i> Munier - Chalmas																											
<i>Vaccinites oppeli felixi</i> Kühn																											
<i>Vaccinites oppeli santoniensis</i> Kühn																											
<i>Vaccinites oppeli</i> Douville																											
<i>Vaccinites oppeli pironaeiformis</i> Lupu																											
<i>Vaccinites chaperi</i> Douville																											
<i>Vaccinites arenensis</i> Kühn																											
<i>Vaccinites carinthiacus recivalis</i> Kühn & Andrusov																											
<i>Vaccinites giganteus</i> d' Hombre Firmas																											
<i>Vaccinites boehmi</i> Douville																											
<i>Vaccinites zurcheri</i> Douville																											
<i>Hippurites matheronii</i> Douville																											
<i>Hippurites heberti</i> Munier - Chalmas																											
<i>Hippurites socialis</i> Douville																											
<i>Hippurites aff. turgidus</i> R. de Roguan																											
<i>Hippurites praerennensis</i> Toucas																											
<i>Hippurites praebioculatus</i> Toucas																											
<i>Hippurites bioculatus</i> Lamarck																											
<i>Hippurites nabresinensis</i> Futterer																											
<i>Hippurites nabresinensis acuticostatus</i> Lupu																											
<i>Hippurites praecessor</i> Douville																											
<i>Hippuritella sarthacensis peroni</i> Douville																											
<i>Hippurites colliciatus</i> Woodward																											
<i>Hippurites lapeirousei</i> Goldfuss																											
<i>Hippuritella castroi</i> Vidal																											
<i>Hippuritella maestrei</i> Vidal																											
<i>Pironaea</i> sp.																											
<i>Radiolites mamillaris</i> Matheron																											
<i>Radiolites angeiodes</i> (Lapeirouse)																											
<i>Radiolites gastaldianus</i> Pirona																											
<i>Radiolites aurigerensis</i> Munier - Chalmas																											
<i>Radiolites squamosus</i> d' Orbigny																											
<i>Radiolites subsquamosus</i> Toucas																											
<i>Biradiolites aff. stopanianus</i> (Pirona)																											
<i>Biradiolites alatus</i> n. sp.																											
<i>Biradiolites biplicatus</i> n. sp.																											
<i>Neoradiolites matheronii</i> (Toucas)																											
<i>Praeradiolites subtoucasii</i> Toucas																											
<i>Praeradiolites caderensis</i> Toucas																											
<i>Praeradiolites plicatus</i> Laj. Negr. Toul.																											
<i>Praeradiolites toucasianus</i> (d' Orbigny)																											
<i>Praeradiolites sinuatus</i> (d' Orbigny)																											
<i>Praeradiolites hoeninghausi</i> (Des Moulins)																											
<i>Praeradiolites aristidis</i> (Munier - Chalmas)																											

**PALMOXYLON TECHERENSE n.sp., (PALMAE)
IN FATA BĂII FORMATION (UPPER MAASTRICHTIAN-LOWER
PALAEOCENE AGE) AT TECHEREU,
METALIFERI MOUNTAINS, ROMANIA**

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Key words: Cortical zone. Central cylinder. Fibrovascular bundles. Xylem. Phloem. Scalariform perforations. Parenchyma. Sclerenchyma. Starch grains. Stegmata.



Abstract: To the list of fossil flora in Fata Băii Formation (Upper Maastrichtian-Lower Palaeocene), *Palmoxylon techerense* is added a new species determined on a remnant of a silicified stem, found in the Techereu village area, the Metaliferi Mountains, Romania. The presence of a palm in this paleofloristic association confirms the existence of a tropical paleoclimate for the Zlatna basin, as for the neighborhood too, at the beginning of the Tertiary.

1. Introduction

The remnant of the Palm stem was found in Techereu village area, the Metaliferi Mountains, Romania, on the Dumbrava Valley at the confluence with the Rupturii Brook, in the "Fata Băii Conglomerates" Formation, to which an Upper Maastrichtian - Lower Palaeocene age is attributed (Borcoş et al., 1986, 1989). This formation is constituted of polymictic conglomerates and gravels with brick-like reddish coloured levels of sandstones and clays inserted, and many rhyolitic, rhyodacitic and andesitic lava levels intercalated (Ghitulescu et Socolescu, 1941; Borcoş et al., 1984); "Almaşu Mare Gravels" sensu Ghiuşescu (1941), are seen as a synchronous formation (Roşu et al., 1996).

Absolute age determinations on the eruptive rocks mentioned above show for this coarse and detritic formation, generally devoid of faunistic elements, an age of up to 65 million years (Lemne et al., 1983), making it correlatable with other similar red-coloured formations from the Transylvanian Basin (Păcila, Râpa Roşie, Sanpetru-Hațeg, Lăpuşiu-Costeiu de Sus-Dobra and Gurasada-Ilia-Sărbi Formations), with the accepted age of Upper Maastrichtian-Lower Palaeocene (Borcoş et al., 1986, 1989).

The paleogeography of the territory at the end of the Cretaceous and the beginning of the Palaeogene, suggests the existence of an intramontane basin, ex-

tended on an area including the localities of Glod-Zlatna-(Roşia Montană?)-Stăniţa-Bucuresci-Brad-Vălișoara-Ormindea-Baița-Vărmaga-Săcăramb, with a southern opening through a corridor to the Mureş-Strei zone, toward the Transylvanian Basin, and through the Brad-Tebea zone, toward the Pannonian Area, with corresponding influences (Borcoş et al., 1986). All this requires the existence of a rather irregular relief on the exonded adjacent zones of the intramontane basin, and the floristic and faunistic associations as described hereby, as in the equivalent formations from the neighborhood areas for this interval, are corresponding to a probably tropical paleoclimate. The lists of flora from sporo-pollinic analysis and plant impressions show, for the beginning of the Tertiary, a thermophilic plant association, and the presence of a Palm in it confirms such an hypothesis (Pax, 1920; Petrescu, 1969-1971; Olaru, 1978).

2. Systematic description

Family Palmae

Genus *Palmoxylon* SCHENK, 1882

Palmoxylon techerense n. sp.

Plates I, II, III.

2.1. Diagnosis. The sample is a remnant of a silicified palm stem, with typical structure, owning



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in cross section a narrow cortical zone and a central cylinder constituted of congested fibrovascular bundles within external and intermediary zones and scattered fibrovascular bundles in a well-developed ground tissue, especially within the central zone.

The *cortical zone* is distinct, with numerous scattered fibrous bundles, with rare, small fibro-vascular bundles and leaf traces in oblique-horizontal position. Sclerenchymatous fibres have thickened walls and the ground tissue owning oval or rounded cells, filled by starch grains. Adjacent to the fibres there are long files of stegmata with spherical silica bodies included.

The *external zone* (dermal zone), moderately narrow, with elongated fibrovascular bundles, radially orientated, congested, with (156) 250-468 (500) μ on radial diameter, (94) 156-218 (234) μ on tangential diameter, and f/v ratio is 0.6/1-1/1, (fibrous/vascular part). Fibrous bundles are frequent. Parenchymatous ground tissue is less developed. Cells inclusions, as spherical silica bodies in stegmata and starch grains in parenchyma cells, are also present.

The *intermediary zone* (subdermal), moderately broad (up to 2.5 cm), has well-preserved fibrovascular bundles, slightly radially elongated, less congested (260 on sq. cm), with 1-2 (3) metaxylem vessels, with (469) 500-680 (718) μ on radial diameter, 320-375 μ on tangential diameter, and f/v ratio is 1.5/1-2.4/1. The leaf traces are almost vertical here, so they appear as less deformed fibrovascular bundles; fibrous bundles are rare; the ground parenchyma is less developed; starch grains with point-like or elongated hilum and long files of stegmata with spherical silica bodies included, are also present.

The *central zone*, broad, has scattered fibrovascular bundles (220 on sq. cm), rounded, of closed collateral type, with continuous sclerenchyma or two unequal polar caps (the phloematic one is of reniform type); the fibrovascular bundles have undivided phloem (rarely apparently divided), sometimes with a "sieved plate", with 2(3-8) metaxylem vessels of (101) 109-125 (132) μ on diameter, with rounded or oval-asymmetrical shape, with thickened walls (6 μ), and the protoxylem constituted of (1) 5-8 (14) vessels with narrower lumina, rounded and with thickened walls; intrabundles parenchyma is regularly arranged around the wood vessels; radial bundles diameter is 530-700 μ tangential diameter is 430-650 μ , and f/v ratio is 1/1-1.6/1. Leaf traces appear as coalescent bundles, vertical, with the following sizes: (938) 1031-1437 m on radial diameter, (625)-687 (781) μ on tangential diameter, and f/v ratio is 0.5/1 - 0.8/1, rarely 1/1. The ground parenchyma is well developed and does not suggest an emphasized "secondary growth" in thickness. The tabular parenchyma is present. The cells inclusions as stegmata in long files, with spher-

ical silica bodies included, and starch grains with point-like or elongated, or branched out hilum in the parenchymatous cells, are present too.

2.2. Macroscopical description

The sample was a remnant of stem, sizes: 10/8/7 cm, broken in two pieces, silicified, compact, dark in colour, found in an Upper Maastrichtian-Lower Palaeocene volcano-sedimentary formation, in the area of the Techereu village. One transverse polished section and 14 thin sections were made to be studied: 5 transverse, 9 longitudinal. The remains of the palm stem are, probably, from an internode zone. The wood structure was quite well preserved, especially in the cortical zone and at central cylinder periphery, where the fibrous and fibrovascular bundles density is bigger; within the central zone, the structure appears to be spongy, and only the moultages of the bundles are visible, in a transparent mass of silica. There are also some fissures filled by opal, calcedony (Plate I, Fig. 9), or even epiclastics.

2.3. Microscopical description

2.3.1. Transverse section. To the periphery of the stem, there is a distinct, narrow cortical zone, with many fibrous bundles, whose mean diameter is (32) 54-78 (132) μ , rare, small and rounded fibrovascular bundles whose mean diameter is (109) 125-234 (281) m, and leaf traces (foliar bundles) in oblique-horizontal position, variable in size, which appear either in cortical zone only (Plate I, Fig. 1), or they are coming out of the central cylinder (Plate I, Fig. 2). The interfascicular parenchymatous tissue, partially preserved, has rounded or elongated thin-walled cells, some of them filled by starch grains (Plate I, Figs. 1-3).

The *central cylinder* could be discussed as being constituted of three distinct zones: external, intermediary and central, (dermal, subdermal and central, respectively - at Sahni school, or external and central - at Tomlinson, 1961), considering the shape, the size, the density of fibrovascular bundles, the quantity of parenchyma, the abundance and the arrangement of parenchymatous cells starch grained to the fibrovascular bundles (Plate I, Figs. 1-5).

The *external zone* (=dermal zone) is rather narrow, has a sinuous shape and is clearly delimited from the cortical zone. It comprises congested fibrovascular bundles, apparently regularly arranged on 1-2 concentric curves. The bundles have a radial elongated shape, some of them are rounded and laying to the others nearby (Plate I, Fig. 3), and it appears to have only protoxylem, rarely with 1-2 metaxylem vessels in addition. The size of the bundles is variable: radial diameter is (156) 250-468 (500) μ . tangential diameter, in the phloematic sclerenchyma cap zone, is



(94) 156-218 (234) μ , and f/v ratio is 0.6/1 - 1/1. The interfascicular parenchyma is represented by 1-3 cells rows thin-walled, radially oval-elongated shaped, rarely rounded, some of them containing starch grains (Plate I, Figs. 2, 3). Frequently fibrous bundles similar to those from the cortical zone, are also to be found.

The *intermediary zone* (=subdermal), moderately broad, 2.5 cm in thickness, is constituted of rather congested fibrovascular bundles (260 on sq. cm), arranged on concentric curves, one below another on the first row, with a tendency of an alternant arrangement more to the inner part (Plate I, Figs. 3, 4). They are elongated and the sizes are the following: (469) 500-680 (718) μ on radial diameter and 320-375 μ on tangential diameter, and f/v ratio is 1.5/1-2.4/1. The wood vessels are represented by 1-2 metaxylem vessels and protoxylem vessels can rarely be met. The leaf traces within this zone have a rather vertical position and they have, without exception, 4-8 metaxylem vessels and 5-8 protoxylem vessels (Plate I, Fig. 5). The ground parenchyma is constituted by elongated thin-walled cells, some of them containing starch grains and are regularly arranged around the fibrovascular bundles, the rest has an emphasized oval-elongated shape (Plate I, Figs. 3, 4). Scattered within the ground tissue of the described zone, there are rare fibrous bundles similar to those of the cortical zone, but also smaller fibrovascular bundles, always arranged in the neighborhood of the foliar bundles, in a laying position to it (Pl. I, Fig. 5).

The *central zone* of the central cylinder is broad and constituted of scattered rounded bundles (220 on sq. cm) and a ground parenchyma partially preserved: the rests of its membranes are pushed to the fibrovascular bundles, resulting a continuous "sheath" which includes flattened parenchyma as well as cells with starch contents (Plate I, Figs. 6, 8, 10; Plate II, Figs. 1, 4, 7); when it is preserved, the ground parenchyma has polygonal thin-walled cells, relatively uniform in size, in the neighborhood of the vascular bundles, as a tabular parenchyma, and slightly radially elongated in the rest, (as a radial parenchyma?), without intercellular spaces and the frequency of cells with starch grains content is smaller (Plate I, Fig. 7; Plate II, Figs. 2, 6, 9). The fibrovascular bundles are of closed collateral type, constituted of sclerenchyma, undivided phloem (only in special cases is apparently divided - Plate I, Fig. 8), wood vessels - meta- and protoxylem - and intrafascicular parenchyma, only in xylematic zone. Sclerenchymatous tissue, constituted of polygonal thickened-walled cells, without intercellular spaces, is arranged round about the vascular bundles, continuously in most cases, or as unequal reniform, polar caps, in the

leaf trace bundles type, with 10-16 cell rows above the phloematic zone, and with 2-3 rows, under the xylematic zone; when the sclerenchyma is continuous, there is only 1, rarely 2 rows of sclerenchyma cells (Plate I, Figs. 6, 7; Plate II, Figs. 3, 4, 5, 7). Sometimes fibrovascular bundles with a very developed fibrous part can be seen (Plate II, Fig. 6). The undivided phloem is quite badly preserved; its place is taken by a nonspecific lacuna and only on small places isolated, polygonal, thin-walled cells are seen, but frequently, under the phloematic sclerenchyma cap, a "sieved plate" is preserved (sensu Greguss, 1968), (Plate I, Fig. 10). The sizes of phloematic lacuna are, as follows: 100-140 μ on radial diameter, and 156-187 μ on tangential diameter. The apparently divided phloem appears only in leaf traces, which result from many merging bundles of different age, and only in the cases when the fusion processus is not finished. In this situation, the "sieved plates" of component bundles, send ramifications to the inner part, so that a divided phloem, which seems badly preserved is suggested (Plate I, Fig. 8; Plate II, Figs. 1, 2, 8). The wood conducting tissue is represented by 2 (3-8) metaxylem vessels, with the mean diameter (101) 109-125 (132) μ , with circular or oval-assymetrical shape, with thickened walls (6 m), and surrounded by 1-2 rows of polygonal parenchymatous cells (Plate I, Figs. 7, 8, 10; Plate II, Figs. 1-9). The protoxylem is not present in all the vascular bundles, but when it is, it is constituted of (1) 5-8 (14) vessels with round lumina, narrower than the metaxylem vessels, with thickened walls, surrounded by a single row of polygonal parenchymatous cells regularly arranged, without intercellular spaces; the intrafascicular parenchyma is present only in the xylematic zone (Plate I, Fig. 8; Plate II, Figs. 4, 5, 6). The bundles sizes are, as follows: 530-700 μ on radial diameter, 430-650 μ on tangential diameter, and f/v ratio is 1/1-1.6/1. In leaf traces, some parenchymatous cells contain starch grains and are arranged almost continuously between meta- and protoxylem (Plate II, Figs. 1, 2, 3, 5-9). This observation sustains the hypothesis that the big bundles, by leaf trace type, appear by merging of 2-4 fibrovascular bundles (Tomlinson, 1961, p. 20), keeping the parenchymatous cells with starch grains, like an outline (Plate II, figs. 1-3, 5-9). The leaf trace bundles from the central zone of the central cylinder have the following sizes: (938) 1031-1437 μ on radial diameter, 625-687 (781) μ on tangential diameter and f/v ratio is 0.5/1-0.8/1, rarely 1/1. Metaxylem vessels mean diameter is (76) 84-106 μ , protoxylem vessels mean diameter is (32) 39-48 μ . Within this zone the fibrous bundles are rare.

Systemizing the vascular bundles observations of our specimen, it is possible to describe four distinct



types:

- Vascular bundles with 1 single metaxylem vessel, a continuous phloematic fibrous zone much developed, with elongated shape; their presence is characteristic of external and intermediary zones of the central cylinder (Plate I, Fig. 3);

- Vascular bundles with 2 metaxylem vessels, with or without protoxylem, with intrafascicular parenchymatous cells lacking starch grains content, with continuous sclerenchyma around the bundle, more developed in the phloematic pole, with a rounded or elongated shape and characteristic of the intermediary and central zone of the central cylinder (Plate I, Figs. 6-8; Plate II, Figs. 3-7);

- Vascular bundles with 3 metaxylem vessel, with 1-5 protoxylem vessels or lacking, with or without "sieved plate", without starch grains content in the intrafascicular parenchymatous cells, with continuous sclerenchyma, more developed in the phloematic zone. Bundles of this type were observed in the central zone of central cylinder (Plate II, Figs. 5, 7);

- Vascular bundles by leaf trace type, with 3-8 metaxylem vessels, with 5-14 tracheids as protoxylem, with a clear "sieved plate", with undivided phloem or only apparently divided, with intrafascicular parenchymatous cells containing starch grains arranged between meta- and protoxylem, and the sclerenchyma as 2 unequal polar caps (Pl. I, Figs. 1, 3, 5-9).

2.3.2. Longitudinal section. The thin sections taken from the cortical zone (Plate III, Figs. 2, 3), show plenty of fibrous bundles constituted of short sclerenchymatous fibres with thickened walls and an interfascicular parenchyma represented by some rows of polygonal-oval cells, quite equal in size, without intercellular spaces and with frequent starch grains content (Plate III, Fig. 3). On the thin sections many stigmata can be seen, i. e. silica cells with inclusions of silica bodies, of spherical type in here (cf. Tomlinson, 1961, p. 53), and arranged in long files, adjacent to sclerenchymatous fibres (Plate III, Figs. 6-8). The ground tissue, well preserved in the external zone, shows a cells expansion as an irregular and unequal volumetrical growth, probably as a result of a diffuse secondary growth in thickness (cf. Tomlinson, 1961, p. 20), and generally regularly arranged around the bundles (Plate III, fig. 4). More in the inner part, where the conducting bundles are more scattered and more rounded shaped, the ground tissue is partially preserved. In all cases, the parenchyma cells with inclusions are very frequent, and they do not have different shape and size, but others are devoid. (Plate III, Figs. 4, 8). The starch grains seen in parenchyma cells are brown coloured, have a point-like or elongated, even branched hilum,

and fill the whole cell; sometimes on some thin sections some cells with brown-darkish content, which is probably tannin, were observed. Sclerenchymatous tissue, which is part of fibrovascular bundles has short fibres with thickenings on the walls and sharp endings in the phloematic sclerenchyma zone, but short septated fibres, in the xylematic sclerenchyma zone, which appear thus to arise from the sclerotisation of a parenchyma cells (Plate III, Fig. 1). Long files of stigmata with spherical silica bodies are adjacent to the sclerenchymatic fibres (Plate III, Figs. 5, 11). Sporadically, inside the fibres, a brownish substance can be remarked, which looks a lot like that one from the parenchyma, composed of many small darkish grains (Plate. III, Fig. 1). The vessels have tilted end-walls with scalariform perforations with 16-26 traversal bars, some of them sometimes branched out (Plate III, Figs. 7, 8). The lateral walls of the vessels have spiral thickenings (Plate III, Figs. 9, 10), or scalariform one (Plate III, Fig. 7). The intrafascicular parenchyma is constituted of uniform, thin-walled, polygonal, small-sized cells, arranged in regular vertical rows, adjacent to fibrous bundles or wood conducting vessels (Plate III, Fig. 5).

3. Discussions, affinities

By its typical anatomical characters of a monocotyledon with woody stem, by the structure of the central cylinder and by the close collateral type of the fibrovascular bundles, our remnant of silicified wood, was attributed to the genus *Palmoxylon*. Its study has permitted to find a correlative in a known living or fossil Palms group. So, this specimen has many affinities with Sabaloid Palms Group, which lives now in a tropical climate as India, Malaysia, Central America. These affinities are:

- a narrow cortical zone with numerous fibrous strands and small vascular bundles;
- an external zone of central cylinder with congested fibrovascular bundles each of them having an individual sclerenchymatous well developed sheath;
- a central zone with scattered and rare fibrovascular bundles;
- the ground parenchyma do not suggest an well marked secondary expansion;
- there are tabular (and radial?) parenchyma, around the fibrovascular bundles;
- fibrovascular bundles have 1, 2 or more then 2 metaxylem vessels;
- the phloem is undivided;
- there are long files of stigmata adjacent to the fibres.

Other specific characters observed at our specimen are, as follows:



- 4 types of fibrovascular bundles with distinct characters;
- 2 ornamentation types on the vessels walls;
- oblique-scalariform inclined perforations, with 16-26 bars;
- a large number of leaf traces, which appear to be born by merging of 2-4 vascular bundles different in age; sometimes the small ones have an abnormal position to the big ones.

This merging is suggested by the arrangement of parenchyma cells with starch grains, which always follows closely the vascular bundles, marking their contour, by the shape and the size of fibres, and also by the "sieved plates" which seem to be a divided phloem, when the fusion is unfinished; all this confirms our specimen as a Sabaloid Palm.

By shape, structure and arrangement of vascular bundles in the central cylinder and by the presence and the shape of tabular parenchyma, it has similitudes with living species of genus *Sabal* (i.e. *S. palmetto* LODD., in Greguss 1954, 1968; Tomlinson, 1961, p. 289).

By the inverse position of the small fibrovascular bundles to the big ones, it resembles the living species of the genus *Trachycarpus* (Tomlinson, 1961, p. 296).

From the fossil species described till now, our specimen has many similitudes with our *Palmoxylon sabaloïdes* GREGUSS, 1968. Though it differs by the presence of 4 distinct types of vascular bundles, the presence of 2 ornamentation types of the vessels (spirally and scalariform thickening) and by the presence of cells inclusions as starch grains in parenchyma cells and spherical silica bodies in stegmata arranged in long files adjacent to the fibres.

4. Conclusions

On a remnant of fossil wood, found in an Upper Maastrichtian-Lower Palaeocene Formation in the Techereu village area, we described a new species of a fossil Palm, and we named it *Palmoxylon techerense* n. sp., a Sabaloid Palm with a narrow fibrous cortical zone, with numerous scattered fibrous bundles and a central cylinder with three zones, where the fibrovascular bundles are congested to the periphery and gradually more scattered to the inner part. It was also remarked the presence of an undivided phloem at the fibro-vascular bundles, a tabular parenchyma around it, and the unfrequency of fibrous bundles into the central zone. Long files of stegmata with spherical silica-bodies and starch grains in parenchyma cells are also present.

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Holotype. I.G.R. Collection Bucharest, no.26276, (specimen P.3., and 3 thin sections).

Derivatio nominis. The species name is coming from the name of origin locality, Techereu [tekereu].

Locality. Techereu, Metaliferi Mts., Romania.

Horizon. Fata Băii Formation.

Age. Upper Maastrichtian-Lower Palaeocene.

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P L A T E S



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Plate I

Figs. 1-10 — *Palmoxylon techerense* n. sp.; I.G.R. Coll., no. 26276, Bucharest.

- Fig. 1 — Transverse section. Leaf trace, fibrous bundles, ground parenchyma in the cortical and external zones of the central cylinder. (x 50).
- Fig. 2 — Transverse section. Fibrous bundles, parenchyma cells with or without starch grains in the cortical zone; leaf trace, fibrovascular bundles in normal and abnormal position and tabular parenchyma in the external and intermediary zones of the central cylinder. (x 70).
- Fig. 3 — Transverse section. Fibrous, fibrovascular bundles and parenchyma in the cortical zone, the external and intermediary zones of the central cylinder. (x 30).
- Fig. 4 — Transverse section. Fibrous, fibrovascular bundles and parenchyma in the intermediary zone of the central cylinder. (x 70).
- Fig. 5 — Transverse section. Leaf trace, laying fibrovascular bundle, belt of starch grained cells around the fibrovascular bundles in the intermediary zone. (x 100).
- Fig. 6 — Transverse section. Fibrovascular bundles with 2 metaxylem vessels and rests of ground parenchyma cells pushed around them like a continuous sheath in the central zone of the central cylinder. (x 65).
- Fig. 7 — Transverse section. Fibrovascular bundles with tabular parenchyma around it, and remains of radial parenchyma in the central zone of the central cylinder. (x 65).
- Fig. 8 — Transverse section. Leaf trace with apparently divided phloem and a rather continuous belt of starch grained cells between meta- and protoxylem, fibrovascular bundles with 2 metaxylem vessels in the central zone of the central cylinder. (x 45).
- Fig. 9 — Transverse section. Microcrystalline aspects of silica, between the bundles. (x nicols).
- Fig. 10 — Transverse section. Leaf trace with phloematic lacuna, "sieved plate", metaxylem and protoxylem vessels, intrafascicular parenchyma and starch grained parenchyma cells belt, in the central zone of the central cylinder. (x 70).



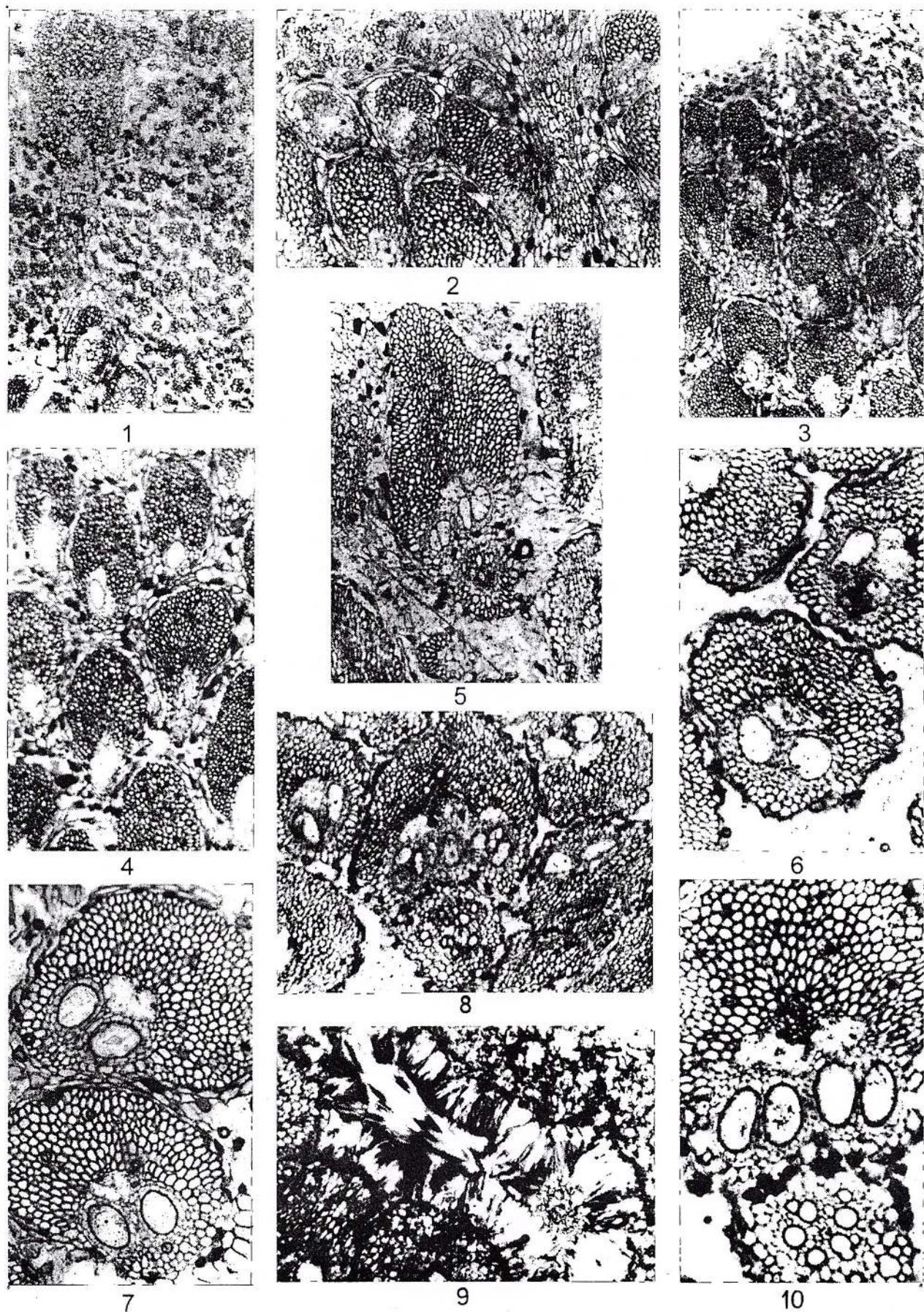
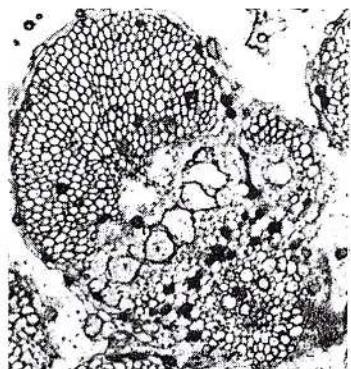


Plate II

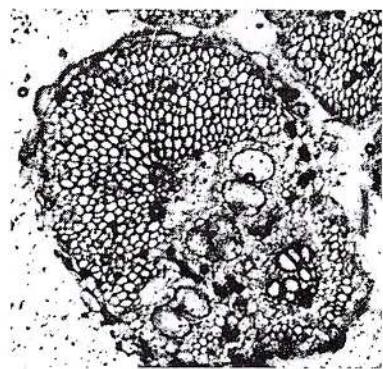
Figs. 1-9 — *Palmostylon techerense* n. sp.; I.G.R. Coll., no. 26276, Bucharest.

- Fig. 1 — Transverse section. Leaf trace (or foliar bundle) and small vascular bundle in a quite normal position to it, in the central zone. (x 45).
- Fig. 2 — Transverse section. Leaf trace born by merging of different age bundles; the incipient phase of fusion is showed by the starch grained cells belt, which is arranged between meta- and protoxylem, but between merging bundles too; fibrovascular bundles with 2 or 3 metaxylem vessels, without protoxylem, in the central zone. (x 45).
- Fig. 3 — Transverse section. Leaf trace, fibrovascular bundle with 2 metaxylem vessels in an abnormal position (reverse), and parenchyma remains, in the central zone. (x 50).
- Fig. 4 — Transverse section. Fibrovascular bundles with 2 metaxylem vessels and with protoxylem, and also with continuous sclerenchyma around, like a sheath, in the central zone. (x 65).
- Fig. 5 — Transverse section. Leaf traces with fibrovascular bundles in a reverse position; fibrovascular bundles with 2-3 metaxylem vessels, in different positions, in the central zone. (x 55).
- Fig. 6 — Transverse section. Leaf traces with some smaller fibrovascular bundles nearby, in lying position; interfascicular parenchyma rests; fibrovascular bundles with 3 metaxylem vessels and without protoxylem, in the central zone. (x 30).
- Fig. 7 — Transverse section. Leaf traces, fibrovascular bundles, fibrous bundles, in the central zone. (x 25).
- Fig. 8 — Transverse section. Leaf trace with lying fibrovascular bundle; fibrovascular bundle with 2 metaxylem vessels in a reverse position; fibrovascular bundles with 3 metaxylem vessels and with protoxylem; interfascicular parenchyma, in the central zone. (x 50).
- Fig. 9 — Transverse section. Leaf trace with a small vascular bundle in opposite position, in the central zone. (x 60).

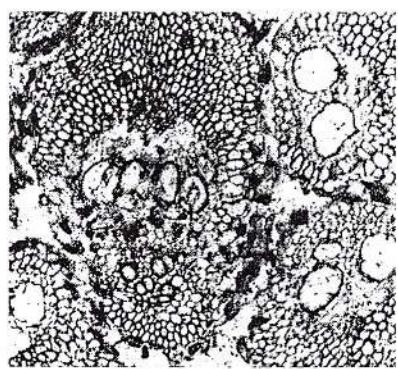




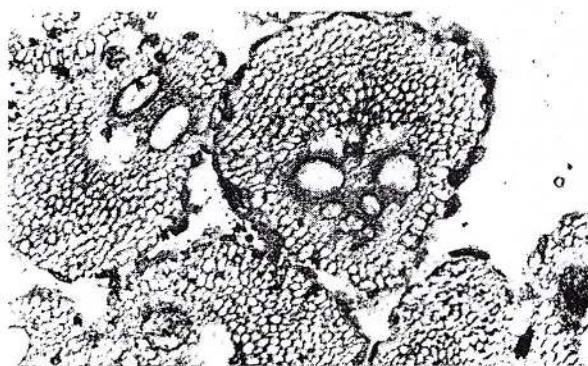
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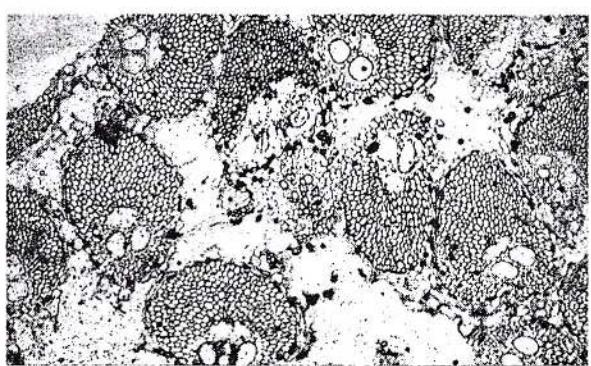
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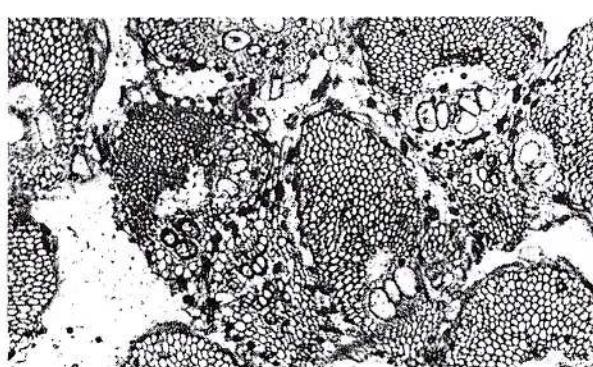
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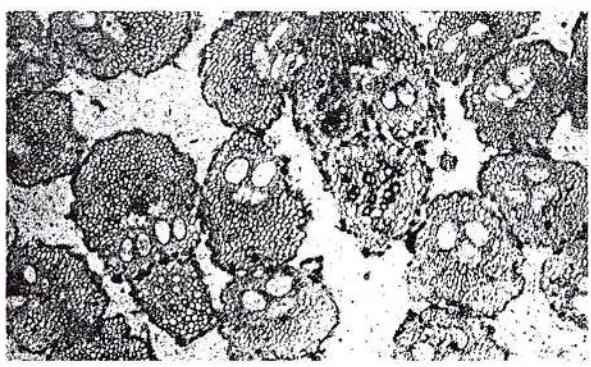
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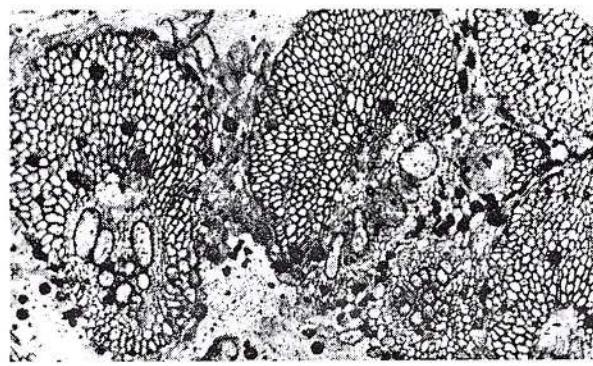
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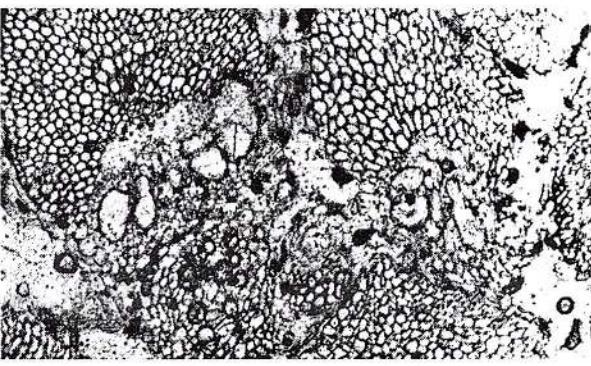
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7



8



9

Plate III

Figs. 1-11 — *Palmoxylon techerense* n. sp.; I.G.R. Coll., no. 26276, Bucharest.

Fig. 1 — Longitudinal section through a leaf trace (foliar bundle): phloematic sclerenchyma cap, metaxylem vessels, intrafascicular parenchyma with starch grained cells, protoxylem, xylematic sclerenchyma cap. (x 75).

Fig. 2 — Longitudinal section through the cortical zone: fibrous bundles, surrounding parenchyma, stegmata files adjacent to fibrous bundles. (x 300).

Fig. 3 — Longitudinal section through the cortical zone: ground parenchyma, starch grained cells, stegmata files adjacent to the fibrous bundles. (x 80).

Fig. 4 — Longitudinal section through the central zone: interfascicular parenchyma with quite uniform sized cells, regularly arranged around the fibrovascular bundles; sclerenchymatous fibres with sharp endings; sclerenchymatous fibres with septate interior. (x 80).

Fig. 5 — Longitudinal section through a fibrovascular bundle from the central zone: metaxylem vessels, xylematic sclerenchyma, long files of stegmata (sometimes they are destroyed and only the insertion places of the silica bodies on the thickened basic wall of silica cell is visible). (x 300).

Fig. 6 — Longitudinal section through a scalariform perforation with 16 bars. (x 75).

Fig. 7 — Longitudinal section through a scalariform perforation on a metaxylem vessel; scalariform ornaments. (x 140).

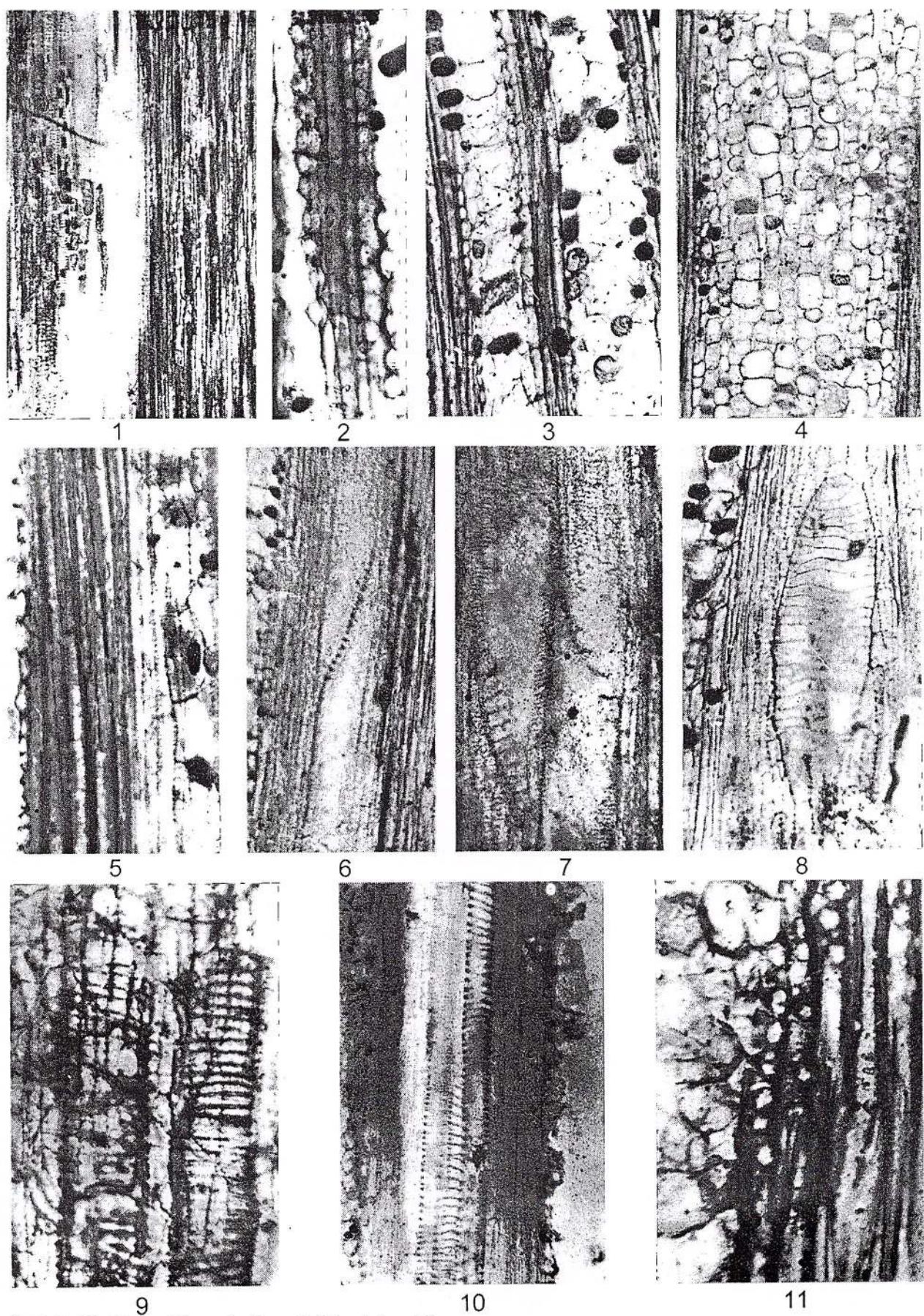
Fig. 8 — Longitudinal section through a scalariform perforation with 26 bars, where more vessels are opened. (x 180).

Fig. 9 — Longitudinal section through metaxylem vessels with spiral thickenings. (x 300).

Fig. 10 — Longitudinal section through protoxylem vessels with scalariform thickenings. (x 160).

Fig. 11 — Longitudinal section through xylematic sclerenchyma with septate fibres and files of stegmata with spherical silica bodies. (x 300).





EOCENE BENTHONIC FORAMINIFERA FROM THE SOUTH-WESTERN PART OF THE MOESIAN PLATFORM

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Key words: Eocene. Benthonic foraminifera. Moesian Platform. Romania.

Abstract: The Eocene benthonic foraminifera from three boreholes located in south-western Oltenia have been investigated. Over 50 species are mentioned: amongst them a new genus, new species have been described. The paleoecological significance of the assemblages is briefly discussed herein.

Introduction

The present paper is an inventory of the Eocene benthonic foraminiferal content from three boreholes drilled in the south-western part of the Moesian Platform, located on both sides of the Jiu River. The area belongs, paleogeographically, to the Lower Jiu River Basin (in fact a northern prolongation of the Lom Basin from Bulgaria).

The three boreholes (Bistrețu, Grojdibodu and Dăbuleni), after penetration of the Neogene deposits, crossed the Paleogene (Eocene) formations. The Grojdibodu and Dăbuleni boreholes have been continuously cored; from the Bistrețu well cores from 50 to 50 m beginning with the 450 m (7 samples) were available.

The studied samples cover the biostratigraphic interval ranging between P7 and P15 of planktonic foraminifera zones (from Lower to Upper Eocene).

The Eocene deposits from this area were previously studied or mentioned by Costea and Balteș (1962), Cosma and Costea (1966), Saulea et al. (1970), Săndulescu et al. (1971). Similar deposits, located south of the Danube, were studied by Tzaneva (1963) and Tzaneva and Vaptzarova (1961).

A recent note concerning the stratigraphy of the Tertiary deposits crossed by Dăbuleni and Grojdibodu boreholes was carried out by Popescu and Enciu (1996). The samples collected by the two above-mentioned authors, to whom I am deeply indebted, were studied in this paper. Similar assemblages of benthic foraminifera were mentioned in Hungary (Hantken, 1875; Sztrakos, 1987), France (Halkyard, 1919; Grünig, 1985; Grünig and Herb, 1984; Mathelin & Sytrakos, 1993; Sztrakos, 1996), and Italy (Hagn, 1956; Grünig, 1985).

Paleontology

The Eocene deposits from the studied wells consist mainly of hemipelagic deposits. Significant changes took place at the end of the Ypresian: extinction of the *Reticulophragmium amplectens* (!) and appearance of the main part of the Middle Eocene fauna (near meter 300), corresponding also to the first appearance of the planktonic foraminifera genus *Hantkenina* (stellate specimens) belonging to the group mexicana. It is worth mentioning the presence of a short nummulitic level (40 cm thick, at m 294) occurring in the Dăbuleni Well. This level should suggest a possible lifting of the basin, accompanied by a gap in sedimentation.

The foraminiferal assemblages are constituted mainly of hyaline foraminifera, a few agglutinate and very scarce porcelaneous specimens. The planktonic/benthonic foraminifera ratio is close to the value 1:1. The benthonic foraminiferal faunas from this area suggest a deep shelf to bathyal, mid-latitude, normal marine environment. Stratigraphic distribution of the benthonic foraminifera was illustrated in Table 1.

Taxonomic notes

Some foraminiferal species identified in the borehole drilled in the south-western Romanian Plain are listed below in alphabetical order. The figured specimens are preserved in the author, collection and, soon, will be filed at the Paleontological Department of the University of Bucharest.

• *Ammodiscus latus* GRZYB., 1898

Ammodiscus latus GRZYBOWSKI, 1898, p. 283, pl. 10, figs. 29, 30; Kaminski & Geroch, 1993, p. 254, pl. 5, figs. 4-6.



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Sample	Depth (m)	Taxa		P 6 - 9	P 10	P 12	P 13 - 14	B A R T.	Chronostratigraphic Units
		Depth (m)	Taxa						
31	200	c	<i>Plecinella dalmatina</i> (Schub.)						
30	203	c	<i>Ossangularia pteromphalia</i> (Gumb.)						
29	206	c	<i>Marginulinopsis fragaria</i> (Gumb.)						
28	210		<i>Ciliavulina parisensis</i> d'Orb.						
27	212		<i>Nummulites ex gr. stiratus</i> (Burg.)						
26	216		<i>Discocyclina</i> sp.						
25	218	c	<i>Operculina</i> sp.						
24	220	c	<i>Tritaxilla haerigensis</i> (Gumb.)						
23	222	c	<i>Tritaxilla pupa</i> (Gumb.)						
22	225	c	<i>Tritaxilla cubensis</i> Cussh.						
21	228	p	<i>Marginulinopsis asperula</i> (Gumb.)						
20	230	c	<i>Marginulinopsis cumulicostata</i> (Gumb.)						
19	232		<i>Hemirobulina subbulata</i> (Hantk.)						
18	235	p	<i>Marginulina propinqua</i> Hantk.						
17	237		<i>Vulvulina nummulina</i> (Gumb.)						
16'	239		<i>Normalinoides calymene</i> (Gumb.)						
16	247		<i>Hanzawaia ammonifera</i> Gumb.)						
15'	264		<i>Uvigerina spinicostata</i> C. & J.						
15	265		<i>Uvigerina ripensis</i> (Cole)						
14'	268		<i>Furstenkoina dibollenensis</i> (C. & A.)						
14	271		<i>Karreniella siphonella</i> (Ress.)						
13'	275		<i>Karreniella halkyardi</i> (Cush.)						
13	283		<i>Lagenia scareaensis</i> Hantk.						
12"	286	c	<i>Lagenia tricincta</i> Gumb.						
12'	293		<i>Neugeborenia gyrata</i> (Mallory)						
12	297	c	<i>Pseudodonodaria hantkeni</i> (Franz.)						
11	300	c	<i>Pseudodonodaria inflata</i> (Born.)						
10	304	c	<i>Rectuvigerina mexicana</i> (Cush.)						
9	308		<i>Nuttallites truempyi</i> (Cole)						
8	310	c	<i>Angonias aragonensis</i> (Nuttall)						
7	312	c	<i>Planktonic Foraminifera</i>						
6	315	c	Biostratigraphic Units						
5'	335	c							
5	345	c							
4	346	c							
3	350								
2	355	c							
1	360	c							

Table - Stratigraphic distribution of the main benthic foraminifera
in Dabuleni Well

Legend:

	First occurrence in this well
	present
	common
	abundant



continued

- **Aragonia aragonensis** (NUTTALL), 1930
Textularia aragonensis NUTTALL, 1930, p. 280, pl. 23, fig. 6.
Aragonia aragonensis (NUTTALL); Morkhoven et al., 1985, p. 309, pl. 101A, figs. 1-3; pl. 101B, figs. 1-4; pl. 101C, figs. 1-3; Braga & de Biase, p. 94, pl. 2, fig. 7.
- **Bolivina antegressa angulata** SAHAKJAN-GEZALJAN, 1974 (Pl. III, figs. 11-13)
Bolivina antegressa angulata SAHAKJAN-GEZALJAN, 1974, p. 311, pl. 151, fig. 17 (fide Ellis & Messina); Grünig, 1985, p. 264, pl. 5, figs. 3-5.
- **Bolivina semistriata** HANTKEN, 1875.
Bolivina semistriata HANTKEN, 1875, p. 65, pl. 7, fig. 13.
- **Buchnerina scaneraensis** (HANTKEN), 1883 (Pl. III, fig. 3)
- **Buchnerina tricincta** (GÜMBEL), 1868 (Pl. III, figs. 1, 2)
Lagena tricincta GÜMBEL, 1868, p. 28 (606), pl. 1, figs. 8a, b.
- **Bulimina aksuatica** MOROZOVA, 1938 (Pl. IV, figs. 12, 13)
Bulimina aksuatica MOROZOVA (fide Ellis & Messina); Subbotina, 1953, p. 207, pl. 9, figs. 3-11.
- **Bulimina cf. B. macilenta** CUSHMAN & BERMUDEZ, 1937
- **Bulimina trinitatensis** CUSHMAN & JAVRIS, 1928
Bulimina trinitatensis CUSHMAN & JAVRIS, 1928, p. 102, pl. 14, fig. 12; Morkhoven et al., 1985, p. 299, pl. 98A, figs. 1, 2; pl. 98B, figs. 1-4; Braga et al. 1975, p. 94, pl. 2, fig. 2; Grünig, 1985, p. 266, pl. 6, figs. 24, 25.
- Bulimina serratospira* FINLAY, 1947, p. 283, pl. 5, figs. 83-86; Decima & de Biase, 1975, p. 94, pl. 2, figs. 3, 4
- **Buliminella calahani** GALLOWAY & MORREY, 1931
Buliminella calahani GALLOWAY & MORREY, 1931, p. 350, pl. 40, fig. 6; Morkhoven et al., 1985, p. 322, pl. 105A, fig. 3; pl. 105B, figs. 1-4.
- **Buliminella grata** PARKER & BERMUDEZ, 1937
Buliminella grata PARKER & BERMUDEZ 1937, p. 515, pl. 59, fig. 6.
- Buliminella grata* PARKER & BERMUDEZ. Morkhoven et al., 1985, p. 163, pl. 54, figs. 1, 2; Decima & de Biase, 1975, p. 93, pl. 2, fig. 1.
- **Burseolina inexculpta** (FRANZENAU), 1889 (Pl. IV, fig. 1)
Cassidulina inexculpta FRANZENAU, 1889, p. 66, pl. 3, fig. 2; Grohbandt, 1962, p. 102, pl. 6, fig. 8.
- Globocassidulina inexculpta* (FRANZENAU). Grünig, 1985, p. 273, pl. 10, figs. 4-6.
- **Citharinella tenuissima** (HANTKEN), 1875 (Pl. II, fig. 12)
Frondicularia tenuissima HANTKEN, 1875, p. 43, pl. 13, fig. 11; Hagn, 1956, p. 139.
- **Clavulinoides** cf. **C. midwayensis** CUSHMAN, 1936
- **Coleites arborescens** (HALKYARD), 1919 (Pl. III, figs. 6, 7)
Frondicularia arborescens HALKYARD, 1919, p. 88, pl. 5, figs. 8, 9.
- **Dorothia fallax** HAGN, 1954
Dorothia fallax HAGN, 1954, p. 16, pl. 4, fig. 10-11; Sztrakov, 1993, p. 39, pl. 24, fig. 8.
- **Dorothia traubi** (HAGN), 1956
Marsonella traubi HAGN, 1956, p. 118, pl. 9, fig. 5-6.
- Dorothia traubi* (HAGN). Grünig, 1985, p. 257, pl. 3, figs. 5, 6.
- **Frondicularia budensis** (HANTKEN), 1875
Flabelina budensis HANTKEN, 1875, p. 44, pl. 4, fig. 17
Frondicularia budensis (HANTKEN). Grünig, 1985, p. 261, pl. IV, fig. 21.
- **Globocassidulina globosa** (HANTKEN)
Cassidulina globosa HANTKEN, 1875, p. 64, pl. 16, fig. 2;
- Globocassidulina globosa* (HANTKEN). Braga et al., 1975, p. 108, pl. 6, fig. 4; Grünig, 1985, p. 273, pl. 10, fig. 3.
- **Haplophragmoides walteri** (GRZYBOWSKI), 1898
Trochammina walteri GRZYBOWSKI, 1898, p. 290, pl. 11, fig. 30.
- Haplophragmoides walteri* (GRZYBOWSKI). Kaminski & Geroch, 1933, p. 263, pl. 10, figs. 3-7.
- **Hydromyia rutteni** DE WITT PUYT, 1941 (Pl. II, fig. 9)
Hydromyia rutteni DE WITT PUYT, 1941, p. 54: fide Loeblich & Tappan; Sztrakov, p. 55, pl. 2, figs. 13, 16.
- **Karreriella arenasensis** CUSH. & BERM., 1937
Karreriella arenasensis CUSHMAN & BERMUDEZ, 1937, CLFR, Contr. 13, p. 5, pl. 1, figs 21, 22: (fide Cushman, 1937); Cushman, 1937, p. 125, pl. 14, fig. 24.
- **Karreriella cubensis** CUSH. & BERM., 1937 (Pl. I, fig. 6)
Karreriella cubensis CUSHMAN & BERMUDEZ, 1937 (Cush. Lab. F. R., Contr. 13, p. 4, pl. 1 figs. 18, 19: (fide Cushman, 1937); Cushman, 1937, p. 124, pl. 14, figs. 25, 26).



- *Karreriella disjuncta* CUSHMAN & JAVRIS, 1929;
Karreriella disjuncta CUSHMAN & JAVRIS, 1929, p. 6, pl. 2, fig. 7; Cushman, 1937, p. 123, pl. 14, figs. 34, 35.
- *Karreriella exilis* HAGN, 1952 (Pl. I, figs. 1, 2)
Kareriella siphonella (REUSS) var. *exilis* Hagn, 1952 (in Hagn & Hözl), p. 139, pl. 1, fig. 7; pl. 2, fig. 9 (fide Hagn, 1956); Hagn, 1956, p. 121, pl. 10, figs. 10-12.
- *Karreriella halkyardi* CUSHMAN, 1936 (Pl. I, figs. 4, 5)
Kareriella halkyardi CUSHMAN, 1936 p. 36, pl. 5, fig. 16; Cuvilier et Szakall, 1949, p. 33, pl. 12, fig. 10; Grünig, 1985, p. 258, pl. 3, figs. 21-22.
- *Karreriella hantkeniana* CUSHMAN, 1936
Gaudryina siphonella HANTKEN (NON REUSS), 1875, p. 14, pl. 1, fig. 3.
Karreriella hantkeniana CUSHMAN, 1936, p. 16, pl. 5, fig. 15; Cushman, 1937, p. 130, pl. 15, figs. 11, 12.
- *Karreriella siphonella* (REUSS), 1851
Gaudryina siphonella REUSS, 1851, p. 78, pl. 5, figs. 40-42.
Karreriella siphonella (REUSS). Cushman, 1937, p. 125, pl. 14, figs. 27-32.
- *Lagena biarritzensis* HAGN, 1956
Lagena biarritzensis HAGN, 1956, p. 142, pl. 10, fig. 21.
- *Lenticulina striata* (LIEBUS), 1911 (Pl. II, figs. 6, 7)
Cristellaria tricarinata var. *striata* LIEBUS, 1911, p. pl., fig.
- *Lenticulina striata* (LIEBUS). Mathlein & Sztrakov, 1993, p. 75, pl. 26, fig. 10.
- *Loxostomoides applinae* (PLUMMER), 1926
Bolivina applini PLUMMER, 1926, p. 69, pl. 4, fig. 1 (fide Ellis & Messina, 1940 et. suppl.)
Loxostomoides applinae (PLUMMER). Morkhoven et. al., 1986, p. 327, pl. 106, figs. 1-3.
- *Marginulina propinqua* HANTKEN, 1883
Marginulina propinqua HANTKEN, 1883, p. 146, pl. 2, fig. 4; Grünig, p. 262, pl. 5, figs. 20, 21.
Marginulinopsis propinqua (HANTKEN). Hagn, p. 133, pl. 11, figs. 15, 16.
- *Martinottiella hantkeniana* (CUSHMAN), 1936
Karreriella hantkeniana CUSHMAN, 1936, p. 36, pl. 5, fig. 19; Cushman, 1937, p. 130, pl. 15, figs. 11, 12.
- *Nuttallites truempyi* NUTTALL, 1930
Eponides truempyi NUTTALL, 1930, p. 287, pl. 24, figs. 9, 13, 14.
- Nuttallites truempyi* (NUTTALL). Morkhoven, 1985, p. 288, pl. 96 A, figs. 1-4; pl. 96 B, figs. 1-3; pl. 96 C, figs. 1-4, pl. 96 D, figs. 1, 2.
- *Percultazonaria fragaria* (GÜMBEL), 1868 (Pl. II, figs. 10, 11)
Marginulina fragaria GÜMBEL, 1868, p. 57, pl. 1, fig. 58.
Cristellaria fragaria (GÜMBEL). Hantken, p. 53, pl. 6, figs. 1-3.
Marginulinopsis fragaria (GÜMBEL). Hagn, 1956, p. 134, pl. 12, figs. 3, 8, 10; Grünig, 1985, p. 262, pl. 5, figs. 24-28.
- *Plectina dalmatina* (SCHUB.), 1911
Gaudryina dalmatina SCHUBERT (in Liebus, 1911), p. 75, pl. 3, fig. 5.
Plectina dalmanitina (SCHUBERT). Grünig, 1985, p. 258, pl. 3, figs. 1-6.
- *Plectofrondicularia striata* (HANTKEN), 1875
Flabelina striata HANTKEN, 1875, p. 43, pl. 13, fig. 13.
Parafrondicularia striata (HANTKEN). Chatelin & Sztrakov, 1993, pl. 75, pl. 7, fig. 22.
- *Rectuvigerina mexicana* (CUSHMAN), 1926
Siphogenerina mexicana CUSHMAN, 1926, p. 15, pl. 5, fig. 4 (fide Morkhoven et al., 1986);
Rectuvigerina mexicana (CUSHMAN). Morkhoven et. al., 1986, p. 150, pl. 49, figs. 1-3.
- *Reticulophragmium amplectens* (GRZYBOWSKI), 1898 (Pl. I, figs. 8, 9, 12, 13).
Cyclammina amplectens GRZYBOWSKI, 1898, p. 292, pl. 12, figs. 1-3.
Reticulophragmium amplectens (GRZYBOWSKI). Kaminski & Geroch, 1993, p. 266, pl. 11, figs. 5-7.
- *Sigmoilopsis* sp. (Pl. I, figs. 10, 11, 14)
- *Rectuvigerina mexicana* CUSHMAN, 1926
Siphogenerina mexicana CUSHMAN, 1926, p. 15, pl. 5, fig. 4.
Rectuvigerina mexicana (CUSHMAN). Morkhoven et. al., 1986, p. 150, pl. 49, figs. 1-3.
- *Spiroloculina texana* CUSHMAN & ELLIOSOR, 1944 (Pl. II, figs. 1-5).
Spiroloculina texana CUSHMAN & ELLIOSOR, 1944, p. 51, pl. 8, figs. 14, 15; McDougall, 1980, p. 37, pl. 5, figs. 3, 4.
- *Stilostomella hoernesii* (HANTKEN), 1875 (Pl. III, fig. 5).
Dentalina hoernesii Hantken, 1875, p. 37, pl. 4, fig. 2.
- Nodosaria* (*Dentalina*) *hoernesii* Hantken, 1868, p. 89, pl. 1, fig. 14.
Stilostomella hoernesii (HANTKEN). Sztrakov, 1979, pl. 19, fig. 15; Sztrakov, 1982, pl. 16, fig. 4.
- *Theodorinella neagui* n. g., n. sp. (see Appendix)



- *Tritaxia szaboi* (HANTKEN), 1875
Clavulina szaboi HANTKEN, 1875 p. 15, pl. 1, fig. 9.
- Tritaxia szaboi* (HANTKEN). Popescu & Iva, 197 , p., pl., fig.; Grünig, 1985, p. 257, pl. 2, fig. 22-23.
- *Turrilina robertsi* (HOWE), 1939 (Pl. IV, fig. 10).
Bolivina robertsi HOWE (in Howe & Ellis), 1939, p. 63, pl. 8, figs. 32, 33.
Turrilina brevispira TEN DAM 1944, p. 110, pl. 3, fig. 14.
- *Unicosiphonina zsigmondyi* (HANTKEN), 1875
Dentalina zsigmondyi HANTKEN, 1875, p. 32, pl. 12, fig. 17.
- *Uvigerina chirana* CUSHMAN & STONE, 1947 (Pl. V, figs. 7, 8).
Uvigerina chirana CUSHMAN & STONE, 1947, p. 17, pl. 2, fig. 25; Hagn, 1956, p. 50, pl. 13, figs. 14, 15; Braga et al., 1975, p. 106, pl. 5, fig. 10; Broesma, 1984, p. 31, pl. 1, fig. 1; Grünig, 1985, p. 267, pl. 7, figs. 3-5.
- *Uvigerina rippensis* COLE, 1927 (Pl. V, figs. 1-6).
Uvigerina rippensis COLE, 1927, p. 11, pl. 1, fig. 27; Sztrakos, 1983, p. 136, pl. 1, figs. 5, 14-23; Sztrakos, 1996, pl. 12, fig. 1.
- *Uvigerina hourqi* GRAHAM, DE KLASZ & RERAT, 1965 (Pl. V, figs. 11-13).
Uvigerina hourqi GRAHAM, KLASZ & RERAT, 1965, p. 75, pl. 1 figs. 9, 10; Sztrakos, 1983, p. 134, pl. 2, figs 1-6.
- *Uvigerina eocaena* GÜMBEL, 1868
Uvigerina eocaena GÜMBEL, 1868, p. 645; Broesma, 1984, p. 152, figs. 1-4; Grünig, 1985, p. 267, pl. 7, figs. 8-10.
- *Vaginulinopsis cumulicostata* (GÜMBEL), 1868
Cristellaria cumulicostata GÜMBEL, 1868, p. 60, pl. 1, fig. 76
- Vaginulinopsis cumulicostata* (GÜMBEL). Hagn, 1956, p. 135, pl. 13, fig. 3; Braga et al., 1975, p. 105, pl. 4, fig. 8; Grünig, 1985, p. 263, pl. 6, fig. 6.
- *Vulvulina haerigensis* (GÜMBEL), 1868
Venulina haerigensis GÜMBEL, 1868, p. 649, pl. 2, fig. 84.
- Vulvulina haerigensis* (GÜMBEL). Hagn, 1956, p. 115, pl. 9, figs. 7, 8; Decima & de Biase, 1975, p. 91, pl. 1, fig. 23.

Appendix

Family **Globocassidulinidae**
 Genus *Theodorinella* n. g.

Diagnosis. Test free, compact, slightly elongated; peripheral outline stellate; chambers cassidulinid arranged (biserially and enrolled, with zigzag suture) increasing in breadth as added, with a distinct median carina, approximately parallel to the sutures; sutures slightly depressed; wall calcareous, optically granular, perforate; surface pustulated except for the apertural face; aperture, an elongate to oval slitlike, extending up on the apertural face; apertural tooth projecting through the previous opening.

Type species: *Theodorinella neagui* n. sp.

Range: Eocene.

Theodorinella neagui n. sp. (Pl. IV, figs. 5-9)

Diagnose. Test compact, slightly conical; chambers biserially and enrolled increasing as added with a distinct tuberculate carina disposed approximately parallel to the suture; suture slightly depressed; aperture oval to elongated slitlike opening, extending up on apertural face.

Range. Middle-Upper Eocene.

Type species. The holotype (pl. IV, fig. 7) comes from Upper Eocene deposits from the Dăbuleni well (m. 177, see text-fig. 1).

Etymology. The name in honor of Prof. Theodor Neagu (Dept. Paleont., Univ. of Bucharest) for his great contribution to the knowledge of Foraminifera.

Remarks. *Theodorinella* differs from *Globocassidulinida* by its ornamentation and larger pores, and conical shape of the test instead of a spherical one.

The species comes from the Upper Eocene deposits (from Dăbuleni and Grojdibodu wells). It was also mentioned by Sztrakos (1996) as *Globocassidulinida* sp. (coming from Monfort, France) in the Acarinina pentamerata Zone, Donzacq Formation.

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Plate I

- Figs. 1-2 — *Karreriella exilis* HAGN: Well Bistretu (WB), m 660, Lower Eocene.
- Fig. 3 — "Textularia" sp. Slătioarele, Pitești. Acarinina pentacamerata Zone (P 9), Lower Eocene.
- Figs. 4-5 — *Karreriella halkyardi* CUSHMAN. Well Dăbuleni (WD), m 203, Middle Eocene.
- Fig. 6 — *Karreriella cubensis* CUSHMAN, WB, m 660, Lower Eocene.
- Fig. 7 — *Martinottiella* sp. WB, m 705, Lower Eocene.
- Figs. 8, 9, 12,13 — *Reticulophragmium amplexens* GRZYBOWSKI. WB, m. 600, Lower Eocene.
- Figs. 10, 11, 14 — *Sigmoilopsis* sp. Well Grojdibodu (WG), m 107 Upper Eocene.



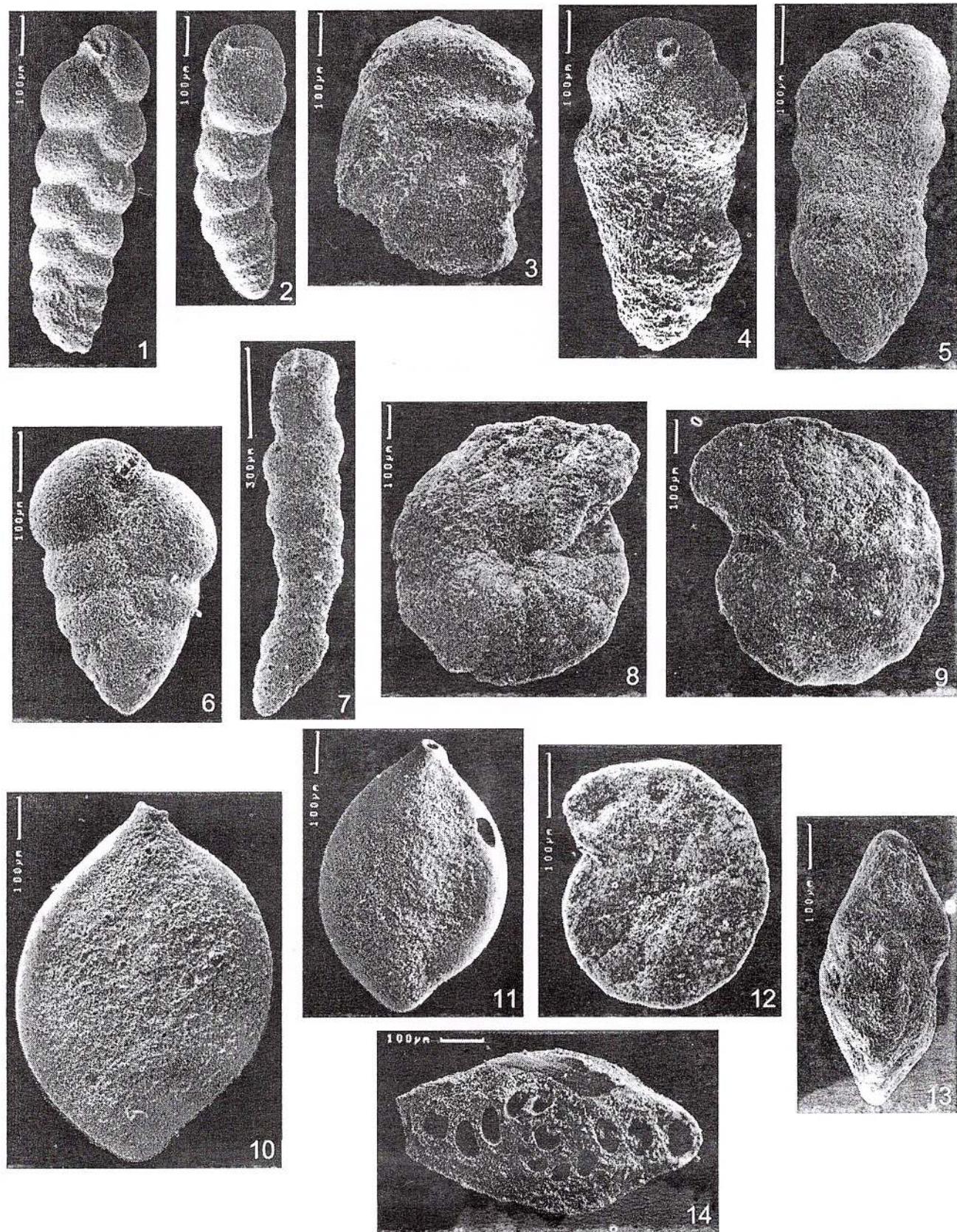


Plate II

Figs. 1-5 — *Spiroloculina texana* CUSHMAN. WD, m 300, Middle Eocene.

Figs. 6, 7 — *Lenticulina strata* (LIEBUS). WD, m 188, Upper Eocene.

Fig. 8 — *Marginulina multiplicata* BERGQUIST. WD, m 210, Middle Eocene.

Fig. 9 — *Hydromyilia rutteni* WITT PUYT. WB, m 600, Lower Eocene.

Figs. 10, 11 — *Percultazonaria fragaria* (GUMBEL). WD, m 225 and res. m 294, Middle Eocene.

Fig. 12 — *Citharinella tenuissima* (HANTKEN). WD, m 188, Upper Eocene.



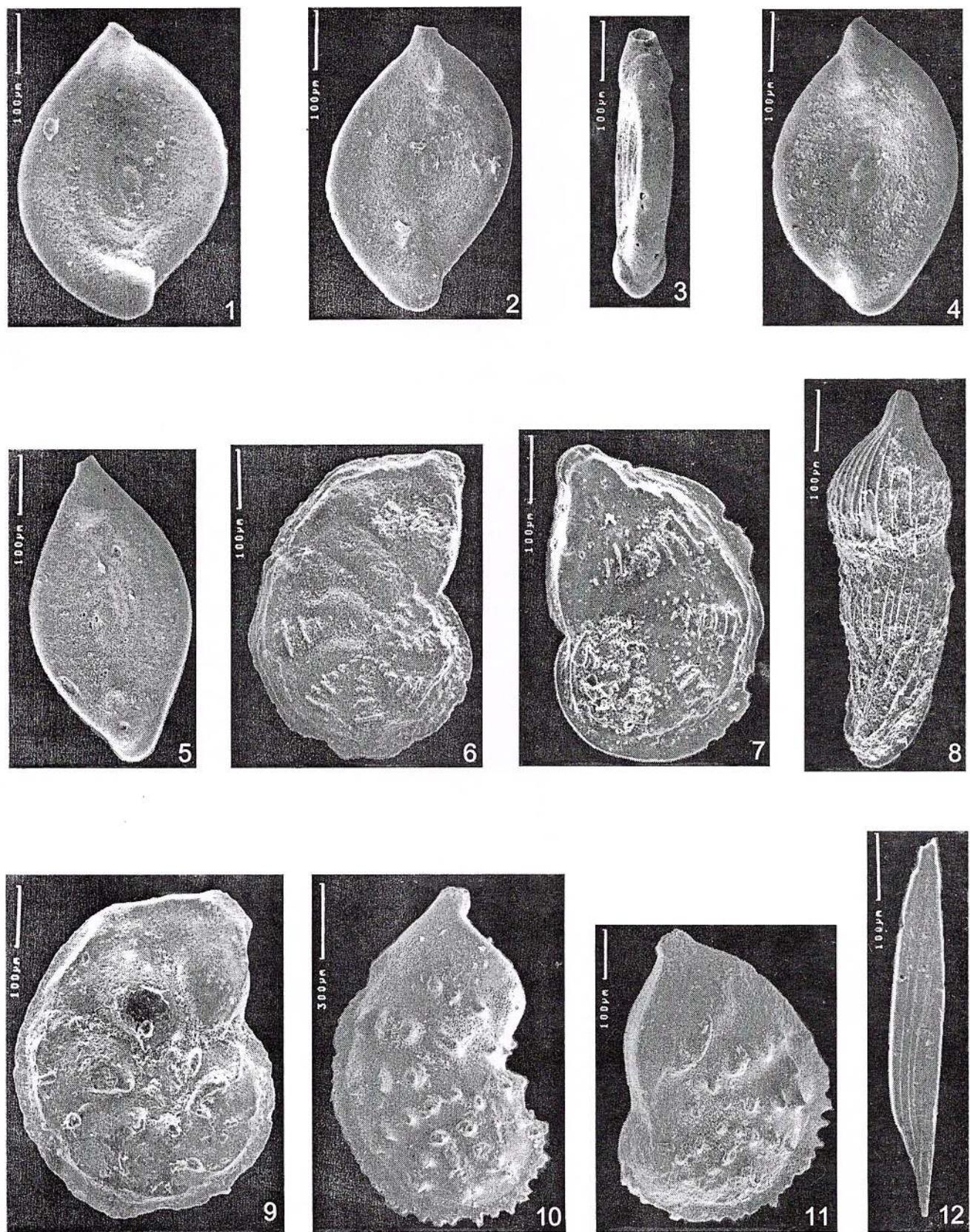


Plate III

Figs. 1, 2 — *Buchneria tricincta* (GUMBEL). WD, m 235, Middle Eocene.

Fig. 3 — *Buchneria scaraenaensis* (HANTKEN). WG, m 120, Upper Eocene.

Fig. 4 — *Buchneria* sp. WD, m 235, Middle Eocene.

Fig. 5 — *Stilostomella hoernesii* (HANTKEN). WD, m 188, Upper Eocene.

Figs. 6, 7 — *Coleites arborescens* (HANKYARD). WB, m 600, Lower Eocene.

Figs. 8, 9 — *Bolivina* sp. WD, m. 173, Upper Eocene.

Figs. 10, 11 — *Buchneria scaneraensis glabrata* (SELLI). WD, m 235, Middle Eocene.

Figs. 12, 13 — *Bolivina antegressa angulata* (SAHAKIJAN-GEZALIJAN). WD, m 188, Upper Eocene.



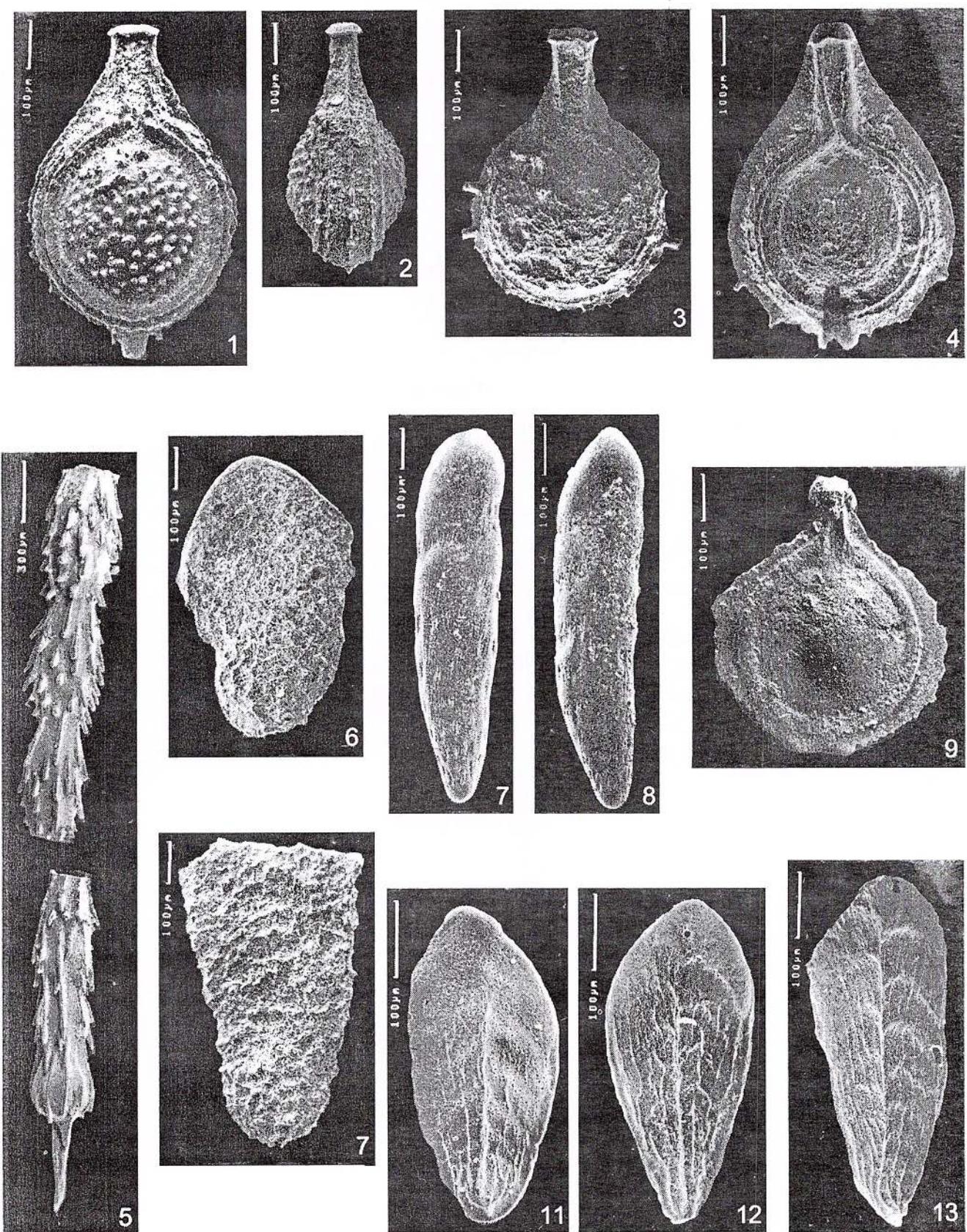


Plate IV

- Fig. 1 — *Burseolina inexculpta* (FRANZENAU). WD, m 188, Upper Eocene.
- Figs. 2, 3 — *Burseolina* sp. cf. *B. inexculpta* (FRANZ.). WD, m 188, Upper Eocene.
- Fig. 4 — *Cassidulina* cf. *C. limbata* CUSHMAN & HUGHES. WD, m 169, Upper Eocene.
- Figs. 5-9 — *Theodorinella neagui* n.g., n.sp. . Fig. 7, Holotype. WD, m 178, Upper Eocene.
- Fig. 10 — *Turrilina robertsi* (HOWE). WG, m 120, Upper Eocene.
- Fig. 11 — *Bullimina macilenta* CUSHMAN & PARKER. WD, m 188, Upper Eocene.
- Figs. 12, 13 — *Bulimina aksuatica* MOROZOVA. WD, m 188, Upper Eocene.



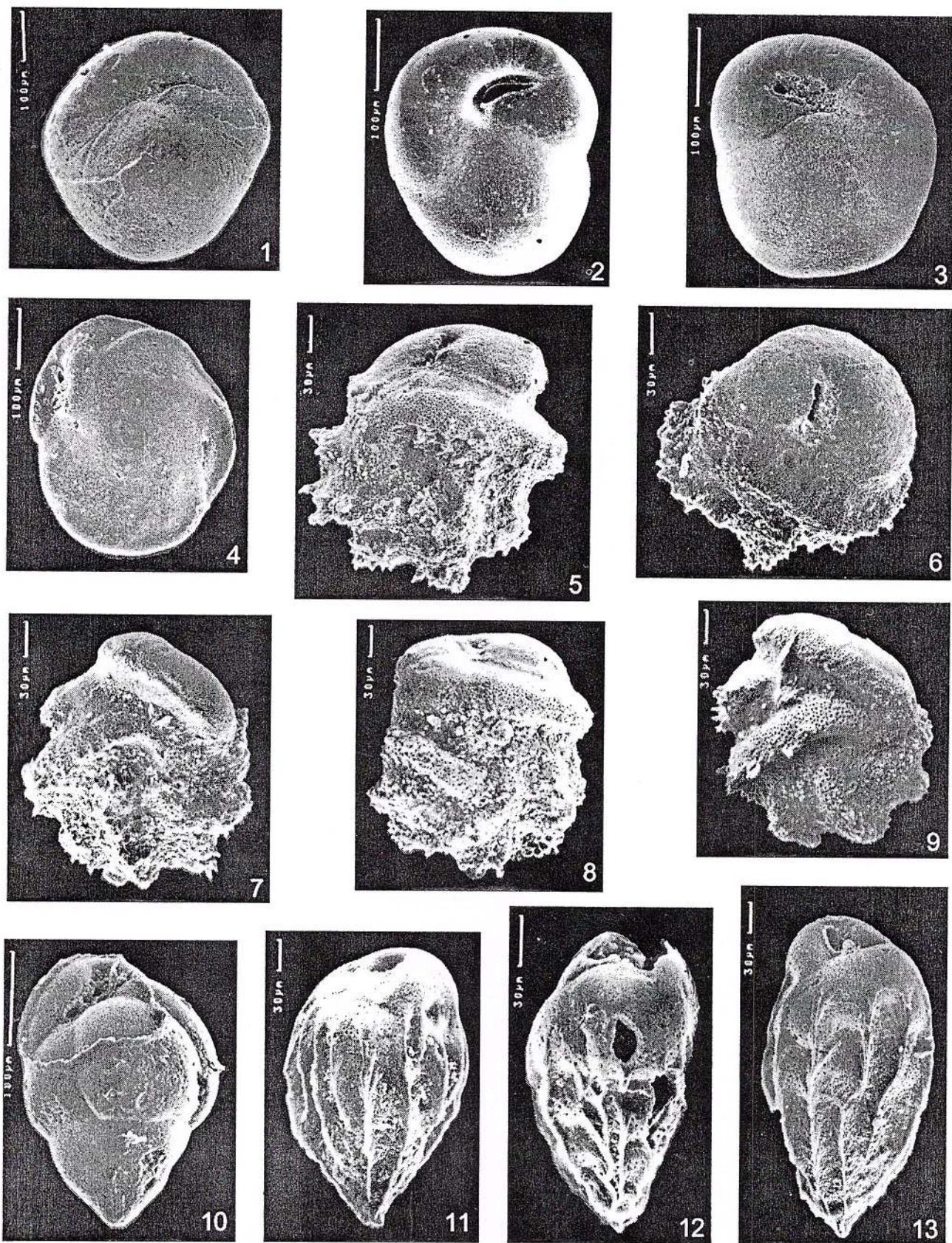


Plate V

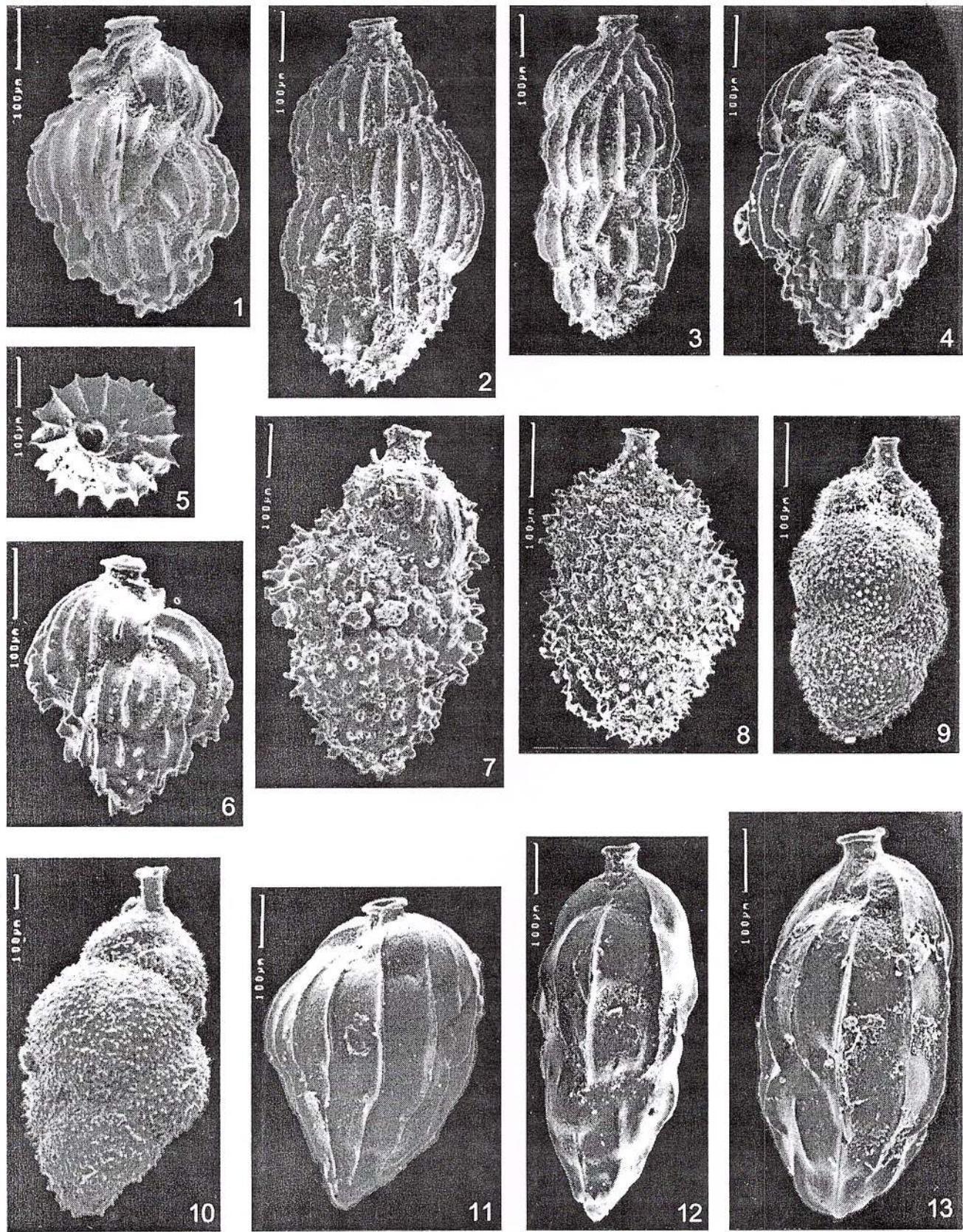
Figs. 1-6 — *Uvigerina rippensis* COLE. WG, m 78, Upper Eocene.

Figs. 7, 8 — *Uvigerina chirana* CUSHMAN & STONE. WG, m 78, Upper Eocene.

Figs. 9, 10 — *Uvigerina gracilis* REUSS. WG, m 72, Upper Eocene.

Figs. 11-13 — *Uvigerina hourcqui* GRAHAM, DE KLASZ & REHAT. WG, m 72, Upper Eocene.





POLYIPNUS ANTEASTEROIDES CIOBANU, 1977
(TELEOSTEI, STERNOPTYCHIDAE) IN THE OLIGOCENE FORMATIONS
FROM PIATRA NEAMȚ AND FIENI (EAST CARPATHIANS)

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Key words: East Carpathians. Oligocene. Piatra Neamț. Fieni. Teleostei. Sternoptychidae. *Sternoptychini*. *Polyipnus*.



Abstract: According to the latest review, almost all the fossil species of the genus *Polyipnus* GUNTHER are questionable. Therefore, we consider that the two Teleostean specimens found in the Oligocene from Piatra Neamț and Fieni, Romania, represent with certainty at least one reliable fossil species of that genus. Because Ciobanu's initial description of *Polyipnus anteasteroides* is quite vague, without mentioning many important features, we redescribe the specimen from Piatra Neamț (holotype) together with a new specimen found at Fieni. All the osteological and meristic data presented in this paper are in conformity with the genus *Polyipnus* GUNTHER. A new diagnosis for *Polyipnus anteasteroides* CIOBANU is also presented. Therefore, we consider that *Polyipnus anteasteroides* CIOBANU, 1977 is the only valid fossil species of the genus *Polyipnus*, having features distinct from the other two genera (*Argyropelecus* and *Sternoptyx*) with which it forms the tribe *Sternoptychini*.

1. Introduction

Polygnoides levis DANILCENKO, from the Eocene in Georgia, well-known as the oldest representative of the Sternoptychidae (DANILCENKO, 1962) can no longer be assigned to this family (Baird, 1971; Weitzman, 1974).

A new species, *Polyipnus sobnoviensis*, was described by Jerzmanska (1960) from the Oligocene Jaslo shales in Poland. However according to Baird (1971) and Weitzman (1974) the main characteristics of *P. sobnoviensis* are similar to those of the genera *Danaphos* and *Valenciennellus*; therefore *P. sobnoviensis* JERZMANSKA cannot be assigned with certainty to *Polyipnus* GUNTHER.

Another species of the genus *Polyipnus*, *Polyipnus brevis*, was briefly described in 1961 by Gorbach, based on a single poorly preserved specimen from the Menilite Beds in the vicinity of Deleatin (Prut River, Ukraine). This species cannot be placed with confidence in *Polyipnus* GUNTHER, as the author himself remarked, comparing its characteristics with the recent species of *Polyipnus*.

Polyipnus oligocenicus CIOBANU, found in the Oligocene formations from Piatra Neamț (specimen no. 124 in CNHM-PN) (CNHM-PN, Collection of Natural History Museum Piatra Neamț) shows osteological characteristics (as reviewed in this paper) resembling *Polyipnus sobnoviensis* JERZMANSKA; we conclude that both species need careful review.

Therefore, the above-mentioned species previously assigned to the genus *Polyipnus* cannot be considered as valid species of that genus. Hence, we are confident that, on the basis of their osteological and meristic characteristics, the only fossil species of the genus *Polyipnus* is represented by the two specimens of *Polyipnus anteasteroides* CIOBANU (no. 125 in CNHM-PN and no. 0551/5F in CPD-B). (CPD-B, Collection of the Paleontological Department, University of Bucharest). We herein redescribe this species and provide a new diagnosis of it.



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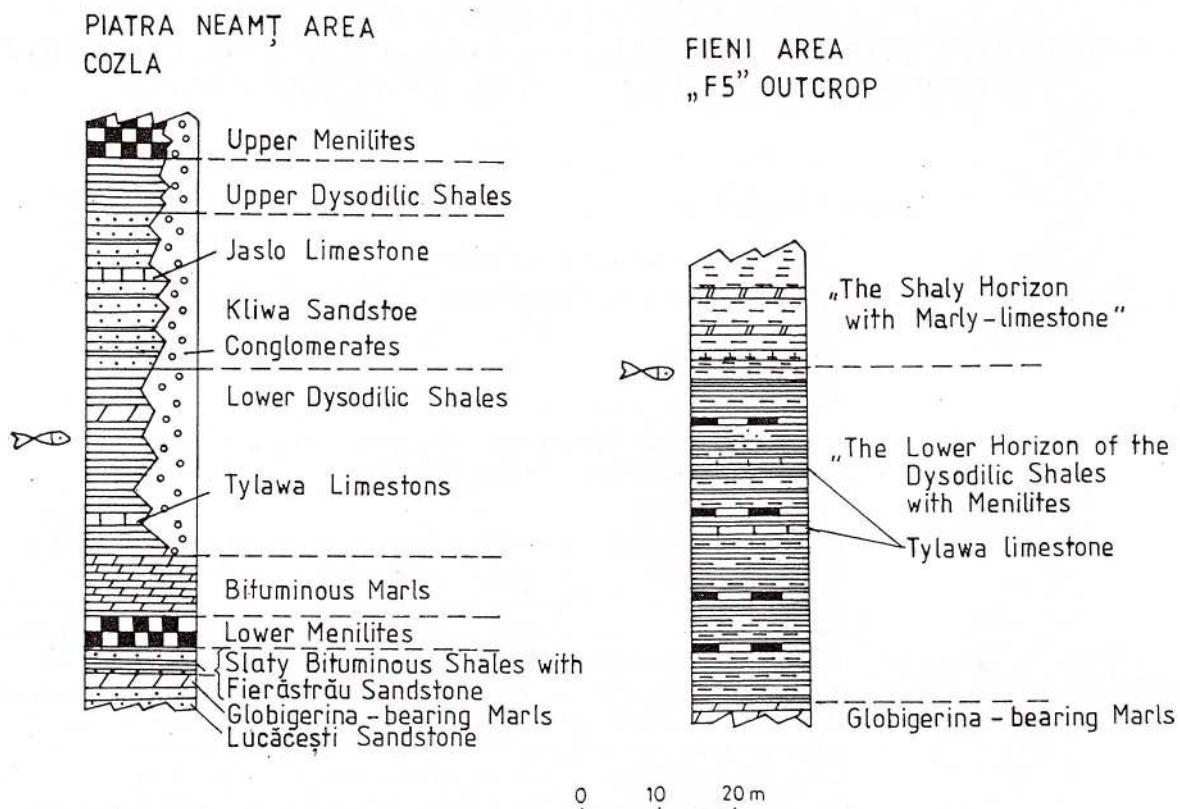


Fig. 1 – Lithostratigraphic columns from Piatra Neamț and Fieni areas where the two specimens of *Polyipnus anteasteroides* CIOBANU (holotype and additional specimen) were found.

2. Geological data

2.1. Piatra Neamț Area

From a structural point of view, this area is comprised within the Marginal Folds Nappe (=Vrancea Nappe). Here, Oligocene-Lower Miocene deposits are developed in Pietricica lithofacies (Grasu et al., 1988). The Cozla area lithologic column (Fig. 1) begins with Bituminous shales (Slaty Bituminous Shales), with quartzose sandstones of Kliwa type interbeds (Fierăstrău Sandstone), and continues with the following "classic" lithostratigraphic sequences: Lower Menilites and Bituminous Marls (with the same petrographic features known for the whole East Carpathians belt area); Lower Dysodilic Shales (which together with bituminous shales also show Tylawa type laminitic limestones); Kliwa Sandstone (massive, orthoquartzitic sandstones interbedded with thin dysodilic shales and some Jaslo laminitic limestone intercalations); Upper Dysodilic Shales and Upper Menilites (with the same well-known petrographic features). Sometimes, beginning with the Lower Dysodilic Shales level, all

the above lithostratigraphic units are invaded by ru-dites, mainly consisting of green schists elements. *Polyipnus anteasteroides* CIOBANU from CNHM-PN was found in the Lower Dysodilic Shales (Rupelian) in this area.

2.2 Fieni Area

The Oligocene-Lower Miocene deposits of this area (Buciumeni Syncline) are included in the post-tectonic cover with Upper Cretaceous tectogenesis which, during younger tectonic stages, had been folded or even removed together with the units which it overlies unconformably (Ceahlău and Teleajen Nappes) (Ştefănescu, 1995). Oligocene-Lower Miocene deposits show a peculiar facies characterized by the lack of arenites, named Valea Caselor Facies (Ştefănescu, 1970). The same author recognized three different lithologic horizons: "The Lower Horizon of the Dysodile Shales with Menilites"; "The Shaly Horizon with Marly-limestone"; "The Upper Horizon of the Dysodile Shales". *Polyipnus anteasteroides* CIOBANU specimen from CPD-B was

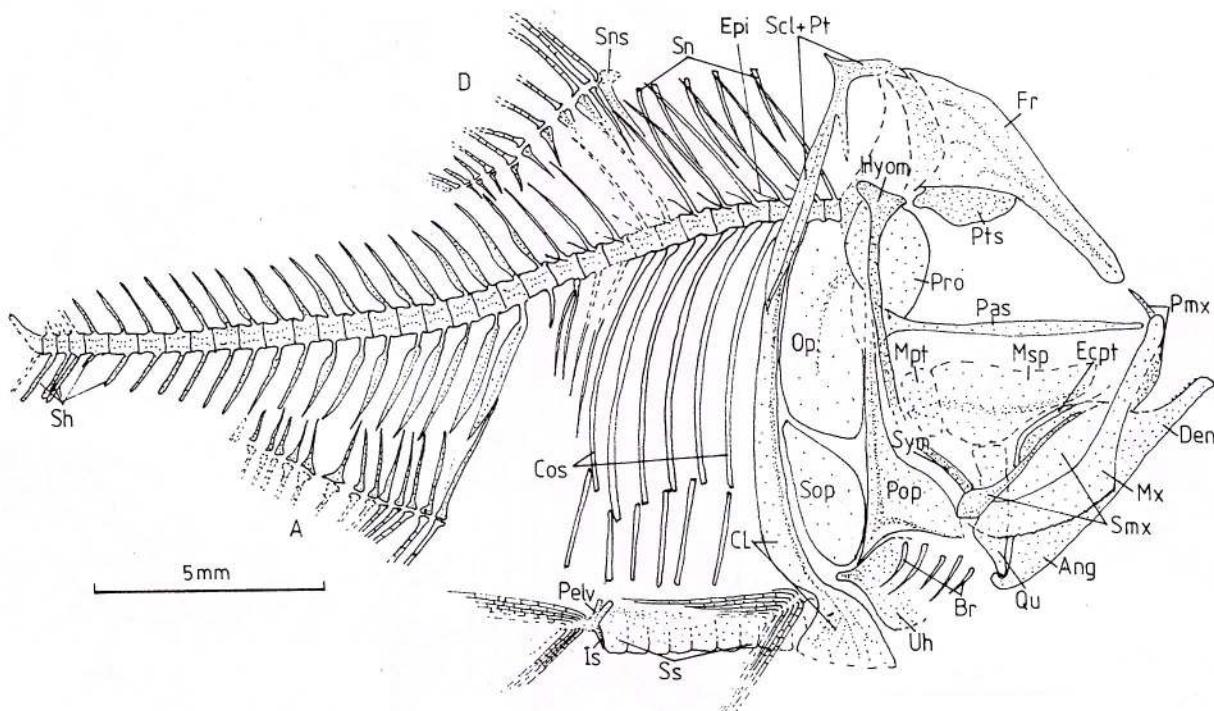


Fig. 2 - *Polyipnus anteasteroides* CIOBANU, 1977; holotype no. 125, SL 25 mm, Lower Dysodilic Shales, Oligocene, Piatra Neamț. Abbreviations for the names of bones: A - anal fin; Ang - angular; Br - brachioistegal rays; Cl - cleithrum; Cos - pleural ribs; Den - dentary; D - dorsal fin; Ecpt - ectopterygoid; Ep - epurals; Epi - epineurals; Fr - frontal; Is - iliac spine; Hyom - hyomandibular; Hyp - hypural; Mpt - metapterygoid; Msp - mesopterygoid; Mx - maxilla; Op - opercle; Pelv - pelvic; Pop - preopercle; Pt - posttemporal; Parh - parhypural; Pro - prootic; Pts - pterosphenoid; Pas - parasphenoid; Pmx - premaxilla; Qu - quadrate; Rr - rudimentary rays; Scl - supracleithrum; Sh - haemal spine; Smx - supramaxilla; Sn - supraneurals; Sns - specialized supraneurals; Sne - neural spines; Sop - subopercle; Ss - specialized scales; Sym - symplectic; Uh - urohyal (these abbreviations are common for figures 3, 4 as well).

found in the upper part of "The Lower Horizon of the Dysodile Shales with Menilites (Rupelian) (Fig. 1) from "F5" outcrop (Grigorescu, Constantin, in press). This formation consists mainly of poorly calcareous, brown or weathered to yellow, argillaceous shales, interbedded with black, thin-layered argillaceous bituminous shales (dysodilic shales type) or with menilite type silicified rocks. Two-three Tylawa laminitic limestone centimetric levels are interbedded in this formation, as well.

3. Systematic part

Order Stomiiformes

Family Sternopychidae DUMERIL, 1806

Tribe Sternopychini BAIRD, 1986

Genus *Polyipnus* GUNTHER, 1887

Polyipnus anteasteroides CIOBANU, 1977

(Figs. 2-4; Pl. I, Figs. 1, 2; Pl. II, Figs. 1-5)

1977-*Polyipnus anteasteroides* CIOBANU; Ciobanu, p. 85-86, pl. XXII, figs. 1, 2.

Material examined. Holotype no. 125 from

Oligocene of Piatra Neamț area in CHNM-PN, and additional specimen no. 0551/5F from Oligocene of Fieni area in CPD-B.

Diagnosis. 33 vertebrae, of which 12 are precaudal; one abdominal carina, between the pelvic and pectoral fins, consisting of 9-10 specialized scales associated with as many photophores; eyes projecting normally; a small spine preceding the dorsal-fin, probably formed by a pterygophore-supraneurial fusion; six pairs of well-developed pleural ribs; four independent hypurals in the caudal-skeleton upper lobe.

Description. Small to medium-sized fishes; body oval-shaped; mouth subvertical, with a well-developed maxilla; head length 34-37.7 % SL; maximum body depth 49.2-51.7 % SL.

Character	Holotype no. 125	Additional specimen no. 0551/5F
Standard length (SL)	25	58
Head length	8.5	22
Maximum body depth	12.3	30

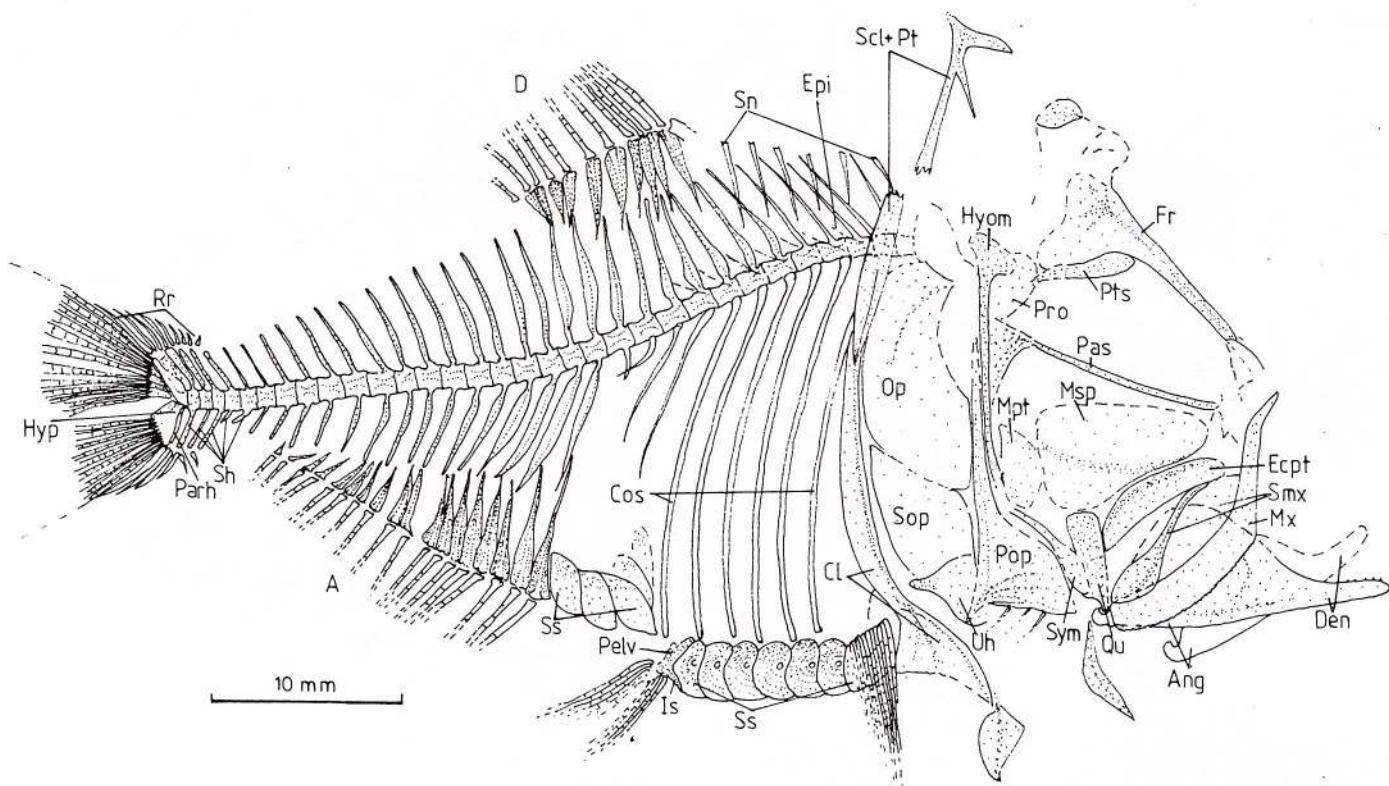


Fig. 3 - *Polyipnus anteasteroides* CIOBANU, 1977; additional specimen no. 0551/5F, SL 58mm, "The Lower Horizon of the Dysodile Shales with Menilites", Oligocene, Fieni.

Skull. Both specimens show typical features of the genus *Polyipnus* (Figs. 2, 3; Pl. II, Figs. 1, 2). There are no striae or perforations on the frontal. Parietal, displayed in the holotype behind the frontal, also without striae. Large pterosphenoid under the posterior part of the frontal (Fig. 2). Well-developed otic region with distinct prootic (Fig. 2). Almost straight, slightly curved parasphenoid, with a subsequent enlargement in the otic region. In both specimens, from well-preserved upper jaw, thin premaxilla with small teeth, 2 supramaxillas and maxilla apparent. Very long maxilla, thin anteriorly, enlarged posteriorly, with a well-developed angle in the median region, ridged ventrally (Figs. 2, 3). Lower jaw (Fig. 3; Pl. II, Fig. 2) characteristic of the genus *Polyipnus* (Weitzman, 1974). Dentary with small teeth, narrow anteriorly, then much enlarged. Angular-quadratare articulation in front of vertical from anterior orbit edge. Large mesopterygoid and smaller metapterygoid in contact posteriorly, and ventrally with the dorsal part of the quadratare and ectopterygoid. Well-preserved hyomandibular apparent in the holotype (Fig. 2). The opercular apparatus has a very small opercle, with the antero-dorsal edge divided by the common point with the hyomandibular (Fig. 2). Preopercle

typical of the genus *Polyipnus*, having two regions: the first, dorsal, thinner and longer; the second, ventral, wider with a slight posterior and ventral spine. Preopercle lateral edge slightly ridged. Subopercula almost triangular. Six branchiostegal rays (Fig. 2) are visible near the well-developed, triangular-shaped urohyal.

Vertebral column. There are 33 vertebrae, of which 12 are precaudal. Shortest haemal spine on the last precaudal vertebra (characteristic mentioned by Weitzman, 1974). Ribs not visible on the first two precaudal vertebrae, covered partially by supracleithrum. There are six pairs of well-developed pleural ribs, present from the third to the eighth precaudal vertebrae (Figs. 2, 3). The ribs become shorter and thinner on the next three vertebrae and there is only a small spine on the twelfth one. Long neural spines visible from the first vertebra, enlarged at the base beginning with the fourth-fifth vertebrae (Fig. 2). At the bases of the neural arches thin epineurals are apparent. Caudal vertebrae haemal and neural spines becoming lanceolate, a specific *Sternopytchini* tribe characteristic (Baird, 1986). Haemal spines becoming shorter in the region of the caudal peduncle, displaying an empty space where photophores are visible as poorly preserved black pigmented spots.

Caudal-fin. Parhypural attached to hypurals 1-2 in lower lobe and independent hypurals 3-5 in upper lobe can be identified (Fig. 4; Pl. II, Fig. 5). Haemal spines become very short and a place for photophores is apparent. Epurals poorly preserved. Caudal-fin upper lobe consisting of 9 rudimentary rays, followed by 12 segmented soft rays.

Dorsal-fin. There are 11-12 segmented soft rays, with 10-11 basal pterygiophores (Figs. 2, 3). A short spine (specialized supraneural) formed by a pterygiophore-supraneural fusion is visible just in front of the dorsal, extending the body dorsal profile. Well-preserved supraneurals 5-6, placed anteriorly to the dorsal-fin without exceeding the body dorsal profile.

Anal-fin. There are 18 segmented soft rays with 18 basal pterygiophores (Fig. 3), gathered into two regions. Between the first region (consisting of 8 pterygiophores) and the second one, there is a small space where some black pigmented spots - photophores - are apparent.

broadening ventrally; it becomes thinner in the pectoral fin region, creating a space for these fins, then it broadens again, in front of the pectoral fin, with a small ventral palette appearing (Figs. 2, 3).

Pelvic fins and girdle. Poorly preserved segmented soft rays. The pelvic girdle appears between the fifth and sixth large pleural ribs. No correlation with these can be noticed. Iliac spine, small and distinct, oriented anteroventrally, apparent in both specimens (Figs. 2, 3; Pl. II, Fig. 4). The pubic region of the pelvic girdle is oriented dorsally and placed slightly anteriorly obliquely to the axis of the body.

Photophores. Appear as poorly preserved black pigmented spots in the abdominal, preanal and caudal regions. Between the pectoral and pelvic fins, very well-preserved carinate scales are apparent (Figs. 2, 3; Pl. II, Fig. 3). These 9-10 scales are associated with the abdominal photophores. Between the pelvic and anal fins, 5 carinate scales, associated with as many photophores, are apparent in the paratype (Fig. 3; Pl. II, Fig. 4).

Discussion. All the above-mentioned osteological and meristic characteristics are specific of the genus *Polyipnus* GUNTHER.

Polyipnus oligocenicus CIOBANU, 1977 (no. 124 in CNHM-PN) does not have typical features of the genus *Polyipnus*. Large pleural ribs form 8-9 pairs and do not have any association with the pelvic girdle. Posttemporal and supracleithrum not fused: posttemporal without any posterior prolongation resembling a spine. A very well-developed coracoid present in the pectoral girdle. Supraneurals visible anterior to the dorsal, but they do not form any association resembling a spine or lamellar bone. The anal fin is simple, without having the above-mentioned separation into two different regions. Carinate scales not present between the pectorals and pelvics or pelvics and anal. Poorly preserved photophores present as black pigmented spots. Fused hypurals 3-4 and 5-6 in the upper lobe of the caudal-fin. This species shows typical Sternopychidae characteristics, but it is closer to the Maurolicidae group.

Polyipnus sobnoviensis JERZMANSKA, 1960 from Poland also has typical Maurolicidae characteristics (Baird, 1971; Weitzman, 1974). Therefore, the above-mentioned species need revision and better systematic placement.

Therefore, we consider that *Polyipnus anteasteroides* CIOBANU, 1977 is the only fossil species typical of the genus *Polyipnus*, having distinct features from the other two genera (*Argyropelecus* and *Sternopyx*) together with which it forms the tribe *Sternopychini* (Baird, 1986).

The genus *Polyipnus* is represented by 21 species in the Recent fauna. These are found in tropical ar-

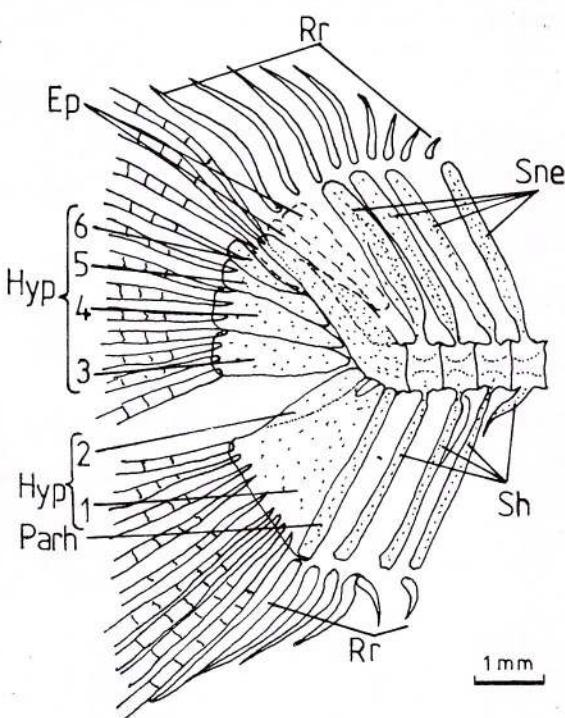


Fig. 4 - *Polyipnus anteasteroides* CIOBANU, 1977; caudal-fin skeleton, additional specimen.

Pectoral fins and girdle. Long pectoral fins, reaching the pelvic fins bases, but poorly preserved, and the rays cannot be counted (Fig. 2). On the pectoral girdle, the postcleithrum is fused with the supracleithrum. Postcleithrum extending posteriorly in its upper part, forming a small simple spine. Long lanceolate supracleithrum appearing as a posttemporal prolongation. Thin cleithrum in its upper part,

eas, around islands and the continental shelf (Baird, 1971). Their vertical distribution is between 50-400 m, and there is no evidence about whether they have diurnal migration.

Baird (1971) placed the Recent species of the genus *Polyipnus* into 3 complexes. The fossil species *Polyipnus anteasteroides* CIOBANU shows some specific features of the *Polyipnus asteroides* complex: posttemporal spine small, simple, abdominal carina smooth in its ventral part. In establishing the correct affiliation of *Polyipnus anteasteroides* CIOBANU to one of the above-mentioned complexes, a comparison between the osteological characteristics, both with those of the *P. asteroides* complex and with those of the *P. laternatus* complexe will be necessary.

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Plate I

Fig. 1 – *Polyipnus anteasteroides* CIOBANU, 1977; holotype no.125, SL 25 mm, Oligocene, Piatra Neamț.

Fig. 2 – *Polyipnus anteasteroides* CIOBANU, 1977; additional specimen no. 0551/5F, SL 58 mm, Oligocene, Fieni.



S. BACIU, P. CONSTANTIN – POLYIPNUS ANTEASTEROIDES FROM THE OLIGOCENE OF
EAST CARPATHIANS

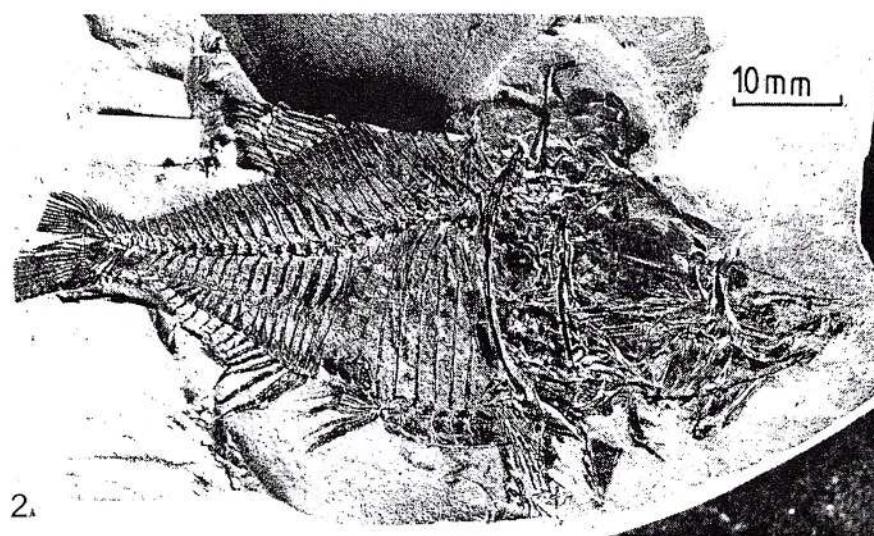
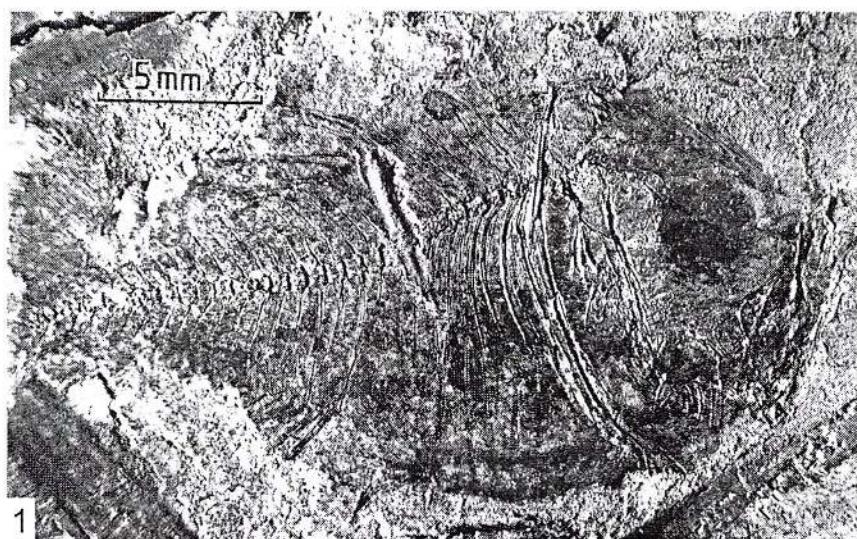


Plate II

Fig. 1 - *Polyipnus anteasteroides* CIOBANU, 1977; head, holotype.

Fig. 2 - *Polyipnus anteasteroides* CIOBANU, 1977; lower and upper maxillas, additional specimen.

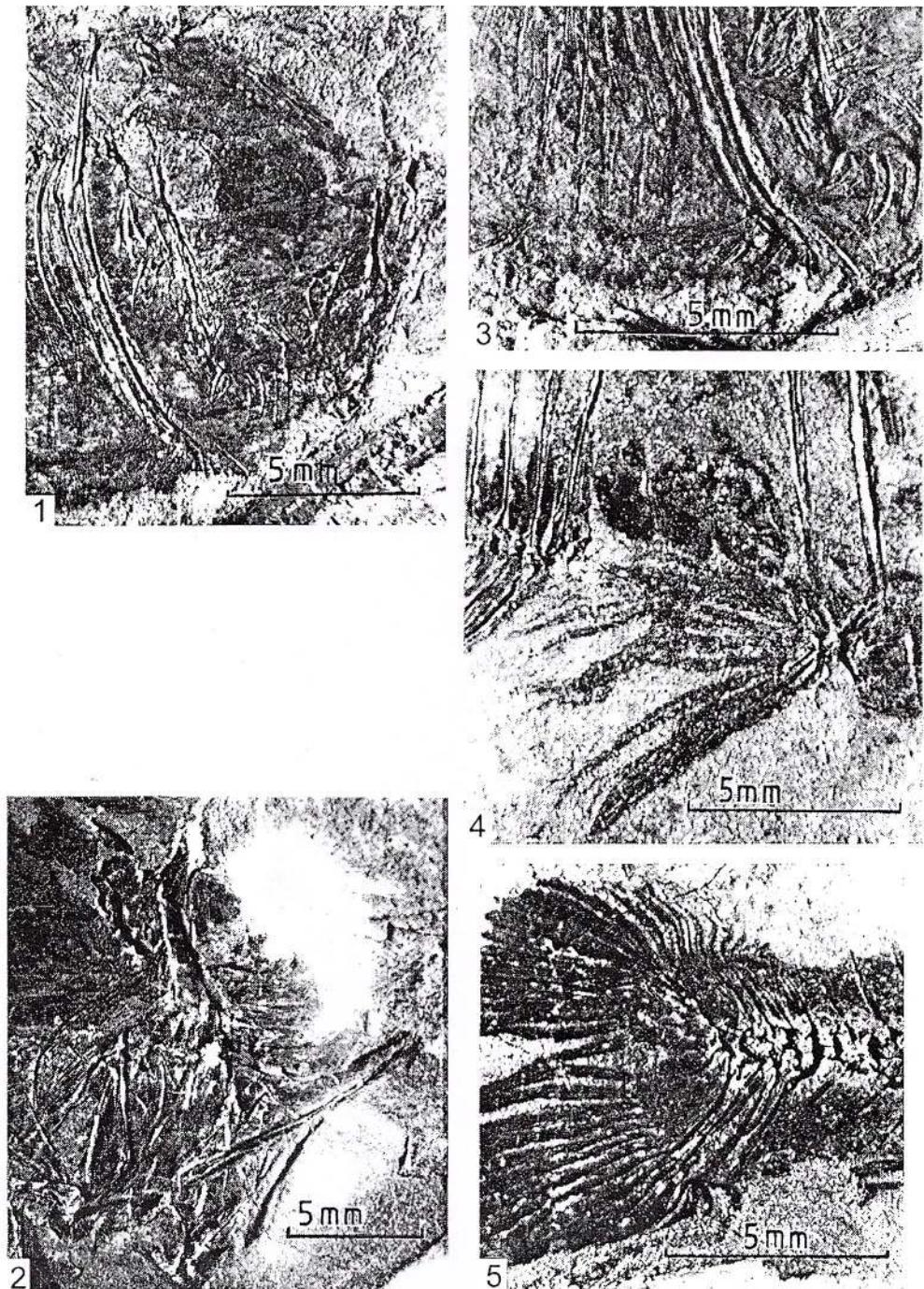
Fig. 3 - *Polyipnus anteasteroides* CIOBANU, 1977; carinate scales between pectoral and pelvic fins, holotype.

Fig. 4 - *Polyipnus anteasteroides* CIOBANU, 1977; carinate scales between pelvic and anal fins, additional specimen.

Fig. 5 - *Polyipnus anteasteroides* CIOBANU, 1977; caudal-fin, additional specimen.



S. BACIU, P. CONSTANTIN – POLYIPNUS ANTEASTEROIDES FROM THE OLIGOCENE OF
EAST CARPATHIANS



THE STUDY OF THE BADENIAN CALCAREOUS NANNOPLANKTON FROM THE MUNTEANIAN SUBCARPATHIANS

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Key words: Calcareous Nannoplankton. Planktonic Foraminifera. Badenian. Muntenian Subcarpathians.

Abstract: The study of the calcareous nannoplankton from the Badenian formations of the Muntenian Subcarpathians allowed the emphasizing of the following bioevents: the first occurrences of *Discoaster exilis* and the beginning of the NN 5 Zone just below the deposits of the Slănic Tuff; the first appearances of *Discoaster brouweri* simultaneously with those of the species *Helicosphaera wallichii* and *Sphenolithus abies* at the top of the NN 5 Zone, identified in the upper part of the Slănic Tuff; the extinction of *Sphenolithus heteromorphus* and the beginning of the NN 6 Zone at the top of the Slănic Tuff; the first stratigraphically successive occurrence of the species *Syracolithus dalmaticus*, *Scapholithus fossilis* and *Calcidiscus pataecus* in the upper part of the NN 6 Zone; the coincidence of the first appearance of the planktonic foraminifer *Globoturborotalita druryi* with that of the species *Discoaster brouweri* at the top of the NN 5 Zone.



1. Lithostratigraphy

The classic lithostratigraphic succession (Popescu, 1951) of the Badenian (divided on the geological maps, scale 1:50,000 of the Geological Institute of Romania, into Langhian and Kossovian) from the Muntenian Subcarpathians is: the Slănic Tuff, the Evaporitic Formation, the Radiolarian Shales and the Spirialis Marls.

The Slănic Tuff, when completely developed, begins with a conglomeratic-sandy sequence, followed by more or less regular alternations of tuffites, tuffs and Globigerina marls. They are overlain by clays and marls with sandstone or, rarely, limestone intercalations, especially on the margins of the basin.

The Evaporitic Formation, made up of gypsums, argillaceous breccias, salt bodies or lenses, contains locally, in its lower part, pelitic intercalations, very rich in foraminifera and nannoplankton.

These two formations are considered as Lower and Middle Badenian in age on the basis of the foraminiferal assemblages belonging to the zones with *Candorbolina universa*/*Globorotalia bykovae*

and *Globoturborotalita druryi*/*Globogerinopsis grilli* (Popescu, 1987).

The Radiolarian Shales show a characteristic facies, represented by marls and clays with frequent argillaceous shales or silt intercalations and rare sandstone and sand intercalations.

The Spirialis Marls are made up of thick beds of pelites, which subsequently have thin sand and sandstone intercalations. In the upper half of the succession one up to two tuffitic levels appear. Both the Radiolarian Shales and the Spirialis Marls were attributed to the Kossovian on the basis of the foraminifera assemblages with *Velapertina* (Popescu, Gheta, 1984; Popescu, 1987).

2. Calcareous nannoplankton (Figs. 1, 2)

The very rich and well preserved calcareous nannoplankton assemblages are almost continuously developed stratigraphically (excepting the Evaporitic Formation) in the Badenian deposits. For the description of these deposits a series of typical sections, where the Badenian deposits are exposed in very well preserved outcrops, was selected.



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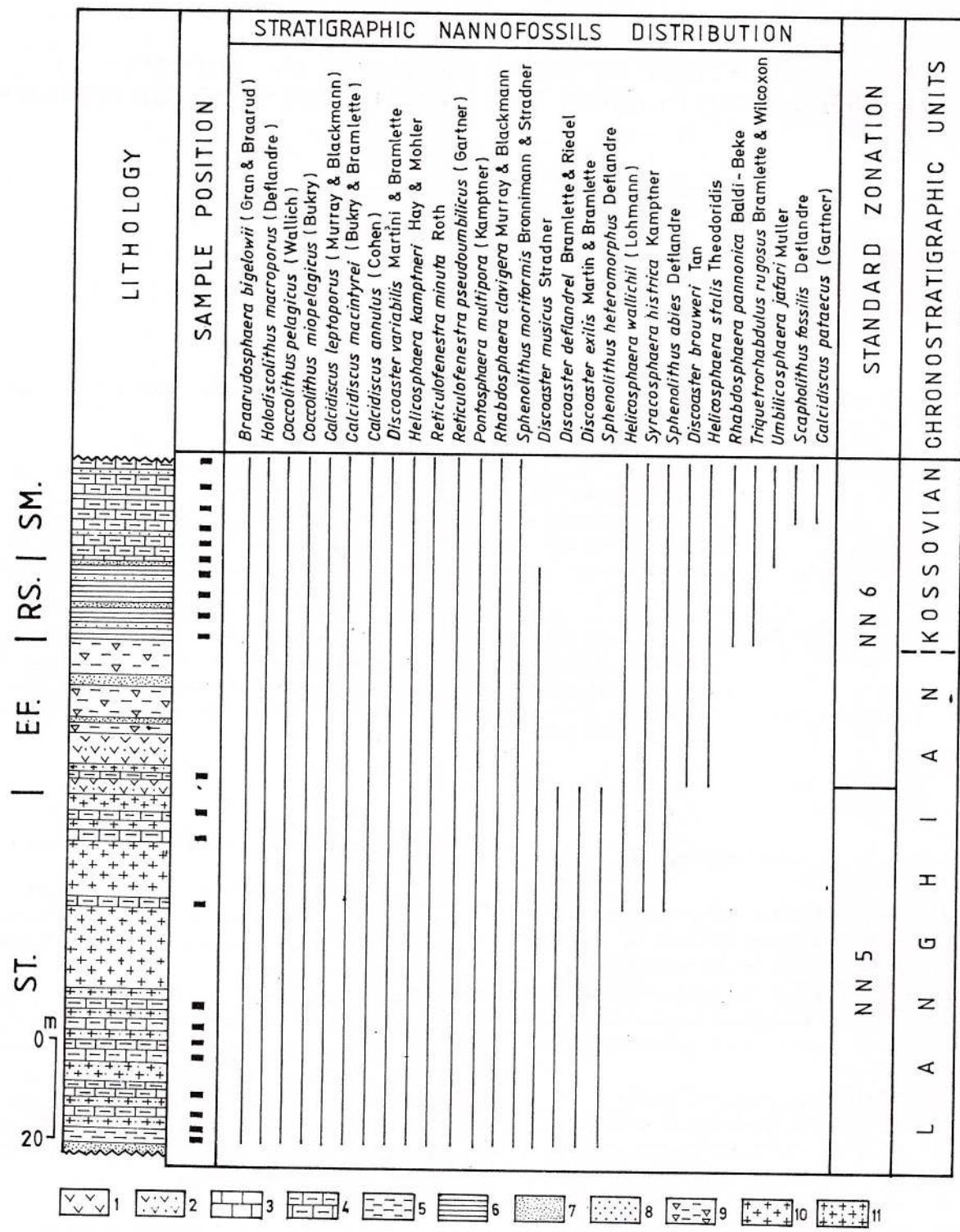


Fig. 1 – Nannoplankton assemblages - Piatra Verde Section

ST, Slănic Tuff; EF, Evaporitic Formation; RS, Radiolarian Shales; SM, Spirialis Marls. 1, gypsum; 2, gypsumiferous sandstones; 3, limestones; 4, marls; 5, clays; 6, argillaceous shales; 7, sands; 8, sandstones; 9, breccias; 10, tuffs; 11, tuffites.

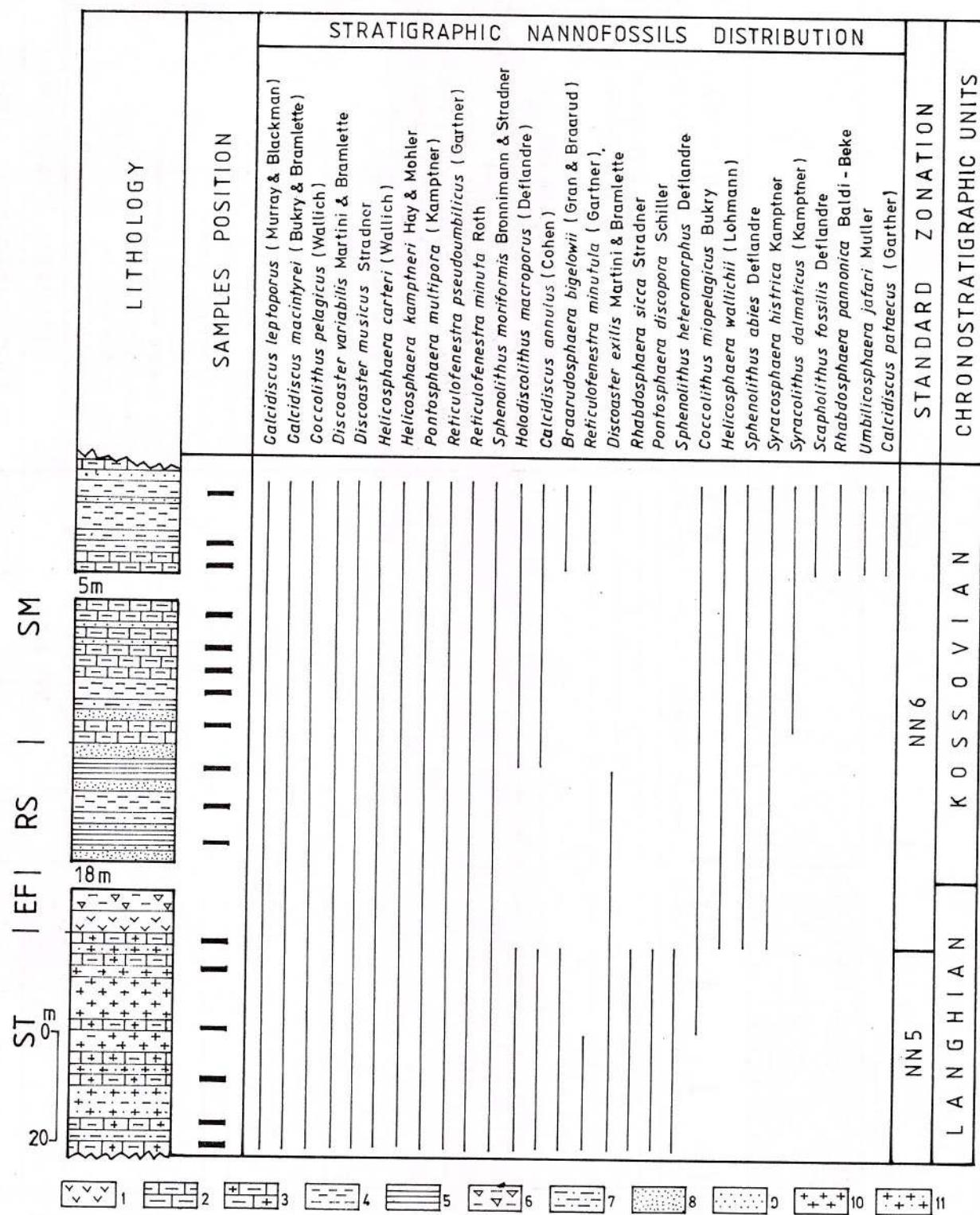


Fig. 2. Nannoplankton assemblages - Lupa Valley Section
 ST, Slănic Tuff; EF, Evaporitic Formation; RS, Radiolarian Shales; SM, Spirialis Marls. 1, gypsum; 2, marls; 3, tuffaceous marls; 4, clays; 5, argillaceous shales; 6, argillaceous breccias; 7, siltites; 8, sandstones; 9, tuffs; 10, tuffites.

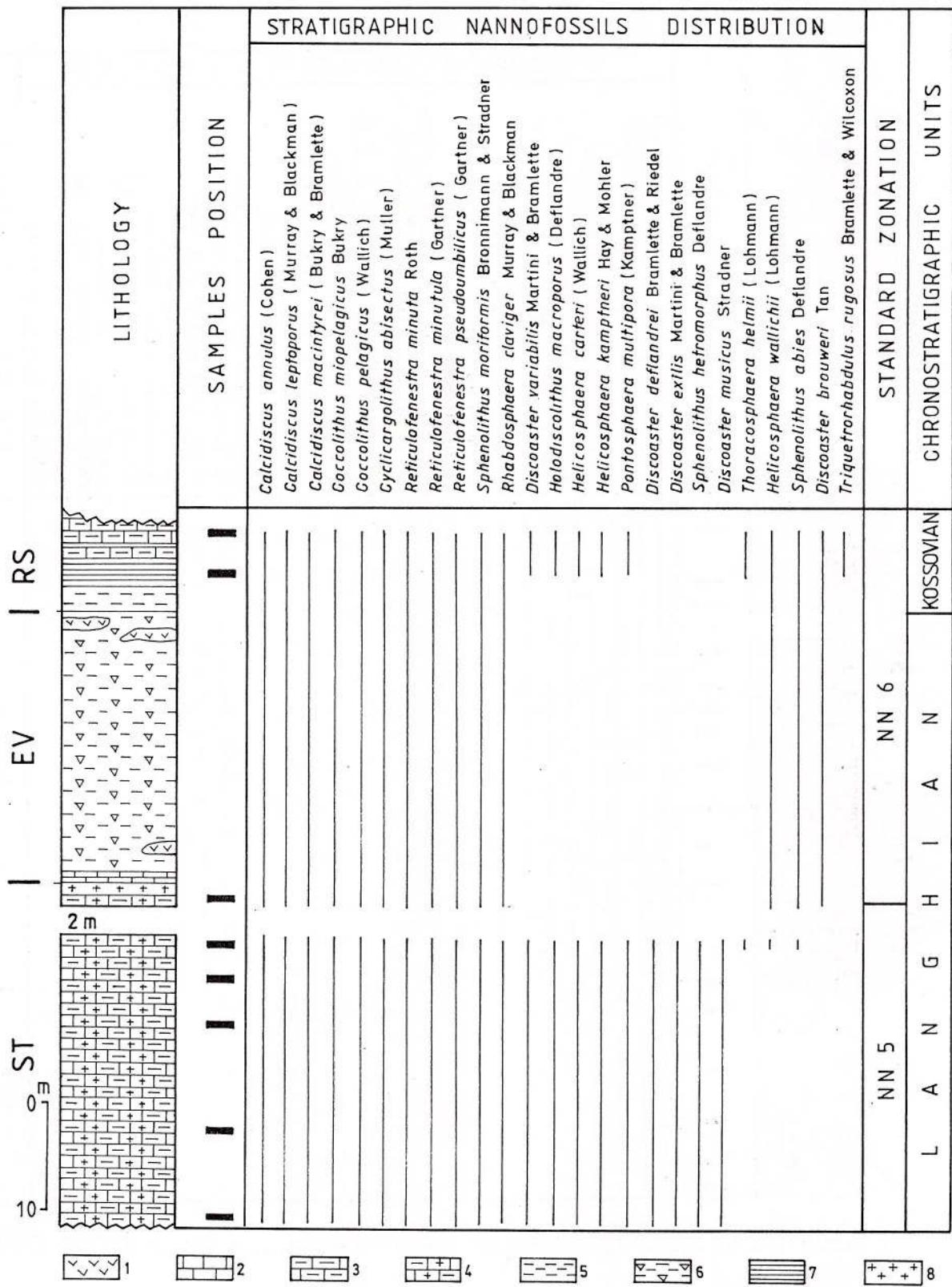


Fig. 3 Nannoplankton assemblages - Prahova Valley Section
 ST, Slănic Tuff; EF, Evaporitic Formation; RS, Radiolarian Shales; 1, gypsum; 2, limestones; 3, marls; 4, tuffaceous marls;
 5, clays; 6, argillaceous breccias; 7, argillaceous shales; 8, tuffs.

1. Piatra Verde Quarry (Fig. 1)

In the Piatra Verde Quarry, from the western slope of the hill with the same name, situated at approximately 3 km east of Slănic Prahova, the complete Badenian sequence is cropping out. Here, the Slănic Tuff is made up of two lithostratigraphical sequences. The lower one begins with alternations of tuffites and Globigerina marls and ends with thin beds of tuffites associated with clays. The upper sequence contains thick beds of tuffs, with rare intercalations of Globigerina marls. The calcareous nannoplankton assemblages from most of the Slănic Tuff belong to the NN 5 Zone. It could be noticed that the species *Helicosphaera wallichii*, *Sphenolithus abies* and *Scyphosphaera histricalis* appear in the uppermost marly levels of the succession, before the simultaneous disappearance of the nannofossils *Discoaster deflandrei*, *Discoaster musicus* and *Sphaenolithus heteromorphus*. The Evaporitic Formation begins with a gypsum packet, a few meters in width, and ends with clayey breccia. The calcareous nannoplankton belonging to the NN 6 Zone was identified only within a pelitic interlayer from the gypsum packet. The nannofossils association contains *Helicosphaera stalis* and *Discoaster brouweri*, the latter species being developed in explosion. The Radiolarian Shales, made up of clayey shales and sandstones, contain the same assemblage characteristic of the NN 6 Zone, in which rare specimens of *Rhabdosphaera pannonica* and *Triquetrorhabdulus farnsworthii* are found. The same nannofossils identified within the Radiolarian Shales, but much richer in specimens number, occur in the Spirialis Marls too, which are predominantly pelitic. Beside them, even from the base of the succession, *Syracolithus dalmaticus* occurs, and a little higher stratigraphically *Scapholithus fossilis* appears, followed by *Calcidiscus pataecus*.

2. Lupa Valley (Fig. 2)

The Lupa Valley section, situated south of the Brebu village, exposes the entire Badenian sequence. The nannoplankton assemblage, identified in most of the Slănic Tuff (here made up of tuffites, tuffs and Globigerina marls), belongs to the NN 5 Zone. In the upper part of this formation, from the nannofossil assemblage the species *Sphenolithus heteromorphus*, *Rhabdosphaera sicca* and *Pontosphaera discopora* disappear and *Helicosphaera wallichii*, *Sphenolithus abies* and *Scyphosphaera histricalis* appear, indicating the beginning of the NN 6 Zone. It is to be noticed that the first occurrences of *Discoaster brouweri* were before the extinction of *Sphenolithus heteromorphus* in the upper part of the NN 5 Zone.

The nannoplankton assemblages from the Evaporitic Formation (made up of gypsum and clayey bre-

cias), the Radiolarian Shales (predominantly clayey) and the Spirialis Marls (pelito-psamitic) belong to the NN 6 Zone, too. From the stratigraphical distribution of the nannofossils within this zone one could notice: the disappearance of *Discoaster exilis* in the lower half of the Radiolarian Shales; the appearance of *Syracolithus dalmaticus* within the lowermost part of the Spirialis Marls and of the *Scapholithus fossilis* in the middle levels of this formation; *Rhabdosphaera pannonica*, *Umbilicosphaera jafari* and *Calcidiscus pataecus* are present only in the terminal part of the Spirialis Marls.

3. Prahova Valley (Fig. 3)

On the banks of the Prahova Valley, near the village of Cornu, the Slănic Tuff (represented by tuffaceous marls with a tuff intercalation in the upper part), the Evaporitic Formation (which begins with a thin level of algal mats and continues with an argillaceous breccia with gypsum lenses) and the Radiolarian Shales (marly-clayey) are cropping out. Like in the previous sections, the nannoplankton assemblages belong to the NN 5 and NN 6 zones, the beginning of the last one being identified in the terminal part of the Slănic Tuff. The stratigraphical distribution of the nannofossils on this section shows the fact that *Discoaster brouweri* appears just before the extinction of *Sphenolithus heteromorphus*, and *Helicosphaera wallichii* and *Sphenolithus abies* appear after its disappearance. *Triquetrorhabdulus farnsworthii* is rarely present in the nannofossils assemblage beginning with those in the lowermost part of the Radiolarian Shales.

4. Câmpinița Valley (Fig. 4)

On this section, situated on the Câmpinița Brook, north of the town of Câmpina, crops out the Slănic Tuff made up of marls, with thin intercalations of argillaceous shales and three tuffaceous intercalations, and a gypsiferous sequence belonging to the Evaporitic Formation, which lacks calcareous nannofossils. The nannoplankton assemblages existing only in the Slănic Tuff and belonging to the NN 5 and NN 6 zones are poorer in the number of specimens. This section is important because the first occurrences of *Triquetrorhabdulus farnsworthii* can be noticed at the top of the Slănic Tuff.

5. Prahova Valley (northern flank of the Poiana syncline) (Fig. 5)

The succession of the Slănic Tuff, exclusively pelitic, and of the Evaporitic Formation, mainly gypsiferous with rare pelitic intercalations, contain rich assemblages of calcareous nannoplankton, belonging to the NN 5 and NN 6 zones. On this section it



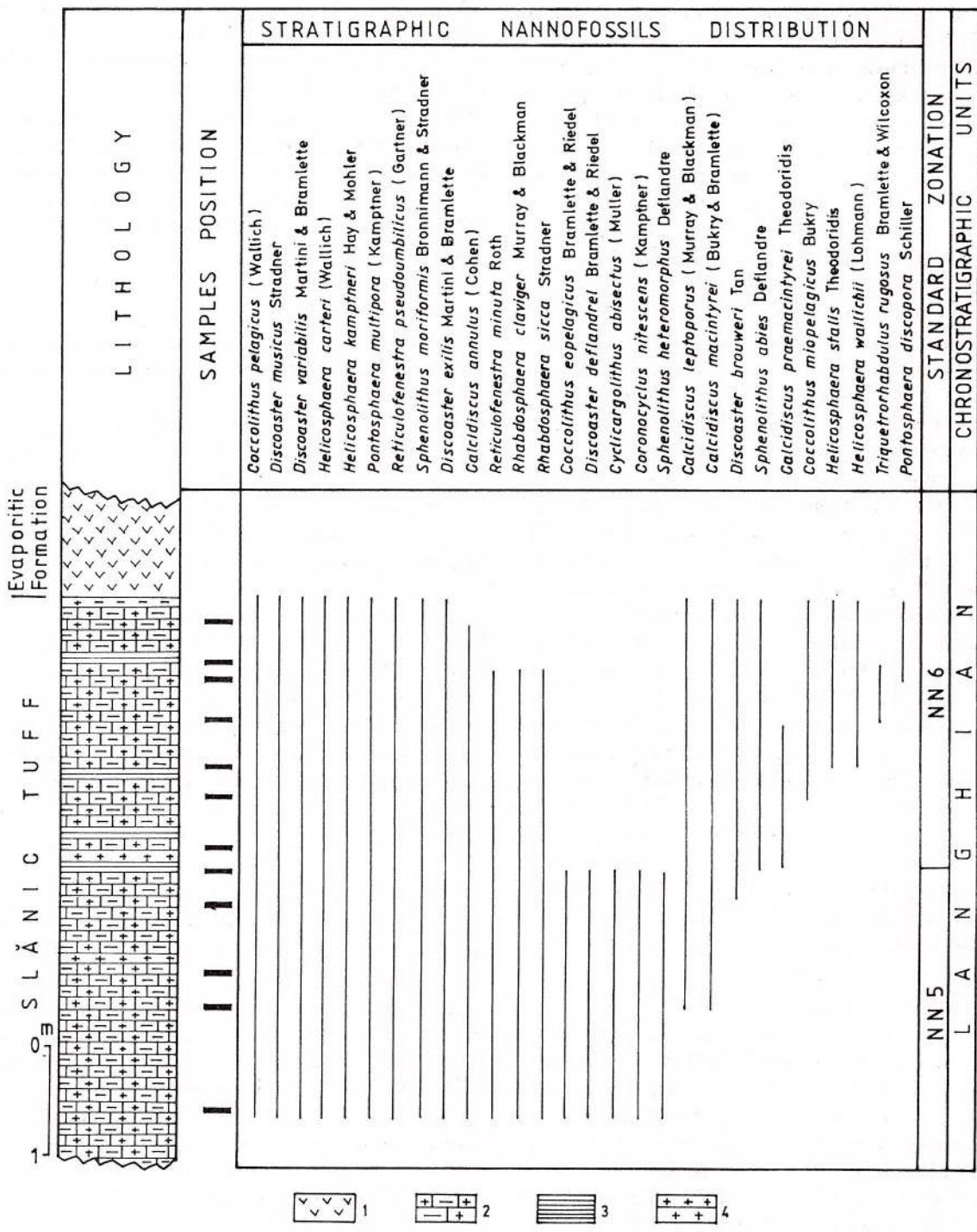


Fig. 4 - Nannoplankton assemblages - Câmpinița Valley Section
 1, gypsum; 2, tuffaceous marls; 3, argillaceous shales; 4, tuffs.

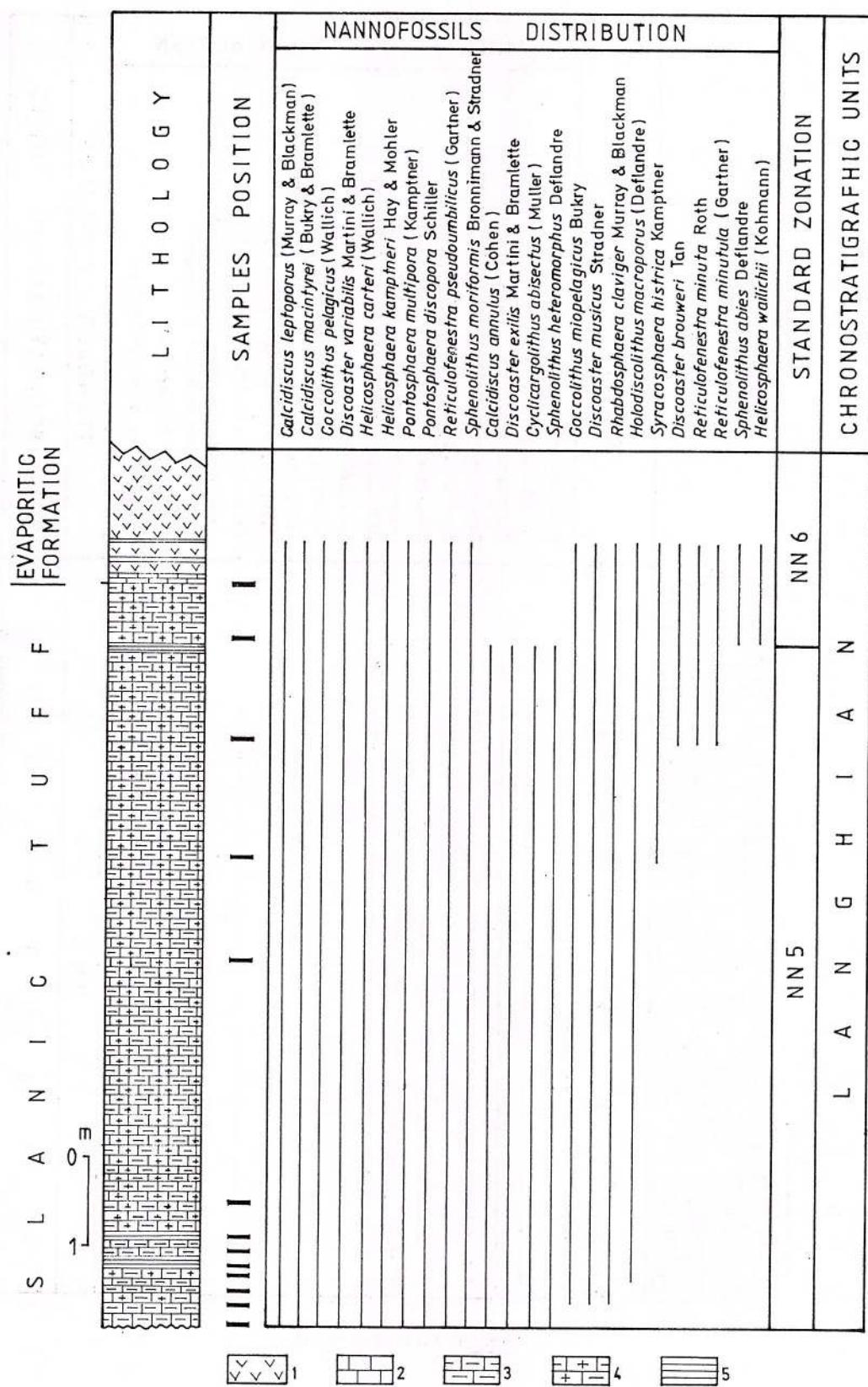


Fig. 5 - Nannoplankton assemblages - Poiana syncline section
 1, gypsum; 2, limestones; 3, marls; 4, tuffaceous marls; 5, clay-shales.

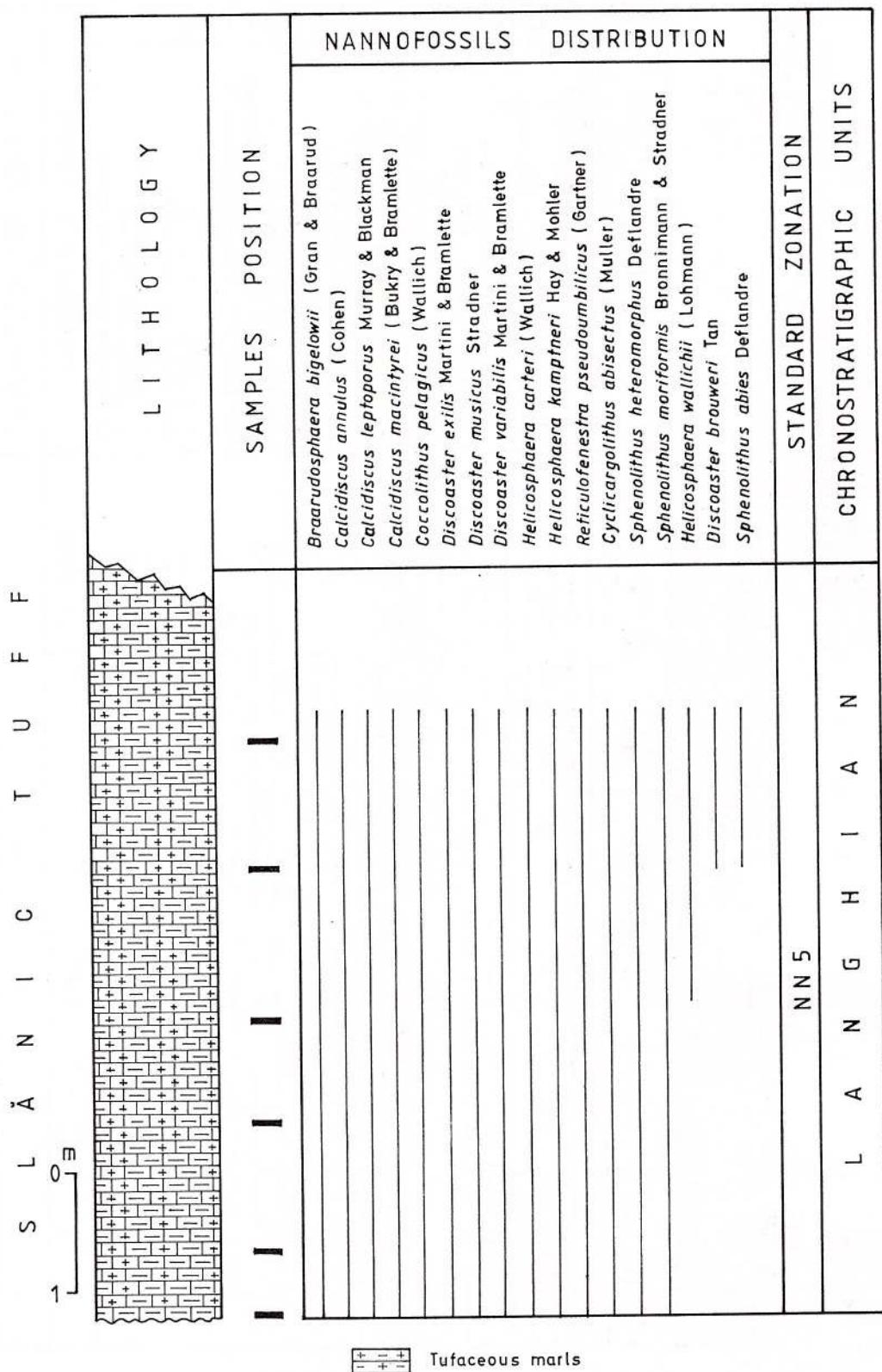


Fig. 6 - Nannoplankton assemblages - Doftana Valley section:
1, tuffaceous marls.

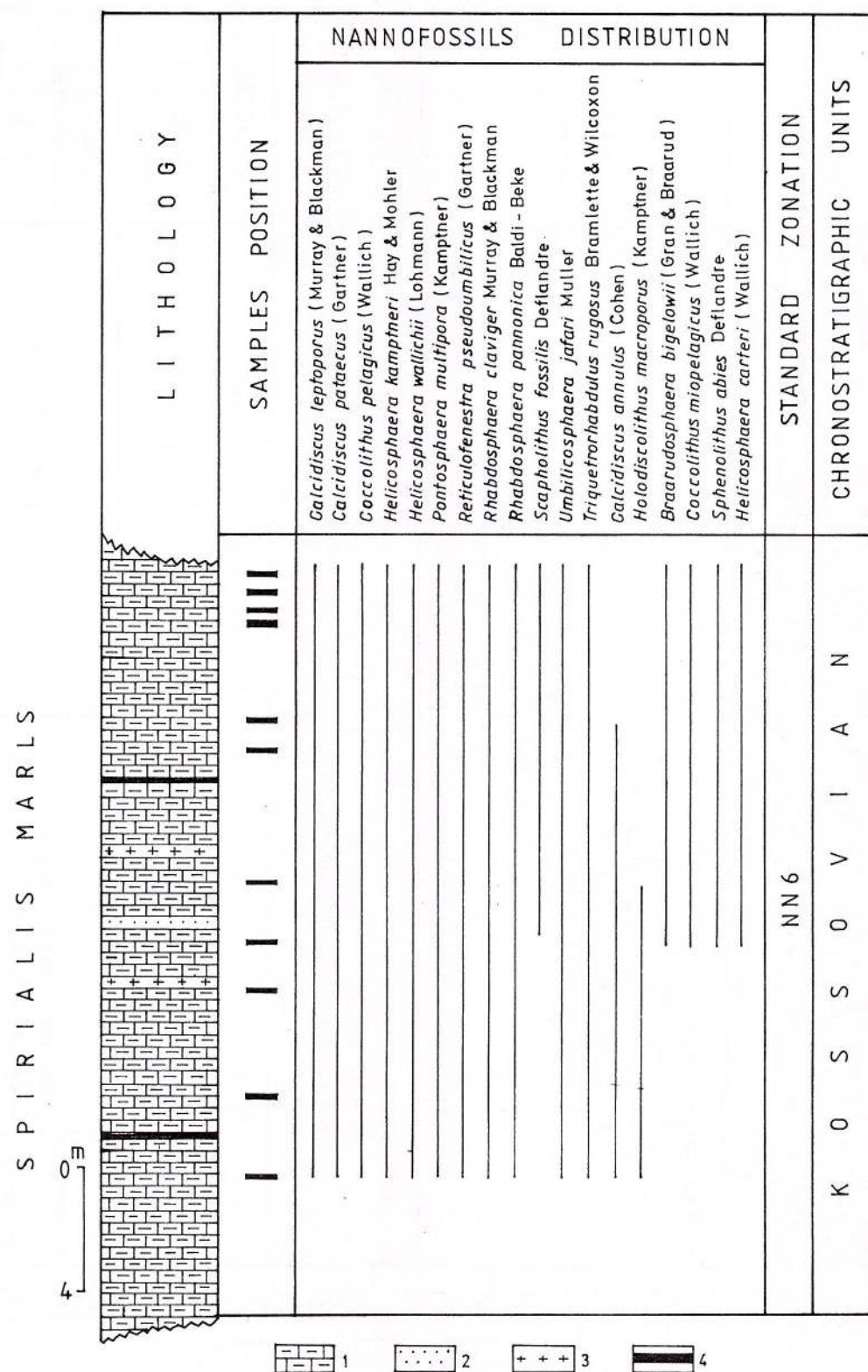


Fig. 7 - Nannoplankton assemblages - Telega Valley section:

1, marls; 2, sandstones; 3, tuffs; 4, coals.

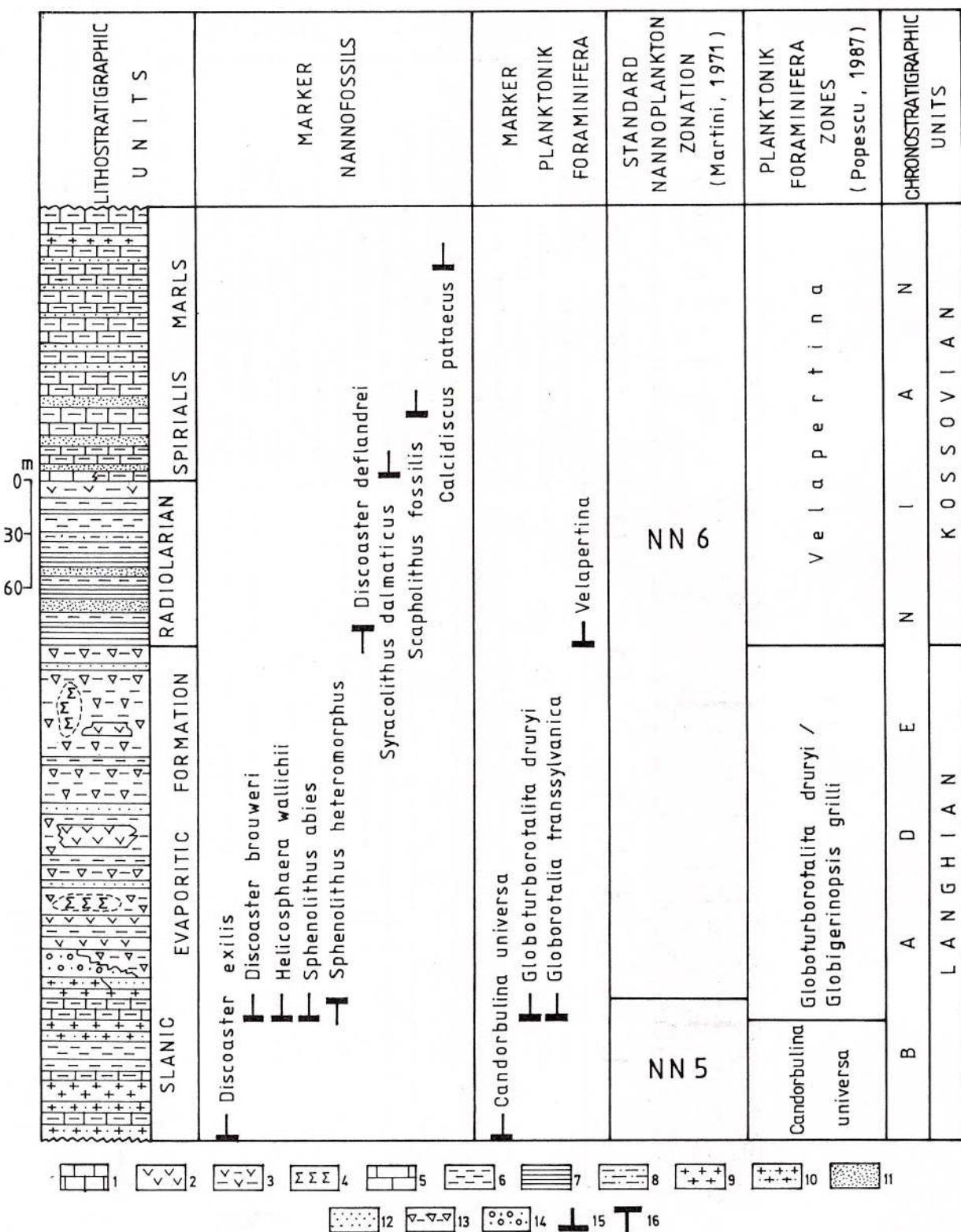


Fig. 8 – Badenian biozones correlation in the Muntenian Subcarpathians:
1, limestones; 2, gypsum; 3, gypsiferous clays; 4, salt; 5, marls; 6, clays; 7, argillaceous shales; 8, silts; 9, tuffs; 10, tuffites;
11, sands; 12, sandstones; 13, breccias; 14, conglomerates; 15, FAD; 16, LAD.

could be noticed that: *Discoaster exilis*, *Calcidiscus annulus* and *Cyclicargolithus abisectus* disappear from the assemblages together with *Sphenolithus heteromorphus*, in the terminal part of the Slănic Tuff; *Discoaster brouweri* and *Reticulofenestra minuta* appear before the extinction of *Sphenolithus heteromorphus*; *Sphenolithus abies* and *Helicosphaera wallichii* are present in the assemblages after the extinction of *Sphenolithus heteromorphus*.

6. Doftana Valley (Fig. 6)

A sequence of tuffitic marls, belonging to the Slănic Tuff, rich in calcareous nannofossils belonging to the NN 5 Zone, crops out in the Doftana Valley, east of the town of Câmpina. From the stratigraphical distribution of the species the concomitant appearances of *Helicosphaera wallichii* and *Sphenolithus abies* can be noticed, immediately after the first occurrences of *Discoaster brouweri*.

7. Telega Valley (Fig. 7)

On the Telega Valley only the Spirialis Marls, made up of pelits and sandstones with a few thin intercalations of coal and tuffites are cropping out. The nannofossils from this formation belong to the NN 6 Zone, evidenced by the rare and discontinuous presence of *Triquetrorhabdulus farnsworthii* together with *Cyclicargolithus floridanus*.

3. Biostratigraphical conclusions (Fig. 8)

The rich and varied calcareous nannofossils assemblages from the Badenian deposits of the extra-Carpathian realm can be attributed only to the *Sphenolithus heteromorphus* - NN 5 and *Discoaster exilis* - NN 6 Zones, on the standard nannoplankton scale (Martini, 1971).

The first zone was defined between the last occurrences of *Helicosphaera ampliaperta*, *Sphenolithus heteromorphus* respectively (Bramlette & Wilcoxon, 1967). Between these limits it was identified in the Slănic Tuff and the Răchitașu Sandstone. However, we point out that its beginning was recorded some time before the deposition of this formation (Săndulescu et al., 1995; Mărunteanu et al., 1996). The nannofossils content, typical of the *Sphenolithus heteromorphus* Zone, is represented by assemblages with *Sphenolithus heteromorphus*, *Discoaster exilis*, *Discoaster formosus*, *Discoaster musicus*, *Discoaster variabilis*, *Calcidiscus annulus*, *Holodiscolithus macroporus* etc. The first appearances of the species *Discoaster brouweri*, *Helicosphaera wallichii* and *Sphenolithus abies* were identified at the top of the zone, a little before the extinction of *Sphenolithus heteromorphus*.

The nannoplankton NN 5 Zone can be correlated

with the foraminiferal zones Candorbulina glomerosa and Candorbulina universa/Globorotalia bykova (Popescu, 1987), Lower Badenian, in age. It is very possible that the top of the NN 5 Zone corresponds with the beginning of the Globoturborotalita druryi/Globigerinopsis grilli (Popescu & Gheta, 1984), since the first generic occurrences of *Globoturborotalita druryi* were recorded together with the first occurrences of the nannofossils *Discoaster brouweri* and before the extinction of *Sphenolithus heteromorphus*.

The *Discoaster exilis* - NN 6 Zone is characteristic of the interval between the last and the first occurrences of the nannofossils *Sphenolithus heteromorphus* and *Discoaster kugleri* respectively (Martini & Worsley, 1970). In the Subcarpathians of Muntenia, it was recorded in the uppermost parts of the Slănic Tuff, in the Evaporitic Formation, in the Radiolarian Shales and in the Spirialis Marls. The beginning of the zone is characterized by the extinction of *Sphenolithus heteromorphus* and the development in explosion of *Discoaster brouweri*, rarely accompanied by *Triquetrorabdulus farnsworthii*. The nannoplankton content, typical of the NN 6 Zone, is represented by assemblages with *Discoaster variabilis*, *Discoaster brouweri*, *Triquetrorabdulus rugosus/T. farnsworthii*, *Sphenolithus abies*, *Helicosphaera wallichii* etc. Within the zone more appearances (*Syacolithus dalmaticus*, *Scapholithus fossilis*, *Calcidiscus pataecus* etc.) and extinctions (*Discoaster deflandrei*, *Discoaster exilis*, *Discoaster musicus*, *Cyclicargolithus abisectus* etc.) can be noticed, some of them being local bioevents due to the facies conditions.

The top of the NN 5 Zone and the lowermost part of the NN 6 Zone can be correlated with the Globoturborotalita druryi/Globigerinopsis grilli planktonic foraminiferal zone, characteristic of the Middle Badenian. The rest of the NN 6 Zone corresponds to the Velapertina Zone, characteristic of the Upper Badenian.

In the stratigraphical distribution of the Badenian nannoplankton from the Muntenian Subcarpathians (Fig. 8) the following bioevents can be emphasized:

- the first simultaneous occurrences of the species *Discoaster brouweri*, *Helicosphaera wallichii* and *Sphenolithus abies*, just before the extinction of *Sphenolithus heteromorphus*, in the uppermost part of the Slănic Tuff;
- the first occurrences of *Triquetrorabdulus rugosus/T. farnsworthii*, together with the explosive development of *Discoaster brouweri* in the first pelites of the Evaporitic Formation or even in the last marly intercalations of the Slănic Tuff;
- the blooming of *Reticulofenestra pseudoumbilicus*, with the subspecies *pseudoumbilicus* and *gelida*, in



the lowermost part of the Radiolarian Shales;

- the first occurrences of *Syracolithus dalmaticus* in the lowermost part of the Spirialis Marls;
- the first occurrence of the species *Scapholithus fossilis* in the upper half of the Spirialis Marls;
- the first occurrence of *Calcidiscus pataecus* at the top of the Badenian deposits.

The correlation of these nannoplankton bioevents with the foraminiferal bioevents stressed out that:

- the first occurrence of *Discoaster exilis* approximates the first, probably nongeneric, occurrence of *Candorbula glomerosa*;
- the first occurrences of *Discoaster brouweri*, *Helicospaera wallichii* and *Sphenolithus abies* are simultaneous with the first occurrence of *Globoturborotalita druryi*.

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PLATES



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Plate I

- Fig. 1 - *Braarudosphaera bigelowii* (GRAN & BRAARUD); 1 a - NII, 1 b - N+; Spirialis Marls, Telega Valley; x 2000.
- Fig. 2 - *Discoaster brouweri* TAN; Evaporitic Formation, Piatra Verde Quarry; x 3500.
- Figs. 3, 4 - *Discoaster brouweri* TAN; Slănic Tuff, Prahova Valley; x 4000.
- Fig. 5 - *Discoaster cf. brouweri* TAN; Slănic Tuff, Prahova Valley; x 4000.
- Figs. 6, 7 - *Discoaster musicus* STRADNER; Slănic Tuff, Prahova Valley; x 4000.
- Fig. 8 - *Discoaster exilis* MARTINI & BRAMLETTE; Slănic Tuff, Prahova Valley; x 3000.
- Figs. 9, 10 - *Discoaster variabilis* MARTINI & BRAMLETTE; Slănic Tuff, Prahova Valley; x 3000.
- Fig. 11 - *Discoaster variabilis* MARTINI & BRAMLETTE; Radiolarian Shales, Piatra Verde Quarry; x 3000.
- Fig. 12 - *Holodiscolithus macroporus* DEFLANDRE; down-distal view, up-lateral view; Spirialis Marls, Telega Valley; x 3000.
- Fig. 13 - *Calcidiscus annulus* (COHEN); Slănic Tuff, Prahova Valley; x 3000.
- Fig. 14 - *Calcidiscus leptoporus* (MURRAY & BLACKMAN); 14 a - NII, 14b - N+; Spirialis Marls, Piatra Verde Quarry; x 4000.
- Fig. 15 - *Calcidiscus macintyreai* (BUKRY & BRAMLETTE); 15 a - NII, 15 b - N+; Spirialis Marls, Telega Valley; x 3000.
- Fig. 16 - *Calcidiscus praemacintyreai* THEODORIDIS; 16 a - NII, 16 b - N+; Slănic Tuff, Prahova Valley; x 3000.
- Fig. 17 - *Coccolithus miopelagicus* BUKRY; 17 a - NII, 17 b - N+; Slănic Tuff, Prahova Valley; x 3000.
- Fig. 18 - *Calcidiscus pataecus* (GARTNER); Spirialis Marls, Telega Valley; x 3000.
- Fig. 19 - *Scapholithus fossilis* DEFLANDRE; Spirialis Marls, Telega Valley; x 4000.



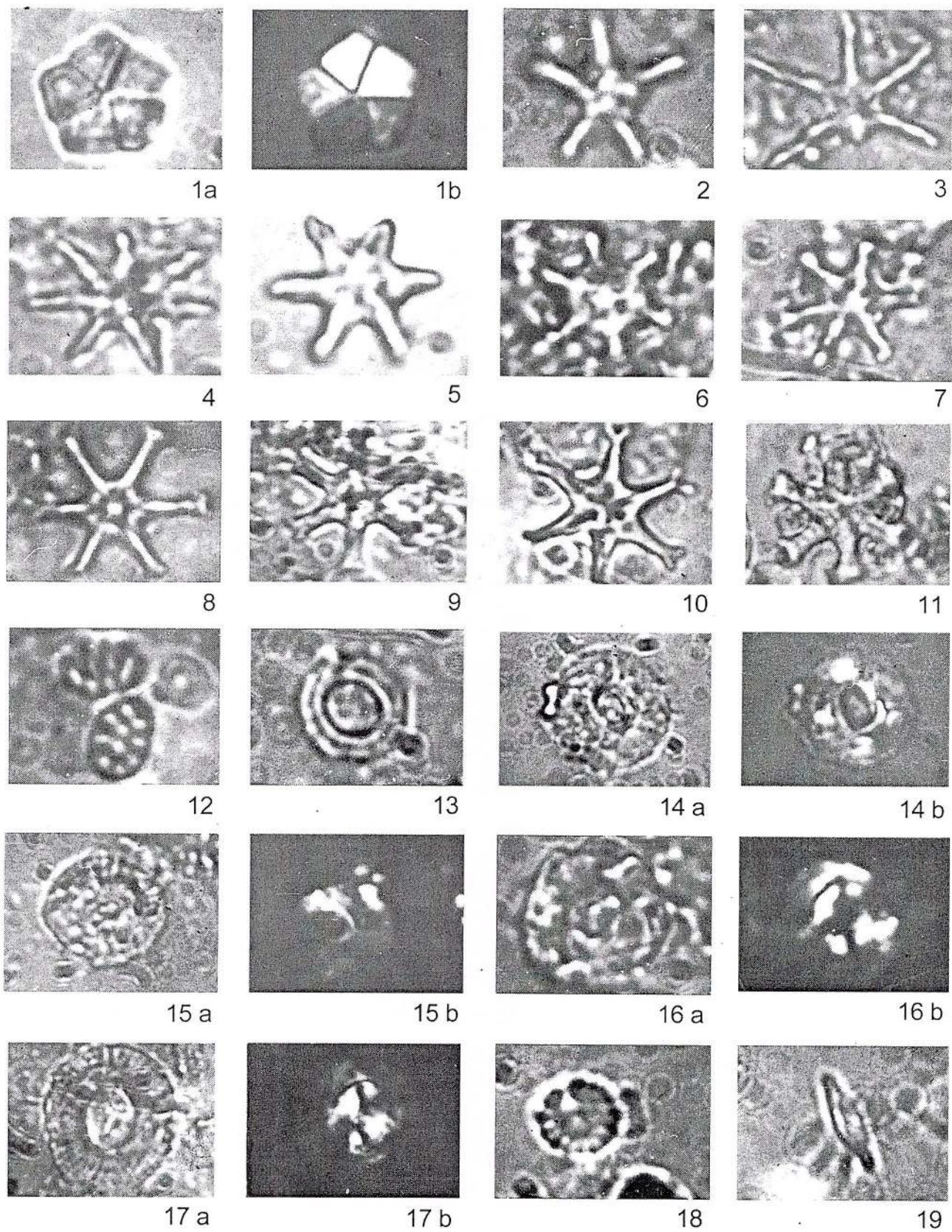
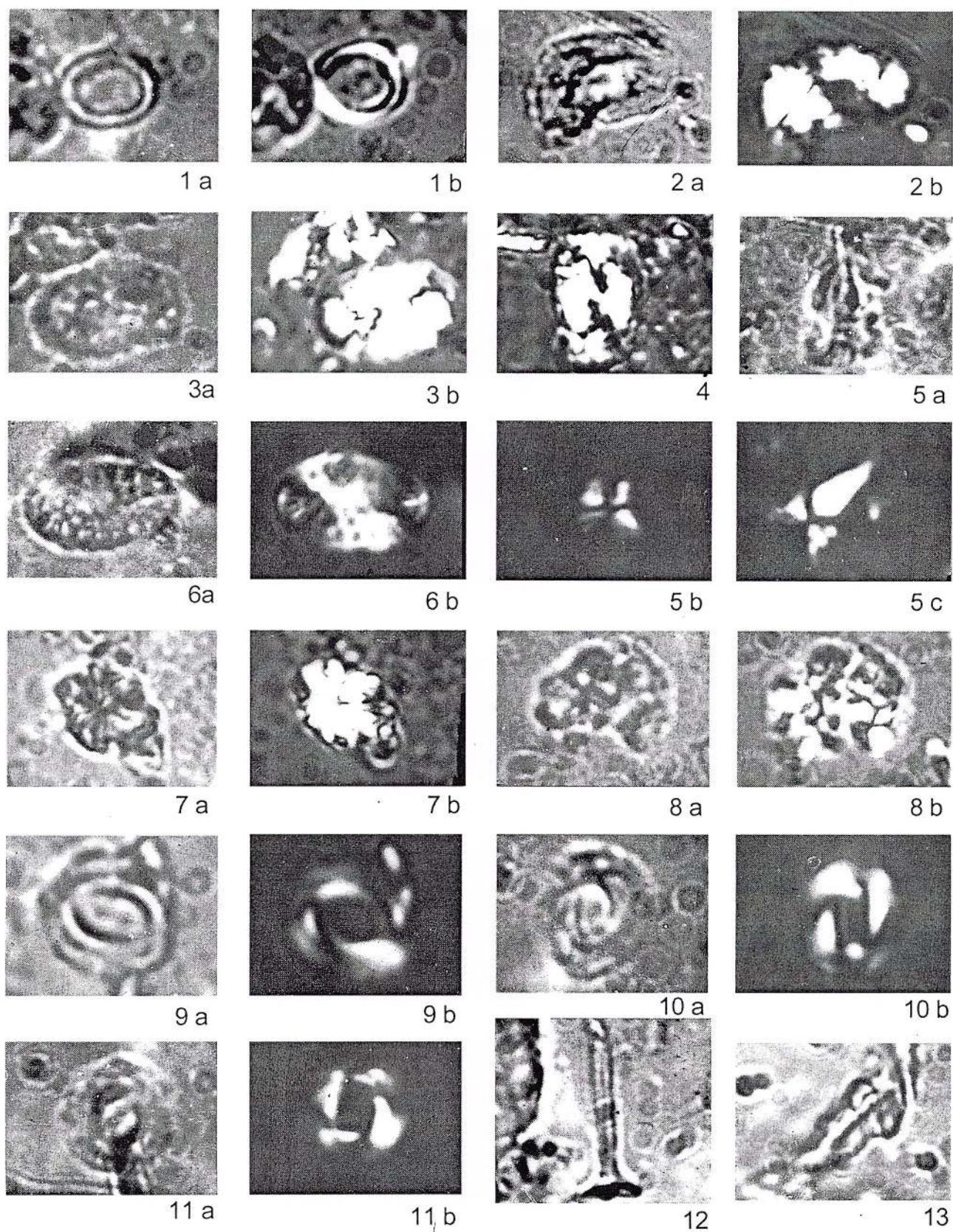


Plate II

- Fig. 1 - *Cricolithus jonesi* (COHEN); 1 a - NII, 1 b - N+; Spirialis Marls, Telega Valley; x 3000.
- Fig. 2 - *Helicosphaera kampfner* HAY & MOHLER; 2 a - NII, 2b - N+; Slănic Tuff, Prahova Valley; x 3000.
- Fig. 3 - *Helicosphaera carteri* (WALLICH); 3 a - NII, 3 b - N+; Slănic Tuff, Prahova Valley; x 2500.
- Fig. 4 - *Helicosphaera wallichii* (LOHMANN); N+; Spirialis Marls, Telega Valley; x 2000.
- Fig. 5 - *Sphenolithus heteromorphus* DEFLANDRE; 5 a - NII, 5 b - N+ at 0°, 5c - N+ at 45°; Slănic Tuff, Prahova Valley; x 3000.
- Fig. 6 - *Pontosphaera multipora* (KAMPTNER); 6 a - NII, 6 b - N+; Slănic Tuff, Prahova Valley; x 3000.
- Fig. 7 - *Sphenolithus moriformis* (BRONNIMAN & STRADNER); 7 a - NII, 7 b - N+; Slănic Tuff, Prahova Valley; x 3000.
- Fig. 8 - *Reticulofenestra minutula* (GARTNER); 8 a - NII, 8 b - N+; Slănic Tuff, Prahova Valley; x 2500.
- Fig. 9 - *Reticulofenestra pseudoumbilicus* *pseudoumbilicus* (GARTNER); 9 a - NII, 9 b - N+; Spirialis Marls, Telega Valley; x 3000.
- Fig. 10 - *Reticulofenestra pseudoumbilicus gelida* (GEIZENAUER); 10 a - NII, 10 b - N+; Spirialis Marls, Telega Valley; x 3000.
- Fig. 11 - *Reticulofenestra pseudoumbilicus* (GARTNER); 11 a - NII, 11 b - N+; Slănic Tuff, Prahova Valley; x 3000.
- Fig. 12 - *Rhabdosphaera claviger* MURRAY & BLACKMAN; Slănic Tuff, Prahova Valley; x 3000.
- Fig. 13 - *Triquetrorhabdulus farnsworthii* (GARTNER); Slănic Tuff, Câmpinița Valley; x 1000.





CUBITOSTREA SEIMENIENSIS n.sp. (BIVALVIA) IN THE UPPER BADENIAN OF SOUTH DOBROGEA

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Key words: Bivalvia. Upper Badenian (Kossovian). New taxa. South Dobrogea.



Abstract: The Upper Badenian (Kossovian) deposits from South Dobrogea (Seimenii Mari) furnished rich faunal assemblages, among them some species belonging to the family Ostreidae. This work deals with the description of a new species: *Cubitostrea seimeniensis*.

The Upper Badenian deposits of South Dobrogea (Seimeni Formation, Andreeșcu, in Ghenea et al., 1984) are developed in shelf-littoral marine environment and consist of limestones, calcarenites, conglomerates and rarely clays or silty clays. The attention is attracted by limestones containing many oysters.

Munteanu and Munteanu (1996) distinguished, in the Cernavodă area, ten genera of the family Ostreidae. The most frequent specimens pertain to *Ostrea*, *Crassostrea* and *Cubitostrea* genera.

Munteanu (1996-1997) has identified seven specimens assigned to the genus *Cubitostrea*: *Cubitostrea subfimbriata* SACCO, *C. digitalina* (DUB.), *C. frondosa* (DE SERR.), *C. caudata* (MUNST.), *C. adriatica* (LMK.), *C. fimbriata crassa* (SCHAFF.) and *C. cf. granensis* (FONT.).

On the Siliștea Valley, near the Seimeni Mici village and on the Boasgic Valley, near the Dunărea village a new species of the genus *Cubitostrea* has been separated.

Family Ostreidae RAFINESQUE, 1815
Subfamily Ostreinae RAFINESQUE, 1815

Genus *Cubitostrea* SACCO, 1897
Cubostrea seimeniensis n.sp.
Pl., figs. 1-6.

Holotype: pl., figs. 1 a, 1 b; Geological Institute of Romania Repository, no. 18845.

Locus typicus: Siliștea Valley, near Seimeni Mici village and Boasgic Valley, near Dunărea village.

Stratum typicum: Upper Badenian (Kossovian), biogenic limestones.

Derivatio nominis: from the Seimeni locality name.

Material. Siliștea Valley: 1 left valve, 1 right valve, 2 fragmented left valves; Boasgic Valley: 1 left valve, 1 right valve.

Dimensions (in mm) and ratios:

Valve	Height (H)	Length (L)	H/L	Plate
Left	36.0	32.5	1.10	Fig. 1
	92.0			Fig. 3
Right	33.0	28.0	1.17	Fig. 5
	91.0			Fig. 6

Diagnosis. Small to medium size, crescentic-triangular in outline, inequilateral, with concave, elongate and angulate posterior part. External surface of the left valve is covered with concentric growth squamae and 32-36 high rounded ribs. Height/length ratio is bigger than 1.

Description. Valve is small to medium size, crescentic-triangular in outline, inequilateral, with its elongated posterior part representing about 65 % of the valve length. Height/length ratio is bigger than 1. The posterior part of the valve is concave. External surface of the left valve is sculptured with concentric growth squamae and with 32-36 rounded radial ribs. The left valve is obscurely keeled. Crescentic keel is located nearer to concave posterior valve margin, which is angulate, angulation indicating position of inhalant pseudosiphon during life. Margins of the left valve are strongly crenated. Adductor muscle imprint comma-shaped is located approximately halfway between hinge and branchitellum. A short row of chomata (5-10 mm) is present on each side of hinge. Ligamental area is longer than high, forming triangles projects above the posterior margin of the

valve. Right valve, without ribs, has only appressed concentric growth squamae.

Remarks. This new species resembles *Cubitostrea perplicata* (DALL) but it differs from the latter by the presence of a smaller number of ribs. The difference between the new species and *C. frondosa* consists in the height/length ratio about 1 to *C. frondosa*, and bigger than 1 to *C. seimeniensis*; the posterior part of new species is more concave than *C. frondosa* one. *C. caudata* differs from *C. seimeniensis* n.sp. in its longer posterior part and by its smaller number of ribs. *C. fimbriata crassa* differs from new species by the greater thickness of valves.

Occurrence. South Dobrogea, Upper Badenian (Kossovian).

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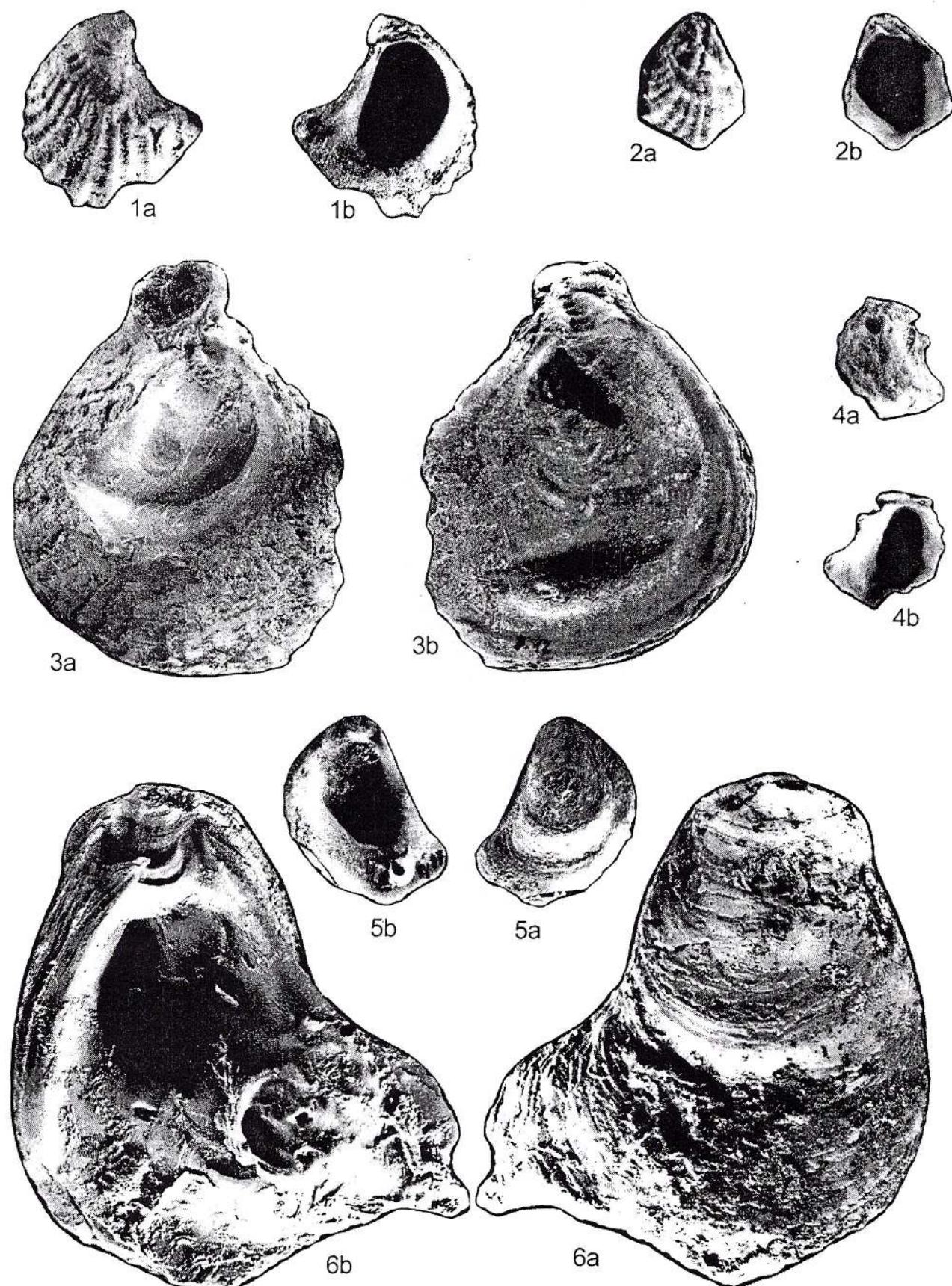
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Plate

Figs. 1-6 – *Cubitostrea seimeniensis* n.sp. Fig. 1, holotype, Geological Institute of Romania Repository, no. 18 845; figs. 1 a-4 a, left valve (LV) ext.; figs. 1 b-4 b, LV int.; figs. 5 a, 6 a, right valve (RV) ext.; figs. 5 b, 6 b, RV int. Figs. 1, 2, 4-6, xl; fig. 3, x 0.77. Figs. 1-3, 5 - Siliștea Valley, Kossovian; figs. 4, 6 - Boasgic Valley, Kossovian.





MAGNOLIA ATTENUATA WEBER, 1852 DANS LA FLORE FOSSILE DU PANNONIEN DE ROUMANIE

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Key words: *Magnolia attenuata* WEB. Early Oligo-Miocene. Romania. Pannonian. Valea Crișului. Romania.

Abstract: *Magnolia attenuata* WEBER, 1852 in the fossil flora of the Pannonian in Romania. A new taxa for the early Pannonian flora of Romania-*Magnolia attenuata* WEBER, 1852, is described and discussed.

Introduction

L'examen d'un échantillon de feuille fossile non déterminé du gisement à plantes fossiles de Valea Crișului (ante Valea Neagră) département de Bihor, gisement dont la flore a été publiée en 1962 par l'auteur, puis revisée en 1992, nous a révélé l'existence d'un taxon nouveau pour la flore tertiaire de la Roumanie, à savoir *Magnolia attenuata* WEBER, 1852.

Situation géographique et géologique

Toutes ces données ont été largement décrites dans la monographie de cette flore (Givulescu, 1962). Nous en revenons brièvement: le village Valea Crișului est situé à 4km nord du village Bratca, celui-ci situé à son tour sur la rivière Crișul Repede. Le point fossilifère est situé sur le rivage gauche de la Valea Brusturilor, quelques dizaines de mètres en amont de son confluent avec la Valea Negruții. Au point de vue géologique, on a affaire à une succession de marnes jaunes à minces intercalations de cinérites. La présence d'*Orygoceras fuchsi fuchsi* KITTL. confirme l'âge pannnonien inférieur de cette succession et de la flore en question.

Description du matériel

Grande feuille conservée presqu'en totalité. Feuille elliptique à base du type normal, acute à bord entier. L'apex non conservé était probablement du type acute. La consistance de la feuille était membraneuse, le pétiole est long et fort. La nervation est du type

camptodrome-eucamptodrome; la nervure primaire forte et droite s'amincit de la base vers le sommet, les nervures secondaires à disposition régulière, alterne, suivent un trajet légèrement courbé et un angle d'émergence étroit aigu. La nervation tertiaire est bien visible, on distingue bien qu'elle est du type droit, oblique constant (formule AO - acute/obtuse). La nervation du quatrième ordre est très fine, du type orthogonal, formant des aréoles régulières de forme polygonales, sans vénules. La nervation marginale est formée d'aréoles développées le long de la marge foliaire.

Biométrie: L - 160 mm, probable 180 mm; l - 45 mm; h - 104 mm. L/l - 4,00; h/L - 57,77 % (calculé à la longueur probable); β - 30-350, γ - 110-115°, S - (à base de la longueur probable) - 54,027 cm² - notophylle; L - pétiole 22 mm.

Discussion

Le taxon *Magnolia attenuata* a été établi par Weber en 1852, à parti de la moitié inférieure d'une feuille assez bien conservée, provenant de Quegstein, c'est-à-dire de l'Oligocène supérieur. Ludwig (1859-61) décrit de Salzhausen, à savoir du Miocène moyen, une autre feuille, bien différente de la première, qu'il attribue pourtant au même taxon. La feuille de Ludwig (voir Pl. I, f. 2) diffère de celle de Weber par forme, nervation et pétiole. Ettingshausen (1868) décrit de Wetterau, à savoir du Pliocène inférieur, une feuille semblable en tous les points à celle de Ludwig, et l'attribue à un nouveau taxon: *Magnolia ludwigi*. Il paraît, en effet, qu'il s'agit de deux espèces différentes et c'est probablement la raison pour laquelle Ettingshausen a utilisé un autre épithéton. Enfin, c'est Weyland (1937) qui découvre de nouveau la *Magnolia acuminata* à Rott, près de Bonn, dans



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des dépôts appartenant à l'Oligocène supérieur. Son matériel ressemble beaucoup à celui de Weber. Quant au matériel de Valea Crișului, il est indubitablement plus proche de celui de Ludwig, mais il n'est pas dans notre intention de discuter la justesse d'une ou de l'autre de ces dénominations proposées dans la littérature paléobotanique.

Conclusions

Il faut remarquer: 1, l'aréal très restreint du taxon, seulement dans l'ouest de l'Allemagne; 2, sa large répartition stratigraphique, Oligocène supérieur-Pliocène inférieur; 3, son apparition sporadique. Par notre découverte, l'aréal s'élargit beaucoup vers l'est. L'échantillon est conservé dans la collection de l'Institut Géologique de Roumanie, à Bucarest, sous le numéro d'inventaire p. 22.569. L'auteur adresse ses vifs remerciements à la direction de l'Institut, pour avoir l'amabilité de lui emprunter l'échantillon en cause.

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Planche I

Fig. 1 — *Magnolia attenuata* WEB., Valea Crișului, 1:1.

Fig. 2 — *Magnolia attenuata* WEB., échantillon figuré par Ludwig, T. 42, f. 1.



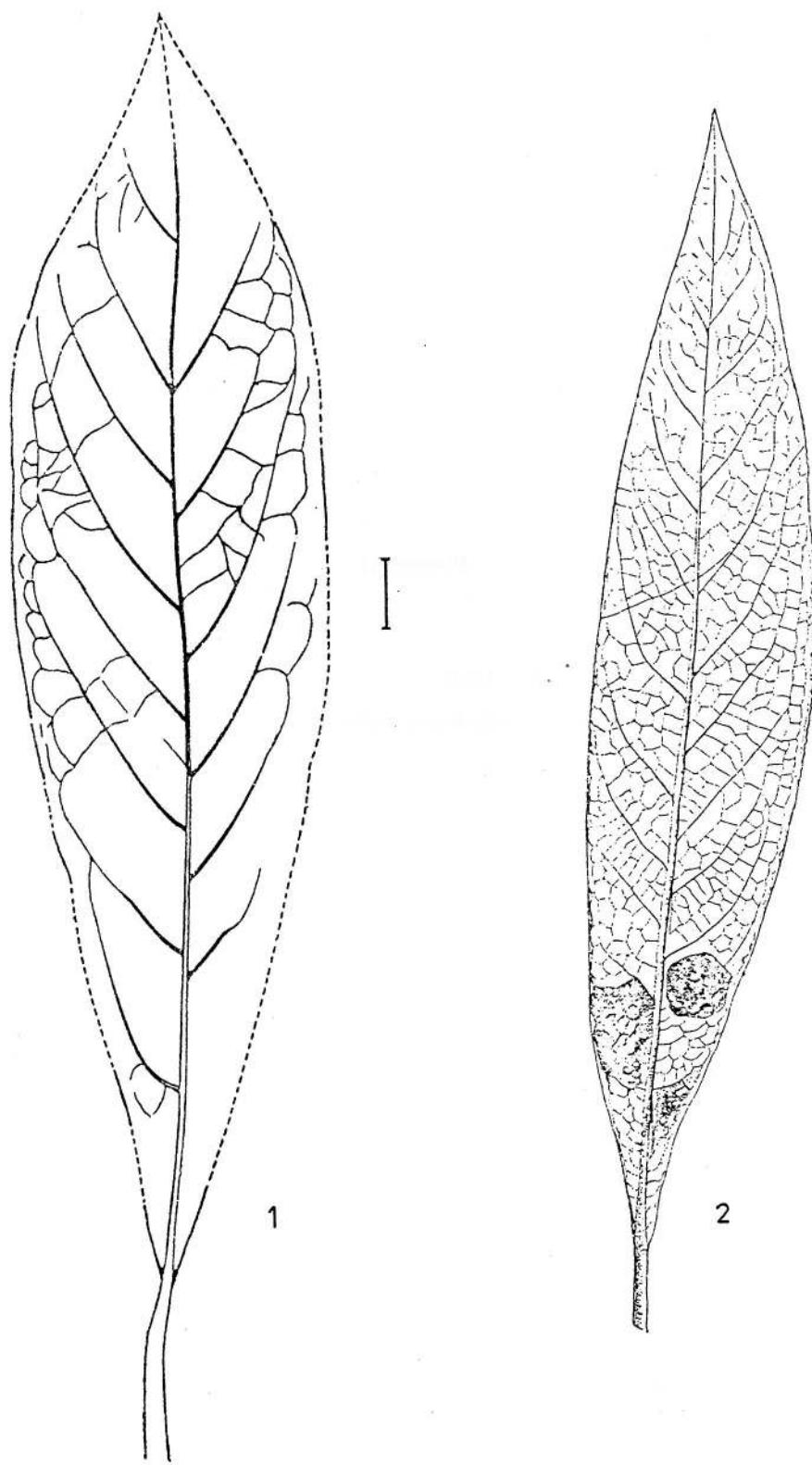


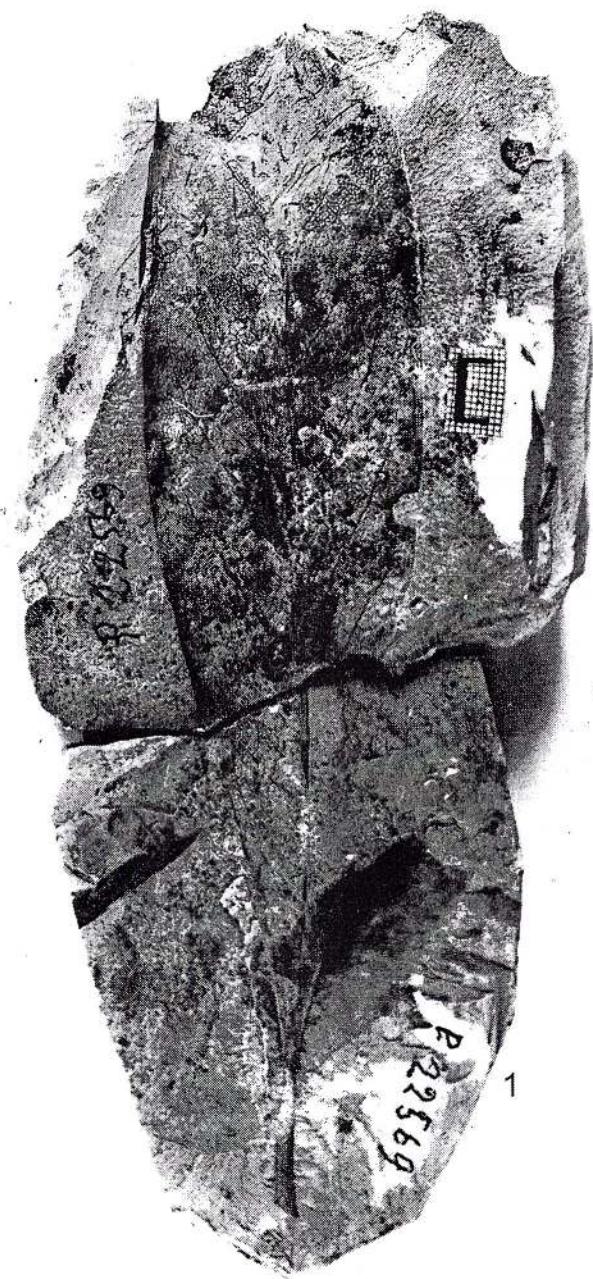
Planche II

Fig. 1 – *Magnolia attenuata* WEB., Valea Crișului, 1:0,8

Fig. 2 – La même, détail de la nervation du 3-eme et du 4-eme ordre; 3x.



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ORIGIN AND EVOLUTION OF BIOLOGICAL ENERGY CONVERSION

Edited by Herrick BALTSCHEFFSKY

1996, V.C.H. Publishers, Inc., New York, Weinheim, Cambridge

This volume is a collection of current knowledge about the origin and evolution of biological energy conversion. The eleven chapters written by invited scientists working in important Universities and Institutes for Researches in the field of molecular and cell biology, biochemistry, biogeochemistry, biophysics, bioenergetics, cover those major metabolic systems for which significant information about the evolutionary aspects of bioenergetics reactions appears to exist. The first five chapters deal with various basic questions, and examine recent results providing new openings. The next six chapters treat the evolution of the most essential part of photosynthetic and respiratory energy conversion.

Experimental results obtained in the last few years by interdisciplinary researches, contribute significantly to a new picture of how the bioenergetic reactions and systems may have originated and evolved, opening a fascinating field for scientific scenarios on the beginnings of the Earth.

The main idea of this book is to support a possible scenario for the earliest stages of life on the Earth, showing that the fundamental requirement of the energy is to drive a multitude of energy-requiring reactions in all living matter, including those for building the informational macromolecules: deoxyribonucleic and ribonucleic acids.

In this respect it is treated the evolution of biological redox reactions, which provided O₂, H₂, or prebiotic C compounds: CO₂, CO, CH₄, HCHO, (formaldehyde). Such reactions were possible in the earliest sea, where such inorganic materials and high temperatures were disposable, because redox states of the prebiotic Earth were far from equilibrium, and energy could be obtained by combination of these components. Other studies try to demonstrate that it is possible to obtain by photic, thermal or chemical energy, from inorganic pyrophosphate, a complex protein as ATP (adenosin-triphosphate), because these materials are involved in the enzymatic metabolism of living cell at bacterial level.

It is considered that the primary light energy used in photosynthesis was ultraviolet (UV) light, and the first UV pigment selected by the living cell was the

adenine, because (1) - it has the highest UV absorption coefficient, in comparison with others purines and pyrimidine, (2) - it has the highest stability to the decomposing action of UV and (3) - it has the longest life time of excited state, properties that derive from the greatest resonance energy of adenine, and the same UV energy. Adenine is used for nonenzymatic synthesis of adenosine, ribose, AMP, ADP, ATP, and far away to coenzymes (components of nucleotides), and nucleic acids. These products of photosynthesis, catalysed by rather long chains of enzymes realize the synthesis, in the day light, from CO₂ and H₂O, and the decomposition, in the absence of the light, of carbohydrates, resulting in ATP formation. This is the simplest kind of light energy storage, used by living cell.

By both photolysis of the water, and action of UV, the terrestrial atmosphere was enriched in oxygen and ozone, which diminished UV action; also, because UV light has been "poisonous" for the living cell, it had to invent a photosynthetic mechanism activated by the still available visible light. This way, another pigment than the adenine has been selected.

It is well known the presence in the proteins of ferredoxine type, the presence of Fe-S clusters. These proteins are stable even in extremely thermic conditions, and their roles are catalytic, other than electron transfer, when their functionality is defined by their midpoint reduction potentials.

The value of these observations and conjectures is that they lead to hypotheses that can be tested experimentally. The interconversion of [4Fe-4S] and [3Fe-4S] clusters is already being investigated by sequence-directed mutagenesis. The evolution of complex electron-transfer proteins by combination of the genes for catalytic centers may be investigated by genetic engineering techniques. The substrate cycles, taking place on crystallising pyrite surface, proposed by Wachterhauser, may be simulated chemically, although detection of the products as a surface layer is challenge to analytical chemistry.

Analysing the redox potential of all the metals and non-metals, one demonstrates that few elements are involved in the reactions in aqueous solutions at pH 7,



and the range of potential of -0.5 to +0.0 V, elements that give complex formation or precipitate, and it is very interesting that the today anaerobic bacteria (prokaryotes) and archaeabacteria, as the most primitive kind of life, do contain these elements: (Mn), Fe, Co, Ni, Mo, W, (V), si H, C, N, O, S, (Se).

The functional significance of these elements is very different, some of them managing the osmotic regulation and charge balance of the cell.

The metabolic processes in redox anaerobic and aerobic systems are represented by very complex reactions, with Fe, Mn, S involved, with a feedback control by some proteins that manage the cytochromes production.

It is very interesting to note that all the considerations are touching the bacterial level, because it represents the most primary forms of life, hence the existence of three "domains" or kingdoms: *Archaea* (*Archaeabacteria*), *Bacteria* (*Eubacteria*) and *Eukarya* (which contains fungi, plants and animals).

Nevertheless, the evolution of bacteria is a nebulous concept, even though they are considered older than any other form of life, having a very simple anatomy, very rapid generation times, promiscuous life and no fossil record. The principal differences among them are metabolic and all the adaptations to the changing environment are made by simple mutagenesis or by gene transfer. The evolutionary schemes are based on ribosome sequence 16S rRNA, because ribosome is ubiquitous, large, and essential, and therefore representative for the genome as a whole, still unlikely to be transferred among the species. The bacterial evolution is far more complicated, and is not admitted that ribosome sequences do represent it. Also, there is no proof that any particular evolutionary scheme is correct, and the "universal phylogenetic tree of life" is not represen-

tative of bacterial genomes, because bacteria have a mixture of metabolisms, on various branches of the 16S rRNA tree. All these cytochromes act as soluble electron transfer proteins that are reaction photosynthetic centers at bacterial organisms, represent a background for a scenario that imagines a monophyletic evolutionary tree of photosynthesis, coming from pseudomonads, where the first cytochrome types have appeared.

The problems of molecular and cell biology become more fascinating, though more data being obtained, the more incongruent the results between them will be.

For example, in 1995 was discovered a hyperthermophilic enzyme with tungsten, in an archaeabacterium (*Pyrococcus furiosus*), which grows optimally at 100°C, but the detailed bioenergetic and evolutionary implications remain a question for the future. Other discovery also in 1995 was the first complete nucleotide sequence of bacterial genomes, from the kingdom *Bacteria* (*Eubacteria*), from *Haemophilus influenzae* and *Mycoplasma genitalium*. It is expected to contribute to the clarification of the major pathways in bioenergetic evolution. Another discovery is a multisubunit protein (in 1995 too), a cytochrome c-oxidase, in a high-resolution three-dimensional structure, at 2.8 Å, which gives additional insights into the mechanisms involved in electron transport and proton pumping.

All this leads to a new understanding of various molecular interrelations between bacterial, plant and animal systems, and the results regarding the molecular aspects of biological energy conversion provide increasingly detailed knowledge about the mechanisms involved in the biological transformations, coupling, conversion and conservation of energy.

Eugenia IAMANDEI



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