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FORAMINIFERS AND DETAILED MICROBIOSTRATIGRAPHY OF THE BOUNDARY BEDS OF THE LOWER CRETACEOUS STAGES IN THE TUNISIAN ATLAS**

(Figs. 2, Pls. 3)

Abstract: Microbiostratigraphic subdivision of the Lower Cretaceous boundary beds of Tunisia is carried out in classical areas (Dj. Zaghouan, D. Oust), rich in ammonite fauna. The question of the vertical range of stratigraphically important species is discussed. The new species *Caucasella handousi* n. sp., which is the index species of the Lower Hauterivian, is described.

Резюме: Микробиостратиграфическое подразделение граничных слоев нижнего мела в Тунисе проводится в классических районах (Dj. Zaghouan, D. Oust) богатых аммонитовой фауной. Обсуждается проблема вертикального распространения значительных видов. Описывается новый вид *Caucasella handousi* n. sp., который является индексовым видом нижнего готерива.

Introduction

The Lower Cretaceous sediments of the Tunisian trough in the area SE of the Zaghouan Massif and in the area of Djebel Oust represent classical areas in the Tunisian Atlas (see Fig. 1). The mentioned areas were studied on the basis of macrofauna mainly by Castany (1951); Jauzein (1967); Memmi (1965, 1969, 1981) and Busnardo and Memmi (1972). The first results of correlative macro- and micropaleontological studies were presented at the I. Geological Congress in Nigeria in the year 1970 (Stránik — Menčík — Memmi — Salaj, 1974). The proposal of zonal subdivision of Lower Cretaceous sediments of the Tunisian Atlas was presented at the V. African Micropaleontological Colloquy in Addis Ababa 1972 (Salaj, 1975), at the VI. African Micropaleontological Colloquy in Tunis 1974 (Maamouri — Memmi, 1974; Maamouri — Salaj, 1974) and at the I. Symposium Continental Margin Benthic Foraminifera — Halifax 1975 (Salaj, 1976). The summarized results of microbiostratigraphical subdivisions of Lower Cretaceous sediments of northern and eastern Tunisia were published recently (Salaj, 1980). The up to present results of correlative macro- and micropaleontological studies confirm that also on the basis of foraminiferal taxa the boundaries of individual Lower Cretaceous stages may be well defined.

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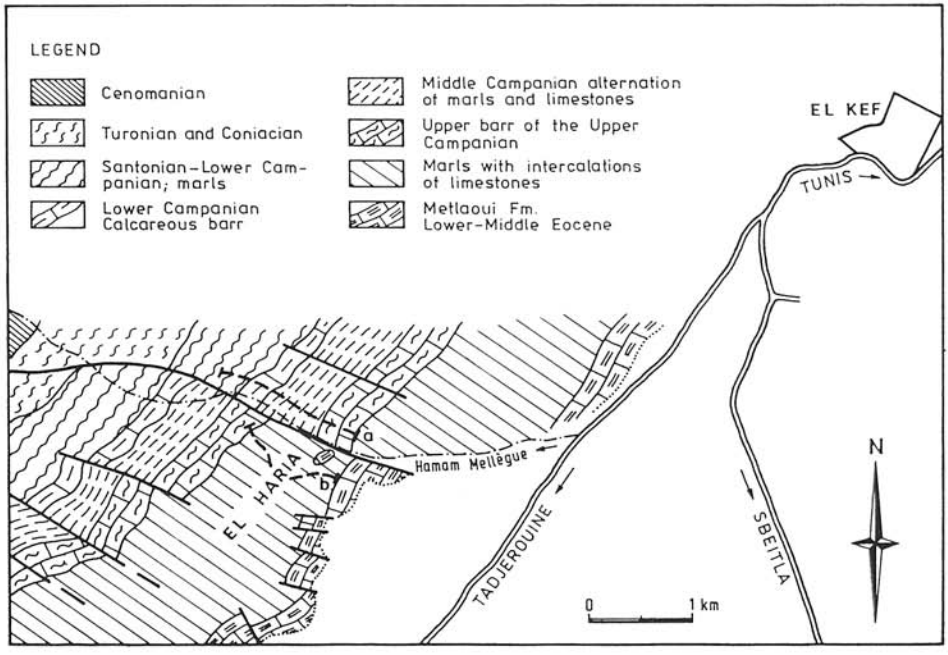


Fig. 1. Map of localities.

Berriasian — Valanginian Boundary

The Upper Berriasian in Tunisia is defined by the ammonite zone *Favriella boissieri*, which coincides with the upper part of the Berriasian microbiostratigraphic *Tintinnopsella carpathica — Spirillina neocomiana* Zone (Memmi and Salaj, 1975). In the Upper Berriasian in the studied area cf. Dj. Oust from foraminifers which appear first *Lenticulina (Lenticulina) nodosa* (REUSS) and *Epistomina (Hoeglundina) caracolla anterior* BARTENSTEIN and BRAND are found. Besides these in the area of Zaghouan (Temple des aux) in marls with layers of organo-detrital, turbidite allodapic limestones *Verneuilinoides neocomiensis* (MJATLIUK), *Dorothia kummi* ZEDLER, *Conorboides valendisensis* BARTENSTEIN and Brand, *Conorboides hofkeri* BARTENSTEIN and BRAND, *Lenticulina (Lenticulina) guttata* BARTENSTEIN and BRAND, *Gaudryina chettabaensis* SIGAL and *Heterostomella chettabaensis* SIGAL (see Pl. 1, Figs. 7, 9) appear in the Upper Berriasian. In the Zaghouan area (Z-1393) in the Upper Berriasian *Trocholina infragranulata* NOTH, *Lenticulina (Planularia) crepidularis* (ROEMER) and *Lenticulina (Planularia) tricarinella* (REUSS) are found.

The Lower boundary of the Valanginian s. str. (= Upper Valanginian or Nemausian; Hoedemaeker, 1982)) with the Berriasian is very well defined in the area of. Zaghouan (Oued Guelta; Memmi, 1965; Stránik et al., 1974) and in the area of Djebel Oust (Maamouri — Memmi, 1974; Maa-

mouri — Salaj, 1978), rich in macrofauna of the *Kilianella roubaudiana* Zone. At the base of the Valanginian s. str. F. A. include the species *Epistomina (Brotzenia) ornata* (ROEMER) and *Epistomina (Hoeglundina) caracolla caracolla* (ROEMER) sample F-1158/19), the index species of a Lower Valanginian zone of equal name (marly facies) originally defined in Tunisia (Salaj, 1975). In the area of Djebel Fkirine also *Trocholina valdensis* REICHEL appears from the Valanginian base.

In this zone and partly also in the *Epistomina (Brotzenia) djaffaensis — Lenticulina (Lenticulina) ouachensis* Interval Zone characterizing the Upper Valanginian flyschoid phase from foraminifers mainly the following species are found: *Epistomina (Brotzenia) djaffaensis* SIGAL, *Epistomina (Brotzenia) ornata* (ROEMER), *Epistomina (Hoeglundina) caracolla caracolla* (ROEMER), *Conorboides valendisensis* (BARTENSTEIN and BRAND), *Conorboides hofkeri* (BARTENSTEIN and BRAND), *Textularia textularoides* (REUSS), *Vaginulina kochii* ROEMER, *Vaginulina striolata* REUSS, *Lenticulina (Lenticulina) nodosa* (REUSS), *Lenticulina (Lenticulina) muensteri* (ROEMER), *Lenticulina (Lenticulina) ouachensis ouachensis* SIGAL, *Lenticulina (Saracenaria) truncatula* (BERTHELIN), *Lenticulina (Saracenaria) scitula* (BERTHELIN), *Citharina rudocostata* BARTENSTEIN and BRAND, *Lagena* aff. *sulcata* (WALKER and JACOB), *Frondicularia* aff. *inversa REUSS*, *Cibicides djaffaensis* SIGAL (see Pl. 1).

In the uppermost Valanginian in the sequence of marly limestones and marls with ammonites, forming a district passage in the flyschoid sequence, *Lenticulina (Lenticulina) einchenbergi* BARTENSTEIN and BRAND, the index species of the zone of equal name defined in the area of Djebel Oust by Maamouri and Salaj (1978) appears for the first time. An uncommonly abundant species is *Lenticulina (Lenticulina) ouachensis* (SIGAL), not only in the area of Djebel Oust but also in the Zaghouan area (Kef El Blidah) where, moreover, also *Lenticulina (Lenticulina) nodosa* (REUSS), *Lenticulina (Astacolus) gibber* ESPITALIE and SIGAL, *Verneuilinoides neocomiensis* (MJATLIUK) and *Vaginulina arguta* (REUSS) are found.

Valanginian — Hauterivian boundary

The marly limestones and marls at the locality Kef El Blidah of the basal Hauterivian, forming a passage in the flyschoid sequence, also contain Hauterivian Ammonites *(Oosterella* div. sp. and *Lyticoceras* div. sp.; Stránik et al., 1974). The Hauterivian base is here determined on the basis of benthic foraminifers by appearance of the species *Lenticulina (Marginulinopsis) djaffaensis* (SIGAL).

The upper part of the mentioned flyschoid sequence in the area of Dj. Zaghouan and Dj. Fkirine belongs to the Lower Hauterivian on the basis of the presence of *Toxaster villei* GAUTHIER (determination by Mme Remarck-Petitot, in Stránik et al., 1974). From foraminifers the species *Haplophragmoides vocontianus* MOULLADE is found, which, as known, appears from the Hauterivian base (Moullade, 1966).

In the area of Dj. Oust the black sublithographic limestones overlying the flyschoid sequence with rare layers of marls (80 m) are evidently of Hauterivian

age (Memmi, 1969; Busnardo and Memmi, 1972; Stránik et al., 1974; Memmi and Maamouri, 1974; Maamouri and Salaj, 1978; Salaj, 1980) where from their base the horizon with *Oosterella* sp. appears. It is defined as the basal zone of the Hauterivian with *Breistrofferella castellanensis* by Memmi (1981, p. 177–178). From the very base (sample 10a) *Caucasella hoterivica* (SUBBOTINA) (see Pl. 3, Figs. 7–9) appears and also *Caucasella handousi* n. sp.

Hauterivian – Barremian boundary

In the uppermost Hauterivian with *Pseudothurmannia angulicostata* D'ORBIGNY (= *Angulicostata balearis* Zone, MEMMI, 1981, p. 178), *Hedbergella infracretacea* (GLAESNER) appears. From important species *Lingulogavelinella sigmoicosta sigmoicosta* TEN DAM, *Miliammina sproulei* NAUSS and *Uvigerina moesiana* NEAGU are found. These are accompanied by the abundant diachronous following species: *Dorothia oxycona* (REUSS), *Dorothia hauteriviana* (MOULLADE), *Dorothia zedlerae* MOULLADE, *Gaudryina reichel* BARTENSTEIN, BETTENSTAEDT and BOLLI, *Lenticulina (Lenticulina) crassa* (ROEMER), *Lenticulina (Marginulinopsis) djaffaensis* (SIGAL), *Lenticulina (Lenticulina) ouachensis striata* FLANDRIN, MOULLADE and PORTHAULT, *Haplophragmoides, vocontianus* MOULLADE, *Verneullinoides neocomiensis* (MJATLIUK), *Verneullinoides filiformis* (BERTHELIN), *Bigenerina clavellata* LOEBLICH and TAPPAN, *Nodosaria sceptrum* REUSS, *Dentalina cylindroides* REUSS, *Dentalina siliqua* REUSS, *Spirillina minima* SCHACKO, *Spirillina neocomiana* MOULLADE, *Epistomina (Brotzenia) ornata* (ROEMER), *Epistomina (Brotzenia) djaffaensis* (SIGAL).

In the sense of new knowledge (Gašpariková, – Michalík – Salaj – Vašíček, 1983) the author proposes to range the sequence assigned to the uppermost Hauterivian so far to the Barremian, i. e. the Hauterivian/Barremian boundary would be at the base of the *Pseudothurmannia angulicostata* Zone (= *Angulicostata balearis*).

As a consequence of this proposal we range the sequence with *Holcodiscus caillaudi*, so far considered as the Barremian base (see Memmi, 1981), to the higher part of the Lower Barremian. In the areas of Zaghouan (Dj. Stâa, Dj. Chama), Dj. Oust, Oued Zarga and the area of Enfidaville the base of this zone is very well defined by appearance of the species: *Lingulogavelinella sigmoicosta barremiana* (BETTENSTAEDT) and *Hedbergella sigali* MOULLADE.

The mighty Barremian sequence several 100 m thick with two distinct passages of the flyschoid sequence is divided in detail on the basis of microfauna and contains rich associations of foraminifers (see Salaj, 1969, 1975, 1980; Maamouri – Salaj, 1978).

In the whole area of the Tunisian trough as well as in the northern part of the Eastern Tunisian platform the top Barremian layers of the pelagic sediments are represented by thin-splintering black, partly bituminous limestones 4–15 m containing *Barremites (Barremites)* sp., *Karsteniceras* sp., *Leptoceras costidiscus* (D'ORBIGNY) and *Leptoceras* sp. (Stránik et al., 1974; Salaj, 1980), which belong to the top of the *Leptoceras puzosianum* Zone (Memmi, 1981) and correspond to the *Leupoldina pustulans* Zone defined by Salaj,

1975. The following important planktic species appear here: *Leupoldina pustulans* BOLLI, Leupoldina cabri (SIGAL) and *Hastigerinoides alpina* SIGAL.

Barremian — Aptian boundary

From the immediate Barremian — Aptian boundary, 3 m below appearance of *Deshayesites deshayesi* (D'ORBIGNY), the index fossil of the Lower Aptian zone of equal name, besides the above mentioned species passing into the Aptian, *Planomalina (Globigerinelloides) ferreolensis* (MOULLADE), the index species of the Lower Aptian zone of equal name, appears.

In the lowermost Aptian from more important benthic foraminifers are found: *Tritaxia pyramidata* REUSS, *Dorothia trochus* (D'ORBIGNY), *Lenticulina (Lenticulina) nodosa* (REUSS), *Lenticulina (Lenticulina) ouachensis multicella* BARTENSTEIN, BETTENSTAEDT and BOLLI, *Lenticulina (Lenticulina) praegaultina* BARTENSTEIN, BETTENSTAEDT and BOLLI, *Lenticulina (Astacolus) incurvata* (REUSS), *Vaginulina truncata* REUSS, *Frondicularia cordai* REUSS, *Conorotalites bartensteini intercedens* BETTENSTAEDT, *Conorotalites bartensteini aptiensis* BETTENSTAEDT, *Lingulogavelinella sigmoicosta barremiana* (BETTENSTAEDT) and *Episomina (Epistomina)* aff. *carpenteri* REUSS.

Aptian — Albian boundary

The best profiles in the Tunisian Atlas for solving of this boundary are the areas of Dj. Fkirine (Dj. Douamess) and Zaghouan (Dj. Ech Chama, Zaghouan) (see Bajaník et al., 1977; Menčík et al., 1978; Salaj, 1980).

In the uppermost Aptian (Clansayesian) together with *Ticinella raynaudi* SIGAL and *Hedbergella rohri* (BOLLI) the following species are found: *Tristix excavatum* REUSS, *Gaudryina reicheli* BARTENSTEIN, BETTENSTAEDT and BOLLI, *Spiroplectinata complanata* (REUSS), *Gyroidina infracretacea* MOROZOVA, *Pleurostomella barroisi* BERTHELIN, Pleurostomella subnodosa REUSS, *Pleurostomella obtusa* BERTHELIN, *Epistomina (Brotzenia) charlottae* VIEAUX, *Discorbis wassoewizi* DJAFFAROV and AGALAROVA, *Anomalina (Anomalina) agalarovae* VASILENKO and *Anomalina (Gavelinella) rudis* REUSS.

The lower boundary of the Albian is determined by appearance of the species *Ticinella roberti* GANDOLFI sensu Reichel and *Haplophragmoides nonioninoides* (REUSS). These species are accompanied mainly by the following species: *Planomalina (Globigerinelloides) bentonensis* (MORROW), *Hedbergella globigerinelloides* (SUBBOTINA), *Anomalina (Gavelinella) ammonoides* REUSS, *Anomalina (Gavelinella) intermedia* BERTHELIN, *Anomalina (Gavelinella) rudis* REUSS, *Haplophragmoides cushmani* LOEBLICH and TAPPAN and *Discorbis wassoewizi* DJAFFAROV and AGALAROVA.

In the thin section of Lower Albian micritic limestones we are also finding: *Colomiella recta* BONET and *Colomiella mexicana* BONET.

The Biostratigraphic results and conclusions

The microbiostratigraphic results in the Tunisian Atlas distinctly confirm that in detailed zonation of the individual Lower Cretaceous stages (proposed

as hypostratotypes, see Salaj, 1980 p. 176–177) and determination of boundaries not only planktic but also benthic foraminifers may be used successfully as it has been proved in various areas of the Tethyan and Boreal realms.

1. Because the Jurassic-Cretaceous boundary in Tunisia was alredy studied in detail by Memmi and Salaj (1973) and Salaj (1978, 1980), we are not dealing with this problem and refer to the quoted works of the mentioned authors. It is only necessary to stress that for small forms of the species *Tintinnopsella carpathica* (MURGEANU and FILIPESCU) a new subspecies name should be introduced.

2. In the upper part of the Berriasian *Tintinnopsella carpathica – Spirillina neocomiana* Zone, represented by the tintinoid *Calpionellopsis simplex* Subzone (Remane, 1969), many distinct above mentioned Lower Cretaceous species appear, the most important species of them is mainly *Lenticulina (Lenticulina) nodosa* (REUSS), the occurence of which from the Upper Berriasian was mainly proved by Bartenstein (1974, 1976 b, c, 1977) and Aubert and Bartenstein (1976). As the index species of the zone of equal name it was defined by Moullade (1974) (originally described as the nodosa – busnardoi Zone – at the Lower – Upper Valanginian boundary – cf. Moullade, 1966). Bartenstein (1976 a) puts this zone as the Suprazone II (Toco and Cuche Fms.) into relation with the Barremian to the lower part of the Upper Aptian. The author proposes to put this *Lenticulina (Lenticulina) nodosa* Interval Zone for Tunisia (pelagic facies) into relation with the *Calpionellopsis simplex* Subzone (see Salaj, 1975). Its lower boundary is determined by appearance of the species *Lenticulina (Lenticulina) nodosa* and the upper boundary by appearance of the species *Epistomina (Hoeglundina) caracolla* BARTENSTEIN and BRAND and *Epistomine (Brotzenia) ornata* (ROEMER), which appear synchronously from the Valanginian base, as was just proved in Tunisia for the first time (localities Temple des Eaux, Oued Guelta, cf. Strážnik – Menčík – Memmi – Salaj, 1974; Salaj, 1975 – Addis Ababa 1972, 1980). For this reason they were established as the index species of the zone of equal name for the Lower Valanginian.

Their synchronous appearance from the Upper Valanginian is pointed out by Bartenstein, Bettenstaedt and Kovatcheva (1971) and Bartenstein (1976 b) and somewhat later Bartenstein (1976 c, 1977) and Ascoli in Bartenstein (1976 c) proved their presence from the Valanginian base or in NW Germany the species *Epistomina (Hoeglundina) caracolla* was already found in the uppermost Berriasian. In Tunisia in the uppermost Berriasian the subspecies of the species *Epistomina (Hoeglundina) caracolla, Epistomina (Hoeglundina) caracolla anterior* BARTENSTEIN and BRAND, was found only.

3. During the Upper Valanginian to the above mentioned species are coming the species *Epistomina (Brotzenia) djaffaensis* SIGAL and *Lenticulina (Lenticulina) ouachensis* SIGAL, index species of a zone of equal name defined in Tunisia (Salaj, 1975). They are species described by Sigal (1952) from North Africa. The last mentioned species is considered by Bartenstein and Bolli (1957, 1973) as the index species of the zone of equal name, characteristic of the Middle-Upper Barremian or Bartenstein (1976 a) pust it in the function of Suprazone I into relation with the Barremian – to lower part of the Upper Aptian. Appearance of the species *Lenticulina (Lenticulina)*

ouachensis from the uppermost part of the Lower Valanginian or from the Upper Valanginian is mentioned by Moullade (1974); Memmi and Maamouri (1974) and Bartenstein (1977). We remark that in the Lower Valanginian of Tunisia the occurrence of this species has not been confirmed so far.

Characteristic of the uppermost Valanginian in Tunisia is appearance of the species *Lenticulina (Lenticulina) eichenbergi*, as is known from many other areas (Moullade, 1974; Bartenstein, 1976 b, c, 1977). For this reason Salaj and Maamouri (in Memmi and Maamouri, 1974) also established an interval zone of equal name for the uppermost Valanginian.

4. The Hauterivian base is mainly determined by appearance of the species *Caucasella handousi* n. sp. and *Caucasella hoterivica* (SUBBOTINA) from planktic foraminifers and from benthic foraminifers the species *Lenticulina (Marginulinopsis) djaffaensis* SIGAL, originally described from the Hauterivian of Algeria by Sigal (1952), and *Haplophragmoides vocontianus* MOULLADE appear (Moullade, 1966, 1974).

The presence of the species *Caucasella handousi* n. sp. in the Lower to Upper Hauterivian permits to establish a new planktic Lower Hauterivian zone, the *Caucasella handousi* I. Z. Its base is determined by appearance of the species *Caucasella handousi* n. sp. The upper boundary is determined by appearance of *Lingulogavelinella sigmoicosta sigmoicosta* (TEN DAM). It is equivalent to the benthic *Lenticulina (Marginulinopsis) djaffaensis* Zone, defined by Salaj and Maamouri (in Memmi and Maamouri, 1974). We remark that in neither case the occurrence of the species *Lenticulina (Marginulinopsis) djaffaensis* SIGAL in the Upper Valanginian could be proved at Tunisian profiles, from which it is mentioned by Bartenstein (1977). The maximum occurence of this species is in the Upper Barremian (in the *Silesites seranonis* Zone) and it is not passing into the Aptian.

5. The Upper Hauterivian planktic zone *Caucasella hoterivica* I. Z. because the occurrence of the species *Caucasella hoterivica* (SUBBOTINA) is proved from the Hauterivian base, should be defined as a Partial Range Zone, the base of which is determined by appearance of the species *Lingulogavelinella sigmoicosta sigmoicosta* (TEN DAM), which begins to appear in the Upper Hauterivian (Bartenstein and Bettenstaedt, 1962; Bartenstein, 1976 b, 1977).

It is confirmed that *Hedbergella infracretacea* (GLAESSNER) appears from the base of the *Angulicostata balearis* Zone. For this reason we propose to use the *Hedbergella infracretacea* Zone and to put it into relation with the *Angulicostata balearis* Zone. It is a modification of the zone formerly defined by Salaj (1969; Salaj, 1980, p. 41). Its lower boundary is determined by appearance of the species *Hedbergella infracretacea* (GLAESSNER), the upper boundary is defined by appearance of the species *Clavihedbergella sigali* (MOULLADE). This zone is at the same time equivalent to the benthic foraminifer *Miliammina sproulei — Uvigerinammina moesiana* Zone (Salaj, 1980).

6. The *Clavihedbergella sigali* (Moullade, 1974) Zone, originally defined as *Hedbergella sigali* (Salaj — Addis Abbaba 1972), begins from the base of the *Holcodiscus caillaudi* Zone and reaches the uppermost part of the *Heteroceras astieri* Zone; e. i. even the base of alternation of limestones and marls (separating the lower flyschoid sequence from the upper, both belonging to the

Upper Barremian). In the frame of this zone successively the index species of the individual benthic subzones appear: *Lingulogavelinella sigmoicosta barremiana* (TEN DAM), *Epistomina (Epistomina) hechti* BARTENSTEIN, BETTENSTAEDT and BOLLI and *Conorotalites bartensteini bartensteini* (BETTENSTAEDT) (S a l a j, 1975). *Lingulogavelinella sigmoicosta barremiana* (TEN DAM) begins to appear at the base of the *Holcodiscus caillaudi* Zone, in its middle part *Epistomina (Brotzenia) hechti* appears and in its upper part and in the underlier of the limestone barr (Dj. Oust and missing in the area of Zaghouan and represented by marls), corresponding to the already Upper Barremian zone with *Hemihoplites feraudianum* (M e m m i, 1981; S t r á n i k et al., 1974). This sequence of alternating limestones and marls or marls, similarly as the overlying lower flyschoid formation (samples No 20 a, 21, 22, 22 a, 22 b, 23 a, 24, 25) belonging to the ammonite *Heteroceras astieri* Zone with rich macrofauna (M e m m i, 1981; S t r á n i k et al., 1974; S a l a j, 1980) corresponds in microfauna to the essential part of the *Conorotalites bartensteini bartensteini* Zone.

7. The alternation of limestones and marls (Dj. Stâa – samples 243, 237, 238, 247, 247 a, Dj. Ech Chama – samples 1768–1752, Dj Oust – samples 25–26 (S a l a j, 1980), separating the lower flyschoid sequence from the upper belongs as to macrofauna to the uppermost part of the *Heteroceras astieri* Zone (M e m m i, p. 180) but in microfauna corresponds to the *Clavihedbergella subcretacea* Zone and the whole *Conorotalites bartensteini intercedens* Subzone.

8. The overlying upper flyschoid sequence as well as 4–15 m thick overlying thin-splintering black partly bituminous limestones surely belong to the Barremian, the *Leptoceras puzosianum Zone* (M e m m i, 1981; S t r á n i k et al., 1974; S a l a j, 1980).

The flyschoid sequence belongs in microfauna to the *Epistomina (Brotzenia) spinulifera – Hedbergella seminolensis* Subzone; the index forms of this zone in the area of Dj. Ech Chama begin to appear already in the uppermost part of the underlying alternation of limestones and marls. Whether this passage 7 m hick in this area already belongs to the *Leptoceras puzosianum* Zone, has not been confirmed.

9. The uppermost Barremian belongs to the *Leupoldina pustulans* Zone originally defined by S a l a j (1972). It can be put into relation with the *Leupoldina protuberans* Zone defined by B o l l i (1959), related to the Lower-Upper (not uppermost) Aptian, later A u b e r t and B a r t e n s t e i n (1976) put it into relation with the uppermost Barremian – lowermost Aptian. L o n g o r i a (1974) similarly as the author considers the species *Leupoldina protuberans* as a synonym of the species *Leupoldina cabri* (SIGAL). The *Leupoldina cabri* Zone defined by L o n g o r i a is put into relation with the lowermost part of the Upper Aptian. In the sense of this author as well as of many other (M o u l l a d e, 1966, 1974; S i g a l, 1952, 1967 a. o.) the representatives of the genus *Leupoldina* or of the genus *Schackoina* are not found in the Barremian and Lower Aptian.

The first occurrence of the representatives of these genera as well as of other representatives of planktic genera in the uppermost Barremian and Lower Aptian is without doubt. Moreover, I stress that in this period the Tunisian trough was maximally deepened for the first time in the Lower Cretaceous

with ideal oceanic conditions suitable for development of so pretentious planktic species as were just these representatives of planktic genera. We remark that many representatives of planktic genera, mentioned by Bolli (1959) and mainly Longoria (1974) from the *Leupoldina protuberans* Zone or *Leupoldina cabri* Zone, are already found in the uppermost Barremian proved by ammonites. They are the following species: *Leupoldina protuberans* BOLLI, *Leupoldina cabri* (SIGAL), *Leupoldina reicheli* (BOLLI), *Hastigerinoides alpina* SIGAL, *Globigerinelloides saundersi* (BOLLI), *Globigerinelloides blowi* (BOLLI), *Globigerinelloides duboisi* (CHEVALIER), *Globigerinelloides cepedai* (OBREGON), *Globigerinelloides gottisi* (CHEVALIER), *Hedbergella infracretacea* (GLAESSNER) and *Hedbergella kuhryi* LONGORIA. Benthic foraminifers are not represented in this zone.

10. In the Lower Aptian (Bedoulian) *Planomalina (Globigerinelloides) ferreolensis* Zone two subzones, of *Conorotalites bartensteini aptiensis* and *Anomalina (Gavelinella) complanata*, are distinguished. When also the subspecies *Conorotalites bartensteini* aptiensis (BETTENSTAEDT) is known in the uppermost Barremian (Bartenstein, 1976 b, c, 1977), it may be considered as an Aptian index species in Tunisia, regarding to the fact that it is not found in uppermost Barremian deep-water sediments.

11. The *Planomalina (Globigerinelloides) algeriana* (CUSHMAN and TEN DAM), an index species of the zone of equal name equally as the subspecies *Epistomina (Brotzenia) spinulifera polypioides* (EICHENBERG), an index subspecies of the subzone of equal name, appear already in the uppermost Lower Aptian underlying the Lower Bedoulian of the *Aconeceras nisum* Zone (area of Zaghouan, Dj. Fkirine; see Stránik et al., 1974; Memmi, 1981). The occurrence of the species *Planomalina (Globigerinelloides) algeriana* (CUSHMAN and TEN DAM) is generally mentioned already in the Upper Gargasian (Moullade, 1966; Sigal, 1966, 1977; Gorbachik and Krechmar, 1969; Longoria, 1974).

12. The species *Biglobigerinella barri* BOLLI, LOEBLICH and TAPPAN, the index species of the zone of equal name defined by Bolli (1966), begins to appear already in the upper layers of the Gargasian of the *Aconeceras nisum* Zone (of the area of Dj. Oust; Memmi, 1981), what is in full agreement with the knowledge of Guillaume, Bolli and Beckmann (1972).

13. The significant Clansayesian species *Ticinella raynaudi* SIGAL. *Ticinella rohri* BOLLI and *Discorbis wassoewizi* DJAFFAROV and AGALAROVA appear as early as the uppermost Gargasian, already belonging to the flyschoid facies and proved by abundant ammonites of the *Subnodosocostatum* Zone (Memmi, 1981; Stránik et al., 1974). The author adjusts the *Hedbergella roberti — Discorbis wassoewizi* Zone, originally defined by Salaj and Samuel (1966), as the *Hedbergella rohri — Discorbis wassoewizi* Zone as a consequence of the taxonomic problem connected with *Hedbergella roberti*. In the Upper Clansayesian the species *Epistomina (Brotzenia) charlottae* (VIEAUX) appears, the index species of the zone of equal name, originally defined by Salaj and Samuel (1966).

14. In the Albian *Ticinella roberti* (GANDOLFI) sensu Reichel, *Thalmanninella subticinensis* GANDOLFI and *Thalmanninella ticinensis* (GANDOLFI), the index species of the individual zones successvely appear. It will be neces-

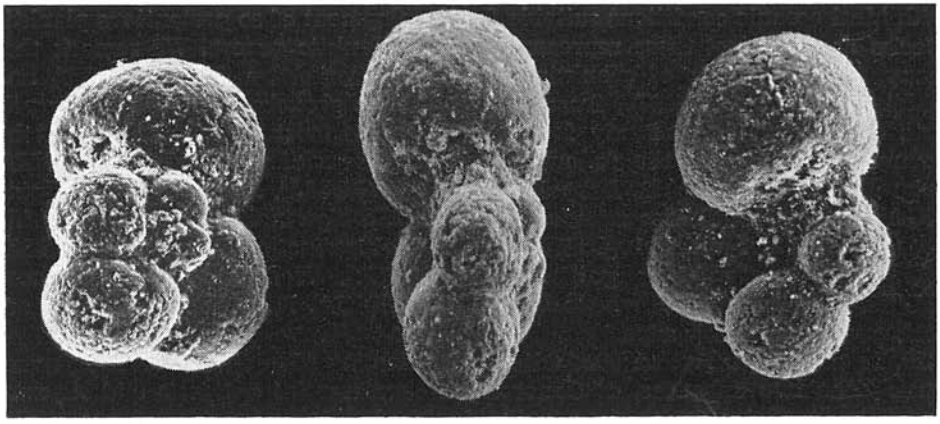


Fig. 2 a, b, c. *Caucasella handousi* n. sp. x 150, x 175 (b).

sary to pay more attention to the vertical range of benthic species in future, regarding to the relatively rich associations of foraminifers and to the possibility of their application for detailed microbiostratigraphical subdivision of the Albian.

Systematic description

Superfamily *Globigerinacea* CARPENTER, PARKER and JONES, 1862
nom. correct. LOEBLICH and TAPPAN, 1961
Family *Caucasellidae* LONGORIA, 1974
Genus *Caucasella* LONGORIA, 1974
Caucasella handousi n. sp.

Type species: Figured in Fig. 2 a, b, c and deposited in the collections of the Dionýz Štúr Institute of Geology in Bratislava, No T-10.

Denomination: to the honour of Dr. H. Handous, Director General Technique Office National de Mines, Tunis, Tunisia.

Type level: Layer of marls overlying the first limestone bank in the sequence of Lower Hauterivian limestones (Sample No 10 a) in the area of Dj. Cust, Tunisia.

Type locality: Djebel Oust, excursion locality of the 6th African Micropaleontological Colloquy.

Material: 20 specimes coming from Sample 10 a.

Diagnosis: *Caucasella* with quadrate outline with 4 globular chambers in the last whorl, separated by deeply depressed radial curved sutures on the umbilical side. Fig. 2 a, b, c.

Description: Test small, coiled in a very low to planar trochospire consisting of two and half whorls; peripheral margin quadrate lobate; four chambers in the last whorl, increasing quadrally in size as added; chambers globular, somewhat ovoidal on both spiral and umbilical sides, separated by

deeply incised sutures; chambers typical ovoidal in peripheral view; sutures radial, slightly curved on both spiral and umbilical sides; wall fine-perforate, surface smooth; primary aperture highly arcuate, extra-umbilical-umbilical, bordered by an imperforate, very narrow imperforate flap; umbilicus circular, deep.

Diameter: 0.30 mm; height 0.1 mm.

Remark: The phylogenically younger Upper Hauterivian species *Caucasella hoterivica* (SUBBOTINA) differs from *Caucasella handousi* n. sp. in a medium – to highly coiled strochospire.

Stratigraphic range: It is found in the Lower Hauterivian sequence of the area of Djebel Oust.

Translated by J. Pevný

Plate 1

Fig. 1. *Ammodiscus rotalarius* LOEBLICH and TAPPAN x 150. No. Z-264 a. Djebel Ech Chama. Upper Gargasian (documentation see Salaj, 1980, p. 53, Fig. 20).
Fig. 2. *Haplophragmoides vocontianus* MOULLADE x 100. No. 10 a. Djebel Oust (documentation see Salaj, 1980, p. 182, Fig. 61). Base of Hauterivian.
Fig. 3. *Textularia textularoides* (REUSS) x 80. No. Z-1 a. Frejd Sach (Djebel Zaghouan area, see Salaj 1980, p. 17, Fig 4). Berriasian.
Fig. 4. *Textularia bettenstaedti* BARTENSTEIN and OERTLI x 70. No. Z-264 a. Djebel Ech Chama. Upper Gargasian.
Figs. 5, 6. *Tritaxis fusca* (WILLIAMSON) x 70, x 80. No. Z-264 a. Djebel Ech Chama. Upper Gargasian.
Fig. 7. *Gaudryina chettabaensis* SIGAL x 50. No. Z-1 c. Frejd Sach. Upper Berriasian.
Fig. 8. *Dorothia oxycona* (REUSS) x 120. No. Z-1 a. Frejd Sach. Berriasian.
Fig. 9. *Heterostomella chettabaensis* SIGAL x 90. No. Z-1 a. Frejd Sach. Upper Berriasian.
Fig. 10. *Dorothia zedlerae* MOULLADE x 110. No 12. Djebel Oust. Lower Hauterivian.
Fig. 11. *Dorothia kummi* ZELDER x 100. No. 12. Djebel Oust. Lower Hauterivian.
Figs. 12, 13. *Dorothia hauteriviana* MOULLADE x 50. No. 10 a. Djebel Oust. Base of Hauterivian.
Fig. 14. *Cibicides djaffaensis* SIGAL x 90. No. Z-1 c. Frejd Sach. Upper Berriasian.
Figs. 15, 16. *Lingulogavelinella sigmoicosta barremiana* (BETTENSTAEDT) x 120, x 100. No. Z-264 a. Djebel Ech Chama. Upper Gargasian.

Plate 2

Fig. 1. *Lenticulina (Lenticulina) ouachensis ouachensis* SIGAL x 100. No. 11. Djebel Oust. Lower Hauterivian.
Fig. 2. *Lenticulina (Lenticulina) excentrica* CORNUEL x 40. No. Z-1 a. Frejd Sach. Berriasian.
Fig. 3. *Lenticulina (Lenticulina) eichenbergi* BARTENSTEIN and BRAND x 140. No. 10 a. Djebel Oust. Base of Hauterivian.
Fig. 4. *Frondicularia parkeri* REUSS x 80. No. Z-264 h. Djebel Ech Chama. Upper Gargasian.
Fig. 5. *Flabelinella* aff. *didyma* (BERTHELIN) x 100. No. 10 a. Djebel Oust. Base of Hauterivian.
Fig. 6. *Lenticulina (Marginulinopsis) collinsi* MELLON and WALE x 70. No. 17. Djebel Oust. Top of Hauterivian.
Fig. 7. *Nodosaria obscura* REUSS x 110. No. 17. Djebel Oust. Top of Hauterivian.
Fig. 8. *Lenticulina (Saracenaria) scitula* (BERTHELIN) x 70. No. U-1 b. Frejd Sach. Berriasian.
Fig. 9. *Dentalina pseudonana* DAM x 40. No. Z-264 a. Djebel Ech Chama. Upper Gargasian.
Fig. 10. *Lenticulina (Saracenaria) trunculata* (BERTHELIN) x 80. No. Z-1 a. Frejd Sach. Berriasian.
Fig. 11. *Lagena* aff. *sulcata* (WALKER and JACOB) x 150. No. Z-1 a. Frejd Sach. Berriasian.
Fig. 12. *Vaginulina kochii* ROEMER x 70. No. Z-1 a. Frejd Sach. Berriasian.
Fig. 13. *Vaginulina duckcreckensis* TAPPAN x 50. No. Z-264 g. Djebel Ech Chama. Upper Gargasian.
Fig. 14. *Vaginulina arguta* REUSS x 90. No. 10 a. Djebel Oust. Base of Hauterivian.
Fig. 15. *Conorboides hofkeri* (BARTENSTEIN and BRAND) x 100. No. Z-16. Frejd Sach. Berriasian.

Plate 3

Fig. 1. *Lenticulina (Lenticulina)* aff. *pulchella* (REUSS) x 80. No. 10 a. Djebel Oust. Base of Hauterivian.
Fig. 2. *Lenticulina (Lenticulina) acuta* (REUSS) x 100. No. 10 a. Djebel Oust. Base of Hauterivian.
Fig. 3. *Lingulina sadeki* SAID and BARAKAT x 80. No. Z-1785. Djebel Ech Chama. Lower Gargasian.
Fig. 4. *Spiroplectammina macfadyeni* SAID and BARAKAT x 70. No. Z-264 a. Djebel Ech Chama. Upper Gargasian.
Fig. 5. *Triplasia emslandensis emslandensis* BARTENSTEIN and BRAND x 65. No. Z-264 a. Djebel Ech Chama. Upper Gargasian.
Fig. 6. *Tritaxia* pyramidata REUSS x 80. No. Z-264 a. Djebel Ech Chama. Upper Gargasian.
Fig. 7. *Caucasella hoterivica* (SUBBOTINA) x 250. No. 10 a. Djebel Oust. Base of Hauterivian.
Fig. 8, 9. *Caucasella hoterivica* (SUBBOTINA) x 100. No. 10 a. Djebel Oust. Base of Hauterivian.
Fig. 10. *Leupoldina pustulans* (BOLLI) x 160. No. Z-1760 a. Djebel Ech Chama. Base of Bedoulian. *Leupoldina pustulans* Zone of the Uppermost Barremian of Lowermost Bedoulian.
Fig. 11. *Planomalina (Globigerinelloides) saundersi* BOLLI x 120. No. Z-1760 a. Djebel Ech Chama. *Leupoldina pustulans* Zone of the Uppermost Barremian to Lowermost Bedoulian.
Fig. 12. *Clavihedbergella bolli* (LONGORIA) x 160. No. Z-1760 a. Base of Bedoulian.
Fig. 13. *Clavihedbergella kuhryi* (LONGORIA) x 160. No. Z-1760 a. Base of Bedoulian.

Plate 1

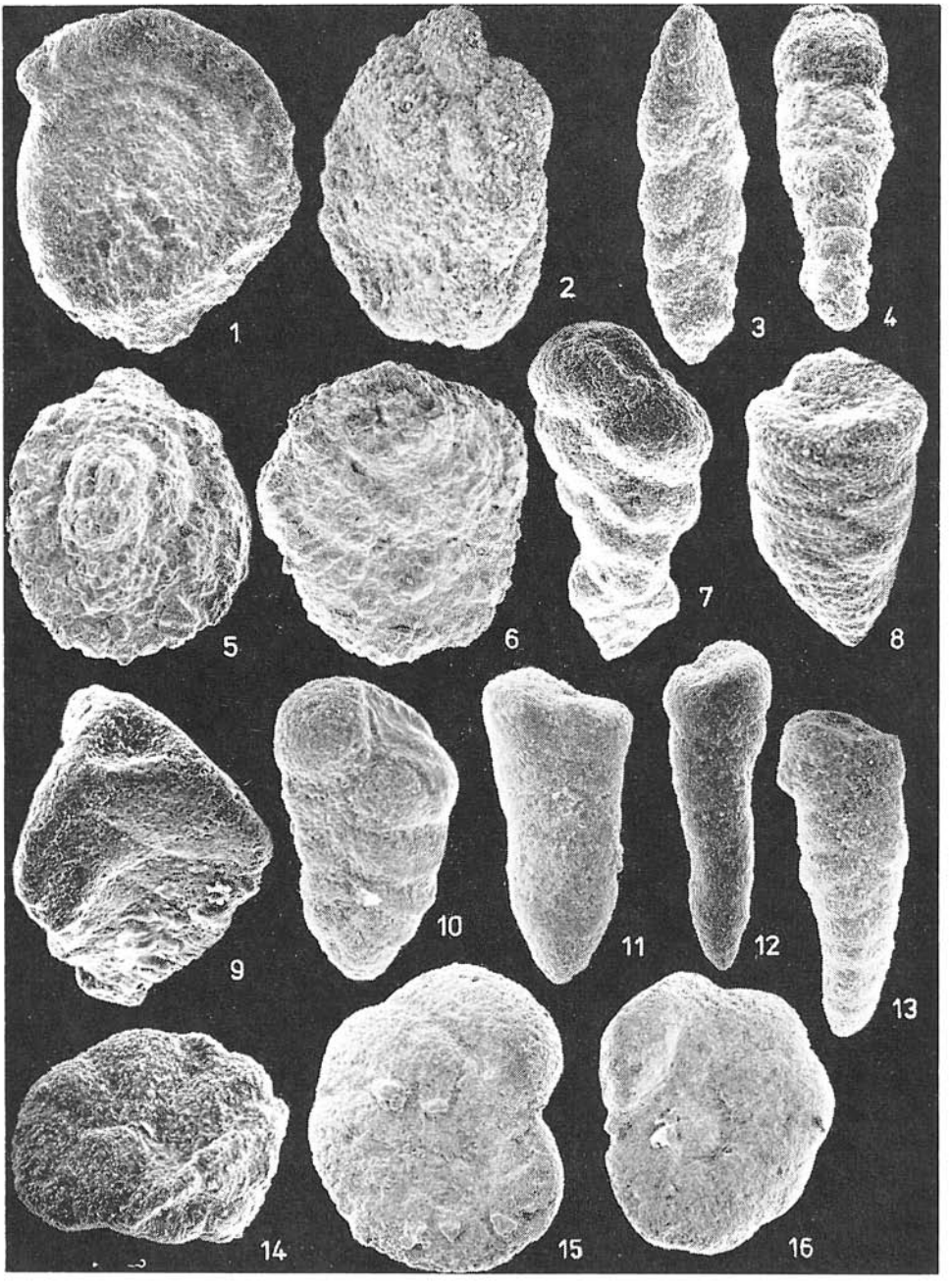


Plate 2

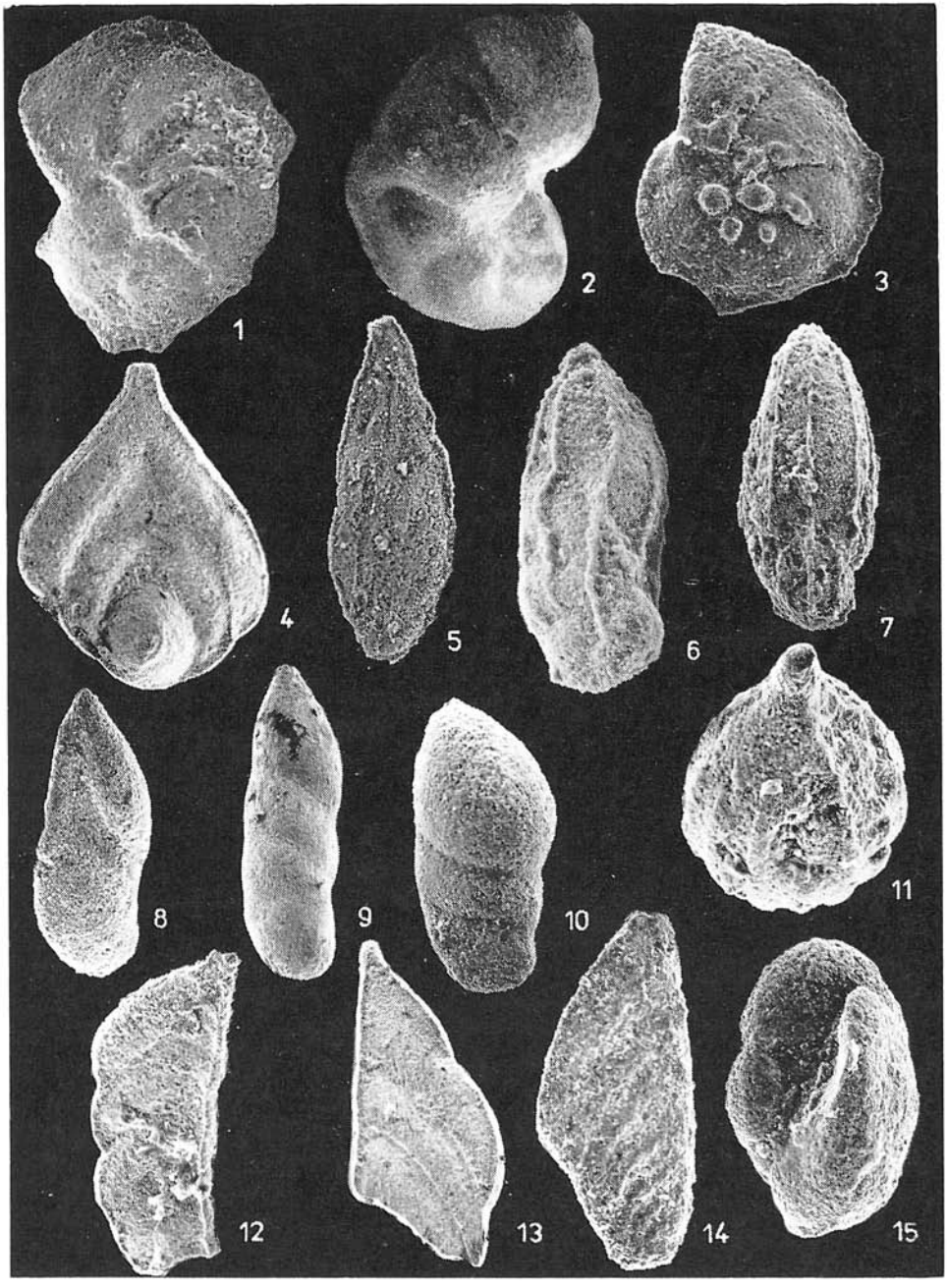
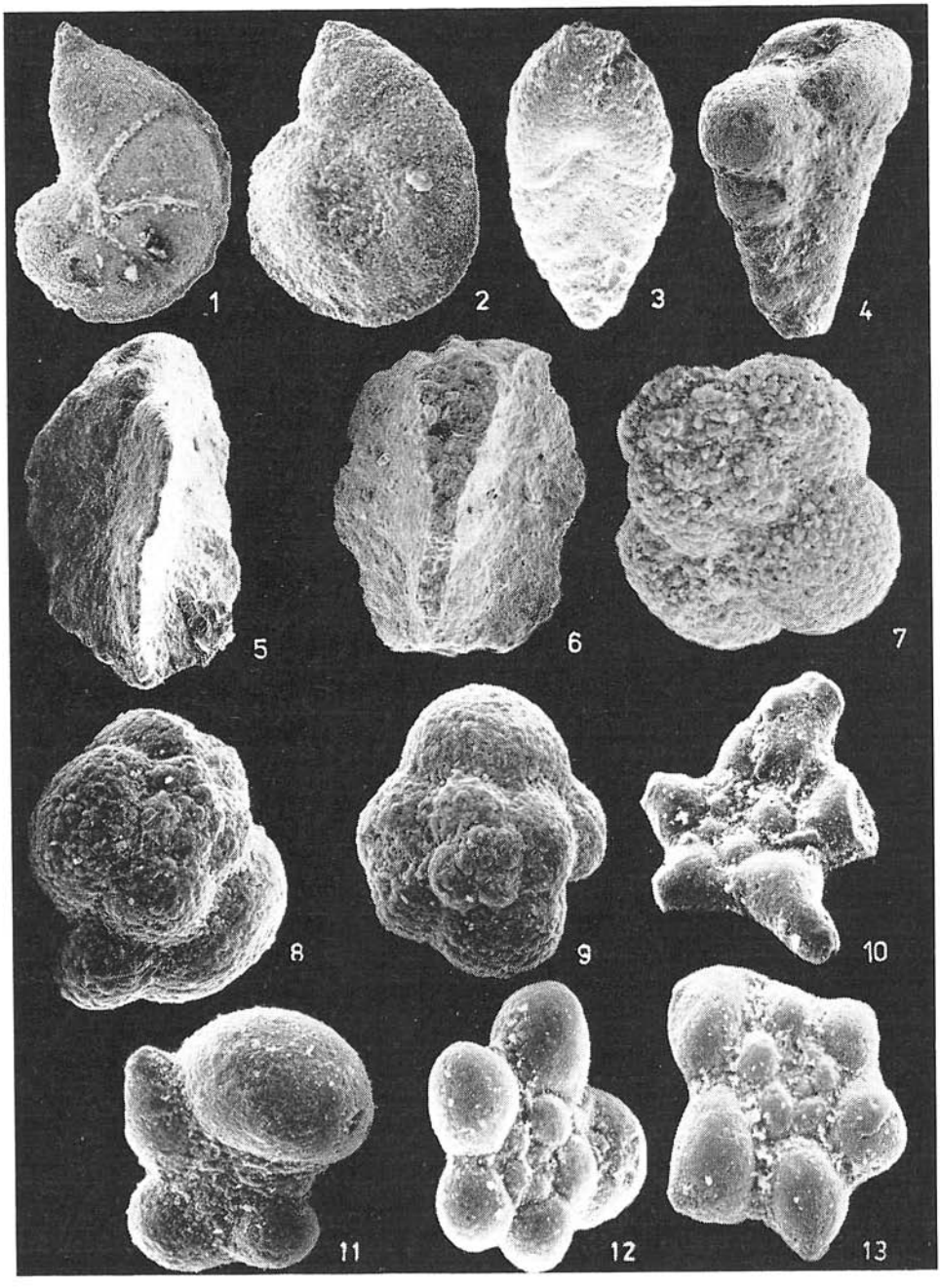


Plate 3



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