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THE FOREDEEP MIOCENE OF BOU SEFRA FACIES IN NORTHERN TUNISIA

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Abstract: The microbiostratigraphy of the Miocene Foredeep of Northern Tunisia is described. Agglutinated foraminifers were found in the marly intercalations of the conglomerate flysch facies of the Serravallian. The different types of the thanatocenoses (Foraminifera) are distinguished in the Miocene of the Bou Sefra Facies.

Key words: Foredeep, Miocene, Northern Tunisia, Foraminifera, biostratigraphy, paleoecology.

Introduction

The Miocene in the Bou Sefra facies studied by Solignac (1927) and defined by Bajaník & Salaj (1972), in the area Oued Zarga, represents a transient type between the Miocene of NW Tunisia (facies du Sillon Tunisian, Burollet 1951) situated N to NW Trassic diapirs (Kujawski 1969; Biely & Salaj 1971; Biely et al. 1974) and the Miocene of East and Central Tunisia (Subdorsal, Eastern Tunisia Platform), situated between Dorsal Tunisien and Chotts (Biely et al. 1972; Salaj & Stráník 1971; Robinson & Wiman 1976; Cassan et al. 1973; Compte & Dufaure 1973; Ballais 1973; Hoyberghs 1973; Meuter & Symons 1973; Hoyberghs & Lajmi 1974; Salaj 1978; Wiman 1978, 1980a, 1980b; Ben Ismail et al. 1984; Abbes & Polák 1984; Van Houten 1980).

The Miocene of the Bou Sefra facies with four depositional cycles defined by Bajaník & Salaj (1972) and Salaj (1975a) is represented by three classical profiles (Fig. 1):

a - Dj. Hendi - Bou Sefra - Dj. Skrira (Fig. 2);

b - Dj. Bou Debbous (The Oued Ermouche - Dj. Zoutine synclines);

c - Dj. Chitana (Bajaník & Salaj 1971a, 1971b, 1972a, 1973, 1974 and Salaj & Van Houten 1988).

Stratigraphy

The Oligocene of the Cherichira facies, dated by nummulites, is mostly overlain by the Fortuna Formation (facies á dragées avec deux á six niveaux conglomératiques; Bajaník & Salaj 1972; Van Houten 1980), which corresponds, in a similar way to the Tunisian Subdorsal and Cap Bon (Salaj 1975b, p. 413), to the Aquitanian - Burdigalian regressive facies (Salaj 1978, p. 408). In the area of Dj. Chitana the sandstones are also represented by mainly gypsum clay facies with marl- and sandstone layers. The marls contain Late Aquitanian microfauna (the *Globigerinoides quadrilobatus altiaperturus* Zone) and Burdigalian microfauna s.l. including the Helvetian[1] which Rutsch & Salaj (1980) as well as Magné (1982) suggested should be accepted again, Gourinard et al. (1985) (the *Turborotalia (Turborotalia) continuosa - Globigerinoides quadrilobatus* Zone and *Globigerinoides bisphaericus* Zone) (Bajaník & Salaj 1971a, 1971b; Salaj 1975a). The *Globigerinoides bisphaericus* Zone comprises coquina layers facially equivalent to limestones of the Ain Grab Formation (Dj. Chitana and NW of Dj. Hendi). These are intercalated and older than the mostly transgressive limestones of the Ain Grab Formation on Cap Bon. The age of these transgressive limestones is late Langhian, as indicated by *Borelis melo* (d' Orbigny) and *Orbulina suturalis* Broennimann (Salaj & Stráník in Biely et al. 1972, p. 89; Salaj 1978, p. 402, 409 - 410; Salaj in Hoyberghs 1973, p. 320; Ben Ismail-Lattrache & Bobier 1984, p. 195 - 201; Abbes & Polák 1984, p. 106 - 109; Beseme & Blondel 1989, p. 201; and Bismuth - pers. com.). There in the Saouaf synclinal they were formerly regarded as late Burdigalian s.l. with *Globigerinoides bisphaericus* (Salaj & Stráník 1971, p. 79) and now after revision as Langhian (with *Orbulina suturalis*, Batik et al. 1991).

Their Upper Langhian age is also confirmed by the overlying basal Mahmoud glauconitic marlstone with Lower Serravallian microfauna (*Orbulina universa* d' Orbigny, see Pl. 3, Fig. 26).

The early Aquitanian age of the base of the Fortuna Formation, i. e. of its lower cycle A_1 (Cassan et al. 1973), with *Globigerinoides quadrilobatus altiaperturus* Bolli (Salaj 1975b, p. 413) has so far been evidenced in one place only, namely in the rocks overlying the Uppermost Oligocene - Lowermost Aquitanian Korbous limestones with *Miogypsinoides complanatus* Schlumberger and lepidocyclinas (Pl. 4). The Oligocene/Miocene boundary limestones were not evidenced at other localities in Cap Bon (e. g. Jebel Abderrahman). The Fortuna Formation, formerly placed in the Oligocene (Burollet 1956), or in the Oligocene - Aquitanian p.p. (Ben Ismail-Lattrache & Bobier 1984), is mostly Aquitanian - Burdigalian s.l. in Cap Bon, as is

[1] The Helvetian of Imihübel corresponds approximately to the stratotype and parastratotype of the Rhodanian with *Globigerinoides bisphaericus* and *Globigeronoides sicanus*. In the level No. 10 of Imihübel (in the cement sparitic of the transgressive conglomerates - thin sections) rare planktonic foraminifers are also present (*Globigerinoides sicanus* or *Praeobulina glomerosa*). The Rhodanian sequence in the area of the parastratotype of the Burdigalian is also transgressive.

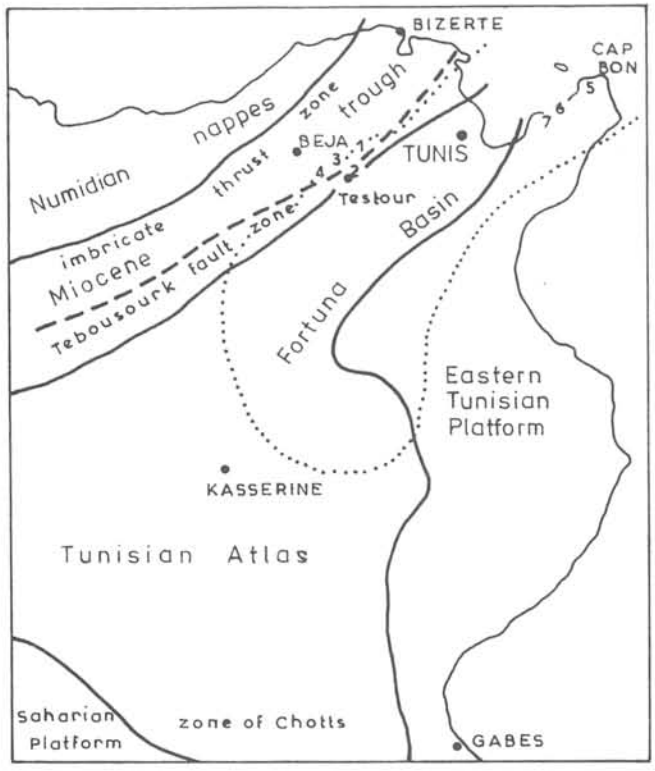

Fig. 1. Index map of Tunisia showing major structural features and studied localities.
1 - Dj. Chitana; 2 - Dj. Hendi; 3 - Bou Sefra and Dj. Skrira; 4 - Dj. Es Zoutina and Oued Ermouche synclines; 5 - El Houraria; 6 - Korbous; 7 - Ain Oktor.

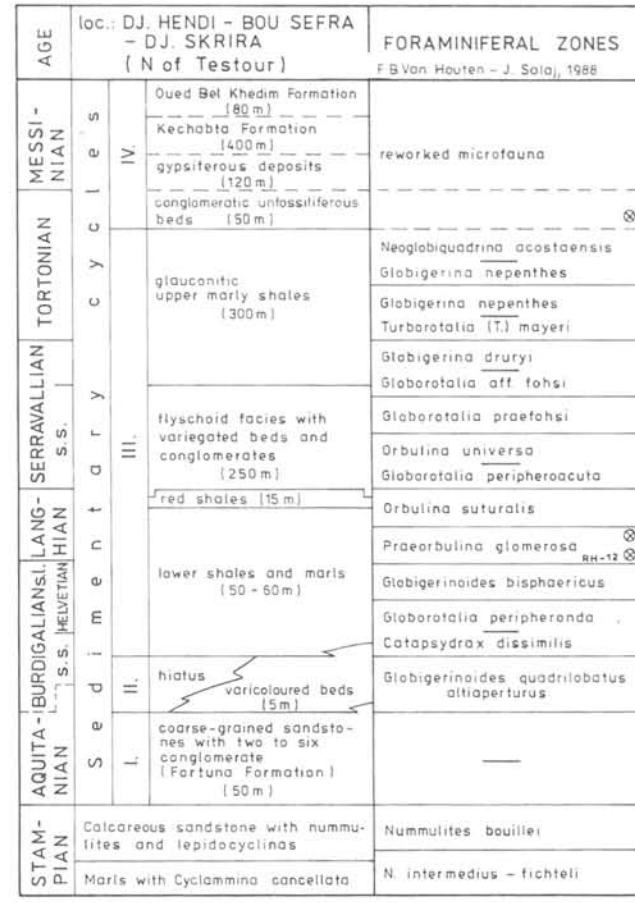

Fig. 2. Biostratigraphic section of Miocene Bou Sefra facies in vicinity of type locality.
* - horizons with fossil rodents.

shown by the almost complete Oligocene bed sequence indicated by planktonic foraminiferal zones (Ben Ismail-Lattrache 1981) in the beds overlying the Eocene marls of Cap Bon (Salaj 1980; Ben Ismail-Lattrache 1981; Ben Ismail-Lattrache & Bobier 1984). The zones are: *Cassigerinella chipolensis - Pseudohastigerina micra, Globigerina ampliapertura* and *Globorotalia opima opima - Globigerina angulisuturalis.* The last Uppermost Oligocene zone, defined formerly by Hoyberghs (1973), Hoyberghs & Lajmi (1974), Salaj (1980), in the area of Korbous, is also present between lower Korbous limestones with *Miogypsinoides complanatus* Schlumberger (Salaj 1975b, p. 413) and upper Korbous limestones with Uppermost Oligocene - basal Aquitanian lepidocyclinas (Lorenz 1969). The lepidocyclinas also occurs on the Zembra Island in the Tunisia Gulf (Bismuth et al. 1972).

In the area of Oued Zarga rich Burdigalian to Tortonian foraminifer associations are present in the lower and upper shales and marls separated by the flyschoid facies with variegated beds and conglomerates (see Fig. 2).

The uppermost part of the Miocene marine sediments of the Bou Sefra Facies, represented by upper shales and marls, is defined by foraminiferal planktonic zones as Lower Tortonian (Bajaník & Salaj 1972; Salaj 1975a).

The higher Miocene members, represented by the Oued Mellah and Kechabta Formations, in lagoonal and continental facies, contain only resedimented Cretaceous and Paleogene microfauna (Bajaník & Salaj 1971a, 1972, 1973).

It is necessary to remark that reworked Cretaceous and Paleogene foraminifers are not present in the Lower and Upper shales and marls. Extremely rare specimens of globotruncanas were found in the flyschoid facies with variegated beds and conglomerates. We conclude from this knowledge that extensive areas of Eastern and Northern Tunisia, including the Bou Sefra area, were flooded by shallow platform sea in Burdigalian - Lower Tortonian. Tectonic activity in the Serravallian contributed to the formation of the Miocene Foredeep, in the foreland of the nappes forming in the Numidian zone.

Paleoecology

The best preserved foraminiferal assemblage is from the Neogene Béjaoua subfacies, and/or from the Middle Miocene of the Mahmoud Formation of the East Tunisian Platform, and corresponds to thaphocoenoses of autochthonous character. The assemblages were buried in sediments under quiet conditions, and represent paleobiotops which, after their death, remained in the original ecological niches where they lived. Foraminiferal assemblages from the Bou Sefra facies Miocene represent autochthonous taphocoenoses only in isolated cases (Dj. Chitana; Dj. Debbous - lower shales and marls). They are mostly allochthonous. They partly migrated from the original niches of their

burial owing to movements of shallow water masses. Partly because of their contact with detrital mobile quartz, they are stightly abraded and displaced (Pl. 1, Figs. 17, 18, 22, 24 - 28). Most dead assemblages prepared to be covered with sediments, i. e. liptocoenoses, did not stay in their niche. Various paleobiotopes from various environment were largely displaced, mixed and formed thanatocenoses after being covered with sediments. These foraminiferal assemblages originated from the same stratigraphic horizon, but from different ecological niches, as is also proved by their species composition. In this case thanatocenoses also represent oryctocoenoses. In Upper Langhian sediments of the *Orbulina suturalis* Zone oryctocoenoses occur, in which foraminiferal assemblages of this zone contain species from two consecutive stratigraphic horizons. As well as foraminiferal assemblages of the *Orbulina suturalis* Zone, there are also resedimented foraminiferal assemblages from the preceding stratigraphic horizon, i. e. from the *Praeorbulina glomerosa* Zone. It is an Upper Langhian oryctocoenose mentioned by Biely (1973).

With respect to sedimentologic-facial evolution, the lower marls of the Uppermost Burdigalian - Lower Langhian, overlying the variegated lacustrine sediments, represent sediments deposited in a shallow neritic area with calmer sedimentation. Individual microfaunal horizons contain some species with signs of mechanical damage but not resedimented, only displaced over the floor prior to their burial in sediments. Among planktonic foraminifers globigerinas and globoquadrinas, i. e. globular forms, are dominant. Globorotalia are scarce. They are indicative of a maximum 100 - 150 *m* depth of the Bou Sefra Basin. Foraminifers from these marls were formerly described by Bajaník & Salaj (1971a, 1972, 1974) and Salaj (1975b). Some significant species are depicted in Pls. 2 - 3. Foraminiferal assemblages formerly attributed to the Aquitanian, are Burdigalian.

During the latest Langhian, the series of 10 - 15 *m* of red non-fossiliferous shales (= Hakina Fm. intercaled of Burollet 1971) were deposited in a closed but relatively deep lake, separated from the open sea.

After a short period marine conditions were established again. The sediments are represented by the Uppermost Langhian - Serravallian conglomerate flysch mollassic sequence (similar as in the Catalonia area of Spain).

The Uppermost Langhian - Serravallian flysch sequence are typical foredeep sediments. During the Upper Langhian - Middle Serravallian, the foredeep reached its maximum depth. Abundant agglutinated microfauna forms (see Pl. 1), and several horizons with turbidity sedimentation chracterized by transport from emerged zones (Bajaník & Salaj 1971a, p. 20) occur. There are mixed agglutinated foraminiferal assemblages, with dominant plnktonic and calcareous benthic foraminifers. Many show signs of transport from higher ecological niches on a continental slope, into the basin, and moreover some of them (Pl. 2, Figs. 21, 23) show signs of dissolution. So the Bou Sefra basin floor was below CCD or foraminiferal lysocline in the time of maximum deepening. Because of the nearness of continent, water pollution by turbidity currents, high C_{org} content, the level of the foraminiferal lysocline could not have been deeper than 700 *m*. It is most likely to have fluctuated between 400 and 600 *m* (Salaj & Van Houten 1988).

The upper marls sequence was deposited under approximately the same conditions as the lower marls sequences. A deeper environment is indicated by frequent uvigerinas and planktonic foraminifers. Planktonic foraminifers are represented by *Neogloboquadrina acostaensis acostaensis* (Blow), *Neoglobiquadrina acostaensis trochoides* (Bizon), *Globigerina druryi* Todd and *Globigerina nepenthes* Todd.

In the course of approximately the Middle Tortonian, the marine sedimentation (glauconitic upper marls sequence) changes into lacustrine, interpreted here as an Upper Tortonian conglomeratic unfossiliferous sequence (50 *m*, Fig. 2), and later into lagoonal (Oued Mellah Formation) and lagoonal-continental sedimentation (Kechabta and Oued Bel Khedim Formations). These sediments mostly contain resedimented microfauna (Bajaník & Salaj 1971a, 1972).

The marine Pliocene in the Raf-Raf marls facies is particularly rich in microfauna (areas of Bizerte and Enfidaville). It was studied in detail by Hoyberghs (1977), Colleuil (1976), Wiman (1978, 1980a, b), Bizon et al. (1980), Bismuth (1984) a. o.

Conclusion

The Bou Sefra Basin represents a Miocene Foredeep (one part of the South Tellian resedimentation basin; Caire 1978), with continuous sedimentation and possible decreasing erosion of nappes at the beginning of the Serravallian (Burollet 1971, p. 4). So in the course of the Serravallian the tectonic movements in Tunisia culminated (Bajaník & Salaj 1971a).

During the Serravalian to Tortonian, the Beglia and Saouaf Formations were deposited, in Eastern Tunisia (Cap Bon) and the Tunisian Subdorsal, with slight tectonic movements (Tortonian - Messinian, Biely et al. 1972; Robinson & Wiman 1976; Wiman 1978, 1980a, b). The formations differ conspicuously from higher members of the foredeep in the Medjerda region. The members are best exposed around Bizerte (Burollet 1951) and Oued Zarga (Fig. 2).

Post-tectonic formations of the Upper Miocene, deposited in the Bou Sefra facies, comprise the conglomeratic unfossiliferous sequence (Upper Tortonian), the Oued Mellah, Kechabta and Oued Bel Khedim Formations (Burollet 1951, 1971), all of Messinian age. However in the area of the East Tunisian Platform, Central Tunisia and Subdorsal, these are represented by the Upper Tortonian - Messinian Souaf and Segui Formations (Biely et al. 1972; Robinson & Wiman 1976; Abbes & Polák 1984).

The main deformation phase of folding in this region occurred at the end of the Miocene, before deposition of continental sediments of the Pliocene Zeldou Formation (Bajaník & Salaj 1972, p. 134). This is the Orbatine phase (Dally 1985), during which the Miocene "nappe structure" was formed according to Dally (1985). As principal result of these tectonic phases in the Boursouk fault (Fig. 1) very narrow zone (Bajaník & Salaj 1972, p. 131) similar to the klippen zone of the Alpine-Carpathians orogenetic system. The Boursouk fault zone is formed by the Triassic, Jurassic, Cretaceous and Paleogene klipps.

From the paleogeographical-tectonic point of view it is necessary to mention that according to Beseme & Blondel (1989) and Blondel & Demarcq (1990), the transgression of the marine Langhian coming from the north extended at least 60 *km* to the south of El Kef. Thus it is clear that the Miocene Foredeep of the middle part of Medjerda was already flooded by marine

transgression before the Langhian. This is in agreement with the presented work.

The time of the Late Burdigalian corresponded to the formation of flysch nappes, whil in the Uppermost Burdigalian (including the Helvetian sensu Imihübel (Rutsch & Salaj 1980) - in the Lower Langhian a relaxation phase existed. According to Hoyez (1989, p. 417) this phase was manifested by significant vertical movements resulting in individualization of grabens, also including the Middle Medjerda graben on the one hand and in general marine transgression in these sunken zones on the other.

Throughout the Langhian - Lower Serravallian, tectonic reactivation (Hoyez 1989, p. 420) was without doubt as a consequnce of the N - S approach of Europe and Africa, with deepening of grabens prevailingly with marly sedimentation taking place at the same time.

In the zone of the Numidian flysch compressions, as a consequence of Lower Miocene tectonics, and thrusting of this flysch over foredeep Langhian - Serravallian, grabens may be identified, as mentioned by Hoyez (1989).

The first deformations can be identified in the Upper Serravallian, but regarding to their gradual advancement in space, as stressed by Hoyez (1989), some regions were tectonized much later, during the Lower Tortonian (Hoyez 1989) and up to the end of the Miocene (Dally 1985) only.

According to (Hoyez 1989, p. 420), the Middle Medjerda graben has very regressive sediments (Burdigalian s.s.), and the existence of scarce evidence shows that folding still did not reach this area. It is necessary to remark that mainly Upper Serravallian sediments with relatively well represented specimens of the genus *Elphidium* Montfort should be considered as regressive, which may also testify to a brackish environment in a delta area.

On the contrary, the Lower Tortonian, represented by glauconitic marls (upper marls), would practically indicate revival of the marine regime, moderate deepening in the frame of the neriticum of the vanishing foredeep of Middle Medjerta. This was rapidly replaced by lagoonar and freshwater lacustrine sediments.

Translated by J.Pevný.

Plate 1: Fig. 1 - *Valvulina flexilis* Cushman et Renz; magn. 110 x. Sample No. 925, loc.: Dj. Chitana. *Praeorbulina glomerosa* Zone. Lower Langhian. Fig. 2 - *Textularia kugleri* Cushman et Renz; magn. 70 x. Sample No. 1551 Ch-a, loc.: Bou Sefra. *Globorotalia fohsi peripheroacuta - Orbulina universa.* Serravallian. Fig. 3 - *Gaudryina thalmanni* Cushman et Renz; magn. 60 x. Sample No. 925. Fig. 4 - *Dendrophrya robusta* Grzybowski; magn. 50 x. Sample No. 1551 Ch-a, intercalation of the marls in the conglomerates. Fig. 5 - *Rhabdammina cylindrica* Glaessner; magn. 110 x. Sample No. 925. Fig. 6 - *Haplophragmoides coronatum* (Brady); magn. 80 x. Sample No. 1550 c, loc.: Bou Sefra. Serravallian. Fig. 7 - *Haplophragmoides carinatum* Cushman et Renz; magn. 80 x. Sample No. 1550c, intercalation of the marls in the conglomerates. Serravallian. Fig. 8-9 - *Haplophragmoides* sp.; magn. 60 and 50 x. Sample No. 1550 c. Fig. 10-11 - *Cyclammina latidorsata* (Bornemann); magn. 50 and 50 x. Sample No. 1550c. Fig. 12 - *Cyclammina latidorsata* (Bornemann); magn. 80 x. Sample No. 1551 Ch-a. Fig. 13 - *Cyclammina vulchoviwnsis* Venglinskij; magn. 80 x. Sample No. 1551 Ch-b, loc.: Bou Sefra. Fig. 14 - *Cyclammina* sp.; magn. 100 x. Sample No. 1551 Ch-a. Fig. 15 - *Ammodiscus* sp.; magn. 60 x. Sample No. 1550 c. Fig. 16 - *Haplophragmoides* sp.; magn. 50 x. Sample No. 1550 c. Fig. 17 - *Stilostomella consobrina emaciata* Reuss; magn. 50 x. Sample No. 925, loc.: Dj. Chitana. *Praeorbulina glomerosa* Zone. Lower Langhian. Fig. 18 - *Stilostomella verneuilli* (d' Orbigny); magn. 50 x. Sample No. 1551 Ch-a, loc.: Bou Sefra. *Globorotalia fohsi peripheroacuta - Orbulina universa* Zone. Fig. 19 - *Stilostomella monilis* (Silvestri); magn 70 x. Sample No. 1550 e, loc.: Bou Sefra. Fig. 20 - *Lenticulina* (Robulus) *melvilli* (Cushman et Renz); magn. 80 x. Sample No. 1551 Ch-a. Fig. 21 - *Gyroidinoides girardanus peramlus* Cushman et Stainfort; magn. 175 x. Sample No. 197, loc.: Bou Sefra. *Neoglobiquadrina acostaensis - Globigerina nepenthes* Zone. Fig. 22 - *Florilus scaphum* (Fichtel et Moll); magn. 150 x. Sample No. 1551 Ch-b, loc.: Bou Sefra. Fig. 23 - *Pullenia bulloides* d' Orbigny; magn. 150 x. Sample No. 1550 e. Fig. 24 - *Ammonia beccarii* (Linné); magn. 100 x. Sample No. 925. Fig. 25 - *Gyroidinoides girardanus girardanus* (Reuss); magn. 100 x. Sample No. 5 g, loc.: Bou Debbous. *Praeorbulina glomerosa* Zone. Lower Langhian. Fig. 26 - *Gyroidinoides laevigatus* (d' Orbigny); magn. 140 x. Sample No. 1551 Ch-a. Fig. 27 - *Gyroidinoides altiformis* (R. E. et K. C. Stewart); magn. 110 x. Sample No. 1550 e. Fig. 28 - *Gyroidinoides soldanii nitidula* (Schwager); magn. 150 x. sample No. 1550e.

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Plate 2: Fig. 1-2 - *Heterolepa bellincionii* (Giannini et Tavani); magn. 140 x. Sample No. 1551 Ch-a. Fig. 3 - *Heterolepa dutemplei* (d' Orbigny); magn. 90 x. Sample No. 182, loc.: Bou Sefra. *Turborotalia (T.) periferonda - Catapsydrax dissimilis* Zone. Burdigalian. Fig. 4 - *Heterolepa dutemplei* (d' Orbigny); magn. 80 x. Sample No. 1550 c, loc.: Bou Sefra. Serravallian. Fig. 4 - *Heterolepa dutemplei* (d' Orbigny); magn. 80 x. Sample No. 1550 c, loc.: Bou Sefra. Serravallian. Fig. 5 - *Heterolepa dutemplei* (d' Orbigny); magn. 120 x. Sample No. 1551 Ch-a, loc.: Bou Sefra. Serravallian. Fig. 6 - *Melonis soldania* (d' Orbigny); magn. 90 x. Sample No. 1551 Ch-a. Fig. 7 - *Melonis pompilioides* (Fichtel et Moll); magn. 150 x. Sample No. 182. Fig. 8 - *Globocassidulina subglobosa* (Brady); magn. 100 x. Sample No. 1551 Ch-a. Fig. 9 - *Cibicides lobatulus* (d' Orbigny); magn. 70 x. Sample No. 925, loc.: Dj. Chitana. *Praeorbulina glomerosa* Zone. Lower Langhian. Fig. 10-11 - *Siphonina reticulata* (Czjzek); magn. 130 x. Sample No. 1551 Ch-b, loc.: Bou Sefra. Serravallian. Fig. 12-13 - *Siphonina planoconvexa* (Silvestri); magn. 150 and 110 x. sample No. 1551 Ch-a. Fig. 14 - *Cibicides ungerianus* (d' Orbigny); magn. 90 x. Sample N0. 1551 Ch-a. Fig. 15 - *Uvigerina semiornata albingensis* Daniels et Spiegler; magn. 70 x. Sample No. 1550 c, loc.: Bou Sefra. Serravallian. Fig. 16 - *Uvigerina hemmooriensis* Daniels et Spiegler; magn. 80 x. Sample No. 1550 c. Fig. 17 - *Uvigerina semiornata semiornata* d' Orbigny; magn. 60 x. sample No. 1551 Ch-a, loc.: Bou Sefra. Serravallian. Fig. 18 - *Uvigerina macrocarinata* Papp et Turnovsky; magn. 100 x. Sample No. 1551 Ch-b, loc.: Bou Sefra. Serravallian. Fig. 19 - *Uvigerina semiornata kusteri* Daniels et Spiegler; magn. 100 x. Sample No. 1551 Ch-a. Fig. 20 - *Uvigerina venusta deurmensis* De Meuter & Laga; magn. 80 x. Sample No. 1551 Ch-a. Fig. 21 - *Uvigerina schwageri* Brady; magn. 90 x. Sample No. 1550 e, loc.: Bou Sefra. Serravallian. Fig. 22 - *Bulimina* aff. *costata* d' Orbigny; magn. 170 x. Sample No. 1551 Ch-a. Fig. 23 - *Bulimina alazanensis* Cushman; magn. 120 x. Sample No. 197. Fig. 24 - *Bulimina pyrula* d' Orbigny; magn. 140 x. Sample No. 5 g. Fig. 25 - *Bolivina antiqua* d' Orbigny; magn. 80x. sample No. 1551 Ch-a.

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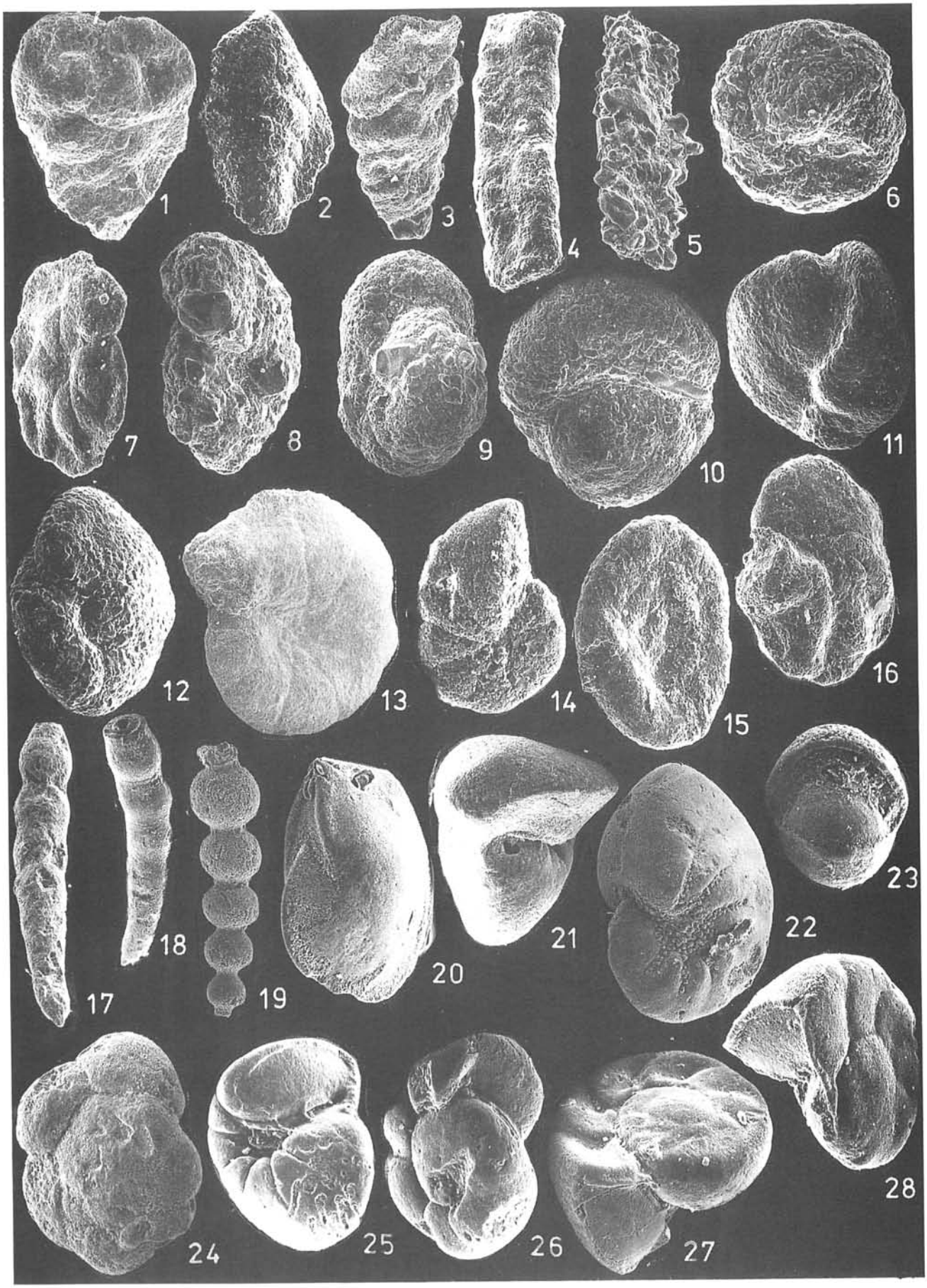
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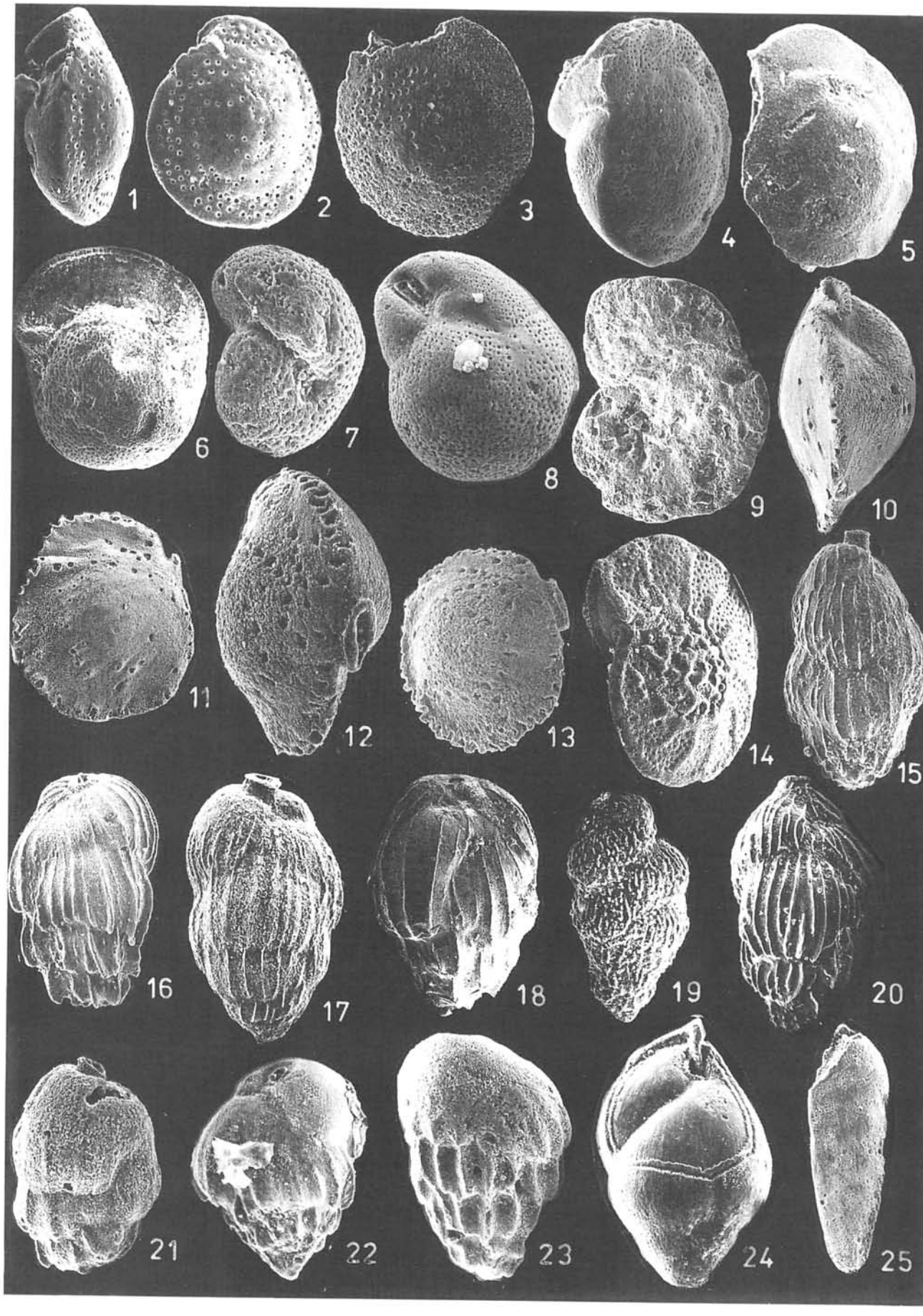
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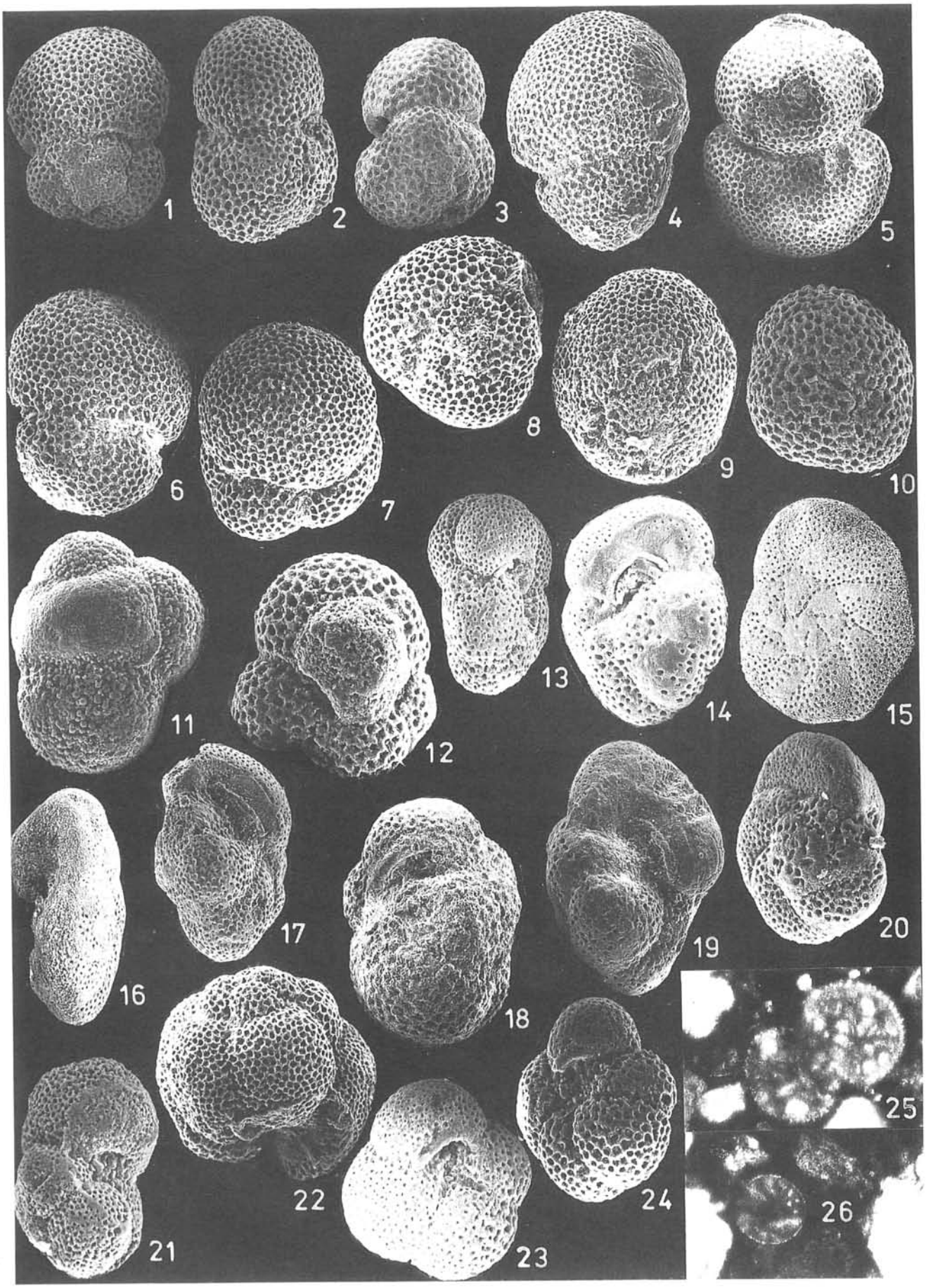
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Plate 4

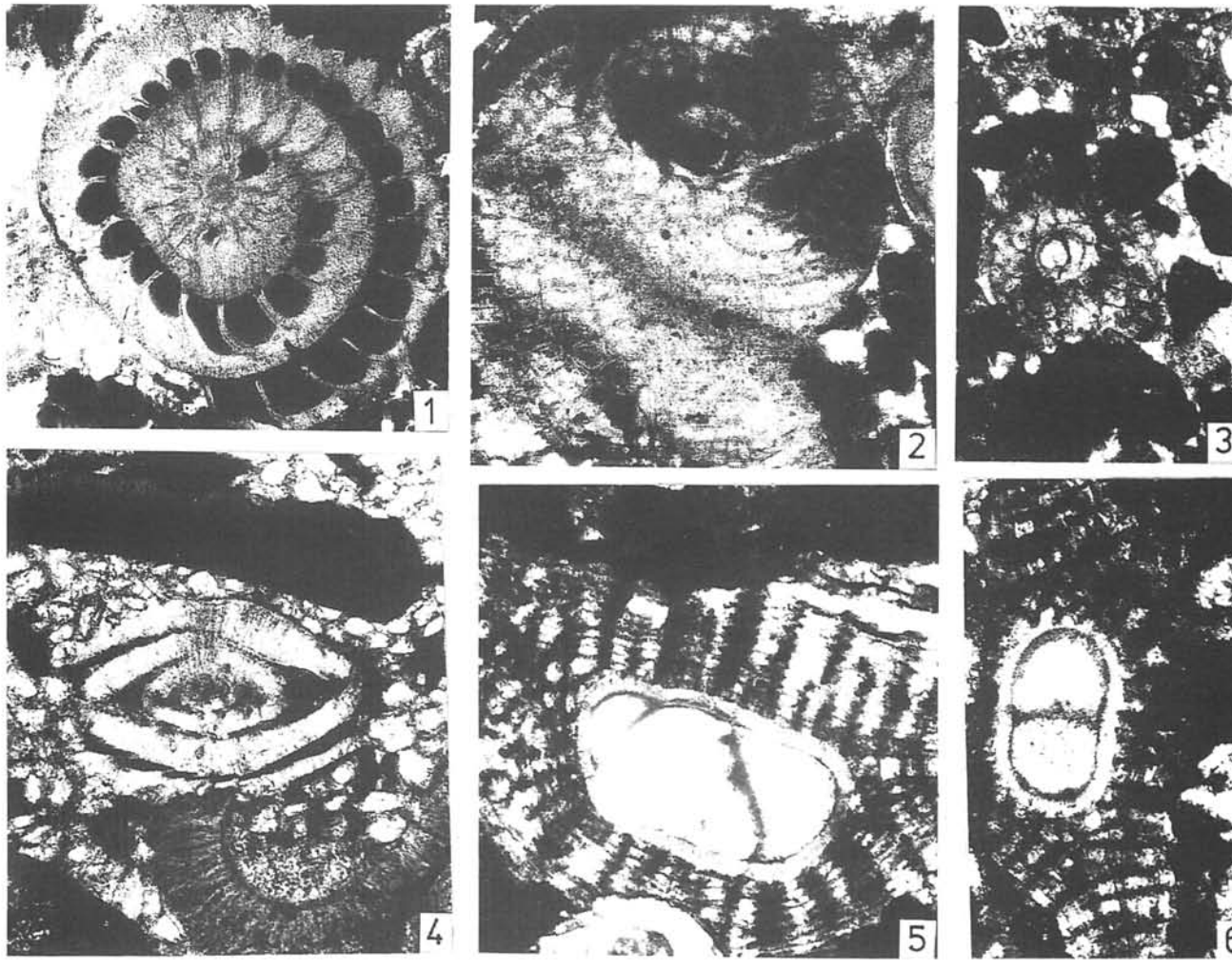

Plate 3: Fig. 1 - *Globigerinoides trilobus* (Reuss); magn. 90 x. sample No. 182, loc.: Bou Sefra. *Turborotalia (T.) periferonda - Catapsydrax dissimilis* Zone. Burdigalian. Fig. 2 - *Globigerinoides immaturus* le Roy; magn. 120 x. Sample No. 1550 e, loc.: Bou Sefra. Serravallian. Fig. 3 - *Globigerinoides* ex gr. *ruber* (d' Orbigny); magn. 130 x. Sample No. 1551 Ch-b. Fig. 4 - *Globigerinoides bisphaericus* (Todd); magn. 80 x. sample No. 1551 Ch-b. Fig. 5 - *Biorbulina bilobata* (d' Orbigny); magn. 80 x. Sample No. 1551 Ch-b. Fig. 6 - *Globigerinoides sicanus* de Stefani; magn. 100 x. Sample No. 1550e. Fig. 7 - *Praeorbulina glomerosa curva* (Blow); magn. 120 x. Sample No. 1550e. Fig. 8 - *Praeorbulina glomerosa glomerosa* (Blow); magn. 100x. sample No. 5 g, loc.: Bou Debbous. *Praeorbulina glomerosa* Zone. Lower Langhian. Fig. 9 - *Orbulina suturalis* Broennimann; magn. 80 and 100x. Sample No. 1550 c, loc.: Bou Sefra. Fig. 10 - *Globigerinoides* aff. *quadrilobata* (d' Orbigny); magn. 150 x. Sample No. 182. Fig. 11 - *Catapsydrax stainforthi* Bolli, Loeblich et Tappan; magn. 175 x. Sample No. 182, loc.: Bou sefra. *Turborotalia (T.) periferonda - Catapsydrax dissimilis* Zone. Burdigalian. Fig. 12 - *Catapsydrax dissimilis* Cushman et Bermúdez; magn. 200 x. Sample No. 182. Fig. 13 - *Neogloboquadrina acostaensis* (Blow); magn. 130 x, Sample No. 197. Fig. 14 - *Turborotalia (T.) mayeri* Cushman et Ellisor; magn. 225 and 200 x. Sample No. 197. Fig. 15-16 - *Globorotalia pseudomiocenica* Bolli et Bermúdez; magn. 175 and 200 x. Sample No. 1551 Ch-b, loc.: Bou Sefra. Serravallian. Fig. 17 - *Globorotalia scitula gigantea* Blow; magn. 200 and 200 x. Sample No. 1551 Ch-b. Fig. 18 - *Globorotalia continuosa* Blow; magn. 175 x. Sample No. 1551 Ch-b. Fig. 19 - *Globorotalia fohsi peripheronda* Blow et Banner; magn. 250 x. Sample No. 1551 Ch-b. Fig. 20 - *Globorotalia fohsi peripheroacuta* Blow et Banner; magn. 200 x. sample No. 1550 e, loc.: Bou Sefra. Serravallina. Fig. 21 - *Globorotalia obesa* Bolli; magn. 150 x. Sample No. 182, loc.: Bou Sefra. *Turborotalia (T.) periferonda - Catapsydrax sissimilis* Zone. Burdigalian. Fig. 22 - *Globoquadrina altispira altispira* (Cushman et Jarwis); magn. 100 x. Sample No. 182. Fig. 23 - *Globigerina nepenthes* Todd; magn. 150 x. Sample No. 1550 e. Fig. 24 - *Globigerina druryi* Akers; magn. 150 x. sample No. 197, loc. : Bou Sefra. *Neoglobiquadrina acostaensis - Globigerina napenthes* Zone. Tortonian. Fig. 25 - *Bi orbulina bilobata* (d' Orbigny); magn. 40 x. Fig. 26 - *Orbulina universa* (d' Orbigny); magn. 40 x. Sample No. 5, loc.: El Haouaria; glauconitic marly limestone at the base of the basal Serravallian. *Orbulina universa - Globorotalia peripheroacuta* Zone.

(See page 301)

Plate 4: Fig. 1 - *Nummulites vercus* Joly et Leymerie; magn. 25 x. Sample no. 3, loc.: Ain Octor. Upper Oligocene (Chattian). Fig. 2 - *Heterostegina antilles* Cushman; magn. 25 x. Sample No. 5, loc.: Korbous. Upper Oligocene to Lowermost Aquitanian. Fig. 3 - *Heterostegina antillea* Cushman; magn. 25 x. Sample No. 5, loc.: Korbous. Upper Oligocene to Lowermost Aquitanian. Fig. 4 - *Nummulites vascus* Joly et Leymerie; magn. 25 x. Sample no. 3, loc.: Ain Octor. Upper Oligocene. Fig. 5 - *Lepidocyclina (Nephrolepidina)* ex gr. *dilatata*; magn. 25 x. Sample No. 5, loc.: Kornous. Upper Oligocene to Lowermost Aquitanian. Fig. 6 - *Lepidocyclina (Nephrolepidina)* ex gr. *dilatata*; magn. 25 x. Sample No. 4, loc.: Korbous. Upper Oligocene to Lowermost Aquitanian (Upper Korbous limestone).

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