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CAMPANIAN TO PALEOCENE AGGLUTINATED FORAMINIFERA FROM FRESHWATER INFLUENCED MARGINAL MARINE (DELTAIC) SEDIMENTS OF SOUTHERN EGYPT

by

P. LUGER

With 3 figures and 2 plates

ZUSAMMENFASSUNG

Einige artenarme Assoziationen agglutinierender Foraminiferen aus obercampanen bis paleozänen Sedimenten Südägyptens werden vorgestellt und diskutiert. Die Gattung *Ammoastuta* wird erstmalig aus Nordostafrika beschrieben. Der Vergleich mit anderen rezenten und fossilen Foraminiferenassoziationen, in denen *Ammoastuta* vorkommt, zeigt die Verwendbarkeit dieser Gattung als Faziesleitfossil für küstennahe, brackische Flachwasserbereiche warme Paläoklimate mit hohen Niederschlägen, auch wenn es sich bei ausschließlich aus agglutinierenden Foraminiferen bestehenden Assoziationen größtenteils um Oryktozönosen (Rückstandsgemeinschaften) mit diagenetisch reduzierten Faunenspektren handelt.

ABSTRACT

Low diversity agglutinated foraminiferal assemblages from the Campanian to Early Paleocene of southern Egypt are described and discussed. The occurrence of the genus *Ammoastuta* is reported for the first time from northeast Africa. *Ammoastuta* is regarded as a facies-index fossil for brackish littoral conditions in warm climates with high rainfall and high runoff.

INTRODUCTION

From Aptian/Albian to Eocene time, marine transgressions from the northern Tethyan Sea invaded the large intracratonal basins of southern Egypt. The major transgression started during the Campanian and, interrupted by minor regressive phases, culminated during the Late Paleocene. Due to a constantly high input of terrestrial material from the south, the Campanian to Middle Paleocene sediments can be subdivided into a northern pelitic basinal and a southern psammitic marginal lithofacies with very gradual interfingering of sedimentary environments. The psammitic marginal lithofacies shifted southwards with increasing transgression.

This facies differentiation was studied in a number of sections of Maastrichtian to Middle Paleocene sediments along the 350 km long, NNE/SSW trending escarpment of the great limestone plateau west of the River Nile (Luger 1985). The Campanian data are derived from a different area further to the north: Gebel Qreiya, at the southern end of Wadi Qena, Eastern Desert (figure 1).

THE FORAMINIFERAL ASSOCIATIONS OF SOUTHERN EGYPT

The sediments of the upper Hawashya Formation (mainly pelitic facies, Campanian), Dakhla Formation (mainly pelitic basinal facies,

Luger, P., TU-Berlin, SFB 69, Sekr. ACK 9, Ackerstr. 71-76, 1 Berlin 65, WEST GERMANY.

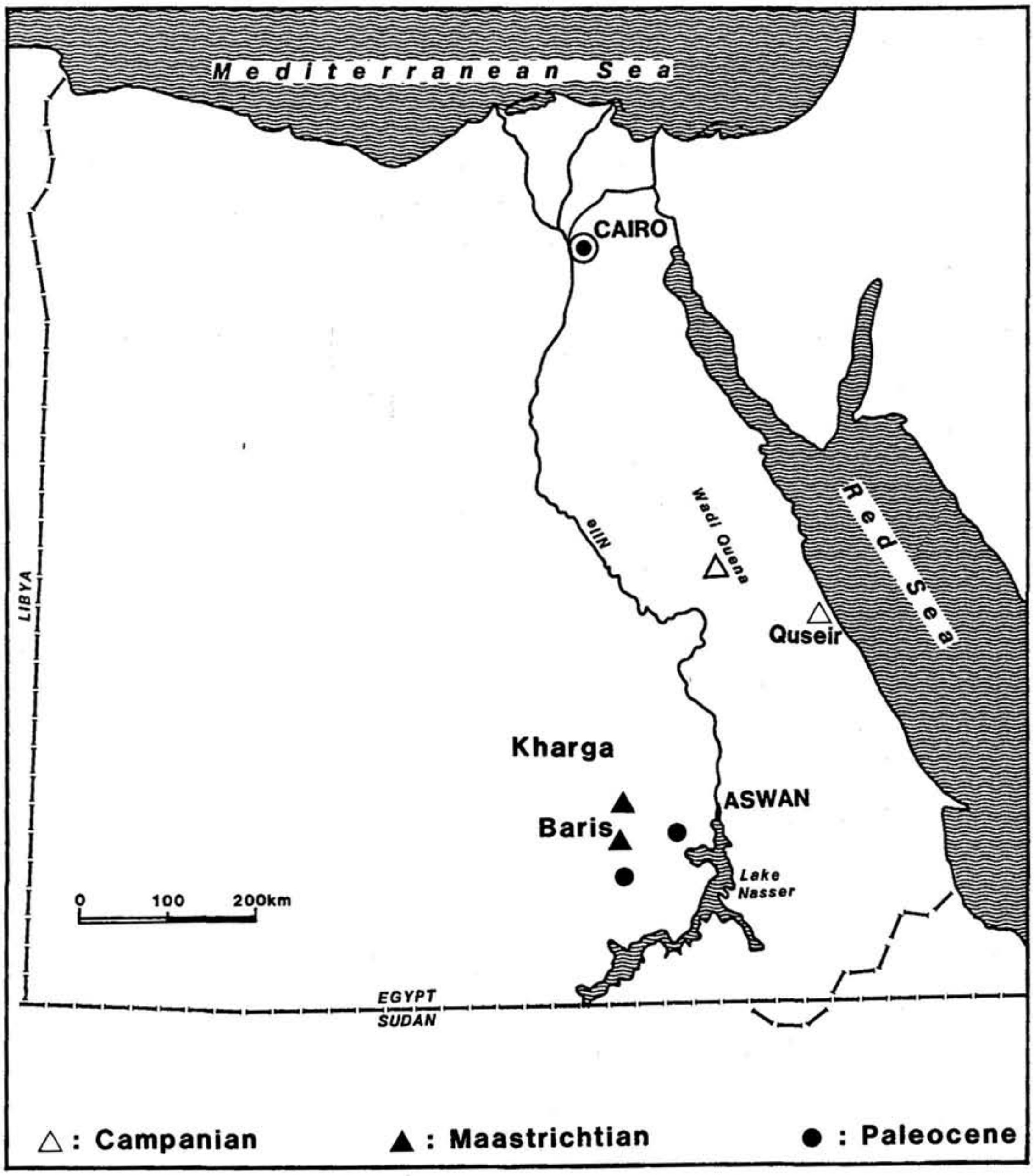

Fig. 1.
Occurrence of *Ammoastuta* assemblages in Egypt.

Maastrichtian to Middle Paleocene), Shab Member of Kiseiba Formation (mainly psammitic marginal/deltaic facies, Maastrichtian) and Kurkur Formation (mainly psammitic marginal/deltaic facies, Paleocene) yielded foraminiferal assemblages which may roughly be grouped into the following three categories (for stratigraphic correlation see figure 2):

1. Midway fauna (Paleocene) and Midway-like (Maastrichtian) assemblages:
   Composition: Calcareous and agglutinated benthics, abundant to common planktonics. Agglutinated benthics use calcareous and siliciclastic material for building their tests; forms using calcareous material dominate the agglutinated association. Benthic foraminiferal species diversity is high.
   Origin: Middle to outer shelf.
   Occurrence: Dakhla Formation (Maastrichtian to Middle Paleocene).

2. Shallow shelf assemblages:
   Composition: Calcareous and agglutinated benthics, planktonics rare to absent. Agglutinated benthics use calcareous and siliciclastic material for building their tests; forms using siliciclastic material dominate in the agglutinated association. Benthic species diversity is low.
   Origin: Shallow euryhaline shelf or lagoons.

Occurrence: Dakhla Formation (Maastrichtian part only).

3. "Littoral" associations:
Composition: Almost exclusively agglutinated foraminifera, using only siliciclastic material for building their tests. Foraminiferal species diversity is very low.
Origin: ?euryhaline lagoons to mixohaline lagoons, marshes and coastal swamps.
Occurrence: Dakhla Formation (Maastrichtian part only), Kurkur Formation, upper Hawashya Formation, Shab Member of Kiseiba Formation.

DESCRIPTION OF THE "LITTORAL" ASSOCIATIONS

The "littoral" associations are found mainly in non-calcareous pelitic sediments which may have been decalcified in early diagenetic stages. Therefore they cannot be interpreted as taphocoenosis but instead as oryktocoenosis (=relic assemblages). Among them the following types occur:

A) Composition: *Ammobaculites* div. sp., *Haplophragmoides* div. sp., *Reophax* div. sp., *Saccammina* sp., *Textularia*? sp., *Trochammina* sp.
Species diversity: 1-6
Occurrence: Basinal and marginal facies, Campanian to Middle Paleocene.

B) Composition: *Miliammina* div. sp., *Ammobaculites* div. sp., *Ammodiscus* sp., *Haplophragmoides* sp., *Trochammina* sp.
Species diversity: 1-8.
Occurrence: Transition between basinal and marginal facies as well as marginal facies, Campanian to Maastrichtian.

C) Composition: *Ammoastuta* div. sp., *Ammobaculites* div. sp., *Ammodiscus* sp., *Haplophragmoides* div. sp., *Miliammina* div. sp., *Reophax* sp., *Trochammina* sp.
Species diversity: 1-8
Occurrence: Interfingering of basinal and marginal facies as well as marginal facies, Campanian to Early Paleocene.

The most important constituents of the associations A-C are figured on plates 1 and 2. Most of the components of the associations of type A may co-occur in the shelf assemblages of categories 1 and 2. As decalcification may have occurred, some of the associations of type A could represent oryktocoenosis of normal marine shelf assemblages.

The important constituents of types B and C, *Ammoastuta* div. sp. and *Miliammina* div. sp., (plates 1 and 2), occur exclusively in associations of category 3. The associations type B and C are usually found in pelitic sediments which contain high amounts of terrestrial plant debris (mainly Gymnosperms). Occasionally they occur in the pelitic parts of fining-upwards sequences of shallowing cut-and-fill channel systems. Sandstones with root relics sometimes were observed in the vicinity of the sediments bearing the low-diversity agglutinated associations. Very rarely calcareous rotaliid foraminifera (*Anomalinoides* sp. only, plate 2), occur in associations of type C. This indicates that a possible decalcification did not drastically change the generic composition of the associations of this type.

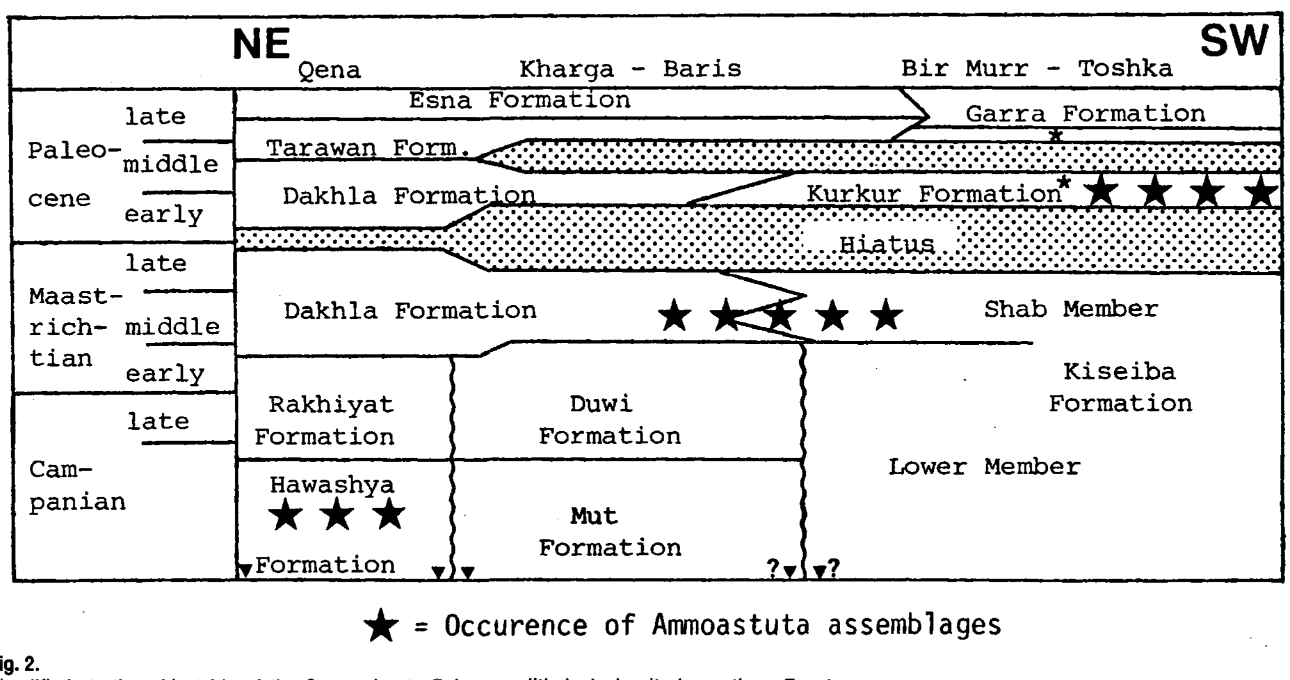

Fig. 2.
Simplified stratigraphic table of the Campanian to Paleocene lithological units in southern Egypt. Not scaled.

In associations of type C, the genus *Ammoastuta* in Egypt is represented by different species. In the Campanian occurs *Ammoastuta* sp., in the Maastrichtian (*Ammoastuta megacribrostomoides* Luger, 1985) and in the Early Paleocene *Ammoastuta aegyptiaca* Luger, 1985:see plate 2). These species differ from each other in the shape of the test and in the form of the secondary cribrate aperture. None of the different species occur together in the few localities where the genus is observed. It is not clear whether this phenomenon is controlled by biostratigraphical or paleocological reasons, for example, possible restriction of species to certain sub-environments controlled by salinity, substrate oxygenation, pH etc.

Palynological investigations carried out by Schrank (*in*: Schrank and Perch-Nielsen 1985) proved the existence of different species of *Spinizonocolpites* in Maastrichtian deposits of several localities in the middle latitudes of Egypt. *Spinizonocolpites* is the pollen of the *Nypa*-palm, a mangrove-like plant, known from the tropical regions of southeast Asia in Recent time. The occurrence of *Spinizonocolpites* in open marine sediments of the Maastrichtian clearly indicates the existence of extended mangrove-type coastal swamps along the southern sea shore during that time. This facies may be represented by some sediments of the Shab Member of the Kiseiba Formation.

COMPARISON WITH RECENT ASSEMBLAGES

Associations very similar to those of types B and C were recorded by Phleger (1954, 1955) from Recent sediments of the Gulf of Mexico and the Mississippi Delta. There, *Ammoastuta, Ammobaculites, Arenoparella, Miliammina, Haplophragmoides, Leptodermella, Proteonina* (=*Reophax*), *Trochammina* and *Urnulina* live in mixohaline marshes and bays. Rare calcareous foraminifera such as *Elphidium, Rotalia* and miliolids also occur. Hiltermann and Tüxen (1978) carried out a statistical analysis based on Phleger's results and named assemblages containing living *Ammoastuta* "*Ammoastutetum ineptae*". They demonstrated the restriction of living *Ammoastuta* to the mixohaline sedimentary environments mentioned above. Dislocated dead specimens of this genus were rarely found in the Mississippi Sound. Recent *Ammoastuta* are known from mixohaline marshes and bays of the Mississippi Delta area and Trinidad as well as from brackish mangrove swamps of Brazil (Hiltermann *et al.* 1981; Brönnimann 1986). Unlike *Miliammina*, the genus does not occur in hypersaline environments. If the genera not known before the Miocene (*Arenoparella, Leptodermella, Urnulina*) and the calcareous forms which might not be preserved in Recent brackish assemblages given by Phleger (1954, 1955) and Hiltermann and Tüxen (1978) are excluded, the remaining generic composition of the Recent *Ammoastuta* assemblages ("*Ammoastutetum ineptae*") appears to be almost identical to the fossil record.

FOSSIL AMMOASTUTA ASSEMBLAGES

Fossil *Ammoastuta* assemblages, consisting of *Ammoastuta, Ammobaculites, Haplophragmoides, Trochammina* and others have been described from the Eocene of Rio Guamal, Columbia (Petters, V. 1954) and the Turonian-Santonian Pindinga Formation in northwestern Nigeria (Petters, S.W. 1979). They were interpreted to be of brackish lagoonal to marsh origin by the authors mentioned above. The Nigerian, Columbian and the Egyptian *Ammoastuta* assemblages are found in the vicinity of the Late Cretaceous to Early Paleocene paleoequator, *i.e.* in areas in which warm climates with high rainfalls and high runoff have to be assumed (figure 3).

Some fossil foraminifera, such as "*Ammoastuta*" *curfsi* Hofker (1966, from marine strata of the Maastrichtian-Danian from Denmark) and "*Ammoastuta*" *sakhalinica* Voloshinova (1961, Miocene) have erroneously been ascribed to the genus *Ammoastuta*. These forms do not fit the generic definition of *Ammoastuta* as they lack the typical secondary aperture (for emended generic definition see: Brönnimann 1986).

CONCLUSIONS

Recent living *Ammoastuta* is known only from brackish littoral environments. The fossil and Recent *Ammoastuta* assemblages and the (paleo-)climatic conditions of the areas they are found in are very similar. This clearly indicates the value of the genus *Ammoastuta* as an ecological index fossil for brackish littoral environments. Therefore, associations consisting mainly or entirely of agglutinated foraminifera (type C of this paper) in which *Ammoastuta* occurs, may be interpreted to be of mangrove-swamp, marsh or lagoonal origin with considerably reduced salinity in warm climates with high runoff. The possibility of dead *Ammoastuta* specimens having been transported into normal marine environments can be disregarded as far as the Egyptian material is concerned. The studied specimens have a very delicate test which would not have withstood long-distance transport. Also, no specimens have been found in associations, which indicate euryhaline conditions during sedimentation.

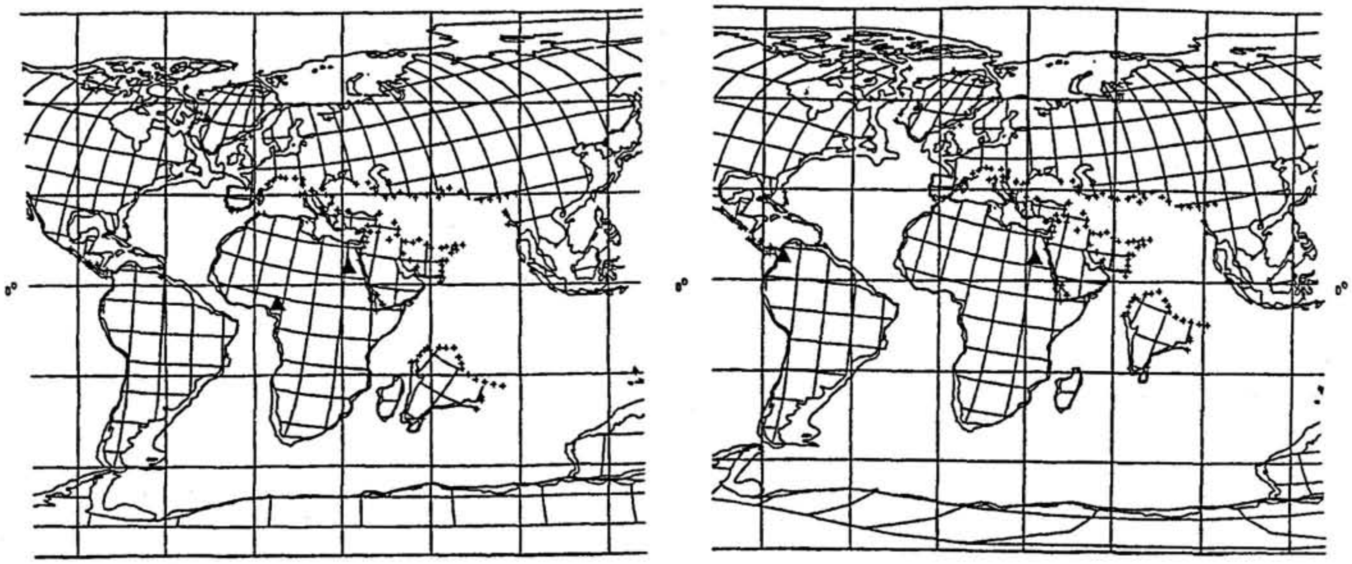

Fig. 3.
Known fossil occurrences of *Ammoastuta* assemblages (▲).
Maps after SMITH et al. (1982). Left = Late Cretaceous; right = Paleogene.

The *Ammoastuta* associations are known from the Late Cretaceous to Recent times. Future investigations may show whether or not the different species of this genus can be used as stratigraphical markers in extreme environments which are usually devoid of any index fossils.

Low-diversity agglutinated foraminiferal associations with *Miliammina* as the main constituent, in which *Ammoastuta* is not present, may be interpreted as being of marsh to lagoonal origin. However, if no further information is available, it cannot be decided whether they were formed under mixohaline or hypersaline conditions (type B). Low-diversity agglutinated associations without any of the two forms mentioned above may indicate extreme environmental conditions during sedimentation, but may just as well represent oryktocoenosis of euryhaline shallow shelf assemblages (type A).

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PLATE 1

Figure 1	*Saccammina* sp., distorted specimen, Maastrichtian, Dakla Formation, about x135.
Figure 2	*Ammodiscus cretaceus* (Reuss), Maastrichtian, Shab Member of Kiseiba Formation, about x135.
Figure 3	*Ammodiscus* sp., Campanian, upper Hawashya Formation, about x340.
Figure 4	*Miliammina telemaquensis* Saunders, Maastrichtian, Shab Member of Kiseiba Formation, about x340.
Figure 5	*Miliammina onyeamensis* Petters, Maastrichtian, Shab Member of Kiseiba Formation, about x340.
Figure 6	*Reophax texanus* Cushman and Waters, Maastrichtian, Shab Member of Kiseiba Formation, about x135.
Figure 7	*Reophax texanus* Cushman and Waters, Maastrichtian, Shab Member of Kiseiba Formation, about x135.
Figure 8	*Haplophragmoides calculus* Cushman and Waters, Maastrichtian Shab Member of Kiseiba Formation, about x135.
Figure 9	*Ammobaculites* sp., Campanian, upper Hawashya Formation, about x135.
Figure 10	*Ammobaculites fragmentarius* Cushman, Shab Member of Kiseiba Formation, about x135.
Figure 11	*Ammobaculites subcretaceus* Cushman and Alexander, Maastrichtian, Shab Member of Kiseiba Formation, about x85.
Figure 12	*Ammobaculites coprolithiformis* (Schwager), Paleocene, Kurkur Formation, about x125.

PLATE 1

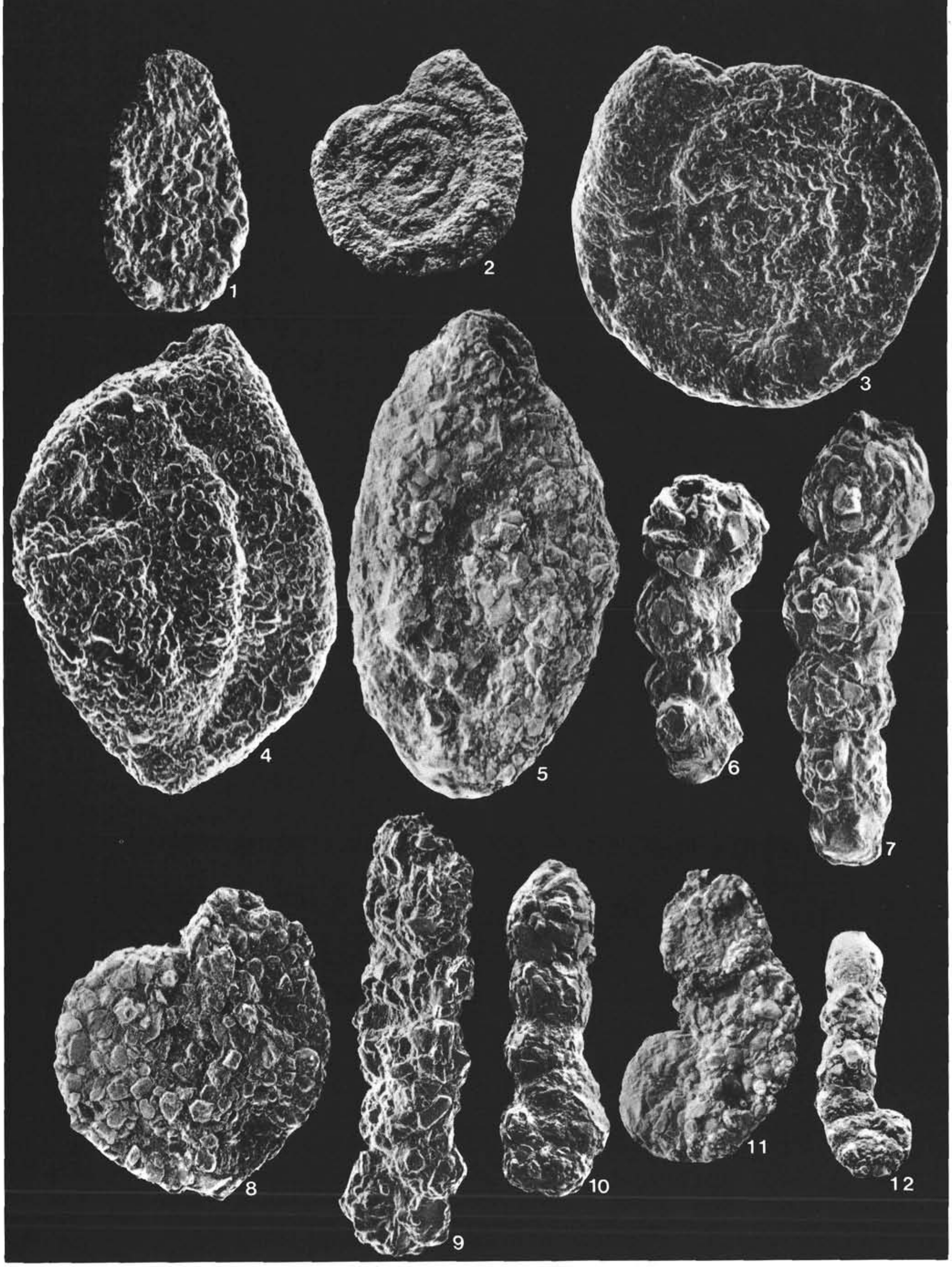

PLATE 2

Figures 1, 2 *Ammobaculites texanus* Cushman, Maastrichtian, Dakhla Formation, about x50.

Figure 3. *Ammoastuta* sp., Campanian, upper Hawashya Formation.
a) lateral view, about x135.
b) same specimen, front view of last chamber, note position of primary oval aperture at about one-third of chamber length from the secondary cribrate aperture, about x145.
c) same specimen, view of secondary cribrate aperture, about x340.

Figures 4,5 *Ammoastuta aegyptiaca* Luger, Paleocene, Kurkur Formation, about x135.
4a) lateral view.
4b) same specimen as 4a, semi-lateral view, note small secondary cribrate aperture restricted to the last chamber.
5) lateral view.

Figures 6,7 *Ammoastuta megacribrostomoides* Luger, Maastrichtian, Shab Member of Kiseiba Formation, about x135.

Figure 8 *Trochammina afikpensis* Petters, umbilical view, Paleocene, Kurkur Formation, about x135.

Figure 9 *Trochammina* sp., Campanian, upper Hawashya Formation, about x135.

Figure 10 *Anomalinoides* sp., Maastrichtian, Dakhla Formation, about x135.

PLATE 2