CALCAREOUS NANNOFOSSIL BIOSTRATIGRAPHY OF THE LATE CRETACEOUS - EARLY TERTIARY OF WADI FEIRAN AND GEBEL QABELIAT, SW SINAI, EGYPT*

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Abstract: A biostratigraphic study of the Upper Cretaceous-Lower Tertiary rocks of Wadi Feiran and Gebel Qabeliat, SW Sinai has allowed the application of several calcareous nannofossil biozones. A Cretaceous/Tertiary nannofloral break is present in the two studied sections and the magnitude of the hiatus is greater to the south, at G. Qabeliat. This boundary occurs somewhere at the top of the Sudr Chalk in the W. Feiran section and in the lowermost part of the Esna Shale in the G. Qabeliat section. No nannofloral break was observed within the Esna Shale at the Paleocene/Eocene boundary in the sections.

Introduction

The stratigraphy of the Late Cretaceous-Early Tertiary rocks in Sinai has attracted the attention of many authors (*e.g.* Nakkady, 1949, 1950; Said & Kenawy, 1956; Ghorab, 1961; Abdel Malik, 1967; Abdel Malik *et al.*, 1978a, b; Masters, 1984; Khalil, 1986; Hewaidy, 1987; Abou-El Enein, 1989; Cherif *et al.*, 1989; El-Dawoody, 1992; Ismail, 1992). The objective of this work was to study the calcareous nannoplankton present in the Wadi Feiran and Gebel Qabeliat sections (Figure 1) and to provide a biozonation of this area.

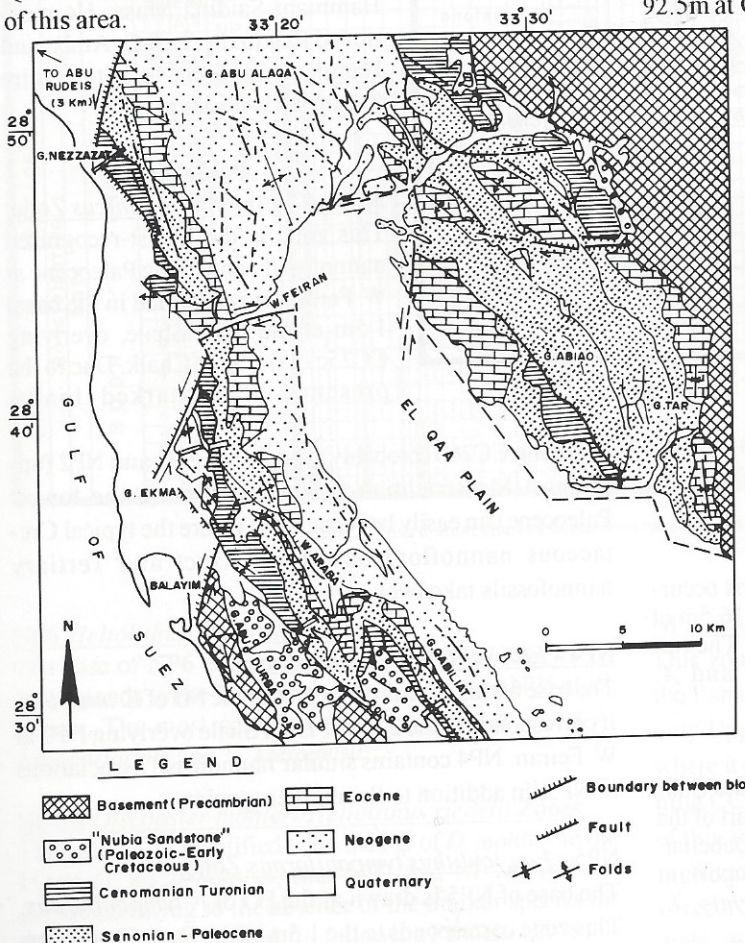

Figure 1: Geological map of the area, showing Wadi Feiran and Gebel Qabeliat, SW Sinai (after Cherif *et al.*, 1989).

Description of the studied sections

The studied succession comprises two lithostratigraphic units, the Sudr Chalk and the Esna Shale (Figure 2). Above the Esna Shale is the Thebes Formation, which was outside the scope of the present study.

Sudr Chalk: generally consists of a sequence of white chalk with marly limestones, or with a limestone sequence intercalated with chert beds. In the study area, the Sudr Chalk varies greatly in thickness from one section to another. At W. Feiran it is 119.5m thick, whereas it measures 92.5m at G. Qabeliat.

Esna Shale: includes all the greenish-grey shale succession with its associated marly limestone. The thickness of this formation varies from 38.5m at W. Feiran to 33.5m at G. Qabeliat.

Biostratigraphic remarks

In most of the studied samples, the nannofossils are abundant to common and their preservation is generally good. The distribution of nannofossils in the sections, their abundances and state of preservation are shown in Figures 3 and 4.

The zonation used in this study, compiled by Sissingh (1977) and Perch-Nielsen (1985), is most applicable for the Upper Cretaceous, and the Martini (1971) biozonation scheme was adopted for the Paleocene and Lower Eocene.

Upper Maastrichtian

CC25a - *Arkhangelskiella cymbiformis* Zone:

This is the oldest zone recognised in the sections and is represented by the lower two-thirds of the Sudr Chalk at both G. Qabeliat and W. Feiran. It varies from 63m to 91m thick in the two sections, respectively. The lower boundary of this zone could not be delineated because of

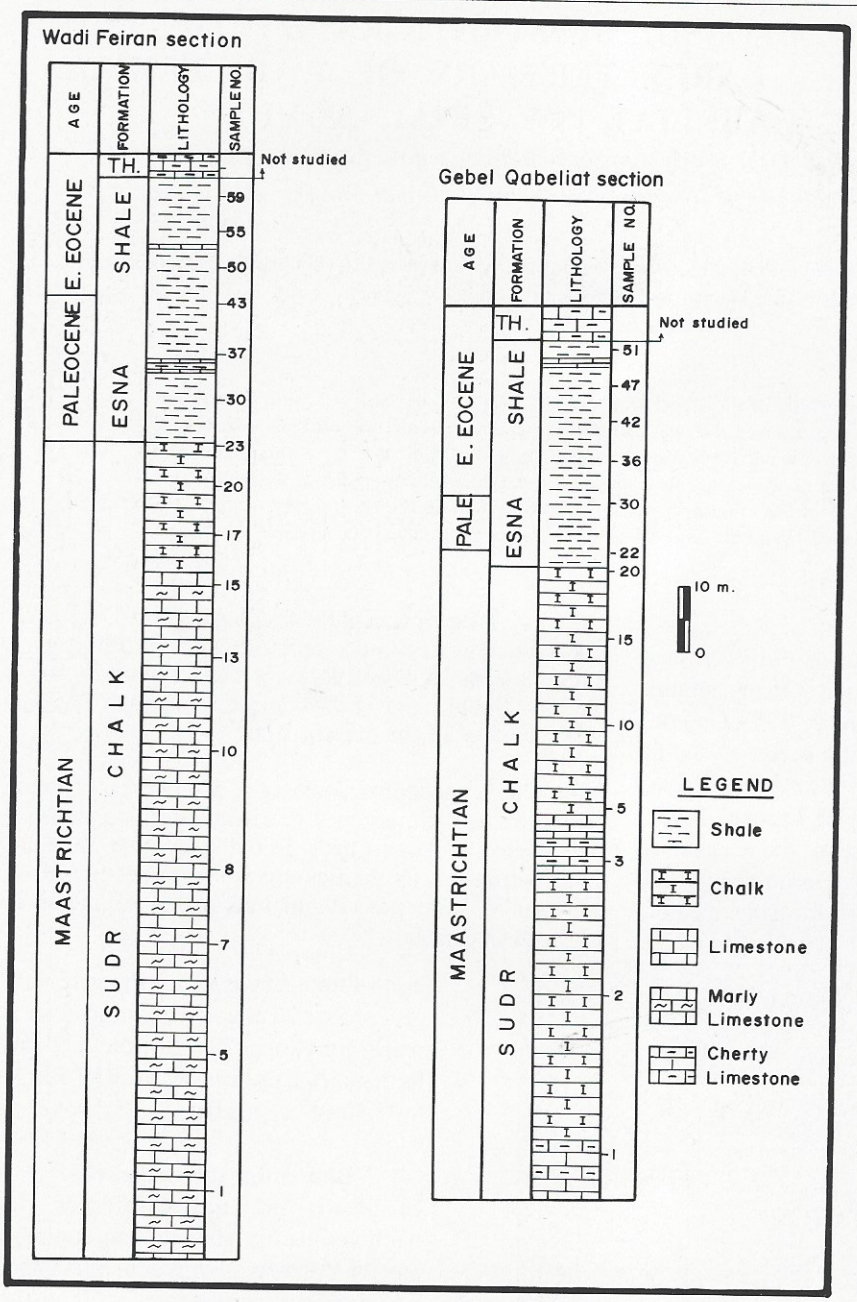

Figure 2: Stratigraphical sections of the study area.

the absence of *Reinhardtites levis*, which marks the base of CC25a by its last occurrence (LO). The most abundant species in the zone is *A. cymbiformis*.

CC25b - '*Lithraphidites quadratus* Subzone':
The base of this subzone is recognised by the first occurrence (FO) of *L. quadratus*. It is recorded in the 16.5m of Sudr Chalk overlying the *A. cymbiformis* Zone. The important common species are *L. quadratus* and *A. cymbiformis*.

CC25c - '*Micula murus* Subzone':
This zone is represented in the upper part of the Sudr Chalk at W. Feiran, whilst it occupies the upper part of the Sudr Chalk and the base of the Esna Shale at G. Qabeliat. The thickness of this zone is upto ~13m. The important common species recognised are *A. cymbiformis*, *L. quadratus* and *M. murus*.

The marker species of the uppermost Maastrichtian nannofossil subzone, *Micula prinsii*, was not observed here, indicating that the top of the Maastrichtian may be missing in the studied sections.

Cretaceous/Tertiary (K/T) boundary

The K/T boundary lies somewhere at the top of the Sudr Chalk at W. Feiran and in the lowermost part of the Esna Shale at G. Qabeliat. In the study area, this boundary can be drawn at the top of CC25c, and is characterised by the extinction of Cretaceous species. A hiatus is present at the boundary in the studied sections and the magnitude of the hiatus is greater to the south at G. Qabeliat (Figure 5).

The top of the Maastrichtian at W. Feiran coincides with the Sudr Chalk/Esna Shale contact. At G. Qabeliat, the top of the Maastrichtian occurs within the lowermost part of the Esna Shale. It is worth mentioning that Masters (1984) recorded the K/T boundary at the top of the Sudr Formation at W. Feiran and within the Esna Shale at Gebel Araba and Hammam Saidina Musa. He mentioned that to the S, at G. Araba and Hammam Saidina Musa, the entire Paleocene is missing.

Paleocene

NP3 - *Chiasmolithus danicus* Zone:
This zone is the oldest-recognised nannofossil zone in the Paleocene at W. Feiran. It is recorded in the basal 1.5m of the Esna Shale, overlying CC25c in the Sudr Chalk. Due to the presence of a marked hiatus spanning CC26b (probably) and Zones NP1 and NP2 (uppermost Maastrichtian-Lower Paleocene), the lowest Paleocene can easily be recognised where the typical Cretaceous nannoflora becomes extinct and Tertiary nannofossils take over.

NP4 - *Ellipsolithus macellus* Zone:
The base of this zone is delineated at the FO of *E. macellus*. It corresponds to the 2.5m of Esna Shale overlying NP3 at W. Feiran. NP4 contains similar nannofossil associations to NP3, in addition to the marker species.

NP5 - *Fasciculithus tympaniformis* Zone:
The base of NP5 is drawn at the FO of *F. tympaniformis*. This zone corresponds to the 1.5m of the Esna Shale overlying NP4 at W. Feiran. It is characterised by the following taxa: *F. tympaniformis*, *F. janii*, *F. billii* and *F. ulii*.

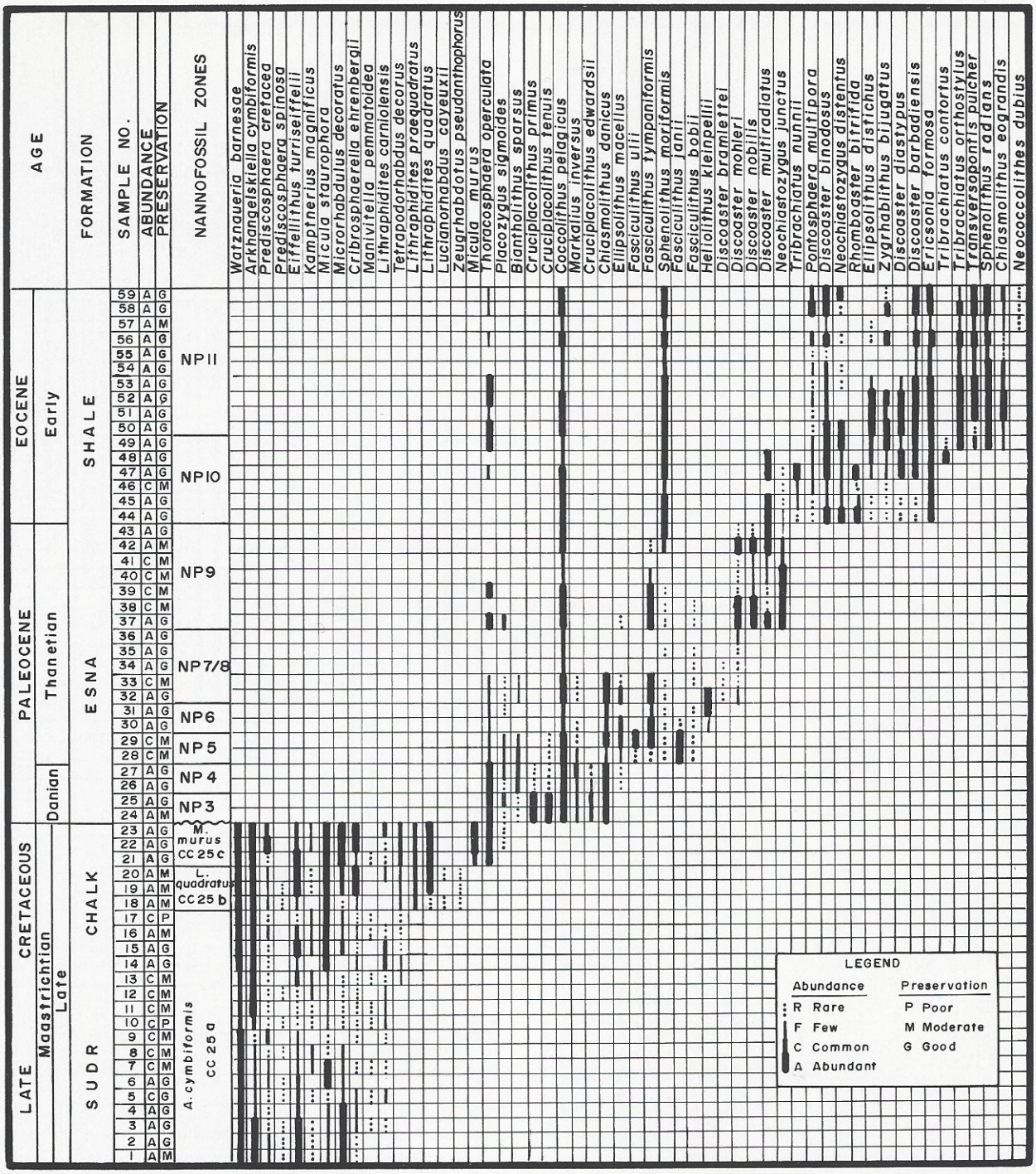

Figure 3: Distribution chart of calcareous nannofossils in the Wadi Feiran section.

NP6 *Heliolithus kleinpellii* Zone:

The base of NP6 is drawn at the FO of *H. kleinpellii*. It corresponds to the 2m of Esna Shale overlying NP5 at W. Feiran. The most common species in this zone are *F. tympaniformis* and *H. kleinpellii*.

NP7/8 *Discoaster mohleri/Heliolithus riedelii* Zones:

This interval is identified from the FO of *D. mohleri* to the FO of *D. multiradiatus*, thus NP7 and NP8 have been combined owing to the absence of the marker species for the base of NP8, *H. riedelii*, following Romein (1979). It corresponds to the 5m of Esna Shale overlying NP6 at W. Feiran.

NP9 *Discoaster multiradiatus* Zone:

This zone is the youngest Palaeocene Zone recorded in the Esna Shale at W. Feiran. At G. Qabeliat, NP9 is the only Upper Paleocene zone recorded in the Esna Shale, where it overlies CC25c, with a considerable hiatus spanning CC26b and NP1 to NP7/8 (Figure 5). The thickness of this zone reaches about 8.5m in the studied sections. It is characterised by a distinct nannofossil assemblage. NP9 is recorded from several localities in Egypt (*e.g.* Sadek, 1971; Perch-Nielsen *et al.*, 1978; El-Dawoody, 1992, 1994; Faris, 1993).

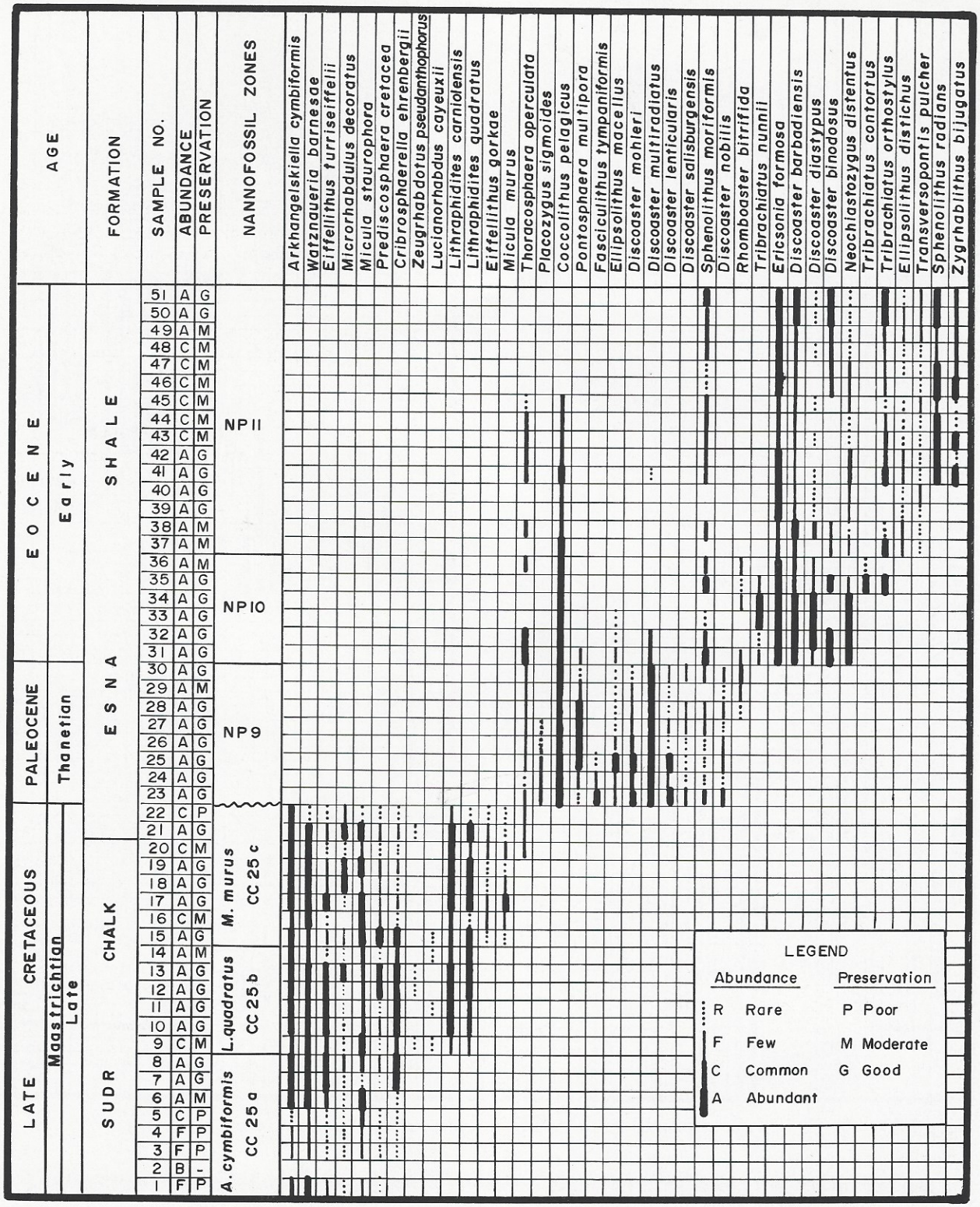

Figure 4: Distribution chart of calcareous nannofossils in the Gebel Qabeliat section.

Paleocene/Eocene (P/E) boundary

This boundary is marked by the FO of *Tribrachiatus nunnii* (= *T. bramlettei*), which also marks the base of NP10. The FO of *Discoaster diastypus* was used by Okada & Bukry (1980) to recognise this boundary. The occurrence of both taxa in these sections is used as a marker in the present study. This boundary occurs within the Esna Shale without any remarkable change in the lithology.

Lower Eocene

NP10 - *Tribrachiatus contortus* Zone:

This zone corresponds to the 3-6m of Esna Shale overlying NP9 at both W. Feiran and G. Qabeliat. The base of the zone is defined by the FO of *T. nunnii*, and is characterised by the following taxa: *Discoaster binodosus*, *D. barbadiensis*, *D. diastypus*, *Ericsonia formosa*, *Sphenolithus moriformis*, *S. radians*, *T. contortus* and *T. orthostylus*.

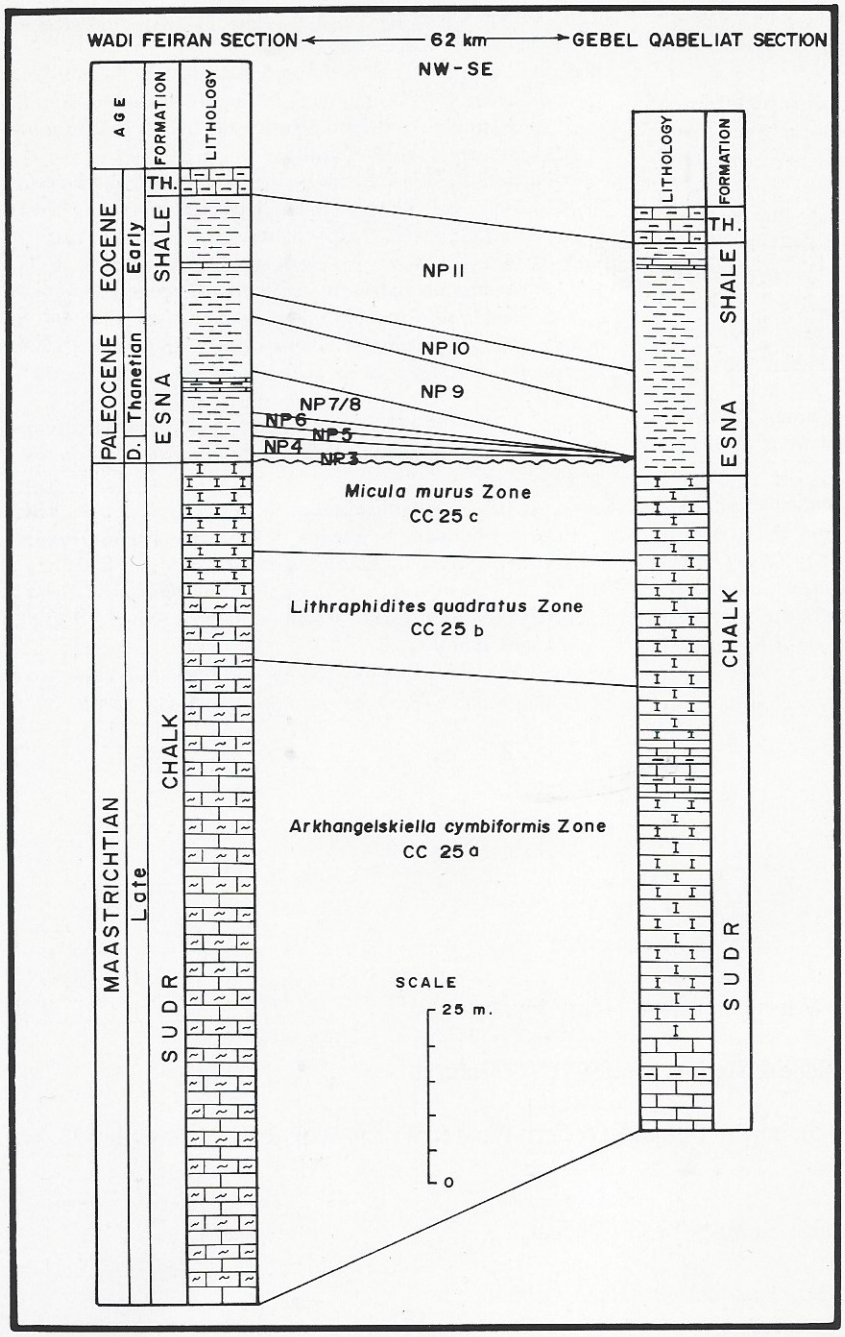

Figure 5: Correlation between the Sinai sections.

NP11 - *Discoaster binodosus* Zone:

The base of NP11 is drawn at the LO of *T. contortus*. NP11 is the youngest zone recognised in the studied sections. It is represented by the upper part of the Esna Shale. It is ~16m thick in both sections. The most characteristic species of NP11 are *D. binodosus*, *D. barbadiensis*, *S. moriformis*, *S. radians*, *Chiasmolithus eograndis*, *Zygrhablithus bijugatus* and *T. orthostylus*.

Summary and conclusions

Investigation of the nannofloras of the Upper Cretaceous-Lower Tertiary succession in W. Feiran and G. Qabeliat, SW Sinai has led to the following conclusions:

1. 11 nannofossil (sub)zones are recognisable at W. Feiran, whilst six are recognised at G. Qabeliat. The zones range in age from Upper Maastrichtian (CC25a) to Lower Eocene (NP11).

2. The K/T boundary occurs at the top of the Sudr Chalk in the W. Feiran section and in the lowermost part of the Esna Shale at G. Qabeliat.

3. A K/T boundary nannofloral break is present in both sections, but the magnitude of the hiatus is greater to the south, at G. Qabeliat.

4. No nannofloral break was observed in the Esna Shale at the P/E boundary.

Acknowledgements

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PLATE 1

All figures x1250

Figs 1-2: ***Arkhangelskiella cymbiformis*** Vekshina. Sample #15, W. Feiran.

Figs 3-4: ***Lithraphidites quadratus*** Bramlette & Martini. Sample #12, G. Qabeliat.

Figs 5-6: ***Tetrapodorhabdus decorus*** (Deflandre *in* Deflandre & Fert) Wind & Wise *in* Wise & Wind. Sample #23, W. Feiran.

Fig.7: ***Microrhabdulus decoratus*** Deflandre. Sample #18, G. Qabeliat.

Figs 8, 21: ***Micula staurophora*** (Gardet) Stradner. Sample #15, G. Qabeliat.

Figs 9-10: ***Cribrosphaerella ehrenbergii*** (Arkhangelsky) Deflandre *in* Piveteau. Sample #23, W. Feiran.

Figs 11-12: ***Manivitella pemmatoidea*** (Deflandre *in* Manivit) Thierstein. Sample #16, W. Feiran.

Figs 13-14: ***Lithraphidites carniolensis*** Deflandre. Sample #12, G. Qabeliat.

Figs 15-16: ***Eiffellithus turriseiffelii*** (Deflandre *in* Deflandre & Fert) Reinhardt. Sample #17, G. Qabeliat.

Figs 17-19: ***Watznaueria barnesae*** (Black *in* Black & Barnes) Perch-Nielsen. Sample #15, W. Feiran.

Fig.20: ***Prediscosphaera cretacea*** (Arkhangelsky) Gartner. Sample #22, G. Qabeliat.

Figs 22-23: ***Placozygus sigmoides*** (Bramlette & Sullivan) Romein. Sample #25, W. Feiran.

Fig. 24: ***Thoracosphaera operculata*** Bramlette & Martini. Sample #26. G. Qabeliat.

PLATE 1

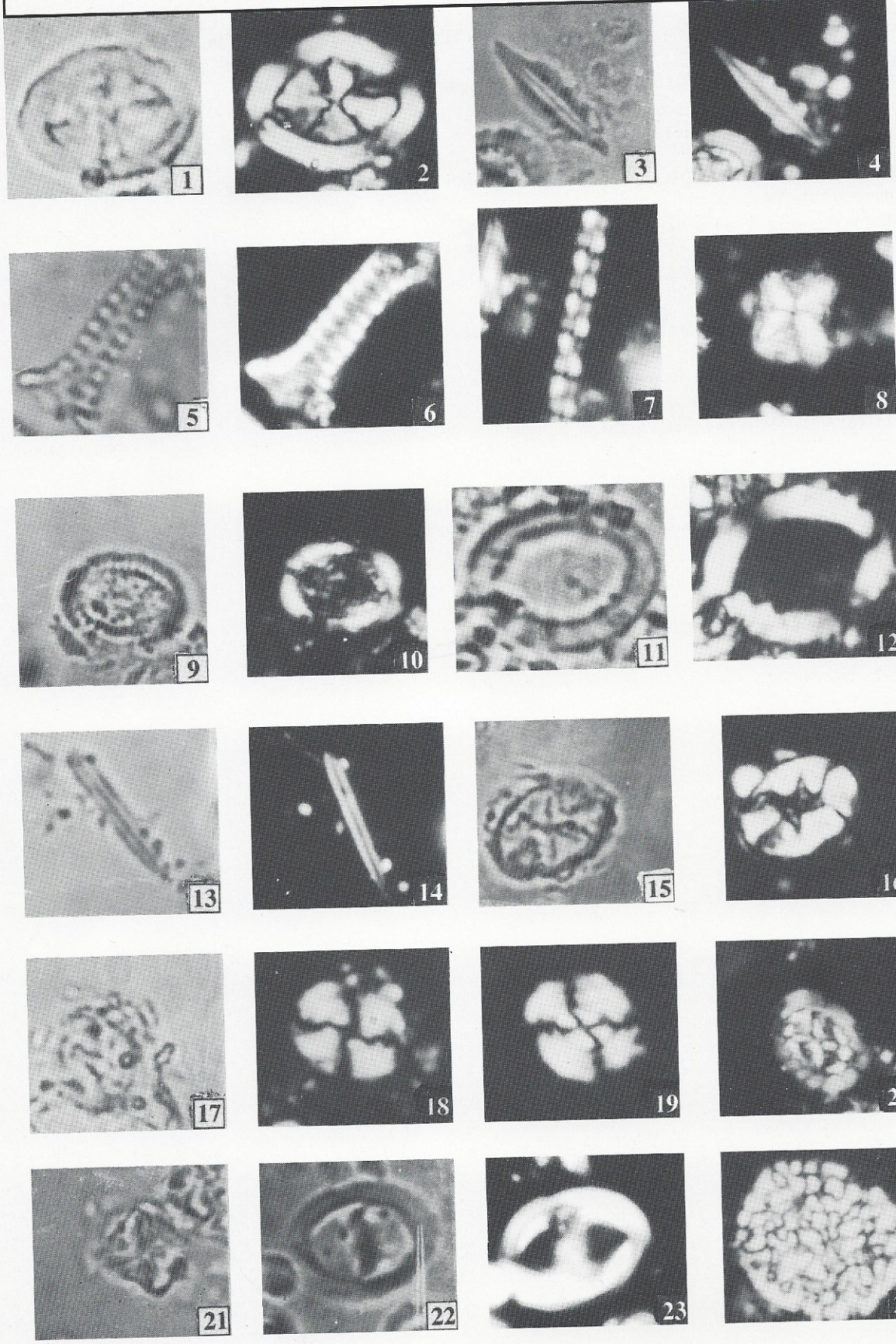

PLATE 2

All figures x1250

Figs 1-2: ***Chiasmolithus danicus*** (Brotzen) Hay & Mohler. Sample #25, W. Feiran.

Figs 3-4: ***Neochiastozygus junctus*** (Bramlette & Sullivan) Perch-Nielsen. Sample #43, W. Feiran.

Fig.5: ***Discoaster multiradiatus*** Bramlette & Riedel. Sample #27, G. Qabeliat.

Figs 6-7: ***Ellipsolithus macellus*** (Bramlette & Sullivan) Sullivan. Sample #27, W. Feiran.

Fig.8: ***Fasciculithus tympaniformis*** Hay & Mohler. Sample #29, W. Feiran.

Figs 9-10: ***Pontosphaera multipora*** (Kamptner) Roth. Sample #27, G. Qabeliat.

Figs 11-12: ***Transversopontis pulcher*** (Deflandre *in* Deflandre & Fert) Perch-Nielsen. Sample #58, W. Feiran.

Fig.13: ***Tribrachiatus contortus*** (Stradner) Bukry. Sample #35, G. Qabeliat.

Fig.14: ***Tribrachiatus nunnii*** (Bronnimann & Stradner) Proto Decima *et al.*. Sample #33, G. Qabeliat.

Figs 15-16: ***Heliolithus kleinpellii*** Sullivan. Sample #31, W. Feiran.

Fig.17: ***Tribrachiatus orthostylus*** Shamrai. Sample #52, W. Feiran.

Figs 18-19: ***Discoaster binodosus*** Martini. Sample #50, G. Qabeliat.
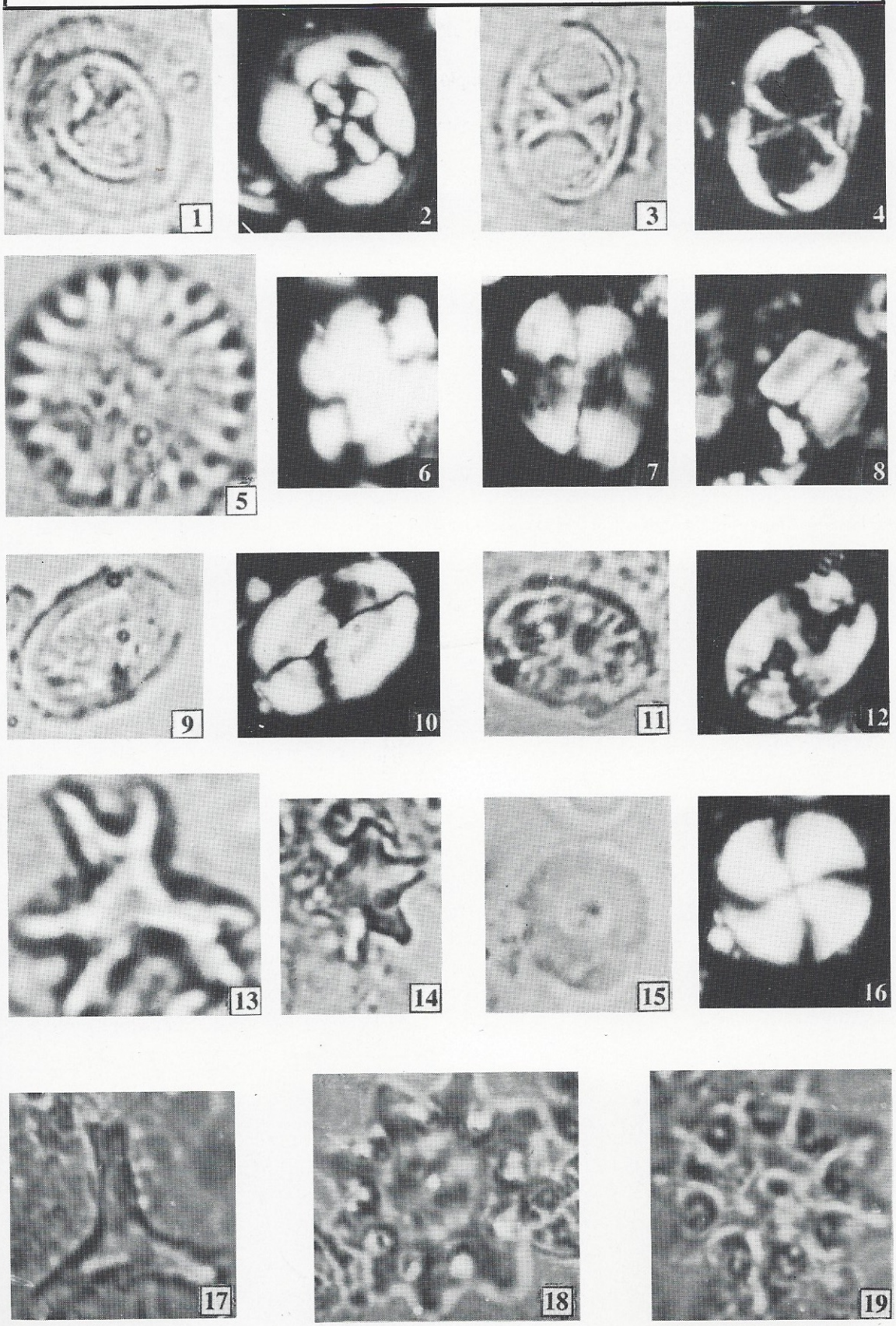
PLATE 2