MEMORIE DI SCIENZE GEOLOGICHE
già *Memorie degli Istituti di Geologia e Mineralogia dell'Università di Padova*

Allegato al Vol. XLIII, pagg. 163-170, 3 figg.
Padova, maggio 1992

TAMAR GAVTADZE *

# PALEOGENE NANNOPLANKTON STRATIGRAPHY OF GEORGIA

## CONTENTS



*Key words: Nannoplankton, biostratigraphy, Paleogene, Paleocene, Eocene, Oligocene, Maastrichtian, Georgia.*

## ABSTRACT

Study of the vertical distribution of calcareous nannoplankton from numerous sections of Paleocene - Eocene deposits and adjacent intervals in Georgia made it possible to distinguish 25 biostratigraphical units (zones and subzones) within the Maastrichtian to Lower Oligocene interval. The characteristic of these units are presented. Correlation of the distinguished zones with the corresponding nannoplankton zones of other regions within and outside the USSR is carried out.

## RIASSUNTO

Lo studio della distribuzione verticale del nannoplancton calcareo di numerose sezioni del Paleocene ed Eocene ed intervalli adiacenti in Georgia ha consentito di distinguere 25 unità biostratigrafiche (zone e sottozone) dal Maastrichtiano all'Oligocene inferiore. Vengono esposte le caratteristiche di queste unità e la loro correlazione con le zone corrispondenti di altre regioni, sia interne che esterne all'URSS.

## INTRODUCTION

Paleogene deposits occupy a considerable area in Georgia (Fig. 1). They are represented by rather diverse facies: terrigene, carbonate, volcaniclastic - fhyshoid and others. At present, nannoplankton has been studied only from the deposits in the northern part of Georgia, near the contact line of two geotectonic units: the folded system of the Greater Caucasus and the Transcaucasian Block (Fig. 1).

Studies of rock samples from numerous sections of the calcareous Paleogene reveal a rich and diverse nannofossil assemblage in all the sections. Nannofossils occur throughout the Paleogene from the lowermost Danian up to and including the Oligocene. Based on regular temporal changes of the nannoplankton assemblages, 25 biostratigraphical units have been established. The proposed subdivision is a combination of the schemes by MARTINI (1971) and OKADA and BUKRY (1980) with some alterations. In our opinion, the presented subdivision reflects changes of environment, and in particular temperature, during the Paleogene. The analysis of the nannoplankton assemblages suggests that during the Paleogene the accumulation area of the carbonate facies was situated on the boundary of warm and moderately cold climatic belts; this boundary was not stable.

* Geological Institute, Z. Rukhadze St. 1/9, 380093 TIBLISI, Georgia.

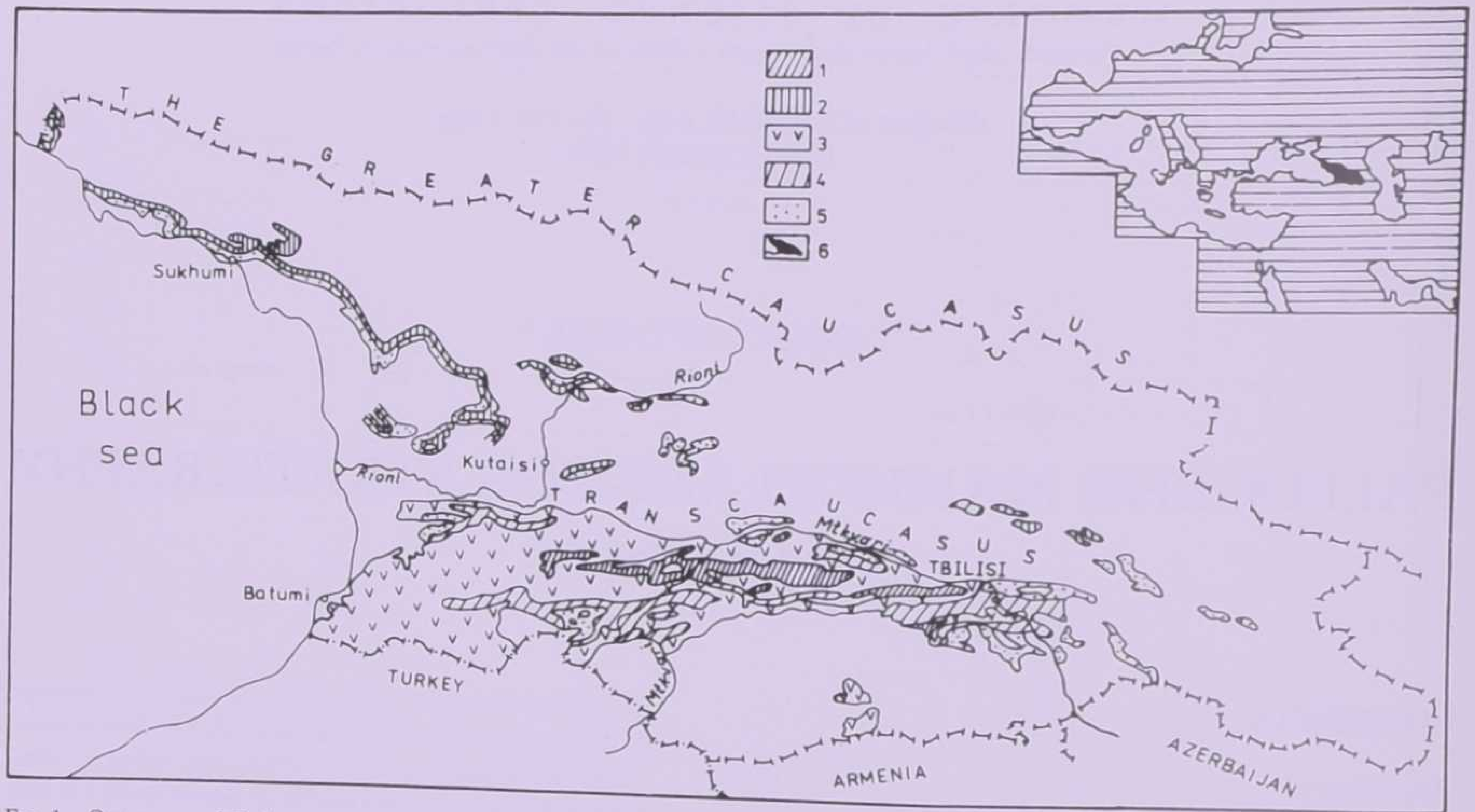


FIG. 1 - Outcrops of Paleogene deposits of Georgia. 1, Paleocene - Lower Eocene, clays, marls, sandstones (flysch); 2, Paleocene-Eocene, limestones, marls; 3, Middle Eocene, andesite covers and their volcanic tuffs; 4, Upper Eocene, clays, marls, sandstones, rarely volcanogenic formations; 5, Oligocene - Lower Miocene, clays, sandstones (Maikopian suite).

During almost the entire Paleocene the nannoplankton assemblages from the Georgian territory had a moderately cold water habitat. In this part of the Paleogene our scheme coincides with the scheme by MARTINI (1971), based mainly on material of moderate latitudes of Europe. But already in the terminal Paleocene the boundary of the moderately cold belt shifts to the north. Discoasters, sphenoliths and thoracosphaeres start flourishing within the *Discoaster multiradiatus* Zone, which continues up to the end of the Middle Eocene. But along with them occur forms characteristic of moderate latitudes. The mixed character of the Eocene nannoflora in this area indicates that during the Eocene the boundary between the warm and moderately cold water nannoplankton assemblages was situated approximately in this area of Georgia. Accordingly, the Eocene part of our scheme is comparable to the OKADA and BUKRY (1980) scheme, which was worked out for the low latitudes. However, we can't speak of a complete conformity of our scheme with those of MARTINI (1971) and OKADA and BUKRY (1980), as there are some distinctions caused by the paleoclimatic fluctuations discussed above (Fig. 2).

## BIOSTRATIGRAPHIC ZONATION

### EARLY PALEOCENE

An abrupt change takes place in the nannoplankton taxa at the Cretaceous - Paleocene boundary, as almost all the species of the rather diverse association of the *Micula mura* Zone disappear. In the lowermost part of the *Biantholithus sparsus* Zone, in samples very poor in nannoplankton, only rare *Watznaueria barnesae* pass from the Cretaceous, along with *Thoracosphaera* and *Braarudosphaera*.

#### *Biantholithus sparsus* Zone

Definition: LO of abundant Cretaceous forms to FO of *Cruciplacolithus tenuis*.
Author: PERCH-NIELSEN 1971.
Common species: *Thoracosphaera operculata, Braarudosphaera bigelowii, B. turbinea, B. discula, Markalius inversus, Biantholithus sparsus, Zygodiscus sigmoides.*

#### *Cruciplacolithus tenuis* Zone

Definition: FO of *Cruciplacolithus tenuis* to FO of *Chiasmolithus danicus*.

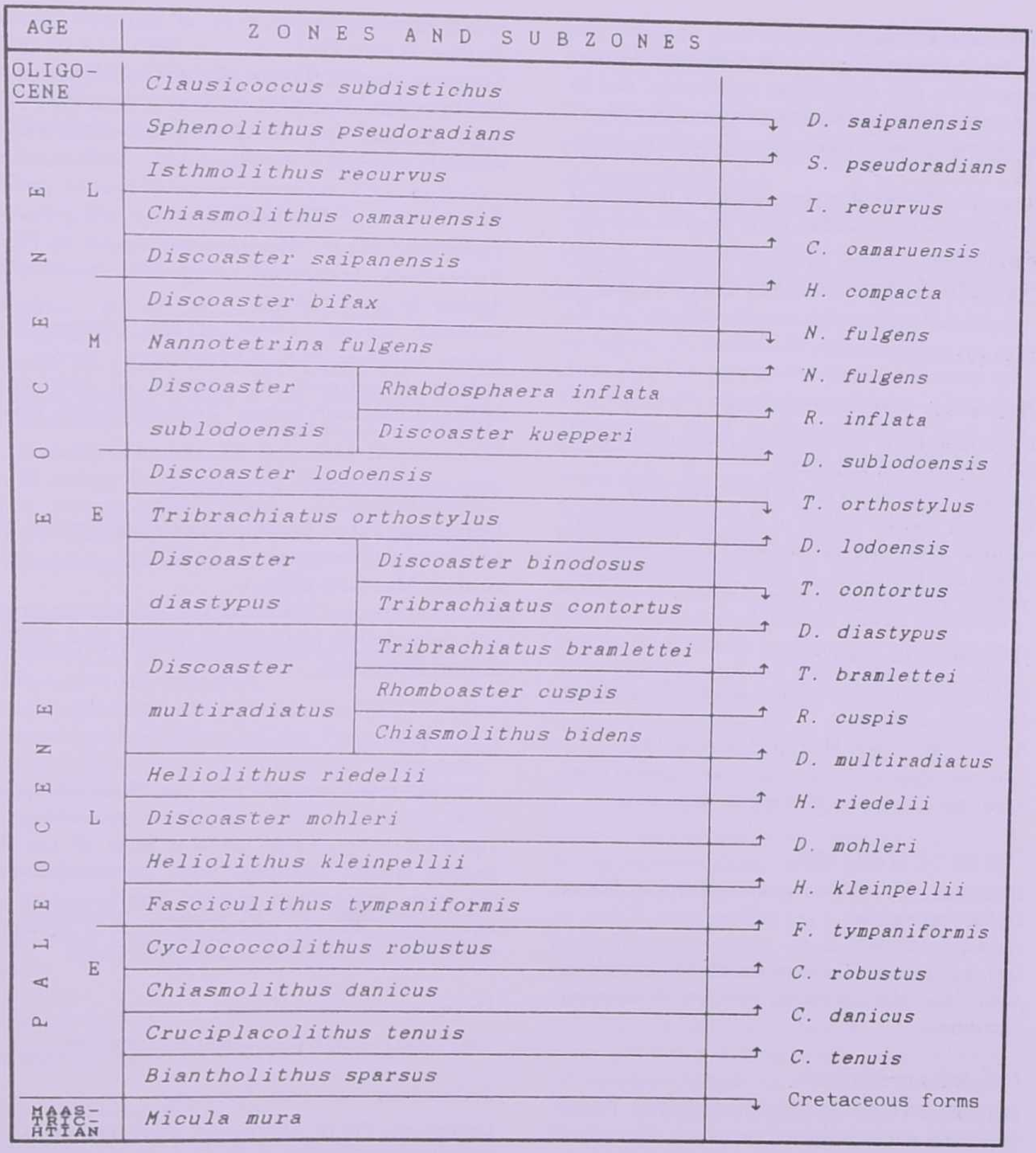


Fig. 2 - Nannoplankton zonation of the Paleocene - Eocene of Georgia.

Authors: Mohler & Hay in Hay *et al.* 1967, emend. Martini 1970.
Common species: Those of the *Biantholithus sparsus* Zone plus *Cruciplacolithus tenuis*, *Coccolithus cavus*, *C. subpertusus*, *Prinsius dimorphosus*.

*Chiasmolithus danicus* Zone

Definition: FO of *Chiasmolithus danicus* to FO of *Cyclococcolithus robustus*.
Author: Martini 1971.
Common species: Those of the *Cruciplacolithus tenuis* Zone, plus *Chiasmolithus danicus*, *Neochiastozygus concinnus*, *Prinsius martinii*.

*Cyclococcolithus robustus* Zone

Definition: FO of *Cyclococcolithus robustus* to FO of *Fasciculithus tympaniformis*.

Authors: GARTNER 1971.
Common species: Those of the *Chiasmolithus danicus* Zone, plus *Coccolithus eopelagicus*, and in the upper part *Chiasmolithus bidens, Cruciplacolithus cruciformis, Toweius* sp., *Zygodiscus herlynii.*
Remarks: The FO of maker species of the base of the *Ellipsolithus macellus* Zone suggests that the *Ellipsolithus macellus* Zone corresponds to the upper part of the *Cyclococcolithus robustus* Zone.

### LATE PALEOCENE

#### *Fasciculithus tympaniformis* Zone

Definition: FO of *Fasciculithus tympaniformis* to FO of *Heliolithus kleinpellii.*
Authors: MOHLER & HAY in HAY *et al.* 1967.
Common species: Those of the *Cyclococcolithus robustus* Zone plus *Fasciculithus tympaniformis, F. magnus, F. pileatus, F. janii, Toweius eminens, T. tovae, Chiasmolithus solitus.*

#### *Heliolithus kleinpellii* Zone

Definition: FO of *Heliolithus kleinpellii* to FO of *Discoaster mohleri.*
Authors: MOHLER & HAY in HAY *et al.* 1967.
Common species: Those of the *Fasciculithus tympaniformis* Zone plus *Heliolithus kleinpellii.*

#### *Discoaster mohleri* Zone

Definition: FO of *Discoaster mohleri* to FO of *Heliolithus riedelii.*
Author: HAY 1964.
Common species: Those of the *Heliolithus kleinpellii* Zone plus *Discoaster mohleri, Heliolithus cantabriae.*

#### *Heliolithus riedelii* Zone

Definition: FO of *Heliolithus riedelii* to FO of *Discoaster multiradiatus.*
Authors: BRAMLETTE & SULLIVAN 1961.
Common species: Those of the *Discoaster mohleri* Zone, less *Heliolithus kleinpellii*, plus *Heliolithus riedelii, Coccolithus pertusus.*

#### *Discoaster multiradiatus* Zone

In Georgia, as well as Transcaucasia and Crimea, it is possible to subdive this zone into three subzones. Such subdivision of the *Discoaster multiradiatus* zone was first suggested by MUZYLOW (1980) for the North Caucasus and Crimea.

#### *Chiasmolithus bidens* Subzone

Definition: FO of *Discoaster multiradiatus* to FO of *Rhomboaster cuspis.*
Author: BUKRY 1973.
Common species: Those of the *Heliolithus riedelii* Zone plus *Discoaster multiradiatus, D. lenticularis, D. delicatus, D. perpolitus, Fasciculithus alanii, F. schaubii, F. tonii.*

#### *Rhomboaster cuspis* Subzone

Definition: FO of *Rhomboaster cuspis* to FO of *Tribrachiatus bramlettei.*
Author: MUZYLOV 1980.
Common species: Those of the *Chiasmolithus bidens* Subzone plus *Rhomboaster cuspis, Discoaster megastypus, D. araneus, D. helianthus, Sphenolithus anarrhopus, Rhabdosphaera herculae.*

#### *Tribrachiatus bramlettei* Subzone

Definition: FO of *Tribrachiatus bramlettei* to FO of *Discoaster diastypus.*
Author: MUZYLOV 1980.
Common species: Those of the *Rhomboaster cuspis* Subzone less *Heliolithus riedelii,* plus *Tribrachiatus bramlettei.*

### EARLY EOCENE

At the lower boundary of the *Discoaster diastypus* Zone, the nannoplankton assemblage is significantly renovated. At this level all the Paleocene species disappear with the exception of the more cosmpolitan species. The boundary between the Paleocene and the Eocene is drawn at the base of the *Discoaster diastypus* Zone.

#### *Discoaster diastypus* Zone

This zone is subdivided into two subzones.

#### *Tribrachiatus contortus* Subzone

Definition: FO of *Discoaster diastypus* to LO of *Tribrachiatus contortus.*
Authors: HAY 1964, emend. BUKRY 1971.
Common species: *Coccolithus eopelagicus, C. formosus, Tribrachiatus orthostylus, T. contortus, Zygrhablithus bijugatus, Sphenolithus anarrhopus, S. radians, Discoaster diastypus, D. salisburgensis, D. falcatus, D. binodosus, D. boulangeri, Thoracosphaera operculata, T. deflandrei, Cruciplacolithus delus.*

#### *Discoaster binodosus* Subzone

Definition: LO of *Tribrachiatus contortus* to FO of *Discoaster lodoensis.*

Authors: MOHLER & HAY in HAY *et al.* 1967, emend. BUKRY 1971.
Common species: Those of the *Tribrachiatus contortus* Subzone, less *Tribrachiatus contortus, Discoaster heliantus*, plus *Discoaster kuepperi, Cyclococcolithus gammation, Transversopontis pulcher, Sphenolithus moriformis, Chiasmolithus consuetus, Discoaster deflandrei.*

*Tribrachiatus orthostylus* Zone

Definition: FO of *Discoaster lodoensis* to LO of *Tribrachiatus orthostylus.*
Authors: BRONNIMANN & STRADNER 1960.
Common species: Those of the *Discoaster diastypus* Zone less *Discoaster diastypus, D. boulangeri, D. salisburgensis*, plus *D. lodoensis, D. geometricus, D. mirus, D. woodringii, Micrantholithus mirabilis, Neococcolithes dubius, Chiphragmalithus calatus, Chiasmolithus grandis, C. californicus, Helicosphaera seminulum.*

*Discoaster lodoensis* Zone

Definition: LO of *Tribrachiatus orthostylus* to FO of *Discoaster sublodoensis.*
Authors: BRONNIMANN & STRADNER 1960.
Common species: Those of the *Tribrachiatus orthostylus* Zone less *Tribrachiatus orthostylus, Coccolithus pertusus*, plus *Helicosphaera lophota.*

## MIDDLE EOCENE

Considerable changes in the nannoflora take place at the base of the *Discoaster sublodoensis* Zone.

*Discoaster sublodoensis* Zone

The zone is subdivided into two subzones.

*Discoaster kuepperi* Subzone

Definition: FO of *Discoaster sublodoensis* to FO of *Rhabdospaera inflata.*
Author: BUKRY 1971.
Common species: Those of the *Discoaster lodoensis* Zone less *Discoaster woodringii, D. mirus*, plus *Discoaster sublodoensis, D. floreus, D. colletii, D. trinus, D. molengraafii, Triquetrorhabdulus inversus, Cyclicargolithus floridanus, Reticulofenestra coenura, Chiasmolithus gigas.*

*Rhabdosphaera inflata* Subzone

Definition: FO of *Rhabdosphaera inflata* to FO of *Nannotetrina fulgens.*
Author: BUKRY 1971.
Common species: Those of the *Discoaster kuepperi* Subzone plus *Rhabdosphaera inflata, Discoaster wemmelensis.*

*Nannotetrina fulgens* Zone

Definition: FO of *Nannotetrina fulgens* to LO of *Nannotetrina fulgens.*
Authors: HAY in HAY *et al.* 1967 emend. BUKRY 1971.
Common species: Those of the *Discoaster sublodoensis* Zone, less *Discoaster lodoensis, D. sublodoensis, Rhabdosphaera inflata*, plus *Nannotetrina fulgens, N. cristata, N. mexicana.*
Remarks: The vertical distribution of several species within the *Nannotetrina fulgens - Discoaster saipanensis* Zone in Georgia differs from that known either in the warm water or in the cold water belts. For example *Rhabdosphaera gladius* becomes extinct at the boundary between NP15 and NP16 of moderate latitudes, while in Georgia this species only occurs in the *Discoaster saipanensis* Zone (NP17). This same zone is characterized by *Discoaster distinctus* and *D. germanicus*, species occurring up to the top of the *Discoaster bifax* Subzone and the *Discoaster tanii nodifer* Zone (NP16) of moderate as well as low latitudes. The appearance of *Chiasmolithus gigas, Discoaster deflandrei* and *Cyclicargolithus floridanus* in low and median latitudes takes place in the middle part of the Middle Eocene, while in Georgia they appear in the lowermost part of the *D. sublodoensis* Zone (lower part of the Middle Eocene). *Reticulofenestra umbilicus, D. saipanensis* and *D. tanii nodifer* are found at much lower levels in other regions, whereas in Georgia they occur from the *Discoaster saipanensis* Zone. To all appearance, in Georgia the development of the nannoflora within the *N. fulgens - D. saipanensis* zonal interval was considerable influenced by local ecological factors. As a result, *R. umbilicus, R. gladius* and *D. tanii nodifer* can't be used as markers for the upper boundary of the *Nannotetrina fulgens* Zone.

*Discoaster bifax* Zone

Definition: LO of *Nannotetrina fulgens* to FO of *Helicosphaera compacta.*
Author: BUKRY 1973.
Common species: Those of the *Nannotetrina fulgens* Zone less *N. fulgens, N. cristata,* plus *Discoaster bifax.*

## LATE EOCENE

The age of the *Discoaster saipanensis* Zone must be discussed in detail. Almost all researchers date it as Middle Eocene, but material at our disposal convincingly points to a Late Eocene age:

1. The abrupt change in the nannoplankton association which takes place near the lower boundary of the *D. saipanensis* Zone clearly indicated this. Although at this level the presence of some forms - as we have already mentioned - is conditioned by ecological factors, on the whole such considerable renovation of the flora is evolutionary - as for example the extinction of *Chiasmolithus solitus*, *Cyclococcolithus gammation*, and of typically Middle Eocene species such as *Nannotetrina mexicana*, *Helicosphaera lophota*, *Birkelundia staurion*, *Triquetrorhabdulus inversus*, *Discoaster wemmelensis* and *D. bifax*, and the appearance near this boundary of *Reticulofenestra bisecta*, *R. reticulata*, *Helicosphaera salebrosa*, *H. compacta*, *H. reticulata*, *Rhabdosphaera tenuis* and *R. crebra*, which are all characteristic of the Upper Eocene. The first occurrence of the genera *Clathrolithus*, *Orthozygus*, *Corannulus* and *Guttilithion* that are widespread in the Upper Eocene takes place in the *D. saipanensis* Zone. On the other hand, the only changes that took place at the lower boundary of the *Chiasmolithus oamaruensis* Zone are the appearance of *Chiasmolithus oamaruensis* and the disappearance of *Chiasmolithus grandis*. Obviously, it is more natural to draw the boundary between Middle and Upper Eocene at the base of the *D. saipanensis* Zone than at its top. For this reason the *D. bifax* and *D. saipanensis* subzones of BUKRY (1973) are here distinguished as separate zones.

2. In Georgia, and not only there, larger foraminifera present in sediments of the *D. saipanensis* Zone or in the time equivalent *Globigerina turkmenica* Zone date these deposits as Late Eocene. In the sections of Georgia, Azerbaidjan, Armenia and on the southern slope of the Greater Caucasus, many authors at different times noted nummilitic species typical of the Upper Eocene within the *G. turkmenica* Zone. These are *Nummilites fabianii*, *N. budensis*, *N. chavanensis* (SALUKVADZE 1985). It must be noted that in Syria KRASHENINNIKOV and NEMKOV (1975) have observed *N. fabianii*, *N. chavanensis* and others in deposits corresponding to the *G. turkmenica* Zone, and their Late Eocene age is not doubted by nummulite specialists. From these observations we can conclude that *G. turkmenica* and *D. saipanensis* Zone deposits are of Late Eocene age.

*Discoaster saipanensis* Zone

Definition: FO of *Helicosphaera compacta* to FO of *Chiasmolithus oamaruensis*.
Author: MARTINI 1971.
Common species: Those of the *Discoaster bifax* Zone less *Nannotetrina mexicana*, *Helicosphaera lophota*, *Transversopontis inversus*, *Discoaster wemmelensis*, *D. bifax*, *Chiasmolithus solitus*, plus *Reticulofenestra umbilicus*, *R. bisecta*, *R. reticulata*, *R. oamaruensis*, *Corannulus germanicus*, *Guttilithion cassum*, *Discoaster saipanensis*, *D. distinctus*, *D. tanii nodifer*, *Lanternithus minutus*, *Pontosphaera multipora*, *Orthozygus aureus*, *Pemma angulatum*, *Rhabdosphaera tenuis*, *Helicosphaera reticulata*, *H. compacta*, *H. salebrosa*, *Clathrolithus spinosus*.

*Chiasmolithus oamaruensis* Zone

Definition: FO of *Chiasmolithus oamaruensis* to FO of *Isthmolithus recurvus*.
Author: MARTINI 1971.
Common species: Those of the *Discoaster saipanensis* Zone less *Discoaster germanicus*, *D. distinctus*, plus *Chiasmolithus oamaruensis*.

*Isthmolithus recurvus* Zone

Definition: FO of *Isthmolithus recurvus* to FO of *Sphenolithus pseudoradians*.
Authors: HAY, MOHLER & WADE 1966, emend. MARTINI 1971.
Common species: Those of the *Chiasmolithus oamaruensis* Zone plus *Isthmolithus recurvus*.

*Sphenolithus pseudoradians* Zone

Definition: FO of *Sphenolithus pseudoradians* to LO of *Discoaster saipanensis*.
Author: MARTINI 1971.
Common species: Those of the *Isthmolithus recurvus* Zone plus *Clausicoccus subdistichus*, *Reticulofenestra callida*, *Discoaster tanii ornatus*.

## EARLY OLIGOCENE

In the Lower Oligocene beds of Georgia *Sphenolithus*, *Helicosphaera*, and *Isthmolithus recurvus* show a strong decrease, and *Reticulofenestra* becomes prevalent. We observe a gradual increase in the amount of *Orthozygus aureus*, *Clathrolithus spinosus* and *Corannulus germanicus*. This suggests that by the end of the Eocene a gradual sallowing takes place, and temperature falls.

*Clausicoccus subdistichus* Zone

Definition: LO of *Discoaster saipanensis* to LO of *Coccolithus formosus*.
Authors: ROTH & HAY in HAY *et al.* 1967.
Common species: Those of the *Sphenolithus*

*pseudoradians* Zone less *Discoaster saipanensis* and *D. barbadiensis.*

*Helicosphaera reticulata* Zone

Definition: LO of *Coccolithus formosus* to LO of *Reticulofenestra umbilicus.*

Authors: Bramlette & Wilcoxon 1967, emend. Martini 1971.

Common species: Those of the *Clausicoccus subdistichus* Zone, less *Coccolithus formosus, Di-*

| AGE | | HAY et al. 1967 | MARTINI 1971 | GARTNER 1971 (Joides Blake Plateau) | PERCH-NIELSEN 1972 | ROMEIN 1979 (North Spain) | OKADA & BUKRY, 1980 (low latitudes) | | MUZILOV 1977 (Southern USSR) | | GAVTADZE 1985 (Georgia) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OLIGOCENE | | E. subdistichus | E. subdisticha | H. reticulata | E. obruta | | H. reticulata | C. subdisthicus | H. reticulata | C. subdisthicus | | C. subdistichus |
| EOCENE | L | I. recurvus | S. pseudoradians | S. predistentus | I. recurvus | | D. barbadiensis | I. recurvus | D. barbadiensis | layer with S. pseudoradians | | S. pseudoradians |
| | | | | D. barbadiensis | | | | | | | | |
| | | | I. recurvus | I. recurvus | | | | | | I. recurvus | | I. recurvus |
| | M | D. tani nodifer | C. oamaruensis | H. situliformis | R. umbilica | | | C. oamaruensis | | C. oamaruensis | | C. oamaruensis |
| | | | D. saipanensis | H. compacta C. grandis | / | | R. umbilica | D. saipanensis | R. umbilica | D. saipanensis | | D. saipanensis |
| | | | D. tani nodifer | B. serraculoides | | | | D. bifax | | D. bifax | | D. bifax |
| | | | | P. papillatum | | | N. fulgens | C. staurion | | N. fulgens | | N. fulgens |
| | | | | R. umbilica/ S. furcatolithoides | D. tani nodifer s.l. | | | | | | | |
| | | | C. alatus | D. tani / S. radians | | N. fulgens | | C. gigas | | | | |
| | | C. quadratus | | C. quadratus | N. fulgens | | | D. strictus | | | | |
| | | D. sublodoensis | D. sublodoensis | D. sublodoensis | D. sublodoensis | D. sublodoensis | D. sublodoensis | R. inflata | D. sublodoensis | R. inflata | D. sublodoensis | R. inflata |
| | | | | | | | | D. kuepperi | | D. kuepperi | | D. kuepperi |
| | E | D. lodoensis | D. lodoensis | D. lodoensis | D. lodoensis | D. lodoensis | D. lodoensis | | D. lodoensis | | D. lodoensis | |
| | | M. tribrachiatus | M. tribrachiatus | M. tribrachiatus | T. orthostylus | T. orthostylus | T. orthostylus | | M. tribrachiatus | | T. orthostylus | |
| | | D. binodosus | D. binodosus | D. binodosus | D. binodosus | D. binodosus | D. diastypus | D. binodosus | D. diastypus | D. binodosus | D. diastypus | D. binodosus |
| | | M. contortus | M. contortus | M. contortus | T. contortus | T. contortus | | T. contortus | | T. contortus | | T. contortus |
| PALEOCENE | L | | | | | | D. multiradiatus | C. eodela | D. multiradiatus | M. bramlettei | D. multiradiatus | M. bramlettei |
| | | D. multiradiatus | D. multiradiatus | D. multiradiatus | D. multiradiatus | D. multiradiatus | | | | R. cuspis | | R. cuspis |
| | | | | | | | | C. bidens | | C. bidens | | C. bidens |
| | | H. riedelii | H. riedelii | H. riedelii | D. nobilis | D. mohleri | D. nobilis | | H. riedelii | | H. riedelii | |
| | | D. gemmeus | D. gemmeus | D. gemmeus | D. gemmeus | | D. mohleri | | D. mohleri | | D. mohleri | |
| | | H. kleinpellii | H. kleinpellii | H. kleinpellii | H. kleinpellii | H. kleinpellii | H. kleinpellii | | H. kleinpellii | | H. kleinpellii | |
| | E | F. tympaniformis | F. tympaniformis | F. tympaniformis | F. tympaniformis | F. tympaniformis | F. tympaniformis | | F. tympaniformis | | F. tympaniformis | |
| | | C. tenuis | E. macellus | E. robusta | E. macellus | E. macellus | E. macellus | | C. tenuis s.l. | C. robusta | | C. robustus |
| | | | C. danicus | C. tenuis | C. danicus | C. tenuis | C. danicus | | | C. danicus | | C. danicus |
| | | | C. tenuis | | C. tenuis | | Z. sigmoides | C. tenuis | | C. tenuis s.str. | | C. tenuis |
| | | M. inversus | M. inversus | M. astrophorus | B. sparsus | C. dimorphosus | | C. primus | | | | B. sparsus |
| | | | | | | C. primus | | | | | | |
| | | | | | | B. sparsus | | | | | | |

Fig. 3 - Correlation of the nannoplankton zonation of Georgia with the zonations of other regions.

*scoaster tanii, D. tanii nodifer,* plus *Reticulofenestra hillae, R. minuta, R. gartneri.*

## CONCLUSION

Study of the species composition of the successive nannofloras of the Paleocene - Eocene and stratigraphically adjacent deposits enabled us to correlate them with the corresponding assemblages of the southern USSR and elsewhere in the world (Fig. 3). The evolutionary development in the Paleogene is similar in these regions. The majority of the nannoplankton zones recognized in the Paleogene of Georgia are interregional, as they are observed in almost all regions of the world. Only two subzones, the *Rhomboaster cuspis* and *Tribrachiatus bramlettei* Subzones are regional Caucasian units.

## ACKNOWLEDGEMENTS

I would like to express my gratitude to prof. N. MREVLISHVILI and Dr. N. SALUKVADZE for their consultations on larger and smaller foraminifera. I am also very grateful to the translators E. AKHMETELI and M. LORTKIPANIDZE for their help in translating the paper. Useful corrections by the reviewer SHIRLEY E. VAN HECK are gratefully acknowledged.

## REFERENCES

BRAMLETTE M. N., SULLIVAN F. R., 1961 - *Coccolithus and related nannoplankton of the Early Tertiary in California.* Micropal., v. 7, pp. 129-188, New York.

BRAMLETTE M. N. & WILCOXON J. A., 1967 - *Middle Tertiary calcareous nannoplankton of the Cipero Section. Trinidad W. I.* Tulane studies geol., v. 5, n. 3, pp. 93-132, New Orleans.

BRONNIMANN P., STRADNER H., 1960 - *Die Foraminiferen und Discoasteriden Zonen von Kuba und ihre interkontinentale Korrelation.* Erdoel-Zeitschr., v. 76, n. 10, pp. 364-369, Stuttgart.

BUKRY D., 1971 - *Cenozoic calcareous nannofossils from the Pacific Ocean.* Trans. San Diego Soc. Natur. Hist., v. 16, n. 14, pp. 303-328, La Jolla.

BUKRY D., 1973 - *Low-latitude coccolith biostratigraphic zonation.* Init. Rep. Deep Sea Drill. Porj., v. 15, pp. 685-703, Washington.

GARTNER S., 1971 - *Calcareous nannofossils from the Paleogene nannofossils zonation.* Tulane stud. Geol. and Paleont. v. 8, n. 3, pp. 101-121, New Orleans.

HAY W. W., 1964 - *Utilisation statigraphique des Discoastéridés pour la zonation du Paléocène et de l'Éocène inférieur.* Mem. B. R. G. M., v. 28, pp. 885-889, Paris.

HAY W. W., MOHLER H. P., 1967 - *Calcareous nannoplankton from Early Tertiary rocks at Pont Labau and Paleocene - Eocene correlations.* J. Paleontol. vol. 41, pp. 1505-1541, Tulsa.

HAY W. W., MOHLER H. P., ROTH P. H., SCHMIDT R. R., & BOUDREAUX J. E., 1967 - *Calcareous nannoplankton zonation of the Cenozoic of the Gulf Coast and Caribbean - Antillean area and transoceanic correlation.* Trans. Gulf. Coast assoc. Geol. Soc., v. 17, pp. 428-480, Boulder.

HAY W. W., MOHLER H. P., & WADE M. E., 1966 - *Calcareous nannofossils from Nalchik (northwest Caucasus).* Eclogae Geol. Helv., v. 59, pp. 379-400, Basel.

KRASHENINNIKOV V. A., NEMKOV G. I., 1975 - *Relationship between the faunes of planktonic foraminifera and Nummilites in Paleogene deposits of Syria.* Questions of Micropaleont., n. 18, pp. 179-211, Moskow.

MARTINI E., 1970 - *Standard Paleogene calcareous nannoplankton zonation.* Nature, v. 266, pp. 560-561, London.

MARTINI E., 1971 - *Standard Tertiary and Quaternary calcareous nannoplankton zonation.* Proc. II Plank. Conf., pp. 739-785, Roma.

MUZYLOV N. G., 1980 - *Stratigraphy of the Paleogene of the South of USSR by Nannoplankton (The North Caucasus and Crimea).* Trans., v. 348, 93 pp., Moscow.

OKADA H., BUKRY D., 1980 - *Supplementary modification and introduction of code numbers to the Low-latitudes Coccolith biostratigraphic zonation* (BUKRY, *1973, 1975*). Marine Micropaleont., v. 5, pp. 321-325, Amsterdam.

PERCH-NIELSEN K., 1971 - *Neue Coccolithem aus dem Paleozän von Dänemark, der Bucht von Biskaya und dem Eozän der Labrador See.* Bull. Geol. Soc. Denmark., v. 21, pp. 51-56, Kobenhavn.

ROMEIN A. J. T., 1979 - *Lineages in Early Paleogene calcareous nannoplankton.* Utrecht Micropal. Bull., v. 22, 231 pp. Utrecht.

SALUKVADZE N., 1985 - *On Biostratigraphy of Paleocene and Eocene of Georgia.* Stratigraphy and Paleontology of Paleogene of Georgia, pp. 3-21, Tbilisi.