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K. Perch-Nielsen, F. Rögl, H. Stradner, R. Braunstein

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INTERNATIONAL NANNOPLANKTON ASSOCIATION

President

K. Perch-Nielsen

ETH-Z, Geol. Inst.
CH-8092 Zürich
SWITZERLAND

Secretary / Treasurer

A.J.T. Romein
Instituut voor Aardwetenschappen
Budapestlaan 4
Postbus 80.021
NL-3508 TA Utrecht
THE NETHERLANDS

Bank account:
55.53.90.101 Algemene Bank Nederland
Postal account (post giro): 419813

Editor

S. E. van Heck
Shell UK Expro, UEE/3
Shell-Mex House, Strand
London WC 2R ODX
ENGLAND

Bibliographer

J. C. Steinmetz
Denver Research Center
Marathon Oil Company
PO Box 269, Littleton, Colorado 80160
USA

Silicoflagellates from the Aitania-section, a quantitative inventarisation.

by: René Almekinders *

Twenty-two samples of upper-lower Pliocene to lower-middle Pliocene age, taken from the Aitania-section (Crete), were examined for their contents of silicoflagellates and ebridians.

Sixteen silicoflagellate species were recognized along with three rare ebridian species. The species distribution in each of the twenty-two samples is expressed in percentages based on counts of 100 specimens per sample. A paleotemperature curve is constructed by means of the Dictyocha/Distephanus-ratio as described by Mandra and Mandra (1972). This curve shows a slight increase in temperature during the studied interval.

The assemblages of the Aitania-section can be assigned to the Dictyocha fibula zone and the Dictyocha stapedia zone of Bukry (1981).

* Instituut voor Aardwetenschappen, Budapestlaan 4, Postbus 80.021,
NL-3508 TA Utrecht, The Netherlands

NANNOFOSSIL ACCUMULATION PATTERNS: THE LATE MIDDLE EOCENE THROUGH EARLY OLIGOCENE FROM THE SOUTH ATLANTIC

Jan Backman

Department of Geology, University of Stockholm, S-106 91 Stockholm, Sweden

Quantitative analyses have been made for middle and late Eocene and early Oligocene calcareous nannofossil species from Site 522 (Holes 522 and 522A) and Site 523 of DSDP Leg 73, using 20-cm sample intervals. The counts performed are calculated to reflect, grossly, accumulation changes of the different species. Hole 522 preserves a continuous record across the Eocene/Oligocene boundary. Oxygen and carbon isotopes have been analysed from the identical sample set. Biostratigraphically, the investigated record begins in the upper part of Zone NP 15 and continues just across the NP 22/NP 23 boundary. Sediment accumulation rates vary between 0.7 and 1.0 cm/kyrs, except for a 5-m interval in Site 523 (0.4 cm/kyrs). The recovered sediments contain an unusually well preserved magnetostratigraphic record (Tauxe et al., 1984), making them valuable for calibration between bio- and magnetostratigraphy at a southern mid-latitude position. The marine magnetic anomaly time-scale of Berggren et al. (in press) has been used for calculation of sediment accumulation rates and ages of the nannofossil datums.

Sofar, the following species has been analysed (mostly in the critical intervals around first appearances or extinctions): *B. serraculoides*, *C. formosus*, *C. grandis*, *C. protoannulus*, *C. reticulatum*, *D. hesslandii*, *D. barbadiensis*, *D. saipanensis*, *E. subdisticha*, *I. recurvus*, *Nannotetrina* spp. and *R. umbilica*. The early Oligocene shift in oxygen isotope composition -analysed on bulk sediment- is clearly defined at the very base of anomaly 13, but not associated with changes in the taxonomic evolution of the nannofossils. A concentration of nannofossil changes occur shortly above anomaly 13, indicating that the oxygen isotope shift reflects a paleo-oceanographic event which did not immediately affect surface water conditions.

A morphometric study has been made on the *D. bisectus*-*D. hesslandii* complex, from the initial appearance of this group in the middle Eocene throughout the early Oligocene using roughly 40 selected samples from Site 523. In numerous samples, qualitative estimates of size differences (length and width) within this group would suggest that both species are present. However, the morphometric study reveals that no bimodal size distribution occurs in any of the samples, raising some doubt regarding the taxonomic validity of one of these species. Additional studies representing other stratigraphic intervals and geographic areas have to be made before a final conclusion can be reached on this taxonomic problem.

Magneto- and biostratigraphy of an Eocene sequence from
borehole Somlóvásárhely 1. /SW Bakony Mts, Western Hungary/
by B. Bernhardt^X, M. Lantos^X, P. Márton^{XX}, M. Báldi-Beke^X,
K. Horváth-Kollányi^X and T. Lecskeméti^{XXX}

In Western Hungary the Eocene sequence is about 300 m thick. Outcrops are available for the Middle Eocene limestone while the Middle and Upper Eocene marls rarely occur on the surface. Continuous sequences have been known only from boreholes. One of the latest hole is Somlóvásárhely Sv-1, where the whole marine series of sublittoral to bathyal origin have been drilled.

The borehole was drilled for Cretaceous coal seams in 1983-1984, and the whole sequence was recovered by coring. We took the opportunity to perform an integrated magneto- and biostratigraphic analysis on the Eocene part of it.

The transgressive Eocene sequence lies unconformably on the Upper Cretaceous sediments. It is overlain by Oligocene continental deposits.

The Eocene series begins with fluvial gravel, sand and marl with brackish molluscs in its upper part. Above these sediments there is nummulitic limestone with rock building quantity of larger foraminifera /Nummulites, Alveolina, Assilina and Discocyclina/. The limestone gradually grades upwards into a marl abundant in planktonics. In the transitional part a glauconitic marly intercalation can be recorded. In the uppermost part of the marl there are andesite tuff layers of a few centimetres thick. At 582.3 m the sequence changes upwards from marly to tuffaceous sand with traces of gradation and containing marl and tuff debris or pebbles. There are thin /0.1 to 0.4 m/ autochthonous marly beds between the resedimented sandy layers.

During sampling for magnetic studies, some parts of wet marls had already been destroyed giving rise to a few gap of an interval of 20 m at the Middle / Upper Eocene boundary. The average sample spacing was 0.9 m. Apart from that gap, the polarity zonation based on inclination data seems fairly reliable. The magnetic intensities of the samples after thermal demagnetization of 220-400°C ranged from noise-level /0.005 nT/ to 40 nT. The highest values /not less than 2.0 nT/ were recorded in the uppermost part, while the lowest /up to 0.150 nT/ were in the limestone.

The correlation with polarity time scale /Lowrie and Alvarez 1981/ shows that the studied Eocene sequence spans a time of 10 m. y. or so.

^X Hungarian Geological Institute, Budapest, Népstadion út 14.
1143

^{XX} L. Eötvös University, Department of Geophysics, Budapest,
Kun Béla tér 2. 1083

^{XXX} Museum of Natural History, Paleontological Department,
Budapest, Múzeum krt. 14. 1088

Our biostratigraphy is based on planktonic foraminifera and nannoplankton. The zonation of Bolli /in Bolli 1972 and Stainforth et al. 1975/ and that of Martini /1971/ are used. Paleontological studies have been carried out on benthonic foraminifera /smaller and larger/, Dinoflagellates, pollen grains and mollusc too.

The lowermost sequence of the Eocene part of the section contains *Discoaster* cf. *sublodoensis* indicating zone NP 14. *Discoaster lodoensis*, *D. sublodoensis* and *Rhabdosphaera inflata* were found earlier in several boreholes close to /Báldi-Beke 1984/.

The nummulitic limestone is extremely poor in planktonics but *Nummulites laevigatus*, *N. obesus*, and higher the *N. perforatus* and *N. millecaput* stress the Middle Eocene age and shallow sublittoral origin of the formation.

From about 757 m upwards the *Globigerinatheca subcoglobata* subcoglobata zone is likely present. In the same level the nannoplankton is characterized by the *Braarudosphaera*. This ecologic horizon is known from other boreholes too, the only hole was Káptalanfa 2 near Sv 1, where *Nannotetrina mexicana* occurred, placing this horizon into zone NP 15.

From 708.9 m upwards *Reticulofenestra placomorpha* (=R. *umbilica*), represented by large specimens gives the evidence for NP 16.

All the following nannoplankton zonal boundaries are recognized by primary criteria. At the NP 16/17 boundary the last *Chiasmolithus solitus* and *Sphenolithus furcatolithoides* are followed by the first *Sphenolithus predistentus* /as in the other Hungarian sections, Báldi-Beke 1984/ and the abundance of *Reticulofenestra bisecta*. The NP 17/18 boundary is marked by the first *Chiasmolithus oamaruensis*. *Chiasmolithus grandis* is rather common below this level, but occasionally occurs as high as the base of NP 19. The first appearance of *Isthmolithus recurvus* marks the base of zone NP 19.

The planktonic foraminiferal zonation of the lower /calcareous/ part of the section is uncertain. The position of the higher part is based on secondary indicators. The only primary indicator is *Globigerinatheca semiinvoluta*. The occurrences of the taxa used for biozonation are displayed on the figure.

The highest tuffaceous sand contains *Nummulites fabianii* and *Miliolids* transported from the shallow, marginal parts of the sea. The resedimented beds contain almost the same Late Eocene smaller foraminifera fauna and nannoflora as the pelitic autochthonous layers. The *Nummulites* specimens occur only in the sand, neither in the marl nor in the resedimented marly pebbles.

Chronostratigraphic boundaries:

The Tertiary of this borehole starts with layers somewhat younger than the base of the Lutetian. They belong to the younger half of NP 14 and are found in a reversed interval below magnetic anomaly 21.

Regarding to the position of the Lutetian/Bartonian boundary there are some possibilities: either it is the base of

Orbulinoides beckmanni zone from which level upwards Rhombodinium draco occurs /Rákosi 1984, manuscript/, or it can be designated in the magnetic anomaly 20 at /near/ the base of NP 16, or somewhere between these two.

The Bartonian/Iriabonian boundary can be put either on the base of NP 18 or on the base of Globigerinatheca semiinvoluta zone, which means about 10 m difference in the studied section. At both case the boundary is near the base of magnetic anomaly 17.

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The structural development of early Mesozoic coccoliths and its evolutionary and taxonomic significance.

P R Bown
Micropalaeontology Unit
University College London

Detailed structural analysis of Upper Triassic and Lower Jurassic coccoliths from Austria and Britain, using the scanning electron microscope, has revealed the presence of several fundamentally distinct modes of coccolith construction. Four major 'coccolith structural groups' are recognised, named and defined; two of these groups are present in the earliest known coccolith assemblages, in the Upper Triassic (Norian) and two appear at a later time of rapid diversification in the Lower Jurassic (Pliensbachian). The evolutionary significance and the components of these four major groups are reviewed and compared to previous related work, notably by Prins (1969) and Jafar (1983). The importance of detailed structural analysis in coccolith taxonomy and the fundamental importance of the rim structure as revealed by early coccoliths are discussed.

NANNOFOSSIL STRATIGRAPHY AND MAGNETOSTRATIGRAPHIC
CORRELATION AT THE JURASSIC-CRETACEOUS BOUNDARY.

BRALOWER, Timothy J., Scripps Institution of Oceanography, CA 92093 U.S.A.

MONECHI, Simonetta, Dipartimento Scienze della Terra, Università di Firenze, Via La Pira n. 4, 50121 Firenze, Italy.

Numerous pelagic sections across the Jurassic-Cretaceous boundary have been investigated. These include the Fiume Bosso, Fonte Giordano and Bottaccione in Umbria, Italy; Foza in the Southern Alps, Italy; Berrias in S.E. France; Carcabuey in Spain; Grindstone and McCarty Creeks in Northern California; and DSDP Sites 391C and 534A in the Western N. Atlantic. These sections cover a wide paleogeographic area and show a variety of nannofossil preservational states.

The DSDP sites allow detailed taxonomic studies and combined with the continuous land sections, we have been able to establish a globally-applicable high resolution succession of nannofossil events in the Tithonian and Berriasian stages.

The Jurassic-Cretaceous boundary interval is a time of dramatic changes in nannofossil assemblages and up to 35 possible events can be recognized in the DSDP sites studied. Up to 15 events can be consistently identified in the land sections.

Published magnetostratigraphies exist for many of these sections encompassing reversals M14 to M22. These can be correlated precisely with the nannofossil events and our results indicate that most events are globally synchronous to within one sunchron.

Nannofossil stratigraphies are also correlated with previously published calpionellid, ammonite and Buchia zonation schemes.

NOTE ON ARCHAEMONADS FROM OTTENTHAL, LOWER AUSTRIA, DISTURBED MOLASSE, OLIGOCENE

by Roswitha E. BRAUNSTEIN, Institut für Paläontologie, Universität Wien, Universitätsstr. 7/2, 1010 Wien, Austria.

At Ottenthal a 60 m long road embankment exposes Latdorfian and Rupelian shales, marls and clays with microfauna, nannofossils and also occasional layers with siliceous microfossils (diatoms, silicoflagellates and archaeomonads).

The family of the Archaeomonadaceae DEFLANDRE 1932 embraces not only marine fossil chrysomonads, but also those living in brackish water. They probably are planktonic in the photic zone of the oceans. During their life cycle the single cells formed cysts consisting of SiO_2 which may be considered as states of rest.

The siliceous cysts of the archaeomonads are found in great numbers co-occurring with the remains of planktonic diatoms, rare silicoflagellates and ebridians.

In the Ottenthal section four different facies of archaeomonads can be distinguished:

1. Marl shales and menilite shales:

Archaeomonas cratera DEFLANDRE, Litheuspherella frenguelli DEFL., Archaeomonas cf. A. chenevieri DEFL., A. mangini DEFL., Archaeospheridium ornatum DEFL., Pararchaeomonas sp.

2. Marl shales with siliceous clay:

A. mamillosa TYNAN, A. mangini DEFL., A. angulosa DEFL., Litheuspherella sp., A. glabra DEFL.

Silicoflagellates (Corbisema triacantha, Naviculopsis lata, Dictyocha fibula)

Dinoflagellates (Actinodiscus elongatus, A. pentasterites)

Diatoms (Micrampulla sp., etc.)

No nannoplankton was found.

3. Diatomites:

Litharchaeocystis oamaruensis DEFL., Archaeomonas areolata DEFL., Pararchaeomonas colligera DEFL., A. cf. chenevieri DEFL. and many diatoms.

4. Diatomite with thin yellowish intercalations:

A. lefeburei DEFL., A. heteroptera DEFL., A. pachyceros DEFL., A. dangeardianum DEFL., A. scrabulata DEFL.

Some of the latter low salinity assemblage show an evident increase of their size. The nannoflora (Reticulofenestra ornata, Transversopontis zigzag, T. obliquipons) indicates a reduced salinity (pers. comm. H. STRADNER).

Concerning dimorphism in Early Jurassic coccoliths and the origins of the genus Discorhabdus Noël 1965

J. A. Crux

Stratigraphy Branch, BP Research Centre, Sunbury-on-Thames.

ABSTRACT

I propose an evolutionary lineage from the genus Biscutum Black 1959, through the genera Sollasites Black 1967 and Calyculus Noël 1973 to the genus Discorhabdus Noël 1965. This evolutionary lineage is complicated by dimorphism in the coccoliths of the genus Calyculus. This dimorphism is thought to be similar to the more recent example seen in the genera Pontosphaera Lohmann 1902 and Scyphosphaera Lohmann 1902.

NANNOS, CALPIONELLID, FORAMINIFERAL BIOSTRATIGRAPHY OF THE MAIOLICA FORMATION
(LATE TITHONIAN-APTIAN) FROM THE LOMBARDIAN PREALPS (NW BRESCIA, ITALY).

Erba Elisabetta & Quadrio Barbara

Dipartimento di Scienze della Terra, Milano (Italy).

The study regards the Maiolica formation and its transitions to the underlying Rosso ad Aptici and to the overlying Scaglia Variegata formations. The Maiolica is represented mainly by a limy sequence with several black shaly interbeds in its upper portion. Four detailed sections covering the entire thickness of the unit were studied both from lithological and micropaleontological point of view. Calcareous Nannofossils, Calpionellids and planktonic Foraminifera were analyzed in the same samples.

Eight Nannofossil zones (C. mexicana, N. colomi, C. angustiforatus, C. oblongata, L. bollii, M. hoschulzi, C. litterarius and P. angustus Zones) and twenty-one events were identified in the interval from Late Tithonian to Late Aptian. Five Calpionellid zones, six subzones and thirteen events were recognized from Late Tithonian to Valanginian, whereas two planktonic Foraminiferal zones and three events were identified in the Early Aptian.

The obtained biostratigraphic correlations are consistent with those known from the Tethys region except for minor differences around the Barremian-Aptian boundary.

VARIATIONS IN THE CALCAREOUS PLANKTON OF THE TORTONIAN-MESSINIAN
TRANSITION OF THE N-W PART OF THE GUADALQUIVIR BASIN (SPAIN).

J.A. FLORES VILLAREJO & F.J. SIERRO

Department of Paleontology. University of Salamanca. Spain.

The present work examines in depth the qualitative and quantitative changes taking place in the associations of calcareous nannoplankton in the Gibralfón, Beas-Trigueros, Guillena, Cantillana and Arroyo Galapagar (Base of the Andalusian) sections, located on the NW boundary of the Guadalquivir Basin; the events observed are compared with those occurring in the assemblages of planktonic foraminifera.

The lithological peculiarities of some of the sections studied imply that it is not always possible to establish the traditional zone divisions since the usual markers of such zones (ceratoliths, asteroliths...) appear only sporadically and with little regularity; nevertheless, in certain columns this has been possible. The results are summarized in the accompanying figure. In this sense, the sections shown would define the zones NN-10 (?) and NN-11 (of *Discoaster calcaris* and *Discoaster quinqueramus*, respectively) of the Standard Zonation (MARTINI, 1970) and the subzones of *Discoaster berggrenii* and *Amaurolithus/Ceratolithus primus* proposed by BUKRY (1973; 1975), ROTH (1973), MAZZEI (1977) and MAZZEI et al. (1979). The units defined essentially coincide with those already reported by MARTINI (1971), BERGGREN & HAQ (1976) and BOSSIO et al. (1977) for this region. However, the lower limit between the *Discoaster calcaris/Discoaster quinqueramus* zones in the Arroyo Galapagar column is situated by us as slightly below them, as described by BERGGREN & HAQ.

At the same time a series of quantitative analyses was carried out on the most representative taxons or groups of taxons. The most significant changes (see figure) are found between what we have called "small placoliths", the *Reticulofenestra minutula/Reticulofenestra haquii* set, and the species *Dictyococcites antarcticus*. Within the "small placoliths" group we have included those specimens belonging to the genera *Reticulofenestra* and *Dictyococcites* (difficult to differentiate with light microscopy) with sizes consistently smaller than 3 microns.

We have thus been able to note a horizon in which a synchronic increase in the "small placoliths" takes place from 20% or less to values close to or above 50%. A reduction of similar proportions occurs in the *Reticulofenestra minutula/Reticulofenestra haquii* set. *Dictyococcites antarcticus* starts a progressive increase, passing from a relative abundance of 5% to more than 10%. Likewise, variations, though not so manifest, are observed in other taxons such as *Coccolithus pelagicus*, *Geminolithella jafari*, *Sphenolithus* spp., *Helicosphaera* spp., and *Eudiscoaster* spp. The event recorded appears in zone NN-11.

We discard the possibility of changes in the set being due to a process of selective alterations in the different samples since in all of them forms easier to dissolve than would be expected in "small

placoliths" may be noted.

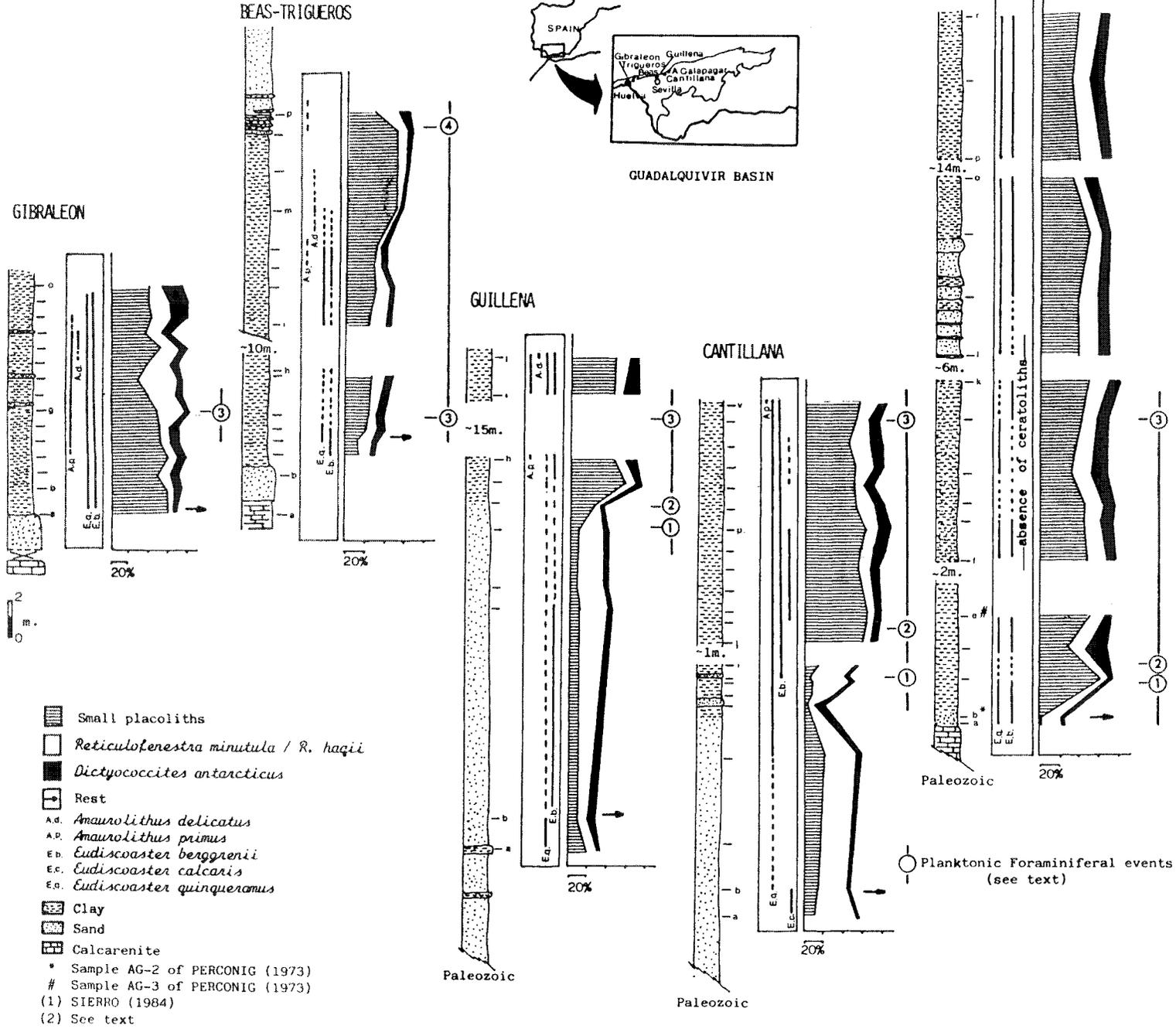
Among the planktonic foraminifera, of outstanding interest are the variations taking place in the associations of keeled globorotaliids (SIERRO et al. in prep.); according to these, three important events are recorded. In the lower part of the series the presence of abundant specimens of the first group of "*Globorotalia menardii*" (sinistral forms) may be observed. After a short interval in which the keeled globorotaliids are practically absent a noteworthy appearance of the second group of "*Globorotalia menardii*" (dextral forms) marks the second event. The replacement of this latter group by that of *Globorotalia miotumida* (sinistral forms) determines the third event, which may be correlated with the appearance of *Globorotalia conomiozea* in the Mediterranean. The fourth event is characterized by a change in coiling direction from sinistral to dextral in the group of *Turborotalia acostaensis* and is only found in the Trigueros section.

Considering the whole set of calcareous plankton we observed that the most important quantitative change in the associations of calcareous nannoplankton takes place at approximately the same time as the first two events between the planktonic foraminifera. Comparing this with the remaining data presented, it seems to be synchronic throughout all the columns and furthermore may have paleoecological implications.

It remains to be discovered what kind of changes operated on the environment, though it is possible that they could have been due to a decrease in temperature of the waters in which the species developed. We place the Tortonian/Messinian boundary in the sections studied at a level coinciding with the third event recorded in the planktonic foraminifera (see SIERRO, in prep.) such that the important changes shown throughout the plankton would be situated in the upper Tortonian.

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ARROYO GALAPAGAR

**CALCAREOUS NANNOFOSSIL BIOSTRATIGRAPHY
OF LATE QUATERNARY ARCTIC SEDIMENTS**

Gunilla Gard

Department of Geology, University of Stockholm
S-106 91 Stockholm, Sweden

Calcareous nannofossil assemblages of late Quaternary age have been investigated in short sediment cores from the eastern Arctic Ocean and the Norwegian Sea. The ages estimated in these cores are mainly based on calibration with a northern North Atlantic reference material, where the first appearance of Emiliana huxleyi occurs in oxygen isotope stage 8 at 264 kyrs, and its sharp increase in relative abundance occurs in oxygen isotope stage 4 at 61 kyrs. Minor amount of reworked Cretaceous and Tertiary specimens are present throughout the cores. Intervals where nannofossils occur in abundance represent warmer interstadial or interglacial conditions, whereas barren intervals represent glacial conditions. Holocene ice-free conditions are recognised by high frequencies of Coccolithus pelagicus. Sediment accumulation rates show considerable variation and range between 1 and 13 cm/kyr.

REFINED NANNOPLANKTON ZONATION FOR THE DANIAN OF THE CENTRAL NORTH SEA

By S.E. van Heck and B. Prins*

The discovery of hydrocarbons in the Chalk of the North Sea resulted in an increasing interest in this interval. Biostratigraphic zonations needed to be improved to help solve the problems encountered. The abundantly occurring calcareous nannofossils were the obvious choice for this interval, and proved extremely useful.

As the calcareous nannoflora show a strong speciation in the Danian following the severe extinctions at the end of the Cretaceous, numerous new appearances make a refined subdivision possible. Some groups are particularly common, and their evolution can be studied in detail. By using successive species of an evolutionary lineage and their intermediates to characterise certain intervals, it is possible to obtain a subdivision that is not only more refined, but also more reliable than more conventional zonations.

Special attention has been paid to the lineages of *Neochiastozygus* and *Cruciplacolithus* - *Chiasmolithus*, and representatives of these lineages proved to be valuable markers. Moreover, the analysis of the quantitative development within the *Cruciplacolithus* - *Chiasmolithus* lineage makes it possible to recognise almost any irregularity in the stratigraphic succession. By applying the quantitative method in combination with the conventional markers, minor hiatuses could be recognised, as well as allochthonous bodies of which the age differs by less than one zone from the autochthonous material.

* Shell UK, Expro, UEE/3, Shell-Mex House, Strand, London WC 2R ODX, England & Shell Int. Petrol.M. c/o KSEPL, Volmerlaan 6, NL-2288 GD Rijswijk, The Netherlands

The evolution of Eiffellithus eximius: a pre-Cenomanian nannofossil event

by

Merton Hill* and Tim Bralower**

ABSTRACT

Contrary to much of the literature, which typically documents a middle to late Turonian first evolutionary appearance of Eiffellithus eximius, this species evolved by late Albian time, before the evolution of E. turriseiffeli. This observation is based on very well-preserved samples from the Duck Creek Formation of northern Texas and southern Oklahoma. E. eximius first occurs at the Cenomanian/Turonian Boundary in slightly less well-preserved material from the Blue Point Section, Black Mesa, Arizona; Rock Canyon Section, Pueblo Colorado; and the KAF Section, Manitoba Escarpment.

Albian and Cenomanian forms of E. eximius are commonly not recognized because they are: (1) generally rare relative to E. turriseiffeli; (2) "lumped" together with E. turriseiffeli; and/or (3) assigned to a different species. Identification of E. eximius is problematic because three morphologies (which may be preservational states) exist and only one looks like the holotype. The first, and most common in the Duck Creek Formation, has an open central area, looks the least like the holotype, and appears to be morphologically transitional with Vagalapilla matalosa; the second has a completely-closed central area, is rare, and is identical to the holotype; and the third is intermediate in appearance and is very rare. All three forms are documented with light and scanning electron microscopy and compared to "typical" Turonian--Campanian species.

Recognition of the early evolution of E. eximius is stratigraphically important and may be used to define a new zone once its earliest appearance is established. Documentation of its earliest appearance may be difficult, however, since this species waxes and wanes throughout its range.

* UNOCAL Science and Technology Division, 376 South Valencia Avenue,
Brea, California, 92635

** Scripps Institution of Oceanography, University of California,
La Jolla, California 92093

PALEOGENE CALCAREOUS NANNOFOSSIL EVENTS AND MAGNETOSTRATIGRAPHIC CORRELATION IN THE SCAGLIA FORMATION, CENTRAL ITALY.

MADILE M. and MONECHI S., Dipartimento Scienze della Terra
Via la Pira n. 4, Università di Firenze, Firenze, Italy.

The Scaglia Formation, consisting of pelagic biomicritic limestones and marls, contains a remarkably continuous pelagic sequence from Late Cretaceous to Oligocene and allows detailed bio- and magnetostratigraphy correlations. Limitedly to the Paleogene, nine sequences have been studied in order to detect and describe the evolutionary events concerning calcareous nannofossils.

The investigated sections (see location map Fig. 1) belong to the Northern (Gubbio) and Southern (Visso) umbrian carbonate facies (Renz, 1936). The latter one is characterized by the presence of frequent calcareous turbidites originated from the adjoining Abruzzi platform.

The following localities have been studied:
Northern carbonate facies: Monte Cagnero (Late Eocene-Early Oligocene), Monte Acuto (Late Eocene-Early Oligocene), Contessa Highway (Early Paleocene-Early Oligocene), San Marco (Early Oligocene);

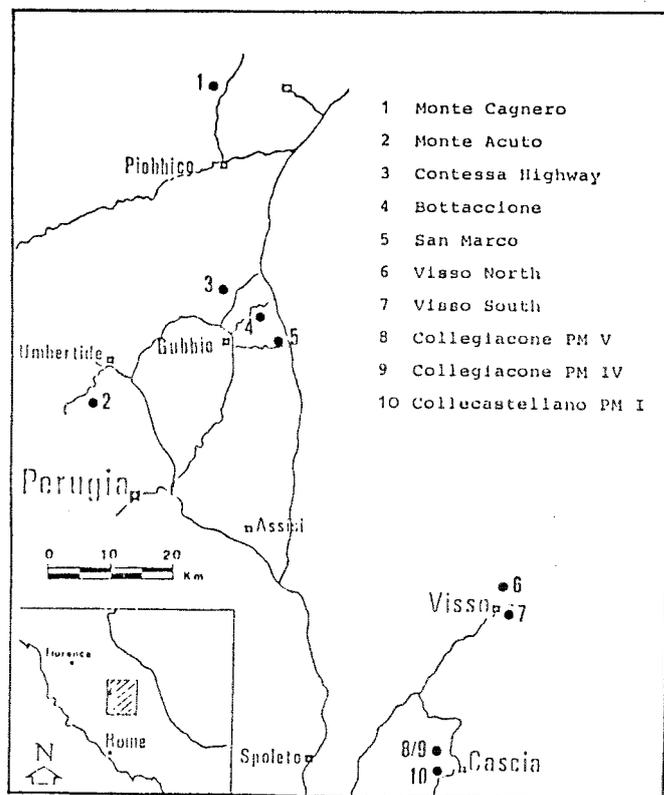


Fig. 1 Location map

Southern Umbrian carbonate facies: North Visso (Late Eocene-Early Oligocene), South Visso (Middle Eocene), Collegiacone PMIV (Early Eocene-Late Eocene), Collegiacone PM V (Late Eocene) and Collecstellano (Late Eocene-Early Oligocene). Further sections have been considered such as: Bottaccione (Early Paleocene-Late Eocene, data from Monechi & Thierstein, 1985), Contessa Quarry and Contessa Road (Middle Eocene-Late Oligocene, Lowrie et al. 1982).

From the study of the all afore mentioned sections it has been possible to define a succession of nannofossil events from the Early Paleocene to the Early Oligocene. These events were recognized and correlated with the planktonic foraminifera zonation and magnetostratigraphy of the Contessa Highway section (Premoli Silva et al, in press) (Fig. 2), Visso section (Nocchi et al, in press) and Contessa Quarry (Lowrie et al., 1982).

Particular attention has been paid to the Eocene-Oligocene boundary and to the early evolution of *R. umbilica* s.l. in Middle Eocene.

The Eocene-Oligocene boundary in the Umbrian sequences is not marked by any catastrophic extinctions, both in nannofossil and foraminifera distribution, but is rather characterized by sequential events. As to the foraminifera, the most important Middle and Late Eocene species become progressively extinct and the Eocene-Oligocene boundary is marked by the last occurrence of *Hantkenina*, *Cribrohantkenina* and *G. tropicalis*.

D. barbadiensis and *D. saipanensis* disappear together and before the Eocene-Oligocene boundary, based on planktonic foraminifera. Variations in abundance of several calcareous nannofossil species have been observed close to the boundary. An increase of *I. recurvus*, a cold water indicator, seems to be a peculiar event well recognizable also in Spain and in some sites from South Atlantic.

The magnetostratigraphy of the Contessa and Visso sections revealed that in between the well defined Anomalies 13 and 15 there are three normal discrete events, rarely recorded elsewhere and only found at DSDP Site 522 (Hsü et al., 1984), the youngest of these events almost coincides with the E/O boundary.

The biostratigraphy and magnetostratigraphy correlations suggest that most of the events recognized in our sections seems to be globally synchronous to within one subchrone. Only a few discrepancies exist with the sections studied by Lowrie et al., 1982 and by Hsü et al., 1985 for the same interval of time.

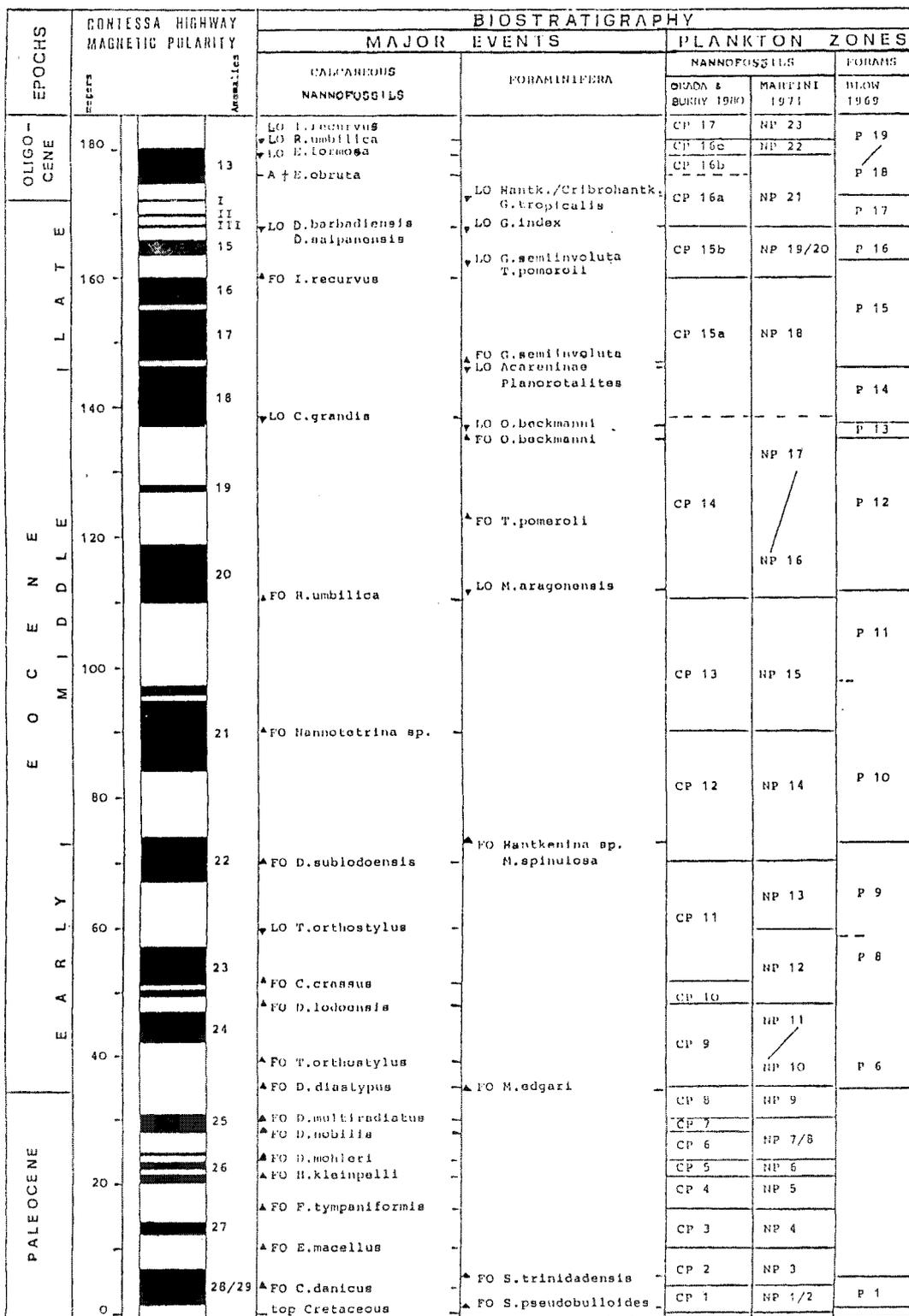


Fig. 2 Major calcareous nannofossil and planktonic foraminiferal biostratigraphic events plotted against magnetostratigraphy in the Contessa Highway section (modified from Nocchi et al.).

LATE JURASSIC-EARLY CRETACEOUS NANNOFOSSILS AND MAGNETO-STRATIGRAPHIC CORRELATIONS

H. MANIVIT, Lab. de Micropal. BRGM, BP. 6009, Orléans Cedex 45018
France

The present work deals with Late Jurassic and early Cretaceous Nannofossils from different parts of the Tethys realm.

The material is choised in the subbetic zone (Spain), in the Sicani mountains (Sicily) or in the S..E FRANCE and also in Central Transdanubian mountains (Hungaria).

These land sections have yielded a biostratigraphically succession of coccoliths and Nannoconus, whose assemblages and events allow us to propose a zonation from the Upper Jurassic to the early Neocomian.

After a brief history of the previous biozonations, as in boreal than in Mesogean regions, we give the results of our observations.

Though, we have noted some changes in Upper Jurassic nannofossils zonations published in the epicontinental sea deposits, because in our sediments the delicate marker species with short ranged are missing ; an extensive dissolution rather than biogeographic effect seems to be responsable for the differences in the Jurassic nannofossils of the Tethys and of the boreal, like those of Western and North Atlantic.

Our proposed zonation is correlated with ROTH'S biozonation (1983) for the North Atlantic.

Comparaison schemes of different biozonations are presented with Coccoliths and Nannoconus. It is possible to distinguish the apparition of the first small Nannoconus of the Tithonian. We have discussed about the J/C boundary in Mesogean regions and given correlations with Calpionellids and Ammonites zonations. Two sections in Hungaria one in Spain and the last in S.E FRANCE (the stratotypic outcrop of Berrias) have shown a good magnetic reversal sequence compared with others land sections from Italy (Southern Alps (OGG 1981, CIRILLI and al 1984, Lowrie and CHANNELL 1984, Spain (OGG, et al 1984) and with the polarity scale derived form the oceanic magnetic anomalies.

We have noted a broad agreement of the interpreted magnetostratigraphy of Umbrian Maiolica with corresponding segments from land sections in the Transdanubian region (MARTON, 1982, 1984) and with only some minor differences, with magnetostratigraphic results from DSDP site 534 (OGG, 1983). The present study correlates the Upper Jurassic/Cretaceous boundary between M 17 ad M 18, close to the base of anomaly M 18, using a paleontological criterion : the base of the Calpionella alpina zone and the rapide increase in size and abundance of Nannoconus colomii, and the first apparition of several coccoliths.

- We have correlated anomalies M 18/M 19 with the uppermost Tithonian. The Berriasian extends from the base of anomaly M 18, to the top of anomaly M 19.

Calcareous nannoplankton distribution in anoxic sediments
from the Barremian (Lower Cretaceous) of NW-Germany

Jörg Mutterlose, Institut für Geologie und Paläontologie,
Universität Hannover, Callinstr. 30, 3 Hannover 1

Within the Lower Cretaceous of NW-Germany and adjacent areas there occur several finely laminated horizons which were deposited under anoxic conditions. One of these horizons, the "Hauptblättertön", which is of Lower Barremian age, has been examined from five localities in NW-Germany.

The calcareous nannoplankton shows a similar distribution pattern in all the sections worked on:

1. In comparison to the beds above and below the "Hauptblättertön" is rather rich in both individuals and species.
2. Within the "Hauptblättertön" the diversity and the number of individuals vary.
3. Thin sections show coccolith rich - and coccolith poor laminae.
4. The relative abundance of tropical (?) species (Nannoconus ssp., Conusphaera mexicana, Diadorhombus rectus) seem to indicate warm water.

These results are confirmed by the distribution of dinoflagellates and miospores which strongly support the idea of a sediment rich in organic planktonic material deposited under warm water conditions. The fine lamination is supposed to be due to seasonal planktonic blooms, which caused a poisoning of the bottom water. Still difficult to explain is the large amount of coarser terrigenous material in these sediments.

MAASTRICHTIAN: The generally poorly preserved Maastrichtian assemblages do not include the Middle Maastrichtian marker species *Lithraphidites quadratus* or the Late Maastrichtian markers *Micula murus* and *Micula prinsii*. Several samples include reworked (?) *Quadrum trifidum* and *Reinhardtites levis/anthophorus* from the Campanian or Lower Maastrichtian. MAURRASSE (1981) indicates the presence of the *Globotruncana contusa* and *Abathomphalus mayaroensis* Zones from the Béloc Formation's lower, Maastrichtian part. *Thoracosphaera operculata* is present in varying amounts in all Maastrichtian samples and does not increase in frequency across the C/T boundary as determined by the planktic foraminifera.

DANIAN: At first sight, no typical Danian calcareous nannofossils were found in the sediments dated as Danian by planktic foraminifera by MAURRASSE (personal communication, 1980). None were found at a second sight, either. Renewed, careful investigation of the smallest fraction of the slides by light microscope revealed the presence of the tiny *Biscutum? romeinii* (ca. 2 microns) and *Biscutum? parvulum* (ca. 2.5 microns) in several samples. These species were described by SEM 1981 and 1979 respectively and are among the first species to evolve after the C/T boundary. They are most common in El Kef, Tunisia, while only *B? parvulum* was found in Caravaca, Spain. Very small specimens of questionable *Cruciplacolithus primus* (ca. 3 - 4 microns) are difficult to distinguish from *B? parvulum*, and were only found in few samples. A search with the SEM seems hopeless, since they are extremely rare among the mainly Maastrichtian coccoliths and the abundant small calcite particles. Sample 79/60 seems to include an acme of *B? parvulum*. Such an acme was reported by ROMEIN & SMIT (1981) shortly before the first occurrence of *C. primus* in Caravaca and by PERCH-NIELSEN (1981) from El Kef. This would suggest, that the lowermost Tertiary coccolith zone NP 1 is very thick at Béloc, since 79/60 lies about 10m above the C/T boundary and the first *C. primus* still higher (exact position of samples 77-69 not known, but indicated above 67). No *Braarudosphaera* and no *Biantholithus sparsus* were found.

MAURRASSE, F., 1981. New data on the stratigraphy of the Southern Peninsula of Haiti. In: F. M.:Transact. 1er coll.Géol. Haiti, Fac. des Sciences, Port-au-Prince 27-29.3.1980: 214-220.

PERCH-NIELSEN, K. 1981. Nouvelles observations sur les nannofossiles calcaires à la limite Crétacé-Tertiaire près de El Kef (Tunisie). Cahiers de Micropal. 3:25-36.

ROMEIN, A.J.T. & SMIT, J., 1981. Carbon-oxygen stable isotope stratigraphy of the C/T bd interval; data from Biarritz section (SW France). Geol. & Mijnbouw 0016-7746/81/6004-0541: 541-544.

Calcareous nannofossils are rare to few in the Maastrichtian sediments. They are usually poorly preserved. *N. frequens*, the marker species of the Upper Maastrichtian in high latitudes is present in most samples, also in the lowermost one which was taken some 13m below the M/D bd. The lowermost *M. murus* was observed about 3m below the boundary. No *M. prinsii* was found. Its absence might be due to dissolution. The Maastrichtian assemblages include very rare specimens of the Survivors (PERCH-NIELSEN et al., 1982) *N. neocrassus*, *B. constans*, *M. inversus*, *C. margerelii*, *C. reinhardtii* and *B. bigelowii*, but no *Thoracosphaera*. A single specimen of *B. sparsus* was found in sample 101 just below one of the marly thin layers at the M/D boundary (bioturbation?). Very rare pieces of *Thoracosphaera* appear in samples 102 and 27/11 above marly layers and are found in very small amounts in all higher samples. The presence of very rare *Thoracosphaera* and the single *B. sparsus* are the only indications of Danian as recognisable with calcareous nannofossils. There is no increase in Survivors nor a decrease in Cretaceous forms and none of the small new coccoliths as *Biscutum? romeinii* or *B? parvulum* which become common in well preserved low latitude Early Danian assemblages could be found. Maastrichtian coccoliths are still more common than Survivors or new species in sample 25. In sample 31, which was taken above the lowermost Danian hard-ground, Survivors and species having evolved from them are more common than the Maastrichtian forms and large specimens (ca. 10 microns) of *C. primus* suggest NP 2. Due to the poor preservation of all assemblages, no attempts were made to count the 3 groups (Maastrichtian, Survivors, new species). *Braarudosphaera* does not reach the high numbers found in many other Lower Danian sections. The Danian assemblages are similar to those found in the lowermost Danian and other high latitude sections.

- NAIDIN, D.P., ALEKSEEV, A.S., BENJAMOVSKI, V.N., KOPAEVICH, L.F. 1982. Maastrichtian-Danian boundary in the section Kyzylsaj (Mangyshlak) and some features of this border line. Doklady Akad. Nauk SSSR, 1982, vol. 267, N 1: 177-180. In Russian.
- NAZAROV, M.A., BARSUKOVA, L.D., KOLESOV, G.M., NAIDIN, D.P., ALEKSEEV, A.S. 1983. Origin of the Iridium anomaly at the Maastrichtian-Danian boundary. Geochimica, 1983, N 8: 1160-1178.
- PERCH-NIELSEN, K., MCKENZIE, J., HE, Q. 1982. Biostratigraphy and isotope stratigraphy and the "catastrophic" extinction of calcareous nannoplankton at the Cretaceous/Tertiary boundary. Geol. Soc. Am. Spec. Paper 190: 353-371.

SAMPLE	ABUNDANCE PRESERVATION	C=common F=few R=rare +present M=moderate P=poor VP=very poor		Cretaceous species
51 F, Pm	+			<i>Watznaueria barnesae</i>
50 F, Pm	+			<i>Prediscosphaera cretacea</i>
44 R, P	+			<i>Micula decussata</i>
31 +, VP	+			<i>Cribrosphaera ehrenbergii</i>
25 +, VP	+			<i>Arkhangelskiella cymbiformis</i>
105 +, P	+			<i>Lithraphidites quadratus</i>
103 R, P	+			<i>Nephrolithus frequens</i>
102 Rf, P	+			<i>Eiffelolithus turriseiffelii</i>
101 Fc, Pm	+			<i>Placozygus fibuliformis</i>
22 F, P	+			<i>Strachneria crenulata</i>
17 F, Pm	+			<i>Prediscosphaera stoveri</i>
16 F, Pm	+			<i>Reinhardtites mirabilis</i>
10 F, Pm	+			<i>Lucianorhabdus cayeuxii</i>
32 +, VP	+			<i>Kampfnerius magnificus</i>
31 +, VP	+			<i>Chiastozygus fessus</i>
29 +, VP	+			<i>Prediscosphaera majungae</i>
25 +, VP	+			<i>Ahmullerella octoradiata</i>
27/1 F, P	+			<i>Prediscosphaera arkhangelskyi</i>
2 F, P	+			<i>Cribrocorona gallica</i>
3 Rf, P	+			<i>Cribrosphaera? daniae</i>
4 Rf, P	+			<i>Micula murus</i>
5 Rf, P	+			<i>Prediscosphaera spinosa</i>
6 Rf, P	+			<i>Microrhabdulus stradneri</i>
7 Fr, P	+			<i>Micula swastica</i>
8 Rf, P	+			<i>Zeughrabdodus pseudanthophorus</i>
9 R, P	+			<i>Eiffelolithus parallelus</i>
10 R, P	+			<i>Prediscosphaera grandis</i>
11 R, P	+			<i>Manivitella pemmatoides</i>
12 R, P	+			<i>Eiffelolithus gorkae</i>
13 Rf, P	+			<i>Lithraphidites carniolensis</i>
27/14 Rf, P	+			<i>Microrhabdulus belgicus</i>
21 Rf, P	+			<i>Rhagodiscus reniformis</i>
19 R, P	+			<i>Braarudosphaera bigelowii</i>
				<i>Cyclagelosphaera reinhardtii</i>
				<i>Biscutum</i> sp.
				<i>Micrantholithus</i> sp.
				<i>Markalius inversus</i>
				<i>Cyclagelosphaera margerelii</i>
				<i>Biantholithus sparsus</i>
				<i>Thoracosphaera operculata</i>
				<i>Neocrepidolithus</i> sp.
				<i>Placozygus sigmoides</i>
				<i>Cruciplacolithus primus</i>
				<i>Neocrepidolithus cruciatus</i>
				<i>Neocrepidolithus</i> sp. (6 microns)
				<i>Ericsonia cava</i>
				<i>Cruciplacolithus edwardsii</i>
				<i>Prinsius dimorphosus</i>
				<i>Ericsonia subpertusa</i>
				<i>Prinsius tenuiculum</i>
				<i>Prinsius martinii</i>
				<i>Thoracosphaera saxea</i>
				<i>Neochiastozygus modestus</i>
				<i>Chiasmolithus danicus</i>
				<i>Chiasmolithus consuetus</i>
				<i>Cruciplacolithus tenuis</i>
				<i>Neochiastozygus perfectus</i>
				<i>Toweius selandianus</i>
				<i>Neochiastozygus saepes</i>
				<i>Octolithus multiplus</i>
				<i>Chiasmolithus bidens</i>
				<i>Sphenolithus primus</i>
				<i>Micrantholithus</i> sp. (high)
				<i>Ericsonia robusta</i>
26				CC (SISSINGH, 1977)
				NP (MARTINI, 1971)
				D : S (PERCH-NIELSEN, 1979)
MAASTRICHT	DANIAN	MAASTRICHT	DANIAN	SEL AGE

Fig. 3 Calcareous nannofossils at the M/D boundary in Kyzylsaj

CALCAREOUS NANNOFOSSIL FAMILIES AND GENERA - REMARKS ABOUT RELATIONS AND "NON-RELATIONS".

K. Perch-Nielsen, Geol. Inst. ETH-Z, CH-8092 Zürich

We can distinguish at least 4 types of families and genera used by calcareous nannofossil specialists:

Families/Genera including only related coccolithophorids

Families/Genera including probably/possibly/maybe related calcareous nannofossils

Families/Genera including probably related forms and similar, but probably unrelated forms

Families/Genera including similar, but probably unrelated calcareous nannofossils.

WHY, then, bother to use genera and families at all? Obviously many colleagues have "solved" the problem by lining up their species in alphabetic order of the species name in rangecharts or species lists. On the other hand, other colleagues indicate that a certain number of calcareous nannofossil families cross the Cretaceous/Tertiary boundary, and such numbers keep appearing in general papers on evolutionary rates and boundaries. Thus, non-specialists have long since figured out how many families can be found in any given interval of time or at any specific boundary, while specialists cannot agree on families and their content or do not believe in families at all.

During my recent attempt to provide an overview over stratigraphically important calcareous nannofossils (PERCH-NIELSEN, 1985a,b) I wanted to show also the forms similar and/or related to the marker species. In several cases I ended up collecting and illustrating all available data on holotypes of a genus or family (*Helicosphaera*, *Sphenolithus*, Ceratolithaceae). It was clearly not satisfactory, not even practical, to arrange the species just in alphabetic order. In other cases I just included similar objects on the same figure to show the choice for the determination of such an object. I had started to work on the Mesozoic chapter first and then had to continue with the Cenozoic chapter for logistic reasons. I finished the Cenozoic chapter and had to send it off before continuing with the Mesozoic chapter and finding out that I would be assigning the same genus in different families in the Mesozoic and in the Cenozoic....

There was no time for a complete overview of families, not even one for the Cenozoic chapter, which was sent off before I found out it would be practical to have such an overview and constructed one for the Mesozoic chapter. Fig. 1 shows the Mesozoic families and their characteristics - a Poster will show a similar overview for the Cenozoic families (and none for the Recent...) and attempts to connect some genera and families and "disconnect" others. It will not be the final word about this subject, but a base for discussions at the meeting. A guide for the distinction of Tertiary families can be found in PERCH-NIELSEN (1971).

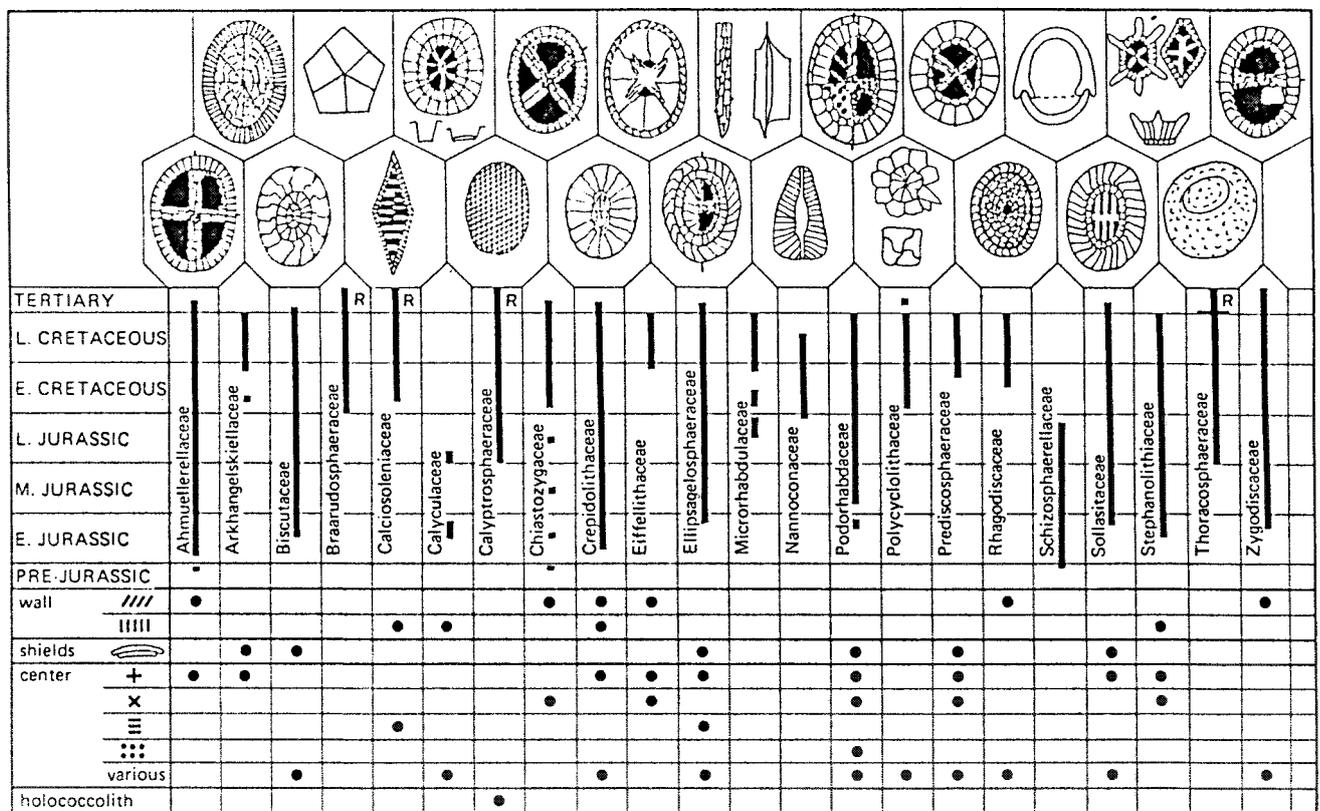


Fig. 1 Mesozoic calcareous nannofossil families. From: PERCH-NIELSEN, 1985a.

PERCH-NIELSEN, K. 1971. Durchsicht Tertiärer Coccolithen. In: Farinacci, A. ed.: Proceedings II Plankton. Conf., Rome, 2:939-80.

PERCH-NIELSEN, K. 1985a,b. Mesozoic calcareous nannofossils. Cenozoic calcareous nannofossils. In: Bolli, H.M. et al. Plankton Stratigraphy. Cambridge University Press. In press, 1985.

CRUCIPLACOLITHUS TENUIS AND CHIASMOLITHUS DANICUS -- A DISCUSSION OF PROBLEMATIC DANIAN MARKER SPECIES.

K. Perch-Nielsen, Geol. Inst. ETH-Z, CH-8092 Zürich

Shortly after BROTZEN (1959) described *Cribrosphaerella danica* from the Danian of southern Sweden, STRADNER (1961) described *Heliorthus tenuis* from the Danian of Austria and BRAMLETTE & SULLIVAN (1961) described *Coccolithus bidens* and *C. consuetus* from the Upper Paleocene of California. HAY et al. (1966) introduced *Chiasmolithus* for forms with a diagonal central cross or X and HAY & MOHLER (1967) described *Cruciplacolithus* for forms with a central cross aligned with the axes or a +. For many years, any Danian coccolith with a central cross along the exes was determined as *Cr. tenuis* and any specimen with a diagonal cross named *Ch. danicus*. This was still the practice when MARTINI (1971) used the FO (first occurrences) of the two species to define the bases of his "Standard Nannoplankton Zones" NP 2 and NP 3 respectively.

PERCH-NIELSEN (1969) had introduced *Cr. inaequus* for forms with additional diagonal bars, *Cr. subrotundus* for round and subround forms and *Cr. brotzenii* for specimens with a central cross and additional elements filling the central area completely, from the Danian of Denmark. She also noted (1969:60, translated from German) "*Cr. tenuis* in its present definition includes forms with a wide and forms with a narrow central area, empty or filled quadrants between the bars of the cross and with an elliptical or long-elliptical outline. In the type material of *Cr. tenuis* all such forms are present". PERCH-NIELSEN (1977:746) described *Cr. notus* from NP4 as a species differing from *Cr. tenuis* by the presence of "feet" at the ends of the bars and *Cr. primus* as a small form with a "relatively large central opening spanned by a slender cross and bordered by a relatively steep wall". She pointed out that STRADNER's first illustration of *Cr. tenuis* (1961, Fig.1) shows a form with a wide wall with hardly any open space and no feet at the ends of the bars. Subsequent illustrations (1963a, 1963b, also as *C. helis*) show specimens with an open central area and bars with feet (Figs 2,3).

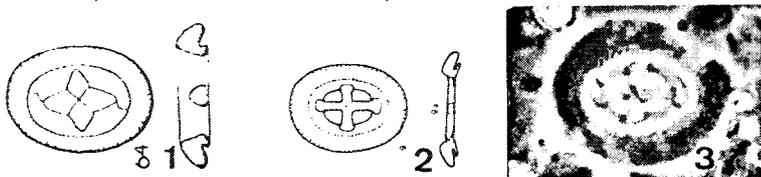


Fig. 1 *C. tenuis* STR.1961
 Fig. 2 " STR.1961b
 Fig. 3 " STR.1961a

By 1979, ROMEIN introduced *Cr. edwardsii* for forms with a slightly turned central cross, the bars meeting at 90° in the holotype. He pointed out that the "real" *Cr. tenuis* had feet and thus that *Cr. notus* was a junior synonym of *Cr. tenuis*. He also showed, that *Cr. primus* started out as a very small form of about 3 microns and reached 9 microns by the time the first *Cr. edwardsii* appeared and up to 10 microns by the time the first "real" *Cr. tenuis* with feet appeared. He included forms with a wide central opening and forms with a small central opening in *Cr. primus*, as long as they did not have feet.

Since "typical" *Cr. tenuis* were shown to appear A F T E R the FO of *Cr. edwardsii*, the oldest form with an oblique central cross, NP 2 and NP 3 could no longer be determined unless *Ch. danicus* was better defined and distinguished consistently from *Cr. edwardsii* and a way was found to restore the sequence of events to define their lower boundaries.

The illustrations of *Ch. danicus* in BROTZEN (1959) do not provide details of the central structure nor the shields (Fig. 4). My recent attempts to get a look at the original slides or receive type material have failed. In southern Sweden, sediments representing most of the Danain can be found and it is therefore difficult to reconstruct, which coccolith zone of the Danian the type material represented. Since BROTZEN (1959) distinctly described a diagonal central cross we might assume that it is a relatively late form with a well developed central X rather than one as described in *Cr. edwardsii*, where it is only a slightly turned +. Forms usually attributed to *Ch. bidens* appear near the top of the Danian in Denmark in layers which are not known from Sweden. *Ch. consuetus* also has been reported from NP 3 and NP 4 (mainly before the description of *Cr. edwardsii*).

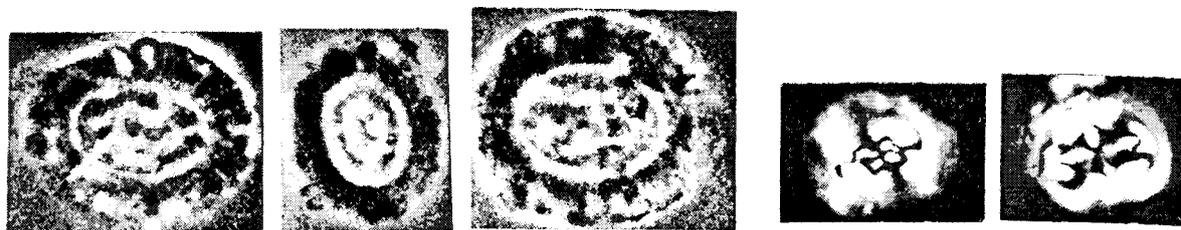


Fig. 4 *Ch. danicus*, type material, BROTZEN, 1959. *Cr. edwardsii*, ROMEIN, 1979

At the present "state of the art", NP 2 and NP 3 although well defined, can not be distinguished properly due to the poor definition of the marker species at the time when the zones were proposed.

The fact to have numbered Standard Zones has certainly helped our communication with geologists and specially geophysicists. We have an interest to use Standard Zones whenever possible - at least as a generally useful and accepted framework for more local zonal schemes. But we also must find and agree on ways to adapt the Standard Zones when we realise that the original markers were poorly defined at the time, and that we now have evidence, that their e v o l u t i o n a r y appearance was in reversed order than assumed at the time of their introduction as zonal markers.

I hope several possibilities will be discussed at the present meeting:

- re-describe *Cr. tenuis* and *Ch. danicus* from their type material (NP 3/4* in the case of the former, NP 3 - by definition? - in the case of the latter. * = changed boundary of NP).
- agree on a definition of either species
- change the definition of the lower boundaries of NP 2 and NP 3 (not acceptable if we want to keep them as "Standard Zonation"?).
-

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EARLY PALEOCENE CALCAREOUS NANNOFOSSILS FROM DAKAR, SENEGAL

K. Perch-Nielsen, Geol. Inst. ETH-Z, CH-8092 Zürich

The investigation - as a contribution to IGCP 183 - of 9 samples from the "Formation des Madeleines" has yielded Early Paleocene calcareous nannofossil assemblages from an area and age where little is known about the coccolith stratigraphy or assemblages. Details about other fossils and the outcrop - cliffs along the sea at Dakar - are given in BELLION et al. (in press), whereas details of the calcareous nannofossil assemblages are given here.

SAMPLE	ABUNDANCE PRESERVATION	Fossil Species																ZONE: MARTINI (1971), (P.-N. 1979)																			
		<i>Micula decussata</i> *	<i>Watznaueria barnesae</i> *	<i>Prediscosphaera cretacea</i> *	<i>Cribrrosphaera ehrenbergii</i> *	<i>Placozygus fibuliformis</i> *	<i>Markalius inversus</i>	<i>Markalius apertus</i>	<i>Thoracosphaera operculata</i>	<i>Thoracosphaera saxea</i>	<i>Biantholithus sparsus</i>	<i>Crepidolithus sp.</i>	<i>Placozygus sigmoides</i>	<i>Octolithus multiplus</i>	<i>Braarudosphaera bigelowii</i>	<i>Ericsonia cava</i>	<i>Ericsonia subpertusa</i>		<i>Cruciplacolithus primus</i>	<i>Cruciplacolithus tenuis</i>	<i>Cruciplacolithus edwardsii</i>	<i>Chiasmolithus danicus</i>	<i>Chiasmolithus consuetus</i>	<i>Neochiastozygus primitivus</i>	<i>Neochiastozygus modestus</i>	<i>Neochiastozygus sp.</i>	<i>Prinsius tenuiculum</i>	<i>Biscutum? sp.</i>	<i>Acanthoica? sp.</i>	<i>Chiastozygus ultimus</i>	<i>Cyclagelosphaera reinhardtii</i>						
0+5m	Ca, Mp					+	F	+			F				C	+	R	+	+	+	+		+	+	+					+	+	+		+	+		
0+3.5m	Cf, Pm						F				R				R		R	+	R	+	+		+	+	?												
0+1.5m	Ca, M					+	F	+			R	+			C	R	R	+	+	+	+	+	+	R	+	+	+	+	+	+	+	+	+	+	+		
0+0.5m	Ac, M	+	+	+		+	C	+	+		R				C	R	R	+	+	+	+	+	R	R	+	+	+	+	+	+	+	+	+	+	+		
0m	Rf, Pm	+					R	+			+				R	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
+1m	Ca, M	+	+			+	F	+			R	+		+	F	R	R	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	R	
-1m	Cf, Mp			+		+	F	+	+	+	F			+	F	R	R	+	R	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
-2m	C, Mp	+	+				F	+			R				R	R	R	+	+	+	+	+	+	+	+	C	+									R	
-2.5m	Rf, Pm					+	R	+			R				R	R	+		+	+	+	+			+	+	?										

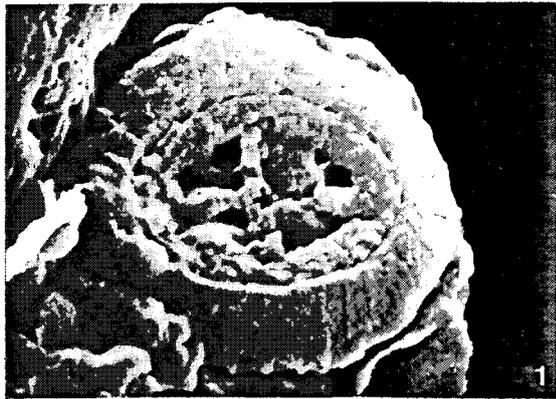
The presence of *C. danicus* assigns the assemblages, which are dominated by *E. cava*, to the Late Danian NP 3. *P. tenuiculum* appears in the upper part of this zone, shortly before *N. modestus* (Subzone D 7). The assemblages correspond to the *E. subpertusa* association which HAQ & LOHMANN (1976) found in the South Atlantic and the Caribbean. Figs 1-7 show several species.

BELLION, Y., AUSSEIL, J., COLIN, J.-P. et al., in press. Précisions sur l'âge de la Formation des Madeleines de Dakar (Sénégal).

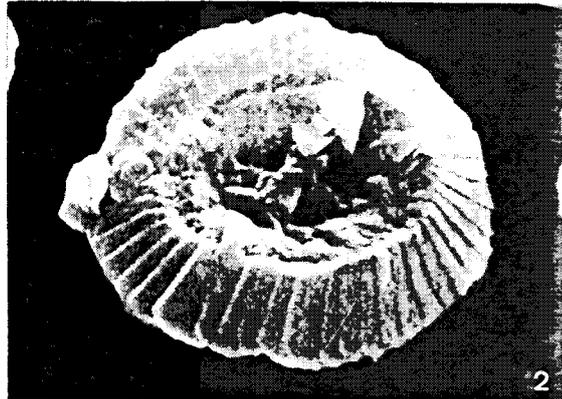
HAQ, B.U. & LOHMANN, G.P. 1976. Early Cenozoic calcareous nannoplankton biogeography of the Atlantic Ocean. Mar. Micropaleont., 1:119-194.

MARTINI, E., 1971. Standard Tertiary and Quaternary calcareous nannoplankton zonation. Proc. 2nd Planktonic Conf., Roma:739-785.

PERCH-NIELSEN, K., 1979. Calcareous nannofossil zonation at the C/T bd in Denmark. Symposium C/T bd events, Copenhagen: 115-136.



Cruciplacolithus tenuis



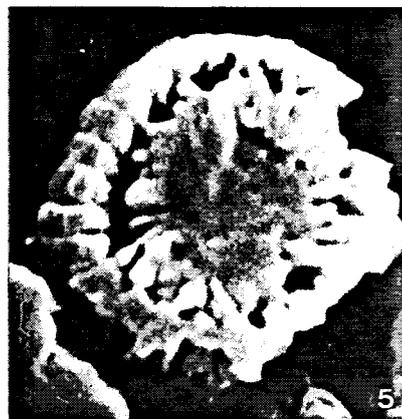
Cruciplacolithus edwardsii



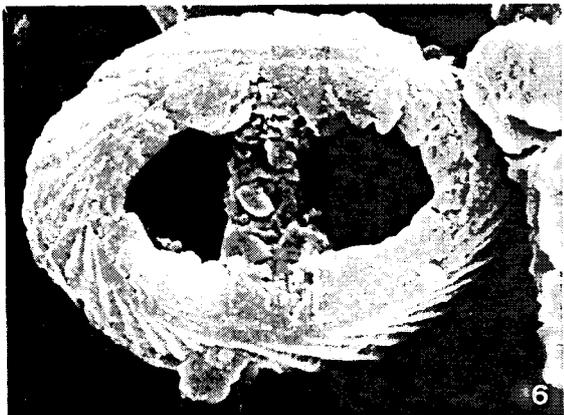
Cruciplacolithus primus



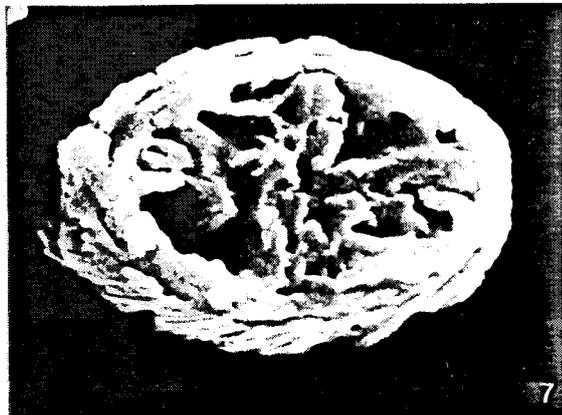
Ericsonia subpertusa



Nodosella? sp.



Placozygus sigmoides



Neochiastozygus primitivus

Calcareous nannofossils from Sample - 1m, marnes des Madeleines,
Dakar, Senegal. Negatives at Geol. Bundesanstalt, Vienna.

Magnifications: 1:10 000x, 2:6 250x, 3:6 000x, 4:4 000x, 5:12 500x,
6:6 500x, 7:11 500.

Contribution to IGCP 183, West African Mesozoic and Cenozoic Correlations

NOTES ON THE PRINSIACEAE, A CENOZOIC CALCAREOUS NANNOPLANKTON
FAMILY

K. Perch-Nielsen, Geol. Inst. ETH-Z, CH-8092 Zürich

In many Cenozoic samples, small or large representatives of the family Prinsiaceae dominate the calcareous nannofossil assemblage. They are more solution resistant than most other Tertiary coccoliths and also survive in colder and less saline waters than most other coccolithophorids.

ORIGIN

There are no forms assignable to the Prinsiaceae in the lowermost Paleocene. *Prinsius petalonus* and *P. dimorphosus* appear in NP 1 and NP 2 respectively. Their distal shield consists of elements interlocking like those in Cretaceous *Biscutum* and *Prediscosphaera*. *Prediscosphaera* species always have 16 elements in the distal shield, whereas their number varies in *Biscutum* and *Prinsius*. Two very small forms probably belonging to *Biscutum*, *B.?* *romeinii* and *B.?* *parvulum* appear before any other new coccoliths above the Cretaceous/Tertiary boundary and before the FO of *P. petalonus*. The elements in their distal shields also interlock like in larger, Cretaceous *Biscutum* and the elements forming the end of the ellipse are wider than those along the sides, just as in Cretaceous *Biscutum*. Large forms of *Biscutum* (>5 microns) increase in abundance above the C/T bd in high latitudes. Very small forms (*B. notaculum*) are known from the Upper Maastrichtian of the Falkland Plateau. The interlocking of shield elements is still visible in many specimens of *P. martinii* in NP 4, but has vanished in forms like *Toweius eminens* or *T. pertusus* which appear in NP 5/6. *Biscutum* thus seems a likely ancestor of *Prinsius* and thus the Prinsiaceae.

The forms of *Biscutum* and early forms of *Prinsius* have non-birefringent distal shields which stay dark between crossed nicols, whereas the distal shield is partly birefringent in *P. bisulcus* (NP 4,5) and wholly birefringent in most species of *Toweius*. Thus while the construction of the central area remained similar from *Prinsius* to *Toweius* (two cycles or layers), the elements of the distal shield became re-oriented. Eocene and younger forms all have birefringent distal shields.

SPECIES AND GENERA

Many species have been described and many are difficult to distinguish. The genera are shown in Fig. 1

PRINISIACEAE	OUTLINE	SIZE	DISTAL SHIELD	WALL(S)	OPENING, CENTRAL AREA	ZONES RANGE
* generotype o other species ● holotype ○ other specimens Genus Species		LENGTH 5 10				BIREFR. centr. ar. prox. shield
<i>Emiliana</i>						
<i>E. huxleyi</i> *						
<i>Gephyrocapsa</i>						
<i>G. aperta</i>						
<i>G. caribbeanica</i>						
<i>G. ericsonii</i>						
<i>G. lumina</i>						
<i>G. margerelii</i>						
<i>G. mediterranea</i>						
<i>G. muelleriae</i>						
<i>G. oceanica</i> *						
<i>G. omega</i>						
<i>G. ornata</i>						
<i>G. parallela</i>						
<i>G. pelta</i>						
<i>G. protohuxleyi</i>						
<i>G. rota</i>						
<i>G. sinuosa</i>						
<i>Pseudoemiliana</i>						
<i>P. doricoides</i>						
<i>P. lacunosa</i> *						
<i>Noelaerhabdus</i>						
<i>N. bozinovicae</i> *						
<i>Dictyococcites</i>						
<i>D. antarcticus</i>						
<i>D. bisectus</i>						
<i>D. callidus</i>						
<i>D. danicus</i> *						
<i>D. daviesii</i>						
<i>D. hesslandii</i>						
<i>D. onustus</i>						
<i>D. productellus</i>						
<i>D. productus</i>						
<i>D. scrippsae</i>						
<i>Reticulofenestra</i>						
<i>R. caucasica</i> *						
<i>R. dictyoda</i>						
<i>R. gelida</i>						
<i>R. hampdenensis</i>						
<i>R. haqii</i>						
<i>R. hillae</i>						
<i>R. minuta</i>						
<i>R. minutula</i>						
<i>R. oamaruensis</i>						
<i>R. placomorpha</i>						
<i>R. pseudumbilica</i>						
<i>R. samodurovii</i>						
<i>R. umbilicus</i>						
<i>R. lockeri</i>						
<i>R. clatrata</i>						
<i>R. ornata</i>						
<i>R. tokodensis</i>						
<i>Cyclicargolithus</i>						
<i>C. abisectus</i>						
<i>C. floridanus</i> *						
<i>C? luminis</i>						
<i>C. marismontium</i>						
<i>Cribocentrum</i>						
<i>C. coenurum</i>						
<i>C. foveolatum</i> *						
<i>C. martinii</i>						
<i>C. reticulatum</i>						

Fig. 2 PRINISIACEAE overview: do-it-yourself characterisation of species and genera

THE TERTIARY CALCAREOUS NANNOFOSSIL GENUS *HELICOSPHAERA* -
A BASIS FOR DISCUSSIONS

K. Perch-Nielsen, Geol. Inst. ETH-Z, CH-8092 Zürich

Nearly 50 species of *Helicosphaera* have been described sofar and about 1/4 of them have been used as biostratigraphic markers. HAQ (1973) gave a first overview of the genus and suggested evolutionary lineages (Fig.1). JAFAR & MARTINI (1975) discussed the use of *Helicosphaera* versus *Helicopontosphaera*.

Two new overviews have been published recently within a few months by THEODORIDIS (1984) and PERCH-NIELSEN (1985). The former discussed most species, introduced 6 new species from the Mediterranean, suggested a new terminology and evolutionary connections (Figs 1 = 5). The latter gave an overview by reproducing most illustrations of the holotypes, by giving tentative rangecharts and by suggesting evolutionary connections in a chapter of a text-book on plankton stratigraphy (Fig.2). The two authors based their groupings and successions on different criteria. While THEODORIDIS observed mainly the changes in the distal shield (his blanket), PERCH-NIELSEN concentrated on the outline and the type of bridge. A combination of the two schemes of lineages will be attempted on a Poster and should serve as a basis for discussions at the meeting.

TERMINOLOGY

While P-N used a relatively simple terminology (Fig.4), TH developed a more sophisticated one (Fig.5).

Note: TH's	bridge	corresponds to PN's	optically distinct bridge
	bar		continuous bridge
	normally oriented openings		oblique bridge
	inversly oriented openings		"inverse" bridge
	spur	} wing termination }	terminal flange
	abrupt		
	gradual		
	proximal expansion		-
	-		notch
	proximal plate types I,II,III		central area
	flange types I,II		proximal/distal shield
	blanket types I,II,III		-
	principal suture		-

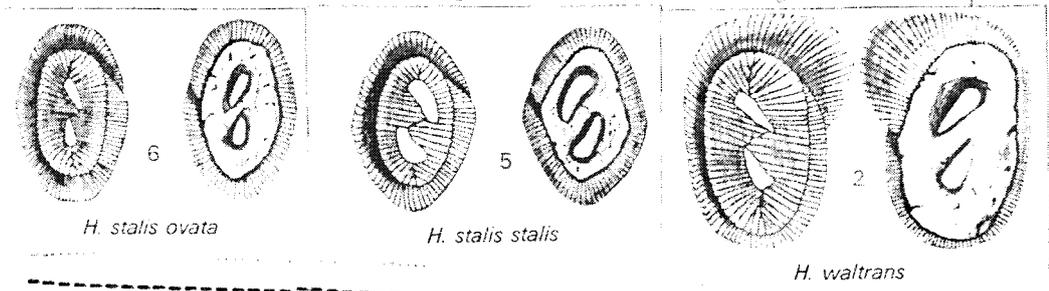
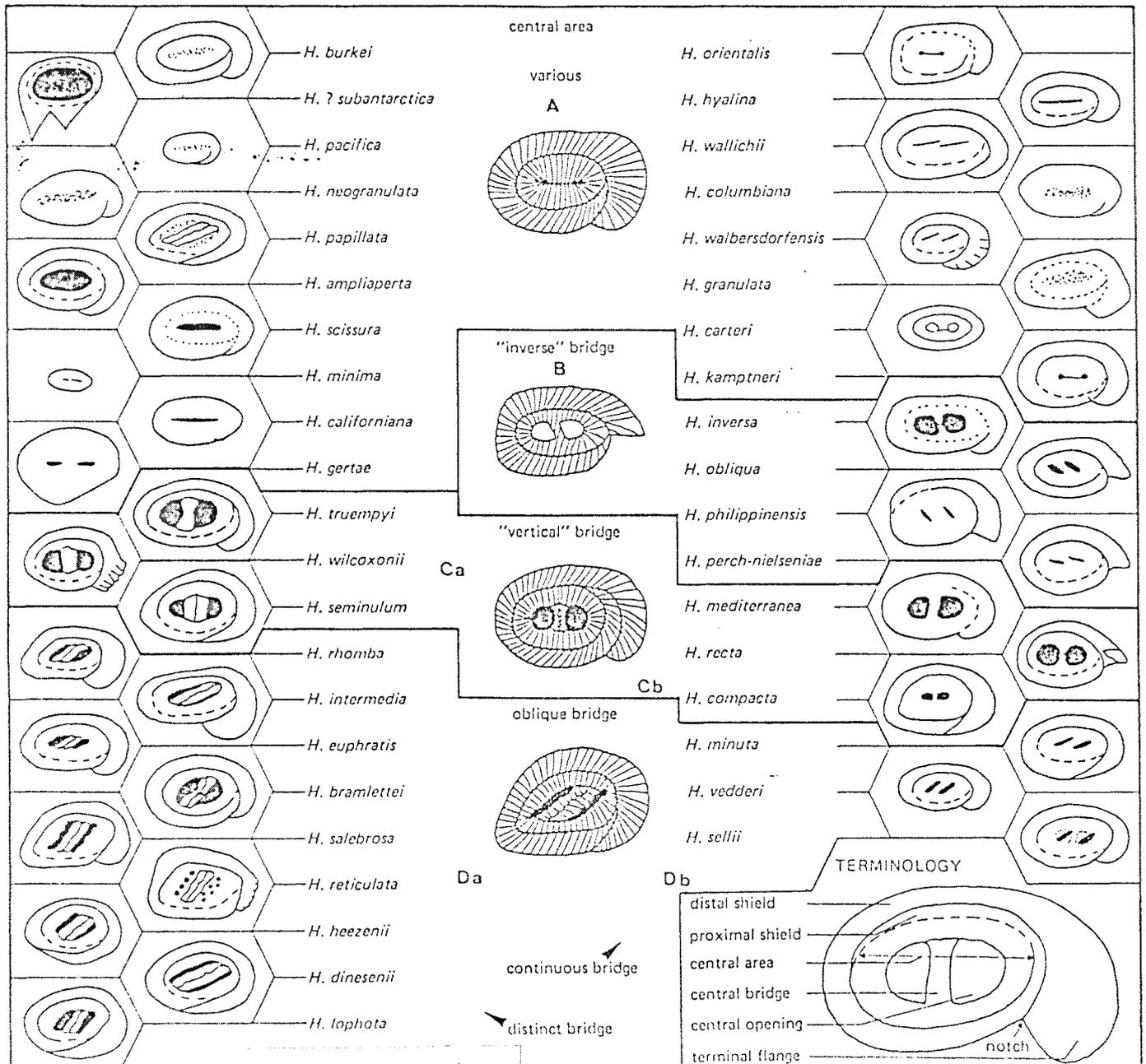


Fig. 4 overview
Helicosphaera
from PERCH-N. 1985
and THEODORIDIS, 1984

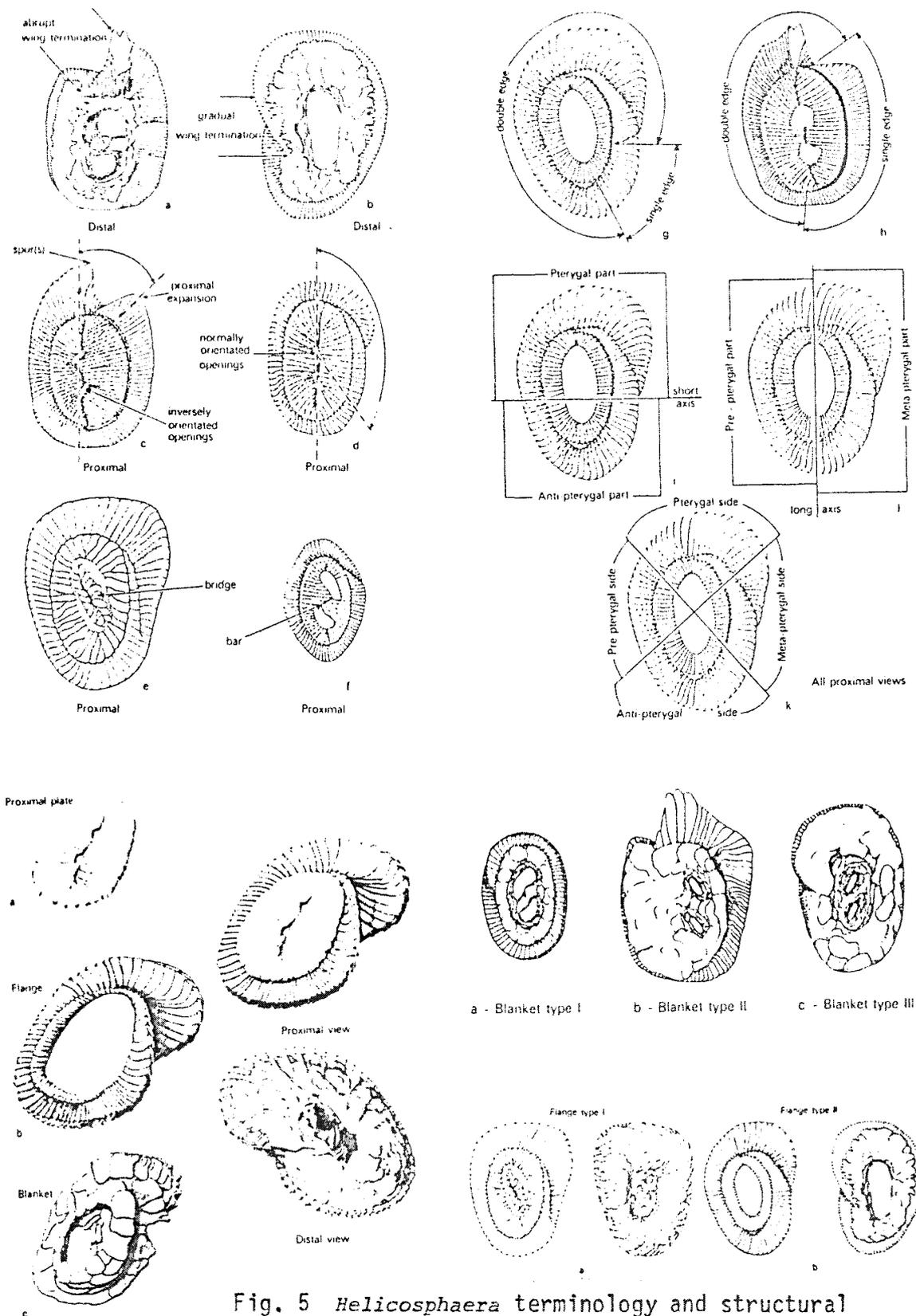


Fig. 5 *Helicosphaera* terminology and structural units. From THEODORIDIS (1984, Figs. 51,52,54,55): Calcareous nannofossil biozonation of the Miocene and revision of the helicoliths and discoasters. Utrecht Micropal. Bull. 32:1-271.

TRIASSIC NANNOLITHS FROM AUSTRIA

by Friedrich POSCH and Herbert STRADNER, Geol.B.A. Wien.

Since Triassic nannoliths have been described in important papers by FISCHER, HONJO & GARRISON 1967, MOSHKOVITZ 1982, JAFAR 1983 and BOWN 1985, who all have examined samples from sites in Austria, we have tried to collect further data and give more evidence on the species so far described.

Among sixty samples of our collection unfortunately only five are fairly well suited for electron microscopy. In the others the state of preservation and frequency were not found rewarding.

Our nannofossiliferous samples are of Upper Triassic (Norian and Rhaetian) age and come from the Hohe Wand, Lower Austria, the Poetschenpass, Upper Austria, the Fischerwiese, Styria (2 samples) and from the Ampelsbach in the Tyrol. None of these samples is identical with any used for previous studies.

The following three species were identified:

Conusphaera zlambachensis (MOSHKOVITZ 1982)

1982 *Conusphaera zlambachensis* nov. spec.
MOSHKOVITZ, p. 612, pl.1, fig. 1-10

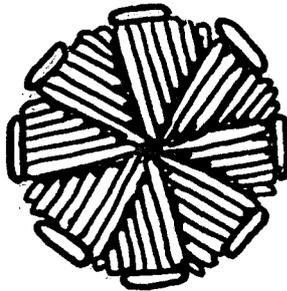
1983 *Eoconusphaera tollmanniae* nov. spec.
JAFAR, p. 228, figs 6/1a-1c, 6/2.

These Triassic cone-shaped nannofossils have an interior crystal arrangement slightly different from that of the Lower Cretaceous *Conusphaera mexicana* TREJO 1969. While *Conusphaera mexicana* is composed of three conical layers of elongate crystal lamellae with the two inner ones in more or less radial arrangement and the outer one in peripheral orientation to form the mantle of the cone-shaped body, *Conusphaera zlambachensis* shows only two different groups of elements, namely the core and the mantle. The core of the conical body consists of 7 or 8 piles of tabular rhombohedral calcite plates, which are obliquely stacked and are aligned in such a way, that the longer edges of the crystal plates of one pile are bordering the serrate edges of the neighbouring pile. The cross-section of a conical body shows a distinct twist of the radially arranged piles. The mantle surface consists of elongated, smooth plates each separated from each other by an interval or a deep suture (compare MOSHKOVITZ, pl.1, fig.3), while in *Conusphaera mexicana* the mantle appears to be tightly fitting and entirely closed (compare THIERSTEIN, pl.3, fig.1 and GRÜN & ALLEMANN, pl.8, fig.10 and text-fig.30).

The mantle of *Conusphaera zlambachensis* seems to be analogous to the middle layer in *Conusphaera mexicana*. The outer mantle of *C. mexicana* seems to be a later evolution during the time from Upper Triassic to Lower Cretaceous, or it has not been preserved and thus never been observed in *Conusphaera zlambachensis*.

In analogy to *Conusphaera mexicana* (compare original description by TREJO 1969, figs. 7 and 8) also the conical nannoliths of *Conusphaera zlambachensis* are considered to represent the "building-stones" of hollow spherical shells with an overall diameter four times that of the width of the wall.

Since the wall in *Conusphaera*-spheres in most cases is disintegrated, the length of a conical body would correspond to the width of the wall of the sphere. By measuring the angle of the cone, one can calculate the diameter of the entire "nannolithosphere", which in the case of *Conusphaera zlabachensis* has varied from 25 to 40 microns.



Cross section of
a conical body
of *Conusphaera*
zlabachensis
MOSHKOVITZ

Prinsiosphaera triassica JAFAR 1983

- 1967 "ultramicroscopic bodies composed of batteries of small plates".
FISCHER, HONJO & GARRISON, p.36, Figs.79-81.
- 1979 *Thoracosphaera* ssp. 6 & 7. JAFAR; Pl.3, Figs. 7a-b, 8a-b.
- 1982 Undetermined globular calcitic body - MOSHKOVITZ, p.614, pl.2, Figs.3 and 4.
- 1983 *Prinsiosphaera triassica* JAFAR, p.232, Fig.8/ 1a-1c.

The calcareous bodies are usually spherical with a depression at one end. They have a compact core, which is covered by a separate shell, both core and shell being composed of parallelly stacked groups of calcite plates. Speaking generally these crystal stacks lie in random distribution, however towards the depressed end or the crater they in some specimen show an orientation along the meridians of the globular body (compare also MOSHKOVITZ, pl.2, Fig.3). There is only one crater per specimen, and it appears to be spared out by the crystal stacks.

In all our samples more common than *Conusphaera* .

Prinsiosphaera geometrica JAFAR 1983

- 1983 *Prinsiosphaera geometrica* JAFAR; p.233, Figs.10/5 and 10/6.

Spherical or hemispherical calcareous bodies which on one side, the domal part, show a more delicate ultrastructure consisting of minute equidimensional interpenetrant calcite rhombohedra. The rest of the surface shows similar features as in *Prinsiosphaera triassica* JAFAR. Very rare in our samples.

At the INA-Meeting in Vienna a poster with lightmicroscopic pictures and electronmicrographs will be shown as basis for discussion about the above mentioned species as well as about "nannoproblematica".

LATE EOCENE TO HOLOCENE
MEDIUM- AND SMALL-SIZED
"RETICULOFENESTRIDS"

A.PUJOS , Laboratoire de Géologie et d'Océanographie , Université de
Bordeaux I , Ave des Facultés , 33405 , Talence , France .

The "Reticulofenestrids" term is usually attributed to coccoliths presenting similar morphologic characteristics i.e. 2 oval shields joined by a simple tube which ends by a collar on the distal side and sometimes by a grid . Taxonomically , the "Reticulofenestrids" belong to the Gephyrocapsaceae family which is here the subject of Cenozoic and Quaternary sediment observations (in Leg 85) . The small-medium species of this family are represented by the genera *Reticulofenestra* , *Dictyococcites* , *Gephyrocapsa* , *Crenalithus* , *Pseudoemiliana* and *Emiliana* . A distinction between the above genera is , however , difficult to make because of the evolutionary trends (*Reticulofenestra* --> *Gephyrocapsa* , *Dictyococcites* --> *Gephyrocapsa* , *Reticulofenestra* --> *Pseudoemiliana* , ...) and/or the forms' convergence , probably instigated by ecological factors . The smallest "Reticulofenestrids" Tertiary specimens have been studied to obtain an accurate morphologic definition of the species : *minuta* , *tagana* , *haqii* , *minutula* and *insignita* . A true *Gephyrocapsa* is dated as early middle Miocene - late Pliocene; its distribution could be related to a very high productivity rate induced by water upwelling .

In the Tertiary high latitude sediments , nannofossils are almost exclusively "Reticulofenestrids" . Subsequently , a zonation on the basis of these species cannot but be very useful . They have , in fact , usually been ignored in sequences rich in classical datums . Such well-dated sequences should however , be used to yield stratigraphic calibrations of "Reticulofenestrids" . These highly informative sequences are encountered in high productivity central Equatorial Pacific areas . In this productive area , a "Reticulofenestrid" zonation is established in relation to the Bukry's low latitude zonation and magnetostratigraphy . The stratigraphic distribution of these species is later searched in papers alluding to Tertiary sediments of various oceans and at various latitudes . Finally , "Reticulofenestrids" are observed

in several Antarctic cores of the Indian ocean .

"Reticulofenestrids" show from low to high latitudes several distribution differences which may be attributed to taxonomic problems or to the "latitudinal impact" which either advances or delays Highest or Lowest "Reticulofenestrids" occurrences . More specific ecologic factors are in this study questioned , e.g. *Reticulofenestra pseudo-umbilica* which disappeared between 8 and 10 M.a. at low latitudes in the Pacific with the upwelling of ancient deep water masses .

Cretaceous - tertiary boundary at the Pointe-St-Anne - Section (Bay of Biscay - French Basque country)

C.SEYVE *

The Pointe-St-Anne section, in the French Basque country, (south western France - Aquitaine Basin) is a location with a well exposed outcrop of the Cretaceous-Tertiary boundary, located by the Atlantic ocean, only a few kilometers from the well known Bidart section (south of Biarritz).

The calcareous nannofossils of a sequence of 10 m thick have been studied. Qualitative and semi-quantitative study allowed us to propose a biostratigraphical interpretation of this section. Great changes occur in the calcareous nannofossil taphocoenosis, prior to the Maastrichtian/Danian boundary. As the limit is abrupt and tectonically evident, this good section is unfortunately, certainly not complete.

One must point out the similarity between this section and the Bidart section, from a lithological and paleontological point of view. Such a comparison makes us feel that, the Bidart section, despite the occurrence of the Iridium anomaly is not complete either.

* Elf Aquitaine
Centre de Recherche de Pau, Dpt. Biostratigraphie, E.25
64018 PAU Cedex, France

A taxonomic and bibliographic analysis
of calcareous nannoplankton literature

John C. Steinmetz, Denver Research Center, Marathon Oil Company,
P.O. Box 269, Littleton, Colorado 80160 USA

Analysis of literature on calcareous nannoplankton, based on bibliographies published by Loeblich and Tappan, van Heck, and Steinmetz, reveals the following: 521 new genera, 3712 new species (including new subspecies and new variations), and 1390 new combinations have been validly published since the first new species was published by Ehrenberg in 1839. One-half of all new genera have been described since 1967, one-half of all new species since 1966, and one-half of all new combinations since 1971. This is largely in response to the publication of monographic works based on land-sections and of the results of the Deep Sea Drilling Project. Publication trends in the 1980s suggest that the numbers of new taxa described will decline, reflecting the thoroughness of study the calcareous nannoplankton have received.

Analysis of the subject matter included in over 1900 titles from the International Nannoplankton Association Newsletter bibliographies (through volume 6) shows the following: 68 % of the papers deal with stratigraphy and 37 % with systematics. Only 3 % of the papers published include the introduction or re-definition of new zones or subzones. Thirteen percent contain changes in systematics, i.e. new taxa or new combinations. The most-studied geologic period is the Tertiary (1230 papers), followed in decreasing order by: the Cretaceous (584), the Quaternary (144), the Recent and Jurassic (both with 118), and the preJurassic (7). The most-studied ocean basin is the Atlantic (185 papers), followed by the Pacific (131), the Mediterranean (83), the Indian (25), the Antarctic (21), and the Arctic (1). Forty-eight papers deal with calcareous nannoplankton on a worldwide basis. The terrestrial regions of the world to receive the most study are the following: Western Europe (335 papers), North America (139), Eastern Europe (129), East Asia (89), North Africa (48), Australasia (35), and Southwest Asia (21). Regions with notably few studies are Russia (14 papers), Central America (12), South America (5), and Central and South Africa (1).

Shifts in publishing trends are shown in the recent increase in the number of papers dealing with the biology and ecology of calcareous nannoplankton, stable isotopes, and the Cretaceous-Tertiary boundary.

DISTRIBUTION OF RECENT CALCAREOUS NANNOPLANKTON IN THE NORTHERN ATLANTIC IN WINTERTIME

J.W. Verbeek
Geological Survey of The Netherlands

Between January 19th and February 3rd in 1984, 57 surface water samples were taken between the English Channel and San Juan (Puerto Rico). These samples generally consisted of ten liters of surface sea-water. The water was passed through a 0.8 micron filter, and parts of the filters were examined in a SEM to determine the presence or absence of nanoplankton. This study resulted in the preliminary recognition of four assemblages separated by barren intervals.

Assemblage A is defined according to the dominance of *Emiliana huxleyii*, *Cyclococcolithina leptopora*, and *Coccolithus pelagicus*. The assemblage consists of a small number of species. Besides the three species mentioned, *Gephyrocapsa oceanica* and *Gephyrocapsa* sp. occur. *Coccolithus pelagicus* is restricted to assemblage A. This assemblage is also recognizable at two stations of Okada and MacIntyre (1977, 1979), Charlie and Bravo, and is quite well comparable with MacIntyre and Be's (1967) floral zone IV. In the winter period, the association has been found north of 50 degrees in the northeastern Atlantic, although MacIntyre and Be (1967) put the southern boundary of their floral zone IV north of Scotland. In the northwestern part of the Atlantic this boundary seems to be located about five degrees farther south.

Assemblage B is defined on the basis of the dominance of *Emiliana huxleyii*, *Cyclococcolithina leptopora*, and *Gephyrocapsa* sp. This assemblage too has a small number of species. It differs from assemblage A by the absence of *Coccolithus pelagicus*. Assemblage B was recognized in two samples separated by a small barren interval. In the southern sample *Umbellosphaera irregularis* also is abundant. Comparison of this assemblage with the floras described by MacIntyre and Be (1967) or Okada and MacIntyre (1977, 1979) is difficult. The distribution seems to be restricted to an area between 38 and 45 degrees north and is possibly limited to the eastern part of the North Atlantic. It is also possible that assemblage B is only recognizable during the winter.

Assemblage C is defined by the dominance of *Emiliana huxleyii*, *Umbilicosphaera sibogae*, and *Gephyrocapsa ericsonii*, but this applies only to the northern part of the area to which the assemblage has been assigned. In the southern part the flora shows no characteristic features. This flora has been assigned to assemblage C on geographical grounds. Between the distribution areas of assemblages C and D there is a rather long barren interval. Further investigation in this area is required to solve this problem. *Umbilicosphaera sibogae* and *Gephyrocapsa ericsonii* are restricted to assemblage C, and other *Gephyrocapsa* species occur more frequently than in the other assemblages. Some species of the genus *Syracosphaera* are also restricted to this assemblage, e.g. *S. corrugis*, *S. mediterranea* and *S. variabilis*. The assemblage has a moderate number of species, but with the exception of *Homozygosphaera wetsteinnii* in sample 27 holococcoliths are absent.

Okada and MacIntyre (1977) report *U. sibogae* as a common species in the Delta and Echo stations, and in their 1979 paper *G. ericsonii* is mentioned as an important species. Therefore, the floras at these two stations in the winter are similar to our assemblage C.

The geographical distribution is not entirely clear, but in the eastern part of the North Atlantic the assemblage seems to cover an area of the Atlantic between about 29 and 35 degrees and to the east the northern boundary reaches almost to 40 degrees north. In the extreme east, due to the influence of the Gulf Stream, the southern boundary may be located at about 35 degrees north.

Assemblage D is defined on the basis of the dominance of *Emiliana huxleyii*, *Umbellosphaera irregularis*, and *Umbellosphaera tenuis*. Other commonly occurring species are *Neosphaera coccolithomorpha* and *Umbilicosphaera hulburtiana*. Holococcoliths were found frequently, e.g. *Homozygosphaera schilleri*, *H. triarcha*, *Sphaerocaliptra papillifera*, *Calyptrorpha catillifera*, *C. oblonga*, and *C. pirus*. Some *Syracosphaera* species too were only found in assemblage D, e.g. *S. lamina*, *S. exigua*, *S. histrica*, and *S. nana*. As found for the above-mentioned assemblages, the area where assemblage D was recognized showed some barren intervals. Like assemblage C, assemblage D showed a decrease in the number of species toward the south. If our results are compared with fig. 10 in Okada and MacIntyre's 1979 paper, it is evident that the flora of their station Hotel can only tentatively be assigned to our assemblage D. It is remarkable that the flora of September 1973 at the station Hotel corresponds better than those of January and February with our assemblage D. The southern boundary of assemblage D was not reached during the present study and no data are available from the eastern part of the Atlantic.

In the western part of the North Atlantic the northern boundary seems to reach from 25 degrees to about 35 near the east coast of the United States.

References:

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Calcareous Nannofossils of Quaternary Discovered in Yangzi
Delta and its Paleoenvironmental Significance (Abstract)

Wang Chongyou, Huang Wei

(The Institute of Geology, Chinese Academy of Geological
Sciences, Beijing, China)

The discovery for the first time of calcareous nannofossils in Yangzi Delta, China, one of the biggest deltas in the world, including Shanghai and parts of Jiangsu and Zhejiang, provides new data for the geological study in this area in the future. Calcareous nannofossils have been found in the eight drilling holes in the Quaternary strata in Yangzi Delta and 10 species of 9 genera were recognized. They are: *Braarudosphaera bigelowi*, *Coccolithus pelagicus*, *Cyclococcolithus leptoporus*, *Emiliana huxleyi*, *Gephyrocapsa oceanica*, *Helicopontosphaera hyalina*, *H. wallichi*, *Pontosphaera japonica*, *Syracosphaera lamina*, *Umbilicosphaera sibogae* etc.. Among them, *G. Oceanica* is the most abundant, *E. Huxleyi* and *H. wallich* are less common, and others are relatively rare. A few elements are well preserved. A regular distribution of the calcareous nannofossils is recognized in the Quaternary strata. Thus providing an additional basis for stratigraphical classification and palaeoenvironmental study. In the light of the change of nannofossils in genera and species, their content and state of preservation, seven transgressions tending to intenser and intenser can be recognized from early to late Quaternary. Together with the regressions without nannofossils they represent the principal evolution of geological history of Quaternary in Yangzi Delta. (Table).

Late stage of Early Pleistocene — 1. Haichao transgression yields a paleomagnetic age of more than 0.9 Ma. The fossiliferous stratum is only about 1-2 m thick, containing only one species of *G. oceanica*. The monotonous and strongly etched fossils indicate that the transgression was so weak as to be confined to the coastal area of Haichaosi. The short-term transgression is clearly reflected on the change of climate from cold to warm. This may be correspondent to Hongya-poyang interglacial period in China and Donou-Gunz period in Europe; the Paleoenvironment was thought to be tributary area of the delta. The first regression lasted relatively long. Flora indicated a cold climate corresponding probably to Poyang glacial period in China and Gunz glacial period in Europe.

Early Middle Pleistocene — 2. Nanhui transgression The lower limit of M. Pleistocene yields a paleomagnetic age of 0.73 Ma. The thickness of the fossiliferous stratum may reach 4-10 m. Though the fossil content increases a little *G. oceanica* is the only one found in Nanhui-Haichao area. The fossils were strongly etched. The flora indicate that the climate was moderate and wet. Paleoenvironmentally, this area was considered as a marginal beach of the delta.

Late Middle Pleistocene — 3. Nanhui-Jiading transgression Fossiliferous stratum is 30 m thick with evidently increasing fossil species

and content. *G. oceanica* is most common and *E. Huleyi*, *H. wallichii* etc. are less important. Fossils were strongly or moderately etched and distributed further westward to Jiading, west of Shanghai. The flora were suggested a warm and wet climate. Paleoenvironmentally it may belong to the front of the delta and inner-neritic sea.

The second and third transgressions of the early to late Middle Pleistocene correspond to Poyang-Dagu interglacial period in China or Gunz-Mindel in Europe; the third regression corresponds to Dagu glacial period in China or Mindel in Europe.

Early Late Pleistocene — 4. Jiading-Jiashan transgression The lower limit was paleomagnetically dated at 0.2 Ma. The fossiliferous stratum has a thickness of 14m. The fossil content and species increase obviously. With *G. oceanica* as the main content, *E. huxleyi*, *U. sibogae*, *H. wallichii* etc. have also been found. There are only a few fossils well preserved. The transgression advanced westward passing Jiading and other places to reach Jinshan, Jiashan and Penghu areas of Zhejiang, covering the east part of Yangzi Delta. The flora pointed to a warm and wet climate. It is assigned to Dagu-Lushan interglacial period in China or Mindel-Riss in Europe. The paleoenvironment is thought to be the front of the delta to inner neritic sea. The fourth regression coincided with Lushan glacial period in China or Riss in Europe.

Middle Late Pleistocene — 5. Shanghai-Suzhou transgression The fossiliferous stratum has a maximum thickness of about 40 m. Both fossil species and content increased greatly. Eight species have been found; they are predominantly *G. pelagicus* and rarely *E. huxleyi*, *H. wallichii*, *H. hyalina*, *C. pelagicus*, *Cy. leptoporus*, *B. bigelowi*, *S. lamina*. etc.. Most of the elements are moderately etched and less of them are well preserved. The stratum is rich also in other marine fossils. The transgression then advanced to cover the middle and east parts of Yangzi Delta and reached Jiangyin-Suzhou-Qiaosi line in the west. The temperature in this period was higher than that of today. The transgression was correspondent to Lushan Dali interglacial Period in China or Riss-Wurm in Europe. The paleoenvironment was representative of the front of the delta to neritic sea. The deepest water reached 60 m. The fifth regression was referred to the early Dali glacial Period in China and early Wurm in Europe.

Late Pleistocene — 6. Shanghai-Taihu transgression The maximum thickness of the fossiliferous stratum is about 35 m. Fossils vary in quantity, *G. oceanica* predominating over *H. wallichii*, *H. hyalina*, *E. hixleyi*, *Cy. leptoporus*, *S. lamina*, *B. bigeloui*. Most of the elements moderately etched and some of them are well preserved. This stratum is rich also in other marine fossils. Up to this time transgression reached as far as Taihu, Changzhou and other places. The flora represents a warm and wet climate, and was suggestive of Dali interglacial period in China or Wurm in Europe. Paleogeographically, this area was the front part of the delta and inner-middle neritic sea. The sixth regression was so great as to reveal almost the whole area of East Sea continental shelf and develop a layer of dark green or tan continental solid clay without nannofossils.

Holocene — 7. Shanghai—changzhou transgression The lower boundary was dated at $0.12 \text{ Ma} \pm$ by C14 method. Fossiliferous stratum has a maximum thickness of about 13–20 m. Fossils vary greatly in content and species, Showing a high peak value in the middle period and low peak values on the early and late periods, which happen to be the three-fold subdivisions of Holocene. The middle Holocene was dated by C14 method at an age of 9 thousand years for the base limit and 3–4 thousand years for the upmost limit. Nannofossils reached their climax both in quantity and species and were well preserved. The most extensive transgression in Quaternary stretched as far as the west margin of the delta west of Changzhou, covering almost the whole delta. The palaeoenvironment was thought to be the distributary marginal beach to neritic sea. Water had maximum depth of 60 m. Flora is representative of warm and wet climate. The temperature was higher than that of today, corresponding to post-glacial period. The nannofossils in Early Holocene are similar to those in Late Holocene and less than those in Middle Holocene, both in quantity and species.

The area covered by the transgression was significantly reduced and the environment was correspondent to the front of the delta. The early Holocene climate ranged from moderate cool to moderate and belonged to preboreal period–Boreal period. In Late Holocene, the climate was similar to that of nowadays and was correspondent to sub-Atlantic period and Subboreal period.

Distribution of coccolithophores at the water surface and sediment surface of the southwest Indian Ocean.

Amos Winter, Mark Fincham and Peter Friedinger

University of Cape Town
Cape Town, South Africa

Living coccolithophore assemblages were investigated during January, 1983 to February, 1984 from thirty-five surface-water samples collected in the area of the Natal Valley (southwest Indian ocean). Fifty nine species were recognized using scanning electron microscope (SEM). Cluster analysis revealed nine different species assemblage groups dominated by Emiliana huxleyi, Umbilicosphaera hulbertiana, Umbellosphaera tenuis and Gephyrocapsa oceanica. The regional distribution of the assemblage groups seems to reflect two different oceanographic regimes: the nearly stable region of the Agulhas Current and the more labile area of its return current where the hydrological and ecological conditions change frequently.

Coccolithophore assemblages and stable isotope compositions of foraminifera in ninety-core top samples from the southwest Indian Ocean were also studied. Thirty-nine modern and eight relict coccolithophore species were identified by scanning electron microscope. The assemblages were dominated by Emiliana huxleyi, Gephyrocapsa oceanica, Umbilicosphaera sibogae, and Calcidiscus leptoporus. The relative distribution of these species at the sediment surface is mainly determined by preservation and latitude. Stable oxygen isotope work on foraminifera in the core tops reveals the relative age of the samples and shows that the ocean floor over the Natal Valley is of glacial age indicating that no modern deposition is taking place in most of this area. By using the stable isotope data we hope to reconstruct a paleobathymetric map of the southwest Indian ocean.

HOMOEOMORPHY AND FUNCTIONAL MORPHOLOGY OF CALCAREOUS NANNOPLANKTON
JEREMY YOUNG (Imperial College, London SW7 2BP, England)

Only a limited amount has been written on the possible function of coccoliths and other nannoliths. For the most part it seems to have been assumed that their functions were not inferable or even that they might have no function, acting solely as sinks for carbonate produced as a metabolic byproduct. Both these positions seem unreasonably pessimistic given the enormous diversity and complexity of nannoliths. An alternative is to examine the form of nannoliths for clues to possible functions. In particular forms which recur homoeomorphically in different groups are worth investigating, since they are likely to reflect repeated adaptation for the same function. As has been shown by work on, for instance, planktonic forams the recognition of such patterns can help in elucidating evolutionary relationships and palaeoecology, even when the underlying function is incompletely understood.

The single strongest shared characteristic of coccoliths, and most other nannoliths, is that they provide a continuous cover over the cell. This is paralleled in other algal groups by different organic and inorganic plates (or periplasts), to the extent that there are virtually no genuinely naked algae. So it seems this cover performs an essential protective and/or supportive function (cf. I. Manton 1985). The morphology of many coccoliths can be explained in terms of this function combined with various other controls not directly related to function. These include; calcite crystallography: the shape of the algal body: the mechanisms of coccolith formation: an apparent need to maintain a porous structure: and the availability of calcite. Variation occurs through the action of these controls, and from the adoption of different strategies in different coccolith groups.

There remain however numerous coccoliths, and more particularly other nannoliths, which display morphological features not explicable in these terms. Notable are bowl shapes, in many groups: the possession of spines, frequently with flaring tips, particularly in various Upper Cretaceous groups: bithecate tests. The independent recurrence of these in disparate taxa suggests that they have functional significance, possible explanations include creation of biochemical buffer zones, flotation control, and enhanced protection.

Reference I. Manton "Functional parallels among calcified and uncalcified periplasts." Abstracts International Symposium on Biomineralisation in Lower Plants and Animals, Birmingham 1985.

EXCURSION GUIDE : INA MEETING VIENNA, 22. 9. 1985

K. PERCH-NIELSEN, F. ROGL, H. STRADNER, R. BRAUNSTEIN

GEOLOGICAL OUTLINE

Vienna is situated at the western border of the V i e n n a B a s i n (Fig. 1). This basin is a SSW to NNE elongated pull-apart basin within the Alpine-Carpathian nappe system. The nappes of the Northern Limestone Alps (K a l k a l p e n z o n e) and the main part of the F l y s c h nappes are thrown down along thrusts making up the basement of the Neogene basin filling. The nappe system is overthrust to the NW over the Tertiary Alpine foredeep - the M o l a s s e B a s i n. Squeezed in between the autochthonous Molasse sediments and the Flysch nappes is a tectonically strongly disturbed zone, the W a s c h b e r g Z o n e. It consists of wedges of Tertiary silty and marly clays of Late Oligocene to Early Miocene age which are intercalated with klippen and thrust slices of Upper Jurassic to Middle Oligocene rocks. The basement of the Molasse Basin consists of the crystalline of the Bohemian Massif (B ö h m i s c h e M a s s e) deepening towards S/SE below the overthrust Alpine - Carpathian system.

Coming from Vienna the excursion crosses the northeastern end of the Late Cretaceous to Eocene Flysch nappes (Stop 1). The main part of the visited outcrops belongs to the W a s c h b e r g Z o n e (Stops 2 - 5) with its strongly changing facies and variable stratigraphy. Return along the Čechoslovakian border and into the V i e n n a B a s i n.

Lit.: GRILL 1953, 1968
JANOSCHEK & MATURA 1980
OBERHAUSER 1980
THENIUS 1974

STOP 1: FLYSCHZONE

CAMPANIAN/MAASTRICHTIAN CC 22/23

Rehgraben, old quarry NE of Langenzersdorf.

Kahlenberg beds of Kahlenberg nappe (Late Cretaceous, GRILL & KÜPPER, 1954; BRIX, 1961)

DELLMOUR (Figs. 3,4) counted 29 cycles in this flysch section (1984) with graded sandstones, marls and claystones. In the middle of the section, a distinct whitish marker bed of endurated marly limestone ("Biancone") is visible.

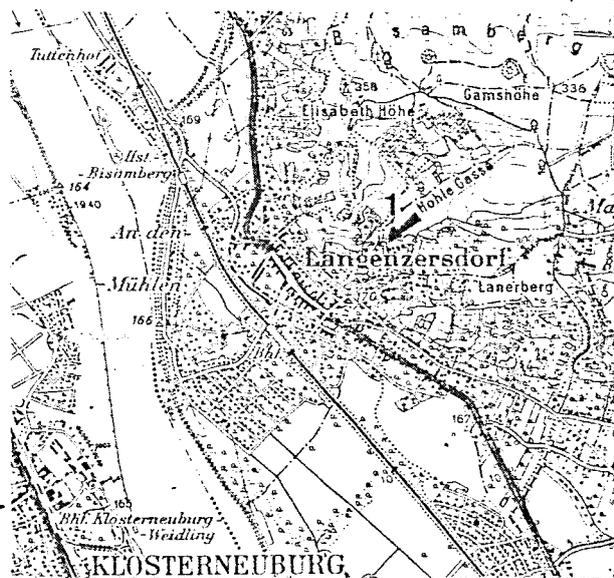


Fig.2 STOP 1

Flora: Arkhangelskiella cymbiformis, Reinhardtites levis, R. anthophorus, Ceratolithoides aculeus, Quadrum trifidum a.o. The assemblages are affected by dissolution.

Fauna: Clays contain agglutinated foraminifera. Sample

GZ 19/42 (Figs. 3,4):

- Rhabdammina sp.
- Ammodiscus tenuissimus
- Glomospira irregularis
- Trochammina sp.

- Bathysiphon sp.
- Reophax pilulifer
- Glomospirella gaultina

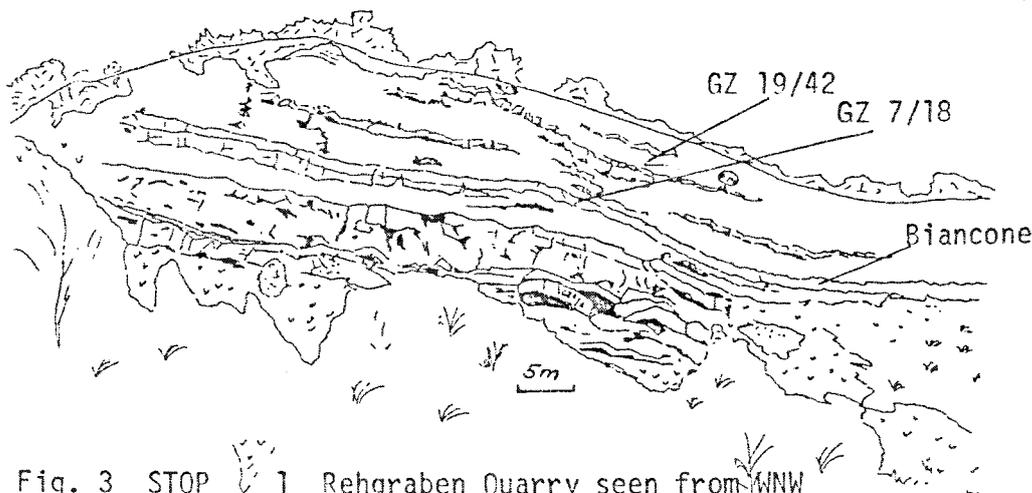


Fig. 3 STOP 1 Rehgraben Quarry seen from WNW

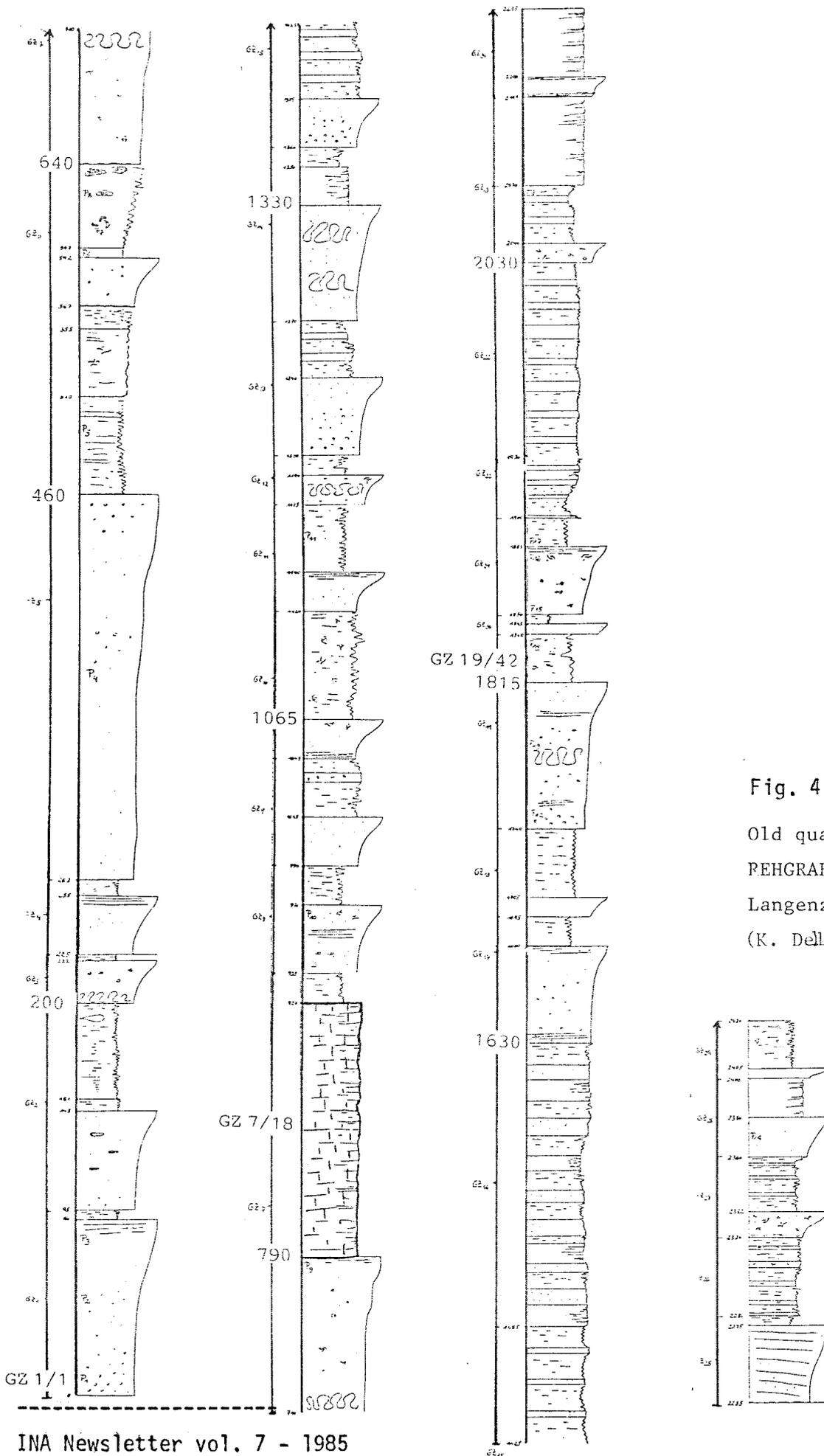


Fig. 4
 Old quarry
 PEHGRABEN,
 Langenzersdorf
 (K. Dellmour, 1984)

STOP 2: WASCHBERGZONE

Reingruberhöhe N of Brudern-
dorf; entrance to old quarry,
700m WNW of pt. 322.

Klippen of Reingruber Serie;
Outcrop and foraminiferal
fauna are described by GOHR-
BANDT (1962) and GRILL
(1962). The glauconitic sands
with marly matrix include the
coccolith assemblage typical
of NP 19 of MARTINI (1971).

Flora: Isthmolithus recurvus

Cribocentrum reticulatum

Dictyococcites bisectus

Reticulofenestra umbilica

Braarudopshaera bigelowii, Micrantholithus sp.,

Pontosphaera multipora, P. wechesensis, Zygrhablithus

bijugatus, Ericsonia ovalis, Blackites spinosus, Heli-

cosphaera lophota s. ampl., Discoaster tanii, Markalius

inversus, Sphenolithus sp. a. m. o., but discshaped

discoasters are extremely rare. STRADNER (1962) described
the following genera and species from this locality:

Corannulus, C. germanicus, C. arenarius, Zygoolithus au-

reus (now Orthozygus aureus), Trochoaster conglobatus,

Guttolithion, G. cassum, Lanternithus, L. minutus

Fauna: larger foraminifera: Discocyclina, Asterocyclina

planktonic species: Globigerina linaperta (frequent)

Catapsydrax unicavus Globigerinatheka index

Globorotaloides suteri Globorotalia cer.cerroazulensis

Chiloguembelina cf. cubensis

The overlying "Schieferige Tonmergel" or "Auspitzer Mergel"
compare to the pelites and psammities of the Zdanice - Hu-
stopece Formation in the Outer West-Carpathians. They are
Late Oligocene to Early Miocene in age and normally scarce
in microfossils (compare Stop 3).

LATE EOCENE
TYPE LOCALITY NP 19

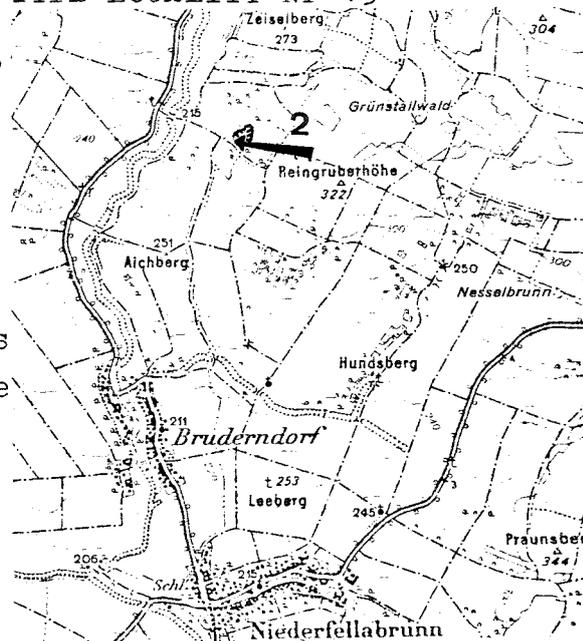


Fig. 5 STOP 2

STOP 3 WASCHBERGZONE EARLY MIOCENE SILICOFLAGELLATES

Ernstbrunn.

Brick yard near entrance to village from the S. Shaley clay-marls/ Auspitzer Mergel, Eggenburgian (GRILL 1968).

Grey, silty clays with diatoms, silicoflagellates, radiolarians, sponge spicules, calcareous nannofossils and foraminifera.

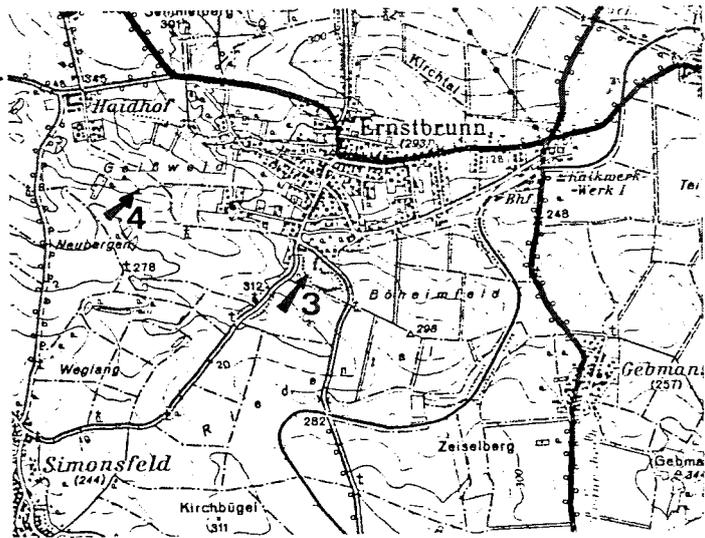


Fig. 6 STOP 3 and 4

Flora: BACHMANN (1971) reported the following species from

this outcrop: Naviculopsis navicula, N. iberica, Mesocena elliptica, Distephanus crux, D. crux parva, D. fibula rhombica, D. speculum speculum, D.s. cannopiloides, Cannopilus hemisphericus, Corbisema triacantha flexuosa, Septamesocena apiculata

Calcareous nannofossils are few to common, poorly to moderately well preserved. The assemblage is dominated by small Prinsiaceae, includes C. pelagicus, S. moriformis, Dictyococcites sp. and rare reworked Eocene (S. radians) and Cretaceous (Micula decussata, W. harnesae) coccoliths. No markers were found.

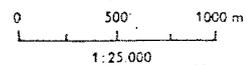
Fauna: Fairly rich foraminiferal assemblage. Planctonics:

Globigerina praebulloides G. cipercensis ottnangiensis
Globoquadrina langhiana Cassigerinella boudecensis

STOP 4 DANIAN: Cruciplacolithus tenuis type loc.

WASCHBERG ZONE

1. x: 1. Grabung (1959)
 2. x: 2. Grabung (1961)



Haidhof W of Ernstbrunn; artificial outcrop at the slope SE of the estate (SCHMID, 1962, GRILL, 1963)

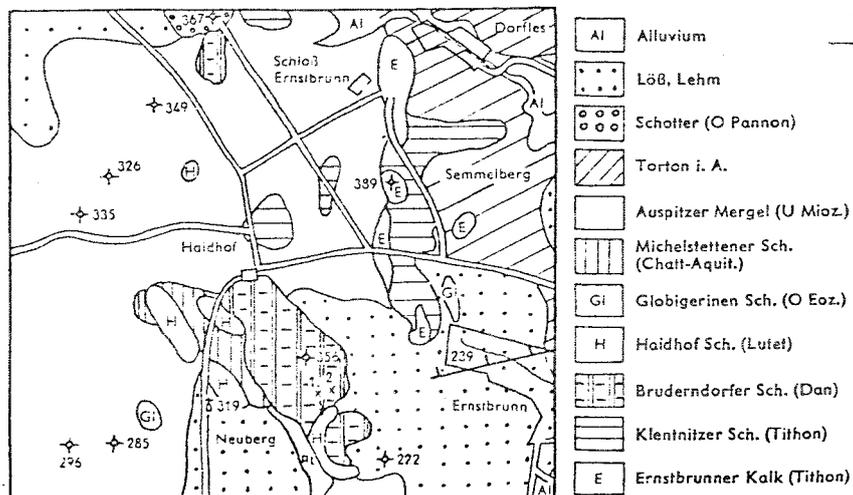


Fig. 7. STOPS 3 & 4 on geologic map (SCHMID, 1962)

Light grey sandy and silty marls underlying sandstones and algal limestones on the crest of the hill. Common occurrences of echinoids and also of Hercoglossa danica.

Flora: calcareous nannofossils are few to common and are moderately well preserved. STRADNER (1961) described Cruciplacolithus tenuis from this locality. The assemblage also includes:

Chiasmolithus consuetus, Prinsius martinii, Neochiastozygus saepes, N. denticulatus, N. imbriei, Markalius sp., M. inversus, Thoracosphaera operculata, T. saxea, Placozygus sigmoides, Ericsonia cava, E. subpertusa, Braarudosphera bigelowii, Micrantholithus sp., a.o. For a discussion of C. tenuis and related forms see PERCH-NIELSEN (this volume). This assemblage can be considered of late Danian age (correlatable to NP 3/4, despite the absence of the markers Chiasmolithus danicus and Ellipsolithus macellus, based on the presence of N. saepes and P. martinii, see PERCH-NIELSEN, 1979).

Fauna: very rich foraminiferal fauna described by SCHMID (1962).

Planctonic foraminifera:

<u>Subbotina triloculinoides</u>	<u>Globoconusa daubjergensis</u>
<u>Globorotalia pseudobulloides</u>	<u>Globorotalia compressa</u>
<u>Globorotalia inconstans</u>	<u>Chiloguembelina midwayensis</u>

STOP 5 WASCHBERGZONE EARLY to LATE OLIGOCENE

Ottenthal, road cut
SE of the church
along road towards
Kleinschweinbarth
(JÜTTNER, 1938: 97;
GRILL, 1968: 43).

Menilitischefer, cor-
responding to the
Globigerina marls and
Menilit Formation of
the Outer West-Car-
pathians.

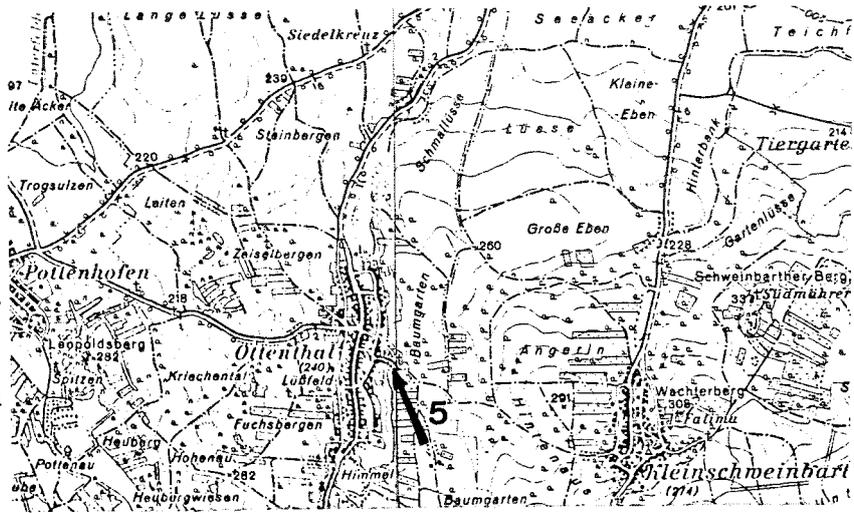


Fig. 8 STOP 5

Flora: A new study of calcareous and siliceous nannofossils is presently under way (BRAUNSTEIN, R.; see also this volume). The assemblages are as varied as the lithologies which span from chalks with pteropods over marls with gypsum to diatomites and lignites and laminated clays.

Lower Oligocene, rich coccolith assemblages include Isthmolithus recurvus, Dictyococcites bisectus, Ericsonia ovalis, E. fenestrata, E. obruta, various species of Pontosphaera and Transverso-pontis and well preserved holococcoliths (Zygrhablithus bijugatus, Lanternitus minutus, Orthozygus aureus, Zygosphaera brytika). They are dominated by small Prinsiaceae and include no siliceous fossils. The presence of I. recurvus in the absence of discshaped discoasters suggests an Early Oligocene age, despite the absence of Ericsonia formosa and Reticulofenestra umbilica, unless we assume that I. recurvus survived R. umbilica (top of NP 22) into the Middle Oligocene NP 23.

Transverso-pontis pax characterises the low salinity assemblage of Early Oligocene age (indicated by I. recurvus and E. formosa, see STRADNER & SEIFERT, 1980). This assemblage is dominated by small Prinsiaceae and also includes other species of Transverso-pontis and O.

aureus. Diatoms (Melosira granulata) and Archaeomonads are common. Upper Oligocene assemblages including very rare S. distentus and S. predistentus together with Helicosphaera recta (upper part of NP 23 to NP 24) are barren of siliceous fossils. They are dominated by small Prinsiaceae and Sphenolithus moriformis accompanied by Cyclicargolithus floridanus, Pontosphaera sp., E. ovalis, H. compacta and very rare reworked Cretaceous specimens.

Fauna: Lowermost 3 m of section:

dark brown marly clays with fish debris, mainly planktonic

<u>Subbotina angiporoides</u>	<u>Catapsydrax unicavus</u>
<u>Subbotina tripartita</u>	<u>Catapsydrax martini scandretti</u>
<u>Subbotina linaperta</u>	<u>Globigerina cf. officinalis</u>
<u>Globorotalia postcretacea</u>	<u>Pseudohastigerina naguewichiensis</u>
<u>Chiloguembelina cf. cubensis</u>	<u>Early Oligocene</u>

At 3 m dark greyish-brown laminated clays with fish scales and gypsum. No microfossils.

Sample 4.2m in a part of laminated dark grey clay with gypsum, many fragments of pteropod shells; planktonic foraminifera badly preserved and crashed, some are Globigerina cf. ciperensis (very large specimens, to compare with the Middle Oligocene in deep wells of the Molasse Basin., common Globigerina praebulloides, rare Globorotalia opima nana, Catapsydrax unicavus.

4.8 - 6.3m menilites with bituminous/lignitic layer

6.3 - 6.5m chalk layer

6.8 m laminated dark grey and brown clays, containing gypsum; no microfossils, only sponge spicules

7.6 - 8.3m chalk layer

8.3 - 12.3m laminated dark brown clays with yellowish bedding planes and thin chalk layers in the upper part

12.3 - 43.7m dark brown and grey clays, disturbed and folded; sample at 16 m: fairly poor preserved foraminiferal fauna

with

Globigerina praebulloides,

Globigerina ouachitaensis

Globigerina labiacrassata

Globigerina cipercoensis (rare)

Globorotaloides suteri

Chiloguembelina cf. cubensis

Middle Oligocene

sample at 33.5 m: dark brown and grey clay with gypsum and limonite; only agglutinated forams, poorly preserved:

Haplophragmoides sp.

? Silocosigmoilina sp.

43.7m fault

43.7 - 52.5m laminated clays and menilites

sample 52.5 - 52.7m whitish chalk with a rich fauna of pteropods, but all strongly crashed. Compares to the Spiratella zone, M. Oligocene, of Hungary and southern Russia (T. Baldi, pers.comm.).

Flankforaminifera: not very distinctiv Oligocene;

Globigerina officinalis Globigerina ouachitaensis

Globigerina cf. cipercoensis Catapsydrax unicavus

Overlying dark brown laminated clays with some layers of pteropods and a second layer of whitish chalk, with rare small bivalves of the Cardium lipoldi - Ergenica zone (pers.comm.T.Baldi) comparable to the Middle Oligocene of Hungary and Southern Russia.

This 60 m long profile in the Oligocene from the Waschberg Zone at Ottenthal, including shales, marls, limestones and diatomites has been investigated for siliceous and calcareous nannofossils. The calcareous nannofossils contain a characteristic Lower and Upper Oligocene flora which can be assigned NP 21,22 and 24. Reworked Upper Cretaceous (Micula staurophora, Praediscosphaera spinosa, Chiastozygus litterarius) and Upper Eocene (Discoaster tani nodifera) are also included. The nannofossil distribution points to a highly varying salinity.

- a) full marine facies with and without Lanternithus minutus,
Silicoflagellates (Corbisema triacantha, Naviculopsis,
Cannopilus) and Archaeomonadaceans
- b) lagunal facies with Transversopontis pax
- c) brackish water facies with diatoms (Melosira granulata)
- d) brackish facies manifested by a Braarudosphaera horizon
(B. bigelowii).

Some layers in the profil are dominated by various specimens of Reticulo fenestraens. A detailed study of the Archaeomonadaceans is under way (The Archeomonadaceans of Ottenthal, NE Austria, by Roswitha Braunstein).

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