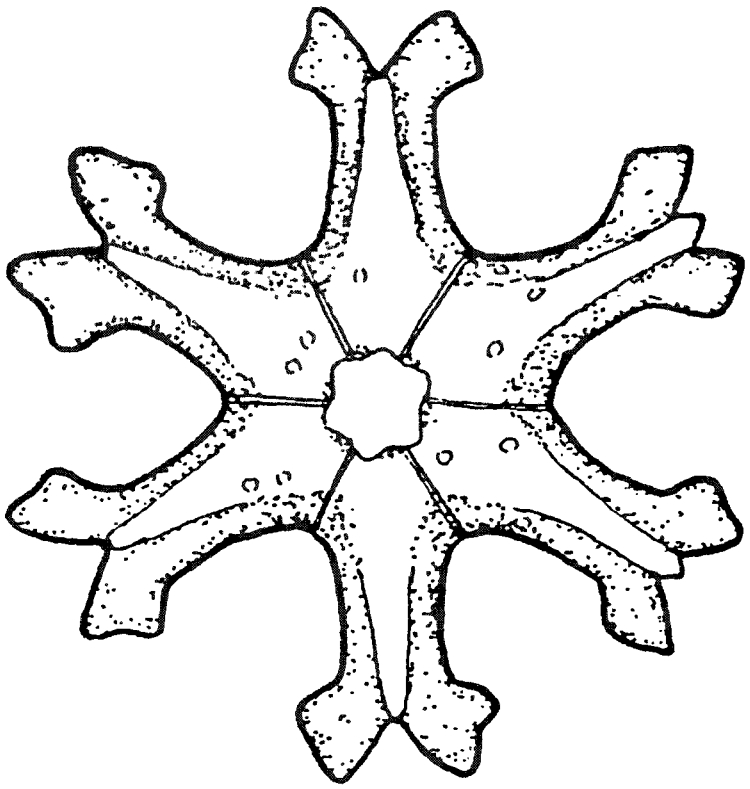
13/2

INA NEWSLETTER



4th INA CONFERENCE, PRAGUE 1991

ABSTRACTS

INTERNATIONAL NANNOPLANKTON ASSOCIATION

VOLUME 13 NUMBER 2 1991

CONFERENCE DETAILS

MAIN VENUE / MEETING PLACE - Klub Techniku, **Novotneho Lavka** 5, Praha 1. This is in the very heart of Prague, to the right of the Charles Bridge (Old Town - Stare Mesto bank of the Vltava River). All the most important historic monuments are within walking distance. *Nearest metro station - Staromestska.*
SECONDARY VENUE (for workshops etc.) - **Dept. of Palaeontology,** Charles University, Albertov 6. *Nearest metro station - Karlovo Namesti, then Tram 18 or 24 (direction Nusle, Vrsovice) - 3 stops.*

ACCOMMODATION

Hotels - booking should have been made through Cedok travel Agencies, Hotel Space is very limited in Prague.
Private Flats - possible booking via AVE Agency Prague. Tel. +42/2236 2560, +42/2236 3075, Fax +42/2236 2956.
Kajetanka Student Hostel, Radimov 12, Praha 6, Brevnov. We have reserved apartments in the hostel for all registrants who requested them. Several further beds are available for anybody who is unsuccessful in seeking hotel accommodation. *Nearest metro station - Hradcanska, then take Bus 108 or 174 (three stops).*

ENTRY TO CZECHOSLOVAKIA

Border formalities - Valid passport and visa are necessary (visa not currently needed for most West European countries & USA but check with Embassies).
Car drivers need Passport; International Driving Licence; Vehicle Registration Document; Car Insurance, and Green Card (with validity for Czechoslovakia). For buying fuel special talons are needed - available at border crossings, hotels, banks and travel agents.

PRAGUE PUBLIC TRANSPORT: There are three Metro lines (A, B, & C), trams and buses. Buy tickets in advance (4 crowns) from souvenir shops, tobacconists, newspaper shops or automats.

TELEPHONES: Calls cost 1 Crown within Prague. Emergency number, Bohumil Hamrsmid at Kajetanka hostel - 352550 or 354750.

EMERGENCY MONEY: We will not be able to pick up everyone from the airport, bus or train stations. For colleagues in difficulties (closed exchange office ...) emergency money will be deposited at distinct points in the airport, and stations. This money can be used for telephone calls and public transport, only.

WEATHER: Prague usually has nice warm weather in september, average temperatures are about 20C (70F). But this has been very cold and rainy in central Europe, don't forget a warm sweater and umbrella.

FACILITIES

SCHEDULED SESSIONS: The talks will be organised stratigraphically with an additional session on Palaeoceanography (chairman Woody Wise).
Language - English.
Length of talks - 15 minutes.
Facilities - two slide projectors (24 x 36mm), and overhead projector available.
Publication - the proceedings can be published as a special volume of "Knihovnicka ZPN". The excursion guide will be available at registration.

POSTERS: These will be exhibited in the vestibule of the meeting place (Novotneho Lavka). Pins and tape will be provided. Poster panels are 1 x 1.5 metres.

UNPLANNED EXCHANGES: A room will be available for informal discussions, and workshops. 3 or 4 light microscopes will be available, both at Novotneho lavka and in the Dept. of Palaeontology. ***PLEASE BRING SMEAR SLIDES FOR DISCUSSION, AND ROCK SAMPLES FOR EXCHANGES***

INTERNATIONAL NANNOPLANKTON ASSOCIATION

4th CONFERENCE

PRAGUE 8 - 11th September 1991

ABSTRACTS

Conference convenor

Bohumil Hamrsmíd, MND Hodonín

Organising Committee

Jan Krhovsky, Charles University, Prague

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Abstract volume edited by, J.R. Young

CONTENTS

EDITORS NOTES AND ACKNOWLEDGEMENTS

The abstracts are not exactly as submitted since this volume was mainly produced via a Kurzweil text scanner - which converted the heterogeneous original copy into word processor files. The accuracy of the scanning was heavily dependant on the print quality of the originals and despite checking it is inevitable that some errors will have been introduced. Accents were a special problem, and rather a lot have been lost. I have also made corrections to spelling (including standardisation to UK spelling) - and to grammar where there were obvious problems with English usage. There has, however, been no scientific editing or vetting of the abstracts, and in particular the taxonomic usage is entirely the authors responsibility.

As an experiment topic codes similar to those used in INA Bibliographies have been added to the abstracts, and used to produce a guide to the abstracts. These codes are (1) Age range covered. (2) Geographical provenance of studied material. (3) General topic of paper. (4) Particular feature of the abstract.

I am very grateful to the co-operative set of authors who sent abstracts on disk, and to most authors for closely observing the reference format etc. Technologically I am extremely grateful to David Ward for lending his text scanner, to Alistair Rees for use of his Apple Macintosh, and to Peter Whybrow for lending his laser printer.

STRATIGRAPHICAL GUIDE TO THE ABSTRACTS

FIRST AUTHOR	PERIOD	REGION	THEME	
LIVING & RECENT				
Knappertsbusch	Living	N.Atlantic	Ecol/oc	Productivity
Jordan	Living	Global	Taxonomy	Terminology
Cachão	Recent	Portugal	P'ecol/oc	Neritic env
Flores +	Recent	Spain	P'ecol/oc	
Young	Living +	Global	Morphology	*C.pelagicus*
Yan Zhiguang	Recent	S.China Sea	P'ecol/oc	
Yan Zhiguang	Recent	S.China Sea	P'ecol/oc	Dissolution
NEOGENE				
Cachão	Pliocene	W.Mediterranean	P'ecol/oc	Milankovitch
Castradori	Pleistocene	E.Mediterranean	P'ecol/oc	Sapropels
Dmitrenko	Cenozoic	Global	P'ecol/oc	Biogeography
Marunteanu	E.Miocene	P'tethys/Romania	Biostrat	
Mészáros	E.- M.Miocene	P'tethys/Romania	Biostrat	
Negri +	Plio - Pleist	Global	Biometrics	*P.lacunosa*
Siesser	P'oc - Pleist	Indian Ocean	P'ecol/oc	ODP Leg 122
Sutovská	E.Miocene	P'tethys/Cz	P'ecol/oc	Productivity
Toker	E.- M.Miocene	Turkey	Biostrat	
Weiterman +	Neogene	USA (Florida)	Biostrat	Hiatuses
Huang Yongyang	Neogene	Pacific Ocean	Biostrat	
PALAEOGENE				
Báldi-Beke	Eoc. - Olig	P'tethys/Hungary	Biostrat	
Bubík	Oligocene	P'tethys/Cz	Distrib	"Blooms"
Dmitrenko	Cenozoic	Global	P'ecol/oc	Biogeography
Krhovsky +	Oligocene	P'tethys/Cz	P'ecol/oc	Milankovitch
de Leon +	Olig - L.Mio	Phillipines	Biostrat	
Mészáros	Eoc. - E.Mio	P'tethys/Romania	Biostrat	
Nagymarosy	Oligocene	P'tethys	P'ecol/oc	"Blooms"
Naji	P'oc - Eoc.	Jordan	Biostrat	
Root +	M.Eocene	USA (Texas)	Biostrat	Sequence strat.
Siesser	P'oc - Pleist	Indian Ocean	P'ecol/oc	ODP Leg 122
Pospichal	L.P'oc - E.Eoc	Southern Ocean	P'ecol/oc	Discoasters
Wei +	Palaeocene	Global	Biometrics	*Prinsius*
Wei +	Palaeogene	Southern Ocean	Biostrat	Magnetostrat.
LATE CRETACEOUS				
Burnett	Camp - Maas	Global	Zonation	
Covington	Tur. - Camp	USA	P'biol	Coccocylinders
Erba	Apt. - Cen.	W. Pacific	P'ecol/oc	ODP Leg 129
Fiorentino	Maastrichtian	Israel	Distrib	"Blooms"
Girgis	L.Cretaceous	North Sea	Zonation	

Gorostidi +	Cen. - Tur.	Spain	Zonation	C-T boundary
Henriksson	Maastrichtian	Global	Zonation	*M. prinsii*
Lodeserto	L.Cret - Eocene	Italy	Biostrat	
Varol	Cretaceous	Global	Distrib	Polycycloliths
Wagreich	Tur. - Sant	Austria	Distrib	Holococcoliths
Watkins +	Tur. - Maas	Southern Ocean	Biostrat	Biogeography
Romaniv	Berr - Maas	Ukraine	Biostrat	
Shumenko	Cen. - Maas	Ukraine	Zonation	
Svábenická	Apt. - Maas	Czechoslovakia	Zonation	Distrib
Yulin Xu	Apt. - Maas	Tibet	Biostrat	P'environments

EARLY CRETACEOUS

Bralower	Apt. - Alb.	Global	P'ecol/oc	Anoxia
Erba	Apt. - Cen.	W. Pacific	P'ecol/oc	ODP Leg 129
Halásová	E.Cretaceous	Czechoslovakia	Biostrat	
Melinte	Tith - Haut	Romania	Zonation	
Karakitsios +	E.Cretaceous	Greece	Biostrat	
Mutterlose	Berr - Alb.	Global	P'ecol/oc	Biogeography
van Niel	Ryaz - Apt.	N.W. Europe	Distrib	*Nannoconus*
Ozkan +	Tith - Val.	Turkey	Biostrat	Calpionellids
Romaniv	Berr - Maas	Ukraine	Zonation	

JURASSIC & TRIASSIC

Baldanza +	E.- M.Jurassic	Tethys	Zonation	Biogeography
Bown	Trias - E.Jur	Canada	Distrib	Biogeography
Gardin	E.- L.Jurassic	N. Atlantic	Zonation	DSDP Leg 79
Janofske	L.Triassic	Alps	Distrib	Calcispheres
Reale +	M.- L.Jurassic	Tethys	Zonation	*C.deflandrei*

Notes & Abbbreviations
P'oc - Palaeocene.
P'tethys - Paratethys
P'ecol/oc - Palaeoecology and palaeooceanography
Distrib - Distribution, of taxa in time and/or space
Were necessary abstracts have been listed twice.

BIOSTRATIGRAPHIC SYNTHESIS OF NANNOFOSSILS IN THE EARLY - MIDDLE JURASSIC OF SOUTHERN TETHYS

Angela Baldanza & Emanuela Mattioli, Dipartimento di Scienze della Terra, Università degli Studi di Perugia, Piazza dell'Università, 06100 Perugia, Italy.

Topics: E.-M. Jurassic, Tethys, Zonation

A study of calcareous nannofossil assemblages of sections belonging to the Tethyan Realm, southern border of Tethys, was carried out. Several sections of the Umbria-Marche area (Central Italy) were studied. Two sections and several samples coming from an area located at north of Tago river (Central Portugal) were examined. In north-west Greece the study were carried out on three sections of the Epire area. In Hungary three examined sections are located in Central Hungary (Bakony Mountains) and one in SW Hungary (Mecsek Mountains). In South-West France two studied sections belong to the Digne area. Several samples of Subbetic area (Spain) were examined as well.

This study allowed to recognize a succession of events, from the early Pliensbachian to the early Bajocian, which were well correlated with the ammonite zonations, therefore they provided a good stratigraphic resolution. Semi-quantitative analyses of the nannofloras were performed on light microscope. Nannofossils were always present and their abundance varied from rare to abundant. Their preservation fluctuated from poor to moderate according to different lithology.

The comparison of first and last occurrences of several nannofossil species showed that the age of the events changed in different areas. The first discrepancies occurred in the Pliensbachian: *Mitrolithus jansae, Biscutum finchii* and *Lotharingius hauffii* showed a different distribution from one region to another. Between the upper Domerian and the early Toarcian probably a different circulation pattern developed into the western Tethys and differences became less marked. In fact some important events, like the FO of *Calyculus* sp. and the FO of *Lotharingius crucicentralis*, were consistent in all the studied areas. In the middle-upper Toarcian some species, *L. velatus, L. contractus* and *Watznaueria barnesae*, appeared first in restricted and isolated basins, with particular environmental conditions, such as Portugal and Umbria-Marche area, and later in more open areas. In the Aalenian Bajocian period also, the same trend were observed. The FO of *W. manivitae* and the FO of *W. britannica* were detected first in the Umbria-Marche area and later in other areas.

All these discrepancies could be related to the evolution and spreading of nannofossils due to the complex physiography of the southern border of Tethys and to the circulation of sea currents, as well as to environmental factors.

ON THE AGE OF THE SZOLNOK FLYSCH AND ITS POSSIBLE CORRELATION WITH THE CARPATHIAN FLYSCH ZONES

Maria Báldi-Beke, Hungarian Geological Survey, Budapest,& Andras Nagymarosy, Eötvös University, Dept. of Phys. and Hist. Geology, Budapest

Topics: Eocene-Oligocene, Hungary, Biostratigraphy

In the Szolnok flysch trough beneath the Great Hungarian Plain (Fig. 1.) a more than one thousand metre thick clastic sedimentary series has been penetrated by drilling activity. The boreholes have not yet reached basement. The sequence is overlain by Miocene volcanites. Earlier the flysch was thought to be deposited continuously in the Cretaceous and in the Paleogene. With detailed study of the available core materials we could find assemblages only of a few nannozones, while there was not any proof for the others.

In the Cretaceous only Campanian - Lower Maastrichtian nannoplankton is documented. The next assemblage, a much younger one is the Uppermost Paleocene - Lowermost Eocene (NP9-10). From the Middle Eocene upwards NP16-19, NP21-22 and NP24-25 nannozones were proved, but the poor assemblages allow, that the other Upper Eocene and Oligocene nannozones may be present, too.

Although more than 100 drillings have reached the flysch sequence, its petrographical composition is poorly known, because of insufficient coring, and there is, no continuously cored profile of the Szolnok flysch. The few well-investigated cores show a complex consisting of alternating pelites and sandstones, sometimes graded. Two significant lithologies show strong affinities to the Outer Carpathian flysch sequences; non-calcareous red shales of Late Paleocene-Early Eocene age, and mottled, variegated marls with conglomeratic interbeddings from the Bartonian.

The stratigraphical sequence of the Szolnok flysch can give an explanation also to its geotectonical position. Flysch-type deposits usually occur at the margins of continental blocks, either on the edge of continents, or directly on oceanic crust. The Szolnok flysch at the present day is in an exotic position on the inside of the Carpathian arc. It is thrust upon the NW edge of the Tisza megaunit and its strike is parallel with the Mid Hungarian megafault, which separates the Pelso (North Pannonian) and Tisza megaunits (Haas 1989, Nagymarosy and Csontos 1991). The imbricate structure of the Szolnok flysch can be proved at least in three different borehole profiles, where the Late Cretaceous rocks are thrust upon the younger, Paleogene deposits: Debrecen-2 and Nadudvar-15 drillings (this paper), Bucsa-Ny-1 drilling (Pap 1990).

One may suppose, that the Szolnok belt can be the emplaced continuation of one of the Outer Carpathian flysch belts, which disappear near to the NE termination of the Mid Hungarian line. One such unit is the Magura nappe, whose continuation is not known toward the South. Another such unit, the Pieniny Klippen Belt forms a curve near the Soviet-Rumanian border, and takes a new direction toward the SW, in the direction of the Szolnok flysch. Its southwesternmost occurrence can be traced in the Botiza Klippen (Sandulescu 1980). A third solution can be the assumption, that the Szolnok flysch is a continuation of the so called Inner Carpathian flysch (Transcarpathian flysch in Maramures).

Comparing the stratigraphical columns of the Magura, the Klippen Belt and the Inner Carpathian flysches to the Szolnok flysch (Fig. 2), we can conclude, that no similarity exists between the Szolnok flysch and the

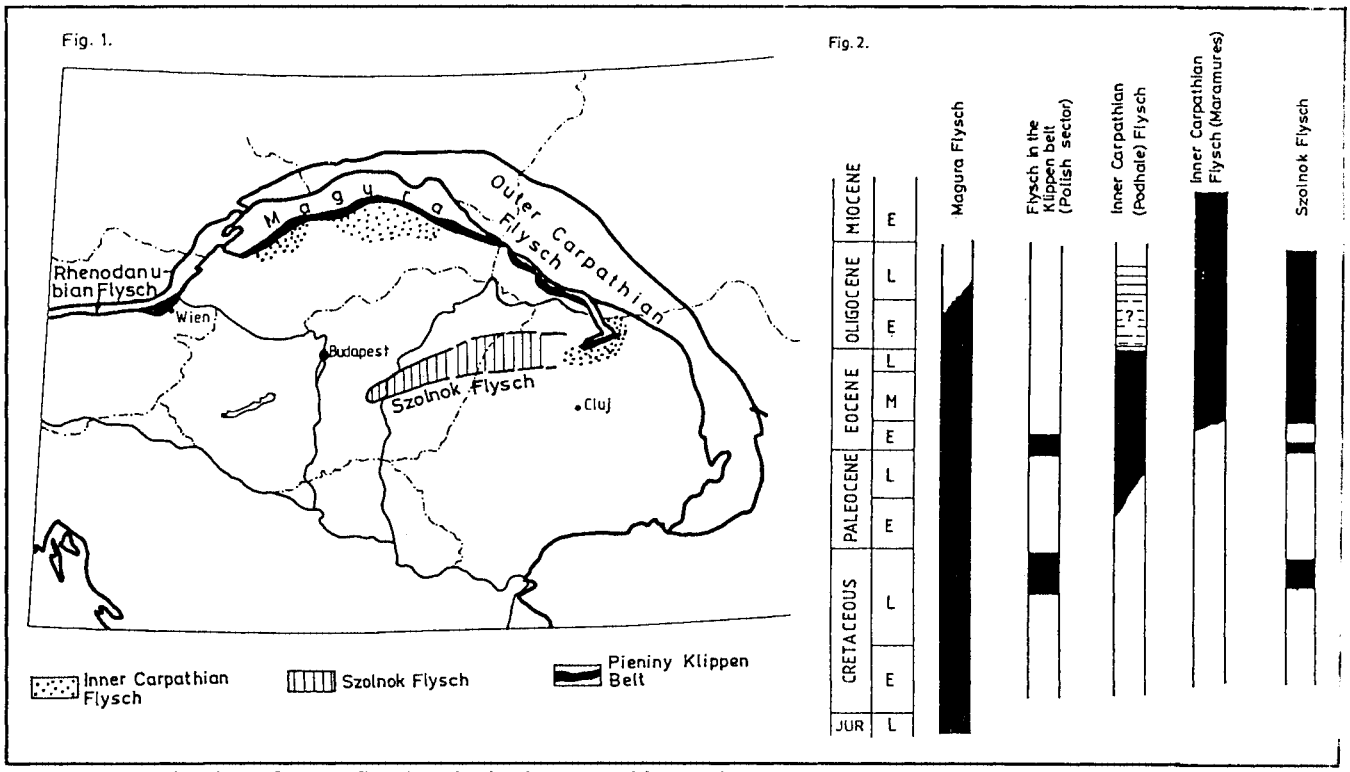

Figure 1. Distribution of some flysch units in the Carpathian realm.
Figure 2. Duration of sedimentation in some Carpathian flysch units.

continuous, uninterrupted sedimentation of the Magura unit. The lower, Late Cretaceous - Early Tertiary portion of the Szolnok sequence resembles the Polish sector of the Pieniny Klippen belt (Birkenmajer et. al. 1909), while the upper, Middle Eocene-Oligocene portion can be correlated better with the Inner Carpathian flysch in Maramures (Dicea et al. 1980).

Taking into consideration all the petrographical and palaeontological features of the Szolnok flysch, we can see a gradual change in its depositional conditions from deep-water pelagic, to a shallower near-shore environment, during the time of its formation.

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CALCAREOUS NANNOFOSSILS FROM THE LATE TRIASSIC - EARLY JURASSIC OF THE QUEEN CHARLOTTE ISLANDS, BRITISH COLUMBIA

Paul R. Bown, Department of Geological Sciences. University College London

Topics: Triassic - E. Jurassic, Canada, Distribution

Samples collected from the Triassic and Lower Jurassic sequences of the Queen Charlotte Islands have yielded the first early Mesozoic calcareous nannofossils from North America. The assemblages are generally poorly preserved but are comparable with those found in northwest Europe in the Lower Jurassic, and the rare Triassic nannofossil localities, in Austria, Indonesia, and northwest continental shelf of Australia.

Palaeobiogeographic interpretations are inconclusive and fail to positively confirm the low-latitude ("Tethyan") position of the Queen Charlotte Islands as indicated by the macrofossil data. However, important biogeographic features include the absence of *Schizosphaerella punctulata* and *Mitrolithus jansae* in the Lower Jurassic, and the absence of *Eoconusphaera zlambachensis* in the Triassic.

Several other sections from the Americas will also be discussed.

DYSOXIC/ANOXIC EVENTS IN THE APTIAN-ALBIAN (MIDDLE CRETACEOUS)

Timothy J. Bralower, Dept. of Geology, University of North Carolina, Chapel Hill, NC 27599, U.S.A., & William V. Sliter, Div. of Paleontology and Stratigraphy, U.S. G. 5., Menlo Park, CA, 94025, U.S.A.

Topics: Aptian - Albian, Global, P'ecol/oc, Anoxia

Three episodes of anoxia/dysoxia interrupted normal marine deposition in the Aptian Albian. These are recorded by the occurrence of organic carbon-rich sediments in pelagic and hemipelagic land sections from Europe and DSDP/ODP sites in the North and South Atlantic, Indian and Pacific Ocean Basins. We have conducted an integrated biostratigraphic and lithostratigraphic investigation of numerous sequences from a range of geographic and oceanographic settings in order to elucidate the spatial and ztemporal relationships of these carbonaceous sediments. Based on resulting high resolution, integrated foraminiferal and nannofossil stratigraphy, we distinguish an ocean-wide anoxic/dysoxic episode in the early Aptian *Globigerinelloides blowi* foraminifer Zone and the *Chiastozygus litterarius* nannofossil Zone, shortly after magnetic Chron CM0. Widespread, but not global, anoxic/dysoxic episodes occurred in the early Albian (*Hedbergella planispira* foraminifer Zone, *Prediscosphaera cretacea* nannofossil Zone, subzone NC8B) and late middle Albian (*Ticinella*

praeticinensis foraminifer Zone, *Axopodorhabdus albianus* nannofossil Zone, Subzone NC9B). Each episode corresponds to a highly carbonaceous land deposit including the lower Aptian Selli Horizon of Italy, the lower Albian Paquier Horizon of the Fosse Vocontien, France and the upper middle Albian Toolebuc formation of the Queensland Basin, Australia. Although none of these episodes is associated with extinctions, each is characterized by changes in community structure of foraminifera, which are often excluded competitively by radiolaria. Nannofossil taxa in these horizons often show marked epicontinental affinities or are excluded competitively by dinoflagellates. We distinguish between black shales deposited in these three episodes which generally have higher organic carbon contents and a larger proportion of marine organic material, and which are associated with significant fauna and floral assemblage changes, and other Aptian-Albian black shales which do not appear to be ordered spatially or temporally. The proposed anoxic/dysoxic episodes appear to correlate with sea level highstands or late transgressive phases. The early Aptian episode also appears to correspond to an interval of active volcanic activity in the Pacific Ocean Basin. We consider sea level and volcanism to be factors which condition the oceans to be prone to anoxia/dysaerobia. The spatial and sedimentological variability in organic carbon-rich intervals, and the fact that at least two of them are not ocean-wide episodes, indicates that regional or even local productivity, climate or tectonic factors actually induce or trigger anoxia/dysoxia.

LOW DIVERSITY CALCAREOUS NANNOPLANKTON ASSEMBLAGES FROM OLIGOCENE SITBORICE MEMBER (SUBSILESIAN UNIT WEST CARPATHIANS) FROM BYSTŘICE NAD OLSI

Miroslav Bubík, Czech Geological Survey Brno, Leitnerova, 22, 658 69 Brno, Czechoslovakia

Topics: Oligocene, Czechoslovakia/Paratethys, Distribution, "Blooms"

The changes of nannoplankton assemblages from the Sitborice Member (Menilitic Formation) from Bystrice nad Olsí has been studied. Five low diversity assemblages dominated by *Cyclicargolithus* species have been recognised. 1. *C. floridanus - D. bisectus*; 2. *C. floridanus - C. pelagicus*; 3. *C. floridanus - Pontosphaera* sp.; 4. *C. floridanus - Z. bijugatus*; 5. *C. abisectus - C. pelagicus- C. floridanus*. Changes of assemblages and diversity could be explained by changes of salinity. The effect of oriented recrystallization of structural elements on the morphology of various species will be discussed.

INTEGRATING BIOSTRATIGRAPHICAL ZONATIONS

Jackie Burnett, Micropalaeontology Unit, Department of Geological Sciences, University college London, Gower Street, London, WC1E 6BT.

Topics: Campanian - Maastrichtian, Global, Zonation

The greatest biostratigraphical resolution possible can only be achieved by integrating as many reliable sources of information as are available. To date, this has not been achieved for more than a small number of individual sections (e. g. Robaszynski et al., 1982, 1985, 1990). Haq et al. (1987) produced a supposedly integrated table of zonation schemes which, on close examination, is misleading, particularly for non-biostratigraphers, who might conclude from the table that full integration has been achieved.

Numerous attempts to *correlate* the zonation schemes of different groups necessarily fall short of producing an accurate and globally-reliable biostratigraphical picture, being based on a local scale.

Herein, an attempt is made to give an insight into the feasibility of global biostratigraphical integration in the Late Cretaceous, and how biostratigraphers can correct misconceptions arising from poor correlation of biozones by documenting, in particular, stage-boundary biosuccesions. The Campanian/Maastrichtian boundary is used as an example of how global integration can work.

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CALCAREOUS NANNOFOSSIL RECORD PROM PORTUGUESE COASTAL ENVIRONMENTS (Preliminary data)

Mário Cachão, Dept. of Geology, Lisbon University, Portugal.

Topics: Recent, Portugal, P'ecol/oc, Neritic

Traditionally calcareous nannofossil assemblages are better studied in sediments and/or water columns related to oceanic domains. In the present study an attempt is made to recognize palaeoenvironmental potentials of nannofossils in near shore coastal environments.

Present day sediments collected along profiles perpendicular to the coastline were used to perform relative frequency distributions of certain calcareous nannoplankton morphotypes by a 300-assemblage counting procedure. Using this methodology certain taxa showed strong inverse correlation with depth while others appeared to have an opposite behaviour.

Reworked forms percentages were used as a tool for better understanding silty-clay transport mechanisms on the portuguese continental shelf and slope.

Calcareous nannoplankton present day record in portuguese restricted lagoons with sand barrier/inlet systems were studied in order to determine in which conditions and to what extent direct marine influence occurs inside these lagoons. By monitoring coccolith sedimentation as a sort of marine phytoplankton tracer we hope we can better understand present day and past circulation patterns in this transitional environment.

A preliminary model for calcareous nannoplankton distribution related to depth/distance to shoreline from open ocean conditions to paralic systems is discussed and applied to palaeoenvironmental interpretation of Pliocene fossiliferous outcrops from the portuguese west margin.

PLIOCENE MEDITERRANEAN PALAEOCEANOGRAPHIC EVOLUTION BASED ON CALCAREOUS NANNOFOSSILS (Preliminary data)

Mário Cachão, Dept. of Geology, Lisbon University, Portugal, & Domenico Rio, Dept. of Geol. Pal. Geofsica, Padova University, Italy.

Topics: Pliocene, W. Mediterranean, P'ecol/oc, Milankovitch

Pliocene calcareous nannofossil assemblages from ODP Site 107-653 sequence (Tyrrhenian Sea - Western Mediterranean) were defined using a 300-assemblage counting procedure. Polynomial smoothed relative frequencies of nineteen taxonomic units were performed and compared with oxygen and carbon isotopic data to recognize palaeoecological and palaeoceanographic signals between approximately 1.8 and 4.5 Ma.

Temperature/light and nutrient availability were interpreted as major palaeoecological parameters which seemed to control nannofossils behaviour during this time interval.

Spectral analysis were performed in order to recognize cyclicity in nannofossil assemblage frequencies as a response to orbital forcing. A model is proposed to study the role of nutrients in oligo-, meso- and eutrophic conditions.

Fractal concept and properties are applied to calcareous nannoplankton record as a tool for better understanding patchy distributions and self-similarity of phytoplankton successions structure in time.

Data obtained reveals that:

1) During Pliocene calcareous nannofossils acted as an heterogeneous group from a palaeoecological point of view were several taxonomic units showed specific requirements and distinct behaviours;

2) The Tyrrhenian Sea during the Pliocene epoch acted as a more or less confined "nutrient disturbed" environment compared with open ocean conditions. This feature allowed the amplification of certain nannofossil palaeoecological signals as some kind of resonance box of the palaeoceanographic surrounding conditions.

QUANTITATIVE STUDY OF MIDDLE PLEISTOCENE TO HOLOCENE CALCAREOUS NANNOFOSSILS: RESULTS OF THREE CORES FROM EASTERN MEDITERRANEAN AND FUTURE PROJECTS.

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Topics: Pleistocene, E. Mediterranean, P'ecol/oc, Sapropels

A quantitative study of nannofloral assemblages of three cores from the Eastern Mediterranean has been performed. These cores were chosen along a WNW-ESE transect: the first core (Core Ban 88 - 11GC) was drilled in proximity of a diapiric field named Prometeo 2, some 60 miles south of Crete; the second one (Core Ban 87 - 15PC) comes from the outer southern edge of the Mediterranean Ridge facing the Eridoto Abyssal Plain; the third one (Core Tyro 87- 60PC) was drilled on the Mediterranean Ridge, some 140 miles west of Crete.

All three cores consist of pelagic marls with, sapropels and tephra as minor lithologies. these sediments are Middle Pleistocene to Holocene in age (*P. lacunosa, G. oceanica, E. huxleyi* and *E. huxleyi* Acme nannofossil zones).

The study is based on 61 samples from Core Ban 88-11GC, 48 from Core Ban 82-15PC, and 89 from Core Tyro 87-60PC: in each sample 300 calcareous nannofossils have been counted in random fields of view. *E. huxleyi*, "small" *Gephyrocapsa, G. oceanica*, and *G. caribbeanica* are the dominant taxa throughout the interval studied and therefore a subsequent counting was applied only to the remaining species.

The results of the quantitative study of calcareous nannofossils may be summarised as follows;

1) Some biostratigraphic. events defined on quantitative data such as the Acme of *E. huxleyi,* the corresponding sharp decrease in abundance of *G. caribbeanica, G. oceanica* and "small" *Gephyrocapsa* spp. and the increase in abundance of "small" *Gephyrocapsa* spp just below sapropel S8 (peculiar to the Eastern Mediterranean) have been clearly pointed out. they allow a more precise stratigraphy for the Eastern Mediterranean.

2) The variations in abundance of the dominant taxa (*E. huxleyi*, "small" *Gephyrocapsa, G. oceanica*, and *G. caribbeanica*) have been compared with the climatic curves based on planktonic foraminifera and pteropods (Ban 88-11GC), and with $\delta^{13}C$ at, $\delta^{18}O$ isotopic curves (Ban 82 - 15PC). A climatic control on their trends although possible in some intervals, doesn't seem always clear throughout these two cores The isotope stratigraphy of Core Tyro 87-60PC will be available only in the near future.

3) The fluctuations in abundance of two taxa, *Helicosphaera carteri* and *Syracosphaera* sp. 1, are inversely correlated. *H. carteri* increases systematically in all sapropel and tephra layers, while *Syracosphaera* sp. 1 decreases, and sometimes disappears, in the same intervals.

Many causes may be inferred to originate such peculiar fluctuations. Among them, changes in the transparency of the upper part of the water column, due to river runoff (in the case of sapropel) or to volcanic ash deposition (causing tephra), seem the more attractive hypotheses so far.

Also diagenesis may be regarded as a possible cause for these patterns. However, the presence of small and delicate species within the sapropel associations suggests the possibility that "primary" signals can be still preserved and detectable. In order to better understand these signals, I am now counting calcareous nannofossils from one core drilled in the Angola Basin (equatorial East Atlantic). The results of these countings will hopefully lead to a better comprehension of the mechanisms influencing the changes observed within the Mediterranean, nannofloral associations.

NANNOFOSSILS OF THE UPPER CRETACEOUS NIOBRARA FORMATION, WESTERN INTERIOR NORTH AMERICA

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Topics: Turonian - Campanian, USA, P'biol, Coccocylinders

Multiple horizons of exceptional preservation within the Niobrara Formation (Upper Cretaceous) have revealed new morphologic information on coccolithophores. Nine species were found with coccospheres intact. A species of *Biscutum* was encountered with extraordinary cylindrical 'coccocylinders', rather than the normal spherical coccospheres. While not reported from the fossil record, coccocylinders are found in modern oceans. An unusual feature of these cylindrical tests is the orderly, repetitive arrangement of individual coccoliths. The cylinders are nearly always found open at both ends, but one specimen illustrated with scanning electron micrographs with one end nearly closed reveals significantly smaller coccoliths at the closing end. These smaller, simpler coccoliths probably did not articulate as tightly as those toward the middle of the cylinder, and were easily detached. Because of the difference in size and morphology, these terminal coccoliths may have previously been assigned to other taxa.

The stagnant, anoxic benthic environment prevalent during intervals of Niobrara deposition also fostered the preservation of monospecific coccolith clusters which represent coccospheres formed of disarticulated coccoliths. These clusters, representing more than 30 species, including *Lithraphidites carniolensis, Boletuvelum* sp., *Microrhabdulus belgicus,* and *Rhagodiscus angustus,* provide information on the minimum number of coccoliths originally present on the living cell. Such data may prove valuable for determining the total biomass of the living populations based on the abundances of individual coccoliths in the fossil record.

The Niobrara Formation spans the late Turonian/early Coniacian to early Campanian according to zonal assignments made herein. The truncated ranges of several important nannofossil marker species -- *Micula decussata, Lithastrinus floralis,* and *Lithastrinus septenarius* provide evidence for a disconformity from which upper Coniacian - lower Santonian beds are missing. This interval closely coincides with sea-level low K2.4 on an unpublished Vail coastal onlap curve.

PALAEOCEANOGRAPHY OF THE ATLANTIC AND THE INDIAN OCEANS IN THE CENOZOIC (CALCAREOUS NANNOPLANKTON DATA)

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Topics: Cenozoic, Global, P'ecol/oc, Biogeography

Deep-Sea drilling by the "Glomar Challenger" brought a lot of data on biogeographical distribution of the calcareous nannoplankton in all the Cenozoic epochs. This data has formed the basis of a geographical zonation scheme for the Atlantic and Indian Oceans for 25 time slices of the Cenozoic. The major creation method of these schemes was the analysis of species and nannofossil complexes areal extents, taking into account the characteristic of their quantity changes inside the areal extents in different intervals of geological time. Detailed study of the modern biocoenoses ecology and identification of the temperature limits to the distribution of species and complexes made it possible to determine some species groups that are characteristic of different geographical zones.

The change of the biogeographical conditions was observed from the modern bottom sediments into the past epochs. Sequential actualistic data transfer from modern biocoenoses conditions to older ones was used. A direct connection between biocoenoses, temperatures, currents and water masses was observed for the late Pleistocene. With distancing from the present these connections became more and more hypothetical.

Subtropical and tropical zones existed in Cenozoic constantly. The moderate zones existed from 40m.y., and subpolar from Miocene. Special conditions in the equatorial part of the Atlantic Ocean were developed in the Early Palaeocene - Middle Eocene and were not repeated later. Two most apparent nannofossil regions were distinguished: moderately sub-polar and sub-tropical - tropical. The schemes of palaeobiogeographical zonation

are demonstrated. Migration of zones during the Cenozoic is observed. The evolutionary changes of Cenozoic Nannoflora were studied. The stages of nannoflora development were observed. The fluctuations of the rates correlate well with the changes of different physical parameters of environment: the temperature of surface waters, change of sea level, carbonate compensation depth and so on.

MIDDLE CRETACEOUS CALCAREOUS NANNOFOSSILS FROM THE WESTERN PACIFIC (ODP LEG 129): EVIDENCE FOR PALAEOEQUATORIAL CROSSINGS.

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Topics: Aptian - Cenomanian, W. Pacific, P'ecol/oc, ODP Leg 129

Middle Cretaceous calcareous nannofossils were quantitatively studied at Sites 800, 801, and 802 of ODP Leg 129 in the Western Pacific. Samples were selected after careful inspection of total abundance and preservation of nannofloras in pelagic sediments in order to analyze only the best preserved assemblages and exclude secondary modifications of the assemblages due to dissolution/diagenesis. Nannofossil data were compared with radiolarian distribution and palaeolatitude values to trace the response of planktonic communities to plate motions with respect to the palaeoequator.

Aptian to Cenomanian calcareous nannofloras record changes in composition with sharp increases in abundance of *B. constans* and *Z. erectus*. Both species were previously interpreted as high fertility indices blooming in the palaeoequatorial belt of the Pacific basin and at upwelling sites.

At Sites 800 and 801 the increases in abundance of these indices correspond to increases of radiolarians. At both sites this change was recorded when palaeolatitude values pass from 10°S to 5°S and therefore seems to mark the southern edge of the palaeoequatorial divergence. At palaeolatitudes of approximately 2°S, in the core of the upwelling zone, calcareous nannofossils disappeared and were replaced by extremely abundant radiolarians.

Site 800 reached the high fertility belt during the middle Albian and the core of the palaeoequatorial divergence in the Cenomanian. Site 801 approached the upwelling belt during the late Albian and reached the inner part of the divergence in the Cenomanian.

Data from Site 802 are less clear; here calcareous nannofossils are abundant but poorly preserved in the late Aptian-Cenomanian interval. The high fertility indices do not show increases in abundance and indeed palaeolatitude values point to a location south of the palaeoequatorial upwelling zone. However, nannofossil assemblages might be partially altered by dissolution because of deeper palaeoenvironment.

ASPECTS OF MAASTRICHTIAN NANNOFOSSIL BIOSTRATIGRAPHY IN THE HOR HAHAR SECTION, SOUTHERN ISRAEL

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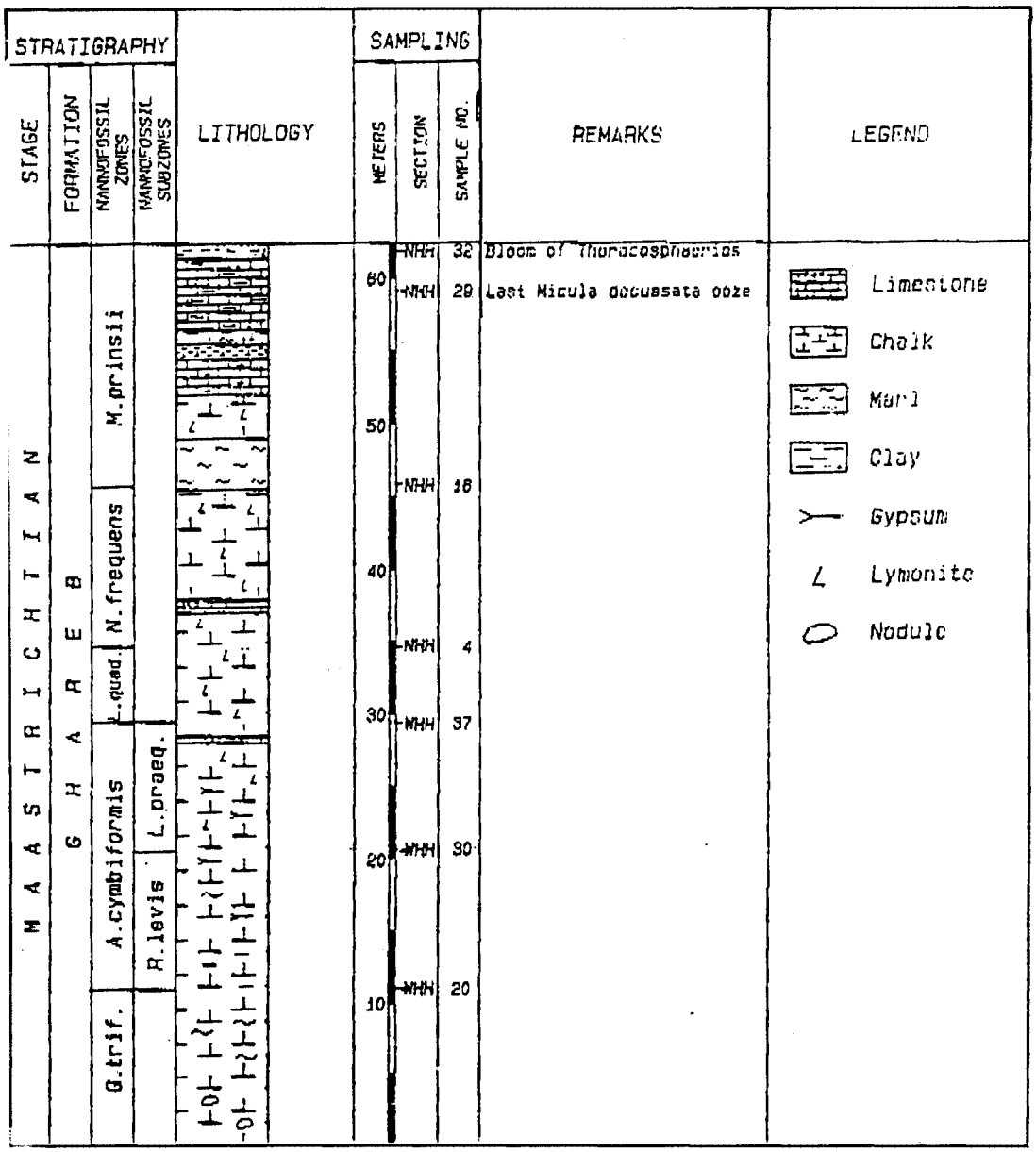
Topics: Maastrichtian, Israel, Distribution, "Blooms"

The continuous Maastrichtian sections studied at Hor Hahar (chalky Ghareb formation, southern Israel) extend to a thickness of, at least, 62m and show the following nannofossil zones from bottom to top: *Quadrum trifidum* zone, *Arkhangelskiella cymbiformis* zone, *Lithraphidites quadratus* zone, *Nephrolithus frequens* zone and *Micula prinsii* zone. The *Arkhangelskiella cymbiformis* zone was divided into two subzones,: *Reinhardtites levis* subzone and *Lithraphidites praequadratus* subzone.

Nephrolithus frequens and *Micula prinsii* are never common moreover, since *Nephrolithus frequens* does not occur in every sample of its range, *Micula murus* is used together with it, to mark the zone. *Quadrum gothicum*, - even though never abundant ranges up into the *M. prinsii* zone. At the base of this zone, *Micula decussata*, after being dominant all through the Maastrichtian, begins to decrease; at the top of the zone a bloom of Thoracosphaerids occurs.



Maastrichtian nannofossil biostratigraphy of the Hor Hahar area, Southern Israel [*Fiorentino*].

The first occurrence of *Nephrolithus frequens* does not coincide here with the last occurrence of *Reinhardtites levis*. This should be due to the time transgressive first occurrence of *Nephrolithus frequens* toward low latitudes which has been explained with the late Maastrichtian global cooling of the water masses (Worsley 1974). Actually, the assemblages found here show that species which are considered Austral or cooler, water forms (*Misceomarginatus pleniporus* and high abundances of *Eiffellithus turriseiffelii* and *Gartnerago obliquum* had occurred well before *Nephrolithus frequens*. Therefore its transgressive first occurrence might have been influenced by different causes.

The bloom of Thoracosphaerids which occurs in the upper part of the *prinsii* zone, has already been observed at a nearby K/T section at Hor Hahar (Eshet et al, 1991) and was reported as a characteristic of the K/T boundary intervals. Since the boundary was not reached in our sections, this event can only be retained as a probable precursor of the K/T crisis, because Thoracosphaerids are considered as harsh environmental condition indicators.

In order to improve the circum-mediterranean nannofossil zonal correlation, a study of additional sections in Israel and in Italy is currently being conducted.

PRELIMINARY DATA ON THE HOLOCENE CALCAREOUS NANNOFLORA ASSEMBLAGE IN THE GULF OF CADIZ (S.W. SPAIN).

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Topics: Recent, Spain, P'ecol/oc

A series of gravity cores recovered in the Gulf of Cadiz between 400 and 900m depth was studied. They were drilled on a platform limited to the NE by the upper slope where today the surface deposits are strongly affected by the deep Mediterranean undercurrent. Changing sedimentation rates, hiatus and sediments with different mean grain-size are evidently related to the variable activity of bottom currents (Nelson et al., in press). Similar sediments were described by Sierro & Flores (1989) in the Neogene of the Guadalquivir basin. This study has been conducted to evaluate the effect of these currents on the sedimentation of calcareous plankton assemblages.

The quantitative analysis of calcareous plankton together with sedimentological data and the present oceanographic conditions enabled us to outline the following aspects:

The abundance of evidently resedimented nannoliths is greater in the area with SE-NW currents than in the vicinity of the upper slope. However the abundance of autochthonous nannoliths is greater in the areas with higher bathymetry.

The proportion of carbonate and terrigenous sediment fractions is similar in the different areas. With similar percentages of terrigenous matter the planktonic foraminifera are more abundant in the vicinity of the upper slope.

The concentration of nannoliths per mm^2 and the carbonate content follow similar patterns, except in the cores which are far from the upper slope. In these cases an inverse relationship was observed, coinciding with the intervals in which the evidently resedimented nannoliths were more abundant.

In the different holes the time distribution of the major components of the autochthonous nannofloristic assemblage follows the same pattern. Generally the assemblage is dominated by *Gephyrocapsa* spp. and *Emiliania huxleyi*. From bottom to top a progressive increase of *E. huxleyi* coinciding with a decrease of *Gephyrocapsa* spp. was recognized. The different morphotypes of *Gephyrocapsa* spp., defined according to the maximum diameter and the characteristics of the central area, also show a similar distribution in all the holes. The distribution of the relative abundance of *Coccolithus pelagicus, Helicosphaera carteri* and *Calcidiscus* do not show the same pattern in the different holes. Sometimes these variations coincide with the pulsations of higher abundance of the resedimented specimens.

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JURASSIC CALCAREOUS NANNOFOSSILS FROM DSDP LEG 79: NEW DATA.

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Topics: E.-L. Jurassic, N.Atlantic, Zonation

During Leg 79 (in 1981) four sites were drilled in the Northwestern African margin, West of Morocco. The recovered sediments, mainly limestones and limestone breccias, belong to an ancient carbonate platform drowned during the early opening of the North Atlantic Ocean. These sediments bear Jurassic calcareous nannofossils ranging from Sinemurian to Tithonian in age. At that time only one section (the lower portion of site 547B) could be zoned, using Hamilton's biostratigraphic scheme. In the last few years, improved studies on Jurassic nannofossil systematics and biostratigraphy (Bergen, 1987; Bown, 1989; Reale et al in press) together with the analysis of the present study has allowed an updated review and amended description of the assemblages found during the previous investigations (Wiegand, 1984). Moreover, the entire site 547B could

be zoned using the zonation proposed by Bergen (1987) which seems to provide the best biostratigraphic scheme for the present investigation.

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A NEW UPPER CRETACEOUS ZONATION SCHEME FOR THE NORTH SEA

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Topics: L. Cretaceous, N.Sea, Zonation

This paper presents a refined zonation scheme for the Upper Cretaceous sediments mainly in the Central and Southern North Sea. The scheme has been developed at The Robertson Group during the last few years in order to achieve both higher stratigraphic resolution and more confident age determination. Emphasis is placed on major changes in nannofloral associations to facilitate the recognition of the zonal units. Variations in the composition of the nannofloras in different sub-basins within the studied area are discussed.

The only published Upper Cretaceous zonation for the offshore North Sea is that of Mortimer (1987). The zonation is largely out of date in the light of the present knowledge, and thus a new scheme including few of Mortimer's zonal markers is introduced here.

CALCAREOUS NANNOFOSSILS AND THE CENOMANIAN-TURONIAN BOUNDARY AT GANUZA (NAVARRA, N.E. SPAIN)

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Topics: Cenomanian - Turonian, Spain, Zonation, C-T boundary

The Ganuza section shows outcrops of the Cenomanian-Turonian transition. Its materials are calcareous-pelitic; an alternation of grey and brown-grey marls and marly limestones, 35 m thick. Its palaeogeographic situation corresponds to an outer shelf, during the maximum of the "middle" Cretaceous transgression in Northern Spain. Fossils are frequent, both microfossils (foraminifers, ostracods, calcareous nannofossils) and macrofossils (ammonites, inoceramids, echinoids, brachiopods). Planktonic foraminifera allow us to determine the *Whiteinella baltica* and *Rotalipora cushmani* zones.

A quantitative study of its nannofossils has been carried out on 500 specimens per sample, randomly picked. A total of 40 samples have been studied. The most abundant species are: *Watznaueria barnesae, Stradneria crenulata, Eiffellithus turriseiffelii, Eprolithus floralis, Tranolithus phacelosus,* and *Parhabdolithus achlyostaurion;* the last species shows a decrease in abundance upward, whereas the species *Lithraphidites acutus* and *Axopodorhabdus albianus,* both rare, are only registered in the lower part of the section. The first appearance of the species *Quadrum gartneri* allows us to recognize the lower boundary of the *Q. gartneri* Zone; its upper boundary in not found in this study.

The FAD of *Q. gartneri* is younger than the LAD of *Rotalipora* spp., *L. acutus,* and *A. albianus,* all of them of latest Cenomanian age. In the Menoyo section, in the same region, we have found a similar sequence of events (Gorostidi & Lamolda, 1990). In addition, the FAD of *Inoceramus (Mytiloides) labiatus* and *Mammites nodosoides,* both of early Turonian age, are younger than the FAD of *Q. gartneri.* Therefore, we agree the species *Q. gartneri* is a good marker to define the Cenomanian-Turonian boundary, as was mentioned by Birkelund et al. (1984).

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LOWER CRETACEOUS CALCAREOUS NANNOFOSSILS FROM TWO SECTIONS IN THE WEST CARPATHIANS

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Topics: E. Cretaceous, Czechoslovakia, Biostratigraphy

Attention is paid to the study of calcareous nannofossils from the Lower Cretaceous sequences of the Chotúc klippe (Periklippen Belt in the middle Vah river valley, klape Belt, Drietoma unit, NW Slovakia) and to the Trstie section (Choc nappe in the middle Vah river valley, NW Slovakia). A comparison is given with results based on foraminifera.

BIOCHRONOLOGY OF THE TERMINAL CRETACEOUS CALCAREOUS NANNOFOSSIL ZONE OF *MICULA PRINSII.*

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Topics: Maastrichtian, Global, Zonation, *M.prinsii*

Many articles have been published during the last decade on the Cretaceous-Tertiary (K-T) boundary extinctions and their causes. In studies of Cretaceous-Tertiary boundary sections, it is important to assess the completeness of the boundary layers. Here, the late Maastrichtian calcareous nannofossil species *Micula prinsii* Perch-Nielsen, is used to determine whether the terminal cretaceous is present or not in deep sea cores.

Six Deep Sea Drilling Project (DSDP) sites, five sites spanning the terminal Cretaceous palaeolatitudinal interval between 36°S and 37°N in the Atlantic Ocean and one site from a palaeolatitude of 16°N in the Pacific ocean, were examined in order to determine the chronology of the *M. prinsii* Zone. The *M. prinsii* Zone is often used to demonstrate the presence of terminal cretaceous sediments. In this study, the chronology of the *M. prinsii* Zone is based on abundance counts, and the base of this zone is correlated to the magnetic polarity stratigraphy. *Micula prinsii* first appears near the boundary between subchrons C29R and C30N. Estimated ages of the first appearance datum (FAD) of *M. prinsii* are based on the assumption that the sedimentation rate from the base of subchron C29R to the K-T boundary was constant and that the C29R/C30N boundary occurred 0.28 m.y. before the K-T boundary. The estimated first appearance of *M. prinsii* is 0.25 $\pm$ 0.02 m.y. before the Cretaceous-Tertiary (K-T) boundary in the South Atlantic. In the North Atlantic sites investigated the abundance of the index species is low, but based on Site 384 the FAD may be dated at 0.22 $\pm$ 0.02 my. before the K-T boundary. In Site 548A the low abundances of *M. prinsii* preclude the determination of the base of the *M. prinsii* Zone. No magnetostratigraphy has been established for the North Pacific Site 465A, which precluded calibration of the FAD of *M. prinsii* to magnetochronology. On the other hand, at the North Pacific DSDP Site 577A, which has been studied with respect to magnetochronology, the length of the *M. prinsii* Zone has been determined by other workers. Calibration to the magnetostratigraphy shows that the FAD of *M. prinsii* occurred at 0.19 $\pm$ 0.02 my. before the K-T boundary at this site. The *M. prinsii* Zone extends up to the K-T boundary, where its index species is among the Cretaceous calcareous nannofossil stock that became extinct. This zone is an important tool for verification of the completeness of terminal Maastrichtian sequences from low to middle latitudes.

CALCAREOUS NANNOFOSSILS OF THE ALPINE UPPER TRIASSIC

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Topics: L.Triassic, Alps, Distribution, Calcispheres

Two sections of the Lower Carnian Cassian Beds (Dolomites, Italy) and five sections of the Rhaetian Kossen Beds/Zlambach Marls (Northern Calcareous Alps, Germany/Austria) were examined for their content of calcareous nannofossils using a preparation technique described in Janofske (1990). The nannoflora assemblages of the Lower Carnian consist of three types of "calcispheres" and one incertae sedis form. The three types of "calcispheres" can be distinguished on the base of their wall structure: there are specimens with orthopithonelloid obliquipithonelloid and pithonelloid wall structure (Keupp 1987). These features and the existence of an aperture suggest a classification as calcareous dinoflagellate cysts. The Rhaetian calcareous nannofossils are the incertae sedis form *Prinsiosphaera triassica* Jafar 1983, the coccoliths *Crucirhabdus primulus* Prins ex Rood, Hay & Barnard 1973, *Crucirhabdus minutus* Jafar 1983 and *Conusphaera zlambachensis* Moshkovitz 1982 and the calcareous dinoflagellate -cysts *Orthopithonella geometrica* (Jafar 1983) Janofske 1989 and *Obliquipithonella rhombica* Janofske 1989. The nannofossil assemblages are clearly dominated by *Prinsiosphaera triassica.* The present results show that there are calcareous nannofossils in both the Lower Carnian and Rhaetian of the Alpine Triassic but the nannofossil assemblages differ completely. None of the Carnian forms could be observed in Rhaetian samples. Coccoliths are not present in the Lower Carnian, but in the Rhaetian which is the so far earliest occurrence of coccolithophorids. So even the calcareous nannofossils seem to reflect an Upper Carnian extinction event, which has been documented for several marine and terrestrial invertebrate and vertebrate groups.

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PROBLEMS IN THE TAXONOMY AND TERMINOLOGY OF LIVING COCCOLITHOPHORIDS.

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Topics: Living, Global, Taxonomy, Terminology

Recent publications and INA workshop discussions have attempted to review our current knowledge of both the taxonomy and terminology of living coccolithophorids and to highlight the existence of problematic areas. In this presentation some of these problems will be discussed and possible solutions proposed.

1) In biogeochemistry and ultrastructure papers the genera *Emiliania, Gephyrocapsa* and *Reticulofenestra* are commonly placed within the Isochrysidales - a group of prymnesiophyte algae which produce alkenone/alkenoate compounds, do not have a well-developed haptonema and until now lack coccoliths. The evidence for this placement is growing, but it poses future classification problems. Namely that some coccolithophorids possess a well-developed, coiling haptonema, a feature normally associated with the Prymnesiales - another order of the Prymnesiophyceae which do not currently produce coccoliths. To separate out the coccolithophorids into these two orders would require observations of living material and chemical analyses from unialgal cultures. At present only a small number of open ocean coccolithophorids are in culture, so reclassification will have to await further research.

2) The genus *Syracosphaera* according to recent classification schemes contains many species with differing caneolith and cyrtolith morphologies, as well as coccolith arrangements around the cell. By using a number of distinct characteristics possibly 5 genera may exist within *Syracosphaera;* these include *"Deutschlandia", , "Caneosphaera", Syracosphaera sensu stricto* and two new genera. However, there would be a need for some genera to have their generic descriptions emended following the transfer of additional species to them.

3) The term "cyrtolith" used in describing both syracosphaerid- and rhabdosphaerid-type coccoliths may be ambiguous, although structurally they appear closely related. In addition, there is some resemblance to the structure of the caneoliths. However, the use of the term "podorhabdid rim" for part of the rhabdosphaerid cyrtolith must be discouraged. The Podorhabdaceae are extinct and current opinion suggests that they did not give rise to any modern groups.

CRITICAL REVISION OF THE AGE OF THE BASAL VIGLA LIMESTONES (IONIAN ZONE - WESTERN GREECE) BASED ON NANNOPLANKTON - PALAEOGEOGRAPHIC CONSEQUENCES.

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Topics: E. Cretaceous, Greece, Biostratigraphy

The age of the basal levels Of the Vigla Limestones Formation (Ionian zone - Western continental Greece) in the Ionian Basin was revised, based on the study of nannofossils and Calpionellidae microfaunas.

The results of the revision show that the deposition of the Vigla Limestones started during the Tithonian - Berriasian and that this starting was synchronous all over the basin. As a consequence, the Vigla Limestones represent the beginning of the post-rift deposition in the Ionian Basin.

ESTIMATES OF COCCOLITH-CARBONATE EXPORT PRODUCTION OF MODERN CALCAREOUS NANNOPLANKTON IN THE NORTH ATLANTIC

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Topics: Living, N. Atlantic, Ecol/oc, Production rates

The vertical and geographic distributions of extant coccolithophores have been investigated at four stations in a transect along 20°W, from 63°N to 40°N in the North Atlantic (Dutch JGOFS Leg 4, from June 2 to 29, 1990). The goal was to quantify of how much CO_2 is actually extracted per unit of time by *Emiliania huxleyi* and other coccolithophore species. At each station, nine water samples from CTD casts were collected at standard depths within the upper 200 meters of the watercolumn, filtered with a Millipore filtering system and the cells counted by light microscopy. In general, the coccolithophore standing stock was restricted to the uppermost 75 meters of the photic layer. With the exception of one station (at 53°N), the maximum coccosphere concentrations decreased from about 2.3 x 10^5 cells per litre at 58.5°N to 6 x 10^4 cells per litre at 40.6°N. In addition, maxima of the coccosphere concentration profiles seemed to shift in a southward direction from the sea-surface (at 58.5°N) to higher water depths (50 m at 40.6°N). This trend, however, was not found at 53°N, where the highest coccosphere concentrations during the present study were observed (3.8 x 10^5 coccospheres per litre). In addition, a high content of loose liths was observed at the same location, which is interpreted as the remains of an altering bloom of *E. huxleyi*. Apart from the southernmost station (40.6°N), *E. huxleyi* was always the dominant species among coccolithophores. Integrated values for the uppermost 200 m of the watercolumn gave 6.1 x 10^8 to 1.1 x 10^{10} coccospheres of *E. huxleyi* per m^2. Assuming a constant doubling rate of about 0.3 cell doublings per day and a constant standing stock in the photic zone all the year round, a conservative estimate of the coccolith carbonate export production between 2.3 g m^{-2} yr^{-1} and 41.7 g m^{-2} yr^{-1} was obtained, the latter value representing a bloom situation. This would imply, that in the North Atlantic (from 63°N to 36°N and from 2°W to 70°W) *E. huxleyi* alone can potentially fix an amount of 7.6 x 10^7 tons CO_2 per year. If seasonal variations of the standing stock, as documented by Okada and McIntyre (1979) were included in the calculations, and if it is also assumed, that the cell doubling rate would decrease linearly with depth, the carbonate export production of *E. huxleyi* varied from about 0.4 g m^{-2} in the oligotrophic waters at 40.6°N to 21.2 g m^{-2} yr^{-1} at 53° N. *Coccolithus pelagicus*, was also found to be important for the extraction of CO_2, especially at high latitudes. Estimates for this species ranged between 0.7 g m^{-2} yr^{1} $CaCO_3$ at 40.6°N

to 33.1 g m^{-2} yr^{-1} $CaCO_3$ at 53°N. Although very few seasonal observations are available until present, the study may demonstrate, that coccolithophore blooms may be essential in fixation of $CaC0_3$ in open ocean conditions.

CHANGES OF THE EARLY OLIGOCENE NANNOFOSSIL ASSEMBLES IN THE SUBMENILITIC AND MENILITIC FORMATIONS OF THE ZDANICE UNIT (THE WEST CARPATHIANS, CZECHOSLOVAKIA).

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Topics: Oligocene, Czechoslovakia/Paratethys, P'ecol/oc, Milankovitch

Beds of marlstones and calcareous claystones 0.2 - 0.6 m thick alternate in the pelagic Early Oligocene *Globigerina* marls (NP 21 Biozone) of the Submenilitic Formation which is supposedly a reflection of the short-time climatic cycles of the Milankovitch type. Changes in the relative abundances of calcareous nannofossil taxa in beds of contrasting lithology are studied in relation to the carbonate content and the stable isotope composition of the bulk sediment.

At the time of the Subchert member deposition (the Menilitic Formation, NP22 Biozone) the temperature decreased and intermittent influence of higher run-off affected the nannofossil assemblages. The subsequent Chert Member is barren of calcareous nannofossils (strong decrease in salinity in the photic zone is supposed).

In the Dynów Marlstones (NP23 Biozone) low diversity or monospecific assemblages with dominant *Reticulofenestra ornata* are characteristic. The alternation of chert and nanno-chalk laminae observed in silicites from locality Krepice show seasonal changes of dominants in phytoplankton assemblages (diatoms and *R. ornata* respectively).

CALCAREOUS NANNOFOSSILS FROM THE AKSITERO-MORIONES AREA WESTERN PART OF TARLAC PROVINCE CENTRAL LUZON BASIN, PHILIPPINES

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Topics: L. Oligocene - L. Miocene, Phillipines, Biostratigraphy

This paper presents a biostratigraphic interpretation of the western part of Tarlac Province in Central Luzon basin, Philippines based on calcareous nannofossils. A total of 144 field samples collected from four formations, namely, Aksitero (Upper), Moriones, Malinta and Tarlac are investigated. Recovered from such investigation are 96 species belonging to 24 genera. None are described as new. A brief taxonomic listing of the species is given, and the nannofloral characteristics of the formations are discussed. The eleven nannofossil zones of Martini (1971) within the Upper Oligocene and Upper Miocene recognized in the area of study are presented in a tentative zonation scheme prepared for the area.

NANNOPLANKTON BIOSTRATIGRAPHY OF THE FIRST SUBLIGURIAN NAPPE(LATE CRETACEOUS-TERTIARY) IN THE NORTHERN APENNINES

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Topics: L.Cretaceous - Eocene, Italy, Biostratigraphy

The Subligurian nappe is the first stratigraphic formation above the Tuscan Sequence in the northern Apennines. It is often difficult to identify and define the former complex due to its intensive tectonic melanges both at the base and the top.

By others authors the Subligurian nappe has been named the Kalk-Ton-Serie (limestone-clay series), Complesso delle Argille e Calcari (clay and limestones complex). Formazione di Santa Fiora, (Santa Fiora

Formation), Flysch argilloso calcareo della Tolfa (limestone-clay flysch of Tolfa). Exposures are scattered over a wide area, from the Trebbia Valley in the north, to Southern Tuscany in the south. The age of the complex was commonly assumed to be Paleocene to Miocene.

In order to define the age of the Subligurian nappe, calcareous nannofossils have been studied from an outcrop in central Tuscany Civitella Val. di Chiana. prov. Arezzo). This section exposes 170m of pelagic limestones and clays which are of turbiditic origin. The detailed examination of calcareous nannoplankton revealed a late Cretaceous age in the lower part of the formation. Nannofossils are not very common in these sediments, most abundant are *Micula* and *Quadrum.* The occurrence of the genus *Reticulofenestra* in the upper part of the sequence suggests middle Eocene - Oligocene age. The ages indicated by foraminifera are consistent with the nannofossil results.

This biostratigraphic data is important in understanding the geotectonic evolution of the Apennines.

SPREADING OF THE MIOCENE CALCAREOUS NANNOFOSSILS IN THE INTRACARPATHIAN AND EXTRACARPATHIAN AREAS OF ROMANIA.

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Topics: E.Miocene, Romania/Paratethys, Biostrat'

A detailed study of the calcareous nannofossil assemblages of the Miocene deposits of Pannonian - and Transylvanian basins, Subcarpathian areas and Moesian platform allow us: to define more accurately the range of several species; to estimate the boundaries of zones using species other than those designated in the "standard zonation" (Martini 1971); to subdivide the NN2 and NN4 zones into subzones; to refine the correlation between the Mediterranean and Paratethyan stages of the Miocene. In the above mentioned areas can be determined:

NN1 - NN2 boundary by the first occurrence of *Reticulofenestra pseudoumbilica*

NN2 - NN3 boundary by the first occurrence of the *Sphenolithus belemnos;*

NN4 - NN5 boundary by the first occurrence of *Discoaster exilis;*

NN6 - NN7 boundary by the last occurrence of *Cyclicargolithus floridanus.*

The NN2 zone can be subdivided into the *Sphenolithus dissimilis* (a) and *Helicosphaera kamptneri* (b) subzones (the limit between them is given by the first occurrence of *Helicosphaera ampliaperta).* The NN4 zone can be subdivided into the *Discoaster adamanteus* (a) and *Calcidiscus leptoporus* (b) subzones (the limit between them is given by the first occurrence of *Calcidiscus leptoporus*). Comparing the nannofossil assemblages of the typical sections of Mediterranean and Paratethyan stages (which were mentioned by Baldi-Beke, 1960, 1964, 1975; Bona & Gal in Papp et al. 1987; Demarque Perrieux, 1984; Martini & Muller 1975; Muller 1974; Muller & Pujol, 1979; Nagymarosy, 1985;. Semenenko & Liulieva, 1978; Stradner & Fuchs, 1979) with those of Miocene deposits from Romania, we suppose the established zones of calcareous nannofossils would be able to be correlated with the Mediterranean and Paratethys stages according to the joined table. The endemic associations of Malvensian deposits, very rich in *Bekeithella* and *Noelaerhabdus,* are more difficult to fit in a biozone of the standard zonation. They would be developed in the interval of zones NN10 and, partially, NN11.

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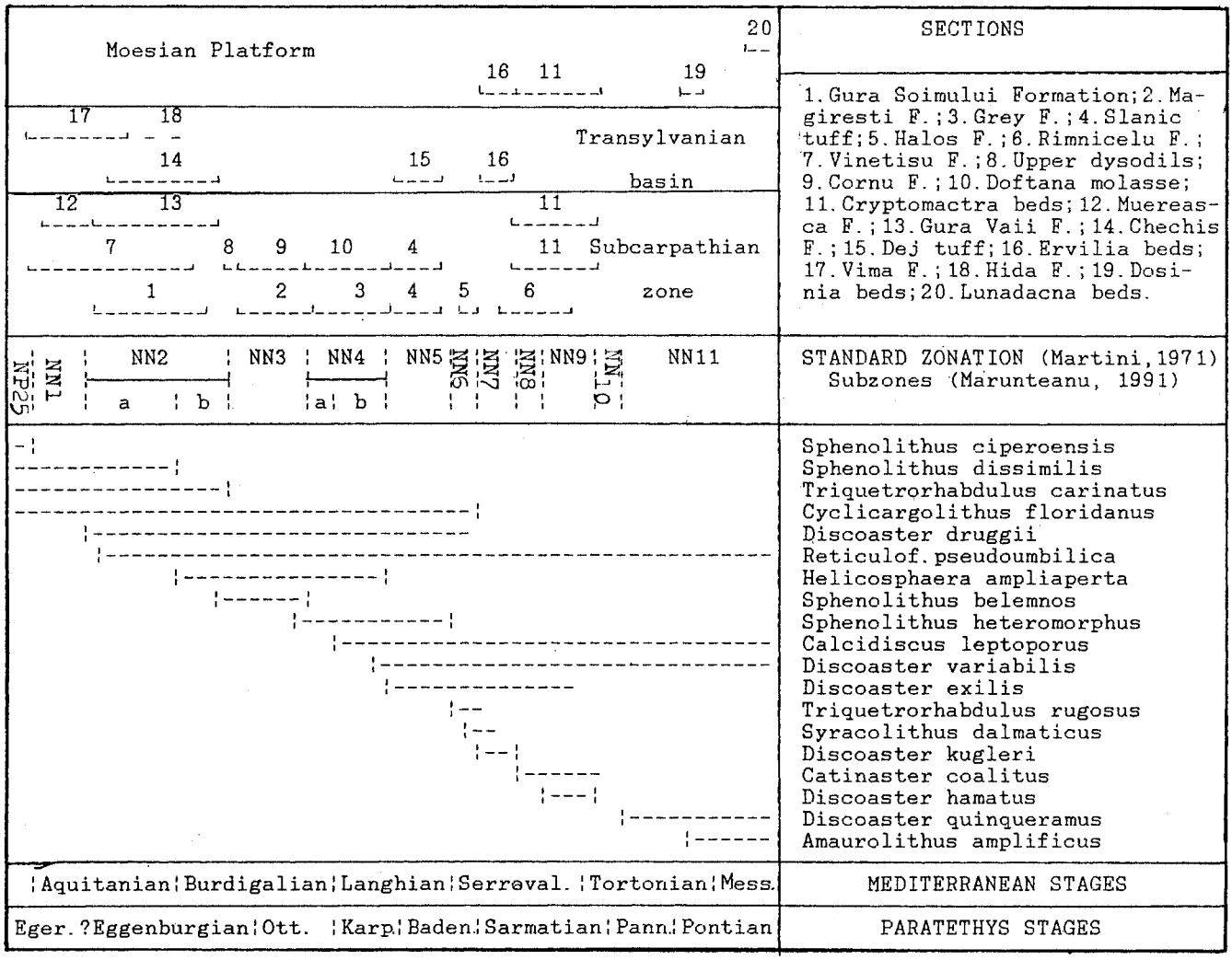

Miocene zonation and stratigraphy of Paratethys [Marunteanu]

LATE JURASSIC - EARLY CRETACEOUS CALCAREOUS NANNOPLANKTON BIOSTRATIGRAPHY FROM SOUTHERN CARPATHIANS (ROMANIA)

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Topics: Tithonian - Hauterivian, Romania, Zonation

Certain rich and diversified nannoflora assemblages have been pointed out from Southern Carpathians (Resita and Svinita zones - Median Dacides).

These nannoflora assemblages have been correlated with the dinoflagellates ammonites and calpionellids zones recognized in the same sections (Antonescu & Avram 1980).

The following nannoplankton zones are described:

Conusphaera mexicana Zone. Age: Early Tithonian

Polycostella beckmannii Zone. Age: Late Tithonian

Nannoconus steinmannii Zone. Age: Early Berriasian

Micrantholithus obtusus Zone. Age: Early Late Berriasian

Stradneria crenulata Zone. Age: Late Late Berriasian

Speetonia colligata Zone. Age: Early Early Valanginian

Calcicalathina oblongata Zone. Age: Early Late Valanginian

Chiastozygus striatus Zone. Age: Late Valanginian - Early Hauterivian

Lithraphidites bollii Zone. Age: Late Hauterivian

The Tithonian-Berriasian nannofossil assemblages show a typical nannoflora from the Tethyan Realm.

At the interval corresponding to the Valanginian the nannoflora recognized indicates Boreal influences.

Otherwise these influences have been observed also in the Eastern Carpathians based on nannofloras studies (Melinte 1981) but also on foraminifera (Neagu 1975) and ammonites (Avram 1988).

During the Hauterivian the nannoflora assemblages pertain entirely at the Tethyan Realm.

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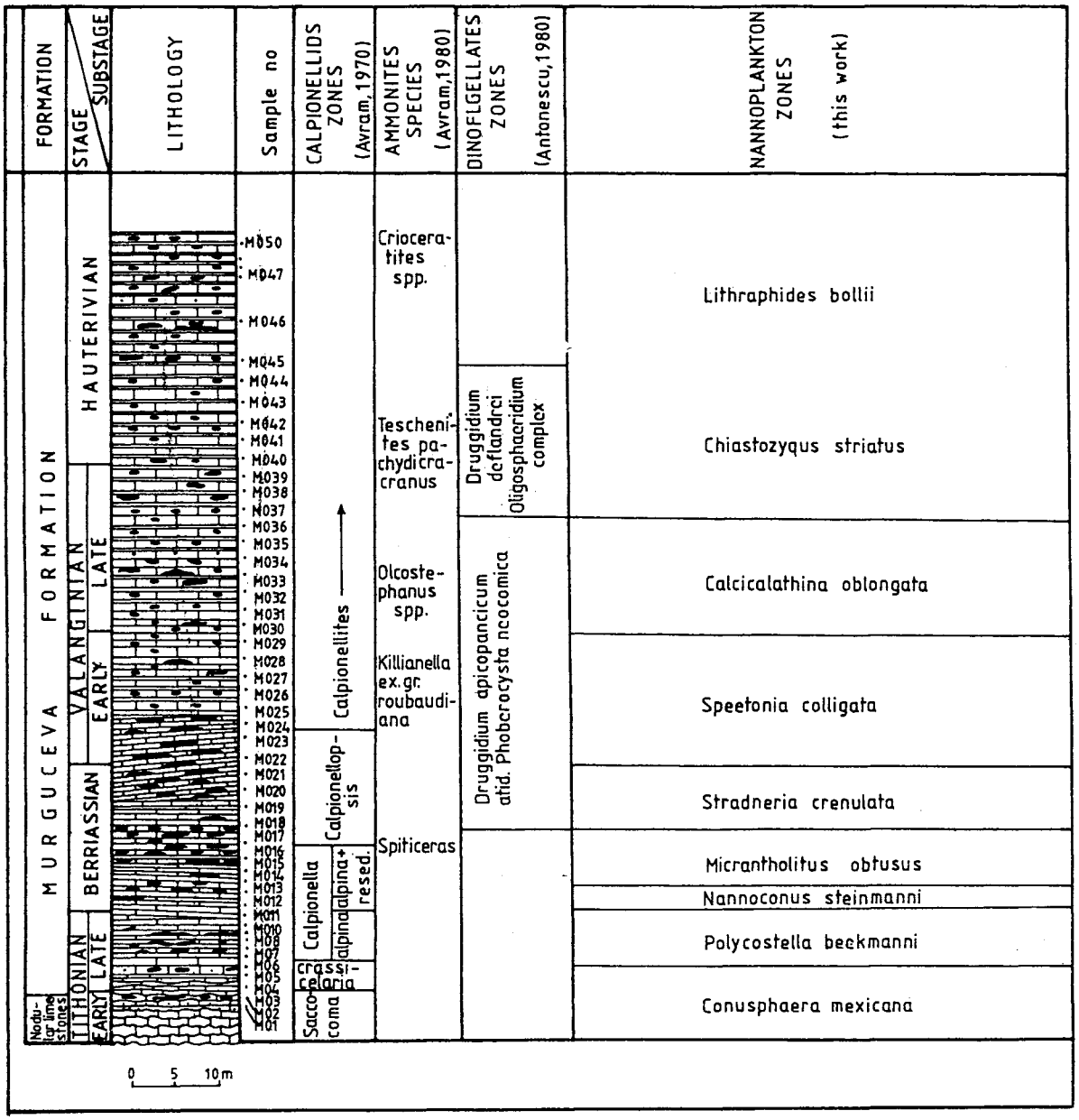

Nannoplankton zonation of the Late Jurassic - Early Cretaceous for Southern Carpathians, Romania. [Melinte]

NANNOPLANKTON ZONES IN THE MIOCENE DEPOSITS OF THE TRANSYLVANIAN BASIN

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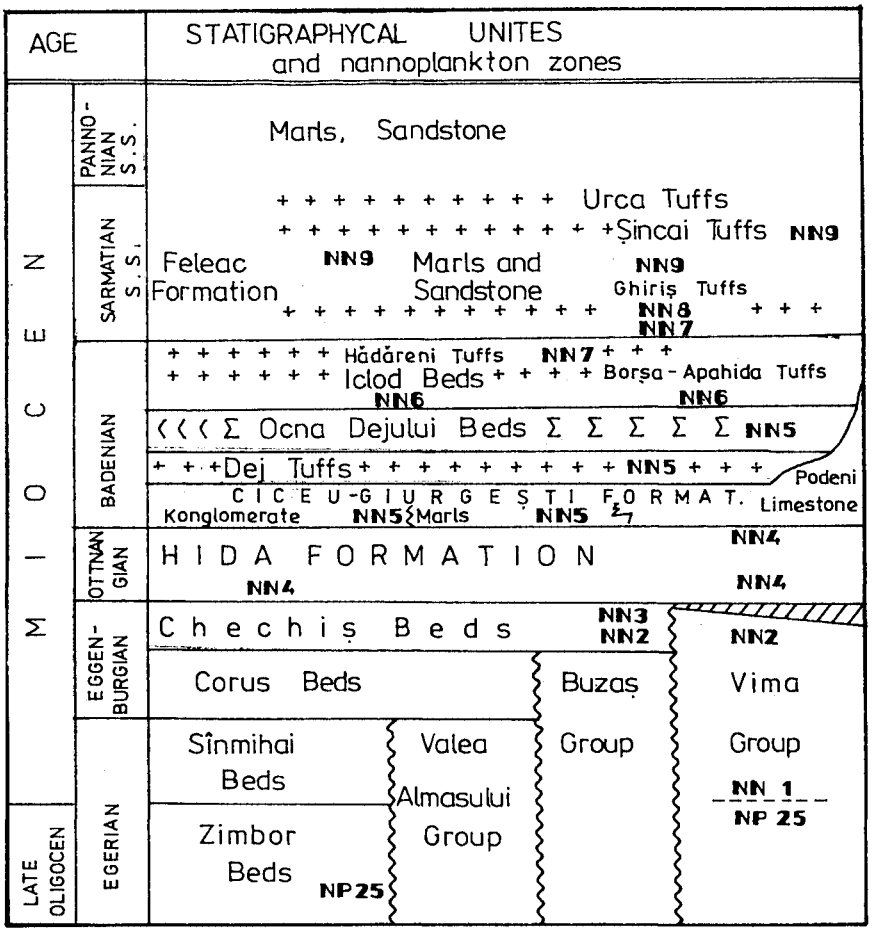
Topics: E. - M. Miocene, Romania, Biostratigraphy, Paratethys

The Oligocene/Miocene boundary has been established in a sequence at Fintinele (South of Tg. Lapus) by means of nannoplankton within the Vima Groups. Within these groups, NP25, NN1 and more or less even NN2 zones were identified. This is the only place where *Triquetrorhabdulus carinatus* has been found so far as a proof of NN1 zone.

In the Buzas Groups, and the Valea Almasului Groups (Sînmihai Beds), the Oligocene/Miocene limit is not possible to establish.

The clay intercalations of the Corus, Beds (Eggenburgian age) also lack age - indicating forms of nanno-



Stratigraphy and nannoplankton zonation of the miocene of the Transylvanian Basin [Mészáros]

plankton.

The Chechis Beds (Eggenburgian age) bear frequent forms of *Sphenolithus belemnos* and *Helicosphaera ampliaperta* belonging to NN3 zone and partly to NN2 zone.

The bottom (Hida) and the upper part (Dej) of the Hida Formation (Ottnangian age) has been assigned to the top of NN4.

The Ciceu-Giurgesti Formation (basal conglomerate, Podeni limestone, marls) and the Dej Tuffs pointed to the presence of NN5 zone with *Sphenolithus heteromorphus* (Lower Badenian - Moravian age).

The gypsum and salt formation comprises the evaporite horizon, Ocna Dejului Formation, accounting for the presence of NN5 zone (Middle Badenian - Wielician age).

The marls bearing Borsa-Apahida, Hadareni Tuffs, belong to the Iclod Formation and to that with Radiolaria and *Spiratella*, i.e. to NN6 zone and the lower part of NN7 zone (Upper Badenian - Kossovian age).

The Feleac Formation and the marls in the inner part of the Transylvanian Basin assigned to Sarmatian deposits s.s. (Volhynian - Lower Bessarabian age) and Pannonian ones s.s. comprising the Ghiris, Sincai, Urca Tuffs, account for the existence of the upper part NN7 zone and the NN8, NN9 zones. Starting with NN8 zone, the deposits are more and more reworked.

As the Miocene sea became sweeter; later nannoplankton associations are represented only by reworked forms.

NANNOPLANKTON ZONES IN THE PALEOGENE DEPOSITS OF THE TRANSYLVANIAN BASIN

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Topics: M. Eocene - E. Miocene, Romania, Biostratigraphy, Paratethys

During research work on the whole Paleogene sequence of beds, samples where collected in several areas, such as the town of Cluj and its surroundings, Leghia, the eastern border of the Meses Mts., east of the town of Jibou and the surroundings of Tg.-Lapus (Gilau, Meses, Preluca Area).

The Paleogene sequence of deposits in this chronological order and its nannoplankton content will be presented further on (Mészáros et al., 1979, 1984, 1987, 1988).

The Jibou formation represented a series of continental sediments devoid of nannoplankton.

The marly-limestone and the beds bearing Anomia and lower gypsum do not contain nannoplankton.

The Racoti group, in the, *Sokolowia eszterhazyi* beds: are of Upper Lutetian age, representing the upper part of the NP15 Zone and the lower part of the NP16 Zone (after Martini).

The *Nummulites perforatus* beds and the *Velates* bearing limestone belong to the NP16 Zone.

The lower third of the *Mortanusa* beds (marls) belong to NP17 Zone. -In the median part of these deposits, species of *Chiasmolithus oamaruensis* become more frequent. This assemblage belongs to the NP18 Zone, the base of the Priabonian.

The Leghia (limestone) - Racoti (sandstone) not prepare substances for the study of nannoplankton.

The Valea Nadasului (Turbuta) Formation is a series of continental sediments and consequently devoid of nannoplankton.

The Cluj group belongs to the *Isthmolithus recurvus, Sphenolithus pseudoradians* Zone(NP19, 20).

The Brebi beds in the uppermost third part belong to NP21/NP 22 Zone, situated at the limit Priabonian/Herian (Eocene/Oligocene).

The Merian Formation belongs to NP22, NP23 Zones (Merian - Lower Rupelian). The holostratotype Merian is represented by the Mera section - including the final part of the Brebi beds, the Hoia, Mera and Moigrad beds. Based on calcareous nannoplankton (mainly NP22, NP23 Zone), correlations with classical sections from the Tethys area and the north european basins are possible.

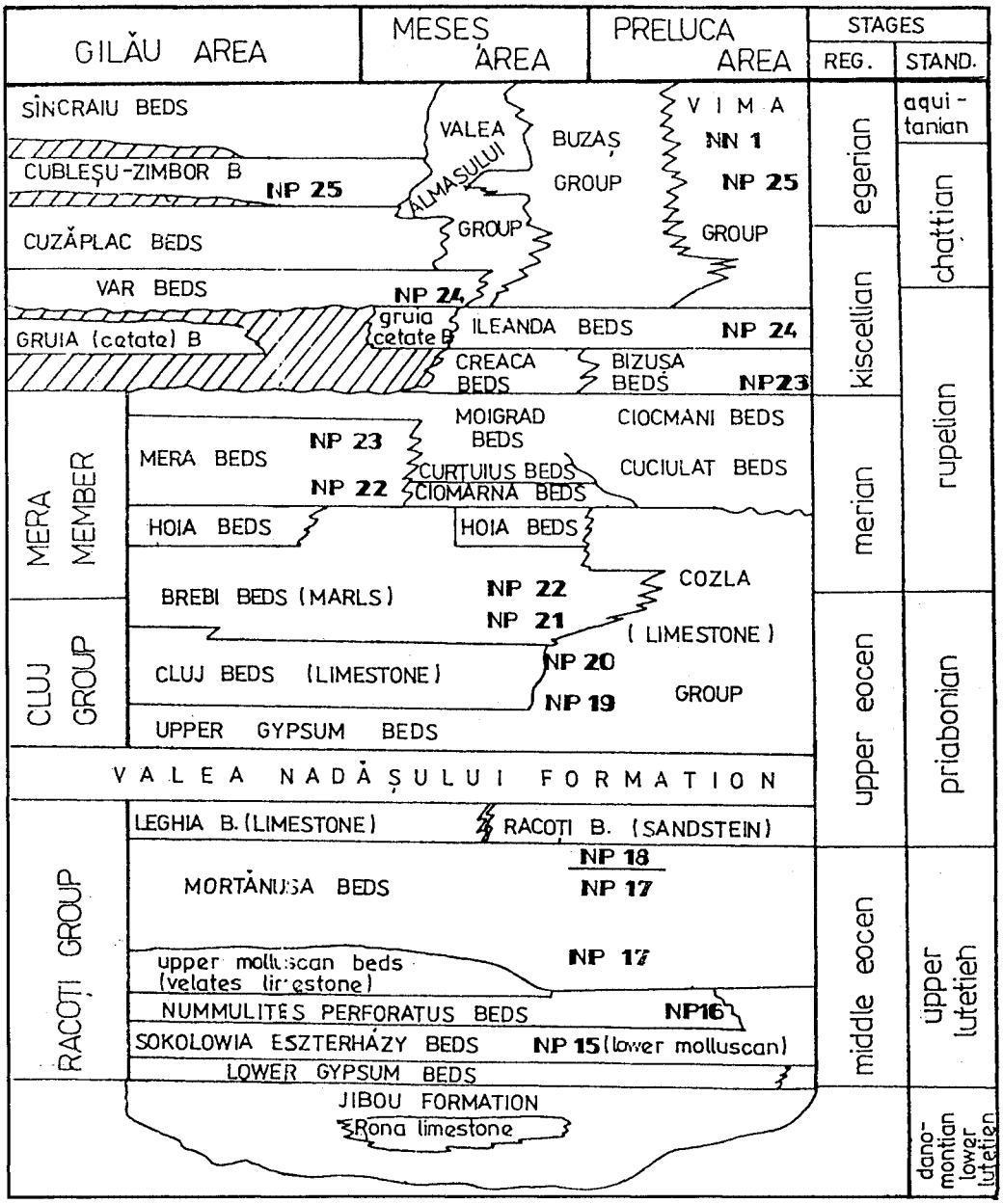
The Bizusa beds belong to the NP23 Zone (Lower Kiscellian - Middle Rupelian).

The nannoplankton assemblage identified at Var - Satinlui Valley (east of Jiboin), at the base of the Var sandstone is clear evidence that the studied deposits belong to NP24 Zone (Ileanda Beds), which resembles the one lying in Cormenisului Valley (Upper part of the Kiscellian and the base of the Egerian).

In the Zimbor Beds (Gilgau - Rea Valley): the nannoplankton assemblage with *Sphenolithus ciperoensis* belongs to NP25 Zone.

In the Fîntînele (Rohia): in the upper part of the Vima group underlying + the Oligocene/Miocene limit. An upper association revealed the presence of *Triquetrorhabdulus carinatus* bearing formation: which delimits NN 1 Zone i.e. the beginning of the Miocene (Upper Egerian age).

In summary nannoplankton studies have enabled us to separate the Eocene from the Oligocene and Miocene and to delimit several nannoplankton zones in the North-Western and Northern part of the Transylvanian Basin.



Stratigraphy and nannoplankton zonation for the Palaeogene of the Transylvanian Basin [Mészáros].

PALAEOBIOGEOGRAPHY AND PROVINCIALISM OF EARLY CRETACEOUS NANNOFLORAS

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Topics: Berriasian - Albian, global, P'ecol/oc, Distribution

The nannofossil assemblages of the Early Cretaceous show a distinctive palaeobiogeographic distribution pattern for the intervals Berriasian - Barremian on one hand and for the Aptian -Albian on the other.

The Berriasian - Barremian period is characterized by provinciality on the generic level. It is possible to differentiate between a Boreal Realm and a Tethyan Realm. Assemblages from the Indo-Pacific area show cosmopolitan elements and weak influences of tethyan floras. Therefore the Tethyan Realm is subdivided into a Mediterranean Province (Tethyan Realm *sensu strictu*) and an Indo-Pacific Province. While the Mediterranean Province is dominated by cosmopolitan and tethyan floras, the latter are absent from the Indo-Pacific Province. In addition to this distribution pattern two high-latitude belts may be recognised, caused by a bipolar distribution of *Crucibiscutum salebrosum*. These bipolar belts are restricted to the Boreal Realm and the Indo-Pacific Province.

The Aptian - Albian period was marked by a floral (and faunal) turnover, causing major changes worldwide. The differences between the Boreal Realm and the Tethyan Realm vanished, as well as the differences in between the two provinces in the Tethyan Realm. Despite this worldwide homogenization of floras, two high-latitude floral belts are still present in the Aptian - Albian, indicated by *Seribiscutum primitivum.*

The changes in the distribution patterns are best explained by: 1. increased sea floor spreading; 2. a sea level high stand in the middle Aptian and; 3. temperature control of some species.

THE RESPONSE OF THE CALCAREOUS NANNOPLANKTON TO THE EARLY OLIGOCENE SEPARATION OF THE PARATETHYS

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Topics: Oligocene, Paratethys, P'ecol/oc, Blooms

Late Eocene orogenic movements, such as the closure of the Rhenodanubian flysch trough and the uplift of the Dinaric chain resulted in partial separation of the Eoparatethys (Báldi, 1984). The Early Oligocene sequences of the Paratethys uniformly display anoxic type sediments extending from the Alpine foredeep to the Aral sea: microlaminated black shales (due to the lack of bioturbation) with high organic carbon content, well preserved fish remains, etc. The formation of the anoxic sediments might be a consequence of the stratification of different salinity water layers among the restricted conditions. The rarity and bad preservation of benthic foraminifera, the almost total absence of planktonic foraminifera, and the generally poor macrofossil record gives the nannoplankton stratigraphy special importance. Nannoplankton species of less tolerance disappear from the Paratethys area, as a response to the changed conditions, while other forms became predominant. Assemblages characterized by blooms of one or two nannoplankton species appear uniformly in the same time level almost in the whole area of the Paratethys thus providing an excellent tool for the correlation of fossil-poor sequences.

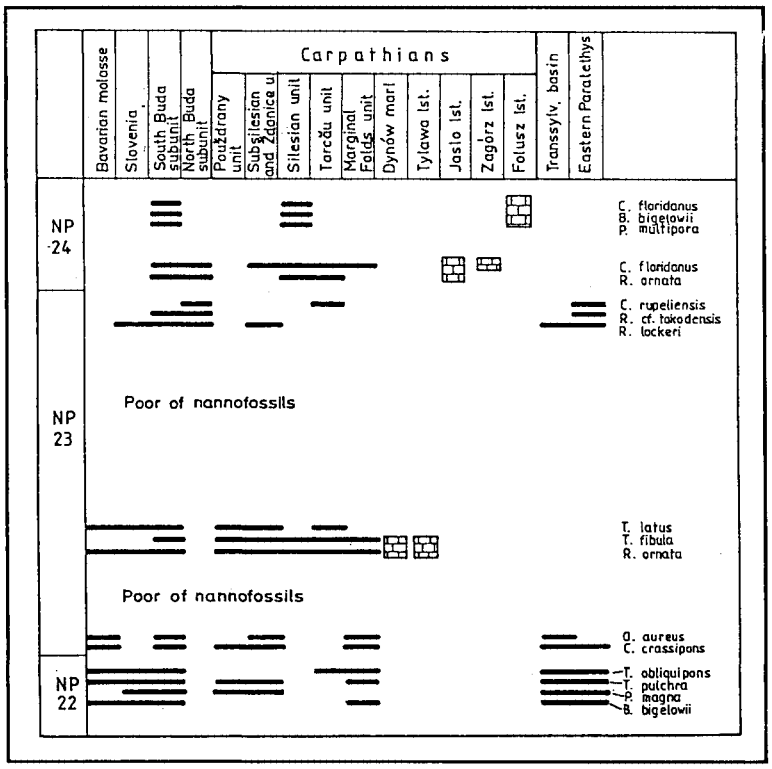
In zone NP22 blooms of *Transversopontis obliquipons* (Deflandre) Hay, Mohler & Wade, *T. pulchra* (Deflandre) Perch-Nielsen, *Pontosphaera magna* Haq and *Braarudosphaera bigelowii* (Gran & Braarud) Deflandre can be observed throughout Paratethys. This is followed by blooms of *Orthozygus aureus* (Stradner) Bramlette & Wilcoxon and *Coccolithus* cf. *crassipons* Boucher at the beginning of zone NP23. These blooms occur in the Schonecker Fischschiefer of the subalpine molasse, in the subcherty beds of the Carpathian flysch in the Lower Tard Clay in Hungary and in the Pshekhian horizon of the Eastern Paratethys.

The separation of the Paratethys was accompanied also by the evolution of an endemic mollusc fauna (e. g. *Cardium lipoldi* Rolle Báldi op. cit.) having appeared near to the NP22/23 zone boundary. The Cardium lipoldi-beds contain very low-diversity and high-abundance nannofloras with blooms of three diagnostic species: *Transversopontis fibula* Gheta (= *T. pax* Stradner = *Zygodiscus vialovi* Andreyeva-Grigorovich), *T. latus* Muller and *Reticulofenestra ornata* Muller. These forms seem to be endemic, because they havwe not been recorded outside Paratethys. The distribution of *T. fibula* is confined only to this particular stratigraphic level, which corresponds to the Heller Mergelkalk in the Subalpine molasse, to the menilite cherts, Dynow Marl and Tylawa Limestone in the Carpathians, the Lower Tard Clay in Hungary, the Bizusa beds in Transylvania and the Polbinian (Lower Solenovian) horizon in the USSR.

The separation of the Paratethys became complete by late NP23 zone, with a significant drop in the salinity of the surface waters. The deposits of this time level contain no nannofloras or very poor assemblages (Bandermergel dysodile shales, Upper Tard Clay Ileanda shale Gechinian=Upper Solenovian horizon).

Connection with the world sea and normal salinity conditions were restored by the beginning of zone NP24. The transitional beds usually contain mono- or duospecific blooms of *Reticulofenestra lockeri* Muller *R.* cf. *tokodensis* Báldi-beke and *Coccolithus rupeliensis* Muller and these are followed by diverse, normal salinity nannofloras in the Tonmergelstufe -of the subalpine molasse, the Kiscell Clay in Hungary, the Vima beds in Transylvania the Lopianka beds in the Carpathians and in the Batalpashinian horizon of the Eastern Paratethys).

At least two significant additional nannoplankton blooms were observed in the Carpathians during the NP24 zone and produced nannochalks: the Jaslo and Zagorz Limestone event and the Folusz Limestone event (Haczewski 1989). The first can be characterized by blooms of *Cyclicargolithus floridanus* (Roth & Hay) Bukry and *Reticulofenestra ornata*, the other with blooms of *C. floridanus*, *B. bigelowii* and *Pontosphaera multipora* (Kamptner) Roth. Traces of these blooms can be observed - with lower intensity in the Oligocene sequences of Hungary, thus proving that a circulation of water masses existed between the Carpathian flysch troughs and the Intra Carpathian basins.



Time and space distribution of nannoplankton blooms in the Early Oligocene Paratethys.

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PALAEOGENE CALCAREOUS NANNOPLANKTON BIOSTRATIGRAPHY OF JORDAN

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Topics: E. Palaeocene - M. Eocene, Jordan, Biostratigraphy

Early Palaeocene to Middle Eocene calcareous nannoplankton assemblages were recovered from outcrop samples as well as from core chips and ditch cuttings samples from oil exploration wells in different areas in Jordan.

Palaeocene sediments consist mainly of marl and marly limestone, soft to slightly hard, partly bituminous and can be subdivided into the following zones: *Cruciplacolithus tenuis, Chiasmolithus danicus, Ellipsolithus macellus, Fasciculithus tympaniformis, Heliolithus kleinpellii, Discoaster mohleri* and *Discoaster multiradiatus.*

The Eocene sequences are composed of chalky limestone, soft to medium hard with chert nodules and limestone, hard, partly

silicified. The following zones have been recognized: *Marthasterites contortus, Discoaster binodosus, Marthasterites tribrachiatus, Discoaster lodoensis, Discoaster sublodoensis, Nannotetrina fulgens, Discoaster tanii nodifer* and *Discoaster saipanensis.*

MORPHOMETRIC STUDY OF *PSEUDOEMILIANIA LACUNOSA* AND ITS BIOCHRONOLOGICAL CONSEQUENCES.

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Topics: L. Pliocene - M. Pleistocene, Global, Biometrics, *P. lacunosa*

Pseudoemiliania lacunosa is one of the most useful biostratigraphic markers because of its wide distribution and because its last occurrence has been well correlated with oxygen isotope stage 12 in different oceans and at various latitudes. The potential for this species for wider biostratigraphic application is great as the species appears to show progressive size and shape changes through time. In this study we analyze morphometrically *P. lacunosa* from DSDP Sites 517 (South Atlantic) and 552 (North Atlantic) and ODP Sites 653 (Mediterranean Sea). Oxygen isotope stratigraphies are available and they provide precise age control for the samples analysed, which facilitates accurate correlation of size and shape changes through time at different sites. Preliminary results indicate that (1) round *P. lacunosa* first occurred between 2.1 and 2.0 M.a.; (2) elliptical *P. lacunosa* show a distinct trend of size increase through time; (3) mean placolith size changes abruptly in the upper Pliocene and in the middle Pleistocene at about 0.7 M.a., and the former change coincides with the first occurrence of round *P. lacunosa.*

DISTRIBUTION OF *NANNOCONUS* IN THE BOREAL CRETACEOUS OF NW EUROPE

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Topics: Ryazanian - Aptian, N.W. Europe, Distribution, *Nannoconus*

The occurrence of *Nannoconus* in the boreal Early Cretaceous of NW Europe has been analysed in terms of geographical and stratigraphical distribution of species. The oldest sample material, of late Ryazanian age, yields low diversity, low abundance nannoconid assemblages, including rare endemic boreal species and tethyan forms. In the Valanginian and Hauterivian diversity increases slightly but abundances remain low; no endemic boreal forms are recognisable. The Barremian is characterized by a significant increase in nannoconid diversity and abundance which is recognized across the European area; endemic species are found abundantly in the boreal area. The Aptian/Albian saw a reduction in nannoconid species diversity and abundance, although short-lived incursion events are recognized. The distribution patterns as outlined above will be analysed in terms of migration between the boreal and tethyan areas, and development of endemicity within the boreal area itself. in relation to contemporary palaeoceanographical patterns The global distribution of nannoconids will be reviewed in order to elucidate the controls on distribution during the Early Cretaceous.

CALCAREOUS NANNOFOSSIL AND CALPIONELLID BIOSTRATIGRAPHY OF THE JURASSIC/CRETACEOUS BOUNDARY INTERVAL IN NORTHWEST ANATOLIA, TURKEY,

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Topics: Tithonian - Valanginian, Turkey, Biostratigraphy, Calpionellids

Calcareous nannofossil and calpionellid data from seven land sections spanning the Yosunlukbayiri and Sogukcam Limestone formations (Tithonian to Valanginian) have enabled a refined biostratigraphic division of the Jurassic - Cretaceous boundary interval in northwest Anatolia, Turkey. The Yosunlukbayiri Formation consists of alternating green to cream coloured marl and micritic limestone. The limestones become detritic (calciturbidites) in the upper part of the formation. The Sogukcam Limestone Formation, which overlies the Yosunlukbayiri Formation, consists of white to pink coloured porcellaneous micritic limestone.

The nature of the sediments required the use of thin sections as well as smear slides for the identification of nannofossils, and particularly nannoconids. The samples yielded poor to moderately well preserved, low diversity, high abundance nannofossil assemblages and frequent calpionellids.

The calcareous nannofossil and calpionellid data, along with information from other fossil groups, e. g. benthic foraminifera, pelagic crinoids, ammonites, etc., has been integrated in order to obtain greater biostratigraphical resolution.

LATE PALEOCENE DISCOASTER DIVERSITY PEAKS IN THE HIGH AUSTRAL LATITUDES

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Topics: L. Palaeocene - E. Eocene, Southern Ocean, DiscoastersE

Oxygen isotope studies on foraminifera tests from nannofossil-foraminifera chalks and oozes cored at ODP Sites 689 and 690 (65°S) in the Weddell Sea have shown that the warmest climates and sea surface temperatures during the Cenozoic for this region occurred, as elsewhere, in the latest Paleocene and early Eocene (Stott et al, 1990; Kennett and Stott, 1990). Corresponding with this peak warming at Sites 689 and 690 is a pronounced benthic foraminfera extinction event, which is also noted at a number of localities worldwide (Thomas, 1990). Preliminary estimations indicate an influx in the numbers and diversity of discoasters in the latest Paleocene at high latitude Weddell Sea Site 690 coincident with this benthic foraminifera extinction event and the $\delta^{18}O$ minimum (peak warming) (Pospichal and Wise, 1990).

The late Paleocene (Zone CP8) nannofossil assemblage at Site 690 is dominated by *Chiasmolithus, Toweius,* and *Prinsius. Discoaster multiradiatus* and *D. lenticularis* generally represent a minor component of the assemblage. However, quantitative studies reveal that during peak warming intervals, discoasters become more abundant and diversity increases to include few to common species related to *D. mediosus, D. megastypus,* and *D. nobilis.* Concomitant with this rise in discoaster abundance is a slight drop in the abundance of colder water forms.

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NEW BIOSTRATIGRAPHIC DATA BASED ON CALCAREOUS NANNOFOSSILS OF THE MIDDLE-UPPER JURASSIC INTERVAL IN THE NORTHWEST ATLANTIC (SITES 534A AND 105) AND IN THE UMBRIA-MARCHE AREA

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Topics: M. - L. Jurassic, Tethys, Zonation, *C. deflandrei*

A detailed biostratigraphic study, based on calcareous nannofossils, of two sites drilled in the North West Atlantic and one section outcropping in the Umbria-Marche area (Central Italy) has provided new data for the biostratigraphy of middle - upper Jurassic.

The sites studied are: site 534A for the middle Callovian - lower Tithonian and site 105 for the Kimmeridgian - lower Tithonian interval respectively. The Valdorbia section in the Umbria-Marche area for the lower Bajocian - lower Tithonian interval, and the Bihendula section in Somaly has been studied.

Given the good preservation of the nannofossil assemblages in the drilled sites, it has been possible to recognize a succession of events, several of which have already been reported in the literature but also new ones

such as the first occurrence and the last occurrence of *Cyclagelosphaera deflandrei minor*, a new subspecies in the middle Callovian.

The last two events are of great importance because it has been possible to recognize them, due to the resistance to dissolution shown by *Cyclagelosphaera deflandrei minor*, even in sections with unfavourable lithology to the preservation of calcareous nannofossil, such as the Valdorbia section, in Italy and Bihendula in Somaly.

Moreover, the succession of events of the lower Bajocian - lower Tithonian interval has been correlated with the known magnetostratigraphy (Channel et al. 1984).

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CALCAREOUS NANNOPLANKTON OF THE UKRAINIAN CARPATHIANS CRETACEOUS

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Topics: Berriasian - Maastrichtian, Ukraine, Biostratigraphy

New results of calcareous nannoplankton investigations of the Ukrainian Carpathians Cretaceous rocks are given in the contribution. In the stratotype and key sections the following layers and zones were recognized based on the index species appearances and nannofossil assemblage changes.

- Layers with *Cretarhabdus crenulatus* (Berriasian - Early Valanginian) were found in Kamyany Potik Formation.
- Layers with *Calcicalathina oblongata* (Late Valanginian - Early Hauterivian) were present in the lower part of Rakhiv Formation

Layers with *Lithraphidites bollii* (Late Hauterivian - Barremian) were singled out in the upper part of the Rakhiv Formation

- The assemblage with *Nannoconus bucheri*, N. steinmannii, *N. wassallii*, *N. colomii*, very seldom in the Carpathians was found in section along the Tereblya River
- Layers with *Chiastozygus litterarius* (Early - Middle Aptian) were singled out both in the lower part of Belaya Tisa Formation and in the middle part of Spass Formation
- The *Parhabdolithus angustus* Zone (Late Aptian - lower part of Early Albian) was recognised in the middle part of Belaya Tisa Formation and in the Tissalo Formation

The *Prediscosphaera cretacea* Zone (upper part of Early Albian - lower part of Late Albian) was ascertained in the upper part of Belaya Tisa Formation and in the lower part of Sukhov Formation

- The *Eiffellithus turriseiffelii* Zone (upper part of upper Albian - Early Cenomanian) was observed both in the lower part of Sukhov and Golovnya Formations and in the upper part of Shypot and Soymul Formations and in the Pasika bed as well.
- The *Chiastozygus cuneatus* Zone (middle Cenomanian) was ascertained in the lower part of Golovnya Formation.
- The *Gartnerago obliquum* Zone (Late Cenomanian - Early Turonian) was recognized in the middle port of Golovnya Formation and in the middle part of Sukhov Formation.
- The *Eiffellithus eximius* Zone (Late Turonian) was observed in the middle part of Sukhov Formation and in the lower part of Pukhov Formation.
- The *Marthasterites furcatus* Zone (Coniacian) was observed in the upper part of both Golovnya and Sukhov Formations.
- The *Micula staurophora* Zone (uppermost Coniacian - lower part of Early Santonian) was recognized in the upper part of both Pukhov and Sukha Formations and in the intermediate beds of both Golovnya and Striy Formations

- The *Tetralithus obscurus* Zone (upper part of Early Santonian - Late Santonian) was ascertained in Pukhov, Striy and Yalovets Formations
- The *Broinsonia parca* Zone (Early Campanian) was observed in Berezna, Pukhov and Striy Formations.
- The *Tetralithus aculeus* Zone (Late Campanian) was observed in Striy Berezna and Pukhov Formations and in the lower part of Tarmut beds
- The *Tetralithus trifidus* Zone (Early Maastrichtian) was recognized in Berezna and Striy Formations.
- The *Nephrolithus frequens* Zone (Late Maastrichtian) was observed in Berezna and Striy Formations

The nannoplankton assemblages were correlated to assemblages of coeval deposits from Roumanian (Costea, Comsa, 1979) and Czechoslovakian (Gasparikova, 1984) Carpathians and more distant regions of Western Europe (Thierstein, 1973).

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"HI-RES" BIOSTRATIGRAPHIC ASPECTS OF SEQUENCE STRATIGRAPHY IN AN EXTENDED MIDDLE EOCENE WELL SECTION, ONSHORE TEXAS, USA

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Topics: M. Eocene, USA (Texas), Biostratigraphy, Sequence strat.

Sequence stratigraphic resolution examined within the context of a high resolution (hires) biostratigraphic framework offers a refined correlation tool for defining and understanding depositional packages. The "hires" stratigraphic aspect of this technique is particularly applicable in: expanded sedimentary sections, where high sedimentation rates over short geologic intervals permit high resolution sampling. In these sections, the traditional marker species approach is often insufficient for detailed correlations. Nannofossil data from Late Middle Eocene (Claibornian) portion of the Mobil. Becker 1 well, Victoria Co., Texas provides an example of this "hi-res", correlation approach. The 1200 meter Middle Eocene section is estimated to have a sedimentation rate of 0.7m/1000 years. Nannofossil acme events are used to identify condensed sections which are - candidates for maximum flooding surfaces and higher order events. Marked decreases in fossil abundances suggest the approximate position of sequence boundaries. Verification of this biostratigraphic interpretation is being done through integration with wire line logs and seismic data.

LATE CRETACEOUS SEDIMENTS ZONATION PROBLEM IN THE UKRAINE

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Topics: Cenomanian - Maastrictian, Ukraine, Zonation

Recent investigations have shown that the no single late Cretaceous zonation scheme is universally applicable in the Ukraine region. Even that of the Crimea (Shumenko, Stetzenko, 1978) could not be used throughout the Dnieper-Donetz region. Being found in the Crimea *Marthasterites furcatus* is rare or absent in the North of the Ukraine. In Black Sea coast region *Tetralithus trifidus* is missing in the Campanian - in Donetz region it is rare or absent. Many other index-species do the same. So for the Dnieper-Donetz region a new Zonation scheme has been proposed:

Lower Cenomanian - bottom of upper Cenomanian; zone *Eiffellithus turriseiffelii.*

Most of the upper Cenomanian - lower Turonian; zone *Microrhabdulus decoratus* and *Chiastozygus anceps.*

Top of lower Turonian - upper Turonian; zone *Tetralithus pyramidus.*

Top of upper Turonian - bottom of upper Coniacian; zone *Lucianorhabdus maleformis.*

Most of upper Coniacian - lower part of lower Santonian - zone small *Micula* cf. *staurophora*, with the appearance in the upper part of rare *Marthasterites furcatus*.

Upper half of lower Santonian - most of upper Santonian - zone *Reinhardtites anthophorus* and *Lucianorhabdus cayeuxii*.

Top of the upper Santonian - most of lower Campanian - zone large *Micula staurophora* and *Arkhangelskiella specillata*.

Top of lower Campanian - bottom of lower Maastrichtian - zone *Broinsonia parca*.

The most of lower Maastrichtian -zone *Lithraphidites quadratus*.

Upper Maastrichtian - zone *Nephrolithus frequens*.

The last two species are very rare.

CENOZOIC CALCAREOUS NANNOFOSSIL BIOSTRATIGRAPHY AND PALAEOCEANOGRAPHY OF THE EXMOUTH PLATEAU

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Topics: Paleocene - Pleistocene, Indian ocean, P'ecol/oc, ODP Leg 122

Cenozoic sediments rich in calcareous nannofossils were recovered at six drilling sites on the Exmouth Plateau, eastern Indian Ocean (ODP Leg 122 Sites 759 - 764). Nannofossils are abundant, diverse (250 species identified) and generally well preserved. The abundance and diversity reflect the open-ocean conditions which prevailed over the Plateau during the Cenozoic. Drilling at Site 762 (central Exmouth Plateau) recovered an almost complete lower Palaeocene to Quaternary stratigraphic section; only Zones NN3, NN8 and NN10 are missing.

Lower Oligocene to lower Miocene sediments from Sites 762 and 763 contain assemblages enriched in braarudosphaerids. The braarudosphaerids appear rather abruptly in the lower Oligocene (in Zone NP21), and reach their greatest numbers in lower Oligocene Zones NP22 and NP23, where they comprise up to 10% of some samples. *Braarudosphaera bigelowii* is the dominant braarudosphaerid in the assemblage, occurring together with rare specimens of *B. discula* and *Micrantholithus pinguis*. The holococcoliths *Peritrachelina joidesa* and *Lanternithus minutus* are also associated with the braarudosphaerid enrichment. Two populations of *B. bigelowii* are present: one of normal size (10-14 μm) and one of large specimens (20-22 μm). The larger braarudosphaerids are more abundant than the smaller forms. Evidence from stable-isotope and trace-element analyses suggest that the enrichment of braarudosphaerids may be due to mid-ocean upwelling of cool, low-salinity, nutrient-rich water during the Oligocene to early Miocene interval.

PRODUCTIVITY OF CALCAREOUS NANNOPLANKTON COMMUNITIES DURING THE KARPATHIAN OF THE WESTERN CARPATHIANS

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Topics: E. Miocene, Czechoslovakia (Paratethys), P'ecol/oc, Productivity

Productivity of calcareous nannoplankton communities have been evaluated as the number of specimens in one drop taken from a suspension of the studied marls in fixed chemical and physical conditions. Studied boreholes (112 samples) originate from deeper (maximal paleodepth about 800 m) as well as from shallower more marginal (maximal paleodepth about 200 m) parts of the Carpathian marine basin. The palaeoenvironment have been reconstructed on the basis of a detail study of foraminiferal communities.

The Karpatian communities of calcareous nannoplankton from the Western Carpathians are characterised by low diversity (1.3- 4.0 after Simpson's formula), by dominance of *Coccolithus pelagicus* and presence of *Syracosphaera* and *Cricolithus*. The productivity of Karpatian calcareous nannoplankton corresponded to a mean Neogene productivity of nannoplankton with a tendency to slight increasing of productivity during the Karpatian.

The productivity of calcareous nannoplankton communities has been correlated with the diversity of the calcareous nannoplankton and with the productivity of the siliceous plankton and the planktonic foraminifers The carbon isotopic composition in a part of the samples had been analyzed.

The best correlation was observed between the diversity and productivity of calcareous nannoplankton communities (correlation coefficient -0.652); high diversity corresponds to low productivity. The correlation between productivity of the planktonic foraminifers and calcareous nannoplankton is slight in general (correlation coefficient = 0.322) though in the shallower part of the basin lower productivity of calcareous nannoplankton correlates with higher productivity of planktonic foraminifers. The lowest correlation was observed between productivity of the calcareous nannoplankton and siliceous plankton (correlation coefficient = 0.291).

Carbon isotopic analyses of tests of benthonic and planktonic foraminifers and carbonates from the studied marls correlated with the productivity of planktonic and benthonic foraminifers. Calcareous nannoplankton and siliceous plankton showed the best correlation between the productivity of calcareous nannoplankton and the carbon isotopic analyses of carbonates from the total rocks.

For that reason we can suppose that the carbonates from the marls are represented mainly by tests of calcareous nannoplankton and their carbon isotopic composition reflects the productivity of calcareous nannoplankton. Very slight dependence between the productivity of calcareous nannoplankton (as well as siliceous plankton) = producers and the foraminifers (= consumers) could show the presence of another more important producers probably without an ability to fossilisation in the Karpatian sea.

UPPER CRETACEOUS NANNOFOSSILS IN THE OUTER FLYSCH GROUP OF THE WEST CARPATHIANS (MORAVIA, CSFR), AND COMPARISON WITH BOREAL AND MEDITERRANEAN REALMS.

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Topics: Aptian - Maastrichtian, Czechoslovbakia, Zonation, Distribution

Calcareous nannoplankton in the sediments of the Outer Flysch Group of the West Carpathians were studied in the stratigraphical range from the Aptian-Albian up to the Maastrichtian. Local nannozones were assigned there and correlated with standard zones of Sissingh (1977).

Two distinctive developments of nannofossils were found in the Campanian: the assemblages with some features of boreal and others of Mediterranean realm. Boreal features were noticed only in the Klement Formation. In the uppermost part of the Lower Campanian (*Globotruncana ventricosa* Zone) there were ascertained taphocoenoses with *Prediscosphaera stoveri* but without representatives of the genera *Ceratolithoides* and *Quadrum*. Hanzlíková (*pers. com.*) mentioned foraminifera with boreal species *Dicarinella concavata* (Brotzen) from the Turonian and Coniacian sediments of the Klement Formation and compared those from the Bohemian Cretaceous basin. Mediterranean development was noticed in all other sediments of the Outer Flysch Group. In the Campanian deposits *Ceratolithoides aculeus, C. arcuatus, Quadrum sissinghii* and *Q. trifidum* are present.

MIOCENE CALCAREOUS NANNOFOSSIL BIOSTRATIGRAPHY OF THE TAURUS BELT (SOUTHERN TURKEY)

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Topics: E. - M. Miocene, Turkey, Biostratigraphy

A detailed biostratigraphic study based on nannofossils has been carried out on the Miocene sediments of the Korkuteli and Hatay basin at the Taurus Belt in Southern Turkey. These basins in which several stratigraphic sections have been measured show many similarities in lithology and nannofossil content.

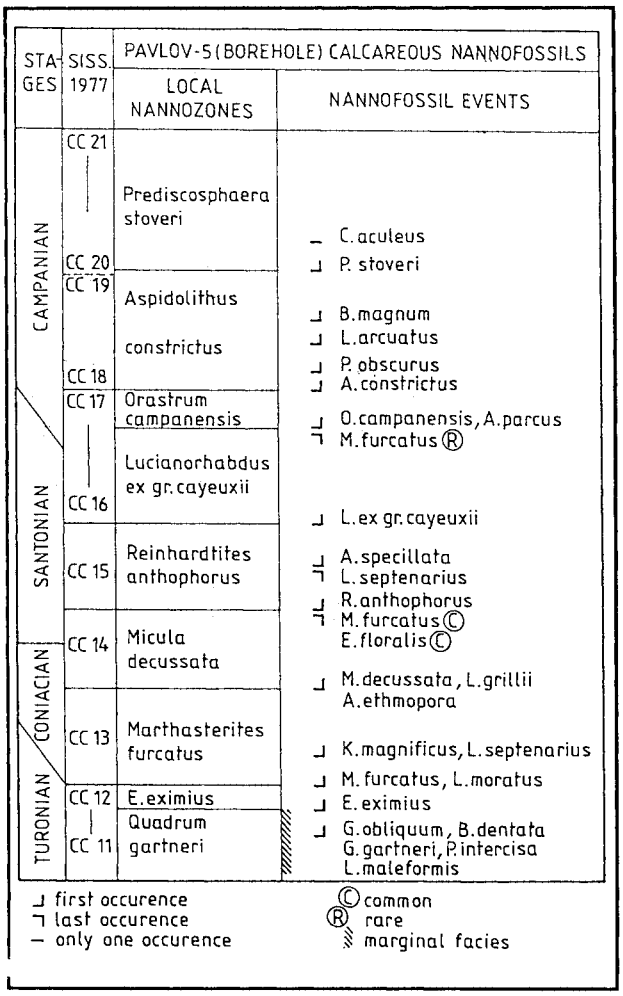
Each of these basins has a thick sediments ranging in age from Aquitanian to Serravallian. Several formations which are studied in two basins consist of marl, shale, sandstone, and limestone. The studied

sequences are well known for a complete planktonic foraminifera zonations. Most of the biostratigraphic events calibrated with the planktonic foraminifera zones.

Standard nannofossil zonation schemes have been applied to the Miocene succession of Taurus Belt using mainly smear-slides.

Forty-five moderately well preserved nannofossil species have been defined in Korkuteli and Hatay basin. Their diversity increases from Aquitanian to Serravallian in both regions.

According to the defined calcareous nannoplankton assemblages in Miocene sediments in this area can be subdivided into the following zones *Triquetrorhabdulus carinatus, Discoaster druggii, Sphenolithus belemnos Helicopontosphaera ampliaperta, Sphenolithus heteromorphus, Discoaster exilis, Discoaster kugleri.*



Proposed nannofossil zonation for the sediments of Klement Formation in the borehole Pavlov-5. [Svábenická]

TAXONOMIC REVISION OF POLYCYCLOLITHACEAE AND ITS CONTRIBUTION TO CRETACEOUS BIOSTRATIGRAPHY

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Topics: Cretaceous, Global, Distribution, Polycyclolithaceae

In this study, the taxonomic revision of Polycyclolithaceae is undertaken and its contribution to high resolution biostratigraphy is demonstrated.

All Polycyclolithaceae are made up of a wall which has two cycles. Each cycle contains the same number of elements in the shape of a ray, petal or brick. Where the two cycles are joined, a diaphragm may be present and it is either median or amedian.

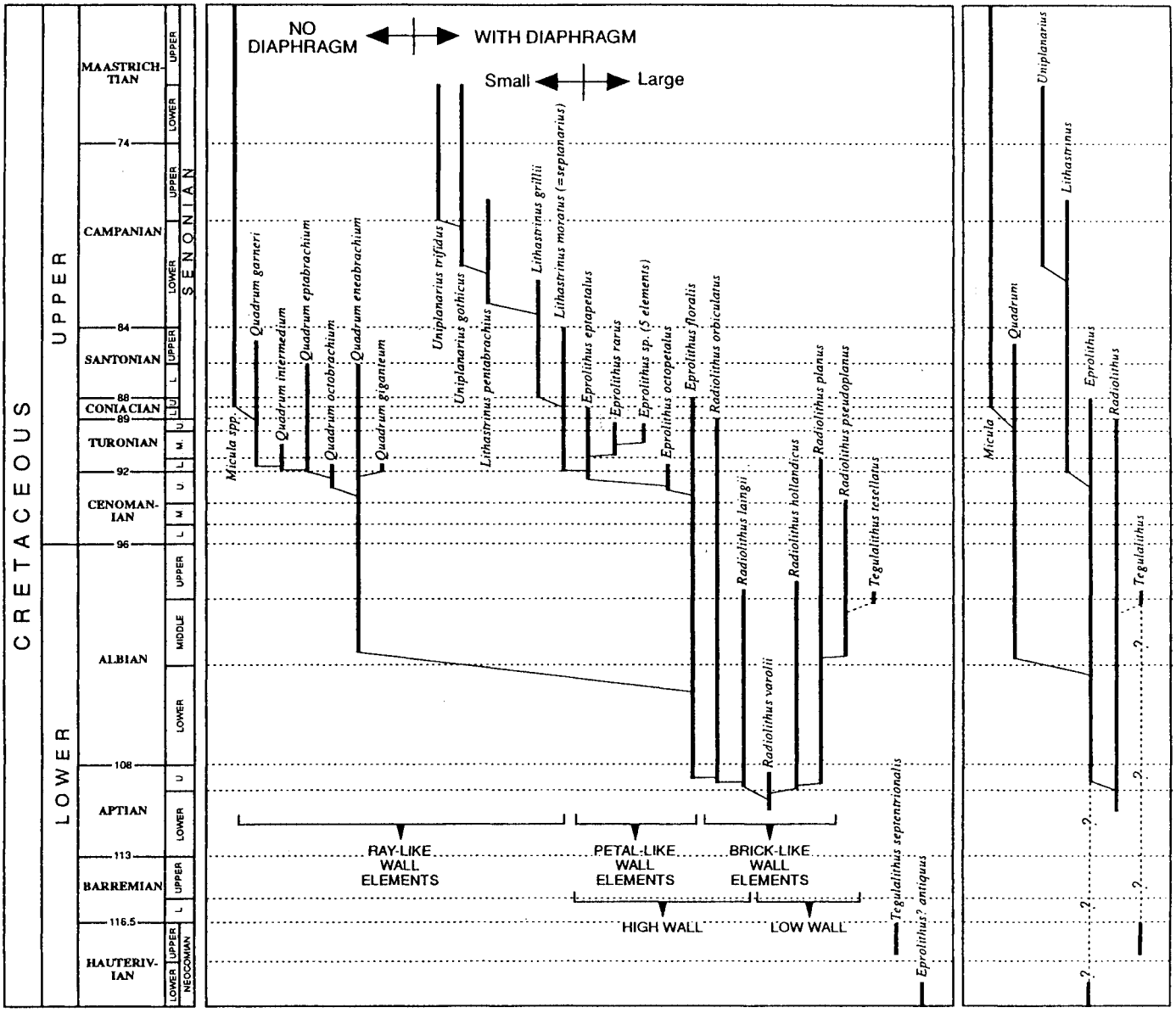
The primary generic determinants are the presence or absence of a diaphragm, the size of the diaphragm and the shape of the wall elements. Of secondary value is the position of the diaphragm. Specific determinants of primary importance for the species are variations of the features by which the genera are diagnosed and the number of wall elements.

The forms assigned to *Quadrum* have no diaphragm and the wall is made up of four to nine ray-like elements. *Micula* also has no diaphragm and is made up of four interlocking elements; possibly, it developed from *Quadrum*.

Lithastrinus has a very small diaphragm and the wall is made up of five to seven ray-like elements. The similarly constructed forms with three to four elements are placed in *Uniplanarius*.

Both *Radiolithus* and *Eprolithus* have wide diaphragms. The wall in *Radiolithus* is made up of nine to twenty-four brick-like elements. The diaphragm is amedian. The wall in *Eprolithus* is made up of five to nine petal-like elements.

The species of Polycyclolithaceae are. less affected by provincialism; they even appear to have flourished in adverse environmental conditions and survived poor preservational conditions. Their contribution to high resolution biostratigraphy is found to be invaluable throughout the world. Important Polycyclolithaceae markers



Stratigraphical distribution of Polycyclolithacaeae species [Varol]

in the North Sea area, West Africa, South America, the Middle East, India, Indonesia and Papua New Guinea are presented.

Twelve new species are introduced: *Eprolithus eptapetalus, E. octopetalus, E. rarus, Lithastrinus pentabrachius, Quadrum eneabrachium, Q eptabrachium, Q. giganteus, Q. intermedium, Q. octobrachium, Radiolithus hollandicus, R. laingii*, and *R. pseudoplanus*.

HOLOCOCCOLITHS AND THE BIOSTRATIGRAPHY OF THE LATE TURONIAN - EARLY CAMPANIAN OF THE GOSAU GROUP OF AUSTRIA

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Topics: Turonian - Santonian, Austria, Distribution, Holococcoliths

Holococcoliths, especially the genera *Lucianorhabdus* Deflandre 1959 and *Calculites* Prins & Sissingh 1977 include several zonal markers of the standard zonation of the Late Cretaceous of Sissingh (1977) and Perch-Nielsen (1985). The sections of the Gosau Group of the Northern Calcareous Alps of Austria provide a good possibility for a test of the biostratigraphic value of holococcoliths of the Tethyan realm from the Late Turonian

onwards, because of the great stratigraphic thickness of the sections, the possibility of calibrating nannofossil events with ammonite horizons and foraminifera, and the relatively high percentages of holococcoliths in individual samples (8 to 15%)

During the Late Turonian, Coniacian and Early Santonian (CC 13 and CC 14/15 of the Sissingh (1977) - Perch-Nielsen (1985) zonation) the genus *Lucianorhabdus* is dominated by the species *L. maleformis* Reinhardt 1966 (small and large varieties), associated with small amounts of *L. arcuatus* Forchheimer 1972 and rare to absent *L. quadrifidus* Forchheimer 1972. During the Late Turonian - Early/Middle Coniacian the *Calculites* group is represented exclusively by *C. ovalis* (Stradner 1963) Prins & Sissingh In Sissingh 1977.

In the Early Santonian (*Texanites quinquenodosus* ammonite zone) *L. cayeuxii* Deflandre 1959 has its first appearence, defining the base of the CC 15. During the Santonian it reaches up to 30% of the total *Lucianorhabdus* assemblage. Rare transitional forms of *C. ovalis* to *C. obscurus* (Deflandre 1959) Prins & Sissingh in Sissingh 1977 can be found in the Late Coniacian to Early Santonian. They are characterized by one or two sutures oblique to the major axis of the elliptical holococcolith and curved, irregular sutures. These farms evolve to C. obscurus s. str. (sutures at an angle of 40° to 50° oblique to the major axis) In the lower part of the Late Santonian, which indicates the base of the CC17-nannozone. The ratio of *C. ovalis* to *C. obscurus* is about 5:1 in the Late Santonian.

In the latest Santonian, a few meters below the Campanian boundary defined by ammonites (*Placenticeras* cf. *bidorsatum*) and planktonic foraminifera (*Globotruncanita elevata*), a curved form of *Lucianorhabdus* (*L. cayeuxii* sp. B) has its first occurrence which defines a regional event within the *C. obscurus*-zone. During the Early Campanian, the abundances of *L. maleformis* decrease constantly whereas the ratio of *C. ovalis* to *C. obscurus* increases in the lower part of the Early Campanian to 1:1.

UPPER CRETACEOUS NANNOFOSSIL BIOSTRATIGRAPHY OF THE SOUTHERN OCEAN AND ITS PALAEOBIOGEOGRAPHIC IMPLICATIONS

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Jason A. Crux, BP Exploration, 5151 San Felipe, Houston Texas, USA
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Topics: Turonian - Maastrichtian, Southern Ocean, Biostratigraphy, Biogeography

Synthesis of Upper Cretaceous nannofossil data from the Falkland Plateau (DSDP 36 & 71), Maud Rise (ODP 113), Northeast Georgia Rise (ODP 114), and Kerguelen Plateau (ODP 120) yields a set of consistent, reliable biohorizons which form the basis of this revised zonation.

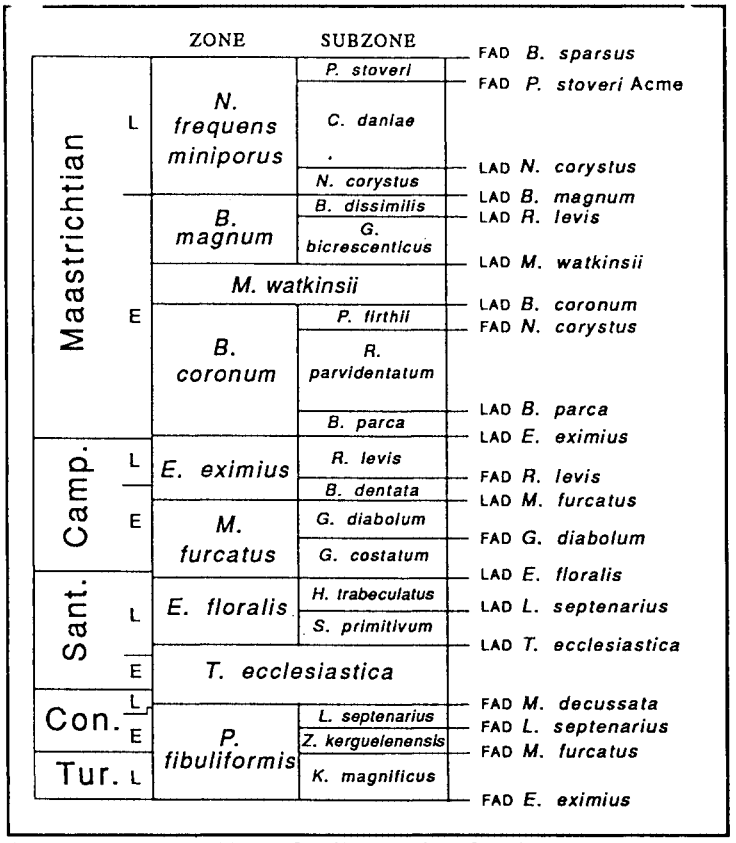
Stratigraphic control is best for the Maastrichtian, because of both its wide geographic distribution (represented at all four areas) and assemblages preservation (mostly in chalks). Ten biohorizons are used to delineate four zones and eight subzones (Figure 1). With the exception of the top and base of the Maastrichtian, all of the zonal indicator taxa are species known to be austral or bipolar. Excluding the stage boundary markers, only two cosmopolitan biohorizons (LAD *B. parca* and LAD *R. levis*) appear useful in the Maastrichtian. *Nephrolithus frequens* has been shown to be so diachronous at higher latitudes as to be of little utility. All other cosmopolitan marker taxa are either absent or, in the case of *T. orionatus*, too rare and sporadic near its last occurrence to be useful. Analysis of the entire assemblage indicates significant palaeobiogeographic separation from temperate areas.

Stratigraphic control is less perfect for the Santonian and Campanian due to lesser geographic coverage (not available from Maud Rise), more disconformities, and poorer assemblage preservation (zeolitic claystones from the Falkland Plateau, limestones from Northeast Georgia Rise). Only two of the six biohorizons used are austral forms: the others are cosmopolitan. Many of the temperate stratigraphic marker species are either rare (e. g. *Broinsonia parca parca* and especially *B. parca expansa*, *Quadrum spp.*) or absent (e. g. *C. aculeus*). The austral subzonal marker *G. diabolum* is known only from the Falkland Plateau. Overall, these assemblages

are characterized as somewhat depauperate temperate assemblages with the addition of a few high latitude species.

The zonation is still considered tentative for the Coniacian and Turonian due to the restricted stratigraphic record available. This interval is represented only in two areas (Falkland and Kerguelen plateaus). In both cases, the records are truncated by disconformities. Biostratigraphic subdivision of this interval is based only on cosmopolitan taxa used in more temperate zonations. As in the Santonian, the Coniacian and Turonian assemblages consist of a subset of the coeval temperate assemblage with a relatively small number of austral species.

Compilation and analysis of the palaeobiogeographic affinities of the assemblages indicate a significant increase in the number of austral or bipolar species in the Maastrichtian. On a stage-by-stage basis, the average number of endemic taxa in the Turonian through Campanian is approximately 4, whereas the Maastrichtian contains at least 14 distinctly high latitude species. The evolutionary radiations within the genera *Biscutum* and *Monomarginatus*, and in the *Cribrosphaerella-Psyktosphaera-Nephrolithus* plexus in the austral region indicate that the Southern Ocean was ecologically distinct from the temperate areas during the Maastrichtian.



Upper Cretaceous Nannofossil Zonation for the Southern Ocean [Watkins et al]

BIOMETRIC STUDY OF *PRINSIUS BISULCUS* - *P. MARTINII* AND ITS BIOCHRONOLOGIC APPLICATION

Wuchang Wei & Li Liu, Department of Geology, Florida State University, Tallahassee, USA

Topics: Palaeocene, Global, Biometrics, *Prinsius*

The major difference in morphology between *Prinsius bisulcus* and *P. martinii* is size, although the size cut off has not been well defined. As this group is generally abundant in Paleocene marine sediments from low to extremely high latitudes and the first occurrence of P. martinii has been widely used as a zonal marker, it is important to examine the size distribution of this group to help clarify the species concepts of *P. bisulcus* - *P. martinii*, and to document its size distribution through time and space to extract biochronologic and palaeoceanographic information. The *P. bisulcus* - *P. martinii* group is studied biometrically using samples from DSDP Sites 516 and 528 in the mid-latitude South Atlantic, ODP Site 689 in the Weddell Sea, and ODP Site 738 in the southern Indian Ocean. Preliminary results indicate that (1) there is a strong linear relationship between the length and width of *P. bisulcus* - *P. martinii* specimens (Fig. 1a); (2) there is a bi-modal size distribution (Fig. 1b), and the size cutoff for the two species should be 5 μm; (3) the mean size increases progressively through time, and the sharpest increase occurs near the CP3/CP4 zonal boundary in magnetic Subchron C26R (Fig. 1c). Our on-going studies will further examine this size-age relationship at various sites to explore fully its biochronologic and palaeoceanographic implications.

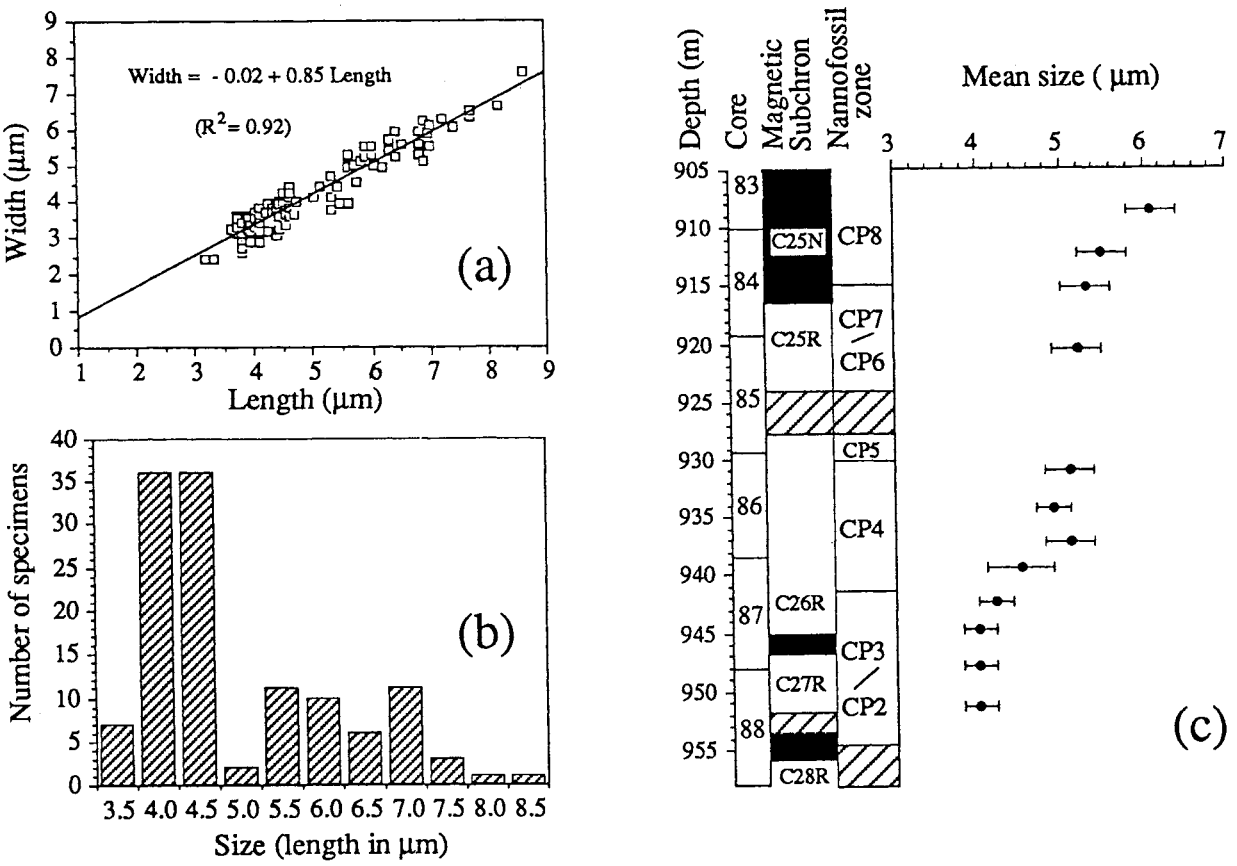


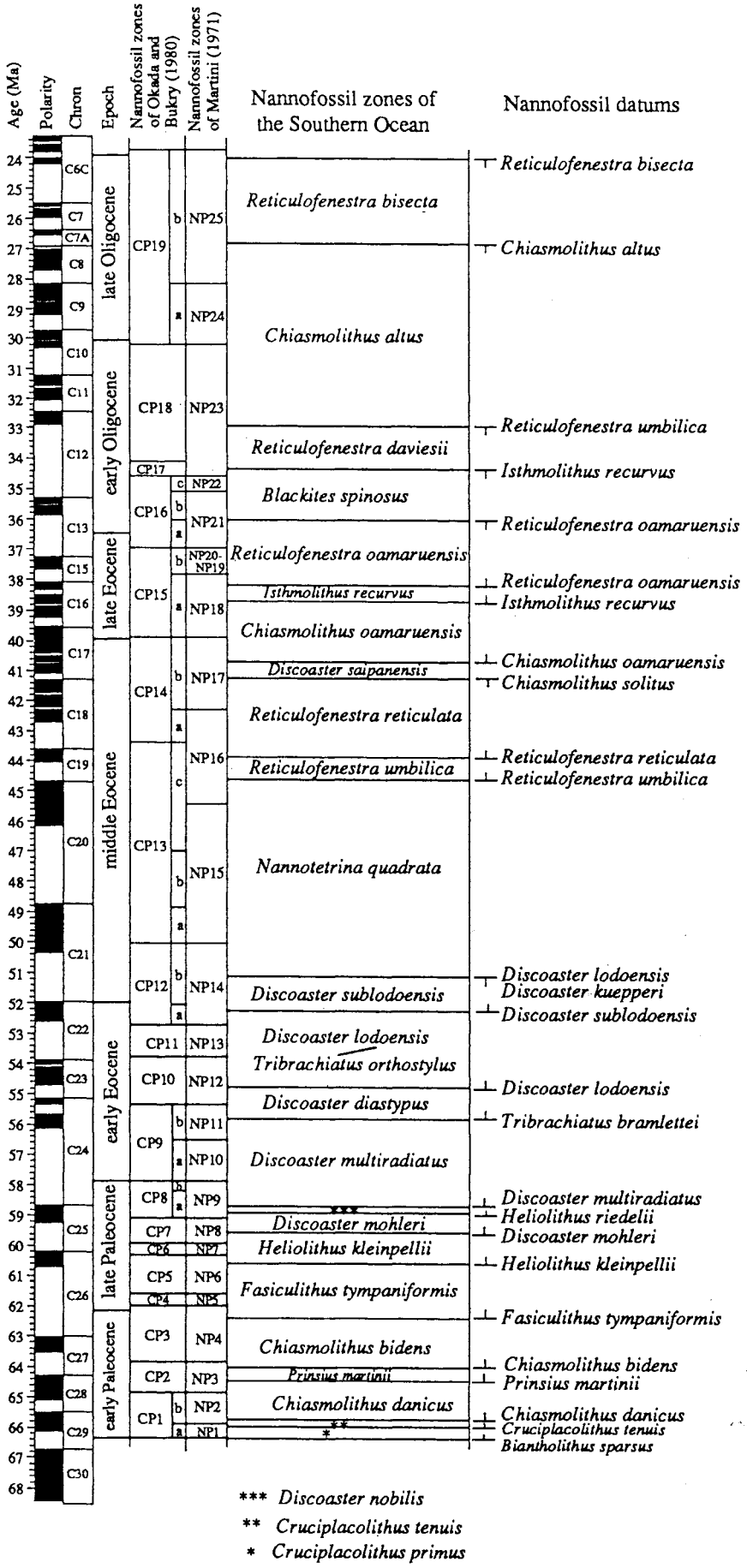
Fig. 1. Biometric results of *Prinsius bisulcus - P. martinii* group from DSDP Site 516; (a) and (b) Sample 516F-86-4, 85-86 cm; (c) mean size changes through time; error bars indicate 95% confidence intervals.

PALEOGENE CALCAREOUS NANOFOSSIL MAGNETOBIOCHRONOLOGY OF THE SOUTHERN OCEAN

Wuchang Wei, James J. Pospichal & Sherwood W. Wise, Jr., Dept. of Geology, Florida State University, Tallahassee, USA

Topics: Palaeogene, Southern Ocean, Biostratigraphy, Magnetobiostratigraphy

Recent ODP Legs 113, 114, 119, and 120 to the Atlantic and Indian Ocean sectors of the Southern Ocean, using new drilling techniques (advanced piston coring and extended core barrel coring), have recovered a number of fairly long and undisturbed Paleogene sections which contain abundant calcareous nannofossils and have yielded detailed magnetostratigraphies. These materials offer for the first time an excellent opportunity to correlate Paleogene nannofossil datums with magnetostratigraphy and to estimate their numerical ages in the Southern Ocean. The nannofossil zonation established in the Southern Ocean (Fig. 1) is substantially different from those used in the mid or low latitudes. Many of the low latitude zonal markers, such as *Sphenolithus ciperoensis, Sphenolithus distentus, Coccolithus formosus,* and *Discoaster saipanensis,* are not useful in the high latitudes because of their scarcity or virtual absence. Figure 1 shows that most of the zonal markers in the high latitudes have significantly different ages than those of the same zonal markers used in the lower latitudes. The age differences are typically 0. 5- 1. 0 m.y. Figure 1 also shows that there is a general trend that index species of *Chiasmolithus* and *Reticulofenestra* appear earlier and disappear later in high latitudes than in lower latitudes,



Synthesised nannofossil zones and zonal markers of the Sourthern Ocean and their correlation with the time scale of Berggren et al (1985), based on ODP Legs 113, 114, 119, and 120. [Wei, Pospichal & Wise]

and index species of *Discoaster* appear later and disappear earlier in high latitudes than in lower latitudes. Detailed comparison of the magnetobiochronologic results from different Southern Ocean sites and mid-latitude sites has revealed the degree of synchrony or diachrony of each marker species through latitude, which makes it possible to date sediments at various latitudes with more precision than the commonly used zonal concept permits.

NEOGENE NANNOFOSSIL BIOSTRATIGRAPHIC FRAMEWORK FOR THE NORTHWEST FLORIDA CARBONATE RAMP SLOPE

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Anne F. Gardulski, Tufts University, Medford, MA, USA
Henry T. Mullins, Syracuse University, N. Y., USA

Topics: Neogene, USA (Florida), Biostratigraphy, Hiatuses

The west Florida continental slope in the northeast Gulf of Mexico is an area of interest to researchers from both industry and academia for several reasons. It is situated within the same latitudinal belt that has seen active industry exploration in the northern Gulf. In contrast to the greatly expanded, predominantly clastic sedimentary sequences that characterize the Cenozoic strata of the petroleum province to the west where salt movements create structural traps, the west Florida slope provides a much thinner but more continuous pelagic carbonate sequence on a tectonically stable margin. As such, the oceanic sequences along the Florida slope can be used to establish standard biostratigraphic and chemostratigraphic reference sections for the region as well as a monitor of sea level fluctuations and palaeoceanographic changes.

Neogene calcareous nannofossils have been studied from seven core holes emplaced along the west Florida ramp slope by a consortium of petroleum companies. The holes were interval cored and tied together by seismic networks (see summaries by Mitchum, 1978 and Mullins et al, 1988). Nannofossils are generally well preserved in the Pliocene/Pleistocene sections, which are largely continuous. Preservation is pristine in the upper Miocene, but diminishes to moderately good in the lower Miocene.

Stratigraphic discontinuities were delineated in the middle and upper Miocene of EXXON core holes CH 29-42, CH 30-43, CH 31-44, CH 32-45, CH 35-46, CH 34-47, and CH 33-48. Seismic stratigraphic analysis suggests that a middle to late Miocene hiatus was caused primarily by the invigoration of the Florida Loop Current, perhaps due to the closure of the Isthmus of Panama. This resulted in a marked change in style of the construction of the ramp from progradational to aggradational, as seen in seismic profile 42-44 (Gardulski et al., in press).

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CRETACEOUS - EARLY TERTIARY CALCAREOUS NANNOFOSSILS FROM SOUTHERN TIBET AND THEIR SEDIMENTARY ENVIRONMENT

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Topics: Aptian - Maastrichtian, Tibet, Biostratigraphy, Palaeoenvironments

The marine Cretaceous - Early Tertiary System are exposed extensively in southern Tibet. Samples containing calcareous nannofossils were collected from three sections in this area: Gongzha (Dingri county). Zongshan and Zongpu (Gangba county). According to Sissingh's zone (1977), six calcareous nannofossil combined zones and one calcareous nannofossil assemblage are established based on the first occurrence of marker species: *Rucianolithus irregularis - Rhagodiscus angustus* (CC7), *Prediscosphaera columnata - Eiffellithus turriseiffelii* zone (CC8 - CC9), *Microrhabdulus decoratus - Cretarhabdus crenulatus zone* (CC10 - CC11), *Eiffellithus eximius - Micula decussata* zone (CC12 - CC15). *Lucianorhabdus cayeuxii - Quadrum gothicum* zone (CC16 - CC21), *Arkhangelskiella cymbiformis - Quadrum sissinghi* zone (CC24 -CC25) and *Coccolithus formosus - Discoaster* assemblage. On the basis of the calcareous nannofossils, the age of the following formations are dated as: The Dongshan Formation - middle to late Aptian, Chaqiela Formation - Albian to early Cenomanian, Lengqingre Formation - middle Cenomanian to early Turonian, Xiawuchubo Formation - early Santonian to early Campanian, Jidula Formation- early to middle Maastrichtian, and Zhepure Formation - middle Eocene in age.

The age of the Jidula Formation was controversial, some authors dated it as Late Cretaceous (Maastrichtian) while others dated it as Early Tertiary (Danian) based on foraminifera. The samples for the present study were collected from the lower part of the Jidula Formation, and dated as early to middle Maastrichtian, The whole Jidula Formation, therefore, is probably a set of transitional strata from Maastrichtian to Danian.

An attempt has also been made of reconstructing the Cretaceous to Early Tertiary palaeoenvironments for the study area by means of the calcareous nannofossil data such as the composed contents arid their relative abundance as well as species diversity. The study area was under normal open sea condition during the Aptian, later in the Albian it deepened to an abyssal and oxygen-deficient environment, then shifted to neritic sea during the Cenomanian to early Turonian. A great transgression happened in this area during middle Turonian to middle Campanian, while a great regression happened at the Maastrichtian. Starting from the Paleocene another transgression submerged the study area but the sea water did not withdraw from the Qimghhai - Xizang (Tibet) plateau until the middle Eocene when the plateau rose from the ocean dramatically.

THE CALCAREOUS NANNOFOSSILS FROM MANGANESE NODULES: BIOSTRATIGRAPHIC SIGNIFICANCE AND GROWTH RATE

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Topics: Neogene, Pacific Ocean, Biostratigraphy, Manganese nodules

Researched material of manganese nodules was obtained from the Central Pacific. They include both smaller and larger nodules. LM investigation of manganese nodule from deep- sea areas has shown that about 15 calcareous nannofossil species have been found. All the calcareous nannofossil are contained within the manganese oxide layers of the polymetallic concretions. Based on the unconformities between micro-layer groups the larger nodules can be divided into three main layer units; internal unit, middle unit, and external unit. Several species (*Triquetrorhabdulus carinatus Discoaster druggii, D. tinqarensis, Sphenolithus conicus* etc.) were recognized in the internal unit. A few species (*Gephyrocapsa oceanica, Cyclococcolithus leptoporus*) were found in the external unit. But nannofossils are poor in the middle unit. Above encountered nannofossils demonstrate that these nodules have grown since early Miocene. The growth rate of - polymetallic concretion is from 1mm/Ka to 10mm/Ka according to the biostratigraphic methods.

DESCRIPTION AND ANALYSIS OF COCCOLITH STRUCTURE

Jeremy R. Young, Palaeontology, The Natural History Museum, London

kk, (Living), Global, Morphology, *C. pelagicus*

A thorough understanding of coccolith structure is essential for elucidating higher level phylogenetic relationships. Structural understanding also provides the best basis for co-ordinating observations of specimens made in different microscopes and in different preservation states, and it forms the most satisfying basis for learning taxonomy. Nonetheless it is probably true to say that there are only two or three groups of heterococcoliths whose structure we understand in detail. I.e. for which we know how the various elements interconnect in three dimensions, and how this relates to growth and crystallography.

Analysis of coccolith structure requires detailed observations by both light microscopy and electron microscopy. It almost always needs to include study of broken specimens, tilted specimens, overgrowth relationships, and ontogenetic sequences. This talk will take *Coccolithus pelagicus* as a case example and show how the various types of information can be derived and synthesised.

Description of coccolith structure requires precise terminology and special illustrative conventions. Proposals in this area will be presented and explained.

CALCAREOUS NANNOFLORAS IN THE SURFACE SEDIMENTS FROM THE NORTHERN SOUTH CHINA SEA

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Topics: Recent, S. China Sea, P'ecol/oc

Calcareous nannofloras in the surface sediments from the northern South China Sea (113°33' - 116°30'E, 17°00' - 20°30'N) have been recorded, *Emiliania huxleyi* and *Gephyrocapsa oceanica* are the commonest species in this area. Three distribution ranges have been recognized based on diversity and other features, They are:

1. The continental shelf and upper continental slope (shallower than 700m), this range is characterized by having an $H_{(s)}$ of less than 1, and a D^* of less than 2, the content of *Emiliania huxleyi* and *Gephyrocapsa oceanica* is more than 90%.

2. The lower continental slope (deeper than 700m), characterized by an $H_{(s)}$ of more than 1, and a D of over 2, the two main species mentioned above constitute less than 90% of the assemblage in this range.

3. The abyssal plain, calcareous nannofloras in this range are rare, moreover, the calcareous nannoflora assemblages from the northern South China Sea and other marginal seas showed the two following common features: A) Compared with same latitude open ocean, the diversity of calcareous nannofloras is very low; B) *Emiliania huxleyi* and *Gephyrocapsa oceanica* have a high percentage abundance.

*H(s) and D are diversity indices.

SELECTIVE DISSOLUTION OF CALCAREOUS NANNOFLORAS IN THE NORTHERN SOUTH CHINA SEA AND THEIR SIGNIFICANCES

Yan Zhiguang, Dept. of Geology, Hebei College of Geology, Shijiazhuang Hebei, 050031, P. R. China

Topics: Recent, S. China Sea, P'ecol/oc, Dissolution

The cores in the vicinity of the calcium carbonate compensation depth (CCCD) from the northern South China Sea contain some selectively dissolved calcareous nannofloras. The author took the percentage of them in the whole assemblage as an indicator of the dissolution potential of the sea water. Calcareous nannofloras which have undergone selective dissolution have been recognized by polarized light microscopy by the following characters:

1. A general character of selectively dissolved calcareous nannofloras is decrease in the brightness of the interference figure.

2. The interference figure of *Calcidiscus leptoporus* leaves gaps along the sutures and separation of distal and proximal shields occurs due to dissolution of the central tubes.

3. The bridge of *Gephyrocapsa oceanica* disappears, and the margins of shields being some what irregular in shape.

4. The interference figure of *Emiliania huxleyi* becomes smaller, It is difficult to separate the remains of *G. oceanica* from those of *E. huxleyi* though the larger size can be used to distinguish between two species.

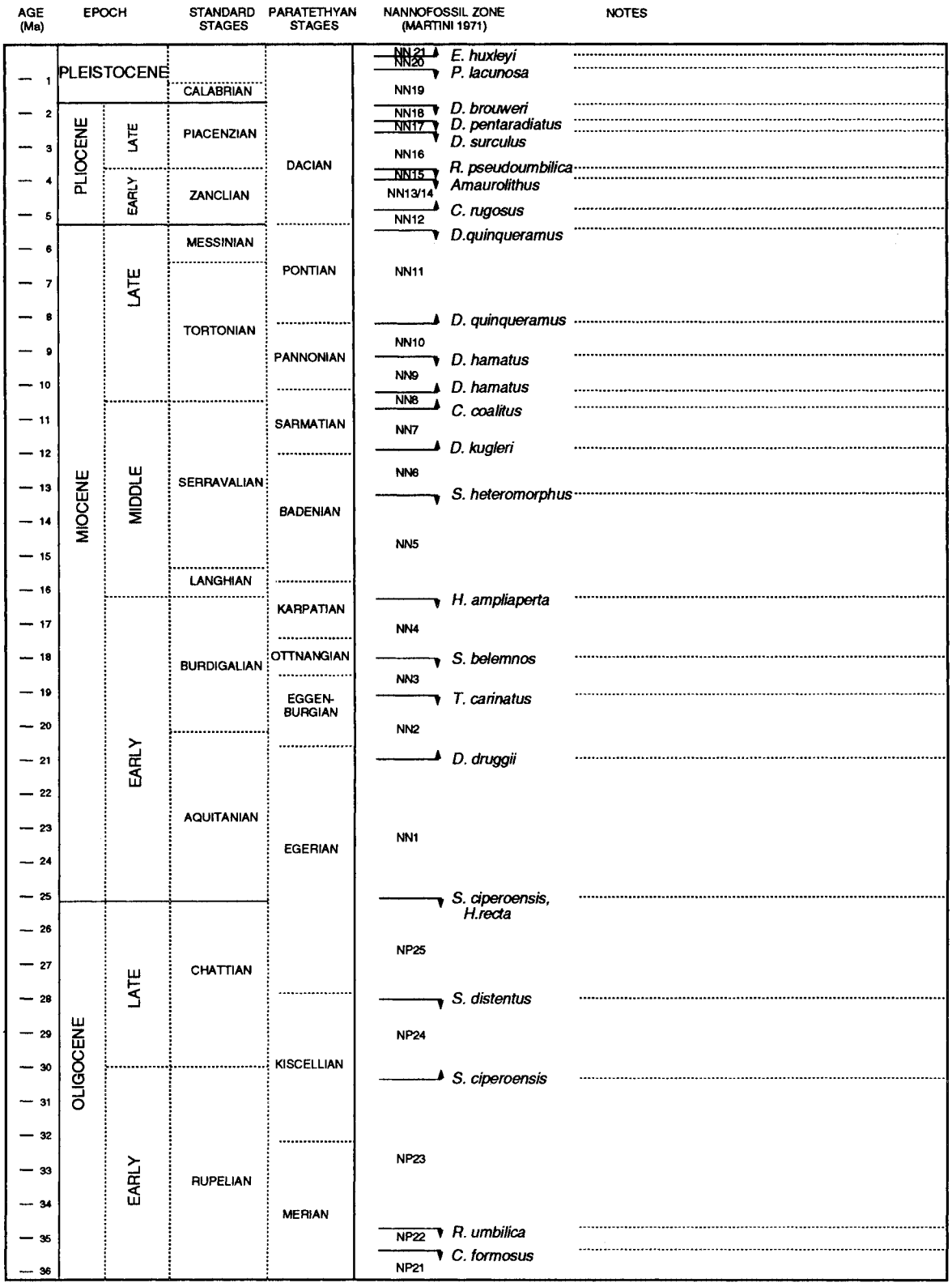
5. The central pores of *Helicosphaera, Umbellosphaera, Umbilicosphaera* and so on are irregularly enlarged. The margins of shields become serrate.

6. Some broken calcareous nannofloras.

Furthermore, *Emiliania huxleyi* which have undergone selective dissolution have been accurately recognized by scanning electron microscopy.

Statistical results from the data of the polarised light microscope and the scanning electron microscope both showed that the percentage of the calcareous nannoflora which had undergone selective dissolution increases in interglacial and decreases in glacial intervals.

In conclusion, the CCCD of the northern South China Sea goes down in glaciations and the dissolution potential becomes weaker, whereas, it goes up in interglaciations and the dissolution potential becomes stronger. This situation is similar to that of the Atlantic Ocean and different from that of the Pacific Ocean.



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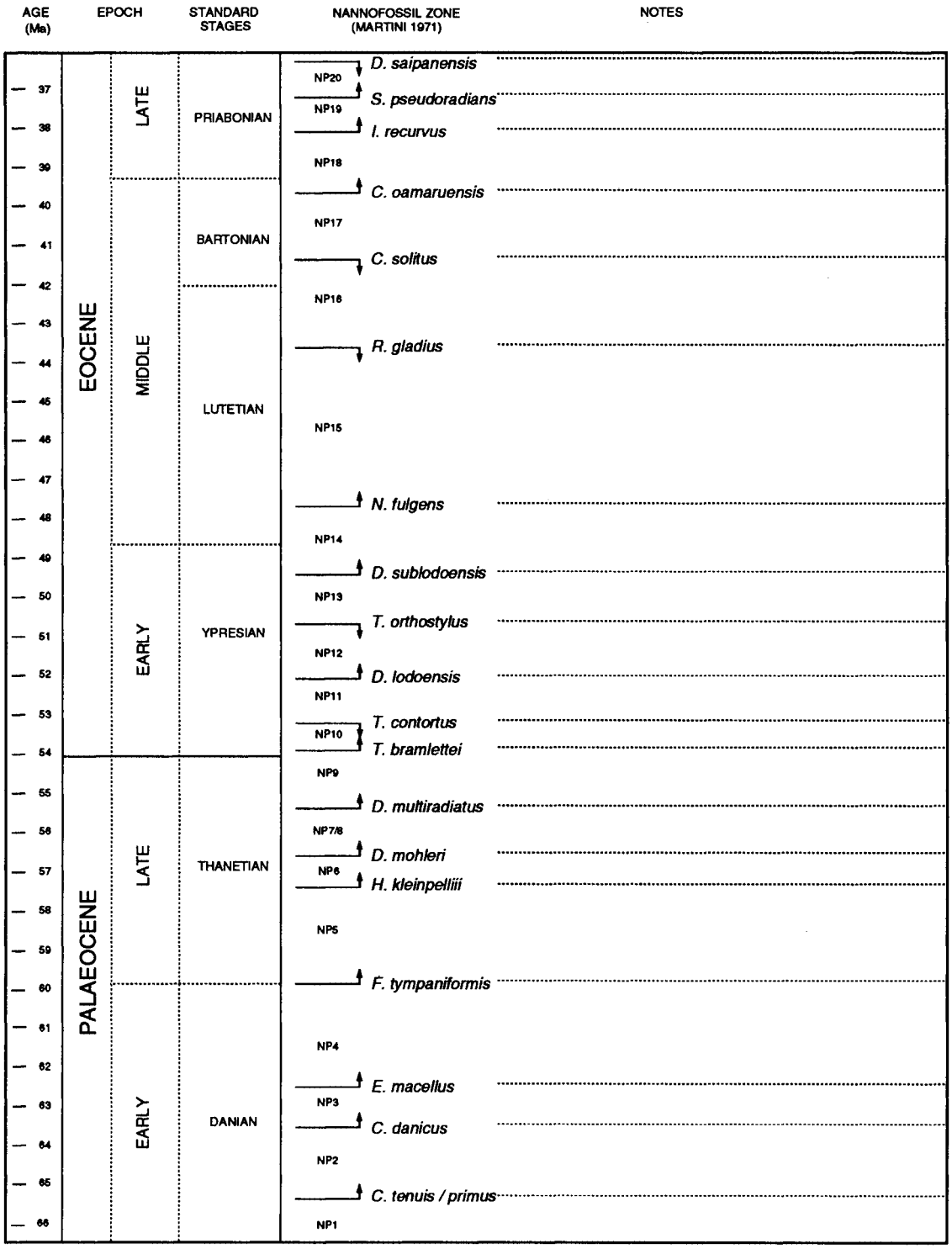

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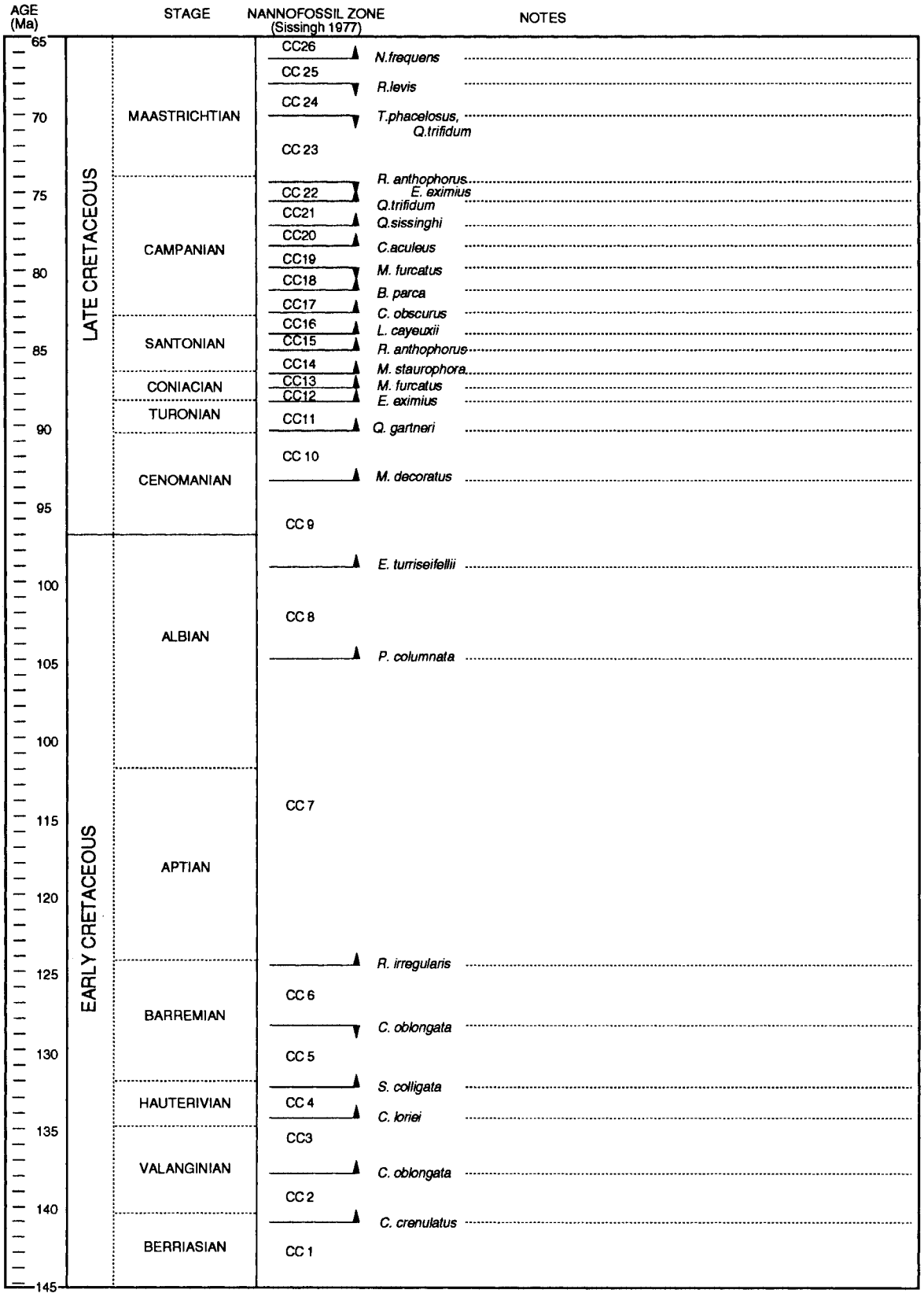
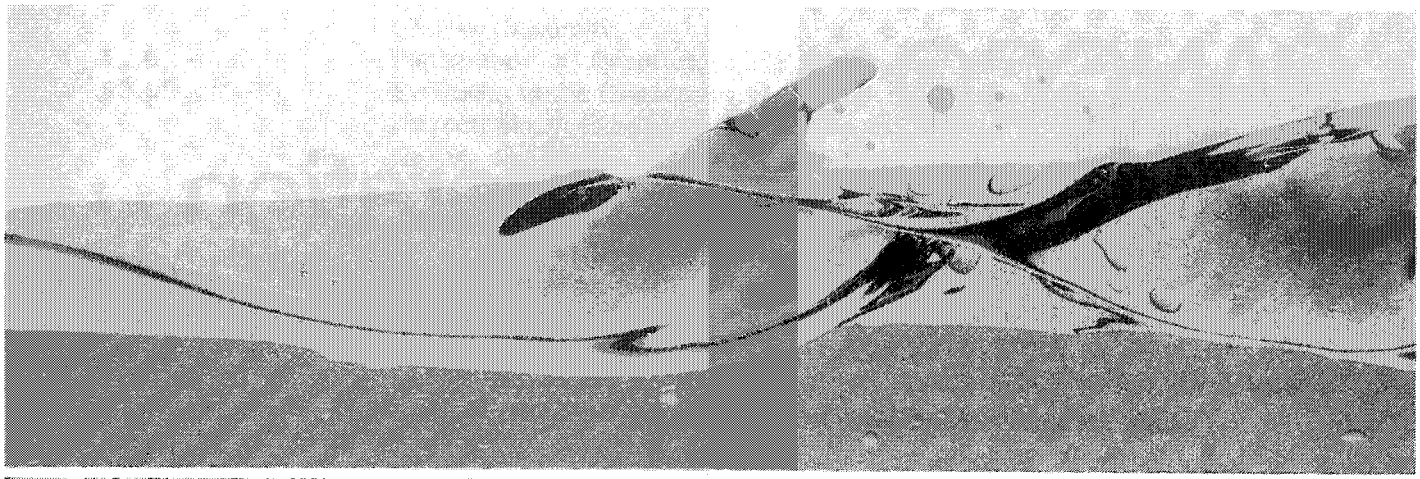
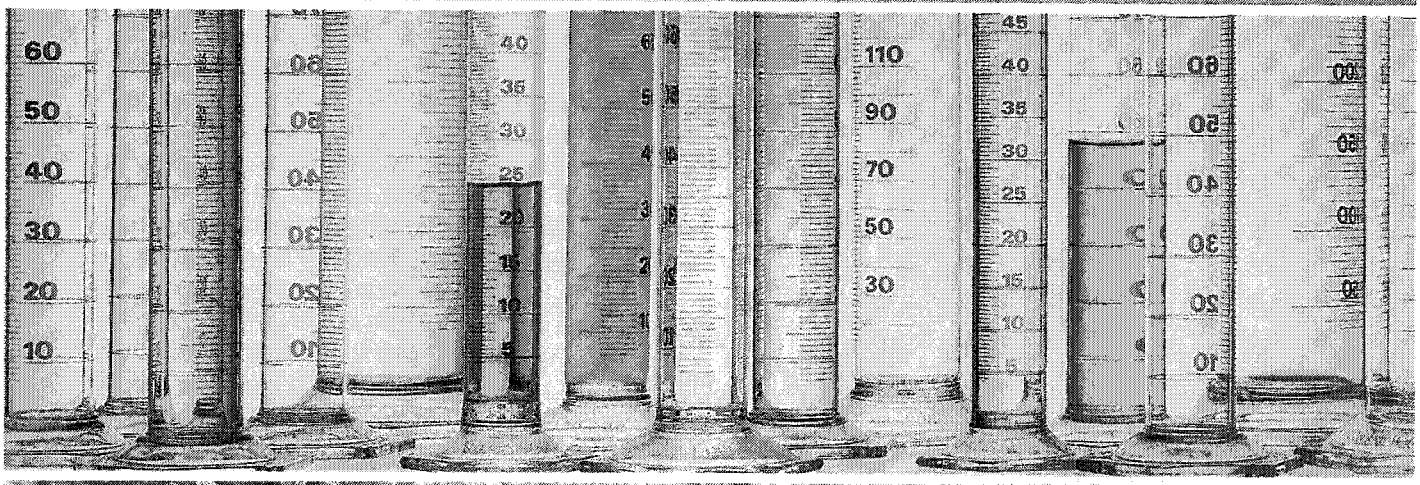
N.B. These columns are only intended for quick reference during the conference and are definetely not the latest word in nannofossil stratigraphy.

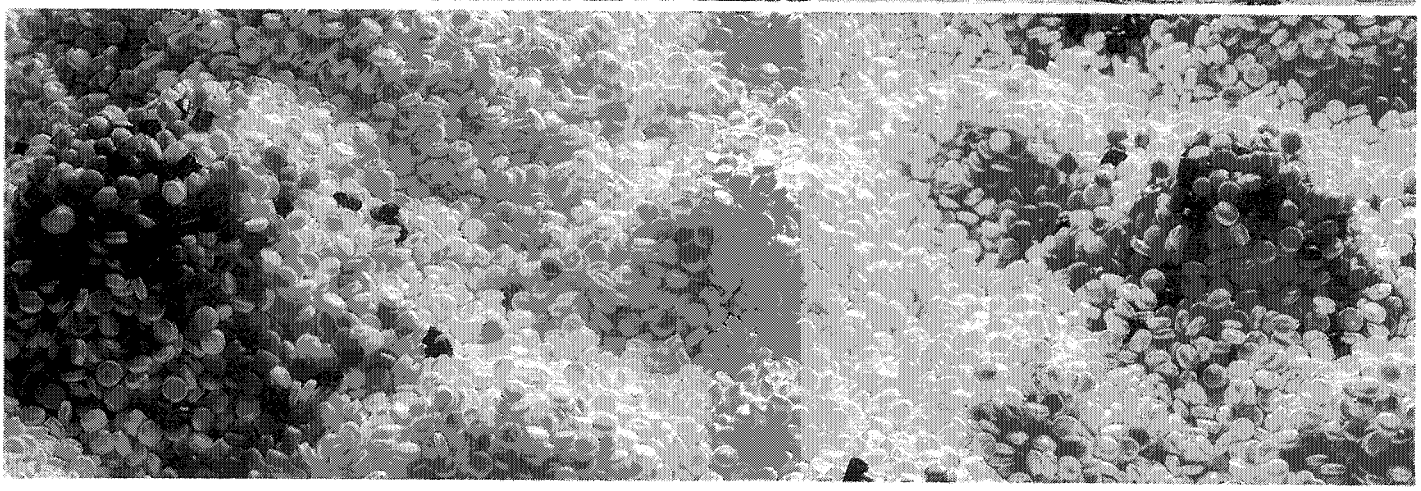


SOURCES
Harland et al 1989, *A geologic time scale*, CUP.
Perch-Nielsen 1985: Mesozoic nannofossils, In Bollii et al *Plankton Stratigraphy*, CUP.

On the competitive edge







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PROVISIONAL PROGRAMME

Thursday 5th - Saturday 7th September

Arrival and registration. Registration at Kajettanka Student Hostel, Radimova 12, Praha 6.

Sunday 8th September - Terminology Workshop and Bohemian Basin Excursion.

8.30 - 12.00	Workshop on "Morphological Terminology of Coccoliths", convenors Katharina von Salis, Jeremy Young. At, Department of Palaeontology, Charles University
12.00 - 13.00	Registration, at Department of Palaeontology, Charles University.
13.00 - 19.00	Excursion to the Cretaceous of the Bohemian Basin. Departs from Dept. of Palaeontology. Exposures of Turonian to Coniacian rocks will be studied at Kysttra and Brezno localities.

Monday 9th September - Scientific Sessions

8.00 - 9.00	Registration (at Novotneho lavka), opening addresses
9.00 - 12.00	Scientific session (with 30minute coffee break).
12.00 - 1.30	Lunch
13.30 - 17.30	Scientific session (with 30minute coffee break).
20.00 - ??.??	Dinner, "Racanska Vinarna" restaurant, Cinska ulice, Praha-Dejvice (near Hotel International, metro station Dejvicka), price 60DM.

Tuesday 10th September - Scientific Sessions

9.00 - 12.00	Scientific session (with 30minute coffee break).
12.00 - 1.30	Lunch
13.30 - 17.30	Scientific session (with 30minute coffee break).
17.30 - 18.30	Poster session
Evening	Concert

Wednesday 11th September - Scientific Sessions

9.00 - 12.00	Scientific session (with 30minute coffee break).
12.00 - 1.30	Lunch
13.30 - 17.30	Scientific session (with 30minute coffee break).
17.30 - 18.30	Poster session
19.30 - ??.??	Farewell party in the brewery restaurant "U Flejku", Kremencova 9, Praha 1.

Thursday 12th September - Jurassic Workshop and departure for S. Moravia

9.00 - 12.00	Workshop on Jurassic coccoliths, convenor Paul R. Bown.
14.00	Departure (from Dept. of Palaeontology) of excursion to South Moravia. Possible visit to Austerlitz en route.
Evening	Lodging "far from civilisation" in the White Carpathian Mountains (Hotel Letka).

Friday 13th September - Excursion to South Moravia

8.00 - 17.00	Outer Units of Western Carpathians. Jurassic (locality - Souteska) and Cretaceous (Turold) of the Washberg Zone. Lower Oligocene of the Pouzdrany Unit (Pouzdrany). Upper Eocene - Lower Oligocene of the Zdanice Unit (Uhercice and Krepice localities).
Evening	Dinner in the wine vaults Cejkovice.

Saturday 14th September - Excursion to South Moravia

9.00 - 18.00	Miocene of the Carpathian Foredeep; Eggenburgian (Nosislav-1 borehole), Karpathian (Nosislav), lower Badenian (Brno-Kralovo pole).

Excursion to South Moravia - return about 18.00.