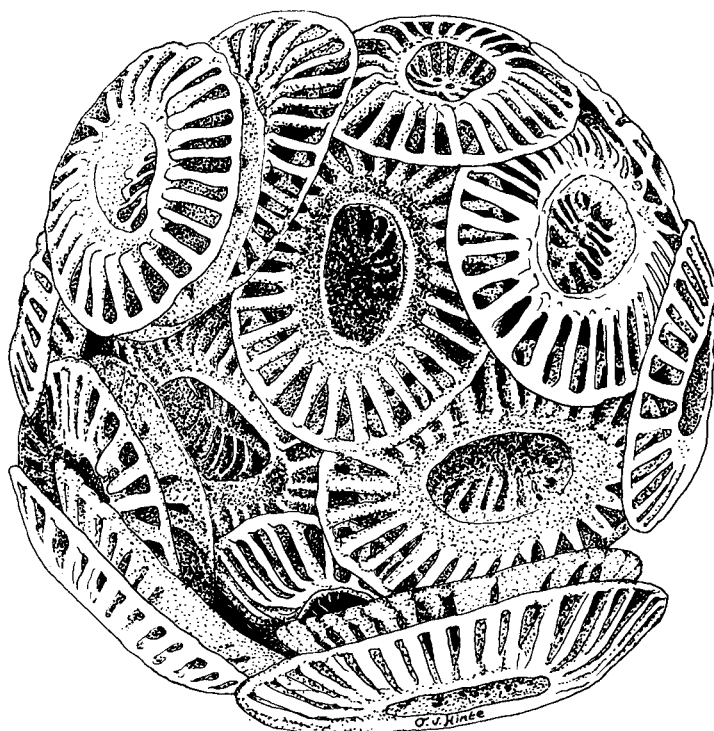


INA

NEWSLETTER



INTERNATIONAL NANNOPLANKTON ASSOCIATION

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# INTERNATIONAL NANNOPLANKTON ASSOCIATION

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!! NOTE !!

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NEXT ISSUE

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DOUBLE SPACING, as this takes up too much space !

## EDITORIAL

In November 1977, ten years ago this month, 18 European nannoplankton workers came together in Rijswijk (The Netherlands) for a meeting on middle Cretaceous nannofossils. During this meeting the problem of the discontinuation of Loeblich & Tappan's much appreciated "Annotated Index and Bibliography of Calcareous Nannoplankton" was brought up, and it was decided there and then to found an Association that would provide a similar service. The Dutch Nannoplankton Working Group committed themselves to the organisation of such an Association, and it was decided the name would be "International Nannoplankton Association". It took almost two years to organise the INA and gather the addresses of all nannoplankton workers known to us. Finally, in August 1979, we produced our first Newsletter (the true birthday of INA - so no celebrations yet). We asked Katharina Perch-Nielsen to become our first President, while Ton Romein served as our first Treasurer, with yours truly as editor of the Newsletter. It was our intention then to have a constitution and organise elections. We soon found that the legal complications for a constitution of an international association were staggering, so we abandoned that idea. Then we realised that it was far more practical to have the officers close together, as frequent communications in the form of phone calls and letters were unavoidable. As elections might result in officers in three different continents, we decided not to bother and get on with the job as long as no-one complained.

Now, ten years on, no-one has complained yet, and things are running fairly smoothly. The Dutch Nannoplankton Working Group no longer exists, its members being scattered all over the world. KPN is still our president, but due to Ton Romein's move to Indonesia the Treasury and Secretariat was taken over by Martin Jakubowski. Due to my work circumstances I was no longer able to do the Bibliography and Taxa (our reason for existence) and John Steinmetz was kind enough to take that over. We have gradually started to include short articles in our Newsletter and, more important, taxonomic papers such as validations. I know not everybody is in favour of the latter but, as we have maintained from the beginning, the Newsletter is a valid publication and is available to everybody who wants it (this includes all the back-issues). Moreover, with the enormous amount of journals available, it is probably the only one that reaches most nannoplankton workers. And because of its informal nature it offers space for communications that could not be published elsewhere. However, we do consider ourselves an association, which implies that we do pay attention to the wishes of our members, as long as those wishes are expressed.

Now for the recent events: on the following pages you will find some accounts of the last INA Meeting in London, and a late abstract that missed the 'Special Issue'. We are now busy working through the manuscripts, and if all goes well the Proceedings will be published next year in the BMS series of special publications (see Newsletter 9.1, p.6). We shall of course keep you informed on our progress.

SvH

## INA MEETING 1987, LONDON - A REPORT

The INA Meeting 1987 at University College London, where Alan Lord was our host, was attended by 50 participants. The organising committee consisting of Shirley van Heck, Jason Crux and Alan Lord were assisted by students and staff of the Micropalaeontology Unit of UCL who not only organised the viewing of the slides and the coffee, but also arranged for three excellent buffet lunches. After the first day's lectures and discussions we met for the conference party on a ship cruising down and up the Thames, so providing us with splendid sights of the London riversides by evening/night, food and bar, and time to renew old friendships and make new ones.

The scientific program (abstracts see Special Issue of the INA NEWSLETTER 9/2) started off with an invited lecture by P. WESTBROEK on "Coccolithophorids and the integration between earth and life sciences" followed by presentations on living and Neogene coccoliths by J. YOUNG, J.W. BIEKART, A. KLEIJNE, A. PUJOS, G. GARD, A. WINTER, B. DRIEVER, L.T. GALLAGHER and J.-A. FLORES & F.-J. SIERRA, V. TOKER and O. VAROL discussed Paleocene zonal schemes.

The morning of the second day was reserved for talks on Cretaceous topics. B. PRINS & H.J. RUIJSMA and S. MOSHKOVITZ discussed various aspects of the Arkhangelskiellaceae and J. MUTTERLOSE, E. ERBA, J.A. CRUX and S.W. WISE & J.L. APPLIGATE & J.A. BERGEN & J.M. COVINGTON treated boreal and Tethyan Mid- and Lower Cretaceous coccolith assemblages. In the afternoon H.J. & K.M. DOCKERILL, M.K.E. COOPER, S. MONECHI & V. REALE, B. PRINS & J.A.M. DRIEL, P.R. BOWN & M.K.E. COOPER and P.R. BOWN presented us with various aspects of Triassic and Jurassic calcareous nannofossils.

On the last day, the morning was dedicated to talks on phylogenetic strategies by H.J. & K.M. DOCKERILL and B. PRINS and by reflections on geological processes and events and nannofossil distribution by K. PERCH-NIELSEN.

A formal INA MEETING was held in the afternoon and it was agreed:

- to hold the next INA Meeting preferably in FLORENCE, S. MONECHI and her Italian colleagues aim for a date during the fall of 1989.
- to hold topical workshops (such as the one held in Zürich, spring 1986 on the boreal Lower Cretaceous) at the request of a few members.

- to continue the INA NEWSLETTER as before, but to keep an eye on the development of ODP reports (in case paleontological reports are discontinued). We discussed the possibility of launching a more fancy journal but concluded not to go that way in order not to burden our officers with the additional task of finding funds for its printing and not to incur delays through tardy reviewers.

For the rest of the afternoon the meeting was split into working groups and microscopes were available for the investigation of slides. Posters were on view and under discussion. H.J. & K.M. DOCKERILL presented the beginning of a computer program on systematics of coccoliths (so far mainly Jurassic) and J. YOUNG demonstrated the computer drawing discoasters and coccoliths.

While the weather was nice and warm to hot during the 3 days of the meeting, the early start of the EXCURSION on Saturday was rather wet and most of us arrived in rubberboots, ready to brave the elements along the southern coast of England. However, the clouds got thinner and thinner as we approached Folkstone, and the sun was shining at the first outcrop, the cliffs of Copt Point. Here, Middle and Upper Albian could be sampled bed by bed. The aragonitic preservation of the abundant ammonites and bivalves explains the very good preservation shown in BLACK's monographs of the Gault coccoliths. After another excellent buffet lunch above the cliffs of Dover, we descended the Langdon Stairs, sampling Coniacian and Turonian chalk. Finally we collected samples from the basal part of the Thanetian stratotype at Pegwell Bay near Ramsgate, before heading towards dinner at the Falstaff Hotel in Canterbury, where we arrived too late for a visit to the famous cathedral.

The PROCEEDINGS of the London Meeting will be published in 1988 by Ellis Horwood in the series of special publications of the British Micropalaeontological Society under the title "Nannofossils and their applications".

We like to thank the sponsors of the meeting and/or the proceedings: ARCO, BP, the British Micropalaeontological Society, Britoil, Chevron, Clyde Petrol, Esso, Shell UK. Thank's also to all of you who prepared and attended this well-organised and interesting meeting. It was not the organisers fault that a one day bus strike prevented participants to show up on time one day... this is part of life in London. We are sorry for all of you who did not attend and we hope that more non-European members will attend the meeting in FLORENCE in 1989!

KPN

## *Gephyrocapsa* - Workshop

The genus *Gephyrocapsa* is frequently used as a biostratigraphic indicator and increasingly also for paleoenvironmental interpretations. However, the taxonomy of these small placoliths is not clear and each nanofossil specialist tends to work out his own taxonomy and differentiating criteria which often can not be recognised by another person. The workshop, which was attended by about ten specialists, agreed that the taxonomy of the genus *Gephyrocapsa* needs revision.

Scanning electron micrographs of *Gephyrocapsa* coccospheres obtained from plankton samples were shown by A-L. Kleijne. In several cases, the coccoliths on the same coccospheres were of different size and appearance. If these had been found separated from each other in the sediment, they would have been referred to different species.

The separation of living *Gephyrocapsa* into different species is not clear and it is obviously virtually impossible to obtain a biological correct subdivision of fossil assemblages. Therefore, the work-shop agreed that strict morphometric criteria of the coccoliths were most suitable for obtaining a workable taxonomy for the fossil *Gephyrocapsa*, whether these were biologically correct or not.

The parameters most often used by workers today are the total size, size of the central opening, the appearance of the central opening (closed or open) and the angle the central bar makes with the long axis of the coccolith. Several workers have by using some or all these parameters obtained a very high degree of biostratigraphic resolution, however there are great difficulties in correlating the results from different specialists..

The work-shop concluded that the taxonomy of the genus *Gephyrocapsa* needs a total revision. It was suggested that a working group should be formed which should put together the knowledge from different experienced *Gephyrocapsa* workers and formulate strict differentiating criteria. These parameters should be unambiguous and recognisable in the light microscope for a practical approach to geological problems. The working groups suggestions could then form a basis for a new *Gephyrocapsa* work-shop in connection with the next INA meeting and hopefully, a new workable taxonomy could be formulated.

Therefore, anybody who has opinions about the *Gephyrocapsa* taxonomy, please contact Gunilla Gard.

Gunilla Gard

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----- late abstract -----

EXTANT CALCAREOUS NANNOPLANKTON FROM SURFACE WATERS

By A. Kleijne, *Institute for Earth Sciences, Free University, P.O.Box 7161, 1007 MC Amsterdam, The Netherlands*

In May 1984 - August 1985 nanoplankton samples were taken during cruises of the Dutch - Indonesian Snellius II Expedition, in the Indonesian seas, Indian Ocean, Red Sea, Mediterranean and eastern North Atlantic. The species composition and standing crop of the coccolithophorid flora has been examined to recognise floral assemblages and study their relation to water masses, and to study geographic intraspecific variation. The purpose is to improve our understanding of the biogeography and ecology of the coccolithophorid species and to apply this knowledge to paleo-oceanographic studies.

Samples from the upper five metres of the watercolumn were obtained with a seawater pump. The water was filtered through Nuclepore or Millipore filters. Parts of the filters were examined with a Scanning Electron Microscope to determine species composition as well as standing crop. Detailed SEM-micrographs have been made of the approximately 100 species that could be identified. Among these are 43 holococcolithophorid species, including several new species and genera.

In the samples from the Indian Ocean and the Red Sea (Cruise Gx), six assemblages could be recognised and be related to different water masses.

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Please send your reprints of publications on calcareous nanoplankton to:

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CALCAREOUS NANNOPLANKTON (abstract)  
by S.I. Shumenko

Editor: M.S. Mesejnikov, Publishing House "Nedra"

The monograph summarises the results of calcareous nannoplankton studies over the last one and a half centuries that are of great importance for Mesozoic and Cenozoic biostratigraphy of continents and oceans, especially under conditions of a limited number of cores in deep drilling and off-shore drilling.

The subjects of general biology, morphology, ecology and history of research of this variable group are considered. Investigation methods with light and electron microscope are explained in detail. A systematic description of 32 families and 225 genera is presented. Characteristic species and type species of described genera are illustrated on numerous plates with electron microscope photographs. Some information is given about the rock-forming significance and stratigraphic utilisation of nannofossils. The book contains zonation schemes from Jurassic to Recent deposits.

38 figures, 44 plates, 340 references

The book "Izvestkovykh nanoplankton" may be ordered at the address:  
USSR, 199026 Leningrad, Srednij pr., 74  
VSEGEI, Director

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REVIEW

by P.H. Roth, University of Utah, Salt Lake City, Utah, USA

SHUMENKO, S.I., 1987. Izvestkovykh nanoplankton.

In: Sokolov (Editor), Prakticheskoe rukovodstvo no mikrofaune SSSR, M.S. Mesezhnikov (nauchny redaktor = Scientific Editor), volume 1, "Nedra", Leningrad, 240 pp., 54 plates. Price: 1.60 Rubles.

Address of publisher: Izdatelstvo "Nedra", Ul. Farforovskaya, 18, USSR-193171, Leningrad, C-171.

This handbook on calcareous nannoplankton shows the state of the art of Soviet nannofossil paleontology. It is largely a review of the literature, heavily biased towards taxonomy based on electron microscope investigations. The first ten pages contain a review of the biology, ecology, stratigraphic distribution, and history of research. The next twenty pages are devoted to sample preparation and the use of light and electron microscopes in nannofossil investigations. A brief discussion on the principle of nannofossil morphology, with a short vocabulary of terms in English, French, German, and Russian (from Farinacci, 1971) precedes a long section on systematics (about 100 pages). All genera recognized by the author are briefly described (with the type species, a diagnosis, the species belonging to this genus, remarks, and geologic range given for each). Minor emendations are given, one new genus (*Blackiella*) is proposed; unfortunately it is invalid because Shumenko fails to indicate the holotype. Some massive recombinations of what I consider unrelated taxa into very broad genera are proposed. I particularly disagree with putting *Cretarhabdus* in synonymy with *Podorhabdus* while preserving *Hemipodorhabdus*, an unnecessary genus, as the type of *Podorhabdus* possesses two pores only

and would thus have to be assigned to the genus *Hemipodorhabdus*, clearly an invalid taxonomic exercise. The proposed taxonomic scheme is not acceptable in its present form as it ignores optical characteristics almost entirely. The orientation of the optical axis of the calcite crystallites is very stable over geologic time in the various taxonomic groups of nannoliths; it is also less affected by recrystallization and dissolution than ultrastructural details.

Thus, ignoring the optical behavior of coccoliths is bound to lead to very artificial classifications. A good example of this in the present book is seen in *Ethmorhabdus* Noel 1965, which is considered a junior synonym of *Rhagodiscus* Reinhardt 1967. The former has a podorhabdid rim, the latter an eiffellithid rim. Another unfortunate choice is the use of *Stauroolithites* Caratini 1963 (for *Vagalapilla* Bukry 1969), although Shumenko suspects that the holotype of this genus (*S. Jaffittei* Caratini 1963) may be a junior synonym of *Discolithus bochoznicae* Gorka 1957. It could well be some other form with a central cross, as the original drawing and illustrations are totally inadequate. A more careful scrutiny of the taxonomy in this book is needed, but this is not the place to do it. Suffice it to say that there are numerous misspellings. Also annoying is the fact that the index contains a blank column [labelled C., which stands for page(s)] and must be completed by the buyer if he wants to use this book efficiently. Obviously, little time was spent in carefully scrutinizing galley proofs before final production.

The last part of this book reviews Mesozoic and Cenozoic nannofossil zonations. One table may be of special interest to Western readers: table 11 gives the macrofossil, foraminiferal, and nannofossil zonations for the Upper Cretaceous (Cenomanian to Maastrichtian) and Danian of the Crimea. The other zonal schemes are from the published literature and reflect the state of knowledge of the late seventies.

The reference list is rather short; it contains 58 references in Russian or other languages from the USSR, of which 25 are by the author of this book, followed by over 250 references from Western publications.

How does this book serve the community of nannofossil workers? It is a helpful introduction to nannofossil morphology and the potential of nannofossils in Mesozoic and Cenozoic biostratigraphy. It is not as useful as the two review chapters by Perch-Nielsen (in Bolli, Saunders & Perch-Nielsen 1985, *Plankton Stratigraphy*), especially not for the practicing biostratigrapher, paleoceanographer, or paleoecologist. Even for taxonomists, Perch-Nielsen's work is more useful as it is more up-to-date and contains many more modern references. Shumenko's book is useful, however, to facilitate communication for us poor souls that speak Russian only poorly and struggle with different concepts and a different way of thinking when we talk to our colleagues in the USSR.

Thus, I recommend it highly. It is a steal at about US \$ 2.50, compared to US \$ 175 for *Plankton Stratigraphy*. I congratulate Dr. Shumenko, the author, and M.S. Mesezhnikov, the scientific editor, for undertaking this enormous task of digesting and summarizing the vast and widely scattered literature, and making it accessible to a Soviet audience. Last but not least, it provides a key for us to a better understanding of the Soviet approach to micropaleontology, and a basis of discussion for future work - hopefully much of it involving international cooperation.

BIBLIOGRAPHY AND TAXA OF CALCAREOUS NANNOPLANKTON-X

Compiled by John C. Steinmetz

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RECENT  
QUAT  
Atlantic.C.
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RECENT  
QUAT  
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RECENT  
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- |   |                                                                                                                                                                                                                                                                                                                              |                                                                     |
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| 3  | <p><b>LEINEN, M., REA, D. K., &amp; SHIPBOARD SCIENTIFIC PARTY.</b> 1986<br/>         Site 598. [East Pacific Rise]<br/>         -In: Leinen, M., Rea, D. K., et al., Init. Rep. DSDP, vol. 92: 97-116, 11 figs., 5 tbs. [Nannofossils by S. Knüttel.]</p>                                                                             | <p>strat.<br/>         QUAT<br/>         TERT.U.<br/>         Pacific.C.</p>                                            |
| 4  | <p><b>LEINEN, M., REA, D. K., &amp; SHIPBOARD SCIENTIFIC PARTY.</b> 1986<br/>         Site 599. [East Pacific Rise]<br/>         -In: Leinen, M., Rea, D. K., et al., Init. Rep. DSDP, vol. 92: 117-14, 14 figs., 5 tbs. [Nannofossils by S. Knüttel.]</p>                                                                             | <p>strat.<br/>         QUAT<br/>         TERT.U.<br/>         Pacific.C.</p>                                            |
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magnetic and seismic stratigraphy. Atlantic.N.  
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| 6 | <p><b>OKADA, H., YAMADA, M., &amp; MATSUOKA, H. et al</b> <span style="float: right;"><b>1987</b></span><br/>         Calcareous nannofossils and biostratigraphy of the Upper Cretaceous and Lower Paleogene Nemuro Group, eastern Hokkaido, Japan.<br/>         -J. Geol. Soc. Japan, <u>93</u> (5): 329-348, 2 pls., 8 figs., 4 tbs.</p>                                                                                                           | strat.(syst)<br>TERT.L.<br>CRET.U.<br>Asia.E.                           |
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<u>Biscutum novum</u> (GOY 1979) BOWN 1987; p. 44; (ex <u>Palaeopontosphaera</u> ).	A312-3
<u>Calculites sarstedtensis</u> CRUX 1987; p. 33, pl. 1, figs. 13-15, 21. West Germany, Sarstedt near Hannover, late Hauterivian.	A314-7
<u>Calyculus absolutus</u> (GOY in GOY, NOEL, & BUSSON 1979) CRUX 1987; p. 53; (ex <u>Incerniculum</u> ).	A314-6
<u>Calyculus derivatus</u> (GOY 1981) CRUX 1987; p. 53; (ex <u>Incerniculum</u> ).	A314-6
<u>Calyculus hommerlii</u> (GOY in GOY, NOEL, & BUSSON 1979) CRUX 1987; p. 53; (ex <u>Catillus</u> ).	A314-6 *C-2
<u>Calyculus noelae</u> (GOY in GOY, NOEL, & BUSSON 1979) CRUX 1987; p. 54; (ex <u>Vikosphaera</u> ).	A314-6 *C-3
<u>Calyculus noelae</u> ssp. <u>depressa</u> (GOY 1981) CRUX 1987; p. 54.	A314-6 *C-4
<u>Calyculus noelae</u> ssp. <u>recondita</u> (GOY 1981) CRUX 1987; p. 54.	A314-6 *C-5
<u>Calyculus serrai</u> (GOY 1981) CRUX 1987; p. 54; (ex <u>Catillus</u> ).	A314-6
<u>Chiasmolithus danicus</u> (BROTZEN 1959) ex VAN HECK & PERCH-NIELSEN 1987; p. 280, text-figs. 1-4, pl. 1, figs. 11-26, 33, 34. Sweden, Limhamn Quarry, Danian, NP 3.	A318-4
<u>Chiasmolithus edentulus</u> VAN HECK & PRINS 1987; p. 288, pl. 1, figs. 13, 14, text-fig. 5, Danish North Sea, well A-2, Paleocene, NP 4.	A318-5
<u>Chiasmolithus edwardsii</u> (ROMEIN 1979) VAN HECK & PRINS 1987; pp. 288-289; (ex <u>Cruciplacolithus</u> ).	A318-5
<u>Chiasmolithus inconspicuus</u> VAN HECK & PRINS 1987; p. 289, pl. 1, figs. 11, 12, text-fig. 7. Danish North Sea, well A-2, Paleocene, NP 3-NP 4.	A318-5
<u>Chiasozygus cepekii</u> CRUX 1987; p. 30, pl. 1, figs. 1-3, 6, 18-20. West Germany, Sarstedt near Hannover, and England, Speeton (Yorkshire), late Hauterivian-early Barremian.	A314-7
<u>Clepsilithus</u> CRUX 1987; p. 30. Type species <u>Clepsilithus polystreptus</u> CRUX 1987.	A314-7
<u>Clepsilithus polystreptus</u> CRUX 1987; p. 31, pl. 1, figs. 10-11. West Germany, Sarstedt near Hannover, late Hauterivian. Type species of <u>Clepsilithus</u> CRUX 1987.	A314-7
<u>Coccolithus streckeri</u> TAKAYAMA & SATO 1987; p. 690, pl. 1, fig. 4, pl. 2, figs. 1-10, pl. 8, fig. 3. Mid-North Atlantic, DSDP Leg 94, middle Miocene to Recent.	A330-3
<u>Coccolithus subpertusus</u> (HAY & MOHLER 1967) VAN HECK & PRINS 1987; p. 289; (ex <u>Ericsonia</u> ).	A318-5
<u>Coccolithus subrotundus</u> (PERCH-NIELSEN 1969) VAN HECK & PRINS 1987; p. 289; (ex <u>Cruciplacolithus</u> ).	A318-5

- Cretarhabdus? delicatus APPLIGATE, COVINGTON, & WISE in COVINGTON & WISE 1987; pp. 629-630, pl. 16, figs. 3-4. North Atlantic, DSDP Site 603, Hauterivian to lower Aptian. A314-4
- Cretarhabdus inaequalis CRUX 1987; p. 31, pl. 1, figs. 7-9, 22. West Germany, Sarstedt near Hannover, and England, Speeton (Yorkshire), late Hauterivian-Barremian. A314-7
- Cruciplacolithus asymmetricus VAN HECK & PRINS 1987; pp. 289-290, pl. 1, figs. 5-8, text-figs. 8a,b. Danish North Sea, well T-1X, Paleocene, NP 2-NP 4. A318-5
- Cruciplacolithus intermedius VAN HECK & PRINS 1987; p. 290, pl. 1, figs. 1-3, text-fig. 9. Danish North Sea, well T-1X, Paleocene, NP 2-NP 4. A318-5
- Cyclagelosphaera jiangli COVINGTON & WISE 1987; p. 630, pl. 9, fig. 4. North Atlantic, DSDP Site 603, Valanginian. A314-4
- Discoaster misconceptus (THEODORIDIS 1984) MUZA & WISE in MUZA, WISE, & COVINGTON 1987; p. 614; (ex Eu-discoaster). A323-8
- Discorhabdus biradiatus (WORSLEY 1971) THIERSTEIN 1973 ex APPLIGATE, COVINGTON, & WISE in COVINGTON & WISE 1987; p. 630; (ex Rucinolithus?). A314-4  
\*C-6
- Ethmorhabdus? hauterivianus (BLACK 1971) APPLIGATE, COVINGTON, & WISE in COVINGTON & WISE 1987; p. 630; (ex Cribrosphaera). A314-4
- Gephyrocapsa theyeri PUJOS 1987; pp. 255-256, pl. 3, figs. 1-4. Central Pacific, DSDP Site 572, early late Miocene - late Pliocene. A326-6
- Hayesites irregularis (THIERSTEIN in ROTH & THIERSTEIN 1972) APPLIGATE, COVINGTON & WISE in COVINGTON & WISE 1987; pp. 630-631; (ex Rucinolithus). A314-4
- Helicolithus valhallensis MORTIMER 1987; p. 172. A322-5  
\*C-7
- Lithastrinus quadricuspis FARHAN 1987; p. 59, pl. 1, figs. 1-4, pl. 2, fig. 1. Alabama, upper Campanian - lower Maastrichtian. A316-4
- Lithraphidites alatus THIERSTEIN 1972 subspecies magnus COVINGTON & WISE 1987; p. 631, pl. 10, figs. 3-4. North Atlantic, DSDP Site 603, upper Barremian to lowermost Aptian. A314-4
- Octopodorhabdus plethoretus WIND & ČEPEK 1979 ex APPLIGATE, COVINGTON, & WISE in COVINGTON & WISE 1987. A314-4  
\*C-8
- Pickelhaube APPLIGATE, COVINGTON, & WISE in COVINGTON & WISE 1987; p. 631. Type species: Pickelhaube furtiva (ROTH 1983) APPLIGATE, COVINGTON, & WISE in COVINGTON & WISE 1987. A314-4
- Pickelhaube furtiva (ROTH 1983) APPLIGATE, COVINGTON, & WISE in COVINGTON & WISE 1987; pp. 631-632; (ex Cruciplacolithus). Type species of Pickelhaube APPLIGATE, COVINGTON, & WISE in COVINGTON & WISE 1987. A314-4

- Pontosphaera segmenta (BUKRY & PERCIVAL 1971) KNÜTTEL 1986; p. 279; (ex Discolithina). A320-5
- Rhabdophidites aquitanicus (MANIVIT 1971) APPLGATE, COVINGTON, & WISE in COVINGTON & WISE 1987; p. 632; (ex Rhabdolithus). A314-4
- Rhabdosphaera trochos (BYBELL 1975) STEURBAUT 1986; p. 75. A329-7  
\*C-9
- Rhagodiscus infinitus (WORSLEY 1971) APPLGATE, COVINGTON, & WISE in COVINGTON & WISE 1987; p. 632; (ex Mitosia). A314-4
- Rhagodiscus pseudoangustus CRUX 1987; pp. 31-32, pl. 1, figs. 4, 5, 16, 17. England, Speeton (Yorkshire), and West Germany, Sarstedt near Hannover, late Hauterivian - early Barremian. A314-7  
\*C-10
- Rhagodiscus swinnertonii (BLACK 1971) APPLGATE, COVINGTON, & WISE in COVINGTON & WISE 1987; p. 632; (ex Rhabdolithia). A314-4
- Rucinolithus terebrodentarius APPLGATE, BRALOWER, COVINGTON, & WISE in COVINGTON & WISE 1987; pp. 632-633, pl. 17, figs. 7-8, pl. 18, figs. 5-7, pl. 19, figs. 1-4. North Atlantic, DSDP Site 603, Barremian - lower Aptian. A314-4
- Sphenolithus umbrellus (BUKRY 1971) AUBRY & KNÜTTEL in KNÜTTEL 1986; p. 279; (ex Catinaster?). A320-5
- Thoracosphaera crassa VAN HECK & PRINS 1987; p. 291, pl. 1, fig. 25. Danish North Sea, well A-2, Paleocene, NP 2-NP 3. A318-5
- Triscutum beaminsterensis DOCKERILL 1987; pp. 127-128. Type species: Triscutum beaminsterensis DOCKERILL 1987. A314-10
- Triscutum beaminsterensis DOCKERILL 1987, pp. 128-129, pl. 1, figs. 1-8. England, Dorset, Bathonian - Oxfordian, also France and Germany. Type species of Triscutum DOCKERILL 1987. A314-10
- Triscutum expansus (MEDD 1979) DOCKERILL 1987; p. 129; (ex Proculithus). A314-10
- Watznaueria rawsonii CRUX 1987; p. 32, pl. 1, fig. 12. West Germany, Sarstedt near Hannover, and England, Speeton (Yorkshire), late Hauterivian - early Barremian. A314-7
- Zebrashapka COVINGTON & WISE 1987; p. 633. Type species: Zebrashapka vanhinteri COVINGTON & WISE 1987. A314-4
- Zebrashapka vanhinteri COVINGTON & WISE 1987; p. 633, pl. 5, figs. 4-7, pl. 6, figs. 1-9, pl. 7, figs. 1-5. North Atlantic, DSDP Site 603, upper Hauterivian to lowermost Aptian. Type species of Zebrashapka COVINGTON & WISE 1987. A314-4
- Zeugrhabdotus? pseudoangustus BRALOWER, APPLGATE, COVINGTON, & WISE in COVINGTON & WISE 1987; pp. 633-634, pl. 8, figs. 2-4. North Atlantic, DSDP Site 603, Barremian - lower Aptian. A314-4  
\*C-10

\*\*\*\*\*

Species names in alphabetical order.

- |                                    |                                    |
|------------------------------------|------------------------------------|
| absolutus, Calyculus               | noelae, Calyculus                  |
| alatus ssp. magnus, Lithraphidites | noelae ssp. depressa, Calyculus *  |
| aquitanicus, Rhabdophidites        | noelae ssp. recondita, Calyculus * |
| asymmetricus, Cruciplacolithus     | novum, Biscutum                    |
| beaminsterensis, Triscutum         | plethotretus, Octopodorhabdus      |
| biradiatus, Discorhabdus           | polystreptus, Clepsilithus         |
| cepekii, Chiastozygus              | pseudoangustus, Rhagodiscus        |
| crassa, Thoracosphaera             | pseudoangustus, Zeugrhabdotus? *   |
| danicus, Chiasmolithus             | quadriscuspis, Lithastrinus        |
| delicatus, Cretarhabdus?           | rawsonii, Watznaueria              |
| derivatus, Calyculus               | sarstedtensis, Calculites          |
| edentulus, Chiasmolithus           | segmenta, Pontosphaera             |
| edwardsii, Chiasmolithus           | serrai, Calyculus                  |
| expansus, Triscutum                | streckeri, Coccolithus             |
| furtiva, Pickelhaube               | subpertusus, Coccolithus           |
| hauterivianus, Ethmorhabdus?       | subrotundus, Coccolithus           |
| homerilli, Calyculus               | swinnertonii, Rhagodiscus          |
| inaequalis, Cretarhabdus           | terebrodentarius, Rucinolithus     |
| inconspicuus, Chiasmolithus        | theyeri, Gephyrocapsa              |
| infinitus, Rhagodiscus             | trochos, Rhabdosphaera *           |
| intermedius, Cruciplacolithus      | umbrellus, Sphenolithus            |
| irregularis, Hayesites             | valhallensis, Helicolithus *       |
| jiangi, Cyclagelosphaera           | vanhinteri, Zebrashapka            |
| misconceptus, Discoaster           |                                    |

New genus names.

- |              |             |
|--------------|-------------|
| Clepsilithus | Triscutum   |
| Pickelhaube  | Zebrashapka |

\* = Invalid

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Comments

- 1 - A316-5: Also contains calcispheres.
- 2 - B140: This species is misspelled as homerilli in CRUX 1987. Such orthographic errors do not invalidate new combinations when they are corrected (ICBN Art. 73).
- 3 - B140: The generic basionym is misspelled as Vicosphaera in CRUX 1987. Such orthographic errors do not invalidate new combinations when they are corrected (ICBN Art. 73).
- 4 - B140: Invalid new combination; no basionym (ICBN Art. 33.2).
- 5 - B140: Invalid new combination; no basionym (ICBN Art. 33.2).
- 6 - B141: APPLGATE, COVINGTON, & WISE present reasons for the validity of Rucinolithus? biradiatus WORSLEY 1971 and the subsequent acceptance of THIERSTEIN'S new combination Discorhabdus biradiatus (WORSLEY 1971) THIERSTEIN 1973.
- 7 - B141: Invalid nomen nudum (ICBN Art. 34.1); cited as "in prep", but as far as is known, it has never been published.
- 8 - B141: The original description was found invalid by STEINMETZ 1984 (INA Newsl., 6 (2): 72. It is here validated.
- 9 - B142: Invalid new combination; no basionym (ICBN Art. 33.2).
- 10 - B142: A very rare coincidence. Rhagodiscus pseudoangustus and Zeugrhabdotus? pseudoangustus share three aspects in common: 1) they apparently are the same species, 2) they share the same specific epithet, and 3) their discoveries and descriptions were both published in 1987. That R. pseudoangustus and Z. pseudoangustus are in fact the same species is based on their: 1) similar descriptions and sizes, 2) similar appearance, 3) similar geologic ranges, and 4) reference to the same article by PERCH-NIELSEN 1979, in which the authors note the general similarity of this species to Rhagodiscus argustus.

WATZNAUERIA MANIVITAE BUKRY - TAXONOMIC PROBLEMS AND DISTRIBUTION IN THE JURASSIC-LOWER CRÉTACEOUS SEDIMENTS OF ISRAEL AND OTHER TETHYAN AREAS.

By

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Geological Survey of Israel, Jerusalem.

Introduction

Investigators working on the calcareous nannofossil assemblages of the Upper Jurassic and Lower Cretaceous sediments of various parts of the Tethyan Province have long noted the presence, sometimes in high amounts, of large, subelliptical to subcircular coccoliths (France - Manivit, 1966; the Atlantic Ocean - Worsley, 1971; Roth, 1983; Israel - Moshkovitz and Ehrlich, 1976; 1981; the Pacific Ocean - Bukry, 1973; Indian Ocean - Bukry, 1974; Proto Decima, 1974).

These large coccoliths were assigned by various authors to Coccolithus deflandrei Manivit, Cyclagelosphaera deflandrei (Manivit) Roth or to Watznaueria manivitae Bukry.

It is the purpose of this short note to elucidate the taxonomic confusion concerning these distinctive forms and summarize information on their stratigraphical distribution in Israel and other parts of the world, especially in the Tethyan Province.

Taxonomy

Watznaueria manivitae Bukry 1973

Pl. 1, Figs. 1-11

(Neotype Figs. 1-3)

- 1971 Coccolithus deflandrei Manivit - Worsley, Pl. 2, Figs. 37-39.  
1973 Cyclagelosphaera deflandrei (Manivit) - Roth, p. 273 (partim), Pl. 27, Fig. 6 (non Pl. 26, Fig. 7).  
1973 Watznaueria manivitae Bukry - p. 877.  
1974 Watznaueria manivitae Bukry - Proto Decima, p. 595, Pl. 9, Fig. 1.  
1976 Cyclagelosphaera deflandrei (Manivit) - Thierstein, Pl. 2, Figs. 20-21.  
1976 Watznaueria sp. - Moshkovitz and Ehrlich, Pl. 6, Figs. 6-7.  
1981 Watznaueria manivitae Bukry - Moshkovitz and Ehrlich, Pl. 1, Figs. 1-3.  
1983 Cyclagelosphaera deflandrei - Roth, Pl. 2, Figs. 1-2 (non C. cuvillieri)

Description: large subelliptical to subcircular coccoliths (9-15  $\mu$ m), made of two thick superimposed shields. The distal one, which is strongly convex, is composed of two cycles, the outer one with some 30-40 imbricated elements, the inner with short radial elements irregularly arranged. The central area is subelliptical to elliptical, sometimes obstructed by irregular coarse elements. The proximal shield is somewhat smaller and the central area is sometimes blocked by radial elements. In light microscope between crossed nicols, this species is easily recognized by its high birefringence colours and the well marked, relatively small and elongated central area, showing two curved slit-like lines, aligned with the long axis of the ellipse. This form shows features rather similar to those of W. barnesae, which is however much smaller and thinner (Pl. 1, Fig. 14).

Remarks: great confusion exists in the literature concerning the systematic position of coccoliths of Jurassic and Early Cretaceous age, which match the above description and different names have been used (see synonymy).

Large circular coccoliths from the Middle Valanginian of Carnes, France have been described as Coccolithus deflandrei by Manivit (1966). Roth (1973) proposed a new combination, i.e. Cyclagelosphaera deflandrei (Manivit), for similar coccoliths recorded in the DSDP Leg

17, Site 167 (core 73 down to 94) of Late Tithonian-Hauterivian age. Bukry (1973), who worked on the same site, mentioned abundant "large coccoliths" in core 94 (Tithonian or Berriasian) and related them to the genus "Watznaueria" (probably because of their elongated shape). He proposed the name W. manivitae "as a substitute for Coccolithus deflandrei" since the name W. deflandrei was already occupied by another, very small form, i.e. Actinosphaera deflandrei Noël 1965 = Watznaueria deflandrei (Noël) Reinhardt 1971. Unfortunately, Bukry (1973) did not figure or describe his specimens. W. manivitae was, however, later reported from Leg 27, Site 261 (Late Jurassic-Early Cretaceous) by Bukry (1974) and Proto Decima (1974), who worked on the same material, described and figured it as "W. manivitae (Coccolithus deflandrei auct)". The present authors obtained material from the same Leg (Site 261) and could observe in cores 32-2 and 32-4 large subcircular specimens together with subelliptical-elliptical ones (Pl. 1, Figs. 1-4; 6-7). These specimens are identical with the forms found in the Upper Jurassic sediments of Israel and adjacent areas in various localities (e.g. Pl. 1, Figs. 8-11).

Examination of well-dated samples from England, has shown that W. manivitae occurs, although rarely, in the Upper part of the Callovian (Peltoceras athleta zone) and in the Lower Oxfordian (Pl. 1, Fig. 5). Thierstein (1976), who has figured a specimen (Pl. 2, Figs. 20-21) from the lower Oxfordian (Quenstedtoceras mariae zone) in England, has related it to Cyclagelosphaera deflandrei in spite of its subelliptical shape and elliptical central area. Roth (1983) who described the calcareous nannofossils from the West Atlantic (Site 534A), figured (Pl. 2, Figs. 1-2) a large specimen from core 110 cc (a level regarded by him as of latest Oxfordian to earliest Kimmeridgian in age). This specimen with subcircular shape and elliptical central area, which was related by him to C. deflandrei (non C. cuvillieri vide p. 608) bears a great resemblance to other Oxfordian specimens (cf. Thierstein, 1976).

Comparing the reported Jurassic descriptions with the generotypes of Watznaueria (W. barnesae) and Cyclagelosphaera (C. margereli) it seems that most are closer to Watznaueria by their elliptical-subelliptical shape, especially when considering their central elliptical part; this part in various Cyclagelosphaera species (e.g. C. margereli, C. rotaclypeata or C. reinhardtii) is clearly circular (Pl. 1, Figs. 12-13).

It is therefore suggested that the name W. manivitae Bukry by used and to regard as a neotype (since a holotype was not designated by the author from the original locality) the specimen presented hereby in Pl. 1, Figs. 1-3 (given both in LM and in the SEM) from the Eastern Indian Ocean, Leg 27, Site 261, core 32-4, 90-91 cm (Upper Jurassic).

#### Stratigraphical notes and listed distribution

The systematic confusion has led to contradictory conclusions concerning the stratigraphic range of these large nannofossils. Our observations and review of the described forms in the literature have shown that whereas large subelliptical to elliptical forms (which seem to be related to Watznaueria) are present in the Upper Jurassic (Upper Callovian-Berriasian) the circular to subcircular ones (Cyclagelosphaera?) are mostly distributed from the ?Kimmeridgian-Tithonian and upwards. Although Thierstein (1976) assigns a Callovian to Hauterivian range to C. deflandrei, he agrees that the subelliptical forms start in the Middle-Upper Callovian, whereas the circular forms appear later, in the Kimmeridgian-Tithonian (personal communication, 1978).

Forms which were related to the W. manivitae-C. deflandrei group

are found rather commonly in the Paleotethyan Provinces (including the Atlantic, Mediterranean, Indian and Pacific Oceans) where they seem mainly abundant in the eastern parts, however, similar forms were also found in more northern areas (e.g. England).

Reports concerning distribution in various stratigraphical levels and which seem to be relevant to the above discussion are as follows:

Upper Callovian: England - within the Peltoceras athleta zone, adhered to Eboraciceras cadiforme. Israel - NE Negev, within an interval with Peltoceras aff. antiquum, Pachyceras lalandeanum and other Upper Callovian ammonites (Moshkovitz and Ehrlich, 1981).

?Callovian-Oxfordian: Eastern Indian Ocean-DSDP, Leg 27, Site 261, core 30 (Bukry, 1974). Proto Decima (1974) recorded from the same site W. manivitae in levels regarded by her as Oxfordian to Hauterivian in age.

Callovian-Berriasian: Northwest Atlantic Ocean-DSDP, Leg 76, Site 534. Roth (1983) who investigated the nannofossils in this area figured his specimen from core 110 cc which he regarded as of latest Oxfordian to earliest Kimmeridgian in age.

Lower Oxfordian: England - within the Quenstedtoceras mariae zone (Thierstein, 1976; Moshkovitz and Ehrlich, 1981). Israel and adjacent areas (Moshkovitz and Ehrlich, 1976; 1981).

Tithonian-Berriasian: Central Pacific Ocean-DSDP, Leg 17, Site 167, core 94 (Bukry, 1973, p. 877). From the same site Roth (1973, p. 723) records large coccoliths and relates them to the Tithonian-Hauterivian.

Middle Valanginian: France - Carnes. The large coccoliths described by Manivit (1966) as Coccolithus deflandrei and renamed as Cyclagelosphaera deflandrei (Manivit) Roth 1973, are clearly circular both in outer shape and central area.

#### ACKNOWLEDGEMENTS

The authors would like to thank Dr A. R. Lord, University College London, for his critical reading of the manuscript.

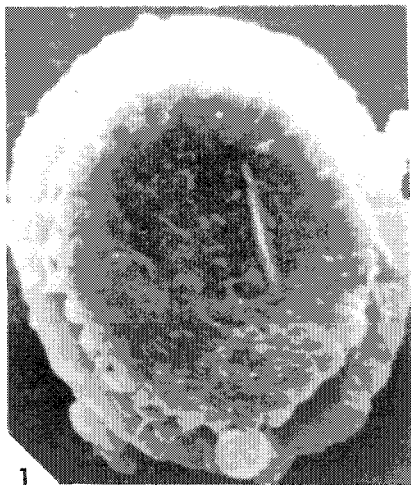
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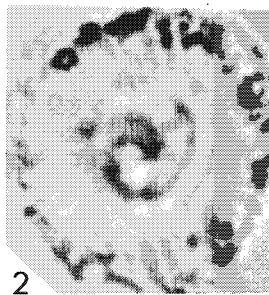
PLATE 1

Figures

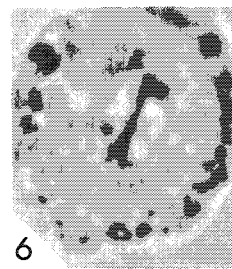
- 1 Watznaueria manivitae Bukry, proximal side. DSDP Leg 27, Site 261, Core 32-4, 90-91 cm, Upper Jurassic. SEM x 4500.
- 2,3 Watznaueria manivitae Bukry, LM (Fig. 2, ordinary light; Fig. 3, polarized light). Same specimen as in Fig. 1. x 3000.
- 4 Watznaueria manivitae Bukry, distal side. Same locality and sample as Fig. 1. SEM x 4000.
- 5 Watznaueria manivitae Bukry, proximal side. Warboys, Huntingdonshire, England. C. cordatum? zone, Lower Oxfordian BK 29; LFS 1938, Geol. Mus. London, GSI N-4918. SEM x 4250.
- 6,7 Watznaueria manivitae Bukry, LM (Fig. 6, ordinary light; Fig. 7, polarized light). DSDP, same locality and sample as in Fig. 1. x 3000.
- 8,9 Watznaueria manivitae Bukry, LM. (Fig. 8, ordinary light, Fig. 9, polarized light), Delta-1 well, Israel offshore, depth 4366 m, Upper Callovian-Oxfordian. GSI. N-958. x 3500.
- 10,11 Watznaueria manivitae Bukry, LM. (Fig. 10, ordinary light, Fig. 11, polarized light). Gan Yavneh-3 well, central coastal plain, Israel, depth 2541 m. Upper Callovian-Oxfordian. GSI-N. 3162. x 3500.
- 12 Cyclagelosphaera margereli Noël, distal side. Mount Hermon, Upper Callovian-Oxfordian, GSI-N. 4066. SEM x 8000.
- 13 Cyclagelosphaera margereli Noël, LM (polarized light). Same locality and sample as in Fig. 12. x 3000.
- 14 Watznaueria barnesae (Bläck) Perch-Nielsen, LM (polarized light). Delta-1 well, Israel offshore, depth 4270 m, Upper Callovian-Oxfordian. GSI-N. 956. x 3000.



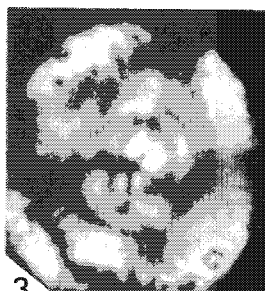
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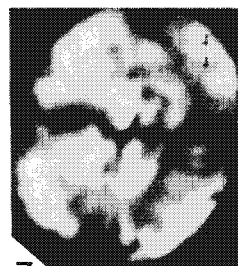
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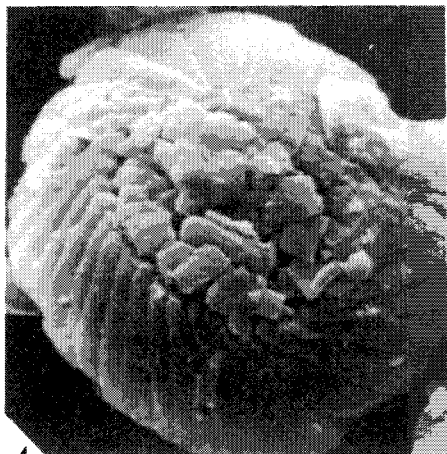
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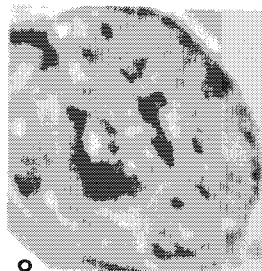
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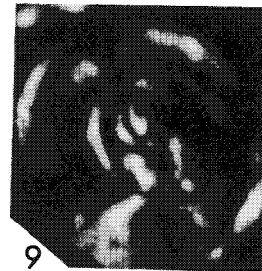
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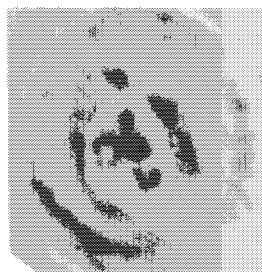
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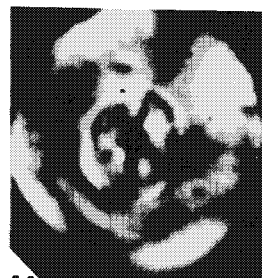
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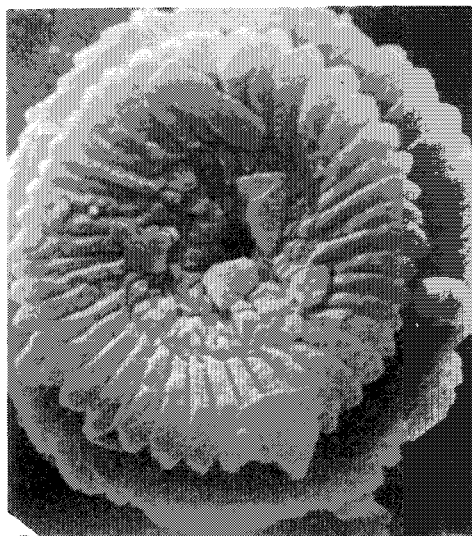
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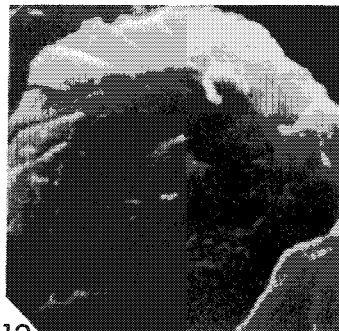
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11



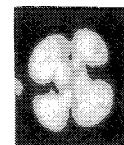
5



12



13



14

Plate 1

## COMPUTER ILLUSTRATION OF NANNOFOSSILS

Jeremy R. Young, Geology Dept., Imperial College, London SW7 2BP.

### 1. INTRODUCTION

At the London INA meeting, a number of people expressed interest in the computer programs I demonstrated, for drawing coccoliths and discoasters, in two dimensions. Since these were written on a BBC micro in BBC BASIC the actual programs cannot be directly used on many computers, but the underlying principles are reasonably simple. The following notes are intended to help others use the same technique. Inevitably they will seem trivial to some workers, but I would have found the discussion useful when I started programming, and hopefully others will do.

My primary reason for writing the programs was to use the computer as a technical drawing tool; to remove some of the labour involved in producing complex geometrical figures. In addition, computer drawings have the considerable advantage that, like word-processed text, they can readily be altered and reused. Finally, for the more asymmetric forms of elliptical coccoliths, the rather indirect technique of computer illustration required development of a model for coccolith geometry; and provided a means of testing the predictions of this model.

### 2. BASIC TECHNIQUE, AND ILLUSTRATION OF DISCOASTERS.

Computer graphics work primarily by cartesian co-ordinates, dividing the screen into several thousand pixels. These pixels are illuminated or not according to the values held in a corresponding area of screen memory. This screen memory can also be readily saved on disc, or dumped to a printer, to produce hard copy of the screen display. There are two basic types of technique for producing computer graphics: The first is from within languages, such as BASIC, using simple graphics commands (such as DRAW), working directly with the cartesian co-ordinate system. The second technique is to use specialist graphics packages, which allow more direct interaction between the user and the graphics, with the aid of mice, cursor controls, or whatever. I have used the former technique since it is more suitable for handling geometrical and symmetrical figures. Drawing nannofossils, such as discoasters, with perfect radial symmetry is particularly easy. Irregular forms, such as ceratoliths, are unsuitable for illustration by this technique.

The problem of drawing discoasters consists of two main parts - defining the shape of a single ray, and symmetrically reproducing it as required. The shape of the ray needs to be defined in terms of the co-ordinates of a series of points around its edge. I did this by the most rudimentary digitising technique available, drawing the ray on graph paper, and using the resultant points as data statements at the end of the program. Alternatives would be to use a digitising tablet; or to write a separate program to interactively design the shape on the screen.

Given the co-ordinates of a set of points it is a simple trigonometrical problem to reproduce these points in other orientations, at different scales, etc. Some graphics systems include commands to do this, but writing the program directly is more flexible. The main equations are those for rotating a point (X,Y) about the origin through an angle (a), to a new position (X',Y'):  $X' = X * \cos a + Y * \sin a$  &  $Y' = X * \sin a + Y * \cos a$  .

The listing shows how these elements can be combined into a short program. This is written in BBC BASIC, but since it contains few obscure commands it could easily be converted into other versions of BASIC, or another language. It is a convenient start point for experimenting with, and can be used for any radially symmetrical forms.

### 3. COCCOLITH DRAWING PROGRAM

Circular coccoliths can be drawn in a similar way to discoasters, but elliptical coccoliths have a greatly reduced symmetry and a more specialised program is needed. For this a set of assumptions, or model, of coccolith geometry is needed. I used the following assumptions; their justification, and implications, are discussed in detail elsewhere (YOUNG 1987, and in prep.).

1. All rays are similar in size and shape - although to compensate for the ellipticity they overlap, or grow sideways, to differing extents. This is based mainly on observations of electron micrographs of coccoliths, in particular rim width, and so element length can be shown to be constant.

2. The rays grow from an initial ellipse, or proto-coccolith ring, near the inner margin of the coccolith rim. This is based on the sequence of coccolith development documented in studies of coccolithogenesis.

3. The rays are evenly spaced around this initial ellipse.

4. The rays radiate from this initial ellipse at a constant angle, to the local tangent to the ellipse.

The last two assumptions, and the use of a true ellipse for the proto-coccolith ring, are convenient assumptions based on examination of electron micrographs, but are not rigorously proven.

Converting these into a program involved a straightforward, but rather complex, development of the approach used in the discoaster drawing program. I defined the shape of individual rays in the same way as for the discoasters. In addition the ellipticity and radius of the proto-coccolith ring, the ray spacing, ray angle, and ray scale, need to be specified for each drawing. One of the advantages of the technique is that each of these parameters can be altered independently; and so the relationship between them and the final coccolith form can be explored.

Additional routines were needed to determine, the origin positions, and angles, of each ray (using Assumptions 2-4). Also, to compensate for the overlap of rays, further routines were necessary; in order not to draw the portions of rays covered by adjacent rays (ie to vary the width of the rays). This was done by testing each pixel between the start and end positions of relevant lines, until the edge of the preceding ray was found.

This position was then taken as the end of the line.

This program is too long to list conveniently, and would require considerable modification to convert from BBC BASIC. An experienced programmer should, however, be able to write a similar program reasonably easily from, the assumptions above.

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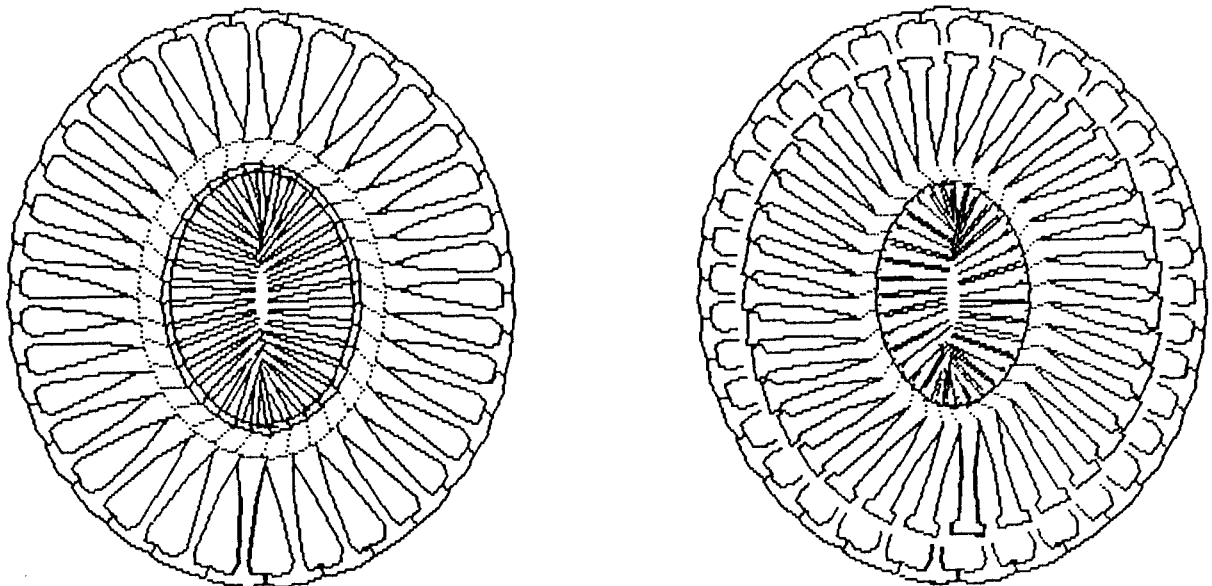
## DISCOASTER DRAWING PROGRAM: LINE NOTES

(See listing on next page)

### 10-40. PRELIMINARIES

20. Asks if print out is wanted. If so diagram needs to be stretched slightly to compensate for the distortion produced by the printer.
- 30,40. Clears the screen; sets graphics mode; sets up array *co-ords* for *DATA*; and draws border.
- 60-210. **MAIN PROGRAM LOOP**, repeated for each of the three sub-diagrams (distal, proximal and side views).
70. **READ** from *DATA*: the origin (*OXI*, *OYI*); *scale*; orientation (*ang*); number of rays (*RZ*); and name (*name\$*), of sub-diagram. Set graphics origin for sub-diagram.
- 80-190. Sub-loop drawing each feature of sub-diagram, (e.g. ray outlines, or central boss).
90. **READ** from *DATA* the number of steps (*SZ*), and **PLOT** mode (*KZ*), of feature.
- 100-120. **READ** co-ordinates of each step from *DATA* into array (*co-ords*). N.B. *control\$* is primarily a separator in the data statements (usually  $\epsilon$ ).
- 130-180. Plotting loop, repeated for each ray; *a* is the angle of the ray.
140. Move (**PLOT** mode 4) to beginning of feature.
150. Draw first half-ray of feature.
- 170-180. Draw second half-ray of feature (omitted for asymmetrical ray features).
230. Print screen, if required.
- 250-270. Procedure *PROCdr*: Called from the program, for drawing from current point to the next. The co-ordinates of the new point are calculated for the current ray angle (*a*), from the co-ordinates for the equivalent point on the first ray (*p,q*). This uses the general equation for rotation of cartesian co-ordinates. A line is then drawn from the current point to the new point, in **PLOT** mode *KZ* (53 dotted line, 5 solid line, 4 no line).
- 290-390. **DATA**
290. Basic **DATA** for first sub-diagram (**READ** by line 70).
300. **DATA** for first feature of sub-diagram (**READ** by lines 90 and 110). The first two figures are the number of points (*SZ*) and the **PLOT** mode (*KZ*). Subsequent numbers are the x and y co-ordinates of each point, separated by the filler *control\$*. *control\$* is also used to note what each data set draws, and to indicate the end of sub-diagrams (*STOP*), and of the entire diagram (*END*).

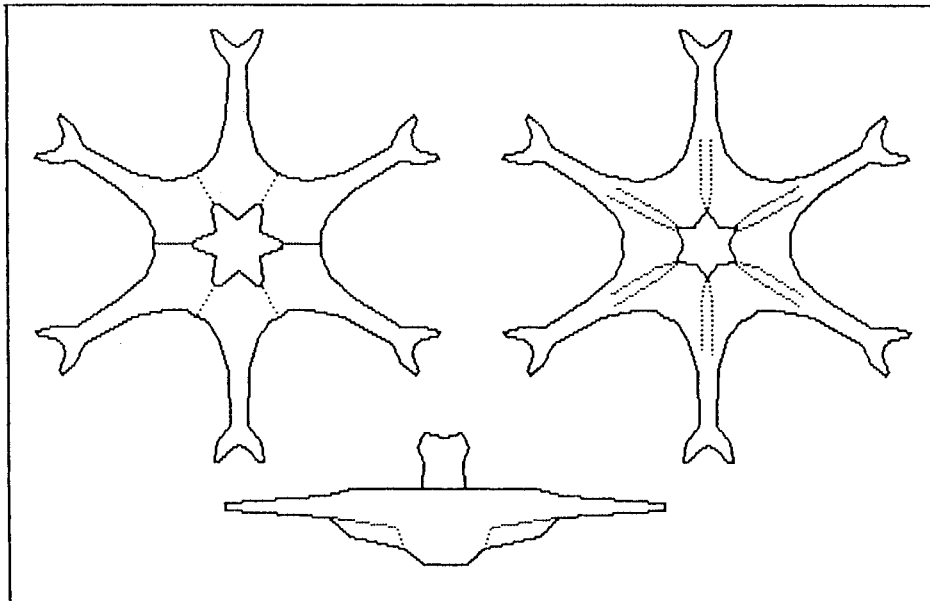
## EXAMPLE FROM COCCOLITH PROGRAM



```

10 REM DISCOASTER DRAWING PROGRAM
20 INPUT print$: IF print$="Y" THEN dist=1.193 ELSE dist=1
30 MODE128: DIMco_ords(25,2)
40 PLOTS,5,5: PLOT5,5,1010: PLOT5,1274,1010: PLOT5,1274,5: PLOT5,5,5
50 :
60 REPEAT
70 READ DXZ,OYZ,scale,ang,RZ,name$: VDU29,DXZ,OYZ;
80 REPEAT
90 READ SZ,KZ
100 FOR step = 1 TO SZ
110 READ co_ords(step,1), co_ords(step,2), control$
120 NEXT step
130 FOR a=2*PI/RZ+RAD(ang) TO 2*PI+RAD(ang) STEP 2*PI/RZ
140 N=KZ: KZ=4: PROCdraw(co_ords(1,1),co_ords(1,2)): KZ=N:
150 FOR TX=1 TO SZ: PROCdraw(co_ords(TX,1),co_ords(TX,2)): NEXT TX
160 IF control$="ASYM" GOTO190
170 N=KZ: KZ=4: PROCdraw(-co_ords(SZ,1),co_ords(SZ,2)):KZ=N
180 FOR TX=SZ TO 1 STEP -1: PROCdraw(-co_ords(TX,1),co_ords(TX,2)): NEXT TX
190 NEXT a
200 UNTIL control$="STOP" OR control$="END"
210 UNTIL control$="END"
220 :
230 VDU26: IF print$="Y" THEN *RUN SCREENDUMP
240 END
250 DEFPROCdraw(p,q)
260 PLOT KZ, scale*(p*-COSa+q*SINa), scale*dist*(p*SINa+q*COsa)
270 ENDPROC
280 REM Date to draw Discoaster bollii
290 DATA 600,50,2.5,0,1, SIDE VIEW
300 DATA 5,5,12,50,distal boss,11,64,£,14,72,£,10,80,£,0,78,£
310 DATA 3,53,63,33,prox ridges,26,28,£,22,16,£
320 DATA 10,5,0,50,main rays,50,50,£,65,45,£,120,42,£,120,38,£,63,33,£,52,23,£,22,16,£,12,7,£,0,7,STOP
330 DATA 960,600,2.5,0,6, PROXIMAL VIEW
340 DATA 2,5,6,11,prox boss,0,19,£,3,53,1,19,£,3,30,£,3,60,£
350 DATA 10,5,23,40,body,17,43,£,11,52,£,6,70,£,5,100,£,12,110,£,14,120,£,11,120,£,5,113,£,0,111,STOP
360 DATA 320,600,2.5,0,6, DISTAL VIEW
370 DATA3,5,13,22,distal boss,10,22,£,0,14,£
380 DATA 2,53,23,40,sutures,13,22,ASYM
390 DATA 10,5,23,40,body,17,43,£,11,52,£,6,70,£,5,100,£,12,110,£,14,120,£,11,120,£,5,113,£,0,111,END

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