JAHRBUCH DER GEOLOGISCHEN BUNDESANSTALT

SONDERBAND 19

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UNESCO

REFRESHER COLLOQUIUM 1971 IN THE FIELDS OF STRATIGRAPHY AND MICROPALAEONTOLOGY

Final Report

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EIGENTÜMER, HERAUSGEBER UND VERLEGER: GEOLOGISCHE BUNDESANSTALT

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Content

Part One: Progress of the Colloquium

1.1. Summary

The Refresher Colloquium was carried out on the basis of the contract Unesco/SC/2363/70, BOC Ref. 20877 dd. 10th Feb. 1971.

The intergovernmental cooperation bases on the Government Agreement between Austria and Czechoslovakia dd. Jan. 23rd 1960, and on a similar Agreement between Austria and Hungary dd. Jan. 15th 1968.

The Geological Survey Organisations of the states mentioned, cooperating with the respective University sections were responsible for carrying out the programme.

The Refresher Colloquium is based on a recommendation of the Prague-meeting of the directors of Unesco-sponsored Post Graduate Courses, April 1968, which considered it advisable, to give former course participants the opportunity, to meet again in Europe for a discussion of trends and developments in their various fields at home and abroad.

The Refresher Colloquium consisted of lectures, discussions, labwork and excursions and also of contributions (lectures) of the participants.

It took place:

in Austria from Sept. 13th to Oct. 1st and from Oct. 21th to Oct. 28th;
in Hungary from Oct. 2nd to Oct. 9th;
in Czechoslovakia from Oct. 9th to Oct. 20th;

21 candidates applied for admission;

17 candidates were selected on May 17th 1971;

3 candidates were selected as alternates;

due to some last-minute withdrawals the final number of participants was 12.

The respective home countries of the participants were Egypt (1), India (4), Indonesia (1), Iran (1), Iraq (1), Pakistan (1), Syria (1), Turkey (1), Colombia (1).

The participants, so far as they did return after their previous course term to their home country, were offered a one-way return ticket Vienna-home country, which was sponsored by an Unesco contribution.

An overall analysis of the programme is summarized by the following:

Layout of programme

Lectures held in:	Austria	Hungary	Czechoslovakia
general themes	7	2	1
specialized themes	6	9	12
Excursion days			
general topics	5	2	1
specialized topics	6	2	4

Specification of lectures	Austria	Hungary	Czechoslovakia
general	6	1	1
megafossils	1		
ostracods	1		
conodonts	2		
bryozoa		1	
larger foram.		1	1
foraminifera	1	3	5
nannofossils	1		2
palynology	1	4	4
diatomology		1	1

Lectures contributed by participants			
general themes	1	1	2
regional themes	11	2	2

The participants were unanimous, in strongly recommending

a) that a similar Refresher Colloquium should be organized again after a 4 years term;

b) that for future colloquia funds should be made available, so that the full tickets home country — Europe — home country could be sponsored.

Although the results of a programme and the meaning of lectures and excursions cannot be documented by the amount of the presentations submitted, we venture to summarize here as the main impression of participants and organizers, that during the 6 weeks programme of the Refresher Colloquium 1971 a compact scientific review was presented by the scientists of the cooperating countries, which was unanimously appreciated by all participants.

The "experiment" of the colloquium, and as such it should be evaluated, is to be considered as a fruitful and recommendable one.

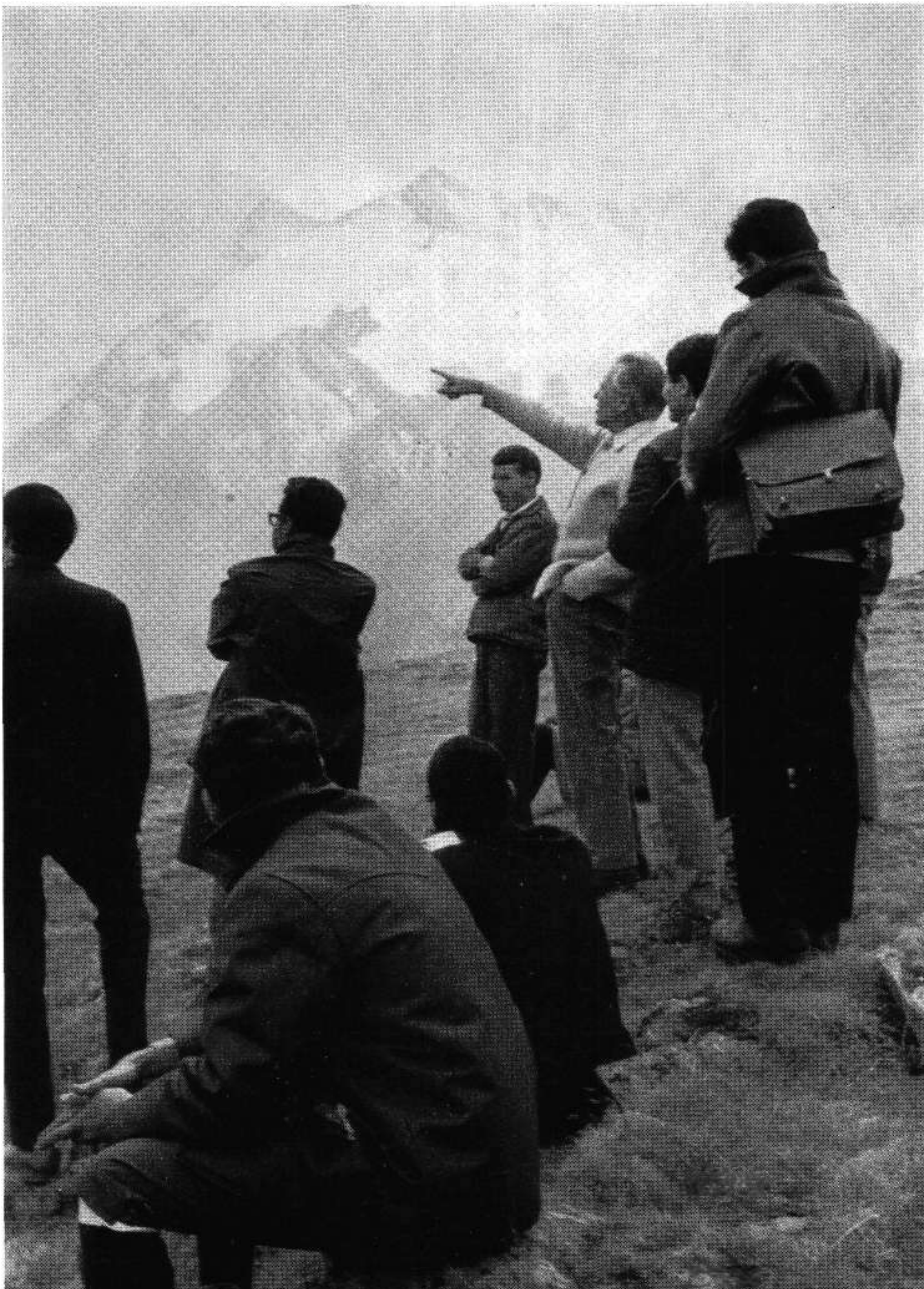
For comments on some worldwide aspects of our course work we might refer to the contribution on page 132 of this report.

Note

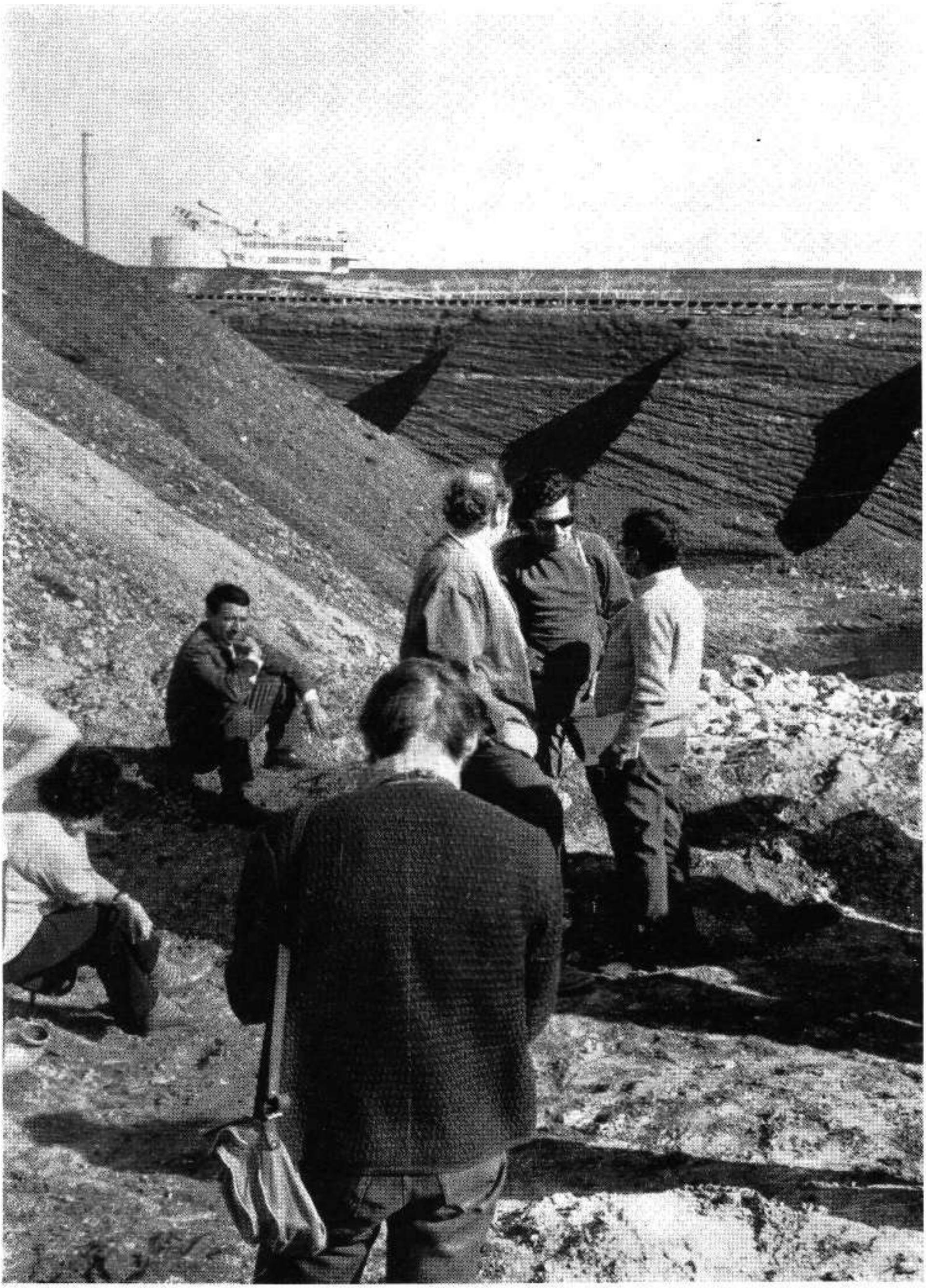
the organisation of the colloquium was in the hands of the following scientists:

M. Hajós, Budapest
E. Hanzlíková, Praha
H. Küpper, Vienna
E. Nagy, Budapest
M. Schmid, Vienna
M. Vanová, Bratislava

Vienna, May 1972
H. Küpper



Austria: Excursion Sept. 24th, Obergurgl.
Explanation of glacier studies.



Hungary: Excursion Oct. 8th.
Lignite mining, Visonta.

Czechoslovakia: Praha, lectures.

1.2. Review of Recommendations

The participants of the colloquium on many occasions discussed their views and opinions as to the value of the venture with respect to a continuation and its development in the future; organizers and staff were joining this exchange of ideas. The following is a short review of the main suggestions discussed; we have mentioned first the ideas submitted, comments as to the feasibility from the side of the organizers were added, where necessary.

a) The basic, unanimous recommendation was, that a similar colloquium should be organized after a four years term. For the organizers too, the meeting was a stimulating experience. The total amount of work and costs invested into the preparation and preformance of such a "multilateral" venture however should certainly not be underestimated. The fact that the colloquium was organized on the basis of a cooperation between Austria, Czechoslovakia and Hungary contributed essentially towards the scientific and personal spirit of the meeting; for geoscientists it is of paramount importance, to gather experiences outside ones own normal daily working sphere. The "transplantation" of this multilateral concept to other centers inside or outside Europa might be possible, provided that a certain variety of cooperating institutions can provide a diversity of problems and approaches.

b) The second basic recommendation, viz. that of the availability of funds for full return travelling costs and also for covering the costs of the colloquium inside the participating countries, is certainly not the question of geoscience-goodwill alone. It is hoped that a multidisciplinary approach within the geosciences on a multilateral working basis might be considered as attractive in the future by sponsoring governmental and inter-governmental organisations.

c 1) Although for some participating members it might have been not too easy, to obtain leave from teaching or laboratory obligations, many recommended an extension of the duration up to about two months, in order to include the possibility for full determination- or labwork, during which special "problem"-samples on a joint basis could be investigated and discussed.

c 2) Some members suggested to receive the detailed programme of lectures and excursions well ahead of the meeting in their homecountry for a still more detailed preparation. It was pointed out, that a multilateral venture could be better preformed on a more flexible basis, which provides the framework of the programme well ahead, but leaves details open for local, last-minute decisions.

c 3) Funds for publication of scientific contributions should be made available from the outset, was another suggestion. Agreeing that it might be rather difficult in some countries, to get scientific contributions printed within reasonable time, the other side of the problem is, that funds can be mostly obtained for such subjects only, which are beyond local interest and of lasting working value.

c 4) Some colleagues suggested, that also internationally known specialists ("star specialists") should be invited to lecture at the colloquium. Apart from the fact, that this might involve financial implications, it was emphasized as basic idea of our meeting, to provide an actual impression of the scientific capacity and standing of organisations, which are engaged in problems, coming up during the normal handling of Geological-Survey — and University Institute-problems; of course, one always can invest more and more in a given subject; the present overall working capacity of governmental and university institutions in a group of central-european countries was for all organizers a reality, they were proud to demonstrate.

c 5) That the timing of the colloquium should consider the full European summer season, or even the date coincidence/closeness with/of international geoscience events/congresses, were other suggestions; their soundness admitted, we had to point out, that it was rather difficult anyhow, to find in Europa a suitable date for a scientific venture, involving the presence of a group of scientists, due to the fact, that the timetable of science institutions in Europa is mostly booked out years ahead.

1.3. Working Programme (abbreviated)

Sept. 13th 1971	Arrival of participants in V i e n n a
Sept. 14th/16th	Lectures
Sept. 17th	Excursion Flysch outcrops
Sept. 18th	Excursion area E of Vienna
Sept. 20th	Excursion Vienna—Gmunden Topic: oilsituation alpine foreland
Sept. 21th	Excursion Gmunden—Salzburg Topic: field palynology
Sept. 22nd	Excursion Salzburg—Innsbruck Topic: hydropower dam-site
Sept. 23rd	Lectures
Sept. 24th	Excursion Obergurgl—Rotmoosferner Topic: modern glacier investigations
Sept. 25th	Excursion surroundings Innsbruck Topic: alpine road construction, quaternary
Sept. 26th	Excursion Innsbruck—Lienz Topic: pipeline crossing of the alps
Sept. 27th	Excursion Lienz—Villach Topic: pipeline pumping station and exposures lower carboniferous
Sept. 28th	Returntrip Villach—Vienna
Sept. 29th/Oct. 1st	Lectures and lab work
Oct. 2nd	Travel Vienna—B u d a p e s t, visit Györ
Oct. 3rd	Sightseeing Budapest
Oct. 4th/6th	Lectures
Oct. 7th	Excursion Sümegh—Tihany Topic: mesozoic stratigraphy
Oct. 8th	Excursion Gödöllö—Eger Topic: young tertiary problems
Oct. 9th	Excursion Budapest—CSSR frontier Topic: old tertiary problems

Note: For the excursions in Hungary a printed guidebook was handed out to the participants.

Oct. 10th	Travel to P r a h a with geological explanations
Oct. 11th/13th	Lectures
Oct. 14th	Excursion cretaceous N of Praha
Oct. 15th	Lectures and visits of institutes
Oct. 16th	Travel Praha—B r a t i s l a v a
Oct. 17th/18th	Excursions Carpathians in Slovakia
Oct. 19th	Lectures Bratislava
Oct. 20th	Travel Bratislava—V i e n n a

Oct. 21th/25th	Lectures
Oct. 27th	Visit metro construction office
	Reception Department of Science and Research
	Farewell meeting
Oct. 28th/30th	Participants departure
	End of colloquium

1.4. Scientific Presentations

These are subdivided into three groups; the first covers those, held in Austria, the second, those held in Hungary and the last one those, given in Czechoslovakia, Prague and Bratislava. The presentations given by the participants of the colloquium are added to the first group; the arrangement in the groups is alphabetical; see also index.

1.4.a. Presentations given in Austria*)

Prof. Dr. H. Hoinkes, University Innsbruck

Modern glaciology and world water reserves

(theme of lecture and excursion)

Prof. Dr. W. Klaus, University Vienna

Review of Palynology

(A b s t r a c t)

Earth Science and Biology received a considerable amount of contributions by palynologists within the last few years. A number of modern developments should be mentioned, with emphasis to those subjects, which may be of interest and possibly also of practical value to geologists of various specializations. These include pollen preservation, the use of accumulation — rate diagrams as opposed to the classical pollen-percentage diagrams, the application of fluorescence-, cathodoluminescence-, interference-phasecontrast and stereoscan-electronic microscopy. Marine palynology and its various prospects for stratigraphy, sedimentology and environmental geology received close attention. Some trends in pre-quaternary palynology include new attempts at a palyno-stratigraphy of Triassic, Cretaceous and Neogene, the many applications of palynological studies of saltdeposits, the growing importance to oil geology with basic contributions to palaeogeography, palaeoclimatology and palaeoecology and a computerbased numerical coding system for the description of pollen-grains and spores. Palynological data about the origin of the gymnosperms, chlamydosperms and angiosperms are considerable increasing. The annual output of scientific publications on palynological subjects reached 1400 in 1965 and reaches about 2000 in 1970.

Numerous important events, which incorporated palynological subjects or were especially devoted to palynology, occured during the last few years: the Gondwana Symposium in Argentina and South Africa, 3rd Int. Salt Symposium in Ohio (USA), First Int. Symposium on Sporopollen in

*) Geologische Bundesanstalt, A-1031 Wien, Rasumofskygasse 23.

London 1970 and the 3rd Int. Palynological Conference in Novosibirsk 1971; special attention will be given to the Silver Jubilee Paleobotanical Conference Dec. 1971 at the Birbal Sahni Institute of Paleobotany in Lucknow (India). A number of important books and periodicals have been issued during the last few years; e. g.

ERDTMAN, G. (1969): Handbook of Palynology. Munksgaard, Kopenhagen.

KEDVES, M. (1969): Palynological studies on Hungarian Early Tertiary Deposit. Budapest 1969. Akad. Kaido.

KRUTZSCH, W. (1970): Atlas der mittel- und jungtertiären dispersen Sporen und Pollen sowie der Mikroplanktonformen des nördlichen Mitteleuropas. 7 Lieferungen. VEB Gustav Fischer Verlag, Jena, DDR.

MANTEN, A. A (1966): Marine Palynology. Special Issue of Marine Geology, Vol. 4, N. 6. Elsevier Publishing Co. Amsterdam.

NAIR, P. K. K. (1966): Essentials of Palynology. Asia Publishing House, Lucknow.

POKROVSKOYA, I. M. (1966): Palaeopalynologia. 3 Volumes. Leningrad (Russian).

TSCHUDY, R. H., & SCOTT, R. A. (1969): Aspects of Palynology. Wiley-Interscience, New York-London-Sydney.

Dr. K. KOLLMANN, Direktor, RAG, Vienna

New Information on the Microstructure of Ostracods as obtained by means of the Scanning Electron Microscope

(Abstract)

The study of bodily preserved microorganisms or their skeletal elements in the reflected light has its limits, where a simple light microscope is used, in that the depth of field as required for a three-dimensional view can be achieved only through reduction of the lens aperture at the expense of resolution. The many times greater resolution of the scanning electron microscope permits of reaching into optical ranges, which are beyond the capacity of even the best light microscopes.

The scanning electron microscope lately brought about remarkable successes in the study of recent and fossil ostracods. It turned out i. a., that the features of the pore canal openings show much more variety than had been assumed only a few years ago. Moreover, there was deepened and supplemented also our so far but sketchy information on the surface ornamentation of the shells, of the hingement, and of the central muscle scar pattern on the interior of the shells.

As most of these features are also of special systematic significance, more and more information on the microstructure will furnish also many new vistas as regards phylogenetic relations, above all between those ostracod groups, whose direct relationship with recent representatives has not yet been clarified. In spite of the numerous advantages of the scanning electron microscope, however, both the binocular and the monocular light microscope will keep their place in research work and, chiefly, in routine analyses.

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HAY, W. W., & SANDBERG, P. A. (1967): The scanning electron microscope, a major breakthrough for micropaleontology. — Micropaleontology, vol. 13, no. 44, pp. 407—418, pls. 1—2, New York.

PLUSQUELLEC, P. L., & SANDBERG, P. A. (1969): Some genera of the ostracode subfamily Campylocytherinae. — Jour. Pal. vol. 15, no. 44, pp. 427—480, pls. 1—10.

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SANDBERG, P. A. (1968): A new specimen stub for stereophotography with the scanning electron microscope. — Micropaleontology, vol. 14, no. 44, pp. 489—498, pl. 1, New York.

SANDBERG, P. A., & PLUSQUELLEC, P. L. (1969): Structure and polymorphism of normal pores in cytheracean Ostracoda (Crustacea). — Jour. Pal. vol. 43, no. 2, pp. 517—521.

Dr. H. A. KOLLMANN, Museum of Nat. History, Vienna

Austria's contribution to Micropaleontology

As "Nautilids" FICHTEL & MOLL described fossil and modern foraminifera in "Testacea microscopica". This paper, published 1803 at Vienna, was one of the first on this group of animals. The types of FICHTEL & MOLL could be traced again some years ago at the Wiener Naturhistorisches Museum; first examination showed, that the effect of these old types on foraminiferal nomenclature, strictly using the old names, would certainly involve difficulties.

Nevertheless the great french paleontologist A. D'ORBIGNY thought FICHTEL & MOLL's paper to be the first scientific treatise on foraminifera. 1846 D'ORBIGNY who first recognized the independence of forams from "Nautilus", described 228 species from the Vienna Basin. This Material was sent to him by FR. V. HAUER who very ealy recognized the importance of foraminifera.

After D'ORBIGNY many papers on Foraminifera were published. Outstanding is the work of A. E. REUSS, who was originally medical doctor in the Bohemian Bilin and 1849 came to Vienna. Besides his work on mollusca, bryozoa and corals he published a large number of papers on foraminifera and ostracodes; his material still exists, but would need a revision.

Besides the work of REUSS a great number of special papers on foraminifera was published at Vienna in the second half of 19th century. One of the outstanding scientific events was the Novaraexpedition (1857 to 1859). STACHE (1864) and KARRER (1864) worked also on foraminifera.

A new epoch of problem-oriented micropaleontological investigation began after World War II. Stratigraphic and phylogenetic work has been done in all fields of micropaleontology.

Reference:

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Prof. Dr. H. Küpper

Outline of the world Petroleum Situation as per 1970

part one: framework of world problems

1.1. raw materials, shift in demand pattern, winter-summer
shift in supply pattern, Africa, Near East
mining, shift to politically stable areas, Austrialia, Canada, Indonesia, Brasil.

1.2. agriculture

yield increase:	India	Pakistan
wheat	34%	7%
rice	40%	22%

Mexico wheat increase since 1944 6 ×
E. Borlaugh, Nobel price speech: world food crisis delayed for 30 years.

1.3. environment, world as finite environment, no outside resources

1.4. world population mid 1970 abt. 3,600 Millions
population as a whole will double within 35 years
developed countries will double within 70 years
developing countries will double within 30 years

part two: world petroleum situation

2.1. basic data

	population	oil consumption	oil production
Eurasia			
W Europe	9.9%	26.7%	0.7%
USSR/China	31.5	14.6	16.8
Near East	2.9	2.4	29.5
Mid/Far East	31.7	13.5	3.0
N America	6.3	35.2	25.8
M/S Amercia	7.9	5.8	11.5
Africa	9.8	1.8	12.7
Total	Mill. 3,630	Mill. 2,268	Mill. 2,333

The threefold discrepancy between population maximum and demand-maximum and production maximum is one of the essential features of the present world oil situation (in the above table the respective maxima are underlined).

2.2. major features in modern exploration
Cenozoic exploration
Far East, classical folding, miocene

Australia, fault traps, marginal basins, eocene — lower cretaceous
Adriatic sea, pliocene gliding
Mesozoic exploration
W Africa, continental slope, salt formation, lower cretaceous
Egypt, cratonic fault traps, lower cretaceous-lower tertiary
Andes foreland, classical folding-strat. traps, cretaceous
Palaeozoic exploration
North sea, cratonic undulations and tertiary basins
Alaska, deep seated foreland structures, devonian

2.3. USSR situation

developement of production
1946: oil 21.7 mill/T, gas 4 mrd m^3
1968: oil 300 mill/T, gas 198 mrd m^3
development of production regions
classical Baku, 1870/1920, 97% of total production
Tertiary/Mesozoic Structures, exploration continues
"second" Baku since 1930, west Ural-Volga region
1968 180 mill. T/y
carboniferous basins, all types of structures
biggest oil province, abt 500 fields
"third" Baku since 1965, western Sibiria
lower cretaceous to lower tertiary basin,
sedimentary thickness 2—7 km.
production 1970 30 Mill. T, estimate 1980 230 Mill. T
other major exploration-production provinces
Timan-Pechora, Palaeozoic, 33 fields in operation
Caspi-Taschkent, mesozoic gas province
Pre Caspi depression (N of lake Caspi)
deepest part of european platform, 15—19 km. sediment
salt structures
Baku-Turkmenistan, permian to pliocene structures
marine exploration

Prof. Dr. H. Küpper

Outline of the Sea Floor Geology as per 1970

part one: continental shelf and continental slope

1.1. marine geology, not oceanography
replacing old theories: permanence of oceans, C. Diener, 1890
continental drift, A. Wegener, 1920

1.2. general setting:
coastal plain

continental shelf
continental slope
• 200 m depth line accepted as
boundary at UN conference 1958
from continental shelf 17% of world oil production
6% of world gas production

1.3. examples of offshore successes:

o l d : Baku, Maracaibo, Louisiana, Persian gulf

m o d e r n : North Sea, Nigeria, Adriatic sea, Australia
New Sealand, Australasia

p a r t t w o : deep sea

2.1. historical-technical developement

until 1950 results from old time dredging
results from refraction profiles
"sediments under oceans must be thin"
1964/65 first drilling vessel after mohole failure
1967/71 Glomar Challenger, first cruise 11. 8. 68.
per 1. 12. 70. 230 holes at 144 sites
58,000 m. drilling
10,000 m. core recovery
deepest water 6140 m.
deepest penetration 985 m.
Gl. Ch. staff: 2 co-chiefs, 4 sedimentologists,
4 palaeontologists, 10 technicians plus crew
cores 6.25 cm. diam, 9 m. length

2.2. outline of features:

	ocean	continent
crust	basic, 6—8 km.	acidic, 35 km.
age	young, 155 mill. y (Jur. limst.)	old, 3.5 bill. y
lithology	thin sediment on basic rocks	complex, sediments, igneous, metamorphic rocks
structure	simple, mid ocean ridges abyssal plains	complex, geosynclines, shields platforms

2.3. mineral resources: unique province-ultra basic ore deposits

primary ore deposits mid ocean, indian ocean Cr, Pt, Ni, Co,
surficial deposits glauconite, manganese, phosphorite/placer
hydrothermal deposits rift zones, Fe, Mn, Sn, Pb, Co,

generally hostile for petroleum and salt formation
except in extension of continental conditions
f. i. Challenger Knoll, 3572 m. oil, gas, Gulf of Mexico

2.4. theoretical framework
central oceanic ridges — mid ocean belts
high temperature convection
earthquake zone on axis
tensional features
thin earth crust
lower density mantle material, peridotite → serpentinite
zones of magnetic orientation parallel to axis
outward spreading 1—10 cm./year
E. L. Gealy 1971/p. 5
"data gathered by the Joides Deep Sea Drilling Project strongly support the theory of crustal accretion along mid-ocean ridges and of lateral spreading of the seafloor away from the ridges. Sediments immediately above basalt basement are younger over the crest of the mid-ocean ridges and, with minor exceptions, are progressively older away from the ridges crests in both the Atlantic and Pacific Oceans."

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Doz. Dr. H. K. Mostler, University Innsbruck

Conodonts of the Triassic

Triassic conodonts were neglected for a long time mainly because the general opinion was that they could not be used for stratigraphic purposes. In 1958 R. Huckriede issued a monograph on the conodonts of the Triassic, discussing at the same time their stratigraphic value by means of a table of distribution and also pointing to their comparatively lesser value for stratigraphy. As a result the interest in Triassic conodonts slackened down.

Intensified research on Triassic sediments, however, beginning some 5 years ago, showed that an exact study of conodont faunes could well be used for a stratigraphic subdivision of the Triassic.

The Lower Triassic (Skythian) to start with, can be subdivided into 3—4 "zones" (Staesche, 1964). W. C. Sweet's attempted subdivision into 9 zones derived from the study of the Salt Range sediments cannot be supported by the author's own investigations (samples from the Himalaya). A subdivision of the Skythian into 4 zones remains acceptable.

The Lower Middle Triassic (Anisian) can be divided into 2 (MOSHER, 1970) and sometimes into 3 or 4 zones (BENDER, 1967); the Lower Anisian (Hydasp) and Higher Anisian (Illyr), however, can very well be subdivided. An exact delimitation of the Skythian — Anisian was not yet possible; this problem is at present being investigated by the author.

The delimitation of the Upper Anisian-Ladinian by conodonts imposes considerable difficulties. According to MOSHER, 1970, the boundary is defined by the extinction of *Neogondolella constricta* (CLARK). HIRSCH made the attempt to define the boundary quantitatively by means of faunal assemblages; though a clear delimitation of the Anisian-Ladinian is not possible at present. A subdivision of the Ladinian is not yet well founded; it seems, however, that a distinction of 2 zones may be possible.

The delimitation Ladinian-Karnian is clearly defined by the extinction of *Epigondolella mungoensis* (DIEBEL), Karnian itself can be subdivided into 3 zones.

The Norian can be divided into 3 zones (KRYSTYN, 1970). The subdivision is partly based on the appearance of simplified "platform-types" and partly on the appearance of new forms shortly before the complete extinction of the conodonts.

Conodonts die out with the end of the Norian; reports concerning the appearance of conodonts in the Rhaetian (MOSHER, 1970), in the Jurassic (NOHDA & SETOGUCHI, 1967) and in the Cretaceous (DIEBEL, 1956) are either the result of a misinterpretation of stratigraphy or the conodonts were redeposited into these particular series.

Note: A preliminary distribution chart of triassic conodonts was handed out during the lecture.

Dr. R. OBERHAUSER, Geol. Survey of Austria

Excursion to the Dobratsch-Range, West of Villach, Carinthia with comments on general alpine tectonics

The Dobratsch-Range belongs to that part of the Southern Calcareous Alps, which is situated just north of the important Alpine-Dinaric fault separating Alps and Dinarids. The Dobratsch still exhibits the facies of the Northern Calcareous Alps in spite of its tectonic position in the south. The peak of Dobratsch consists of limestones of the Middle-to Upper Triassic transitional beds, rich in corals, calcareous sponges such as *sphinctozoae*, *hydrozoae*, calcareous algae and abundant problematic organic remains. Megafossils are rare, only gastropods, especially *Chemnitzia rostborni* HOERNES, are more common. Some finds of cephalopods, namely nautilids, and lamellibranchs (especially pectinids) have been recorded. Foraminifera are very rare, and they are not diagnostic for age determination. The top of the Dobratsch mountain is the type-locality for a problematic, small tubular fossil: *Lamelitubus cauticus* OTT, and for the thalamid sponge *Vesicocaulis carinthiacus* OTT. Fauna and flora of the Dobratsch is indicative of a reef facies. It was studied in thin slides by OLAF KRAUS and ERNST OTT in 1968. The authors described and photographed the following forms: *Tubiphytes obscurus* MASLOV, *Ladinella porata* OTT, *Lamellitubus cauticus* OTT, *Uvanella irregularis* OTT, *Dictyocoelia manon* (MÜNSTER) and *Vesicocaulis carinthiacus* OTT. The fossil list also includes: *Coelospongia catenulata* OTT, *Girtyocoelia oenipontana* OTT, *Vesiocaulis* aff. *depressus* OTT, *Holocoelia toulai* STEINMANN and big Codiaceae as *Mitcheldeania*.

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Prof. Dr. A. PAPP, University Vienna

Global Stratigraphy of the Tertiary

During the last ten years Tertiary stratigraphy has been more and more based upon evolution of planktonic organisms. At present subdivision of the Tertiary rests mainly upon planktonic foraminifera and nannoplancton.

The boundary between the Cretaceous and the Tertiary is characterized by disappearance of Globotruncanas and existence of a „Globigerina-horizon" with *Gl. djaubergensis*, which can be recognized worldwide. Evolution of planktonic foraminifera gives good possibilities for zonation of the Paleocene and Eocene. Besides planktonic forms, larger foraminifera (Nummulites, Assilina, Alveolina a. o.) give evolutionary sequences, which permit zonation of the calcareous marginal facies.

Especially the evolutionary peak in the Middle Eocene offers good possibilities for wide ranging correlations. During the Oligocene evolution of planktonic foraminifera is not characteristic. At the boundary between the Oligocene and Miocene evolution of the genus Globigerinoides begins — which date is often used as definition of the boundary mentioned.

Evolution of Lepidocyclines and Miogypsina gives valuable zone fossils for division of the calcareous marginal facies during the Lower Miocene.

Very important for far reaching correlations during the Miocene is the evolutionary sequence from *Globigerinoides bisphericus* to *Praeorbulina* and further *Orbulina suturalis.* In the tropical regions evolution of *Globigerinatella insueta* and the group of *Globorotalia fohsi* is important.

The Miocene-Pliocene boundary cannot be defined exactly on a worldwide base, since climatic differentiation is already strongly pronounced.

The boundary Tertiary/Quaternary (Pliocene-Pleistocene) is characterized by deterioration of climate and its influence on the fauna and flora over extensive areas in the northern as well as the southern hemisphere.

Doz. Dr. W. RESCH, University Innsbruck

The Pleistocene of the Inn valley/Tyrol

(A b s t r a c t)

Pleistocene deposits and the morphological characteristics of the Inn valley in the Tyrol have gained great importance on the stratigraphy of the Quaternary and the paleogeography of the entire Alpine region as well. Four different main glaciations can be traced in the foreland of the Alps, according to their moraine deposits and fluvioglacial gravel beds (ranging from GÜNZ as the oldest over MINDEL and RISS to WÜRM as the youngest member). In the surroundings of Innsbruck the most complete series of Pleistocene sediments in the inner Alpine region are to be found. This area shows three different ground-moraine deposits of separate glaciations and two fossiliferous beds in interglacial and interstadial sediments.

The "Hötting Breccia" located on the slopes and along the foothills of the "Nordkette" North of Innsbruck was deposited in a comparatively warm interglacial period. In the "Geologenstollen" the underlying ground moraine of the Mindel glaciation (classified by some authors as Riss) can well be made out. The breccia contains frequent plant fossils such as imprints of needles of Pinus silvestris and leaf imprints of Rhododendron ponticum found in some outcrops. The "Conglomerate of Ampaß", which is underlain also by ground moraine deposits, is most probably of the same age.

Both breccia and conglomerate are overlain by younger ground moraine sediments and again above these the so-called "terrace sediments" are following, made up by warved clays and silts near the bottom of the sequence and coarse gravel at its top. In a clay pit situated E of Innsbruck (loc. Baumkirchen) pollen grains, wood belonging to different plants and fish remains were found in fine grained sediments. Radiocarbon dates of the (subfossil) wood gave the result of 26,800 and 31,000 before present. The above clays, silts and gravel beds again are superposed by ground moraine deposits which are related to the latest stade of the Würm glaciation due to the fact, that these are showing the formation of recent soil.

Cloncluding from the finding of erratics, the height of glaciation of the Inn valley glacier system in the vicinity of Innsbruck (574 m. a. s. l. = 1,780 ft.) reached as high as 2,400 m. a. s. l. (= 7,440 ft. a. s. l.).

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Dr. M. E. SCHMID, Geol. Survey of Austria

Evolutionary trends in the foraminiferal genus Uvigerina in the Badenian of the Vienna basin

(Abstract)

The zonation of the Badenian was proved by means of the evolution of the benthonic foraminiferal genus Uvigerina and several guideforms were described already in 1953 (PAPP & TURNOVSKY, Jb. Geol. B.-A., *96*). Unfortunately, these guide-fossils sometimes are lacking while other species, occuring throughout the Badenian beds, normally are present in a sufficient number of specimens.

Due to this fact a method was developed recently, demonstrating the evolution of Uvigerina by means of metrical methods (PAPP & SCHMID, Verh. Geol. B.-A., 1971/1). In this study it is shown, that sculptural features may be neglected and the number of specimen restricted too, thus having the possibility to use this method for samples from wells with an often limited material. The features taken into consideration are: the number of chambers and the length of the tests. An average index-number, representative of the degree of evolution, was determined arithmetically for several surface outcrops representing the type-localities of the Badenian zonation. The increase of the indices from the oldest to the younger beds of the Badenian (14.0 to 64.8) was checked and confirmed by the study of well-samples in superposition too. As the main result it is pointed out, that we are able to evaluate the stratigraphic position of Uvigerina bearing beds from the Badenian of the Vienna basin merely by determination of the index-numbers of the Uvigerina populations.

Dr. W. SCHNABEL, Geol. Survey of Austria

Flysch-Problems

(A b s t r a c t)

The expression "Flysch" was first used by STUDER (1827) in the Simmen-Valley of Switzerland, it characterizes rocksequences of sandy-silty nature, which incline to slide when wheathering and usually form soft regions.

Now, 1970, after 10 years of world-wide and intensive discussion no final d e f i n i t i o n o f "F l y s c h" can be given. Flysch-deposits are characterised by grade-bedded series of psammitic — pelitic detritus (turbidites!), which are usually found as remarkable sequences, as for instance the Flysch formations of the East-alpine and Carpathian "Flysch-zone". Due to this thick formation, which inevitably presupposes sedimentation in sinking or deep basins, a certain relation to tectonical events is given. On these criteria petrographers base their definition of Flysch as WIESENEDER (1962), who regards Flysch as a "certain lithofazies independent of any particular period, which has been formed in geosynclinals at any time".

SEILACHER (1958) goes even further when he includes the small amount of mega-fossils and large quantity of trace-fossils and primitive foraminifera in his definition. According to his definition, Flysch has to have a special L i t h o f a c i e s (graded bedding ...), B i o f a c i e s (trace-fossils, no mega-fossils ...) and T e c t o f a c i e s (great thickness originating in lateral basins of geosyncline before or during the first foldings and tectonical movements of the orogen). Frequent association of these given tectonical, sedimentological and biological features at various points of the earth history demonstrates the significance of the flysch concept. Examples intermediate to other facies types are relatively rare and differ from true flysch in either one (tectonically, sedimentologically or biologically aberrant flysch) or two (flysch-like formations) of the three aspects (SEILACHER, 1967).

The clearest answer to the question of the g e n e s i s o f F l y s c h - d e p o s i t s is given by KUENEN & CAROZZI (1953) in their theory of t u r b i d i t y c u r r e n t s. Material, deposited in adjacent areas slides down as a suspension into the deeper sea, where the suspended material settles down according to grain-size and weight, causing graded bedding. If there was not enough energy to transport the whole material in a suspended condition, F l u x o t u r b i d i t e s are formed (partly sliding movement causing incomplete gradation, DJULYNSKI et al., 1959).

The turbidity current forms current-marks into the clay on the bottom, which reveals the transport direction. In the case of the creation of the alpine flysch-zone the direction of material-transport has changed a few times, which for instance was observed by HESSE (1965) for the Bavarian flysch. Besides the organic traces, anorganic s t r u c t u r e s (ripple-marks ...) where present in the clay-sediment on the sea floor, which

can be partly conserved by the following turbidite. The replicas of all structures on the bottom of a layer can be called basic-marks (current marks, ripple marks, organic traces, load casts ...) and must not be confused with internal-structures, which occur within a bed and are caused by different density gradient, slumpings ect. The most common phenomenon of the internal structures is the convolute bedding (POTTER & PETTIJOHN, 1963). In polish carpathian flysch SUJKOWSKI (1957) pointed out that on an average every 4000 years a turbidity current must have occured. In the Flysch of the Vienna-woods it was found, that a turbidity current extinguishes the bottom fauna and after that, the new formed floor is reinhabited, beginning with primitive agglutinated foraminifera to more and more specialised forms (GRÜN et al., 1964).

Flysch-formations are found in the alpine geosynclinal as well as in the variscian and older sequences. The flysch-zone of the eastern alps and the carpathians is very typical and well investigated (see references).

Many regions today have sedimentation with mechanism of turbidity currents (Gulf of California ...), their sediments can be compared with "fossil" flysches. (v. RAD, 1968). In the Adriatic sea we know four holocene turbidites (VAN STRAATEN, 1970).

From recent observations we know that turbidity currents occur with such great intensity and violence, that deep-sea cables are cut. The investigation of Flysch sediments, Flysch basins and their origin is thus of immediate economic interest (KRAUSE et al.).

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Dr. H. P. SCHÖNLAUB, Geol. Survey of Austria

Palaeozoic Conodonts

(Review)

Conodonts are widespread in Palaeozoic sequences. They are the isolated remains of free-swimming pelagic as well as benthonic or even near-shoreliving animals. However, in a recently published paper G. SEDDON & W. SWEET suggested a modified ecologic model for conodonts as small planctonic animals, different species of which were segregated by depth stratification. As the investigations of the last 20 years have shown, these microfossils are due to their rapid evolution very valuable for dating and mapping the beds, in which they locally occur in great numbers.

Conodonts range in size of less than 1 mm up to 5 mm. They are composed of calcium phosphate and can therefore be obtained from limestones through solution of the latter in acetic acid, whereas they will dissolve in other acids, for example hydrochloric acid. They also may be observed on bedding planes of shales or cherts, where they are preserved as moulds or fragments. They may be easily recognized with help of a magnifying glass and sometimes even be determined in the field.

With regard to the morphology of conodonts three principal types can be distinguished: simple, compound (blade-like) and platform conodonts. Simple conodonts are the oldest ones and occur in the upper part of the Middle Cambrian for the first time. They are widespread throughout the Palaeozoic with a great variability. Compound conodonts can be genetically derived from simple ones. They are characterized by lateral processes or denticles in addition to the main cusp of the simple conodonts. Their first occurence is in the very early Ordovician. In various stages they are of great stratigraphic value. The platform types are generally derivable from compound conodonts, in which specific morphologic elements are widened and emphasized. Due to their rapid evolution these types are guide-fossils for parts of the Ordovician and younger systems. Especially in the Silurian and Devonian, as well as in the Carboniferous of North America and Europe conodont-zonations have been introduced on the base of the biozone concept. The worldwide validity of these zones has often been checked and partly revised by founds of megafossils in the meantime.

During the short review on Palaeozoic conodonts the techniques of conodont research will be studied and then an attempt will be made to determine some important genera of the Ordovician, Silurian, Devonian and Carboniferous by following LINDSTRÖM's key to the conodont-genera.

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Doz. Dr. F. STEININGER, University Vienna

Macro- and Micropalaeontology as a basis of a modern stratigraphy of the Tertiary

The historical subdivision of the Tertiary was based upon marine mollusc faunas and continental vertebrates. This stratigraphy by means of faunal associations is sufficient for subdivision into bigger units, it does not suffice, however, for modern conceptions of a detailed Tertiary Stratigraphy.

A modern biostratigraphic subdivision is based in the first place upon nannoplancton and evolutionary lines of planctonic foraminifera; these are regarded as biostratigraphic indicators of primary importance. They are, however, since climatic zones are already prominent in the Tertiary, restricted to tropical and subtropical regions of sedimentation.

In marginal regions only a few of those planctonic zones are well established. In order to be able to subdivide also intervals between those intercontinental planctonic biozones, local or regional evolutionary lines of various groups of macro- or microorganisms are used, most of them benthonic, in marine as well as in non-marine sediments.

The Central Paratethys is such a region of sedimentation, including marine, brackish, limnic, fluviatile and terrestric sediments. Subdivision of these neogene sediments serves as an example for the manyfold possibilities of modern detailed biostratigraphical analysis, based upon combination of micro- and macropalaeontology.

Dr. H. Stradner, Geol. Survey of Austria

Nannoplankton Stratigraphy

Plates and excerpts from recent papers dealing with the stratigraphic value and the zonation of nannofossils (coccoliths and discoasters, nannoconids etc.) were distributed and discussed during the lecture.

For more detailed information on the standard Calcareous Nannoplankton Zonation of the Tertiary and the Quaternary the paper by E. Martini in the Proceedings of the II. Planktonic Conference Roma 1970 is to be consulted.

At present papers on nannoplankton stratigraphy are in press by Thierstein (Switzerland) and Moshkovitz (Israel). Also see the Initial Reports of the DSDP (Glomar Challenger), especially the reports by the shipboard nannoplankton paleontologist and by David Bukry (USA).

(See also review on page 132 of this report.)

1.4.b. Presentations by Participants

J. Bendeck Olivella (Participants Scientific Contributions page 53).

Bilal Ul Haq, Stockholm University

Rates of Evolution in Cenozoic Calcareous Nannoplankton

(S u m m a r y)

Variations in the total frequency of the cenozoic nannoplankton and the evolutionary rates for coccoliths and discoasters were calculated according to the method outlined by G. G. SIMPSON (1953). It was shown, that calcareous nannoflora diversified rapidly during late Paleocene and early Eocene, but underwent a gradual reduction in frequency during the remainder of Eocene and sharply declined during Oligocene and early Miocene, with a slight second radiation in the middle and late Miocene. A comparison with the paleotemperatures shows, that calcareous nannoplankton increase in diversity during the warmer intervals and decrease in diversity during the cooler ones.

Dr. EL DAWOODY, Cairo

Calcareous Nannoplankton Biostratigraphy of Upper Cretaceous and Lower Tertiary Sediments at Gebel Duwi

(referring to the above theme 3 lectures were given in Viennna, Budapest and Praha; they are based mainly on the thesis of the author, 2 volumes 1970, which was circulated and discussed widely among the participants)

H. HONNAPPA, Dept. of Postgraduate Studies and Research in Geology, Manasa Gangothri, Mysore (India)

Ostracoda From the Recent Sediments of Mangalore Harbour Area, West Coast of India

(S u m m a r y)

Actinocythereis tumefacentis (LUBIMOVA & GUHA) from bore hole sediments of Mangalore Harbour Area, is represented by a large number of individuals of various dimorphic stages. Besides appropriate sketches, the main features relating to as ontogeny, nature of marginal porecanals, hingeline structures, muscle scarpattern, and taxonomic status of the species, have been presented; the length, height and thickness of the individuals have been measured, and the measurements data have been plotted on a scatter diagram; the nature of the ontogenetic developement has been discussed. The detail observation of the hinge structures of larva and adults revealed the different moult stages. By comparitive study of the shape of carpaces, position of the muscle scars, and the marginal pore-canals, the variations and the similarities within the population have been recognised. The nature of the reproduction has been studied with the help of the ratio of female right and left valves. The nature of surface ornamentation, the internal characters, the ratio of closed to isolated carpaces, the degree

and the nature of pyritization enabled to interpret the ecology and the depositional conditions of the recent sediments of the Mangalore Harbour Area of West Coast of India.

S. A. JAFAR, Department of Geology, Aligarh Muslim University, Aligarh, India

Some Aspects of Relict Sediments off the Coast of Bombay, India and its Bearing on the Pleistocene Sea Level Fluctuation

(Abstract)

The inner shelf sediments of the coast off Bombay, India, are characterized by the presence of a veneer of blueish grey mud (terrigenous) of Holocene age underlain by oolitic calcareous sands (relict sediments of late Pleistocene age). The study of oolitic calcareous sands has revealed, that they were formed at the time of lowered sea level, probably during Wisconcin glaciation, from the evidence of their association with typical shallow water benthonic foraminifera. However, the occurence of calcareous sands at different depths both off the east as well as west coast of India remained a problem; the possibility is not altogether dismissed, that they represent different strand line deposits of Pleistocene epoch. The microfauna associated with oolitic sand is largely exotic and hence cannot be relied upon for paleoecologic interpretations.

DARWIN KADAR (Participants Scientific Contributions, page 58).

Dipl.-Geol. IBRAHIM KHOGA, General Petroleum Company, Syria-Damaskus

Palynological Investigation on Upper-Triassic (Kurashine-Dolomit) deposits of northeastern Part of Syria

(Abstract)

Three cores from the borehole JB. 5, NE-Syria, depth 3150—3200 m. were prepared and examined for their contents of sporomorphs. Four genera were described: *Circulina*, *Samaropollenites*, *Caytonipollenites*, *Ellipsovelatisporites*. These genera appeare in different parts of the world, f. e. in Austria, Saudi Arabia, Malagashi and Russia. The sporomorphs found in core 17 were strongly affected by the dolomitic recrystallisation. The age was given as Upper-Triassic according to *Circulina meyeriana* KLAUS, 1962.

This was the first palynological study in Syria.

D. S. N. RAJU

Late Cretaceous and Lower Tertiary foraminiferal zones from different basins of India

(two lectures were given in Budapest and Praha basing mainly on recent publications of the author, e. g. Jb. Geol. B.-A., Sb. 17, 1970)

G. N. SAXENA, Dept. of Applied Geology, University of Sagar, Sagar (M. P.), India

The Danian in South India

The question of Cretaceous-Tertiary boundary has almost exclusively been related to the position of the Danian in the Cretaceous — Eocene succession in any area. Whether the Danian is topmost Cretaceous, Lowest Tertiary or a separate unit in itself has determined the position of Cretaceous — Tertiary boundary also. Some workers e. g. TROMP, refuse to recognise any horizon like Danian and are of the view that this term is superfluous and should be dropped. The controversy mostly revolves around the peculiar nature of the Danian fauna in different areas. Diverse opinions have evolved regarding the existence and position of the Danian on one hand, and the validity of the parameters used for correlation on the other. Status of the Danian s. s. in the Trichinopoly and Pondichery areas of the South India is discussed here. Convincing faunal support is not available to prove the existence of the Danian s. s. in these areas. The strata so far referred to as Danian could at the most be uppermost Danian and possibly Montian.

Trichinopoly: The upper part of the Niniyur beds here is regarded as Danian in age on the basis of the discovery of *Hercoglossa (Nautilus) danicus, Cardita (Venericardita) jaquinoti* and *Orbitoides minor.* The presence of *Orbitoides minor* is a definite indication of the Maastrichtian age of these beds or atleast that part of the beds which has them. SARKAR (1968) re-examined the "danicus" from this area and compared them with the type "danicus" and concluded that the so called "danicus" from this area belong to some allied species and not to "danicus". Moreover, "danicus" is found in situ at the base of Ariyalurs (Campanian) at Sudarampet near Pondichery. In Madagascar it is occurring in Campanian — Maastrichtian. In the type area of Danian in Denmark, the "danicus" is always accompanied by *Baculites* and so is the case in the Franco-Belgian basin. But no ammonite is found with "danicus" in these beds in this area. Regarding the evidence of *Cardita (Venericardita) jaquinoti,* a close ally of *Cardita beaumonti,* RUTSCH (1936) says that if all the species of *Cardita* *beaumonti* of different areas are put together, the range of *Cardita beaumonti* group is much longer and ranges from Maastrichtian to Eocene. All these fossils therefore, do not support the presence of the Danian s. s. in this area. Fossil algae described from these beds also indicate the presence of younger Palaeocene element. These beds, therefore, on the available evidence should not be assigned to Danian, but may belong to some younger horizon.

Pondichery: More work on the microfossils has been done in this area than the previous one. Foraminifera are the most common amongs these. RAJGOPALAN (1964, 1965) made six foraminiferal zones and recognised that the Cretaceous strata continue without interruption into Lower Eocene (Ypresian) in this area. Revising this scheme RAJGOPALAN (1968) concluded that the topmost horizon indicates a Palaeocene age and not Lower Eocene as decided earlier. McGOWRAN (1968) also points out the absence of Danian and leaves a gap between the *Globotruncana tricarinata, G. gansseri* Zone (Campanian — Maastrichtian) on one hand and *Globotruncani trinidadensis, G. uncinata* Zone (Montian — Thanetian) on the other of the horizons suggested by RAJGOPALAN. This gap, therefore, should represent the Danian. *Heliolithus riedeli*, a very characterstic Thanetian nanno-plankton has also been reported by RAJGOPALAN from these beds.

1.4.c. Presentations given at Budapest *)

Prof. E. NAGY Dr. PH., Dr. Sc.

Micropaleontology in the Hungarian Geological Institute

(Abstract)

There has been done intensive paleontological work since the very foundation of the 102 years old Institute. The pioneer work was started in the field of micropaleontology by M. HANTKEN, the renowned first director of the Institute. In the 20th century, one of the most prominent micropaleontologists was B. ZALÁNYI, who specialized in ostracods.

Presently, 3 research teams of micropaleontology are at work in the Paleontological Department of the H. G. I.: on

— *diatoms* and *coccolithophorids*,
— *pollens* and *spores*,
— *small* and *larger foraminifera* and *ostracoda*.

Altogether 14 micropaleontologists are included in the present staff of the Institute.

*) Hungarian Geological Institute, Budapest XIV, Népstadion út. 14.

Prof. E. NAGY Dr. PH., Dr. Sc.

Aspects of Nomenclature, Taxonomy, Ecology, Cenology, Climatology and Faciology in Paleopalynological Research

(A b s t r a c t)

Some methodological aspects of palynological work are discussed, amongst others clean sampling and maceration techniques. The most important part of the palynological work is the identification of forms. Beside morphological identification, biological identification is needed, if possible. This is the basis of any further scientific and practical conclusion. In Hungary, paleoclimatological zones could be distinguished by means of palynological studies.

These and some faciological conclusions including redeposition have proved to be important for industrial exploration work too.

Biostratigraphical information obtained is a serious help for geological mapping done by the Hungarian Geological Institute. Of course, palynological results are evaluated together with those of other micro- and megapaleontological, sedimentological, investigations. Three palynological diagrams display the different possibilities of evaluation.

Dr. J. BÓNA, National Prospecting and Drilling Co., Komló

Palynological Practice in the Investigation of Liassic Coal Measures in the Mecsek Mountains (South Hungary)

(A b s t r a c t)

Continuous Upper Permian to Upper Cretaceous sedimentation in the Mecsek Mountains comprises two cycles. The second one started with the deposition of a 200 to 1200 m. thick black coal bearing formation of Lower Liassic age.

Pollen studies have contributed essentially to settle the following major problems:

1. Approximate determination of carbonization grade (depending mainly on tectonic stresses).

2. Tracing the Triassic/Liassic boundary. Of 128 forms found in the examined sequence, 38 are indicative of the Upper Triassic only, while 38 — of the Lower Liassic. They never occur together.

3. Distinction of swamp zones: deep swamp, shallow swamp and swamp forest, with direct possibilities of coal measures correlation. This is a very important aid in this area, which is very intensely folded.

4. Establishing an adequate picture of Lower Liassic paleogeography. Some continental floral exchanges have been pointed out with the Rhodopean Continent, while marked differences support the existence of a marine area betwen the area of study and the Bohemian Massif.

Dr. E. DUDICH Jr.

Paradoxes and Use of Bryozoa

(A b s t r a c t)

A synthetic review of some crucial problems of paleobryozoology is given. Such are: the contradiction between systematics based mainly on features of the soft body and paleosystematics necessarily based on skeletal morphology; a possible interpretation of paradoxical bryozoan anatomy by means of mosaic evolution; the rule of astogeny, reflecting phylogeny in zoarium development; the two-phase phylogeny through the Earth's past, with virence periods displaying strange reiterations and competition phenomena; non-corallian ecology and possibilities of paleocommunity reconstruction based on the principle of actualism. As for the methodological aspect, traditional and up-to-date techniques are enumerated and commented. Finally, references are cited, with particular regard to practical applications in faciology and stratigraphy. As an example, some conclusions drawn from Upper Eocene bryozoan faunulas in Hungary are presented, concerning age, environment and conditions of sedimentation.

Dr. F. GÓCZÁN

Comparative Palynology and the Paleoclimate of Bauxite Formation

(A b s t r a c t)

The author adopted the concept of E. VADÁSZ (1951, 1956): "bauxite is a particular type of continental sediment which is — independently of its laterite or terra rossa origin — produced by analogous processes from siallitic substances derived from various bedrocks."

A comparative palynological approach is forwarded. As a first step, several maps of recent aluminium enrichment areas are compiled, showing January and July medium temperature, rainfall distribution and sea water temperature data as well as the distribution of climate indicating plants, the ancient equivalents of which can be traced, by means of pollen studies, from Jurassic to Oligocene.

As a second step, these climatic features are compared with maxima of paleoclimatological curves. These have been plotted on one hand from paleotemperature measurements on *Belemnites* and *Nummulites* specimens (oxygen isotope method), and from palynological data, reflecting relative climatic values obtained by the study of continental paleovegetation.

This comparison points out markedly the time intervals of optimum conditions of bauxitization. Accordingly, the majority of bauxite deposits in Hungary seems to have been formed during the Albian.

Dr. M. HAJÓS C. Sc.

Siliceous Unicellulars. Their Use for Faciology and Biostratigraphy

(Abstract)

The study of siliceous unicellulars is of increasing importance. Particularly so in the case of sediments containing no other kind of microfossils.

In Hungarian Geological Institute siliceous unicellulars are evaluated also from the point of view of applied geology.

Siliceous unicellulars are to be found most likely in acidic tuffs and tuffites, or in diatomites accompanying these.

The composition of these assemblages is controlled by the chemical and physical characteristics of the given water medium. Light, temperature, agitation, chemism of the water are decisive for the propagation of these microorganisms. Changes in these involve changes in both the sediments and the assemblages enclosed.

The most sensitive indicators of such alterations are the diatoms.

Consequently paleobotanical conclusions are based first of all on diatoms. However, for faciological and microbiostratigraphic evaluations the whole assemblage should be taken into account: *Archaeomonae, Silicoflagellata, Ebriida, Diatomea, Phytolitharia, Radiolaria,* accompanied by fragments of siliceous sponges. Chitinous tests of planktonic forms "incertae sedis" of characteristic morphological featurs, also occur; these may be of considerable stratigraphic value.

In Hungary, important diatomites are known to occur in the foreland and in some marginal basins of the Mecsek and Bakony mountains. Their age varies from Liassic through Oligocene, Miocene and Pliocene to Holocene. "Marker species", of short haemeras, may be used for stratigraphic dating the age. In the Tertiary, assemblages can be used even for detailed geochronological zonation and even for longdistance correlation with the neighbouring countries.

Dr. M. Jámbor-Kness

Eocene Stratigraphy of the Dorog Basin based upon Larger Foraminifera

(A b s t r a c t)

A chart is presented displaying the distribution of larger Foraminifera in one typical region of the basin, taking into account the lithology and the regional geological setting. In the chronology, the author has adopted the stratigraphic terminology developed by M. Hantken (1871), P. Rozlozsnik, Z. Schréter & K. Telegdi-Roth (1922), modified on the basis of recent stratigraphic research (L. Gidai, 1969) and of her own foraminiferological results (M. Jámbor-Kness, 1965).

The recognized *Nummulites* horizons are illustrated according to their position and importance in the sequence. Frequencies (abundances) of the individual species are represented by thickness of the respective line, while vertical ranges by its length. Surface and equatorial section pictures of the species are added, in order to facilitate quick orientation even for specialists of far-away countries.

Dr. M. Járai-Komlódi, L. Eötvös University, Budapest

Role and Importance of Pleistocene and Holocene Palynology

(A b s t r a c t)

Qualitative and quantitative analysis of pollen spectra is useful for the reconstruction of the ancient climate and vegetation history of Hungary's different phytogeographic areas.

Alternation of cool and warm periods can be well traced. Some plants turned out to be excellent climate indicators, as shown by numerous examples (e. g., *Armeria maritima, Selaginella selaginoides, Hippophaë rhamnoides, Ribes alpinum, Gypsophila fastigiata, Polygonum bistorta, Koenigia islandica).*

A review of glacial, interglacial and post-glacial vegetation history of Hungary is given, with special regard to flora migrations and relict forms in the Hungarian Central Mountains and on the Great Hungarian Plain.

Colour slides of the characteristic forms have been demonstrated.

It is stressed that the climax vegetation of the Great Hungarian Plain is now forest-steppe, while that of the highlands, deciduous oak and beach forest.

Dr. I. Korecz-Laky

Foraminiferal Studies on Miocene Formations of Hungary

(A b s t r a c t)

The Miocene formations of Hungary can be subdivided in detail by means of foraminifera.

The relatively rich foraminifer fauna of the Burdigalian marine clay marls corresponds to that of South Slovakia and of the Eggenburgian in Austria. From the Lower Helvetian, foraminifers abundant in the *Cardium* bearing beds only, being represented very poorly in the lower rhyolite tuff and in the lignite bearing members. On the contrary, the *Oncophora* bearing sands, *Chlamys* sandstones and "Schlier" beds of the Upper Helvetian are very rich in foraminifers. Three biofacies could be distinguished according to the predominance of arenaceous, benthic and planktonic forms, respectively, to the N-NE of the Danube, while to the south, a fish-scale bearing facies is characteristic, with rather scarce foraminifers. This stage is terminated by biotitic, scoriaceous rhyolite tuffs, which are overlain by Lower Tortonian sediments, yielding a very abundant foraminiferal assemblage, characterized by the apparition of *Orbulina* species, and by the predominance of *Lagenidae*, both indicating off-shore environment. The corresponding litoral sediments of "Leithakalk" type, more or less sandy, contain numerous *Amphistegina* and *Heterostegina*. In the Mecsek and the Bakony Mountains, the following fresh-to brackish water member, including brown coal seams, are overlain by Upper Tortonian Corbula and Turritella bearing clay marls, which can be subdivided into three foraminiferal horizons. As a heteropic facies, the "Leithakalk" reappears, which can be distinguished, however, very well from the lower one by means of its different microfauna characterized by *Borelis*, *Peneroplis* and *Dendritina*.

The brackish water sediments of the Sarmatian develop in continuity from the Tortonian, in the same facies. They can be separated by micro-biostratigraphic studies only. Within the Sarmatian, several biofacies could be discerned.

Dr. A. Oravecz-Scheffer

Triassic Foraminiferal Assemblages of Stratigraphic Value in Hungary

(A b s t r a c t)

After a short discussion of techniques, the most characteristic foraminifer assemblages of the Hungarian Triassic are reviewed. A brief description of the Campilian *Meandrospira iulia* bearing beds of Trans-

danubia is given as well as of the assemblages of the Anisian Glomospira and Meandrospira dinarica bearing beds of the Bakony and Villányi mountains.

The rich Karnian assemblages of the Balaton Highlands, the Northern Bakony and the Cisdanubian Horsts and the microfaunistical features of the Rhaetian Dachsteinkalk formation are discussed in detail.

Attention is drawn to the abundance and stratigraphic-ecological importance of some microscopic echinoderm skeletal elements *(Holothurioidea, Asteroidea, Ophiuroidea).* Some typical species have been illustrated by projection of microphotos.

Dr. M. Sidó, C. Sc.

Biostratigraphic Importance of Cretaceous Foraminifera in Hungary

(Abstract)

Relying, above all, upon the studies on boreholes Sp-1 and Sp-2 at Sümeg, Transdanubia, and on the surface profile demonstrated during the field trip, the author presents an overall picture of the Cretaceous (and partly Jurassic) microfaunistic assemblages of Hungary, with particular regard to their use in chrono- and microbiostratigraphy. The importance of the nannoplankton and of the planktonic foraminifers is particularly emphasized beside the benthic communities, in view of correlation and paleogeographic reconstructions.

The phylogenetic analysis of pelagic foraminifers resulted in distinguishing three major evolutionary phases.

1st phase: Valanginian to Middle Aptian inclusive, characterized by nannoplankton, *Tintinnidae, Radiolarian* assemblages, and as for Foraminifera, by the genera *Hedbergella, Ticinella* and *Globigerinelloides.* Subdivisions can be established by the apparition and disparition of particular species. E. g. the *Globigerinelloides algerianus* Zone characterizes the Upper Aptian.

2nd phase: Upper Albian to Turonian, characterized by the genera *Rotalipora, Planomalina* and *Praeglobotruncana.* Flattened *Rotalipora* appear at the lower boundary of the Vraconian, with the predominance of *R. appeninica.* Inflate, angular forms are characteristic of the Cenomanian, including the zones of *Planomalina buxtorfi, Globigerinelloides eaglefordensis* and *Rotalipora* aff. *greenhornensis.*

3rd phase: Turonian to Senonian inclusive, characterized by various forms of the genus Globotruncana: double-keeled in the Turonian, single-keeled in the Lower Senonian, and conical in the Maestrichtian. Within the Senonian, three zones have been recognized: those of *Globotruncana concavata, Gl. calcarata* and *Gl. mayaroensis — Pseudotextularia.*

1.4.d. Presentations given in Praha*) and Bratislava**)

Eva Benešová

Applied micropaleontology in the Paleogene of Moravia

Paleogene sediments of Moravia (Ždánice Unit) contain macrofossils for biostratigraphical correlations. From other groups of fossils smaller foraminifera are suitable for stratigraphical zonation. Stratigraphical ranges of most of planctonic foraminiferal species and their evolutionary lineages may be correlated with planctonic zones used in worldwide measurement. The benthonic part of all foraminiferal assemblages yields material for studying ecological conditions and for the reconstruction of the development and changes in the sedimentary provinces.

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N. Gabrielová

Plant microremains in crude oil

(Abstract)

Recently, the study of organic microremains has proved to be useful in the solution of problems connected with migration of crude oil and its genesis. These problems have been dealt with by many authors (J. C. Sanders, 1937; K. R. Čepikov & A. M. Medvedeva, 1953, 1960, 1961; A. Horowitz & Y. Langozsky, 1965; C. Sittler, 1955; J. Tomor, 1950, 1964, and others) who studied oils of different ages from important petroleum areas. For obtaining microorganisms from crude oil, laboratory preparation is necessary, which mostly consists in filtration or separation by centrifugation. After a microscopic study, the assemblages of organisms from crude oil are compared with those known from the reservoir rocks.

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In Czechoslovakia, crude oil was for the first time examined in this way on samples from bore Lubná-1. The assemblage of organisms established there fully corresponds to that from the Neogene sediments of the Carpathian foredeep. As it is considered to be autochthonous, the conclusion can be drawn that oil originated there in the Neogene.

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E. HANZLÍKOVÁ

Applied micropaleontology in the Cretaceous of Moravia

(Abstract)

The Upper Cretaceous of Moravia has a complete stratigraphic sequence. It is developed in marine facies. All subsequent substages from the Cenomanian to the Maastrichtian were determined by means of foraminifers. In some partial basins the thickness of sediments is more than 5000 meters, especially in the Silesian Flysch trough. The sediments were zoned according to the pattern elaborated by BANDY (1967) and his ideas based in the evolutive lines of Cretaceous planktonic *Globotruncanids* and *Heterohelicids*. From the ratio of different species of planktonics found in the outer Flysch all the Moravian territory belongs to the transitional zone between the Boreal and the Mediterranean bioprovinces. Flysch biotop does not show any of this pattern. It is explained as a permanently subsiding trough with changeable conditions in the salinity (PH factor) redox potential, clarity of water and other abiotic as well as biotic factors, all of them affected by the huge inrush of terrigenous material, coming from the cordilleras, exotic blocks and from the Bohemian massiv too. This biotope is represented by very primitive foraminifers rarely accompanied by planktonics *(radiolarians)*.

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JITKA HERCOGOVÁ

The Foraminifera and their Significance for the Stratigraphy of the Cretaceous of Bohemia

(Abstract)

Upper Cretaceous sediments of the Bohemian Massif were deposited in a period ranging from the Upper Cenomanian to the Lower Santonian. On the basis of micropalaeontologic investigations it has been possible to distinguish the Upper Cenomanian; the Lower, Middle and Upper Turonian; and the Lower and Upper Coniacian. Only sandy sediments, which did not favour preservation of the foraminifers, were deposited during Lower Santonian time.

According to their stratigraphical significance, the foraminifera can be subdivided into the following groups:

1. Species having no stratigraphical significance, these are found in beds ranging in age from the Cenomanian or Lower Turonian to the Coniacian (*Lenticulinae*, most of *Frondicularia*, *Nodosaria*, *Valvulineria lenticula* [REUSS], *Textularia foeda* REUSS, and others).

2. Species limited only to a certain part of the Upper Cretaceous, mostly to its lower portion (up to the end of Middle Turonian) or to the Upper Turonian and Coniacian.

3. Species which were referred to by F. BETTENSTAEDT (1952) as "Häufigkeitsfossilien". These are of wider stratigraphical range over large areas, but confined to certain stratigraphical units in relatively small areals; as in the Cretaceous of Bohemia.; such a limited stratigraphical range is chiefly due to ecological factors; *Cassidella tegulata* (REUSS), *Vaginulina ensis* REUSS, *Stensiöina granulata* (OLBERTZ), *Stensiöina exsculpta* (REUSS), etc.

4. Index fossils (species) confined to a certain stratigraphical unit:

Cenomanian:	*Gavelinella cenomanica* (BROTZEN), *Pseudotextulariella cretosa* (CUSHMAN), *Marginulina muelleri* REUSS, *Marginulina aequivoca* REUSS, etc.;
Lower Turonian:	*Gavelinella rudis* (REUSS)
Middle Turonian:	*Gaudryina ruthenica* REUSS, etc.

5. Members of phylogenetic series, which are considered by F. BETTENSTAEDT (1960) to constitute the most reliable group; *Neoflabellina deltoidea* (WEDEKIND) occurs only in the Lower Coniacian, whereas *Neoflabellina sphenoidalis praecursor* (WEDEKIND) is known only from the Upper Coniacian of the Cretaceous of Bohemia.

A range chart referring to the above data was handed out to the attendants of the lecture.

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MILADA KAISEROVÁ-KALIBOVÁ

Palynology of the Carboniferous of the Bohemian Massif

(Abstract)

The Geological Survey, Prague, carried out a palynological research in the Bohemian Massif especially in the Carboniferous system. Both megaspores and microspores from the coal seams (of Westphalian B-C — Stephanian age) were studied.

The megaspore investigation in the Plzeň Basin has shown that megaspore studies are a useful aid in local seam correlations.

The results of microspore studies carried out in three main basins of the Central Bohemian Carboniferous complex (Kladno—Rakovník, Plzeň, Mšeno basins) were summarized and stratigraphically evaluated.

Two bore-holes in eastern Bohemia may be taken as examples showing that it is possible to use palynology in determining the age of the rocks containing neither coal nor macrofossils.

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MAGDA KONZALOVÁ

Paleophytoplankton in geological research

(Abstract)

The application of phytoplankton investigation in stratigraphic paleontology is outlined. It involves the preparation technique and the general characteristic of various groups of planktonic microfossils — *Acritarcha, Dinoflagellates,* green and blue-green *algae* — known from marine and brackish-marine sediments. The progress of microplankton-research in the Bohemian Massif in the Upper Proterozoic, Early Paleozoic and Upper Mesozoic is outlined. Particular attention is paid to the most characteristic microfossils, their assemblages and geological occurrence. Practical use in stratigraphy and geology is shown.

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R. Lehotayová, D. Stur Institute, Bratislava

Electron Microscopic Investigation of Calcareous Nannoflora from Neogene Pelites in Slovakia

After mentioning the history of investigation and importance of calcareous nannoflora the lecture dealt with the biostratigraphy of Neogene sediments in the western part of Slovakia.

The age of calcareous nannoflora pelites studied from the localities Vel'ká Čausa, Pôtor, Bajtava, Salka, Semerovce, Lontov, Devínska Nová Ves and Pavlová was determined on the basis of planktonic foraminifers in the most cases; it has become known more completely and precisely with investigation by aid of electron microscopy.

In the last years great stratigraphic importance has been ascribed to calcareous nannoplankton in zonation and interregional correlation.

The earliest sediments concerned in the study under consideration are of Eggenburgian age from the locality Vel'ká Čausa (borehole ČČ-3). From calcareous nannoflora the following are most abundantly represented:

Coccolithus eopelagicus
Coccolithus sp. 1
Coccolithus sp. 2
Microrhabdulus cf. *decoratus*
Reticulofenestra umbilica
Reticulofenestra ovalis
Reticulofenestra cf. *danica*
Zygodiscus diplogrammus

The pelitic sediments from the Modrý Kameň area, locality Pôtor (borehole M-2) belong to the Carpathian. The calcareous nannoflora consisted of the following species:

Coccolithus pelagicus
Discoaster sp. 1
Ericsonia ovalis
Helicosphaera carteri
Reticulofenestra sp. 1 etc.

The most part of the studied material is Badenian (Tortonian s. l.) in age, from the localities Salka, Bajtava, Lontov and Semerovce, with very rich associations of nannoflora. The main component was formed by heliolithic forms; discoasterids as well as rhabdoliths were found sporadically only.

Most abundantly were represented:
Coccolithus cf. *celticus*
Coccolithus eopelagicus

Coccolithus floridanus
Coccolithus cf. *minutulus*
Coccolithus cf. *muiri*
Coccolithus parvulus
Coccolithus ex gr. *pelagicus*
Coccolithus sp.
Cribrosphaerella ? sp.
Cruciplacolithus devinensis
Cyclococcolithus cf. *formosus*
Cyclococcolithus leptoporus
Cyclococcolithus reticulatus
Cyclococcolithus rotulus
Cyclococcolithus sp.
Discoaster challengeri
Discolithina macropora
Discolithina multipora
Discolithina phaseola
Discolithina sp.
Ericsonia occidentalis
Ericsonia ovalis
Helicopontosphaera carteri
Lithostromation perdurum
Microrhabdulus sp.
Microrhabdulus sp. 1
Reticulofenestra dictyoda
Reticulofenestra sp.
Reticulofenestra sp. 3
Rhabdosphaera claviger
Rhabdosphaera sp.
Scapholithus fossilis
Syracosphaera sp.
Syracosphaera sp. 1 nov. spec. ?
Umbilicosphaera cf. *mirabilis*

The latest sediments in the Neogene of the Paratethys, thus also in our country, in which calcareous nannoflora is represented, are Upper Miocene, Sarmatian, in age. So far we have obtained coccoliths only from its lowermost horizon, the horizon with large *elphidia.* Among the forms found in the Sarmatian the following were of greatest importance:

Braarudosphaera bigelovi
Discoaster sp.
Reticulofenestra sp.
Reticulofenestra pseudoumbilica
Discolithina macropora

E. PLANDEROVÁ, Dionýz Štúr Institute of Geology, Bratislava, Mlynská dolina 1

Importance of Palynology for Stratigraphy and Development of the Neogene Flora in the Region of the West Carpathians

In the introduction of the lecture a short historical survey was presented from the beginning of the palynological method to its full application for biostratigraphical purposes. Next a general description of the arrangement and structure of pollen grain was mentioned and possible errors and inaccuracies following from application of the palynological method were indicated. On the other hand the possibilities of application of this method in paleoecology, mainly paleoclimatology and stratigraphy, were pointed out. As main contribution for biostratigraphy by aid of the palynological method evaluation of so called standard diagram and pollen grains is being considered. These are treated by evaluation of an amount of sediments of equal age, and serve then as basis for stratigraphy and correlation.

In the next part of the lecture a survey of the results of palynological investigation in Slovakia from the Egerian to the Plio — Pleistocene was presented. Every stage of the Neogene was characterized by the flora with its development of paleoecological conditions in the Neogene of Slovakia.

The development of the climate in the Neogene was not advancing rectilinearly from tropical — subtropical climate towards cooling off. Certain periods of cooling of the climate were alternating with warmer climatic periods. The climate was relatively cooler in the Egerian and Lower Eggenburgian than in the Ottnangian and Carpathian. In the Badenian the climate was subtropical with alternating humidity of the climate. A change in the climate took place in the Lower Sarmatian, when the tropical climate completely retreated and Arctic — Tertiary types of the flora became predominating. In the Pliocene gradual cooling of the climate set in, also reflected in composition of the pollen picture. Wood species became gradually more and more rare and in the uppermost Pliocene herbs of varied associations are most important in the pollen picture.

Z. ŘEHÁKOVÁ

Solution of sedimentological and stratigraphic problems with the use of diatom analysis

(A b s t r a c t)

In the past, diatoms were generally recognized as valuable devices for microbiostratigraphic correlation of sediments. Their importance for

age determination and detailed stratigraphic division of sedimentary formations was mostly underrated. However, the possibility of applying the diatom analysis in stratigraphy on a broader scale has recently been proved. The study of stratotypal floras and extensive comparative studies conducted in various countries of Europe, Asia and America, furnished positive results in this respect.

The author has studied qualitative changes of fresh-water diatom associations in various Tertiary and Quaternary sediments on the territory of Czechoslovakia. On the basis of these investigations she defined diatom associations characteristic of individual stratigraphic units and established the complexes of index species.

Every major time interval is distinguished by the evolution of a specific type of diatom flora. The younger the flora is, the smaller is the percentage of extinct species and the closer is its relationship to the recent diatom associations. The diatom associations of the Miocene are very monotonous, comprising few genera and species; the *Melosira* populations predominate greatly over pennate diatoms, which are quantitatively insignificant. In the Pliocene sediments the diatom associations are more varied; the epiphytic and benthic forms of the order *Pennales,* which are characteristic of the Pliocene, increased substantially in number. Compared with the Miocene, the number of extinct species dropped down to the minimum. Quaternary species of diatoms show close relations to the recent ones; the qualitative changes in their associations are more influenced by the climatic fluctuations and the ecological diversity of the habitat than by the age of sediments deposited during this short time interval.

The results have been checked against the published data on the occurrence of fossil diatoms in the continental deposits of Europe; it has been found that they essentially agree.

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Dana Štemproková-Jírová

Important Foraminifera of the Bohemian Cretaceous

Planctonic and benthonic foraminifera as individual components of the microfossil associations were studied in the Bohemian Cretaceous. Statistical methods were applied in this study. Important species were evaluated in detail. Their study brought some new taxonomic, phylogenetic, ecological, and stratigraphical conclusions.

Margit Vanová, Dionýz Štúr Institute of Geology, Bratislava, Mlynská dolina 1

Nummulites from the Area of Bojnice, the Upper Hron Depression and the Budin Paleogene around Šturovo

In the submitted report the biostratigraphy of the Paleogene of the Central Carpathians from the wider environments of Bojnice, the Upper Hron Depression and the Budín developement of the Paleogene in the Štúrovo area was presented, based on larger foraminifers, mainly *Nummulites.*

In the wider environments of Bojnice the basal transgressive lithofacies were deposited from the Upper Lutetian to the Lower Priabonian, the marginal lithofacies in the Upper Lutetian, the flysch lithofacies from the Upper Lutetian to the end of the Priabonian. In the Upper Hron Depression the basal transgressive lithofacies was deposited from the Upper Lutetian to the end of the Priabonian, the sandy-claystone lithofacies in the Upper Priabonian, the claystone lithofacies in the Upper Priabonian too. In the Štúrovo area a thick complex of sediments contained montonous assemblages of Upper Lutetian age. According to their stratigraphic range larger foraminifers were divided into seven assemblages. The assemblages I—V fall into the Upper Lutetian, the assemblage VI falls into the Lower Priabonian and the assemblage VII into the Upper Priabonian. Comparing bioassociations from the wider environments of Bojnice and the Upper Hron Depression with associations from the Budín developement of the Paleogene in the Štúrovo area, the associations from the first two areas were found to contain granular species with massive shells and the associations from the Budín developement of the Paleogene to contain species with simpler shell structure.

The different nature of bioassociations in the Central Carpathian Paleogene in the wider vicinity of Bojnice, and in the Upper-Hron depression and from the depression and from the Budín Paleogene around Štúrovo may be ascribed to their appurtenance to two different paleogeographical sedimentation areas. The supposed connection of the sedimentation area of the Budín Paleogene across the wider area of Bojnice and the Hornonitrianska kotlina (depression) with the Central-Carpathian Paleogene cannot be documented with nummulite associations. In fact, till the present no nummulite bioassociations have been found as to comprise numerically equal granulated and non-granulated forms.

The occurence of alveolines below the association with *Nummulites gallensis* (HEIM) in the wider vicinity of Bojnice indicates the connection of the Central-Carpathian Paleogene with the epicontinental Paleogene in the Bakony mountains. Here, below the horizon with *Nummulites perforatus perforatus* (MONTFORT) in the horizon with *Assilina spira* (IXth horizon) occur the species *Alveolina elongata* D'ORBIGNY and *Alveolina fusiformis* SOWERBY (G. KOPEK, T. KECSKEMÉTI & E. DUDICH, 1965). The connection of the Budín Paleogene with the central-Carpathian Paleogene across the region of the wider vicinity of Bojnice and Hornonitrianska kotlina (depression) could only be indicated by a sporadical occurence of *Orbitolites* (not yet determined) from the boreholes Mužl'a-3 and Obid-6, situated near Štúrovo.

Part Two:
Participants Scientific Contributions

A Contribution to the Palynological Knowledge of Lower Cretaceous Stratigraphy of the Middle Magdalena Valley, Colombia, South America

(with 3 figures)

By Jorge Bendeck Olivella
Petroleum Engineer and Geologist, Empresa Colombiana de Petroleos, El Centro, Santander, Colombia S. A.

Summary

In the present study a description is given of a pollen grain, which because of its abundance and characteristics, is an indicative fossil of "Tambor" Formation, which is considered in the chronogeological scale as of Valanginian age.

The grain characteristics suggest a generic relation with other grains found in the Alpine Triassic, and other grains reported with different names, including the lower Cretaceous from other places of Europe and Asia (Yemen). It is the first time this grain is reported in South America.

Presentation

This is the first part of a study and some of the preliminary conclusions about a palynological investigation, made by the author under the sponsorship of Empresa Colombiana de Petróleos in its Geological Laboratory at El Centro, Santander, Colombia.

Purpose of the Investigation

With the desire to elaborate a group (column) of fossils as basis for the palynological analysis for Middle Valley of Magdalena River, the studies were started with the deepest Cretaceous, known as "Tambor" or "Arcabuco".

Actually there exists in Colombia a great interest for the Cretaceous because of the recent oil discoveries in sediments of that age, in the Southern part of the country.

Samples and Slides Preparation

The samples were taken from cores of the oil well "Infantas 1613" which situation and location is shown in the attached map (fig. 1).

The material used is exclusively sandstone, almost quartzite, with some thin dark colored inclusions, where one finds very rich organic matter.

The technic of preparation was to remove the silex by H_2F, following the Erdtman Method, improved by W. KLAUS.

The slides were prepared by the system of single grains embedded in glycerin-jelly.

Working Method

The analysis of the grains was made with a binocular Leitz microscope through No. 10, 45, 60, 100 objectives and 10-X eyepiece; photos are taken with an automatic Leitz Camera.

Acknowledgment

The authors gratitude is expressed towards Empresa Colombiana de Petroleos and specially to doctor RAMON A. DIAZ R., General Manager

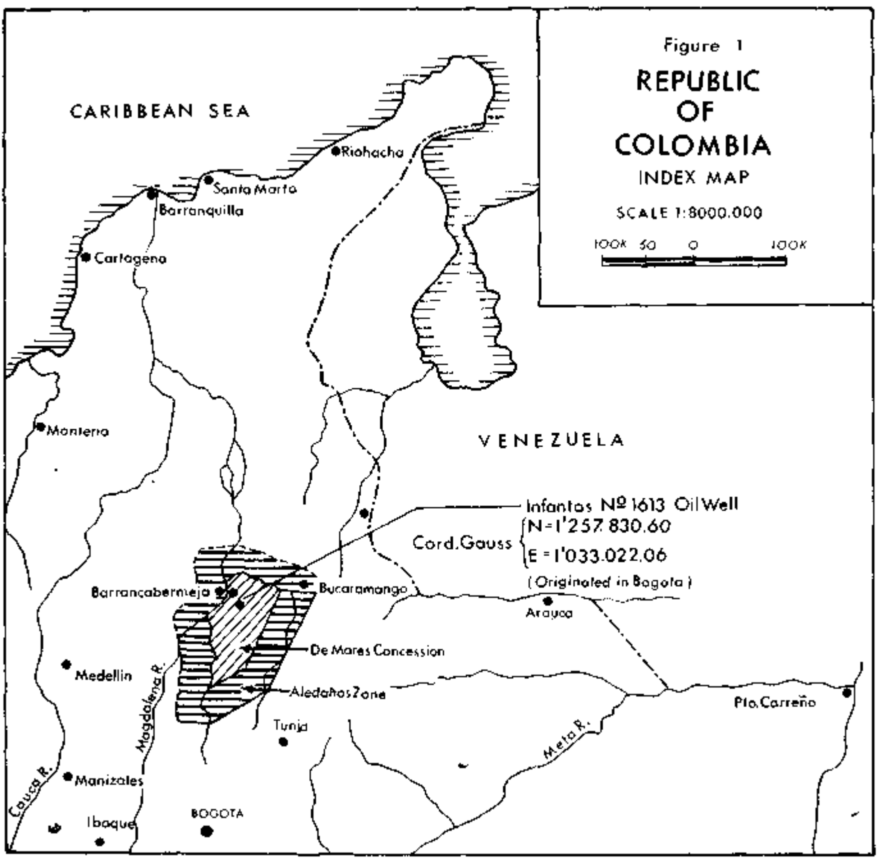

Figure 1
REPUBLIC OF COLOMBIA
INDEX MAP

of "Production Disctrict", for the stimulus and his special interest in my work and also for his agreement to elaborate and submit this work for this opportunity.

Geology

The "Tambor" formation rests unconformably on the Triassic-Jurassic, called "Giron Series", formed by three members: basic group conglomeratic, intermediate group of gray sandstone, shales or red limolites, and the upper group formed by sands.

The red elements found in the lower and medium members are probably reworked "Giron" rocks.

The "Tambor" formation possibly represents continental deposits and litoral deposits from the begining of the Cretaceous cycle of marine sedimentation.

"Infantas 1613" oil well, located in the Gauss coordinates 1.257.830.60-N and 1.033.022.06-E originated in Bogotá, encountered upper oligocene sediments down to 2060 feet, further 1600 feet of Middle Oligocene and lower Oligocene. The Eocene, 500 feet, rests unconformably on the "Galembo" member of "La Luna" formation of the upper Cretaceous. The section through the Cretaceous is represented by 6900 feet of sediments from "La Luna, Simiti, Tablazo, Paja, Rosablanca y Tambor" formations. The total depth of the well is 11,100 feet.

A standard stratigraphical column for Middle Magdalena Valley is attached (fig. 2).

Taxonomy and Nomenclature

The symbols used in descriptions and the morphological terminology follow the principles of IVERSEN & TROELS SMITH (1950).

All preparations, slides and holotypes are kept in the files of Palynological Laboratory of Empresa Colombiana de Petroleos at El Centro, Santander, Colombia.

Anteturma: Pollenites R. POT.

Subanteturma: Praepollenites (PANT, 1954) emend.

Subturma: Circumpolles (PFLUG, 1953) emend.

Genus: *Corollina* MALJAWKINA, 1949.

Corollina ecopetrolis n. sp.

Holotype: Photo No. 1, Slides M-3-a, Single Grain.

Derivatio nominis: Homage to Empresa Colombiana de Petroleos (Ecopetrol).

Description. Polar view circular to oval; side view like an open umbrella (see fig. 3).

On the distal side parallel to the equatorial line there is a bright, light color ring without any relief around the grain, separating two more dark zones.

Standard nomenclature for Middle Magdalena Valley - Colombia (Upper Tertiary excluded)

System	Subdivisions: Colombia	Subdivisions: Gulf Coast	Series	Standard Nomenclature: Group	Standard Nomenclature: Formation	Thickness Meters	Lithology	Generalized Lithologic Description
TERTIARY								mostly conglomerate at base
TERTIARY	MIDDLE	VICKSBURG GROUP	OLIGOCENE (?)	CHUSPAS GROUP	COLORADO FORMATION	575-3200		b lacira fossils; alternating red shale and coarse conglomeratic sandstone
TERTIARY	MIDDLE		OLIGOCENE (?)	CHUSPAS GROUP	MUGROSA FORMATION	575-3200		b mugrosa fossils (local); shale with thin beds fine grained sandstone
TERTIARY	LOWER	JACKSON FM	EOCENE (?)	CHORRO GROUP	ESMERALDAS FORMATION	1225-2300		b los corros fossils (local); C sandstone with interbedded siltstone and shale; C occasional lignite seams
TERTIARY	LOWER	JACKSON FM	EOCENE (?)	CHORRO GROUP	LA PAZ FORMATION	1225-2300		sandstone, massive, cross-bedded conglomeratic; local hard „altered shale" („toro" fm)
TERTIARY	LOWER	MIDWAY FM	PALEOCENE		LISAMA FORMATION	950-1225		C interbedded shale, siltstone and sandstone; C coal seams
CRETACEOUS	UPPER		DANIAN ?		UMIR SHALE	± 1000		C siltstone; C shale, gray, soft, fissile; C scattered concretionary beds of ironstone; coal seams
CRETACEOUS	UPPER	NAVARRO GROUP	MAESTRICHTIAN		UMIR SHALE	± 1000		
CRETACEOUS	UPPER	TAYLOR MARL	CAMPANIAN		UMIR SHALE	± 1000		
CRETACEOUS	UPPER	AUSTIN CHALK	SANTONIAN ? / CONIACIAN	LA LUNA FORMATION	GALEMBO MEMBER	180-350		predominantly calcareous shale with limestone interbeds chert beds and limestone concretions
CRETACEOUS	UPPER	EAGLE FORD SHALE	TURONIAN	LA LUNA FORMATION	PUJAMANA MEMBER	50-225		black, thin-bedded, calcareous shale medium soft
CRETACEOUS	UPPER	EAGLE FORD SHALE	TURONIAN	LA LUNA FORMATION	SALADA MEMBER	50-100		hard, black, calcareous shale limestone beds, pyrite concretions
CRETACEOUS	MIDDLE	WOODBINE FM	CENOMANIAN		SALTO LIMESTONE	50-125		hard, argillaceous limestone, shale partings
CRETACEOUS	MIDDLE	WASHITA GROUP / FREDERICKSBURG	ALBIAN		SIMITI SHALE	250-650		black, thin-bedded shale
CRETACEOUS	MIDDLE	TRINITY GROUP	ALBIAN		TABLAZO LIMESTONE	150-325		limestone and marl abundantly fossiliferous
CRETACEOUS	LOWER	NUEVO LEON GROUP	APTIAN	BASAL LIMESTONE GROUP	PAJA FORMATION	125-625		black, soft, thinly laminated shale
CRETACEOUS	LOWER	NUEVO LEON GROUP	BARREMIAN	BASAL LIMESTONE GROUP	ROSA BLANCA FORMATION	150-425		massive limestone and marl abundantly fossiliferous
CRETACEOUS	LOWER	DURANGO GROUP	HAUTERIVIAN / VALANGINIAN ? / ?		TAMBOR FORMATION	CORE-SAMPLES 0-650		dark red siltstone, sandstone and conglomerate gray at top, with foraminifera
JURA-TRIAS					GIRON FORMATION (UNDIFFERENTIATED)	?		interbedded red and brown siltstone, shale and sandstone, with volcanics

Fig. 2.

There is another zone in the middle of the grain, which is thinner than the rest of the grain body, showing perhaps the reducing thickness of the ektexine possibly indicating the tetrade mark. It lets the light go through easily, compared with the rest of the body (see fig. 3).

The radius of this circle is $^1/_4$ of the equatorial line radius. The ektexina is very thin; its sculpture in the interior zone, limited by the ring, is microreticulated. In the exterior zone of the characteristic luminous ring, one can see concentric rings as lines that come one after the other.

Size: 25—32 microns.

Stratigraphic Distribution

Up to now this type has been found in the upper part of the "Tambor" Formation, equivalent to Valanginian age.

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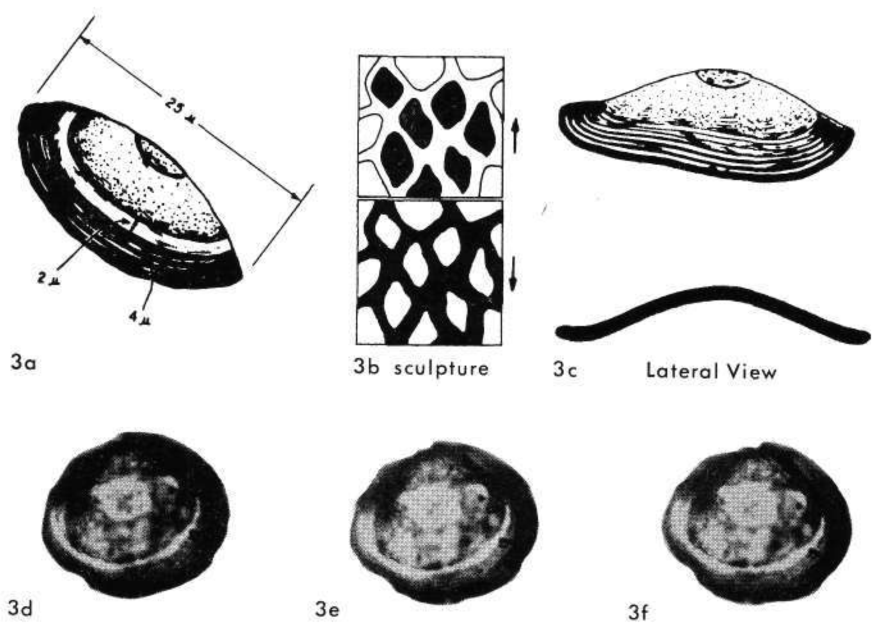


Fig. 3.

Upper Miocene Planktonic Foraminifera From Bali

(with 7 plates and 3 figures)

By DARWIN KADAR

Paleontology Laboratory, Geological Survey of Indonesia

Abstract

Samples of Tertiary sediments discovered recently on the island of Bali by members of the Indonesian Geological Survey were studied. Among them three contain smaller foraminifera, which are particularly significant to the understanding of the geological setting of this island. Thirty three species and subspecies of planktonic foraminifera belonging to eight genera were identified. *Globigerina nepenthes, Globigerina rubescens, Sphaeroidinella seminulina, Sphaeroidinella dehiscens, Globigerinoides obliquus extremus, Globigerinoides ruber, Globorotalia cf acostaensis, Globorotalia margaritae, Globorotalia tumida, Globorotalia tumida flexuosa, Globorotalia crassaformis, Globorotalia cultrata, Pulleniatina primalis, Pulleniatina obliquiloculata obliquiloculata, Pulleniatina obliquiloculata praecursor*, and *Hastigerina aequilateralis* are the most important species among them. Assuming that the range of these species from Bali is similar to the range of the same species in the well known section at Bodjonegoro, East Java, the three Bali assemblages are assignable to the upper Miocene *Globigerinoides obliquus extremus, Globorotalia margaritae*, and *Globorotalia crassaformis* zones.

Introduction

Little is known about the paleontology of the island of Bali. The only article is by HARTONO (1964), which deals with the percentage of coiling direction of *Pulleniatina obliquiloculata* (PARKER & JONES) and *Globorotalia menardii* (D'ORBIGNY). Knowledge of the geology of this island is also very scanty. Except for the southern peninsula and Prapat Agung to the west, almost all tertiary sedimentary rocks are covered by volcanic products (SANDBERG, 1909, unpublished).

New exposures of Tertiary sediments were discovered by members of the Geological Survey of Indonesia during recent geological mapping and a number of samples were sent to the writer for age identification. Three of these contain smaller foraminifera of great importance for understanding of the geological setting of this island.

The purpose of this paper is to present the results of a study of the planktonic foraminifera of these three samples, in which thirty three species and subspecies belonging to eight genera were identified. All species are systematically described and illustrated. The planktonic foraminiferal assemblage is similar to that of well no. 1, Bodjonegoro, in the petroleum-bearing area of East Java (BOLLI, 1966), and thus a similar upper Miocene for the Bali rocks is indicated.

Sample localities

Two of the rock samples come from the banks of the rivers Taman and Mentjatu, near the villages of Padjahan and Galiukir, about 5 kilometers west of the main road between Tabanan and Singaradja (fig. 1; localities number LP 241 and LP 251). The sampled layers are tuffaceous marls, that dip south-eastward, respectively 16° and 20°. Sample number LP 251 contains a small amount of subangular quartz grains. The third sample, JDE III, is calcareous sandstone from the southern flank of Luwur hill near Padang Bay.

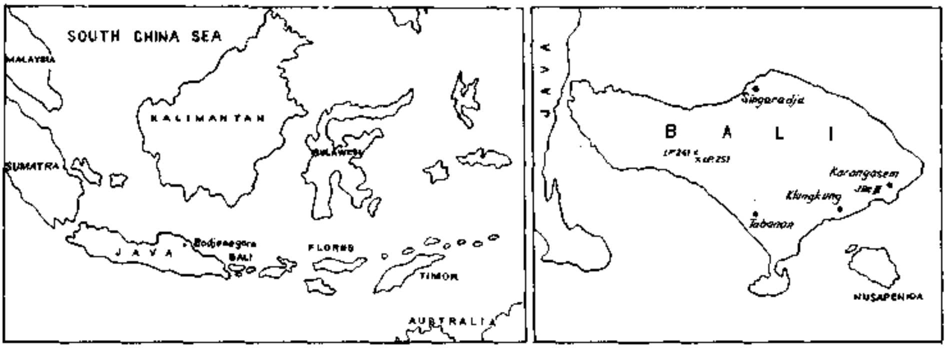
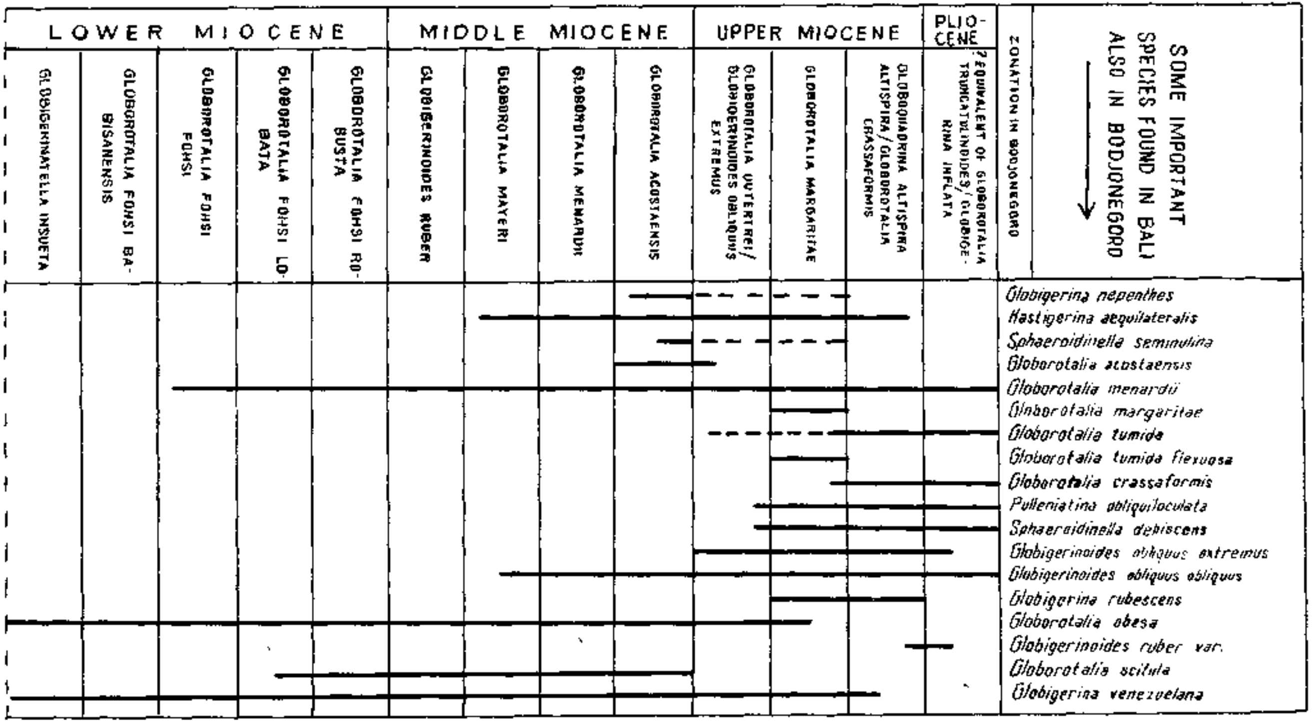


Fig 1 Map showing sample localities

Foraminifera assemblages

As far as the fossil content is concerned, the foraminifera specimens of sample LP 251 are best preserved. The fauna has been identified by comparison with descriptions of faunas of the Miocene Cipero and Lengua formations of Trinidad (Bolli, 1957), Miocene and Pliocene beds from Papua and New Guinea (Beldford, 1962) and from localities in Java. Thirty-three species and subspecies of planktonic foraminifera belonging to eight genera have been identified. All of them are listed in the distribution chart in figure 2.

Sample LP 241 contains ten characteristic species: *Globigerina nepenthes, Globigerinoides obliquus extremus, Sphaeroidinella seminulina, Hastigerina aequilateralis, Pulleniatina primalis, Globigerina venezuelana, Globorotalia cultrata, Globorotalia menardii, Globorotalia tumida* and *Globorotalia cf acostaensis. Sphaeroidinella seminulina* is most abundant. Younger species such as *Globorotalia margaritae* and *Globorotalia crassaformis* are not represented. Except for *Globorotalia cf acostaensis, Globorotalia cultrata* and *Globigerina venezuelana*, all typical species of sample LP 241 are also found in sample LP 251 together with characteristic species such as *Globorotalia margaritae, Globorotalia tumida flexuosa, Sphaeroidinella dehiscens, Globoquadrina altispira altispira, Globoquadrina altispira globosa* and *Globoquadrina dutertrei*. Sample JDE III contains important species such as *Pulleniatina obliquiloculata obliquiloculata, Pulleniatina*



Range in Bodjonegoro
Suggested extended range in Bali

Fig. 2

obliquiloculata praecursor, Sphaeroidinella dehiscens, Hastigerina aequilateralis, Globigerinoides ruber and *Globorotalia crassaformis.*

The most typical species of the above three samples occur also in the Miocene layers of well no. 1, Bodjonegoro (Bolli, 1966). If the range of these species is comparable to the range of the similar assemblage at Bodjonegoro, the three localities on Bali are upper Miocene and correlatives of the *Globigerinoides obliquus extremus, Globorotalia margaritae* and *Globorotalia crassaformis* zones (figure 2).

At Bodjonegoro *Globigerina nepenthes* and *Sphaeroidinella seminulina* are restricted to the *Globorotalia acostaensis* zone, whereas in Bali they are found in *Globigerinoides obliquus extremus* and *Globorotalia margaritae* also, as represented by samples LP 241 and LP 251.

Banner & Blow (1967) consider that these two species range up to the *Sphaeroidinella dehiscens* zone, which is correlated by Bolli (1966) with the *Globorotalia margaritae* zone of well no. 1, Bodjonegoro. *Globorotalia tumida* which appears in Bodjonegoro near the top of the *Globorotalia margaritae* zone appears somewhat lower in Bali namely in the *Globigerinoides obliquus extremus* zone.

Description of species

The systematic arrangement of genera follows the classification of Bolli, 1957.

Family *Orbulinidae* Schultze, 1854

Genus *Globigerina* d'Orbigny, 1826

Globigerina rubescens Hofker

(Pl. 2, Fig. 9)

1962 *Globigerina rubescens* Hofker — Parker, Micropaleontology vol. 8, no. 2, p. 226, figs. 17—18.
1964 *Globigerina rubescens* Hofker — Todd, U. S. Geol. Surv. Prof. Paper, 260-CC, p. 1080, pl. 29, fig. 1.

Test small, high trochospiral; wall calcareous, perforate, strongly beaded; chambers about 12 to 13 arranged in 3 whorls; the four chambers of the last coil increase gradually in size. Sutures deeply depressed; aperture high arch in the umbilicus.

This species is frequently found in sample LP 251. Maximum diameter of figured species LP 251 = 0.28 mm., height of spiral coiling = 0.30 mm.

Globigerina glutinata (Egger)

(Pl. 2, Fig. 12)

1962 *Globigerina glutinata* (Egger) — Parker, Micropaleontology, vol. 8, no. 2, p. 246, pl. 9, figs. 1—6.

Nr	SPECIES	LP. 241	LP. 251	JOE III
1	Globigerinoides trilobus trilobus	c	a	c
2	Globigerinoides trilobus immaturus	.	c	f
3	Globigerinoides sacculiferus	f	c	f
4	Globigerinoides obliquus obliquus	r	c	r
5	Globigerinoides obliquus extremus	f	c	.
6	Globigerinoides conglobatus	r	.	.
7	Globigerinoides ruber	.	.	f
8	Globigerina venezuelana	r	.	.
9	Globigerina pachyderma	.	f	.
10	Globigerina foliata	.	r	.
11	Globigerina nepenthes	c	f	.
12	Globigerina glutinata	.	r	.
13	Globigerina rubescens	.	f	.
14	Orbulina universa	a	a	.
15	Orbulina suturalis	f	.	.
16	Pulleniatina obliquiloculata obliquiloculata	.	.	r
17	Pulleniatina obliquiloculata praecursor	.	.	f
18	Pulleniatina primalis	f	f	.
19	Hastigerina aequilateralis	r	.	r
20	Globoquadrina altispira globosa	.	r	.
21	Globoquadrina altispira altispira	.	c	.
22	Globoquadrina dutertrei	.	c	r
23	Sphaeroidinella seminulina	a	c	.
24	Sphaeroidinella dehiscens	.	r	f
25	Globorotalia menardii	a	a	a
26	Globorotalia margaritae	.	f	.
27	Globorotalia scitula	.	r	.
28	Globorotalia tumida	r	a	f
29	Globorotalia tumida flexuosa	.	r	.
30	Globorotalia crassaformis	.	.	f
31	Globorotalia cf. acostaensis	c	.	.
32	Globorotalia cultrata	f	.	.
33	Globorotalia obesa	r	c	.

Fig. 3. Distribution of planktonic foraminifera
a = abundant c = common f = frequent r = rare

1968 *Globigerina glutinata* (EGGER) — HERB, Eclogae Geologicae Helvetiae, vol. 61/2, p. 478, pl. 3, figs. 4—6.

Test small, trochospiral; wall calcareous, finely perforate, smooth; chambers about 12 to 13 arranged in 3 whorls; four in the last coil. Sutures deeply depressed; umbilicus covered by one bulla; small supplementary apertures are along the border line between bulla and chambers. Maximum diameter of figured species LP 251 = 0.22 mm.

Globigerina foliata BOLLI

(Pl. 2, Fig. 10)

1957 *Globigerina foliata* BOLLI — U. S. National Mus. Bull. 215, p. 111, pl. 24, fig. 1.

This species is rarely found in sample LP 251. Maximum diameter of figured species LP 251 = 0.28 mm.

Globigerina nepenthes TODD

(Pl. 2, Fig. 11)

1957 *Globigerina nepenthes* TODD — BOLLI, U. S. Nat. Mus. Bull. 215, p. 111, pl. 24, figs. 3—4.

Test small, trochospiral; wall calcareous, perforate; surface fairly smooth; chambers about 7 to 8 arranged in 2 whorls; the last one chamber sack-like in shape. Sutures depressed; aperture medium arch, bordered above by a thick lip. This species is commonly found in samples LP 241 and LP 251. Maximum diameter of figured species LP 241 = 0.30 mm.

Globigerina pachyderma (EHRENBERG)

(Pl. 2, Fig. 13)

1968 *Globigerina pachyderma* (EHRENBERG) — HERB, Eclogae Geol. Helv., p. 473, pl. 3, figs. 1—2.

Shape of test trochospiral, periphery rounded; wall calcareous, surface smooth, small pores giving lattice-like appearance. Chambers about 13 arranged in 3 whorls, inflated, increase rapidly in size; sutures deeply depressed. Aperture medium arch, interiomarginal. This species is frequently found in sample LP 251. Maximum diameter of figured species LP = 0.35 mm.

Globigerina venezuelana HEDBERG

(Pl. 2, Fig. 14)

1957 *Globigerina venezuelana* HEDBERG — BOLLI, U. S. Nat. Mus. Bull. 215, p. 110, pl. 23, figs. 6—8.

This species is only found in sample LP 241. Maximum diameter of figured species LP 241 = 0.57 mm.

Genus *Pulleniatina* Cushman, 1927
Pulleniatina primalis Banner & Blow

(Pl. 3 and 4, Figs. 20 and 21)

1967 *Pulleniatina primalis* Banner & Blow — Micropal., vol. 13, no. 2, p. 142—143, pl. 1, fig. 2.

Shape of test trochospiral, axial periphery broadly rounded; wall calcareous, perforate; chambers about 12 to 13 arranged in about 3 whorls, the 5 chambers of the last coil increase rapidly in size. Sutures radial, slightly curved, deeply depressed. Aperture interiomarginal arch, extending ventrally along the base of apertural face, starting from umbilicus to the periphery; apertural face is thickened. This species is frequently found in sample LP 241. Two forms are figured. Twenty and five specimens have been picked up respectively from samples LP 241 and LP 251. All of them are sinistrally coiled. Maximum diameter of figured species LP 241 = 0.50 mm., LP 251 = 0.45 mm.

Pulleniatina obliquiloculata obliquiloculata (Parker & Jones)

(Pl. 4, Fig. 23)

1967 *Pulleniatina obliquiloculata obliquiloculata* — Bannner & Blow, Micropaleontology, vo. 13, no. 2, p. 137—139, pl. 3, fig. 4.

This species is found only in sample JDE III. Maximum diameter of figured species JDE III = 0.47 mm.

Pulleniatina obliquiloculata praecursor (Banner & Blow)

(Pl. 4, Fig. 22)

1967 *Pulleniatina obliquiloculata praecursor* — Banner & Blow, Micropal., vol. 13, no. 2, p. 139—140, pl. 3, fig. 3.

Twenty specimens have been picked up from the sample JDE III, all of them are dextrally coiled. Maximum diameter of figured species JDE III = 0.62 mm.

Genus *Sphaeroidinella* Cushman, 1927
Sphaeroidinella seminulina (Schwager)

(Pl. 3, Figs. 17 and 18)

1957 *Sphaeroidinella rutschi* Cushman & Renz — Bolli, U. S. Nat. Mus. Bull. 215, p. 115, pl. 26, figs. 6—7.

1964 *Sphaeroidinella seminulina seminulina* (Schwager) — Bandy, Micropal., vol. 10, text-fig. no. 6, fig. 1.

Wall smooth, finely perforate, pores giving an almost lattice-like appearance; three to four chambers are in the last coil, the last one is sack-like in shape. Aperture interiomarginal. Two forms are figured, one without sack-like last chamber. Maximum diameter of figured species LP 251 = 0.60 mm., LP 251 = 0.52 mm.

Sphaeroidinella dehiscens (PARKER & JONES)

(Pl. 3, Fig. 19)

1957 *Sphaeroidinella dehiscens* (PARKER & JONES) — BOLLI, LOEBLICH & TAPPAN, U. S. Nat. Mus. Bull. 215, p. 32, pl. 6, figs. 1—5.

1962 *Sphaeroidinella dehiscens* (PARKER & JONES) — PARKER, Micropal., vol. 8, no. 2, p. 234, pl. 5, figs. 1—2.

This species is frequently found in sample JDE III. Maximum diameter of figured species JDE III = 0.80 mm.

Genus *Globoquadrina* FINLAY, 1947

Globoquadrina altispira altispira (CUSHMAN & JARVIS)

(Pl. 3, Fig. 16)

1957 *Globoquadrina altispira altispira* (CUSHMAN & JARVIS) — BOLLI, U. S. Nat. Mus. Bull. 215, p. 111, pl. 24, figs. 7—8.

1960 *Globoquadrina altispira* (CUSHMAN & JARVIS) — COLE, TODD & JOHNSON, Bull. American Pal., vol. 41, no. 186, p. 107, pl. 3, figs. 3—7.

Maximum diameter of figured species LP 251 = 0.50 mm., height of coiling = 0.45 mm.

Globoquadrina altispira globosa BOLLI

(Pl. 3, Fig. 15)

1957 *Globoquadrina altispira globosa* BOLLI — U. S. Nat. Mus. Bull. 215, p. 111, pl. 24, fig. 9.

1964 *Globoquadrina altispira* (CUSHMAN & JARVIS) — TODD, Geol. Surv. Prof. Paper, 260-CC, p. 1081, pl. 291, fig. 4.

Maximum diameter of figured species LP 251 = 0.57 mm., height of coiling = 0.40 mm.

Globoquadrina dutertrei (D'ORBIGNY)

(Pl. 5, Fig. 27)

1941 *Globigerina aff. cretacea* D'ORBIGNY — LEROY, Colorado School of Mines Quarterly, vol. 36, no. 1, pt. 1, p. 43, pl. 2, figs. 108—110.

1962 *Globoquadrina dutertrei* (D'ORBIGNY) — PARKER, Micropal., vol. 8, no. 2, p. 242 to 244, pl. 7, figs. 10—13.

Shape of test trochospiral, exial periphery broadly rounded; wall calcareous, perforate, surface coarsely pitted; chambers about 10 to 12 arranged in 2 to 3 whorls; the five chambers of the last coil increase fairly rapidly in size. Sutures radial, strongly depressed; aperture high arch, bordered above by thin lip. This species is rarely found in samples from Bali. Maximum diameter of figured species LP 241 = 0.42 mm.

Genus *Orbulina* D'ORBIGNY, 1839

Orbulina suturalis BRÖNNIMANN

(Pl. 4, Fig. 25)

1957 *Orbulina universa* D'ORBIGNY — BOLLI, U. S. Nat. Mus. Bull. 215, p. 115, pl. 27, fig. 4.

This species is frequently found in sample LP 241. Matimum diameter of figured species LP 241 = 0.65 mm.

Orbulina universa D'ORBIGNY

(Pl. 4, Fig. 24)

1957 *Orbulina universa* D'ORBIGNY — BOLLI, U. S. Nat. Mus. Bull. 215, p. 115, pl. 27, fig. 5.

This species is found in samples LP 241 and LP 251. Maximum diameter of figured species LP 241 = 0.65 mm.

Genus *Globigerinoides* CUSHMAN, 1927

Globigerinoides trilobus trilobus (REUSS)

(Pl. 1, Fig. 1)

1956 *Globigerinoides triloba* (REUSS) — BLOW, Micropal., vol. 2, no. 1, p. 62, fig. 1.
1960 *Globigerinoides triloba triloba* (REUSS) — JENKINS, Micropal., vol. 6, no. 4, p. 353, pl. 2, fig. 5.

This species is fairly abundant in samples LP 241 and LP 251. Maximum diameter of figured species LP 241 = 0.35 mm.

Globigerinoides trilobus immaturus LEROY

(Pl. 1, Fig. 2)

1957 *Globigerinoides triloba immatura* LEROY — U. S. Nat. Mus. Bull. 215, p. 113, pl. 25, figs. 5—6.
1962 *Globigerinoides quadrilobatus immatura* — BELDFORD, Bull. 62-1-N, Guinea Foram, p. 5, pl. 3, figs. 1—4.

This species is found commonly in sample LP 251. Maximum diameter of figured species LP 251 = 0.45 mm.

Globigerinoides sacculiferus (BRADY)

(Pl. 1, Fig. 3)

1957 *Globigerinoides triloba sacculifera* (BRADY) — BOLLI, U. S. Nat. Mus. Bull. 215, p. 113, pl. 25, figs. 5—6.
1962 *Globigerinoides quadrilobatus sacculifer* — BELDFORD, Bull. 62-1-N Guinea Foram, p. 5, pl. 4, figs. 1—6.

This species is fairly common in samples from Bali. Maximum diameter of figured species LP 251 = 0.50 mm.

Globigerinoides ruber D'ORBIGNY

(Pl. 2, Fig. 8)

1960 *Globigerinoides rubra* (D'ORBIGNY) — JENKINS, Micropal., vol. 6, no. 4, p. 354, pl. 2, figs. 8—9.

This species is frequently found in sample JDE III. Maximum diameter of figured species JDE III = 0.37 mm.

Globigerinoides obliquus obliquus BOLLI

(Pl. 1, Fig. 4)

1966 *Globigerinoides obliquus obliquus* BOLLI — Eclogae Geol. Helv., vol. 59, no. 1, pl. 1, figs. 18—19.

Maximum diameter of figured species LP 251 = 0.42 mm.

Globigerinoides obliquus extremus BOLLI & BERMUDEZ

(Pl. 1, Fig. 5)

1966 *Globigerinoides obliquus extremus* BOLLI & BERMUDEZ — Eclogae Geol. Helv. vol. 59, no. 1, pl. 1, figs. 17—21.

This subspecies is frequently found in samples LP 241 and LP 251. Maximum diameter of figured species LP 251 = 0.35 mm.

Globigerinoides conglobatus (BRADY)

(Pl. 1, Figs. 6 and 7)

1962 *Globigerinoides conglobatus* (BRADY) — BELDFORD, Bull. 62-1-N. Guinea Foram., p. 18, pl. 4, figs. 15—20.

Two different forms are illustrated. One with bulla covering the umbilicus. This species is found only in sample LP 241. Maximum diameter of figured species LP 241 = 0.55 mm and 0.55 mm.

Family *Hantkeninidae* CUSHMAN, 1927

Genus *Hastigerina* THOMPSON, 1876

Hastigerina aequilateralis (BRADY)

(Pl. 4, Figs. 26)

1957 *Hastigerina aequilateralis* (BRADY) — BOLLI, U. S. Nat. Mus. Bull. 215, p. 108, pl. 22, figs. 1—2.

1962 *Hastigerina aequilateralis* (BRADY) — BELDFORD, Bull. 62-1-N, Guinea Foram., p. 21, pl. 5, figs. 15—18.

This species is rarely found in samples of Bali. Maximum diameter of figured species LP 241 = 0.37 mm.

Family *Globorotaliidae* CUSHMAN, 1927

Genus *Globorotalia* CUSHMAN, 1927

Globorotalia margaritae BOLLI & BERMUDEZ

(Pl. 7, Fig. 39)

1965 *Globorotalia margaritae* BOLLI & BERMUDEZ — Boletin Informativo Asociacion Venezolana De Geología Minería y petroleo, vol. 8, no. 5, p. 139, pl. 1, figs. 16—18.

Shape of test low trochospiral, spiral side very convex, umbilical side less convex; axial periphery acute with thin distinct keel. Wall calcareous, finely perforate, surface smooth finely pitted; chambers about 10 to 12 arranged in 2 to 2½ whorls; the five chambers of the last coil increase fairly rapidly in size. Sutures on spiral side strongly curved, slightly depressed; on umbilical side radial and slightly curved. Aperture a slit bordered above by a small thin lip. In Bali this species is frequently found in sample LP 251. Eight specimens were selected, all of them are sinistrically coiled. Maximum diameter of figured species LP 251 = 0.35 mm.

Globorotalia crassaformis (GALLOWAY & WISSLER)

(Pl. 7, Fig. 38)

1949 *Globorotalia crassula* CUSHMAN & STEWART — BOOMGART, Doctoral thesis Univ. Utrecht Netherland, p. 143, pl. 13, fig. 16.

1962 *Globorotalia crassaformis* (GALLOWAY & WISSLER) — PARKER, Micropal., vol. 8, no. 2, p. 253, figs. 17—18.

Shape of test trochospiral, umbilical side highly convex, spiral side nearly flat; axial periphery rounded. Wall calcareous, coarsely beaded; the four chambers of the last whorl increase gradually in size; sutures distinct, slightly curved on spiral side. Aperture a slit situated at the base of a flat apertural face.

This species is frequently found in sample JDE III. Five specimens were picked up, three of them are sinistrally coiled. Maximum diameter of figured species JDE III = 0.55 mm.

Globorotalia cultrata (D'ORBIGNY)

(Pl. 7, Fig. 40)

1962 *Globorotalia cultrata* (D'ORBIGNY) — PARKER, Micropal., vol. 8, no. 2, p. 235, pl. 5, figs. 3—5.

Shape of test low trochospiral, spiral side slightly convex, umbilical side fairly concave; wall calcareous, surface smooth, beaded on thick keel; chambers about 12 arranged in 2½ whorls, 6 in the last coil, inflated, the last two compressed. Sutures deeply incised, slightly curved on the umbilical side, strongly curved and limbate dorsally. Aperture is not clear. This species is found only in sample LP 241. Twenty specimens were picked up; all of them are dextrally coiled. Maximum diameter of figured species LP 241 = 0.67 mm.

Globorotalia tumida (BRADY)

(Pl. 7, fig. 37, Pl. 6, Figs. 34 and 35)

1957 *Globorotalia tumida* (BRADY) — BOLLI, LOEBLICH & TAPPAN, U. S. Nat. Mus. Bull. 215, p. 41, pl. 10, fig. 2.

1964 *Globorotalia tumida* (BRADY) — TODD, U. S. Geol. Survey Prof. Paper, 260-CC, p. 1094, pl. 294, fig. 3.

Three forms of Bali species are illustrated one with slightly folded last chamber. This species is frequently found in samples LP 251 and JDE III, and rarely in sample LP 241. Fifteen specimens were picked up from each sample LP 251 and JDE III; all of them are sinistrally coiled. Matimum diameter of figured species LP 241 = 0.57 mm, LP 251 = 0.70 mm, and JDE III = 0.72 mm.

Globorotalia tumida flexuosa (KOCH)

(Pl. 6, Fig. 36)

1964 *Globorotalia tumida flexuosa* (KOCH) — TODD, U. S. Geol. Surv. Prof. Paper, 260-CC, p. 1094, pl. 294, fig. 4.

This subspecies is rarely found in sample LP 251. Maximum diameter of figured species LP 251 = 0.85 m.

Globorotalia menardii (D'ORBIGNY)

(Pl. 6, fig. 32, Pl. 5, Figs. 30 and 31)

1957 *Globorotalia menardii* (D'ORBIGNY) — BOLLI, U. S. Nat. Mus. Bull. 215, p. 120, pl. 29, figs. 6—10.

1960 *Globorotalia menardii* (D'ORBIGNY) — JENKINS, Micropal., vol. 6, no. 4, p. 362, pl. 4, fig. 8.

This species is fairly abundant in all samples from Bali. Three forms are illustrated. Twenty-two specimens were picked up from sample LP 241 and thirty-one from sample JDE III; all of them are dextrally coiled. Of the 27 specimens picked up from sample LP 251, 24 are sinistrally coiled. Maximum diameter of figured species LP 241 = 0.85 mm., LP 251 = 0.70 mm., JDE III = 0.77 mm.

Globorotalia scitula (BRADY)

(Pl. 6, Fig. 33)

1945 *Globorotalia canariensis* (D'ORBIGNY) — CUSHMAN & STAINFORTH, Cush. Lab. Foram. Res., spec. publ., vol. 14, p. 70, pl. 3, fig. 12.

1957 *Globorotalia scitula* (BRADY) — BOLLI, U. S. Nat. Mus. Bull. 215, p. 120, pl. 29, figs. 11—12.

Maximum diameter of figured species LP 251 = 0.40 mm.

Globorotalia obesa BOLLI

(Pl. 5, Fig. 29)

1957 *Globorotalia obesa* BOLLI, n. sp. — U. S. Nat. Mus. Bull. 215, pl. 19, pl. 29, fig. 2.

This species is common in sample LP 251. Maximum diameter of figured species LP 251 = 0.35 mm.

Globorotalia cf. *acostaensis* BLOW

(Pl. 5, Fig. 28)

1967 *Globorotalia (Turborotalia) acostaensis* BLOW — BANNER & BLOW, Micropal., vol. 13, no. 2, pl. 1, fig. 1 and pl. 3, fig. 1.

Shape of test trochospiral, axial periphery broadly rounded; umbilicus slightly depressed; wall calcareous, surface beaded; chambers about 8 arranged in two whorls, 5 in the last coil. Sutures radial, slightly curved, deeply depressed; aperture a slit, opens from periphery to umbilicus, bordered above by a lip. This species is found only in sample LP 241. Maximum diameter of figured species LP 241 = 0.32 mm.

Acknowledgment

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Darwin Kadar

plates 1 to 7

PLATE 1.

Figs. 1 a—c. *Globigerinoides trilobus trilobus* (REUSS).
LP 241; 100 ×.
Figs. 2 a—c. *Globigerinoides trilobus immaturus* LEROY.
LP 251; 64 ×.
Figs. 3 a—c. *Globigerinoides sacculiferus* (BRADY).
LP 251; 64 ×.
Figs. 4 a—c. *Globigerinoides obliquus obliquus* BOLLI.
LP 251; 64 ×.
Figs. 5 a—c. *Globigerinoides obliquus extremus* BOLLI & BERMUDEZ.
LP 251; 64 ×.
Figs. 6 a—c. *Globigerinoides conglobatus* (BRADY).
LP 241; 64 ×.
Figs. 7 a—c. *Globigerinoides conglobatus* (BRADY).
LP 241; 64 ×.

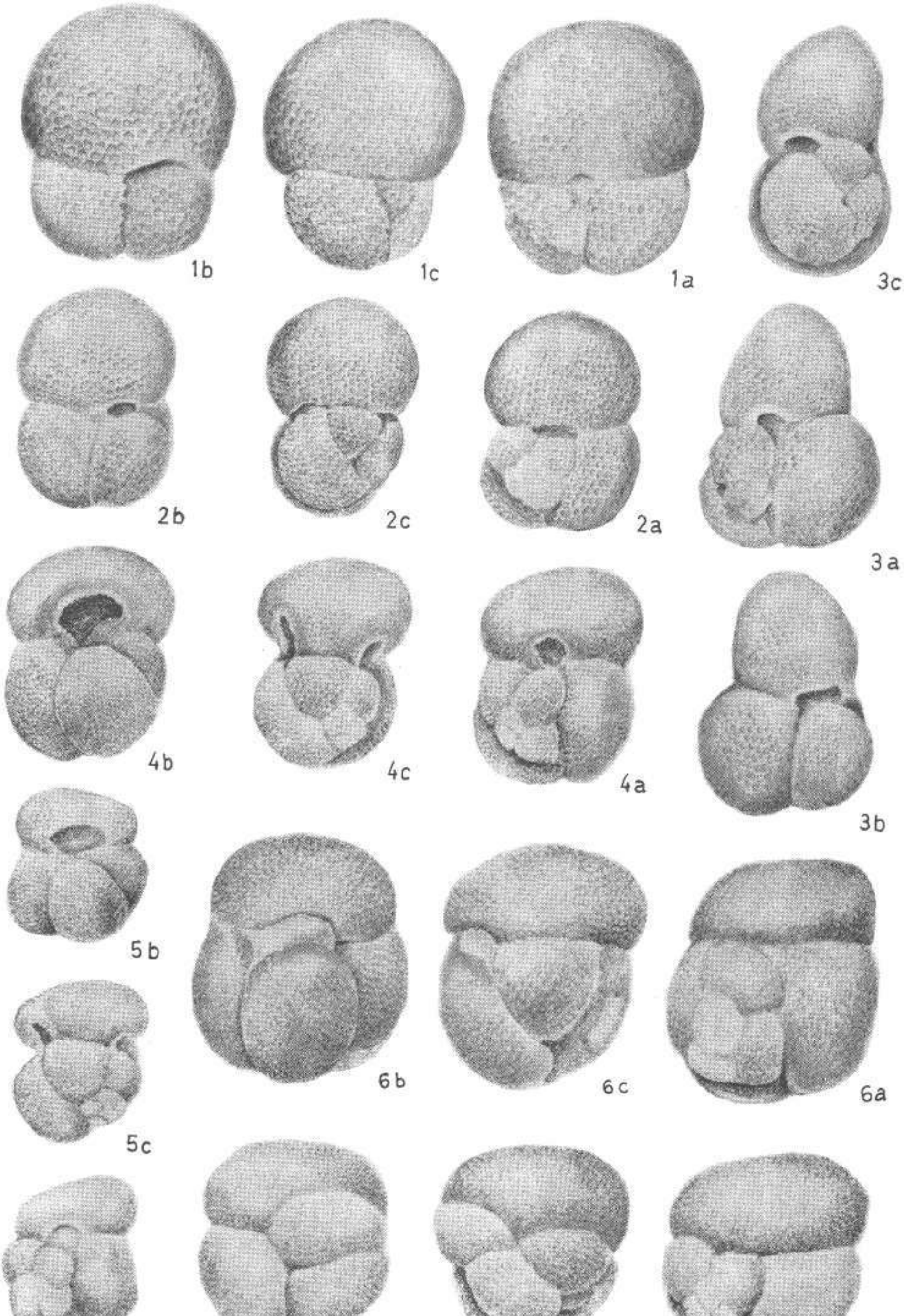
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PLATE 2.

Figs. 8 a—c. *Globigerinoides ruber* D'ORBIGNY.
JDE III; 100 ×.
Figs. 9 a—c. *Globigerina rubescens* HOFKER.
LP 251; 100 ×.
Figs. 10 a—c. *Globigerina foliata* BOLLI.
LP 241; 100 ×.
Figs. 11 a—c. *Globigerina nepenthes* TODD.
LP 241; 100 ×.
Figs. 12 a—c. *Globigerina glutinata* (EGGER).
LP 251; 100 ×.
Figs. 13 a—c. *Globigerina pachyderma* (EHRENBERG).
LP 251; 64 ×.
Figs. 14 a—c. *Globigerina venezuelana* HEDBERG.
LP 241; 64 ×.

PLATE 2

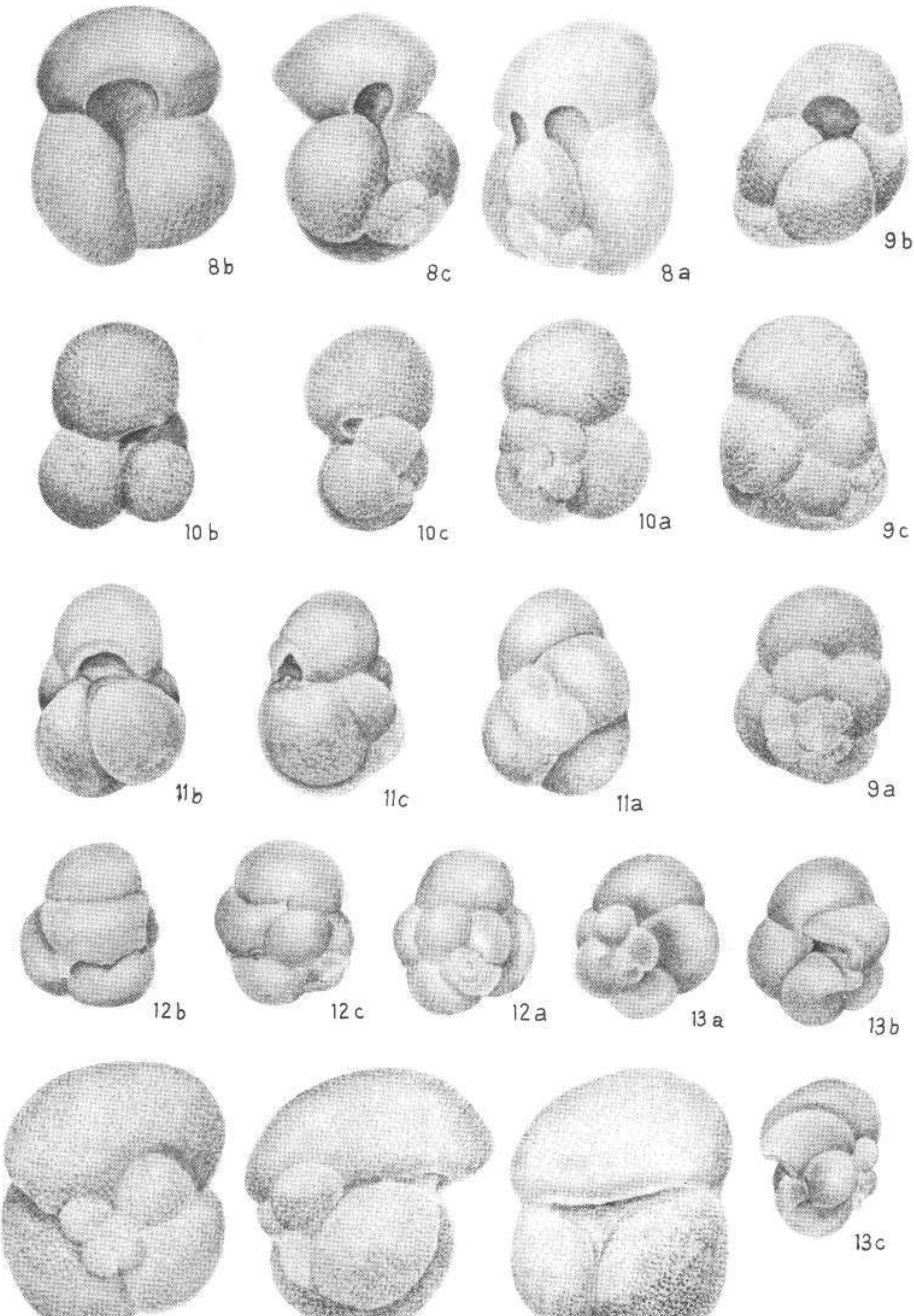
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PLATE 3.

Figs. 15 a—c. *Globoquadrina altispira globosa* BOLLI.
LP 251; 64 ×.
Figs. 16 a—c. *Globoquadrina altispira altispira* (CUSHMAN & JARVIS).
LP 251; 64 ×.
Figs. 17 a—c. *Sphaeroidinella seminulina* (SCHWAGER).
LP 251; 64 ×.
Figs. 18 a—c. *Sphaeroidinella seminulina* (SCHWAGER).
LP 251; 64 ×.
Figs. 19 a—c. *Sphaeroidinella dehiscens* (PARKER & JONES).
JDE III; 50 ×.
Figs. 20 a—c. *Pulleniatina primalis* BANNER & BLOW.
LP 241; 64 ×.

PLATE 3

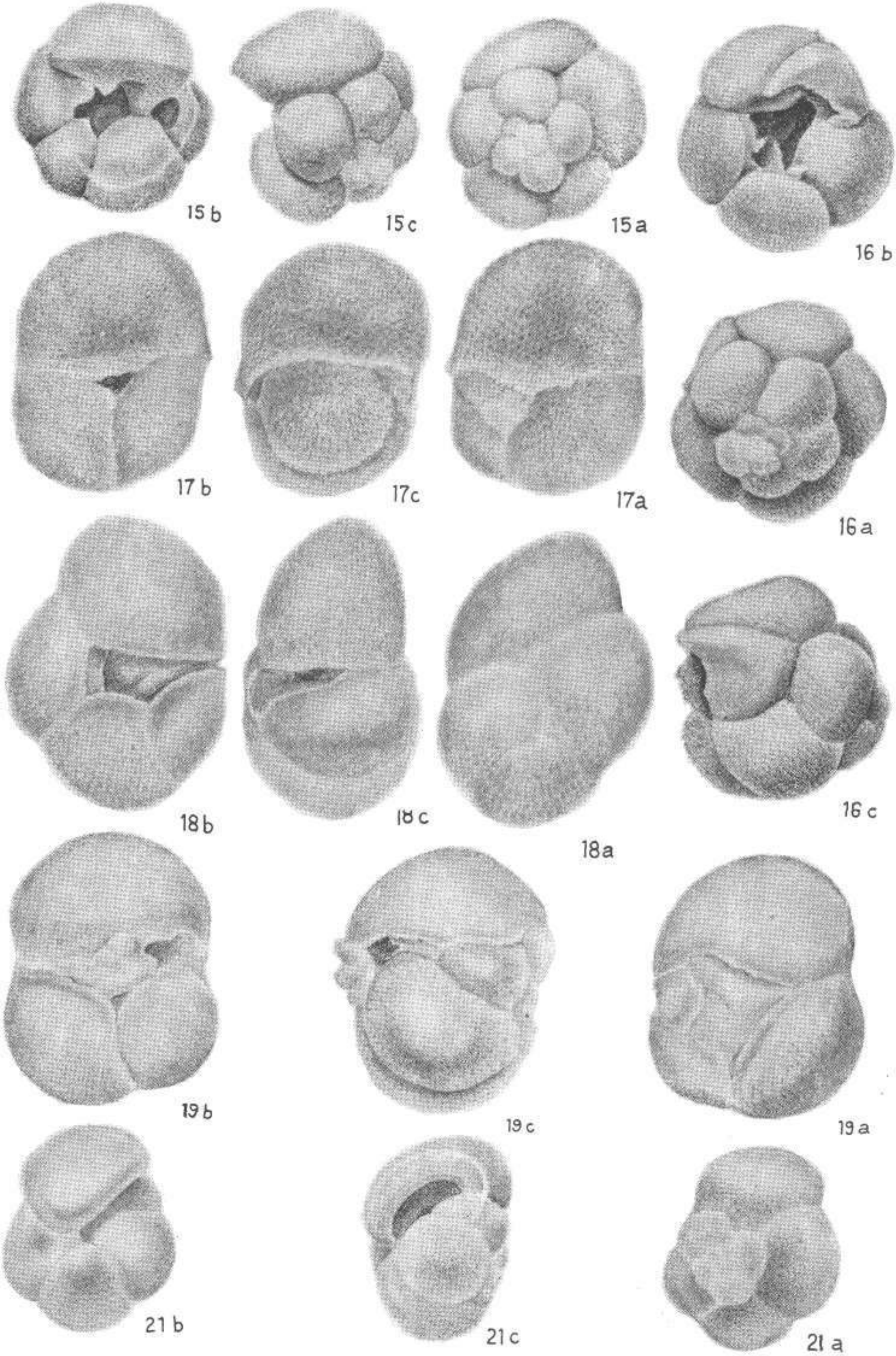
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PLATE 4.

Figs. 21 a—c. *Pulleniatina primalis* BANNER & BLOW.
LP 251; 64 ×.
Figs. 22 a—c. *Pulleniatina obliquiloculata praecursor* (PARKER & JONES)
JDE III; 64 ×.
Figs. 23 a—c. *Pulleniatina obliquiloculata obliquiloculata* (PARKER & JONES)
JDE III; 64 ×.
Figs. 24. *Orbulina universa* D'ORBIGNY.
LP 241; 50 ×.
Figs. 25 a—b. *Orbulina suturalis* BRÖNNIMANN.
LP 241; 50 ×.
Figs. 26 a—c. *Hastigerina aequilateralis* (BRADY).
LP 241; 100 ×.

PLATE 4

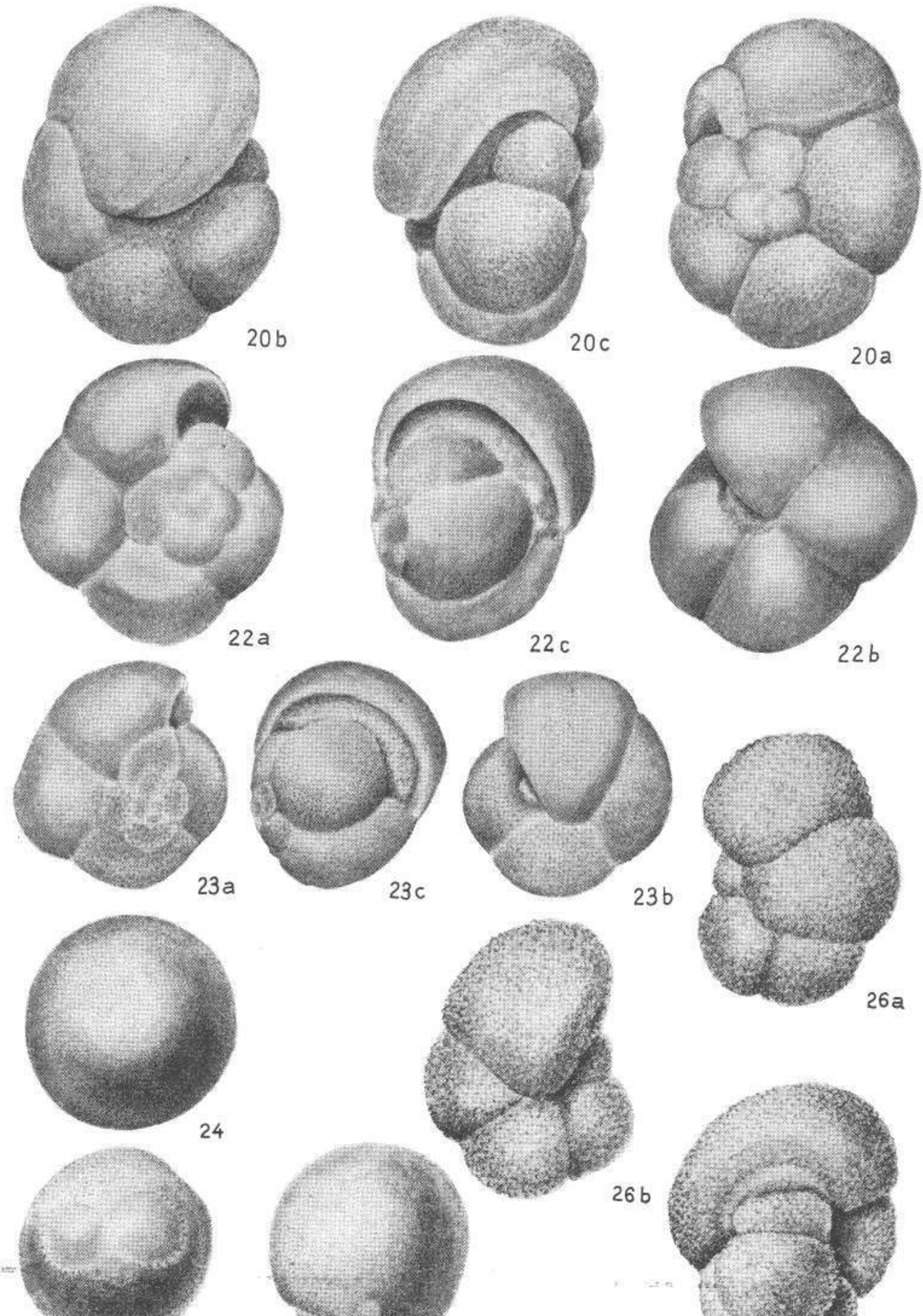


PLATE 5.

Figs. 27 a—c. *Globoquadrina dutertrei* (D'ORBIGNY).
LP 241; 100 ×.
Figs. 28 a—c. *Globorotalia* cf. *acostaensis* BLOW.
LP 241; 100 ×.
Figs. 29 a—c. *Globorotalia obesa* BOLLI.
LP 251; 100 ×.
Figs. 30 a—c. *Globorotalia menardii* (D'ORBIGNY).
LP 251; 64 ×.
Figs. 31 a—c. *Globorotalia menardii* (D'ORBIGNY).
LP 241; 64 ×.

PLATE 5

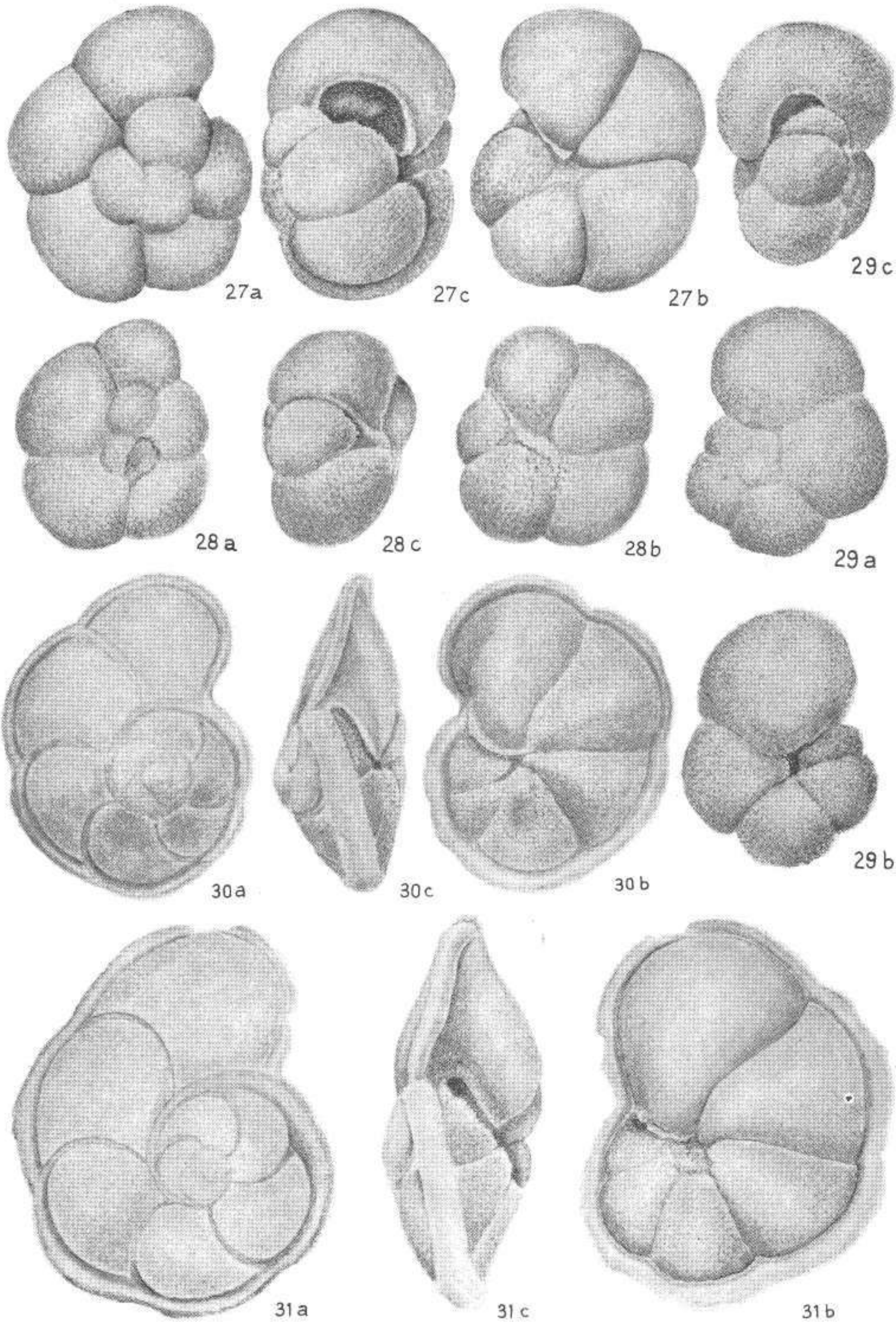


PLATE 6.

Figs. 32 a—c. *Globorotalia menardii* (D'ORBIGNY).
JDE III; 50 ×.
Figs. 33 a—c. *Globorotalia scitula* (BRADY).
LP 251; 64 ×.
Figs. 34 a—c. *Globorotalia tumida* (BRADY).
LP 251; 64 ×.
Figs. 35 a—c. *Globorotalia tumida* (BRADY).
LP 251; 64 ×.
Figs. 36 a—c. *Globorotalia tumida flexuosa* (KOCH).
LP 251; 64 ×.

PLATE 6

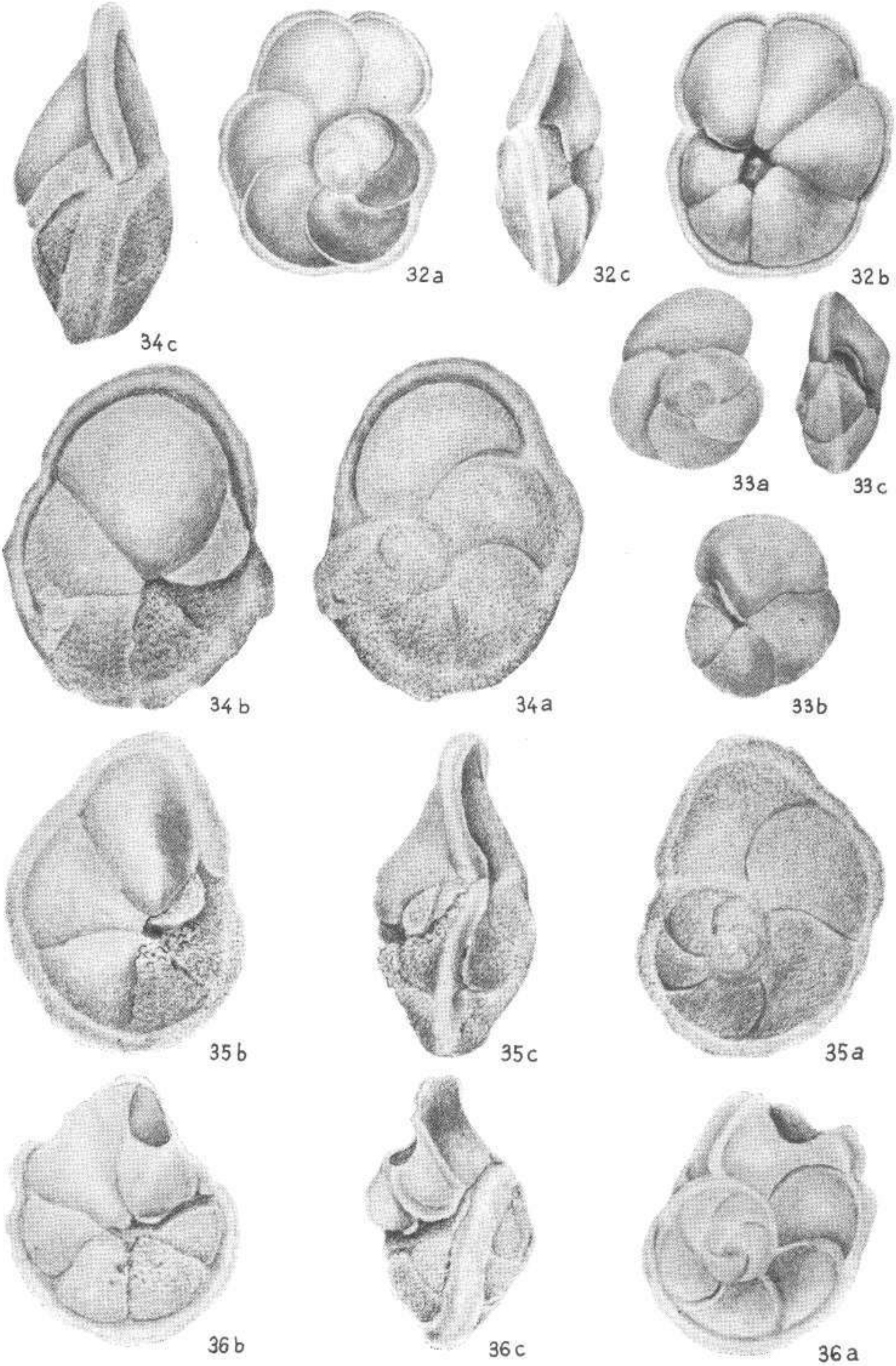
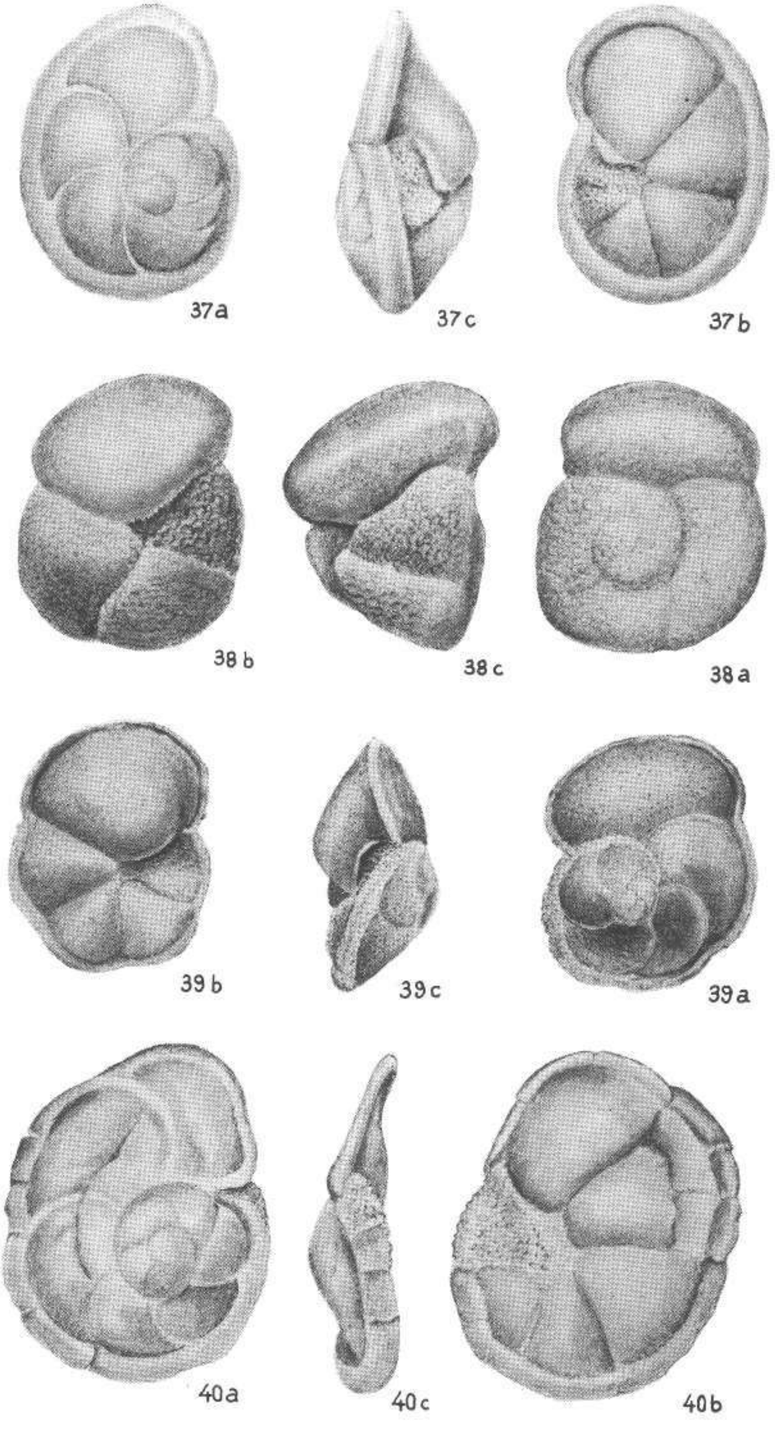


PLATE 7.

Figs. 37 a—c. *Globorotalia tumida* (BRADY).
LP 241; 64 ×.
Figs. 38 a—c. *Globorotalia crassaformis* (GALLOWAY & WISSLER).
JDE III; 64 ×.
Figs. 39 a—c. *Globorotalia margaritae* BOLLI & BERMUDEZ.
LP 251; 100 ×.
Figs. 40 a—c. *Globorotalia cultrata* (D'ORBIGNY).
LP 241; 64 ×.

PLATE 7



Significant Upper Triassic Microspores from Bleiberg, Austria *)

(with 3 plates)

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Abstract

Selected plant microfossils from the Cardita Shales of Upper Triassic age (Carnian) of Austria are presented. Some forms are stratigraphically important and of use in identifying the three different shale units. Seventeen species from sixteen genera are recorded of which five are new.

Introduction

This study is based on fourteen samples from the Antonio-Middle shaft of lead and zinc mines of Bleiberg (Lat. 46° 37′; Long. 31° 19′) in southern Austria. These samples belong to the Cardita Shales, (Carnian stage, Upper Triassic) the age of which is also confirmed by the presence of Cardita gümbeli. This is the second paper by the same author on these samples. In the first investigation, "The results of statistical analysis in Palynology from the Cardita shales (Upper Triassic) of Bleiberg, Austria" 1966 it is demonstrated, that the numerical analysis of spores and pollen assemblages is applicable in finer stratigraphical subdivision of the Upper Triassic sediments. It is also discussed that the three studied shale units (1966 fig. 1) can be readily distinguished from each other by some of the microfloras contained in them. About 54 genera and 85 species of alete, monolete, trilete spores, and pollen grains with disaccate forms of both striate and nonstriated types were enlisted.

In this paper an attempt has been made to describe only some of the important forms mentioned in the earlier paper. Seventeen species belonging to sixteen genera have been illustrated and discussed.

*) This work has been carried out 1965 at the UNESCO Center for Geology; a revision was established during the Refresher Colloquium 1971.

This investigation reveals that the genus Raistrickia is not restricted to the Paleozoic, but can also be found in the Upper Alpine-Triassic sediments. The figured specimens are based on the single grain preparation (S. G. P.). Slides and all the types are deposited at the Palynological laboratory of the Geological Survey of Austria, Vienna.

Systematic Descriptions

Anteturma *Sporites* H. POTONIÉ, 1893

Turma *Triletes* REINSCH, 1881

Subturma *Azonotriletes* LUBER, 1935

Infraturma *Laevigati* (BENNIE & KIDSTON, 1886) POTONIÉ, 1956

Genus *Aulisporites* (LESCHIK, 1955) KLAUS, 1960

Aulisporites astigmosus (LESCHIK) KLAUS, 1960
(Pl. 1, Fig. 1)

Calamospora astigmosus LESCHIK, 1955, p. 22, pl. 2, fig. 17.
Aulisporites astigmosus (LESCHIK) KLAUS, 1960, p. 119, pl. 28, figs. 2—3; VENKATACHALA & GOĆZAN, 1964, P. 210, pl. 1, fig. 7.

Remarks: The illustrated figure with many other specimens that are fairly abundant in all examined samples, corresponds completely with the given description by KLAUS. They are dark brown in colour, subcircular in outline, and have two major folds. Trilete rays clear, but short and usually confined to a small bright circle. Exine is smooth to very finely punctate. The greatest diameter is 64 microns.

Infraturma *Apiculati* (BENNIE & KIDSTONE, 1886) POTONIÉ & KREMP, 1954

Subinfraturma *Baculati* DYBOVA & JACHOWICZ, 1957

Genus *Raistrickia* (S., W., 1944) POTONIÉ & KREMP, 1954

Generotype: *Raistrickia grovensis* SCHOPF, 1944, p. 55, text. fig. 3.

Discussion of the genus: SCHOPF, WILSON & BENTALL, 1944 in the description of the genus *Raistrickia* refer to a rounded subtriangular trilete spore ornamented with heavy truncate spines, which usually split at the terminals. In emending this genus POTONIÉ & KREMP (1954) mentioned the existence of coni between the "bacula", and expressed the opinion, that truncations are not a natural phenomenon but they are due to a latter irregular breaking of the bacula. But presence of the coni have hardly been mentioned by the other authors in the descriptions of their species. They are probably the projections of bacula from one side (distal) on to other (proximal) side. KOSANKE (1950) in the description of *R. prisca* records the existence of the „area contagionis" and the "dotlike thickenings" ornamentation around this region. Many of the workers are of the opinion, that the proximal sides of the specimens of this genus are as spinose as the distal sides. Illustrated figures of *R. protensa* and *R. crocea* of KOSANKE (1950) appear to show that the bacula are from the distal sides.

In addition to the above statements in regard to *Raistrickia* the remarks of POTONIÉ on genus *Neoraistrickia* are also considered. This genus is erected by POTONIÉ from *Trilites truncatus* of COOKSON due to its higher stratigraphic position and absence of coni between the bacula.

Raistrickia alpina n. sp.

(Pl. 1, Figs. 6, 8)

Holotype: Raistrickia alpina n. sp. Pl. 1, Figs. 6, 8. S. G. P. slide No. 1004, sample No. 1077. Deposited at the Palynological Lab., Geol. Survey of Austria, Vienna.

Diagnosis: Spores are trilete, and are more or less spheroidal in shape. The entire sporecoat is covered with terminally bifurcated bacula except for the area contaginous. This area is ornamented differently as granulose, etc.

Dimensions: 65, (55), 45 microns.

Type locality: Austria, Bleiberg (Antonio-Middle shaft, sample No. 1077).

Type level: Upper Triassic, Carnian (Lower Middle Keuper).

Description: Spore is essentially spherical. Trilete mark is inconspicous, but the contact area is distinct and has rounded borders. Exine is thick, and except for the contact area is covered with evenly distributed long, truncate baculiform projections. Bacula are spaced at 3—6 microns approx. The projections are 2—3 microns in length and about 2—3 microns in diameter. The appex of the projections are usually bifurcated. Contact area is without bacula, but covered with scattered, top rounded granular ornamentations. Holotype measures 55 microns in diameter.

Remarks: On the description and in consideration of the discussion given above, this species is classified under the genus *Raistrickia* regardless of its being restricted to the Paleozoic. This new species is rather rare in the Bleiberg samples, it is characterized by its spherical shape, bifurcating bacula, distinct contact area, and granular ornamentations of the area between the rays. To the present author the proximal and the distal sides of the spores, belonging to this genus having evenly distributed baculiform ornamentations, appear to be doubtful. On the other hand this investigation indicates that the proximal sides around the contact area are without bacula. The new character for this genus is the presence of contact area bearing a different ornamentation than the spore coat outside of the curvature.

The author is also of the opinion that the *Raistrickia* and *Neoraistrickia* are congeneric.

Infraturma *Murornati* POTONIÉ & KREMP, 1954

Genus *Anulispora* DE JERSEY, 1959

Anulispora punctus (KLAUS)

(Pl. 1, Fig. 7)

Distalanulisporites punctus KLAUS, 1960, p. 133, pl. 28, fig. 8.

Description: Spore subcircular in equatorial counter. Proximal side is marked by a very pronounced incised trilete mark. Trilete rays do not reach the equator and disappear sharply at $^2/_3$ of the radius. Distal side is characterized by the presence of a thick ring about 5 microns broad and 15—18 microns in diameter. Outer exine is dark yellow and of thickness 4 microns. Surface ornamentation of the exine is punctate. The figured specimen is 36 microns in diameter.

Remarks: This species is closely similar in all respects to the *Distalanulisporites punctus* KLAUS, except in that the trilete rays do not reach the equator.

This characteristic Triassic spore is included in the genus *Anulispora* of DE JERSEY rather than the *Distalanulisporites* KLAUS. DE JERSEY, the first author of *Anulispora,* describes the forms in which the rays do not reach the equator (1962) and also those in which the surface is not smooth (1964).

Genus *Lycopodiacidites* (COUPER, 1953) POTONIÉ, 1956

Lycopodiacidites kuepperi KLAUS

(Pl. 1, Figs. 3 and 4)

Lycopodiacidites kuepperi KLAUS, 1960, p. 135, pl. 31, fig. 27.

Description: The spore is round in equatorial outline. Trilete mark is distinct, extending almost to the equator. Trilete rays are bordered by broad but slightly raised thickenings. Proximal side is essentially smooth and without structure. Distal side is sculptured with irregular ridges about 2—3 microns thick. Exine margin is smooth and about 4 microns thick in optical section. Average diameter of the studied specimen is 44 microns.

Remarks: This species is not very abundant, but generally present in all samples of Bleiberg, and is identical with the species described by KLAUS.

Genus *Corrugatisporites* (THOMSON & PFLUG, 1953) ex. WEYLAND & GREIFELD, 1953

Corrugatisporites klausi n. sp.
(Pl. 2, Figs. 1 and 2)

Generotype: *Corrugatisporites toratus*, WEYLAND & GREIFELD, 1953, p. 42, figs. 56—59 (Lectogenerotype fig. 57, POTONIÉ & KREMP, 1955, p. 96; POTONIÉ, 1956, p. 41).

Discussion of the genus: In the description of *Corrugatisporites toratus* and other related forms no specific mention is made about the ornamentation of the distal side. In view of the general appearance of the shape, and surface features already described by early workers, the species described below is tentatively included in this genus. However, the distal fold-like thickening of the present form, is not in accordance with the generotype.

Corrugatisporites klausi n. sp.
(Pl. 2, Figs. 1 and 2)

Holotype: *Corrugatisporites klausi* n. sp. Pl. 2, Figs. 1 and 2. S. G. P. slide No. 1006, sample No. 1077. Deposited at the Palynological Lab., Geol. Survey of Austria, Vienna.

Diagnosis: Round to subtriangular spores, having a developed trilete mark with rays reaching the cingulum, finely pitted surface, somewhat feeble proximal sculptures, and a circular distal fold-like feature.
Dimension: The type specimen is 54 microns in diameter.

Type locality: Austria, Bleiberg, (Antonio-Middle shaft, sample 1077).

Type level: Upper Triassic, Carnian (Lower Middle keuper).

Description: Spore is round to slightly subtriangular in equatorial outline. Trilete mark on the proximal side is distinct, but the rays are not bordered by lips. Trilete rays are long, straight, and almost reach the cingulum. Proximal side is nearly flat and sculptured with two to three parallel rows of discontinuous ridges. These ridges in polar view present a triangular appearance specially towards the center. The cingulum is relatively thin and almost has the same width as the proximal ridges. The distal surface is ornamented by a nearly fold-like thickning feature running closely parallel to the cingulum. Exine is finely pitted.

Remarks: This species is infrequent, but found sporadically distributed in all the samples. It differs from any other species described so far by its well developed trilete mark, finely pitted surface, less pronounced proximal sculptures, and circular distal fold feature.

Genus *Zebrasporites* Klaus, 1960

Zebrasporites kahleri Klaus

Zebrasporites kahleri Klaus, 1960, p. 138, pl. 30, figs. 18—20.

Remarks: This distinct trilete spore is readily identified by its triangular central body, circular equatorial zone, a smooth proximal side, and the radial arrangements of the rugae on the distal side.

Although this species is a rare form among the Bleiberg plant microfossils, its occurrence is of great importance, as it presumably occurs only in shale unit No. 2. Diameter of the figured specimen is 52 microns.

Turma *zonales* (Beenie & Kidstone, 1886) Potonié & Kremp, 1954

Subturma *Zonotriletes* Waltz, 1935

Infraturma *Zonati* Potonié & Kremp, 1954

Genus *Styxisporites* Cookson &Dettmann, 1958

Styxisporites cooksonae Klaus

(Pl. 2, Figs. 3 and 4)

Styxisporites cooksonae Klaus, 1960, p. 141, pl. 31, figs. 29, 31.

Description: Spore is roundly triangular to moderately subcircular in equatorial outline. Central body circular, dark brown in colour and thickwalled. Distal side of the central body is irregularily covered with 26—30 conical spines, sometimes up to 5 microns thick. Several unequally distributed pores, specially on the proximal side, are visible in deep focus. Trilete rays distinct, rays bordered by lips and extend almost to the limit of the inner part. Outer flange is bright yellow, thin and smooth. Breadth of the flange varies at places from 9—16 microns. Longest diameter of the figured specimen is 72 microns, and the shortest diameter is 66 microns.

Remarks: This form is undoubtedly similar to *Styxisporites cooksonae* Klaus. Its occurrence in the Bleiberg samples is sporadical but seems to be somewhat more frequent in shale unit No. 3. It is less frequent in shale unit No. 2, and extremely rare to absent in shale unit No. 1.

If the distinct trilete scar is absent in the present form, it can probably be included in the genus *Kraeuselisporites* Leschik belonging to the Subturma *Zonaletes* (as in Potonié, 1958, p. 83). But, as it appears, this form is more identifiable with Styxisporites belonging to the Subturma *Zonotriletes* and hence, is considered in this genus.

The recent view of Dettmann (1963) in regard to these two genera is also taken into account. It is still believed that the present form differs from *Kraeuselisporites* in having raised lips, different character of the flange, and the very distinct trilete mark.

Turma *Monoletes* IBRAHIM, 1933

Subturma *Zonomonoletes* LUBER, 1935

Genus *Saturnisporites* KLAUS, 1960

Saturnisporites granulatus KLAUS

(Pl. 2, Fig. 5)

Saturnisporites granulatus KLAUS, 1960, p. 143, pl. 32, fig. 34.

Description: Spore is zonomonolete, oval in equatorial outline, and dark brown in colour. Central body is large, surrounded by a thin zone of about 1/8 of the breadth. Monolete scar is flanked on both sides by a thick raised wavy margin, which is not extended beyond the central zone. The wavy feature around the central scar is about 7 microns in width. Exine ornamentation is finely granulose. Length of the figured specimen is 62 microns, and the breadth is 49 microns.

Remarks: This form is quite similar to the species described by KLAUS, but it varies only in being somewhat larger in size.

The author thinks that the genus *Saturnisporites* is quite different from *Aratrisporites* in the following respects. — 1. the outher margin or zone in this genus is very narrow in most cases; 2. the monolete scar does not usually extend beyond the inner zone, and is always flanked on both sides by a raised wavy margin; 3. it also lacks the two polar triangular extensions; and 4. the proximal folds, which are usually present in *Aratrisporites* are not seen in this genus. Furthermore, it is found in a better state of preservation. These differences have been observed in a large number of specimens of both genera and the author holds the opinion of separating them from each other.

It is also necessary to mention, that these two genera are not pollen grains, because the distal side of the central body does not show any significant criterion to assume the existence of any possible air sac around it (BHARADWAJ & SINGH, 1964). Even in case of the occasional presence of folds, these forms can not be assumed to be pollen grains, because such folds may be due to the separation of inner and outer spore walls, as is also observed in *Isoëtaceae* and *Selaginellaceae*.

Genus *Aratrisporites* (LESCHIK, 1955) KLAUS, 1960

Aratrisporites scabratus KLAUS

(Pl. 2, Fig. 6)

Aratrisporites scabratus KLAUS, 1960, p. 147, pl. 32, figs. 37—38; BHARADWAJ & SINGH, 1964, p. 36, pl. 3, figs. 71—75, pl. 4, figs. 76—86.

Description: The spore is zonomonolete, oval to subelliptical in equatorial outline. Central body delimited by a broad zone of about 11 to 6 microns wide on the proximal side. Inward extention of the zone at each pole forms a small triangular area, (anchor), very clearly seen especially, when the spore is compressed. One or two thin folds may cross the central body, along the shortest axis, on the proximal side. Monolete opening is conspicuous, narrow, and extending the full length of the proximal side. It connects the sharp ends of the two triangular areas situated at the poles. Sculpture pattern is dominantly scabrate. Exine outline is marked with a few but scattered spine-like projections, especially at extremities. The figured specimen measures 59 microns in length, and 52 microns in breadth.

Remarks: This species and all the other previously described species belonging to this genus are present in Bleiberg samples. Unfortunatly the state of preservation is poor and specimens usually contain holes. However, this defect does not prevent the specific identification of the examined specimens. The generic value of these forms is only made use of in the finer stratigraphic division of the Bleiberg area. This genus has its greatest occurrence in the shale unit No. 2, and least occurrence in shale unit No. 1.

Anteturma *Pollenites* POTONIÉ, 1931

Subturma *Circumpolles* (PFLUG, 1953) KLAUS, 1960

Infraturma *Singulipollenites* KLAUS, 1960

Genus *Duplicisporites* (LESCHIK, 1955, POTONIÉ, 1958) KLAUS, 1960

Duplicisporites granulatus LESCHIK

(Pl. 1, Fig. 5)

Duplicisporites granulatus LESCHIK, 1955, p. 23, pl. 2, fig. 23; KLAUS, 1960, p. 161, pl. 35, fig. 33; DE JERSEY, 1964, p. 11.

Remarks: The general shape, the size of the grain, granular sculpture of the exine, and the three distinct folds of the distal side, are in complete agreement with the previous descriptions and figures given for this species. The triletes scar is clearly visible in the recorded specimen. This species may occur in all the samples, but always in a limited number. Size of the figured specimen is 42 microns.

Subanteturma *Eupollenites* KLAUS, 1960

Turma *Saccites* ERDTMAN, 1947

Subturma *Disaccites* COOKSON, 1947

Infraturma *Striatiti* PANT, 1954

Genus *Taeniaesporites* (LESCHIK, 1955) KLAUS, 1963

Taeniaesporites kraeuseli LESCHIK

(Pl. 3, Fig. 1)

Taeniaesporites kraeuseli LESCHIK, 1935, p. 59, pl. 8, figs. 1—6.

D e s c r i p t i o n : This illustrated winged-grain is bilaterally symmetrical and broadly oval in outline. The central body is longer than wide and has four horizontals tripes (taeniea) on the proximal side. The two middle stripes are longer and broader, separated from each other by a wider slit. Other slits are conspicuous but narrow. Air sacs are semicircular, approaching closer on the distal side, slightly yellow, and very-finely reticulate.

Dimension 68 × 44 microns, length of the central body 40 microns.

R e m a r k s : The figured specimen and many other similar forms are the dominant types of disaccate pollen grains in the Bleiberg area. This species (in a restricted sense of LESCHIK) is a good stratigraphical indicator for distinguishing the three different shale units. It interesting to note that when this species is more abundant, the genus *Aratrisporites* is relatively less and vice versa.

Şubturma *Monosaccites* (CHITALEY, 1951) POTONIÉ & KREMP, 1954

Infraturma *Aletesaccitus* LESCHIK, 1955

Genus *Enzonalasporites* LESCHIK, 1955

Enzonalasporites tenuis LESCHIK

(Pl. 3, Fig. 4)

Enzonalasporites tenuis LESCHIK, 1955, p. 44, pl. 6, fig. 1; KLAUS, 1960, p. 168, pl. 37, fig. 66.

D e s c r i p t i o n : Shape of the grain is circular in equatorial outline. The central body is circular with diameter of 36 microns, dark brown in colour, and surrounded by a light yellow bladder about 4—5 microns wide. Exine ornamented with small closely packed, and irregularily bent reticulum-like sculptures. Trilete mark is absent. Figure specimen measures 52 microns.

R e m a r k s : This form is identical with the illustrated specimen of KLAUS. It is present in all the samples of Bleiberg but less numerous in shale unit No. 2. The state of preservation is mostly poor and exine ocasionally contains holes due to pyrite impressions.

Turma *Aletes* IBRAHIM, 1933

Subturma *Azonaletes* (LUBER, 1935) POTONIÉ & KREMP, 1954

Infraturma *Granulonapiti* COOKSON, 1947

Araucariacites australis COOKSON

(Pl. 3, Fig. 2)

Granulatisporites (Araucaricites) australis COOKSON, 1947, p. 130—131, pl. 13, figs. 1—4.
Araucariacites australis COOKSON, COUPER, 1953, p. 39; 1958, p. 151, pl. 27, figs. 3—5; BALME, 1964, pl. 6, fig. 17.

Description: Outline oval to subcircular, exine folded with four major folds around the margin. Surface is scabrate to finely granulose, without any germinal opening. Greatest diameter of the figured specimen is 89 microns.

Remarks: Slight variation in size, number of folds, and/or direction of folding among the specimens is present; but they are all inferred to be same as this species. It is the thirdmost abundant form (after *Taeniaesporites* and *Aratriasporites*) in shale units No. 1 and 2.

Turma *Plicates* (Plicata naumova 1937, 1939) POTONIÉ, 1958

Subturma *Praecolpates* POTONIÉ & KREMP, 1954

Genus *Eucommiidites* ERDTMAN, 1948

Generotype: *Tricolpates (Eucommiidites) troedssonii* ERDTMAN, 1948, p. 267, pl. 1, fig. 15.

Grain of medium size, almost prolate, having three colpae usually equal in length with a smooth to structureless exine is recorded by ERDTMAN as the type. The single specimen recorded in this work, in general, appears to have the characteristics of this genus (if it is considered to have a wide variation). The mentioned "ring-furrow" of HUGHES (1961) is not observed in the figured specimen.

Eucommiidites sp.

The sulcus surface is also pitted, but appears somewhat vertically striate in oil immersion. Exine thickness is about 1—1.5 micron in the greater and 2—2.5 microns at the poles. Size of the figured specimen measures 43 microns.

Remarks: This single grain, the only observed specimen from the Bleiberg samples, shows a probable affinity with the genus *Eucommiidites*, but it differs in having a broader median sulcus and much smaller side opening slits. However, the occurrence of this spore in the Triassic sediments is of great significance.

Description: The grain is more or less circular in equatorial outline. It has a long broad sulcus, bordered with two pronounced ridge-like lips, parallel to the sides of the sulcus. Two other short but slightly curved slit-like openings are also present on either side of the sulcus, located near the equatorial margin. Exine is smooth to very finely pitted.

Subturma *Monocolpates* IVERSEN & TROELS-SMITH, 1950

Infraturma *Diptyches* (Naumovea 1937) POTONIÉ, 1958

Genus *Cycadopites* (WODEHOUSE, 1933) ex. WILSON & WEBSTER, 1946

Generotype: Cycadopites follicularis WILSON & WEBSTER, 1946, p. 274, pl. 1, fig. 7.

WILSON & WEBSTER in designation of the type for genus Cycadopites of WODEHOUSE give the following description: "Ellipsoidal; approximately twice as long as wide; length 39—42 microns; with 18—12 microns; furrow extending along total length of grain, open at ends; usually closed in the middle by furrow edges overlapping in shrinkage; surface smooth wall, 1.5 micron thick; translucent"; this description is being used as the generic base for the species described below.

Cycadopites bleibergensis n. sp.

Holotype: *Cycadopites bleibergensis* n. sp. Pl. 3, Fig. 3. S. G. P. slide No. 1012, sample No. 1074. Deposited at the Palynological Lab., Geol. Survey of Austria, Vienna.

Diagnosis: Oval to fusiform grains with narrow median sulcus surrounded by two full length folds on the distal side and a smooth to infrapunctate surface.

Dimension of the type specimen 92 × 37 microns. Size range 110—80 microns in length, and 45—35 microns in breadth.

Type locality: Austria, Bleiberg (Antonio-Middle shaft, sample No. 1074).

Type level: Upper Triassic, Carnian (Lower Middle Keuper).

Description: Outline oval to fusiform with narrow ends. Approximately two and half times longer than wide. Distal furrow reaches full length of the grain, very slightly expanded at both ends. It is surrounded by two folds on slightly raised inner margins of about 1—1.5 micron thick. Exine is smooth to very finely infrapunctate, and about 2 microns thick in optical section. The figured specimen (Holotype) measures 92 × 37 microns.

Remarks: The species recorded here differs from *Cycadopites subgranulosus* (COUPER) (= *Entylissa reticulata* NILSSON) formerly placed under the genus *Monosulcites*, not only by the greater size, but also by the lack of granular ornamentations. It also differs from *Cycadopites potoniei*, BHARDADWAJ & SINGH, in having two distinct distal folds which have not been discussed by them; however, the present species falls in the given size range of the species of the above authors.

de Jersey (1962) in his description of *Ginkgocycadophytus adjectus* has discussed the presence of distal folds, which are analogus with those of the present form, but his size range of the species is quite smaller (almost half). This species of Bleiberg is also much smaller in size than *Ginkgocycadophytus deterius* (Balme) n. var. *majus* of Sukh Dev (1961) from India. Thus this form is comparatively different from the other forms described earlier and should be designated as new species. It is a good marker in the Bleiberg area for shale units No. 1 and 2 in which it occurs.

Summary

These are the various observations and results of this investigation:

1. The Upper Triassic Cardita shales of Bleiberg are very rich in various kinds of plant microfossils.
2. The fossil spores and pollen assemblages from the three different shale units of the studied area are closely comparable with studies of Leschik (1955) and Klaus (1960).
3. The genus *Raistrickia* continues in the Upper Triassic and is not exactly restricted to the Paleozoic Period. The proximal side of this genus is generally less ornamented (baculae) than the distal side. In all probability the *Neoraistrickia* is congeneric with this genus.
4. *Saturnisporites* and *Aratrisporites* are two distinct genera with different characters. They are zonomonolete spores, and not pollen grains.
5. The existence of *Eucommiidites* (or *Pre-Eucommiidites* ?) in the Upper Triassic sediments is very probably.

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PLATE 1

Magnification 750 ×

Fig. 1. *Aulisporites astigmosus* (LESCHIK).
Sample No. 1064 (S. G. P. No. 1000).
Fig. 2. *Zebrasporites kahleri* KLAUS.
Sample No. 1062 (S. G. P. No. 1001).
Fig. 3. *Lycopodiacidites keupperi* KLAUS (Distal).
Sample No. 1066 (S. G. P. No. 1002).
Fig. 4. *Lycopodiacidites keupperi* KLAUS (Proximal).
Fig. 5. *Dupliciporites granulatus* LESCHIK.
Sample No. 1066 (S. G. P. No. 1003).
Fig. 6. *Raistrickia alpina* n. sp. (Proximal).
Sample No. 1077 (S. G. P. No. 1004, Holotype).
Fig. 7. *Annulispora* (KLAUS).
Sample No. 1074 (S. G. P. No. 1005).
Fig. 8. *Raistrickia alpina* n. sp. (Distal, Holotype).

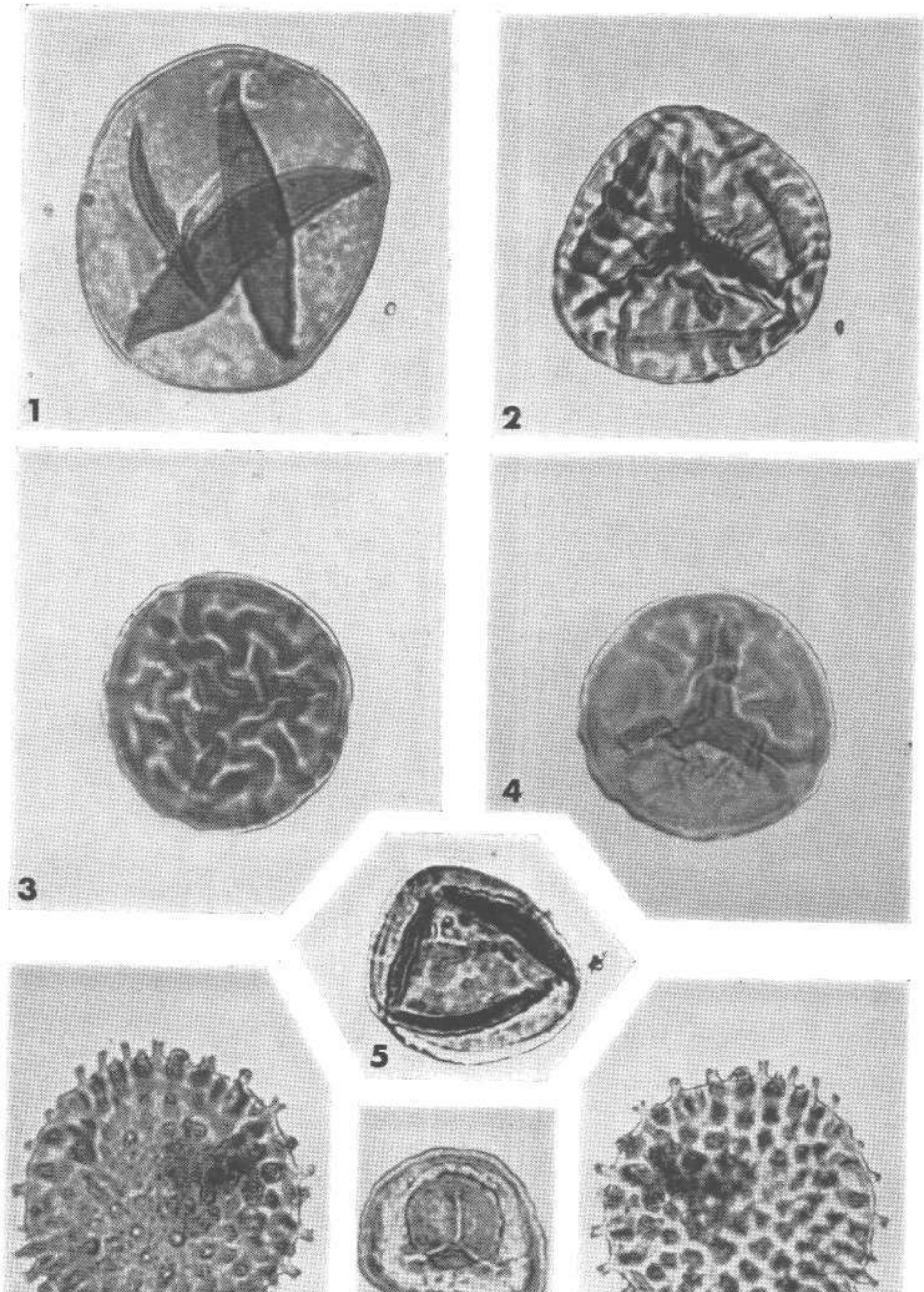
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PLATE 2

Magnification 750 ×

Fig. 1. *Corrugatisporites klausi* n. sp. (Distal).
Sample No. 1077 (S. G. P. No. 1006, Holotype).
Fig. 2. *Corrugatisporites klausi* n. sp. (Proximal, Holotype).
Fig. 3. *Styxisporites Cooksonae* KLAUS (Distal).
Sample No. 1062 (S. G. P. No. 1007).
Fig. 4. *Styxisporites Cooksonae* KLAUS (Proximal, same specimen).
Fig. 5. *Saturnisporites granulatus* KLAUS.
Sample No. 1077 (S. G. P. No. 1008).
Fig. 6. *Aratrisporites scabratus* KLAUS.
Sample No. 1062 (S. G. P. No. 1009).

PLATE 2

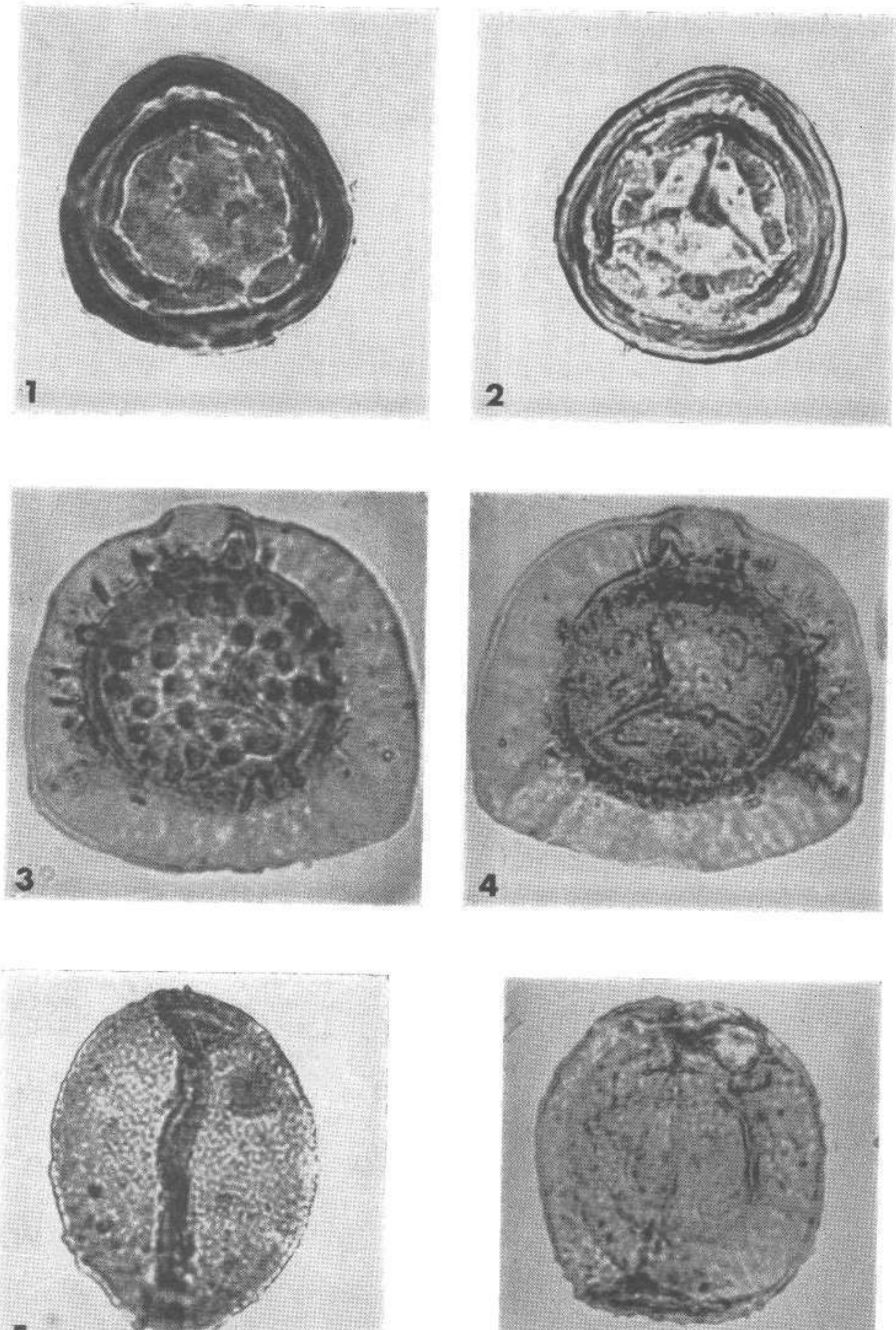
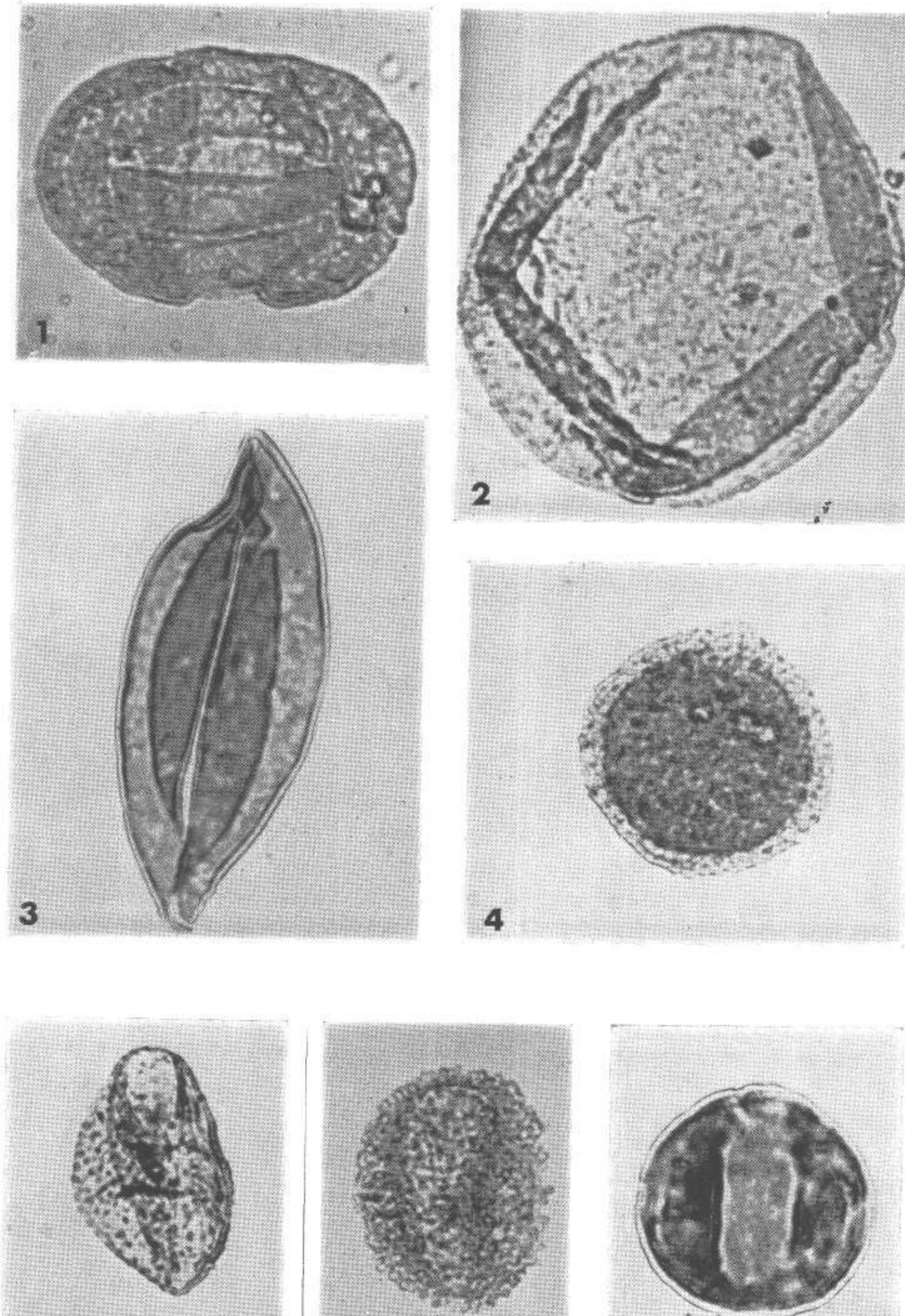


PLATE 3

Magnification 750 ×

Fig. 1. *Taeniaesporites kraeuseli* LESCHIK.
Sample No. 1074 (S. G. P. No. 1010).
Fig. 2. *Araucariacites australis* COOKSON.
Sample No. 1073 (S. G. P. No. 1011).
Fig. 3. *Cycadopites* n. sp.
Sample No. 1074 (S. G. P. No. 1012, Holotype).
Fig. 4. *Enzonalasporites tenuis* LESCHIK.
Sample No. 1073 (S. G. P. No. 1013).
Fig. 5. cf. *Cycadopites*.
Sample No. 1066 (S. G. P. No. 1014, Holotype).
Fig. 6. cf. *Cycadopites*.
Sample No. 1066 (S. G. P. No. 1015, Holotype).
Fig. 7. *Eucommiidites* sp.
Sample No. 1066 (S. G. P. No. 1016).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Nannofossils from the Middle-Upper Eocene Strata of Egypt

(with 2 plates and 1 figure)

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Abstract

Samples collected from the Eocene strata of Gabal Mokattam, Burg El Arab Well, Betty Well and Gazalat Well (North Western Desert) were investigated for their microfaunal content. They yield many different associations of calcareous nannofossils and planktonic foraminifera. The present paper deals with the calcareous nannofossils encountered in the studied samples. These minute fossils are used here as a new tool for biostratigraphic zonation of the Eocene strata in Egypt.

Introduction

Generally, the Middle Eocene rocks cover a large area of the surface of Egypt. They are mainly composed of thick marine limestones and marls, indicating fairly deep water conditions especially to the north of Egypt. The Lutetian strata are divided into two well known formations; the Minia Formation (SAID, 1960) at the base and the Mokattam Formation (ZITTEL, 1883) at the top.

The Upper Eocene deposits are totally different from those of the Middle Eocene. Instead of calcareous and marly sediments in the latter, we have sandstones, grits and shales, all highly coloured and ochreous, containing fossils representing neritic or even litoral origin.

To the east of Cairo, at Gabal Mokattam, the middle and upper Eocene strata are well represented and repeatedly studied by many geologists. The writer has collected many samples from this classical section; he received others from the Eocene section of Beni Suef area (about 200 Km. south of Cairo in the Nile Valley), and some drill-cores from Burg El Arab-, Betty- and Ghazalat wells (North Western Desert).

These samples were investigated for their microfaunal content. They yielded many different associations of calcareous nannofossils and planktonic foraminifera.

The present paper deals with the biostratigraphic zonation of the Egyptian Middle and Upper Eocene deposits by means of calcareous nannoplankton.

Burg El Arab Formation is a new formational name given here for the first time to designate the open marine facies of the lower Lutetian strata in Egypt. It is considered equivalent to the reefal facies of the Minia Formation (type section of the Egyptian lower Lutetian, SAID, 1960).

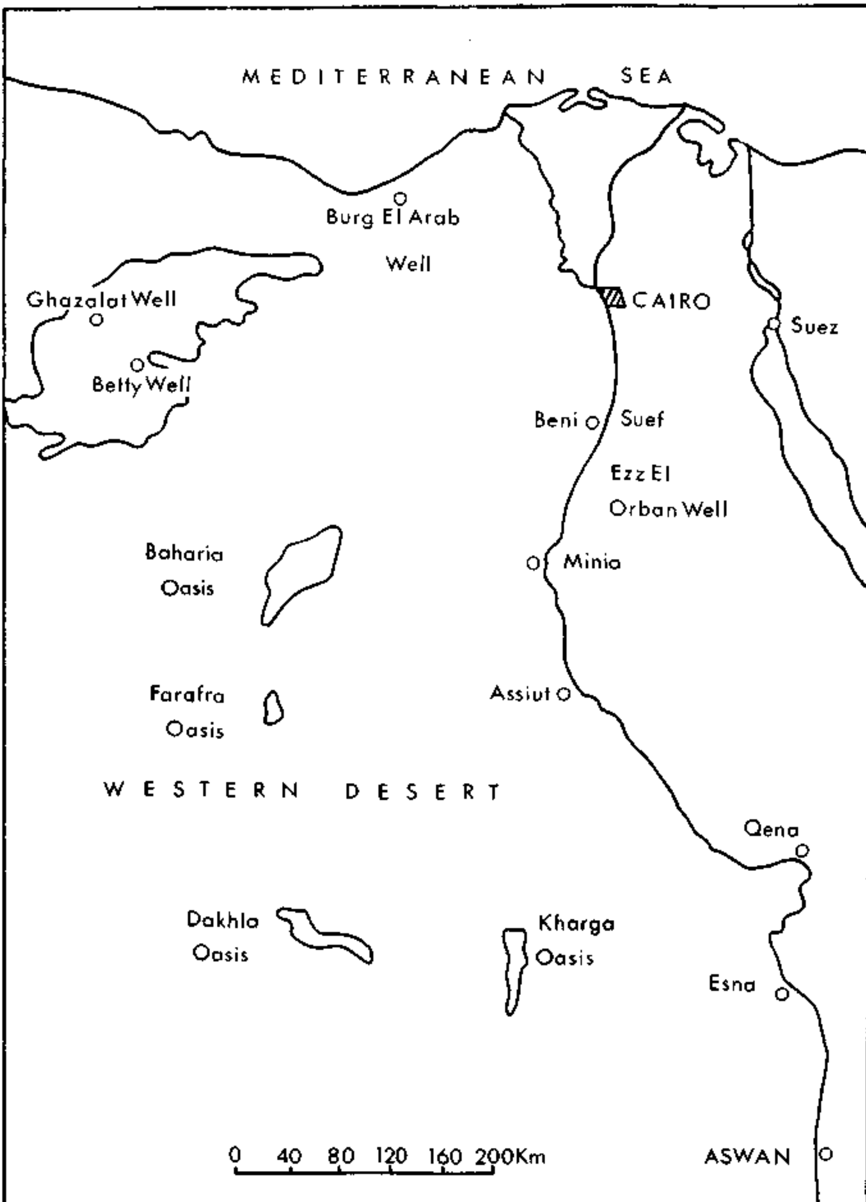

Fig. a

1. General stratigraphy

1.1 Middle Eocene

The stratigraphic sequence of the Middle Eocene deposits in the present study is differentiated from base to top as follows:

Burg El Arab Formation

The studied core samples from Burg El Arab well, depth 5020 to 5124 ft., are mainly composed of marls and shaly limestones, representing facies related to open sea conditions. They attain about 100 ft. thickness containing the following planktonic foraminiferal species and calcareous nannoplankton:

Planktonic foraminifera:

Globigerapsis kugleri
Globigerina frontosa
Globigerina yeguaensis
Globorotalia bullbrooki
Globorotalia lehneri
Globorotalia spinulosa
Truncorotaloides rohri
Truncorotaloides topilensis

Calcareous nannoplankton:

Genus: *Discoaster* TAN SIN HOK, 1927
D. binodosus
D. gemmifer
D. lodoensis
D. mirus
D. sublodoensis

Genus: *Chiasmolithus* HAY, MOHLER & WADE, 1966
C. bidens
C. grandis

Genus: *Chiphragmalithus* BRAMLETTE & SULLIVAN, 1961
C. spinosus

Genus: *Coccolithus* SCHWARZ, 1894
C. eopelagicus
C. solitus

Genus: *Cyclococcolithus* KAMPTNER, 1954
C. spp.

The forementioned planktonic associations of calcareous nannofossils and foraminifera point to lower Lutetian age. On the western side of the Gulf of Suez, in Ezz El Orban well (160 Km. south of Suez, see the index map), a formation representing an open marine facies (150 ft. thick) and of lower Lutetian age, similar in that respect to the present formation of Burg El Arab well, is recorded by BARAKAT & FAHMY (1968).

Globigerapsis kugleri Zone — which is related to the lower Lutetian in many parts of the world — has been encountered in Burg El Arab Formation and detected from other subsurface sections in the western desert.

It means, that Burg El Arab Formation has a wide geographic distribution, since it is traceable in the subsurface of the western desert and present in the Gulf of Suez. The present writer thinks that this formation could be synchronic with the Minia Formation (type section of the lower Lutetian in Egypt).

However, Burg El Arab Formation represents an open marine facies, differing genetically from the reefal facies of the Minia Formation. Hence a new formational name is introduced here to represent the open marine facies of the lower Lutetian in Egypt.

Mokattam Formation

SAID & MARTIN (1964) subdivided the Mokattam Formation into four members as follows from top to base:

Guishi member

Upper Building stone member

Nummulites gizehensis member

Lower Building stone member

The age of the lower three members is upper Lutetian and the upper most unit (Guishi member) is Bartonian.

Samples collected from the Upper Building stone member, at Gabal Mokattam and at Beni Suef area in the Nile Valley, were found to be highly fossiliferous with a well known group of calcareous nannofossils, termed as *Discoaster barbadiensis/saipanensis* association.

The following is a list of the planktonic foraminifera and calcareous nannoplankton encountered in the basal part of the Mokattam Formation:

Planktonic foraminifera

(Beni Suef area):
Globigerina boweri
Globigerina praebulloides
Globorotalia lehneri
Globorotalia spinulosa
Globorotalia spinulionflata
Globigerinatheka barri
Hantkenina dumblei
Truncorotaloides rohri
Truncorotaloides topilensis

Calcareous nannoplankton:

Genus: *Discoaster*
D. aster
D. barbadiensis
D. niloticum
D. saipanensis
D. quinarius
D. spp.
Genus: *Braarudosphaera*
B. discula
B. bigelowi

These faunal associations point to Upper Lutetian age.

1.2. Upper Eocene

Maadi Formation

Conformably overlying the Mokattam Formation, the Maadi Formation (SAID, 1962) is made up of a series of easily identified, well developed, brownish sandy limestones, marls and shales. These sediments are exposed along Gabal Mokattam cliffs east of Cairo.

Samples collected from this stratigraphic horizon at Gabal Mokattam area, were found to contain badly preserved forms of calcareous nannofossils. The occurrence of these minute fossils could be considered as a direct result of reworking of the older strata.

However, other marly samples collected from a similar stratigraphic unit at Heit El Ghorab area — a longitudinal ridge located 3 Km. south of the Sphinx — yielded the following calcareous nannoplankton:

Genus: *Discoaster*
D. barbadiensis
D. crassus
D. plebeius
D. saipanensis
D. spp.

Genus: *Micrantholithus*
M. flos

Genus: *Trochoaster*
T. simplex

It is of interest to record here, that the planktonic foraminiferal species are totally absent in the sediments of Maadi Formation. The occurrence of the above mentioned calcareous nannoplankton — which are related to planktonic organisms — could be explained by reworking.

2. Nannoplankton Zonation of the Eocene Sediments in Egypt

Several papers have been published on the nannoplankton zonation of the Eocene sediments in different parts of the world, Austria, Czechoslovakia, Poland, Switzerland, France, Gulf Coast, the Carribean-Antillean area, California etc..

The nannoplankton zonation introduced by HAY et al. (1967) represents the most outstanding one, and has been followed lateron by many authors. Their zonation of the Paleocene — Eocene strata in SW France is as follows:

Isthmolithus recurvus	Zone	
Discoaster tani nodifera	Zone	
Chiphragmalithus quadratus	Zone	
Discoaster sublodoensis	Zone	
Discoaster lodoensis	Zone	
Marthasterites tribrachiatus	Zone	
Discoaster binodosus	Zone	
Marthasterites contortus	Zone	. . . . Eocene
Discoaster multiradiatus	Zone	
Heloilithus riedeli	Zone	
Discoaster gemmeus	Zone	
Heliolithus kleinpelli	Zone	
Fasciculithus tympaniformis	Zone	. . . . . . Paleocene
Cruciplacolithus tenuis	Zone	. . . . Danian
Markalius astroporus	Zone	. . U. Maestrichtian

As the present paper deals only with the calcareous nannoplankton encountered in the Egyptian Eocene sediments, we shall discuss the nannoplankton-zone recognized in these deposits beginning from base to top as follows:

2.1 Marthasterites tribrachiatus Zone

Cuba

As originally proposed by BRÖNNIMANN & STRADNER (1960), *Marthasterites tribrachiatus* Zone was based on the calcareous nannoplankton encountered in the Capdevila Formation of the Habana area, Cuba. It is characterized by the joint occurrence of *Marthasterites tribrachiatus* and *Discoaster lodoensis*. Other common species include:
Discoaster distinctus
D. binodosus
D. barbadiensis

United States (California)

Under the name "*Discoaster tribrachiatus* Zone", this zone is introduced by BRAMLETTE & SULLIVAN (1961) in their paper on the "Coccolithophorids and related Nannoplankton of the Early Tertiary in California". They stated "the name *Discoaster tribrachiatus* Zone seems appropriate for strata included in biostratigraphic Unit 3 and its equivalents elsewhere, as the species is locally restricted to this unit". They proved that Unit 3 (*Discoaster tribrachiatus* Zone) of the Lodo Formation includes strata that could be correlated well with the Ypresian Stage (Lower Eocene).

France

HAY & MOHLER (1967) defined *Marthasterites tribrachiatus* Zone as the "interval from the first occurrence of *Discoaster lodoensis* to the last occurrence of *Marthasterites tribrachiatus*. It is found that, in the section exposed south of Pau, SW France, the beds, that can be observed in the Tuilerie de Gan, belong to the top of the *Marthasterites tribrachiatus* Zone.

Germany

In 1959, MARTINI proposed a nannoplankton-zonation for the Eocene strata in NW Germany. The "Unter Eozän 3" of MARTINI seems to belong to the *Marthasterites tribrachiatus* Zone, as forms of *Marthaterites tribrachiatus* occur in abundance in this unit.

Austria

According to STRADNER & PAPP (1961), *Marthasterites tribrachiatus* Zone is represented by a section exposed in the Mattsee area, Salzburg, Austria, with an association of microfauna containing *Globorotalia* *aragonensis* (Lower Eeocene). In the Hagenbach Valley, STRADNER (1969) proposed two new subzones which can be discerned within the *Marthasterites tribrachiatus* Zone as follows:

Scyphosphaera tubicena subzone
Scyphosphaera columella subzone

Italy

HAY & MOHLER (1967) deduced that the *Marthasterites tribrachiatus* Zone extends stratigraphically from the upper part of the *Globorotalia formosa formosa/Globorotalia aragonensis* Zone to the lower part of the *Hantkenina aragonensis Zone* of BOLLI & CITA (1960). These zones are recorded from the Eocene section located at Paderno d'Adda area, Italy.

Slovakia

In 1968, SAMUEL & BYSTRICKA introduced their "*Marthasterites tribrachiatus* + *Discoaster lodoensis* Zone". It is found that this zone is correlated with *Globoratalia aragonensis* Zone of Lower Eocene age.

Egypt

Marthasterites tribrachiatus Zone has been recorded by SADEK & ABD EL RAZIK (1970) from Lower Eocene strata related paleontologically to the *Globorotalia subbotinae* Zone (BECKMANN et al., 1967) = *Globorotalia wilcoxensis* Zone of EL NAGGAR (1967). On account of its stratigraphical occurrences in many localities in Egypt, *Marthasterites tribrachiatus* Zone represents the basal part of the Ypresian. It is of interest to record here, that *Marthasterites tribrachiatus* seems to be restricted to this zone and usually occurs without *Discoaster lodoensis.*

2.2 Discoaster lodoensis Zone

Cuba

Originally proposed by BRÖNNIMANN & STRADNER (1960) from the Middle Eocne strata of Cuba.

France

HAY & MOHLER (1967) regarded *Discoaster lodoensis* Zone as Early Eocene and define it as "the interval from the last occurrence of *Marthasterites tribrachiatus* to the first occurrence of *Discoaster sublodoensis.*

Germany

A typical *Discoaster lodoensis* Zone assemblage of calcareous nannoplankton is encountered in the "unteres Ober Eozän" of MARTINI (1959). Other common species include:

Discoaster barbadiensis
D. septemradiatus
D. distinctus
D. binodosus binodosus

D. plebeius
D. germanicus
D. nonaradiatus
Trochoaster simplex
Micrantholithus flos

Austria

Discoaster lodoensis Zone is exposed at Oberkreuzstetten near the Hipplinger Heide north of Vienna (HEKEL, 1968). The strata are assigned to the lower Lutetian age with a nannoplankton assemblage containing *Discoaster lodoensis* without *Marthasterites tribrachiatus.*

Italy

The middle part of the *Hantkenina aragonensis* Zone of BOLLI & CITA (1960) is found to correspond to the *Discoaster lodoensis* Zone (HAY & MOHLER, 1967). It is well known, that *Hantkenina aragonensis* Zone represents the lower Lutetian in Italy, Trinidad, Egypt, and many other countries.

Poland

Discoaster lodoensis Zone is recorded in the Flysch of the Polish outer Carpathians (BIEDA, 1966, RADOMSKI, 1967) and it is assigned to the lower Lutetian age.

Slovakia

According to SAMUEL & BYSTRICKA (1968) the *Discoaster lodoensis* Zone represents the lower Lutetian. They described this zone as "*Discoaster*-Zone" containing *Discoaster lodoensis* without *Marthasterites tribrachiatus.* The following planktonic foraminiferal species were found to occur in this zone:

Globigerina senni
Globigerina boweri
Globorotalia renzi
Globorotalia spinulosa

Egypt

In the present paper, the writer introduces *Discoaster lodoensis* Zone, which is detected in Betty Well (North Western Desert). This zone is located in strata, assigned to the upper Ypresian age, containing a typical calcareous nannoplankton assemblage of *Discoaster lodoensis* Zone without *Marthasterites tribrachiatus,* the same as in Austria and Slovakia. From the stratigraphical point of view, *Discoaster lodoensis* Zone is correlated here with the *Globorotalia formosa formosa* Zone and *Globorotalia aragonensis* Zone of BECKMANN et al. (1967), representing the upper part of the lower Eocene strata in Egypt. However, forms of *Discoaster lodoensis* are observed to occur not only in the Ypresian, but also in some Lutetian strata e. g., Gabal Mokattam Formation; this led to the conclusion that *Discoaster lodoensis* Zone may be ranging from the Ypresian to the Lutetian.

2.3. Discoaster sublodoensis Zone

France

The *Discoaster sublodoensis* Zone is defined by HAY et al. (1967) from their studies on the Eocene strata in France, as "the interval from the first occurrence of *Discoaster sublodoensis* to the first occurrence of *Chiphragmalithus quadratus*.

Austria

In 1968, HEKEL reported the occurrence of *Discoaster sublodoensis* from the upper part of the "Obere Coccolithenschiefer" in the Flysch north of Vienna. This seems to be the youngest part of the Flysch sediments in the sequences of that area (STRADNER, 1969).

Slovakia

In the middle part of the "*Discoaster*-Zone" of SAMUEL & BYSTRICKA (1968) in the middle Lutetian of Slovakia, *Discoaster barbadiensis* and *Discoaster saipanenis* are found to be characteristic. STRADNER (1969, p. 428) stated "as *Discoaster sublodoensis* and *Discoaster saipanensis* are two very closely related species with rather similar outline, it might be rather a matter of different interpretation than of different species". Accordingly, the middle part of the "*Discoaster*-Zone" seems to be equivalent to *Discoaster sublodoensis* Zone.

Egypt

Discoaster sublodoensis Zone is detected in Ghazalat Well (North western desert) at a depth of 1112—1132 ft. The strata contain planktonic foraminiferal assemblages, characteristic of the lower Lutetian. *Discoaster sublodoensis* Zone corresponds to Burg El Arab Formation (see p. 109) representing the lowest part of the Lutetian in Egypt. It seems equivalent to the *Globorotalia bullbrooki* Zone and *Globigerapsis kugleri* Zone of BECKMANN et al. (1967).

2.4. Discoaster barbadiensis/saipanensis Zone

In the nannoplankton zonation of HAY et al. (1967) the upper part of the Lutetian strata (Middle Eocene) is represented by *Chiphragmalithus quadratus* Zone and *Discoaster tani* Zone. Those two zones are not detected in Egypt.

However, this part of the Eocene deposits, which is well known in the Egyptian stratigraphy as "Mokattam Formation", is characterized by the abundance of both *Discoaster barbadiensis* and *Discoaster saipanensis* species.

For this stratigraphic unit, the name *Discoaster barbadiensis/saipanensis* Zone may prove appropriate and seems to be recognizable as a zonal unit in many localities in Egypt (Nile Valley and Western Desert). It is of interest to record here that *Discoaster barbadiensis/saipanensis* Zone represents not only part of the upper Lutetian (Middle Eocene), but also the lower part of the Bartonian (Upper Eocene) in Egypt.

Nannoplankton Zonation of the Lower Tertiary in Egypt

A G E			Planktonic zones in Egypt BECKMANN et al. (1967)	Nannoplankton Zonation KERDANY (1969)	Nannoplankton Zonation SADEK (1970)
Tertiary	Eocen	Bartonian (Upper)	*Cribrohantkenina danvillensis* *Globorotalia cerroazulensis* *Globigerapsis semiinvolutus*		
Tertiary	Eocen	Lutetian (Middle)	*Truncorotaloides pseudodubius* *Porticulasphaera mexicana* *Globorotalia lehneri* *Globigerapsis kugleri* *Globorotalia bullbrooki*		*Discoaster barbadiensis/ D. saipanensis* Zone *Discoaster sublodoensis* Zone
Tertiary	Eocen	Ypresian (Lower)	*Globorotalia aragonensis* *Globorotalia formosa formosa* *Globorotalia subbotinae*		
Tertiary	Paleocene	Landenian	Globorotalia *velascoensis* *Globorotalia pseudomenardii* *Globorotalia angulata*	*D. multiradiatus/ M. contortus* Zone *Heliolithus kleinpelli* Zone	*Discoaster lodoensis* Zone *Marthasterites tribrachiatus* Zone
Tertiary	Paleocene	Montian Danian	*Globorotalia uncinata* Globorotalia *trinidadensis* Globigerina *pseudobulloides*	*Cruciplacolithus tenuis* Zone	*M. bramlettei/ M. contortus* Zone *Discoaster multiradiatus* Zone

3. Systematic Descriptions

Two main groups of the calcareous nannoplankton can be discerned in the examined samples from the Eocene strata of Egypt: firstly the star and rosette-shaped forms known as *Discoasters*, and secondly elliptical, round, polygonal, and tubular forms known as *Coccoliths*.

The described forms are those recognized and determined with the help of the light microscope. Forms smaller than 4 micron are not considered, as such forms fall into the scope of the electronic microscope.

Ordo: *COCCOLITHOPHORALES* SCHILLER, 1926
Subordo: *Discoasterineae* KAMPTNER, 1967
Familia: *Discoasteromonadaceae* BURSA, 1965
Genus: *Discoaster* TAN SIN HOK, 1927
Discoaster aster BRAMLETTE & RIEDEL

(Plate 1, figure 1 and 14)

1954 *Discoaster aster* BRAMLETTE & RIEDEL, p. 400, pl. 39, fig. 7.
1961 *Discoaster aster* BRAMLETTE & RIEDEL; STRADNER & PAPP, p. 63, pl. 1, figs. 1—7.

Asterolith stellate with commonly five or six thick rays, which terminate in a rounded or bluntly pointed tip. The rays are somewhat irregular in outline due to their rather rugose surface.

Distribution: Originally recorded from the Paleocene of Austria (STRADNER & PAPP, 1961). However, the occurrence of *D. aster* in the Lutetian strata of Egypt indicates, that this species may occur throughout the lower Tertiary.

Discoaster barbadiensis TAN SIN HOK

(Plate 1, figures 2 and 3)

1927 *Discoaster barbadiensis* TAN SIN HOK, p. 119.
1954 *Discoaster barbadiensis* TAN SIN HOK; BRAMLETTE & RIEDEL, p. 398, pl. 39, figs. 5 a, b.
1961 *Discoaster barbadiensis* TAN SIN HOK; STRADNER & PAPP, p. 95, pl. 28, figs. 1, 2.
1967 *Discoaster barbadiensis* TAN SIN HOK; LEVIN & JOERGER, p. 172, pl. 3, fig. 17 a, b.

This species is characterized by having 9—13 rays joined throughout their length with bluntly pointed tips forming a serrate margin to the disc. The central area is always occupied by a prominent stem.

Distribution: *Discoaster barbadiensis* is recorded from many Eocene sections allover the world. This species is very common in the Middle-Upper Eocene strata of Egypt, characterizing the Mokattam Formation, hence *Discoaster barbadiensis/saipanensis* Zone is proposed by the present writer.

Discoaster binodosus MARTINI

(Plate 1, figure 4)

1958 *Discoaster binodosus* MARTINI, p. 362, pl. 4, figs. 18 a, b.
1961 *Discoaster binodosus* MARTINI; STRADNER & PAPP, p. 66, pl. 4, figs. 1—7, pl. 5, figs. 1—6.
1967 *Discoaster binodosus* MARTINI; RADOMSKI, p. 388.
1970 *Discoaster binodosus* MARTINI; SADEK & ABD EL RAZIK, p. 51, pl. 4, fig. 4.

Asteroliths with 6—9 rays with pointed or nodged tips. Each ray has always two lateral nodes.

Distribution: Commonly present in the Upper Paleocene-Lower Eocene sediments of many regions in the world. STRADNER & PAPP (1961) recorded forms similar to our specimens occuring in the Upper Lutetian strata of Austria. Therefore the upper limit of the occurrence of *Discoaster binodosus* is still uncerain (STRADNER, 1969).

Discoaster crassus MARTINI

(Plate 1, figure 5)

1959 *Discoaster crassus* MARTINI, p. 138.

Asteroliths consists of 6 sharply pointed rays, joined throughout their length.

Dirstribution: Originally recorded from the Upper Eocene of NW Germany (MARTINI, 1959). Commonly occurs in the Maadi Formation (Upper Eocene), at Heit El Ghorab area, near the Sphinx, Egypt.

Discoaster gemmifer STRADNER

(Plate 1, figure 6)

1961 *Discoaster gemmifer* STRADNER; STRADNER & PAPP, p. 69, pl. 8, figs. 1—10, pl. 9, figs. 1—5.
1968 *Discoaster gemmifer* STRADNER; SAMUEL & BYSTRICKA, p. 122.
1969 *Discoaster* cf. *gemmifer* STRADNER; STRADNER, p. 408, pl. LXXXII, figs. 5—10.

Asteroliths with 4—8 rays. It is characterized by its widely bifurcating tips with adjacent lateral nodes. This species resembles *D. deflandrei* and *D. distinctus* in having a similar outline.

Distribution: Very abundant in the Lower Eocene to the lower Middle Eocene (STRADNER, 1969). In Egypt, *Discoaster gemmifer* is common throughout the Lutetian strata. It is recorded in the Nile Valley, near Beni Suef area from Upper Lutetian sediments (HASSAN, SADEK & BOUKHARY, 1970) and detected by the present writer in the lower Lutetian strata of the North Western Desert, subsurface sections.

Discoaster lodoensis BRAMLETTE & RIEDEL

(Plate 1, figure 9)

1954 *Discoaster lodoensis* BRAMLETTE & RIEDEL, p. 398, pl. 39, figs. 3 a, b.
1960 *Discoaster lodoensis* BRAMLETTE & RIEDEL; BRÖNNIMANN & STRADNER, p. 369.
1961 *Discoaster lodoensis* BRAMLETTE & RIEDEL; STRADNER & PAPP, p. 92, pl. 25, figs. 1—10, pl. 26, figs. 1—6.
1961 *Discoaster lodoensis* BRAMLETTE & RIEDEL; BRAMLETTE & SULLIVAN, p. 161, pl. 12, figs. 4 a, b, 5.
1967 *Discoaster lodoensis* BRAMLETTE & RIEDEL; HAY & MOHLER, p. 1523.
1969 *Discoaster lodoensis* BRAMLETTE & RIEDEL; STRADNER, p. 410, pl. LXXXI, figs. 1—8.

Asteroliths having usually a stellate outline with 6 to 7 rays. This species is characterized by the curvature of its rays in the same sense in the plane of the body of the asterolith. The central area is occupied by a short knob.

Distribution: Common in the Lower and Middle Eocene of many regions. In Egypt, *Discoaster lodoensis* commonly occurs in the Lower Eocene sections of the North Western Desert. However, this species is also noticed in some Lutetian sediments in the Nile Valley (Beni Suef Area, and Gabal El Mokattam).

Discoaster mirus DEFLANDRE

(Plate 1, figure 7)

1954 *Discoaster mirus* DEFLANDRE; DEFLANDRE & FERT, p. 168, text-fig. 118.
1961 *Discoaster mirus* DEFLANDRE; STRADNER & PAPP, p. 68, pl. 6, figs. 1—6, pl. 7, figs. 1—5.
1964 *Discoaster mirus* DEFLANDRE; STRADNER, p. 138, text-fig. 28.
1968 *Discoaster mirus* DEFLANDRE; SAMUEL & BYSTRICKA, pp. 122, 125, 126.
1969 *Discoaster mirus* DEFLANDRE; STRADNER, p. 410, pl. LXXXII, figs. 2, 3.

This species is characterized by having 6—8 rays which have two terminal and two lateral nodes.

Distribution: *Discoaster mirus* has been recorded from the lower Lutetian of Mexico, common in the Lutetian of Austria (STRADNER & PAPP, 1961). This species occurs in abundance in the lower Lutetian strata of Burg El Arab Well (North Western Desert, Egypt).

Discoaster saipanensis BRAMLETTE & RIEDEL

(Plate 1, figure 10)

1954 *Discoaster saipanensis* BRAMLETTE & RIEDEL, p. 398, pl. 39, fig. 4.
1961 *Discoaster saipanensis* BRAMLETTE & RIEDEL; STRADNER & PAPP, p. 90, pl. 22, figs. 5—7, 9.
1970 *Discoaster saipanensis* BRAMLETTE & RIEDEL; HASSAN, SADEK & BOUKHARY, p. 7, pl. 1, fig. 10.

This species is characterized by having 7—8 sharply pointed rays. The central area is occupied by a prominent knob.

Distribution: Originally recorded from the upper deposits of Saipan. Very common throughout the Lutetian of many regions. In Egypt, *Discoaster saipanensis* occurs abundantly in the upper Lutetian strata of Gabal Mokattam, east of Cairo (Egypt).

Discoaster sublodoensis BRAMLETTE & SULLIVAN

(Plate 1, figure 13)

1961 *Discoaster sublodoensis* BRAMLETTE & SULLIVAN, p. 162, pl. 12, fig. 6 a, b.

Asteroliths, with 5 sharply pointed rays, which are joined together through about half their length, and straight-radiating in the separated outer part. High part of each ray forms a ridge along one side, which turns sharply counter-clockwise (BRAMLETTE & SULLIVAN, 1961). The present forms of *Discoaster sublodoensis* recognized in Eocene samples from the Northwestern Desert, are very similar to those described and illustrated by BRAMLETTE & SULLIVAN (1961).

Distribution: Originally recorded from the Middle Eocene strata of California, Texas (U. S. A.) and France. *Discoaster sublodoensis* occurs abundantly in the Lower Lutetian sediments of many Eocene sections in the North Western Desert, hence the name *Discoaster sublodoensis* Zone is proposed here by the present writer to distinguish the lower Lutetian in Egypt.

Discoaster plebeius MARTINI

(Plate 1, figure 8)

1959 *Discoaster plebeius* MARTINI, p. 138.

This species is characterized by having 6 bluntly pointed rays. It is very similar to *Discoaster brouweri* TAN SIN HOK, however, the stratigraphic position of *D. brouweri* (Miocene) differs greatly from that of *D. plebeius* (Eocene).

Distribution: Very abundant in the Upper Eocene of Germany. Common in the Upper Eocene of the Maadi Formation at Heit El Ghorab area, near the Sphinx, Egypt.

Discoaster quinarius (EHRENBERG), BERSIER

(Plate 1, figure 11)

1854 *Actiniscus quinarius* EHRENBERG, pl. 19, fig. 46.
1939 *Discoaster quinarius* (EHRENBERG), BERSIER, p. 234, figs. 1—4.
1961 *Discoaster quinarius* (EHRENBERG), BERSIER; STRADNER & PAPP, p. 89, pl. 22, figs. 1—4.

Distribution: Common throughout the Lutetian strata of many regions. It is detected in the upper Lutetian strata (Upper Building Stone Member) near Beni Suef area and Gabal El Mokattam.

Discoaster sp. 1

(Plate 1, figure 12)

This species is characterized by having 6 rays, each ray has an enlarged end as seen in the figure. It resembles *Discoaster challengerie* in having a similar outline, however the stratigraphic occurrence is a point of discussion, since the present form is found in Upper Eocene strata of Gabal El Mokattam East of Cairo, while *D. challengeri* is recorded from the Miocene.

Discoaster sp. 2

(Plate 2, figure 1)

Asteroliths, having 6 sharply pointed rays, The central is somewhat large. This species is similar to *Discoaster saipanensis* in the general outline, however it differs in having no stem in the central disc. The present species is detected in the Upper Eocene samples of Heit El Ghorab area, near the Sphinx, Egypt.

Genus *Marthasterites* DEFLANDRE, 1959
Marthasterites tribrachiatus (BRAMLETTE & RIEDEL) DEFLANDRE

1954 *Discoaster tribrachiatus* BRAMLETTE & RIEDEL, p. 397, pl. 38, fig. 11.
1959 *Marthasterites tribrachiatus* (BRAMLETTE & RIEDEL), DEFLANDRE, pp. 138, 139.
1961 *Marthasterites tribrachiatus* (BRAMLETTE & RIEDEL); STRADNER & PAPP, p. 110, pl. 35, figs. 1—4, 7.
1967 *Marthasterites tribrachiatus* (BRAMLETTE & RIEDEL); HAY & MOHLER, p. 1522.
1969 *Marthasterites tribrachiatus* (BRAMLETTE & RIEDEL); STRADNER, p. 411, pl. LXXXIII, figs. 1—8.

Asteroliths with triradiate form. The three rays are separated from each other with an angle of about 120. The rays are usually parallel-edged or slightly tapering, and their tips may be rounded or nodged.

Distribution: *Marthasterites tribrachiatus* is considered by the micropaleontologists as a guide fossil in the Lower Eocene strata of many regions. In Egypt, this species occurs in abundance in the Lower Eocene of Abou Had, Gabal Qweina, Loxur and Umm El Heutat area (Southern Egypt).

Subordo: *COCCOLITHINEAE* KAMPTNER, 1958
Familia: *Coccolithaceae* KAMPTNER, 1958
Tribus: *Coccolitheae* KAMPTNER, 1958
Genus: *Chiasmolithus* HAY, MOHLER & WADE, 1966
Chiasmolithus bidens (BRAMLETTE & SULLIVAN) HAY, MOHLER & WADE

(Plate 2, figure 6)

1961 *Coccolithus bidens* BRAMLETTE & SULLIVAN, p. 139, pl. 1, fig. 1.
1966 *Chiasmolithus bidens* (BRAMLETTE & SULLIVAN), HAY, MOHLER & WADE, p. 388.
1969 *Chiasmolithus bidens* (BRAMLETTE & SULLIVAN), HAY, MOHLER & WADE; STRADNER, p. 412, pl. LXXXV, figs. 9—11.

Elliptical placoliths, the central area of which is open and spanned by a diagonal cross. Sometimes, tooth-like projections are present in the central area.

Distribution: Recorded from the Paleocene and Eocene of many regions (California and Austria). This species occurs commonly in the Lower Eocene (Ypresian) and the lower Lutetian of Egypt.

Genus: *Chiphragmalithus* BRAMLETTE & SULLIVAN, 1961
Chiphragmalithus sp.

(Plate 2, figure 4)

Basket-like form, with cross septa dividing it into quadrants. The septa seem to be higher than the side wall, especially at the centre. Small minute spines are noticed around the peripheral margin, resembling in that respect *Nannotetraster spinosus* STRADNER.

D i s t r i b u t i o n : Common throughout the lower Lutetian strata of the North western Desert, Egypt (Betty, Ghazalat, and Burg El Arab Wells).

Genus: *Coccolithus* SCHWARZ, 1894

Coccolithus eopelagicus (BRAMLETTE & RIEDEL), STRADNER & EDWARDS

(Plate 2, figure 8)

1954 *Tremalithus eopelagicus* BRAMLETTE & RIEDEL, p. 392, pl. 38, figs. 2 a, b.
1968 *Coccolithus eopelagicus* (BRAMLETTE & RIEDEL); STRADNER & EDWARDS, p. 15, pl. 6.
1969 *Coccolithus eopelagicus* (BRAMLETTE & RIEDEL); STRADNER& EDWARDS; STRADNER, p. 413, pl. LXXXIV, fig. 11.

Placoliths, elliptical in shape, with larger distal and smaller proximal curved shields. This species is characterized by a longitudinal window occupying the central area.

D i s t r i b u t i o n : Common throughout the Lutetian of many regions allover the world.

Coccolithus solitus BRAMLETTE & SULLIVAN

(Plate 2, figure 7)

1961 *Coccolithus solitus* BRAMLETTE & SULLIVAN, pp. 140—142, pl. 2, figs. 4 a, b, c.
1964 *Coccolithus solitus* BRAMLETTE & SULLIVAN; SULLIVAN, p. 181, pl. 1, figs. 13 a, b.

Placoliths with closely appressed plates and relatively large central opening transversely spanned by a somewhat delicate x-shaped structure. The placoliths are distinguished from those of *Coccolithus bidens* in having more dilcate x-shaped structure.

D i s t r i b u t i o n : Originally recorded from the Middle Eocene of California, Lodo Formation (BRAMLETTE & SULLIVAN, 1961). Common in the lower Lutetian strata of Burg El Arab Well (North Western Desert, Egypt).

Genus: *Cycloccolithus* KAMPTNER, 1958

Cycloccolithus sp.

(Plate 2, figure 9)

Placoliths circular in outline having a distal shield larger than the proximal, with a central depression on the distal shield, producing the illusion of a perforation in the light microscope. The present specimens are very similar to those described and illustrated by KAMPTNER and known as *Cycloccolithus formosus*.

D i s t r i b u t i o n : Common in the lower Lutetian of many regions (Austria, and Czechoslovakia). Very common in Burg El Arab Formation (lower Lutetian in the subsurface Eocene sections in the North Western Desert, Egypt).

Tribus: *Zygosphaereae* Kamptner, 1958
Subtribus: *Zygolithinae* Stradner, 1968
Genus: *Neococcolithes* Sujkowski, 1961
Neococcolithes dubius (Deflandre) Black

(Plate 2, figure 5)

1954 *Zygolithus dubius* Deflandre, in Deflandre & Fert, p. 149, figs. 43, 44, 68.
1964 *Chiphragmalithus dubius* (Deflandre) Sullivan, p. 179, pl. 1, fig. 2.
1967 *Neococcolithes dubius* (Deflandre), Black, p. 143.
1969 *Neococcolithes dubius* (Deflandre), Black; Stradner, p. 418, pl. LXXXVII, figs. 1—3.

Zygoliths elliptical in outline. The open central area is transversely spanned by an "H-shaped" rather than x-shaped structure, which extends higher than the rim.

Distribution: Originally recorded from the Lower Lutetian (Middle Eocene) of Donzacq, France. In California, U. S. A. this species occurs throughout the Lower and Middle Eocene strata. Very common in the Lower Lutetian strata (*Globoratalia bullbrooki* Zone and *Globigerapsis kugleri* Zone of Beckmann et al., 1967) of Burg El Arab Well, North Western Desert, Egypt.

Familia: *Braarudosphaeraceae* Deflandre, 1947
Genus: *Braarudosphaera* Deflandre, 1947
Braarudosphaera bigelowi (Gran & Braarud) Deflandre

(Text-figure 1 a)

1935 *Pontosphaera bigelowi* Gran & Braarud, p. 388, fig. 67.
1947 *Braarudosphaera bigelowi* (Gran & Braarud), Deflandre, p. 439, figs. 1—5.
1954 *Braarudosphaera bigelowi* (Gran & Braarud), Deflandre; in Deflandre & Fert, pp. 165—166, pl. 10, figs. 8—13, pl. 13, figs. 7—9.
1961 *Braarudosphaera bigelowi* (Gran & Braarud), Deflandre; Bramlette & Sullivan, p. 153, pl. 8, figs. 1 a, b, 2—5.
1969 *Braarudosphaera bigelowi* (Gran & Braarud), Deflandre; Stradner, p. 420, text-fig. 3/2, 3.
1970 *Braarudosphaera bigelowi* (Gran & Braarud), Deflandre; Hassan, Sadek & Boukhary, p. 4, pl. 1, fig. 1.

This species is characterized by its pentalith form. The peripheral margin is pentagonal with somewhat rounded angles.

Distribution: Long ranging species as recorded from the Cretaceous to the Recent. Common in the Egyptian Eocene strata.

Braarudosphaera discula Bramlette & Riedel

(Plate 2, figure 3, text-fig. 1 b)

1954 *Braarudosphaera discula* Bramlette & Riedel, p. 394, pl. 38, fig. 7.
1961 *Braarudosphaera discula* Bramlette & Riedel; Bramlette & Sullivan, p. 153, pl. 3, figs. 6 a, b, 8.
1964 *Braarudosphaera discula* Bramlette & Riedel; Sullivan, p. 188, pl. 8, fig. 2 a, b.

Pentaliths almost round in outline, tending slightly to be less pentagonal in shape. *Braarudosphaera discula* differs from *B. bigelowi* in the more rounded form of the pentaliths.

Distribution: It seems to be common in the Eocene of many regions, and particularly in the lower Middle Eocene (BRAMLETTE & RIEDEL, 1954). In Egypt, this species occurs abundantly in Burg El Arab Formation (Lower Lutetian in the North Western Desert, Egypt).

Genus: *Micrantholithus* DEFLANDRE, 1954
Micrantholithus flos DEFLANDRE

(Plate 2, figure 2)

1950 *Micrantholithus flos* DEFLANDRE, p. 1157, figs. 8—11.
1961 *Micrantholithus flos* DEFLANDRE; BRAMLETTE & SULLIVAN, p. 155, pl. 9, figs. 8 a, b.
1964 *Micrantholithus flos* DEFLANDRE; SULLIVAN, p. 189, pl. 9, figs. 5 a, b.
1965 *Micrantholithus flos* DEFLANDRE; SULLIVAN, p. 40, pl. 9, figs. 1—3.

Pentaliths star-shaped, consisting of 5 segments, the marginal sides of which are modified to produce short tapering rays. Our specimens are very similar to those illustrated by SULLIVAN (1965).

Distribution: Recorded from the Lutetian of Austria and from many Eocene sections in France and California. The present species is found in Upper Eocene strata of the Maadi Formation at Heit El Ghorab area, near the Sphinx, Egypt.

INCERTAE SEDIS
Genus: *Trochoaster* KLUMPP, 1953
Trochoaster simplex KLUMPP

(Plate 2, figure 10, 11)

1953 *Trochoaster simplex* KLUMPP, p. 385, pl. 4, fig. 2.
1958 *Trochoaster simplex* KLUMPP; MARTINI, p. 368, pl. 5, fig. 25.
1961 *Trochoaster simplex* KLUMPP; STRADNER & PAPP, p. 131, pl. 42, figs. 1—4, 6 a—d.

This species is characterized by having 6 thin elongate uniform, bluntly pointed rays which are attached to a ring in the central area.

Distribution: Recorded from the Eocene of Mexico, Upper Eocene of Germany and Austria. Common in the Upper Lutetian (Mokattam Formation) at Beni Suef area, and in the Upper Eocene sediments of the Maadi Formation at Hei El Ghorab area, near the Sphinx, Egypt.

Undetermined form

(Plate 2, figure 12)

A circular disc, having three obvious holes in the central part. These holes are arranged in a triangular position.

Distribution: Detected from Upper Eocene strata of the Maadi Formation, at Heit El Ghorab area, near the Sphinx, Egypt.

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PLATE 1

Fig. 1. *Discoaster aster* BRAMLETTE & RIEDEL, 2500 ×.
Figs. 2 and 3. *Discoaster barbadiensis* TAN SIN HOK, 2500 ×.
Fig. 4. *Discoaster binodosus* MARTINI, 2500 ×.
Fig. 5. *Discoaster crassus* MARTINI, 1700 ×.
Fig. 6. *Discoaster gemmifer* STRADNER, 2500 ×.
Fig. 7. *Discoaster mirus* DEFLANDRE, 2500 ×.
Fig. 8. *Discoaster plebeius* MARTINI, 2500 ×.
Fig. 9. *Discoaster lodoensis* BRAMLETTE & RIEDEL, 1700 ×.
Fig. 10. *Discoaster saipanensis* BRAMLETTE & RIEDEL, 2500 ×.
Fig. 11. *Discoaster quinarius* (EHRENBERG), BERSIER, 2500 ×.
Fig. 12. *Discoaster* sp. 1, 2500 ×.
Fig. 13. *Discoaster sublodoensis* BRAMLETTE & SULLIVAN, 2800 ×.
Fig. 14. *Discoaster aster* BRAMLETTE & RIEDEL, 2500 ×.

PLATE 1

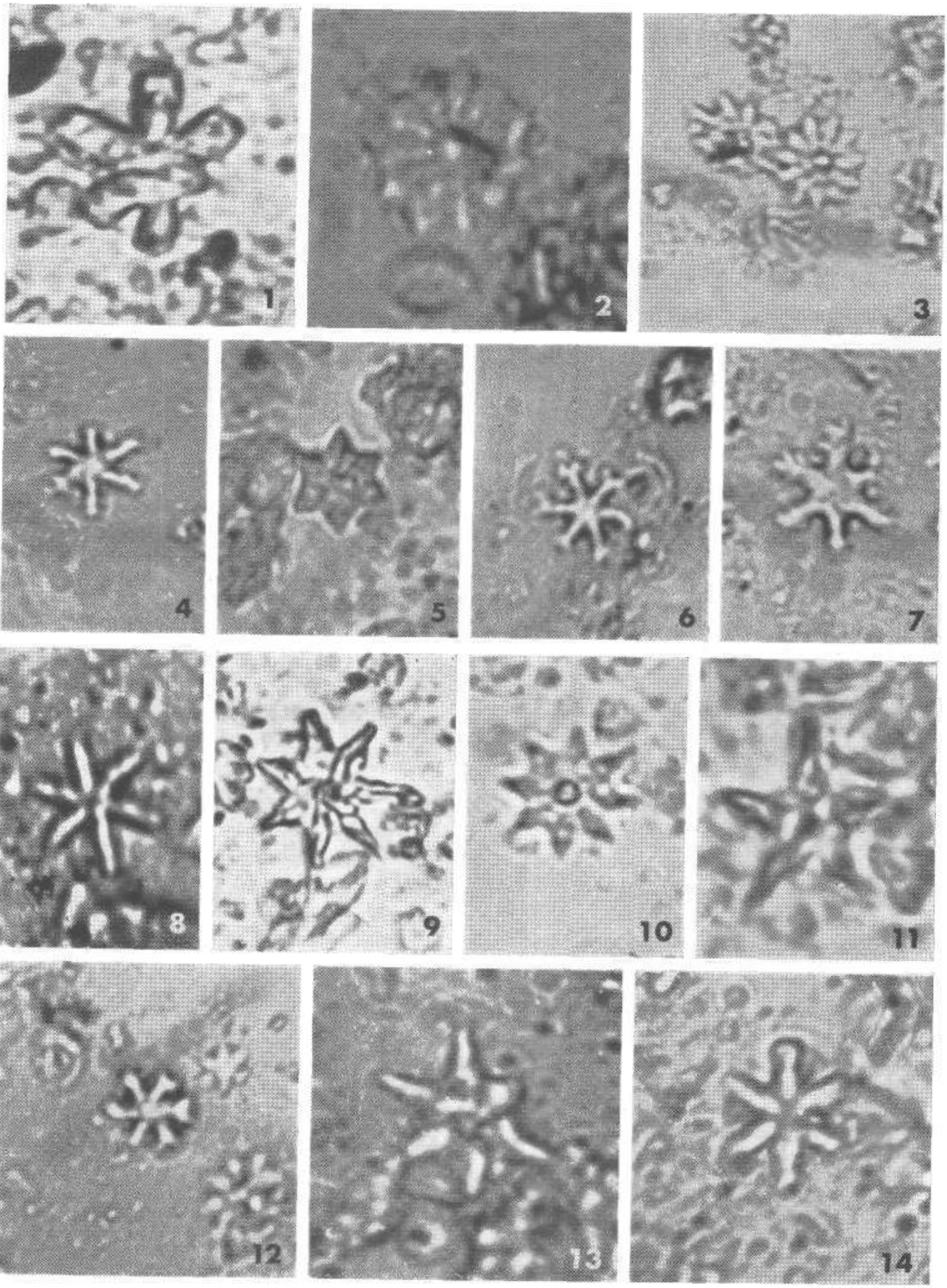
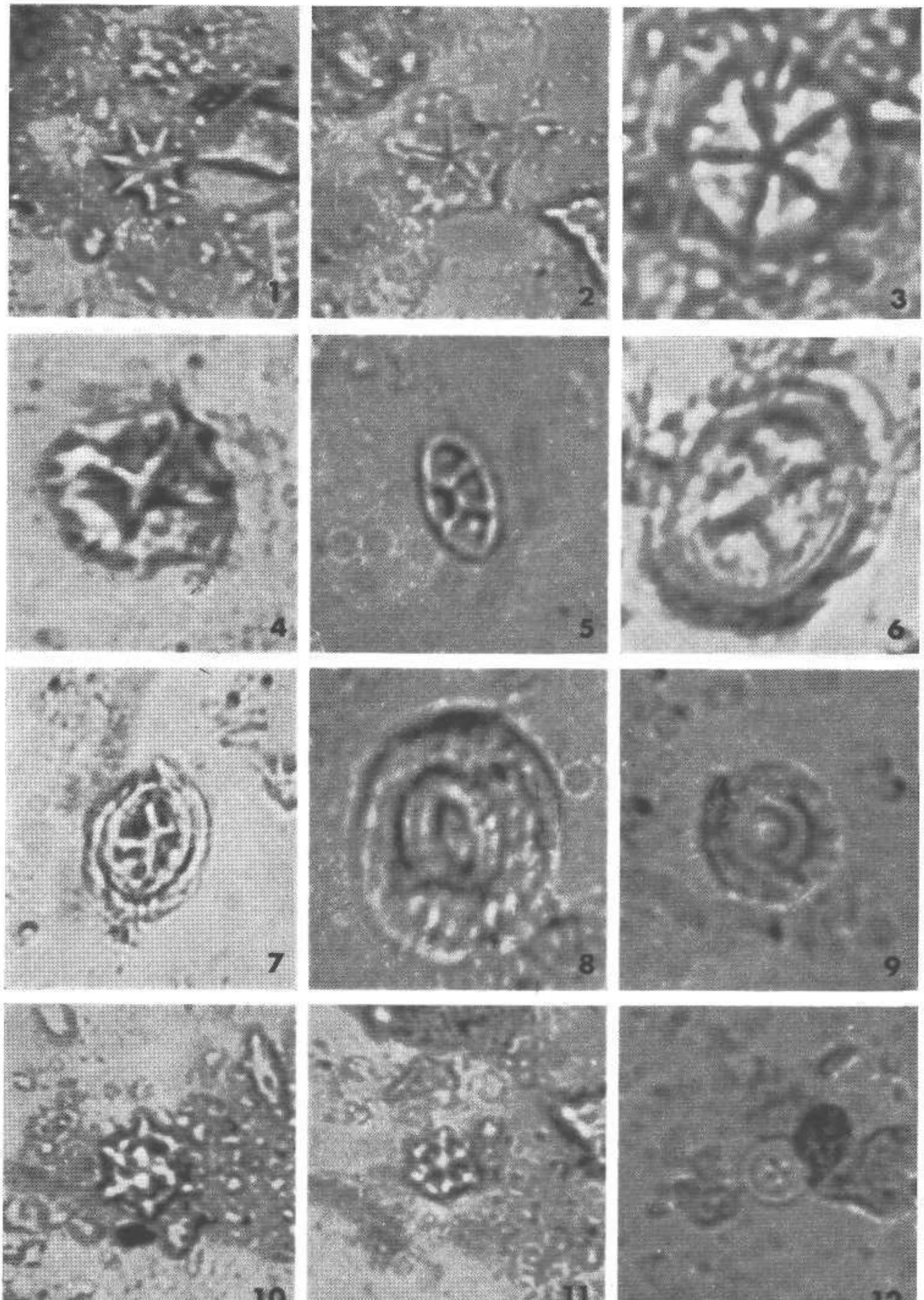


PLATE 2

Fig. 1. *Discoaster* sp. 2, 1700 ×.
Fig. 2. *Micrantholithus flos* DEFLANDRE, 1700 ×.
Fig. 3. *Braarudosphaera discula*, BRAMLETTE & RIEDEL, 2800 ×.
Fig. 4. *Chiphragmalithus* sp., 2500 ×.
Fig. 5. *Neococcolithes dubius* (DEFLANDRE), BLACK, 2500 ×.
Fig. 6. *Chiasmolithus bidens* (BRAMLETTE & SULLIVAN), HAY, MOHLER & WADE, 1700 ×.
Fig. 7. *Coccolithus solitus* BRAMULETTE & SULLIVAN, 2500 ×.
Fig. 8. *Coccolithus eopelagicus* (BRAMLETTE & RIEDEL), STRADNER & EDWARDS, 1700 ×.
Fig. 9. *Cycloccolithus* sp., 1700 ×.
Figs. 10 and 11. *Trochoaster simplex* KLUMPP, 1700 ×.
Fig. 12. *Undetermined form*, 1700 ×.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Review of Calcareous Nannoplankton Investigations

(carried out 1964/72 in connection with the Vienna UNESCO Postgraduate Training Center)

(1 table, 1 plate)

By H. Küpper & H. Stradner

In the years since 1950 contributions on the calcareous nannoplankton were building up fields of research of increasing importance for geosciences. Today they are indispensable as quick tool for stratigraphic investigations of deep sea cores and also as an independent check for age determinations of mesozoic and cenozoic rocks, next to the classical methods of stratigraphy.

Scientific and laboratory facilities in this field were made available to those members of our courses, who wanted to acquaint themselves with this field of study. Moreover a general introduction into this topic was part of the normal programme for all course participants. As for the time being our course venture comes to a conclusion, we like to underline in the following a few facts, which we consider as relevant to be handed on.

The very fact, that nannoplankton stratigraphy was new and is opening new possibilities to approach sample material, which so far has resisted yielding any clues as to its age assignment, was a bond which brought together investigators from Korea, India, Egypt, Argentine on the basis of a common scientific zeal. As seen from the UNESCO-point of view here a basis of transcontinental dimensions was offered by these ultra-minute fossils, which thus promoted common understanding even beyond the science field.

Naturally nannoplankton investigations developed rapidly during the years of our courses in the international field. The ideas of 1970 are different and better documented than those of 1960. Conferences and symposia were marking this progress, thus opening for participating investigators the door to international cooperation and worldwide contacts. This gateway to new scientific and human realms was, what made it highly attractive for teachers and students.

Notwithstanding that in recent years electron microscopy and scanning techniques became desirable working methods, the very roots of the working techniques remained relatively noncomplicated. And this again resulted in a wide and quick dissemination in some countries, where the first steps in this working field were introduced successfully. In this respect we may refer to our colleagues from Egypt, where quite a flow of stratigraphical investigations resulted in new views as to correlations and subdivisions, which before had to be based on less certain considerations.

RANGE-CHART OF NANNOFOSSIL INVESTIGATIONS 1965 / 72

Maastrichtian	Danian	NP 1 Markalius astroporus Zone	NP 2 Cruciplacolithus tenuis Zone	NP 3 Chiasmolithus danicus Zone	NP 4 Ellipsolithus macellus Zone	NP 5 Fasciculithus tympaniformis Zone	NP 6 Heliolithus kleinpelli Zone	NP 7 Discoaster gemmeus Zone	NP 8 Heliolithus riedeli Zone	NP 9 Discoaster multiradiatus Zone	NP 10 Marthasterites contortus Zone	NP 11 Discoaster binodosus Zone	NP 12 Marthasterites tribrachiatus Zone	NP 13 Discoaster lodoensis Zone	NP 14 Discoaster sublodoensis Zone	NP 15 Chiphragmalithus alatus Zone	NP 16 Discoaster tani nodifer Zone	NP 17 Discoaster saipanensis Zone	NP 18 Chiasmolithus oamaruensis Zone	Miocene - Pliocene - Pleistocene	approx. age of samples studied / Author and date of publication
		Paleocene									Eocene										
		Lower				Middle				Upper	Lower				Middle		Upper				
		P 1			P 2	P 3				P 5	P 6			P 9	P 10	P 12	P 13				
o	o									o	o										65/67 Moshkovitz
																				o	65/67 Takayama
															o				o		67/67 Bilgutay et al.
o																					69 Malumian
																o				o	69/69 Ki Hong Chang
																			o		69 Achuthan
o		o	o			o	o			o	o	o	o								69/70 El Dawoody
										o		o	o								70 Sadek et al.
o																					70/71 Shafik
										o	o		o	o	o			o			72 Sadek

Table 1. Chart indicating which parts of the stratigraphic column were covered by the nannoplankton studies of UNESCO Postgraduate Course participants.

We might refrain from entering into a discussion of scientific results and reasoning. Just to give an impression as to the part of the geological time scale, which was covered by the investigations of the Vienna course members here and abroad, we might refer to the attached table 1. which should give a synopsis of the situation. Likewise plate 1. with electron micrographs of Egyptian Paleocene coccoliths, is to illustrate the type of morphological studies performed during the last two years by some of our postgraduates; for details see explanation to plate 1. Finally we refer to the enclosed list of publications, to round out this general information.

Concluding we would like to quote a few lines from Professor Ki Hong Chang, Korea, course term 1968/69, which he has written as a general evaluation of his impressions in this field of study:

"the unique, though trivial merit of this study lies in its approach; it is to throw a new stepping stone for coming students of evolution and biostratigraphy, who want to understand the evolving world of life through nannofossils and to define stratigraphical stages according to the well substantiated evolutionary stages of nannofossils. Nannoplankton, respresenting a basic step towards the living things from the inorganic stage of being, might show the fundamental feature of evolution, supposedly exclusive of perplexing details."

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PLATE 1.

Transmission electron micrographs of *Prinsius bisulcus* (STR.) HAY & MOHLER.
These coccoliths were studied in detail by Dr. A. S. A. EL DAWOODY and the co-author during an investigation of Upper Paleocene nannoplankton from the Upper Esna Shale in the Gebel Duwi, Quseir District, Egypt (UNESCO Postgraduate Course 1969/70).

Fig. 1. *Prinsius bisulcus* (STR.), distal view showing the distal outer shield, the two crystal-cycles of the inner wall and the central area with six pores. Magnification: 10,600 ×.

Fig. 2. Distal view of coccolith with more complicated central area. Magnification: 16,000 ×.

Fig. 3. Distal view of coccolith with central area perforated by two cycles of pores. Magnification: 16,000 ×.

Fig. 4: Distal view of coccolith with central area partly closed by the second, inner wall. Magnification: 10,600 ×.

Fig. 5. Proximal view of a coccolith with only four perforations of the central area. Magnification: 11,700 ×.

Fig. 6. Proximal view of a coccolith showing both proximal and distal shield and six perforations round a central knob. These perforations do not seem to reach the distal side of the coccolith, which there apparently is closed by cover plates. Magnification: 10,600 ×.

Instrument: SIEMENS Elmiskop I of the College for Veterinary Medicine, Vienna.

PLATE 1