STRATIGRAPHIC SIGNIFICANCE OF TWO GENERA OF TERTIARY CALCAREOUS NANNOFOSSILS[1]

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CONTENTS

Abstract

A new species of calcareous nannoplankton *Ceratolithus rugosus* is described, and emended descriptions of two other species of this genus are presented. The worldwide occurrence and partial overlap in the sequence of ranges of these taxa are helpful in age assignment of late Miocene to Holocene strata. A new species *Peritrachelina joidesa* of late Eocene to middle Oligocene age is also described.

I. Introduction

Of approximately 3000 described species of calcareous nannofossils, the stratigraphic significance of only a small percentage has yet been determined. The special stratigraphic value of many of the species lies in their ready identification, which permits their recognition and the assignment of their time range to occurrences in worldwide rock sequences. For most of the ortholithid and larger heliolithid calcareous nannofossils, polarizing light microscope studies provide this ready identification. The taxa considered here can be effectively so identified, and their ranges are indicated from numerous sections. The species of *Ceratolithus* occur in large numbers (relative to most calcareous nannoplankton taxa) in open-ocean sediment suggesting a preference for that environment.

II. Samples

Atlantic Ocean

Challenger 338 (21°15′ S., 14°02′ W.).

Albatross Swedish deep-sea cores 58 (6° 44′ N., 129°28′ W.) and 62 (3° 00′ S., 136°26′ W.).

Lamont core V16-21 (17°16′ N., 48°25′ W.).

Lamont core V12-5 (21°12′ N., 45°21′ W.).

Lamont core V3-153 (28°24′ N., 77°56′ W.).

Lamont core C10-11 (32° N., 64° W.).

JOIDES core 3 (21°30′ N., 77°31′ W.).

JOIDES core 4 (31°02′ N., 77°43′ W.).

JOIDES core 6 (30°05′ N., 79°15′ W.).

Pacific Ocean

Scripps core CAP-38BP (14°16′ S., 119° 11′ W.).

Scripps core LSDH-78P (4°31′ S., 168° 02′ E.).

Tonga Group, Eua Island, north of Vaigana at 120 meters elevation.

Santa Monica Basin grab sample at 911 meters (33°48′ N., 118°48′ W.).

Indian Ocean

Scripps core DODO-141G (24°42′ S., 73°05′ E.).

North America

Red Bluff Clay, Alabama, SW ¼ sec. 28, T. 7 N., R. 10 W., 1 meter above base.

Mint Spring Marl Member of Marianna Limestone, Mississippi, at Mint Spring Bayou, Geol. Soc. America, SE Sec., 1964 Field Guide, stop 2 (Cheetham and Glawe, 1964).

Glendon Limestone Member of Byram Formation, Mississippi, near Vicksburg at intersection of U. S. Hwy 61 and Vicksburg bypass.

Shubuta Member of Yazoo Clay, Missis-

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sippi, Clarke Co., SW ¼ sec. 3, T. 10 N., R. 16 W.

Europe

Lower part of type Plaisancian, 200 meters south of Lugagnano in Torrente Arda, south side of Po Valley, Italy.

Lower Plaisancian at Tabiano, about 15 kilometers east of Lugagnano, south side of Po Valley, Italy.

Trubi Formation, basal Pliocene, near Campofelice, Palermo, Sicily.

Upper Eocene strata (Bartonian) at Biarritz, Côte de Basque section, southwest France.

Upper Eocene strata (Bartonian) at Brihande, in St. Lon region, southwest France.

III. SYSTEMATIC PALEONTOLOGY

Family CERATOLITHACEAE Norris, 1965

Genus CERATOLITHUS Kamptner, 1950

Remarks: This genus is identified by the horseshoe-shaped skeletal elements, ceratoliths, acting optically as single units of calcite. The genus was initially established for Holocene specimens recovered in a sea-floor sample of the *Challenger* expedition. A fossil record of three successive forms from late Miocene to Holocene time had been determined (Martini and Bramlette, 1963) but were not then described and named. The living species producing ceratoliths were first recognized by Norris in 1965 from Indian Ocean plankton samples. The various forms are here assigned to only three species of *Ceratolithus.* The earliest appeared in the upper Miocene.

CERATOLITHUS CRISTATUS Kamptner, emended

Pl. 1, figs. 1-4

Ceratolithus cristatus KAMPTNER, 1954, Arch. Protistenk., v. 100, p. 43, text-figs. 44-45.

Ceratolithus cf. *C. cristatus* (Kamptner). BRAMLETTE & RIEDEL, 1954, Jour. Paleontology, v. 28, p. 394, pl. 38, fig. 9.

Ceratolithus cristatus Kamptner. COHEN, 1964, Micropaleontology, v. 10, p. 246, pl. 5, figs. 5a-d; COHEN, 1965, Leidsche Geol. Meded., v. 35, p. 36, pl. 3, figs. m, n; NORRIS, 1965, Arch. Protistenk., v. 108, p. 19-24, pl. 11, figs. 1-4; pl. 12, figs. 1-4.

Ceratolithus telesmus NORRIS, 1965, Arch. Protistenk., v. 108, p. 21, pl. 11, figs. 5-7; pl. 13, figs. 1-3.

Ceratolithus cristatus TAKAYAMA, 1967, Jb. Geol. B.A., v. 110, p. 196, pl. 1, figs. 2-4.

Remarks: This taxon was originally established for a group of fairly symmetrical horseshoe-shaped calcite bodies. The arms of the horseshoe are smooth or ornamented with a row of small "teeth" or nodes. Between crossed polarizers, and in the usual flat orientation, these ceratoliths are dark (at optical extinction) when the axis of the horseshoe is parallel to the vibration direction of either polarizer and they are uniformly bright when rotated to a position approximately 45° from the polarizer directions. The crystallographic orientation of the calcite, and the non-rugose horseshoe shape are the constant characters of this taxon. Considerable morphologic variation occurs, usually affecting the symmetry of the arms, their relative lengths, or the prominence of the tooth-like ornamentation.

Norris (1965) noted that living specimens show the ceratolith as an internal structure and that an envelope of delicate ring coccoliths (whether calcified or not is unknown) is present at the cell surface. In tropical waters he found a mixed population of cells of similar structure but with morphologic difference in the ceratolith. Since the arms were longer, with less development of "teeth," and the tips closer together on a form not recorded from waters farther south of the equator, he distinguished this new form as *Ceratolithus telesmus.* Abundant Holocene ceratoliths from all ocean floors have shown complete morphologic gradations between this form and the holotype of *C. cristatus* within the same samples. Therefore this variation in morphology is considered to be intraspecific, and *C. telesmus* is placed into synonymy with *C. cristatus.* However, it should be noted that ceratoliths with long, narrow, and smooth arms similar to *Ceratolithus telesmus* Norris are much more common in Quaternary sediments than the *C. cristatus* originally figured by Kamptner.

Distribution: The earliest occurrence of these smooth or "toothed" forms is near the Plio-Pleistocene boundary in many marine cores: first appearance in *Albatross* Swedish deep-sea core 62 above 1,050 centimeters and core 58 above 650 centimeters, these levels being slightly above the *Discoaster brouweri* extinction level, as in Lamont V16-21 at 150 centimeters and other cores. This species is still living and has

PLATE 1
Magnification: 2100×

1-4 *Ceratolithus cristatus* Kamptner, emended.
1 Santa Monica Basin, Holocene, bright field, plan. U.S.N.M. 651130.
2 Santa Monica Basin, Holocene, crossed nicols, plan. U.S.N.M. 651130.
3 Challenger 338, Holocene, bright field, plan. U.S.N.M. 651131.
4 Challenger 338, Holocene, bright field, tilted. U.S.N.M. 651132.

5-9 *Ceratolithus rugosus* n. sp.
5 Holotype, U.S.N.M. 651133, LSDH-78P, 100 cm, Pliocene, phase contrast, plan.
6 Holotype, crossed nicols, plan.
7 Holotype, bright field, plan.
8 V16-21, 600 cm, Pliocene, phase contrast, tilted. U.S.N.M. 651134.
9 CAP-38BP, 571 cm, Pliocene, bright field, plan. U.S.N.M. 651135.

The stratigraphic significance of this species is that it is easily distinguished from other species of *Ceratolithus* by its crystallographic orientation and that it appeared alone and in abundance in the late Miocene and was extinct by the middle Pliocene.

Distribution: The earliest occurrence is upper Miocene in the uppermost marine shale of the type Tortonian section (the upper part, which is assigned to the Messinian by Italian micropaleontologists; see Selli, 1964, p. 328). Among other upper Miocene through lower Pliocene occurrences are JOIDES core 3 from 3 to 16 meters; Lamont core V16-21 from 525 to 700 centimeters; Lamont core V3-153 from about 200 to 541 centimeters (core bottom), with the Miocene-Pliocene boundary near 230 centimeters according to F. L. Parker; and Scripps Pacific Ocean core LSDH-78P from 499 to 519 centimeters (also containing *Ceratolithus rugosus* present through this interval), with the boundary placed near 500 centimeters by F. L. Parker. Sparse land occurrences in the lower Pliocene are noted from the basal Plaisancian of the Torrente Arda in north Italy, at 200 meters south of Lugagnano, and in the Tabiano section about 15 kilometers to the east; it is also present in the Trubi Formation—basal Pliocene of Sicily.

Size: Horn or arch to arm tips, 22 microns, maximum, 6 microns, minimum; rod length, 45 microns, maximum.

Hypotypes: U.S.N.M. 651136-39.

Genera INCERTAE SEDIS
Genus PERITRACHELINA Deflandre 1954

Remarks: The crescent-shaped skeletal elements assigned to this genus are composed of calcite which behaves optically as a single unit. The affinities of the organisms that produced these skeletal elements are unknown. *Peritrachelina ornata* Deflandre, the type species, was described from strata of Eocene (Cuisian or early Lutetian) age. Although specimens of *Peritrachelina* are seldom common in coccolith assemblages, we have noted them in a number of samples of Eocene and Oligocene age. The report of three Cretaceous species from Poland (Gorka 1957) has not been substantiated in other detailed studies of Cretaceous strata (for example, Bramlette and Martini, 1964; Reinhardt, 1966; Gartner, 1968; Bukry, in press), and are probably abraded fragments of coccolith rims—a supposition which could be checked by their appearance between crossed polarizers.

The early Eocene specimens of *Peritrachelina* can be assigned to the type species, *P. ornata* Deflandre. However, a new form, lacking the distinctive ornamentation of *P. ornata* Deflandre, first appears in late Eocene strata.

PERITRACHELINA JOIDESA
Bukry & Bramlette, n. sp.
Pl. 2, figs. 5-8

Description: The crescent outline of this nannofossil is emphasized by the presence of marginal lips bordering a featureless interlip area. The short inner lip, while normally smooth, may be beaded (Pl. 2, fig. 5). The long outer lip is a peripheral ridge, rarely somewhat irregular. In plan view, as the microscope stage is rotated between crossed polarizers, this species remains dark—a character of the genus.

In samples subjected to excess calcification, the area between the lips is progressively filled-in until there is usually no distinction between the lips and the interlip area (for example, in JOIDES Blake Plateau cores where, however, the identity with normal specimens is indicated by rare less calcified ones).

Remarks: The lack of any ornamentation extending from the short inner lip onto the interlip area distinguishes this new species from *P. ornata* Deflandre. Also, *P. ornata* lacks the distinct long outer lip characteristic of *P. joidesa* n. sp.

Care should be taken in identifying this new species, because broken specimens of some co-occurring heliolithid coccoliths like *Apertapetra umbilica* (Levin) may superficially resemble *P. joidesa.* However, the behavior between crossed polarizers makes the distinction obvious, as *P. joidesa* is uniformly dark between crossed polarizers, whereas fragments of a coccolith such as *A. umbilica* have a radial array of numerous calcite elements that produces part of a maltese-cross shaped set of extinction lines (see above comment on Gorka, 1957). Early forms of *Ceratolithus* appearing in the upper Miocene are horseshoe-shaped and likewise remain dark between crossed polarizers. These forms can be distinguished by the slenderness and circular cross-section of the

Ceratolithus arms. The limbs of *Peritrachelina* are wide and planar except when heavily calcified, as in the JOIDES Blake Plateau cores. The crystallographic character and general shape of these two genera might suggest an evolutionary sequence from *Peritrachelina* to *Ceratolithus*. At present, however, the middle Oligocene Blake Plateau specimens of *P. joidesa* n. sp. are the latest known occurrence of *Peritrachelina*, and the late Miocene specimens of *Ceratolithus tricorniculatus* Gartner, emended, are the earliest known occurrence of *Ceratolithus*.

Electron micrographs of *P. joidesa*, referred to as *Peritrachelina* sp., appear in a forthcoming paper by S. Gartner and D. Bukry.

Distribution: Earliest occurrences are from upper Eocene (Bartonian) strata of the Côte de Basque of France at Biarritz; from the St. Lon region of southwest France at Brihande; and from the Yazoo clay of the Gulf Coast of the United States. Oligocene occurrences are from the Red Bluff Clay, in Alabama, the Mint Spring Marl Member of the Marianna Limestone, and the Glendon Limestone Member of the Byram Formation of the Vicksburg Group, in Mississippi; from north of Vaigana on Eua Island in the Tonga Group; and from Lamont core C10-11, at 66 to 71 centimeters. The species is most common in JOIDES core 3 from 85 to 153 meters, and there are sparse occurrences in JOIDES core 4 in the Oligocene between approximately 45 and 75 meters, and in JOIDES core 6 in the lower Oligocene from 7 to 48 meters and in the upper Eocene from 50 to 80 meters. These nearly worldwide occurrences begin in the *Isthmolithus recurvus* Zone and terminate in the *Sphenolithus ciperoensis* Zone (see Bramlette and Wilcoxon, 1967, for this nannofossil zonation).

Size: Maximum length, 14 microns.

Holotype: U.S.N.M. 651140 (Pl. 2, fig. 8).

Paratypes: U.S.N.M. 651141-43.

Type locality: Red Bluff Clay, St. Stephens Quarry, Alabama.

IV. References

Bramlette, M. N., and E. Martini, 1964. The great change in calcareous nannoplankton fossils between the Maestrichtian and Danian: Micropaleontology, v. 10, p. 291-322.

Bramlette, M. N., and W. R. Riedel, 1954. Stratigraphic value of discoasters and some other microfossils related to Recent coccolithophores: Jour. Paleontology, v. 28, p. 385-403.

Bramlette, M. N., and J. A. Wilcoxon, 1967. Middle Tertiary calcareous nannoplankton of the Cipero section, Trinidad, W. I.: Tulane Stud. Geol., v. 5, p. 93-131.

Bukry, D., in press, Upper Cretaceous coccoliths from Texas and Europe: Univ. Kansas Paleont. Contr.

Cheetham, A. H., and L. N. Glawe, 1964. Field guide: Geol. Soc. America, Southeast Sec., Ann. Mtg., Baton Rouge, p. 1-10.

Cohen, C. L. D., 1964. Coccolithophorids from two Caribbean deep-sea cores: Micropaleontology, v. 10, p. 231-250.

Cohen, C. L. D., 1965. Coccoliths and discoasters from Adriatic bottom sediments: Leidsche Geol. Meded., v. 35, p. 1-44.

Deflandre, G., 1952, Classe des Coccolithophorides, *in* P. P. Grasse, ed., Traité de Zoologie: Paris, v. 1, p. 439-470.

Ericson, D. B., M. Ewing, and G. Wollin, 1963. Pliocene-Plistocene boundary in deep-sea sediments: Science, v. 139, p. 727-737.

Gartner, S., Jr., 1967. Calcareous nannofossils from Neogene of Trinidad, Jamaica, and Gulf of Mexico: Univ. Kansas Paleont. Contr., paper 29, p. 1-7.

Gartner, S., Jr., 1968. Coccoliths and related calcareous nannofossils from Upper Cretaceous deposits of Texas and Arkansas: Univ. Kansas Paleont. Contr., no. 48, p. 1-56.

Gorka, H., 1957. Coccolithophoridae z górnego mastrychtu Polski srodkowej, Acta Palaeont. Polonica, v. 2, p. 235-284.

Kamptner, E., 1950. Über den submikroskopischen Aufbau der Coccolithen: Österreichische Akad. Wiss., Math.-Naturw. Kl., Anz., v. 87, p. 152-158.

Kamptner, E., 1954, Untersuchungen über den Feinbau der Coccolithen: Arch. Protistenk., v. 100, p. 1-90.

Martini, E., and M. N. Bramlette, 1963. Calcareous nannoplankton from the experimental Mohole drilling: Jour. Paleontology, v. 37, p. 845-856.

Norris, R. E., 1965. Living cells of *Ceratolithus cristatus* (Coccolithophorineae): Arch. Protistenk., v. 108, p. 19-24.

Parker, F. L., 1967. Late Tertiary biostratigraphy (planktonic Foraminifera) of tropical Indo-Pacific deep-sea cores: Am. Paleontology Bull., v. 52, p. 115-207.

Reinhardt, P., 1966. Zur Taxonomie und Biostratigraphie des fossilen Nannoplanktons aus dem Malm, der Kreide und dem Alttertiar Mittleuropas: Freiberger Forschungshefte, C196, p. 1-109.

Selli, R., 1964. The Mayer-Eymar Messinian 1867, proposal for a neostratotype: 21st Internat. Geol. Cong., Norden 1960, pt. 28, p. 311-333.

Takayama, T., 1967. First report on nannoplankton of the Upper Tertiary and Quaternary of the southern Kwanto region, Japan: Österr. Geol. Bundesanst. Jahrb., v. 110, p. 169-198.

RECENT BOOKS

THE QUATERNARY, edited by Kalervo Rankama. Published by Interscience Publishers (John Wiley & Sons), New York, London and Sydney, 1965, vol. 1, xxii + 300 pp., $15.00; vol. 2, vii + 477 pp., $19.50

These volumes are part of the series *The Geologic Systems*, a very useful survey of regional stratigraphy. Volume one includes Denmark, Norway, Sweden and Finland. Volume two deals with The British Isles, France, Germany and The Netherlands.

GEOSYNCLINES, by Jean Aubouin. Published by Elsevier Publishing Company, Amsterdam, London and New York, 1965, xv + 335 pp., $20.00

Geosynclines is part one of the *Developments in Geotectonics* series. It begins with an historical review of the geosynclinal concept, followed by discussion of geosynclines as illustrated by the Mediterranean chains of the Alpine cycle, and concludes with the author's synthesis of the subject.

PALEOTEMPERATURE ANALYSIS, by Robert Bowen. Published by Elsevier Publishing Company, Amsterdam, London and New York, 1966, x + 265 pp., $16.50

Paleoclimatology, or the study of ancient climates, assists the geologist in reconstructing land and sea distributions in the past. The use of oxygen isotopes in carbonate analysis has contributed greatly to knowledge of paleoclimates. This book describes the method and its practical application in the various geological systems from the Devonian to the Holocene.

HYDROGEOLOGY, by Stanley N. Davis and Roger J. M. De Wiest. Published by John Wiley & Sons, Inc., New York, London and Sydney, 1966, xi + 463 pp., $12.50

This is a companion volume to *Geohydrology* by Roger J. M. De Wiest (John Wiley, 1965). The emphasis is on the geologic aspects of ground water rather than its fluid-flow aspects and the quantitative analysis of engineering problems.

SALT BASINS AROUND AFRICA, published by The Institute of Petroleum, London, 1965, 122 pp., $7.75

This small book contains the proceedings of the joint meeting of the Institute of Petroleum and the Geological Society, held at London, 3 March 1965. The seven papers and discussions bring together much previously unpublished data on this little-known subject.

PRINCIPLES OF GEOCHEMISTRY, by Brian Mason. Third edition, published by John Wiley & Sons, Inc., New York, London and Sydney, 1966, xi + 329 pp., $9.95

This new edition is extensively revised, incorporating changes throughout the text and the bibliographies appended to each chapter, and adding an appendix of questions and problems. There has been much vigorous research and considerable progress in basic concepts and theories of geochemistry in recent years.

ESTUARY AND COASTLINE HYDRODYNAMICS, by Arthur T. Ippen. Published by McGraw-Hill Book Company, Inc., New York, 1966, xvii + 744 pp., $28.50

Coastal engineering, tidal dynamics and near-shore oceanography are the principal subjects treated in this text. Fundamental analytical concepts of wave theory are developed leading to their application to engineering problems in shore line and tidal areas.

AN INTRODUCTION TO THE ROCK-FORMING MINERALS, by W. A. Deer, R. A. Howie and J. Zussman. Published by John Wiley and Sons, Inc., New York, 1966, xi + 528 pp., $11.00

This single volume is a students' text edition of the well-known five volume *Rock Forming Minerals* by the same authors. The organization is similar to that in the larger work, but condensed and presented to serve the dual purpose of text and laboratory manual for undergraduate courses.

—H.C.S.

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