

UPPER CRETACEOUS COCCOLITHOPHORIDS FROM ZULULAND, SOUTH AFRICA

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ABSTRACT. A detailed study of some Upper Cretaceous calcareous nannoplankton of Zululand was undertaken, utilizing the optical as well as the electron microscope. Nine new species belonging to five genera are described as viewed in the electron microscope. These are *Coccolithus cribosphaerella*, *Coccolithus zuluensium*, *Cyclolithus zulu*, *Discolithus crystallinus*, *Discolithus rhabdosphaericus*, *Discolithus spiralis*, *Maslovella africana*, *Maslovella blackii*, and *Maslovella pulehra*. Using the sequential occurrence of the coccoliths through the top 800 ft. of 'Zululand Oil Exploration' Borehole 'A' the age was determined as being Cretaceous Maestrichtian.

THE material on which this study was based was supplied by the Anglo Transvaal Consolidated Investment Company of South Africa. It belongs to part of this company's oil prospecting project and is from Borehole 'A' drilled near Lake Sibaya, Zululand, South Africa.

The method used to extract and prepare the coccoliths for observation under both the optical as well as the electron microscope are similar to those described by Pienaar (1966).

All samples are housed in the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, while the prepared slides and electron micrographs are housed in the Department of Plant Biology, University of Natal, Durban, South Africa.

TAXONOMIC PROBLEMS

It has been shown by numerous workers in this field that the systematics of this group of algae is in a state of turmoil. This has arisen mainly out of the fact that there have been many approaches to this field of study. The use of phase contrast, polarizing, and ordinary optical microscope as well as the electron microscope have resulted in confusion within the group because these algal remains appear so completely different when viewed under the different microscopes.

It has been shown that the only satisfactory way to study this group systematically, is by utilizing the electron microscope which with its high power of resolution reveals the detailed structure of the coccoliths. This is vitally important as the systematics of the Coccolithophoridae is based on hard-part morphology; I do not suggest that the optical microscope be abandoned, and have in fact stressed (Pienaar 1966) that it is invaluable in the stratigraphic application of the group.

In the present report no attempt has been made to place the coccoliths under any hierarchical systematic framework. I consider it premature to do so until there is a good collection of electron micrographs available, and for this reason the coccoliths are described in alphabetical order.

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DESCRIPTIVE TERMINOLOGY

Distal shield. Shield which is the furthest away from the point of attachment of the coccolith to the coccosphere, and is always convex.

Longitudinal axis. Line joining the two longitudinal poles.

Longitudinal poles. Situated at each end of the longitudinal axis of the theoretical ellipse that contains the coccolith.

Plates. Elements which comprise the proximal and distal shields; they vary from being wedge-shaped to rectangular in outline.

Pore. Region where there are no crystals of calcium carbonate, usually within the central area of the coccolith.

Proximal shield. Part of the coccolith which is in direct contact with the coccosphere; always concave.

Shield. Main structural element of a coccolith, always composed of plates.

Shield area. Width of the shields when the coccolith is seen in plan view.

Transverse axis. Line joining the two transverse poles.

Transverse poles. Situated at each end of the transverse axis of the theoretical ellipse that can contain the coccolith.

SYSTEMATIC DESCRIPTIONS

Genus COCCOLITHUS Schwarz 1894

Coccolithus cribosphaerella sp. nov.

Holotype. Plate 70, figs. 4, 5.

Locus typicus. Borehole 'A', Lake Sibaya, Zululand, South Africa. Assemblage 1382, depth 280 ft.: Cretaceous.

Diagnosis. Elliptical placoliths composed of two well-developed shields; distal shield larger, convex, composed of 21–22 plates. The exact detail of the smaller proximal shield is not known. The central area is sculptured with numerous pores aligned parallel to the longitudinal axis of the ellipse.

Description. The scalloped outline is due to the overlapping plates of the distal shield. The proximal shield is presumed to be similarly composed. The central area is sculptured

EXPLANATION TO PLATE 69

Figs. 1, 5. *Maslovella blackii* sp. nov., non-replicated. 1, $\times 28,000$. 5, $\times 10,700$.

Fig. 2. *Discolithus crystallinus* sp. nov., non-replicated; $\times 21,660$.

Fig. 3. *Maslovella pulchra* sp. nov., non-replicated; $\times 27,000$.

Fig. 4. *Cyclolithus zulua* sp. nov. non-replicated; $\times 13,330$.

Figs. 6, 7. *Coccolithus zuluensium* sp. nov., non-replicated. 6, $\times 13,330$. 7, $\times 13,750$.

Fig. 8. *Maslovella africana* sp. nov., non-replicated; $\times 12,850$.

Fig. 9. *Discolithus rhabdosphericus* sp. nov., non-replicated; $\times 13,125$.

with 3–5 rows of pores aligned parallel to the longitudinal axis of the ellipse; the pores vary from circular to hexagonal in shape.

Size. Longitudinal axis, 4.5–6.0 μ . Transverse axis, 3.1–4.8 μ . Width of shield area, 0.75–1.0 μ .

Remarks. This coccolith is well represented in the assemblages studied. The pore size is variable. Stradner (1961) described *Coccolithus opacus* which resembles the South African species and could well be a related form.

Coccolithus zuluensium sp. nov.

Holotype. Plate 69, figs. 6, 7.

Locus typicus. Borehole 'A', Lake Sibaya, Zululand, South Africa. Assemblage 1388, depth 330 ft.; Cretaceous.

Diagnosis. Elliptical coccolith made up of two well-developed shields; distal shield larger. The central area is spanned by two cross-bars which widen centrally and correspond to the axes of the ellipse.

Description. The distal shield is composed of 27–29 overlapping plates. The longitudinal polar plates are wedge-shaped and are larger than the remaining rectangular plates. The proximal shield is similar in construction to the distal shield.

The central area is the characteristic feature of the species; the cross-bars are composed of calcium carbonate crystals arranged in an irregular manner.

Size. Longitudinal axis, 3.25–4.4 μ . Transverse axis, 2.3–3.7 μ . Width of shield area, 0.8–1.0 μ .

Remarks. The coccoliths grouped together in this species resemble *Discolithus rhabdosphaericus* sp. nov. but differ in that they have a proximal and a distal shield and lack a central boss. The species is assigned to the genus *Coccolithus* because of the two-shielded nature. It has been noticed that during the course of the study of the South African Coccolithophorids that the members belonging to the genus *Coccolithus* usually possess large wedge-shaped polar plates.

Genus CYCLOLITHUS Kamptner 1948

Cyclolithus zulu sp. nov.

Holotype. Plate 69, fig. 4; Plate 70, fig. 1.

Locus typicus. Borehole 'A', Lake Sibaya, Zululand, South Africa. Assemblage 1382, depth 280 ft.; Cretaceous.

Diagnosis. Elliptical coccolith composed of a single shield abutting against a raised central rim. The shield is made up of 16–17 plates.

Description. The 16–17 plates are rectangular and overlap slightly. Towards the central area is a raised rim, against which the plates abutt. The raised portion is levigate and devoid of any sculpture.

Size. Longitudinal axis, 4.4–6.0 μ . Transverse axis, 3.6–4.1 μ . Width of shield area, 0.9–1.0 μ .

Remarks. On first impression this specimen appears to have two shields but on closer examination the second shield is seen to be a slightly raised rim with practically no plate structure. Because of its one-shielded nature and the central area devoid of any sculpture, the specimens are placed in the genus *Cyclolithus* Kämtner 1948.

Remarks. Under the Botanical Code of Nomenclature, the name *Discolithus* is retained for these algal fossils (cf. Loeblich and Tappan 1963).

Genus DISCOLITHUS Kämtner 1948

Discolithus cristallinus sp. nov.

Holotype. Plate 69, fig. 2; Plate 70, fig. 2.

Locus typicus. Borehole 'A', Lake Sibaya, Zululand, South Africa. Assemblage 1382, depth 280 ft.; Cretaceous.

Diagnosis. Elliptical one-shielded coccolith composed of 24–40 overlapping plates. The central area is infilled with crystals of calcium carbonate arranged in an irregular order.

Description. The average number of plates is between 28 and 30.

Size. Longitudinal axis, 2.4–2.75 μ . Transverse axis, 1.4–7.0 μ . Width of shield area, 0.25–0.45 μ .

Remarks. Occasionally specimens of *Discolithus cristallinus* were found with a distinct row of crystals following the outline of the central area. Their appearance was almost like the beginning of a second shield. In addition some forms have larger crystals of calcium carbonate covering the smaller crystals. This species is easily recognized by its single shield and the infilled central area.

Discolithus rhabdosphaericus sp. nov.

Holotype. Plate 69, fig. 9; Plate 71, figs. 1, 2, and 6.

Locus typicus. Borehole 'A', Lake Sibaya, Zululand, South Africa. Assemblage 1382, depth 280 ft.; Cretaceous.

Diagnosis. Elliptical one-shielded coccolith composed of 35 overlapping plates. The central area is spanned by a solid parallelogram-like structure, the diagonals of which correspond with the axes of the ellipse.

Description. The sides of the parallelogram are concave and each composed of six plates. The diagonals are raised and unite in the centre to form a boss which is perforated by an axial pore. The proximal surface of the coccolith is markedly concave and no central

EXPLANATION TO PLATE 70

- Fig. 1. *Cyclolithus zulua* sp. nov., replicated; $\times 30,000$.
 Fig. 2. *Discolithus cristallinus* sp. nov., non-replicated; $\times 22,000$.
 Fig. 3. *Discolithus spiralis* sp. nov., replicated; $\times 12,000$.
 Figs. 4, 5. *Coccolithus cribosphaerella* sp. nov., replicated. 4, $\times 14,000$. 5, $\times 12,000$.
 Fig. 6. *Maslovella africana* sp. nov., replicated; $\times 17,500$.

boss is observed when the coccolith is found in this position. The distal surface is markedly convex in comparison with the proximal surface.

Size. Longitudinal axis, 3.5–4.2 μ . Transverse axis, 2.7–3.2 μ . Width of shield area, 0.4–0.6 μ .

Remarks. This is a very common and distinctive species and was assigned to the genus *Discolithus* Kamptner 1948 because of its one-shielded nature and the infilled central area.

Discolithus spiralis sp. nov.

Holotype. Plate 70, fig. 3; Plate 71, fig. 4.

Locus typicus. Borehole 'A', Lake Sibaya, Zululand, South Africa. Assemblage 1387, depth 320 ft.; Cretaceous.

Diagnosis. Elliptical one-shielded coccolith with the central area infilled with crystals of calcium carbonate arranged in a sigmoid pattern.

Description. Shield composed of approximately 56 overlapping plates. The central area is large and elliptical and completely infilled.

Size. Longitudinal axis, 5.4–5.7 μ . Transverse axis, 3.6–3.7 μ . Width of shield area, 0.3–0.4 μ .

Remarks. This is a very distinctive coccolith and may always be recognized by the sigmoid arrangement of the crystals infilling the central area.

Genus MASLOVELLA Tappan and Loeblich 1966

Synonym. *Covillea* Black 1964.

Maslovelia africana sp. nov.

Holotype. Plate 69, fig. 8; Plate 70, fig. 6; Plate 71, figs. 3, 5.

Locus typicus. Borehole 'A', Lake Sibaya, Zululand, South Africa. Assemblage 1387, depth 320 ft.; Cretaceous.

Diagnosis. Circular to subcircular asymmetrical coccolith composed of two well-developed shields. At the locality of the axial pore the central area is infilled with crystals of calcium carbonate. The distal shield is larger than the proximal shield and is placed asymmetrically on top of it.

Description. The distal shield is composed of 25–29 overlapping plates, the average number of plates being 25. The plates are wedge-shaped and those situated at the longitudinal polar regions are larger and more markedly wedge-shaped than the remaining plates. The proximal shield is smaller than the distal shield and composed of 25–29 plates of variable size. In the region of the one longitudinal pole are wedge-shaped plates which are only a little smaller than the distal shield plates. At the opposite longitudinal pole all the plates are smaller and less than half the size of the distal shield plates. The central area is infilled with irregularly arranged crystals of calcium carbonate.

Size. Longitudinal axis, 3.1–3.2 μ . Transverse axis, 2.5–2.7 μ . Proximal shield, 1.9–2.6 $\mu \times$ 2.75–2.9 μ . Distal shield, 3.1–2.5 $\mu \times$ 4.1–3.7 μ .

Remarks. *Maslovelia africana* is common in most of the assemblages studied and characterized by the asymmetrically placed shields. It is tentatively placed in the genus

Maslovella Tappan and Loeblich 1966 which it most closely resembles. Black (1964), however, did not mention in his description of the type specimen any asymmetry in the genus, and thus a new genus might have to be erected. This form has also been found by the author in Type Maestrichtian material sent to him by Dr. E. Martini.

Maslovella blackii sp. nov.

Holotype. Plate 69, figs. 1, 5.

Locus typicus. Borehole 'A', Lake Sibaya, Zululand, South Africa. Assemblage 1382, depth 280 ft.; Cretaceous.

Diagnosis. Elliptical two-shielded coccolith. The distal shield is larger than the proximal shield and is composed of 17–27 plates. The central area is completely infilled with crystals of calcium carbonate.

Description. The plates situated at the longitudinal polar region are larger and wedge-shaped while the remaining plates are rectangular in shape and overlap to varying degrees. The structure of the proximal shield is not known but it is thought to be similar to that of the distal shield. The central area is large, elliptical, and completely infilled.

Size. Longitudinal axis, 1.75–2.8 μ . Transverse axis, 1.5–2.0 μ . Width of shield area, 0.5–0.6 μ .

Remarks. During the study of the South African sediments a number of coccoliths were found which were similar to the type description of the genus *Maslovella* (Black) Tappan and Loeblich 1966, except for a few minor differences. Some had only fourteen plates in the distal shield; others had only one well-developed shield and a robust rim in the place of the second shield. The patterning of the central area also varies by having slightly regular to irregular crystals infilling the central area or with two rows of crystals meeting along the longitudinal axis of the ellipse. These forms are thought to be intermediates or broken forms and are all grouped together into *Maslovella blackii*. *Maslovella blackii* differs from *M. africana* in that the latter form possesses a distinct asymmetry of the two shields, whereas the former species is symmetrical.

Maslovella pulchra sp. nov.

Holotype. Plate 69, fig. 3.

Locus typicus. Borehole 'A', Lake Sibaya, Zululand, South Africa. Assemblage 1387, depth 320 ft.; Cretaceous.

Diagnosis. Elliptical coccolith composed of two well-developed shields. The distal shield and the smaller proximal shield are both composed of seventeen plates. The central area is elliptical and infilled with prolongations of the proximal shield plates.

EXPLANATION TO PLATE 71

Figs. 1, 2, 6. *Discolithus rhabdosphericus* sp. nov., replicated. 1, Distal view, $\times 17,500$. 2, Proximal view, $\times 15,000$. 6, Proximal view, $\times 20,000$.
Figs. 3, 5. *Maslovella africana* sp. nov. replicated; 3, Proximal view, $\times 25,000$. 5, Distal view, $\times 16,000$.
Fig. 4. *Discolithus spiralis* sp. nov., replicated; Proximal view, $\times 12,000$.

Description. The three longitudinal polar plates at each end are larger than the remaining plates and are distinctly wedge-shaped. The proximal shield plates have prolongations which dip inwards towards the central area and meet along the longitudinal axis of the ellipse. The prolongations are rectangular and are on all proximal plates except the six longitudinal polar plates.

Size. Longitudinal axis, 2.0 μ . Transverse axis, 1.4 μ . Width of shield area, 0.5 μ .

Remarks. This form is tentatively placed in the genus *Maslovella* (Black) Tappan and Loeblich 1966 because of the two distinctive shields and the infilled central area. It differs from all the previously described species belonging to this genus in the detail and delicate construction of the central area.

CONCLUSION

The South African material studied is very rich in the remains of these algae and affords excellent opportunity for a more detailed investigation of the coccolith flora of both earlier and later horizons. The work reported in this paper is only a portion of the work done on the Upper Cretaceous of Zululand, South Africa. The remainder of the new species and variations of existing species will be described in later papers.

At present a detailed account of the microstratigraphy of the Cretaceous of Zululand is being prepared. The age of the strata from which the coccoliths were described was determined by the presence of Maestrichtian foraminifera (De Gasparis 1967); this conclusion was supported by the occurrence of Maestrichtian coccoliths.

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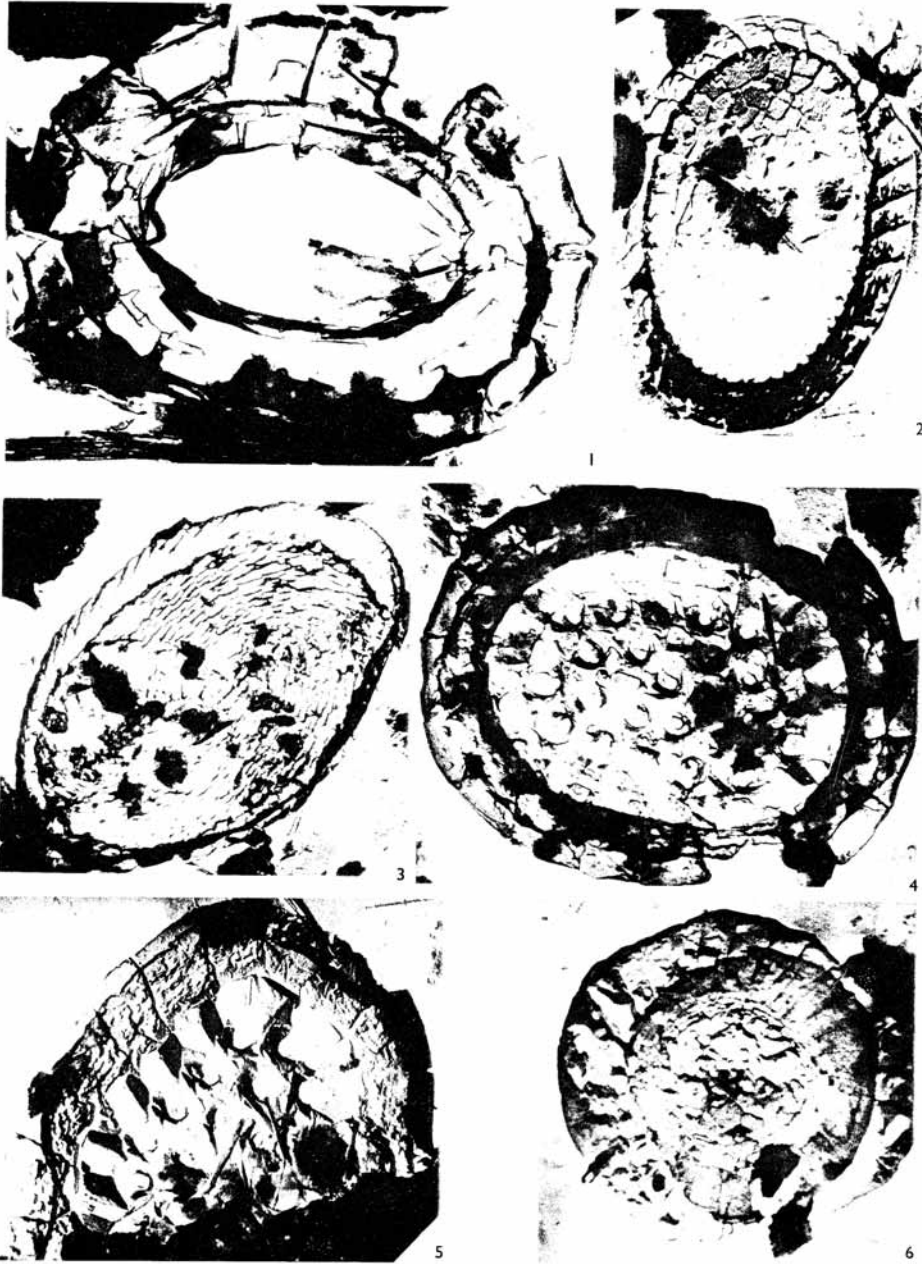
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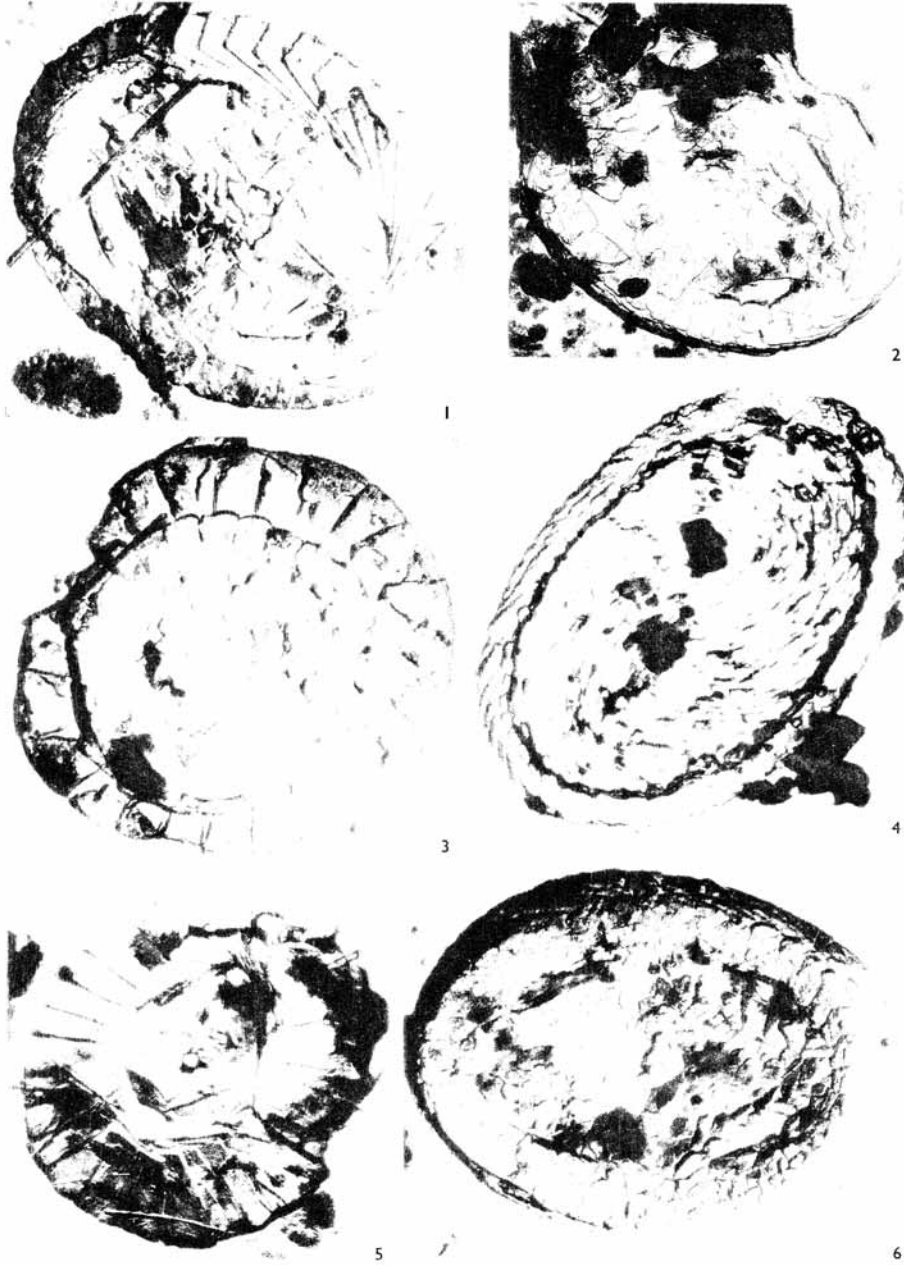
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