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Autor(en): **Hay, William W. / Towe, Kenneth M.**

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Electronmicroscopic Examination of some Rhabdoliths from Donzacq (France)

By **William W. Hay**[1]) and **Kenneth M. Towe**[2])

With 1 text figure and 2 plates (I, II)

I. INTRODUCTION

Rhabdoliths are calcareous skeletal elements produced by minute chrysomonadinid flagellates. They resemble coccoliths, but have an elongate hollow rod attached to the basal disc. In contrast to coccoliths, rhabdoliths usually settle on their sides, so that they are ordinarily seen in side view, but only rarely in top or bottom view. They were first observed by SCHMIDT (1870), who found them in deep-sea muds from the Adriatic. The Challenger expedition found rhabdospheres (analogous to coccospheres), and Sir JOHN MURRAY correctly suggested that they were minute pelagic calcareous algae. MURRAY and BLACKMAN (1898) described living rhabdospherids in detail. The first electronmicroscopic studies of rhabdoliths were made by DEFLANDRE and FERT (1954), who published several transmission micrographs. DEFLANDRE (1954) studied the fossil rhabdoliths from the Eocene marls at Donzacq with light microscopy. BRAMLETTE and SULLIVAN (1961) have studied Eocene rhabdoliths from California and other areas. HAY and TOWE (1962) have illustrated many of the species of coccoliths from the Cuisian marls of Donzacq with electronmicrographs of carbon replicas. This paper represents a continuation of the work, and it is hoped that the electronmicrographs of carbon replicas presented here will provide a useful addition to the excellent descriptions already provided by DEFLANDRE.

The preparation of the sample for electronmicroscopy is the same as that described by HAY and TOWE (1962), except that in some instances the dried nannofossil dispersion was shadowed with platinum prior to shadowing with carbon.

The suprageneric classification used is that of KAMPTNER (1958).

II. TERMINOLOGY

Protists of the genus *Rhabdosphaera* produce calcium carbonate skeletal elements called rhabdoliths (see text fig. 1). Each rhabdolith consists of a centrally perforated basal disc (*basale Scheibe* of KAMPTNER, 1958, p. 81; *embase* of DE-

[1]) Department of Geology, University of Illinois, Urbana, Illinois.
[2]) Electron Microscope Laboratory, University of Illinois, Urbana, Illinois. Present address: Division of Geological Sciences, California, Institute of Technology, Pasadena, California.

FLANDRE, 1954, p. 42ff) made up of one or more cycles of plates. The basal disc is attached to a complex collar, consisting of one or more cycles of plates. The collar is attached to a long hollow stem (*Stab* of KAMPTNER, 1958, p. 82; *hampe* of DEFLANDRE, 1954, p. 42ff) made of cycles of calcium carbonate laths which may be oriented straight along the length of the rhabdolith or which may spiral at differing angles. In the living protist, the rhabdoliths are arranged into a rhabdosphere with the stems projecting outward to give the organism a spiny appearance. The basal plate is proximal and the stem distal. Imbrication of the calcium carbonate plates is common as is inclination of the sutures between the plates. The terms sinistral and dextral imbrication, clockwise and counterclockwise inclination are used as in HAY and TOWE (1962).

III. SYSTEMATICS

Familiy: Coccolithaceae

Subfamily: Coccolithoideae

TRIBE : COCCOLITHEAE

SUBTRIBE: CYCLOCOCCOLITHINAE

Genus: *Rhabdosphaera* HAECKEL, 1894

Type species: *Rhabdosphaera claviger* MURRAY et BLACKMAN, 1898

HAECKEL (1894) created the name *Rhabdosphaera* for those algae which produce rhabdoliths with a simple rod attached to the basal disc, although no species had yet been named. The first species of rhabdolith to be described was *R. claviger*, MURRAY et BLACKMAN, which is regarded as the type species of the genus.
KAMPTNER has proposed the parageneric taxon *Rhabdolithus* for rhabdoliths, restricting *Rhabdosphaera* to the organism as a whole. However, as BRAMLETTE and SULLIVAN (1961) have observed the organisms are recognized by the rhabdoliths they produce, and the proliferation of names seems unnecessary.

Rhabdosphaera vitrea (DEFLANDRE)

Pl. I, fig. 1

1954 *Rhabdolithus vitreus*, DEFLANDRE, Ann. Paléont., v. *40*, 157, pl. 12, figs. 28–29, text figs. 83–84.

1961 *Rhabdosphaera vitrea* (DEFLANDRE), BRAMLETTE et SULLIVAN, Micropaleontology, v. *7*, 147, pl. 5, figs. 16–17.

Hypotype: UI-EML-2094-D

Remarks: This species is distinguished from *R. crebra* (DEFLANDRE) by its flatter basal disc and by the less pronounced collar. The junction of the collar and the basal disc is not incised as in the case of *R. crebra.*

The ultrastructure of *R. vitrea* is essentially the same as that of *R. crebra*, but most of the structural elements are more simply constructed. The plates of the second cycle, only $^1/_2$ to $^1/_3$ as wide as those of the proximal cycle, are inclined counterclockwise. The collar is made up of a cycle of simple plates with margins which flare only slightly at the distal collar edge. The ultrastructure of the stem

of this species cannot be determined in detail from the electronmicrographs, but the laths appear to be directed sublongitudinally.

Rhabdosphaera crebra (DEFLANDRE)

Pl. I, figs. 2–5, Pl. II, figs. 1–5

1954 *Rhabdolithus creber*, DEFLANDRE, Ann. Paleont. v. *40*, 157, pl. 12, figs. 31–33, text figs. 81–82.
1961 *Rhabdosphaera crebra* (DEFLANDRE) BRAMLETTE et SULLIVAN, Micropaleontology, v. *7*, 146, pl. 5, figs. 1–3.
1962 *Rhabdolithus creber*, DEFLANDRE, BOUCHE, Rev. Micropal., v. *5*, 84, pl. 1, fig. 6.

Hypotypes: UI-EML-1613 A, 1623 E, 1624 D, 1670 B, 1670 E, 1922 E, 2095 E, 2099 A.

Remarks: This species is common in the marls from Donzacq and it was possible to obtain electronmicrographs showing it from a variety of angles.

The basal disc consists of four cycles of plates visible in side views and views from the distal end of the rhabdolith. The outer cycle consists of 30–40 relatively large subtrapezoidal plates. The peripheral margins of these plates are finely serrate, each bearing 50 or more minute indentations. The plates of the outer cycle adjoin one another and fit tightly together, but are not imbricate. The sutures joining the plates show a slight counterclockwise inclination when viewed from the distal end of the rhabdolith. The plates of the next inner, or second cycle as seen from the distal end of the rhabdolith overlap those of the first cycle distally and are much narrower and longer. They are two or three times as numerous as the plates of the first cycle, and the sutures between them have a moderate counterclockwise inclination. The third cycle of plates, as viewed from the distal end, overlaps the inner part of the second cycle. The plates of the third cycle have the same width and inclination as those of the second cycle but are much shorter. When the second cycle of plates is missing (Pl. I, fig. 4), a series of plates corresponding to those of the third cycle in size, shape and sutural inclination can be observed adjoining the large first cycle plates. However, no shadow is cast by this series of plates, indicating that the distal surface is depressed beneath the distal surface of those of the first cycle. It is suggested that this series of plates represents a cycle located proximally to the third cycle seen from the distal end of the rhabdolith, and that this proximal cycle can be observed only in proximal view (which has not yet been seen) or when the distally located second and third cycles have been stripped away (apparently the plates of the second and third cycles are only loosely attached as they are often found to be missing.) The close correspondence with the third distal cycle suggests further that the third cycle might actually be double, possessing duplicate proximal and distal cycles, separated peripherally by the plates of the second cycle. The fourth cycle of plates of the basal disc is also apparently the innermost cycle, and surrounds the central pore of the basal disc which connects with the hollow center of the stem. The plates of the fourth cycle are wedge-shaped, number about 60, and are strongly sinistrally imbricate. They cast a much wider shadow than those of the outer cycles of the basal disc, indicating that they are taller, probably extending up into the collar internally.

The collar of *R. crebra* consists of a single cycle of about 60 very complex plates. Proximally the plates possess a wide shallow notch, distally they flare

to form a ridge. The plates of the collar are sinistrally imbricate (when viewed from the distal end of the rhabdolith) except at the extreme distal margin of the collar where they flare to form a ridge, and become dextrally imbricate. It is not clear from the electronmicrographs whether or not the distal edge of the collar is finished with a second cycle of dextrally imbricate plates, but this is suggested in Pl. II, fig. 2. The sutures between the collar plates are inclined counterclockwise when seen from the distal end of the rhabdolith.

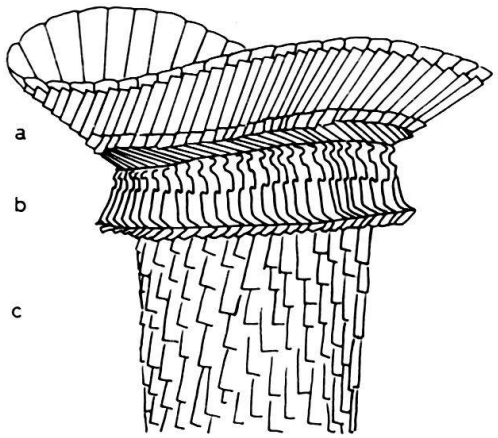

Fig. 1 Schematic drawing of the proximal portion of Rhabdosphaera crebra (DEFLANDRE) seen in side view, showing: a) basal disc, b) collar, c) stem. (Drawn from Plate I, Figure 3)

The stem of the rhabdolith is composed of regular cycles of tabular plates about 1 μ long, 0.1 μ wide and 0.05–0.02 μ thick. The cycles of plates are arranged so that three cycles overlap at any point. The orientation of the plates of each cycle is slightly different, but repetitive in three cycle intervals (Pl. II, fig. 5). The distal termination of the stem has not yet been observed closely enough to know whether or not it is perforate.

Rhabdosphaera sp.

Pl. I, fig. 6

Hypotype: UI-EML-1911 A.

Remarks: Only the central cycle of wedge-shaped plates of the basal disc and part of the stem are preserved. The electronmicrograph is of particular interest however, since it is the only proximal view of the central portion of the basal disc obtained. The wedge-shaped plates are seen to be very high in proportion to their length, suggesting that they may form an internal lining to the hollow collar. The poor state of preservation does not permit this specimen to be assigned a specific name.

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Plate I

Electronmicrographs of rhabdoliths from the Cuisian marls of Donzacq (France)

Fig. 1 *Rhabdosphaera vitrea* (DEFLANDRE), side view of proximal end. Hypotype: UI-EML-2094D,

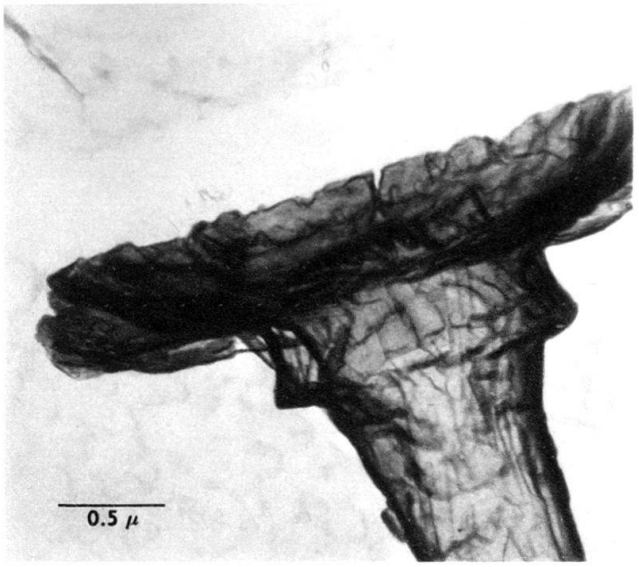
Fig. 2 *Rhabdosphaera crebra* (DEFLANDRE) side view of proximal end. Hypotype: UI-EML-1922E.

Fig. 3 *Rhabdosphaera crebra* (DEFLANDRE), side view of proximal end. Hypotype: UI-EML-2099A

Fig. 4 *Rhabdosphaera crebra* (DEFLANDRE), distal view of specimen with stem and collar missing. Holotype: UI-EML-1623E.

Fig. 5 *Rhabdosphaera crebra* (DEFLANDRE), side view of collar. Hypotype: UI-EML-1670E

Fig. 6 *Rhabdosphaera* sp., oblique proximal view. Hypotype: UI-EML-1911A



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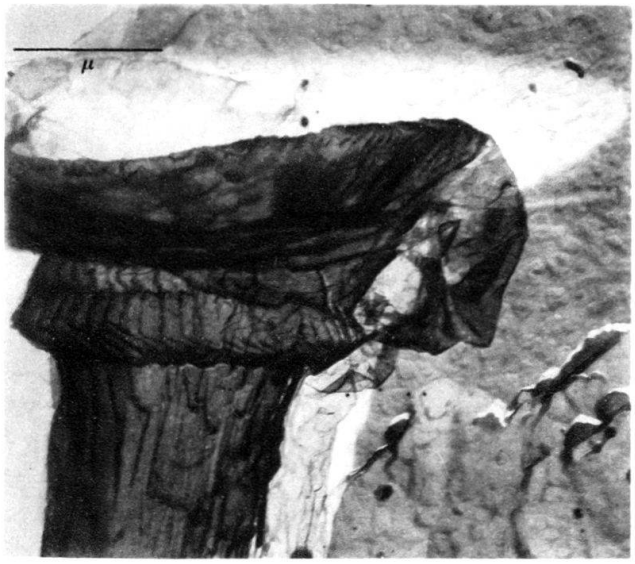

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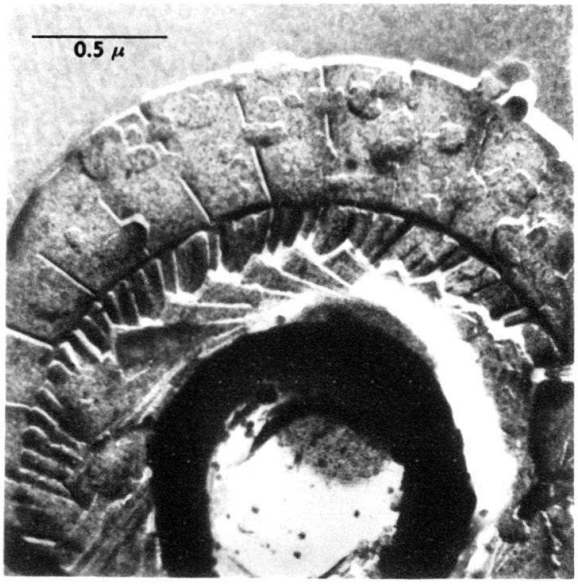

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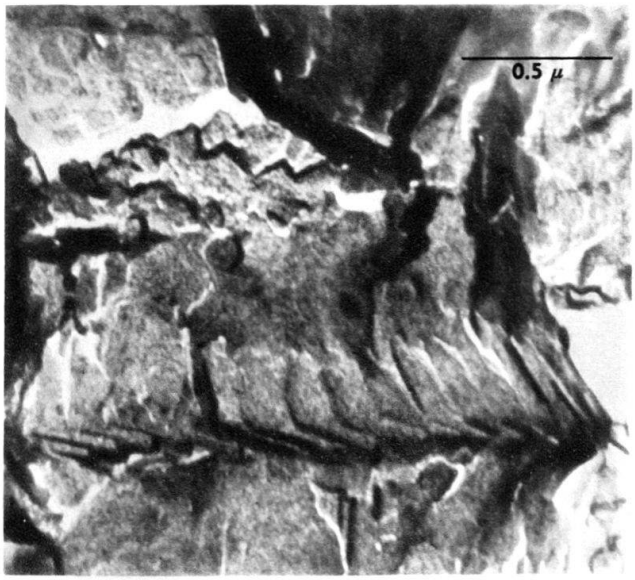

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Plate II

Electronmicrographs of rhabdoliths from the Cuisian marls of Donzacq (France)

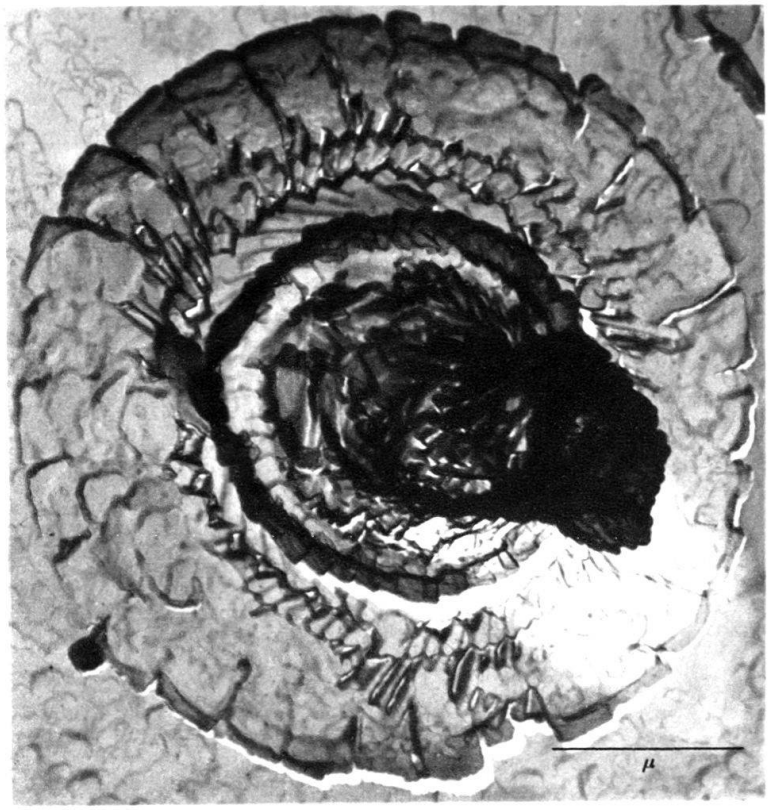
Fig. 1 *Rhabdosphaera crebra* (DEFLANDRE), distal view of complete specimen. Hypotype: UI-EML-2095E.

Fig. 2 *Rhabdosphaera crebra* (DEFLANDRE), distal view of specimen with stem missing. Hypotype: UI-EML-1624D.

Fig. 3 *Rhabdosphaera crebra* (DEFLANDRE), distal view of specimen with stem missing. Hypotype: UI-EML-1613A.

Fig. 4 *Rhabdosphaera crebra* (DEFLANDRE), side view of specimen with basal disc missing. Hypotype: UI-EML-1670B.

Fig. 5 *Rhabdosphaera crebra* (DEFLANDRE), side view of part of stem. Hypotype: UI-EML-1670B.



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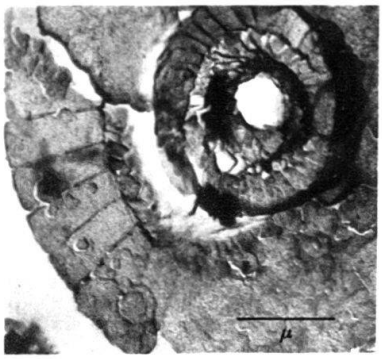

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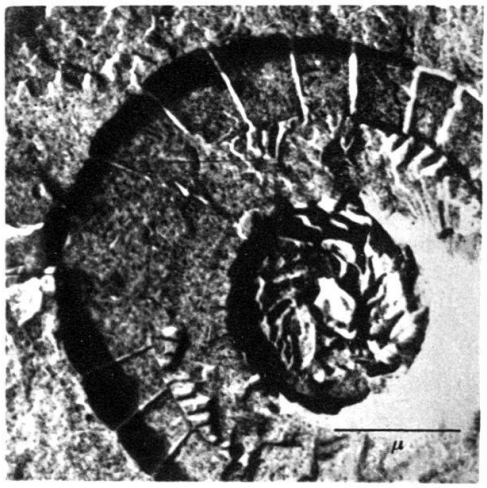

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