

## PROPOSED CHANGES TO THE CLASSIFICATION SYSTEM OF LIVING COCCOLITHOPHORIDS

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The classification system of living coccolithophorids has long been in a state of flux, due to differing opinions and misidentifications. Also there has been no recent attempt to compile a comprehensive catalogue of the modern nannoflora, although several lists have been presented from localised regions or from one or more water masses. In an attempt to rectify these problems a classification system was informally presented and discussed during the workshop on living coccolithophorids, at the INA meeting in Florence. This paper represents the results of the workshop in which a number of changes were proposed and accepted by all the members of the working group. The "complete" taxonomic list will appear in the near future (Jordan & Kleijne, in prep.).

### WORKSHOP MEMBERS:

Linda Eide (Bergen, Norway), Ric Jordan (Cambridge, U.K.), Michael Knappertsbusch (Zurich, Switzerland), Hisatake Okada (Yamagata, Japan), Amos Winter (Mayaguez, Puerto Rico), and Jeremy Young (London, U.K.).

Additional comments were made at the meeting by Niki Hine (Norwich, U.K.), Syed Jafar (Lucknow, India), Katharina von Salis Perch-Nielsen (Zurich, Switzerland), and Phil Weaver (Wormley, U.K.), and subsequently by Annaliese Kleijne (Amsterdam, The Netherlands).

### TAXONOMIC RECOMMENDATIONS

#### i) new varieties

***Ceratolithus cristatus* var. *telesmus*** (Norris 1965) stat. nov. (Notes 1 & 2)

Basionym: *Ceratolithus telesmus* NORRIS, 1965, p.21-22, pl.11/5-8, 13/1-3.

***Oolithotus fragilis* var. *cavum*** (Okada & McIntyre 1977) stat. nov. (Note 1)

Basionym: *Oolithotus fragilis* subsp. *cavum* OKADA and MCINTYRE, 1977, p.11-12, pl.4/4-5.

***Helicosphaera carteri* var. *hyalina*** (Gaarder 1970) stat. nov. (Note 3)

Basionym: *Helicosphaera hyalina* GAARDER, 1970, p.113-119, figs. 1a-g, 2a-d, 3a.

***Emiliania huxleyi* var. *corona*** (Okada & McIntyre 1977) stat. nov. (Note 1)

Basionym: *Emiliania huxleyi* subsp. *corona* OKADA & MCINTYRE, 1977, p.9, pl.1/1-4, 6-7.

#### ii) new combinations

***Reticulofenestra parvula*** (Okada & McIntyre 1977) comb. nov. (Note 4)

Basionym: *Crenalithus parvulus* OKADA & MCINTYRE, 1977, p.6-7, pl.2/1-2.

***Reticulofenestra parvula* var. *tecticentrum*** (Okada & McIntyre 1977) comb. nov. (Note 4)

Basionym: *Crenalithus parvulus* subsp. *tecticentrum* OKADA & MCINTYRE, 1977, p.7, pl.2/3-4, 7.

***Reticulofenestra punctata*** (Okada & McIntyre 1977) comb. nov. (Note 4)

Basionym: *Crenalithus punctatus* OKADA & MCINTYRE, 1977, p.7-8, pl.2/8-9.

***Reticulofenestra sessilis*** (Lohmann 1912) comb. nov. (Note 4)

Basionym: *Pontosphaera sessilis* LOHMANN, 1912, p.42-46, text-fig.9.

***Syracosphaera anthos*** (Lohmann) comb. nov. (Note 5)

Basionym: *Deutschlandia anthos* LOHMANN, 1912, p.46, fig.10/1, 3 (not 2).

***Syracosphaera halldalii* f. *dilatata*** (Heimdal 1981) comb. nov. (Note 6)

Basionym: *Caneosphaera halldalii* f. *dilatata* HEIMDAL, in Heimdal & Gaarder, 1981, p.44, pl.2/9.

iii) new genus and new combination

***Alveosphaera*** gen. nov. (*alveus* L. - trough) (Note 7)

*Coccosphaera fusiformis cum coccolithis monomorphismis. Coccolithi alveoformes, habens duo muri paene paralleli. Latus proximale areae centralis craticula opertum.*

*Typus: Alveosphaera bimurata* (Okada & McIntyre 1977) comb. nov.

Coccosphere spindle-shaped with monomorphic coccoliths. Coccoliths are trough-shaped with two walls arranged almost parallel to each other. Proximal side of central area covered by a grill.

Type species: *Alveosphaera bimurata* (Okada & McIntyre) comb. nov.

***Alveosphaera bimurata*** (Okada & McIntyre) comb. nov. (Note 7)

Basionym: *Calciosolenia? bimurata* OKADA & MCINTYRE, 1977, p.18-19, pl.7/1.

iv) new family

(Note 8)

**Papposphaeraceae** fam. nov.

*Typus: Papposphaera* Tangen, 1972

*Diagnosis: Coccolithi pappolithiformi; margo anguste muriformis exteriorem versus leviter inclinatis, muro assulis speciarum duarum alterne verticalium tangetialiumque dispositis formato; altera species parva partio proximali muri limitata, altera species assulae verticaliter expansa; processus centralis saepe praesens.*

Diagnosis: Coccoliths are pappoliths; rim has form of narrow slightly flaring wall formed of laths of two alternating types. One lath type relatively small, confined to the proximal part of the wall, the other vertically expanded. Central process often present.

## TAXONOMIC NOTES

1) **Use of varieties.** There are several cases where continuity of variation and other criteria suggest that commonly distinguished coccolith morphotypes are examples of intraspecific variation. The workshop members agreed that it was often useful to distinguish these as discrete taxa and that it would be sensible to apply a single taxonomic level consistently. The ICBN treats all taxonomic levels as arbitrary pigeonholes, however, the terms species and subspecies have genetic and ecological meanings which do not conform to our understanding of these cases. Of the other intraspecific levels provided by the ICBN variety has been used much widely than form. It was considered that the status of subspecies should generally be changed to that of variety.

2) **Status of *Ceratolithus telesmus*.** Considerable variations in ceratolith morphology have frequently been seen in modern and fossil assemblages with continuous transition between the *cristatus* and *telesmus* morphotypes (Borsetti and Cati, 1976; H. Okada, our obs.). So we agree with Borsetti and Cati, 1976 that these should be regarded as intraspecific taxa, for the reasons discussed above we recommend use of varietal status.

3) **Status of *Helicosphaera hyalina* and *H.wallichii*.** There is considerable and continuous variation in the size and orientation of the central openings in modern *Helicosphaera*. Such variation is often visible between coccoliths on single coccospheres (Nishida, 1979; workshop members obs.). Specifically *H. carteri*, *H. wallichii* and *H. hyalina* appear to be closely associated. So we support the use of the combination *H. carteri* var. *wallichii* (Theodoridis, 1984) and propose the new combination *H. carteri* var. *hyalina*.

**4) Utility of *Crenalithus*.** As discussed by Backman (1980) there are no objective criteria for separating *Crenalithus* from *Reticulofenestra*, and the type species, *Crenalithus daronicoides* (Black and Barnes 1961) Roth 1973, is of dubious nature. The living species previously placed in *Crenalithus* are similar to typical, small *Reticulofenestra* spp. such as *R. minuta* (L. Gallagher, workshop members obs.). The species are therefore transferred to *Reticulofenestra*.

**5) Utility of *Deutschlandia*.**

Heimdal & Gaarder 1981 demonstrated that *Deutschlandia anthos* Lohmann 1912 was the correct identification of the species termed *Syracosphaera variabilis* (Halldal & Markali 1955) by various authors (Okada & McIntyre 1977, Nishida 1979, Winter et al 1979). They decided to retain the genus *Deutschlandia*, however, the generic descriptions of *Deutschlandia* (emend. Heimdal & Gaarder, 1981) and *Syracosphaera* (emend. Gaarder & Heimdal, 1977) differ on only two points. Firstly that *Deutschlandia* has incomplete rather than complete caneloliths. Secondly, that the central part of the exothecal cyrtoliths in *Deutschlandia* have a distally raised hollow cone whilst their counterparts in *Syracosphaera* have a central depression.

Other workers taxonomy does not accord well with these generic concepts. For instance, Okada & McIntyre (1977) described several new species of *Syracosphaera*, resulting in a much wider morphological variation than that of Gaarder & Heimdal (1977).

*Syracosphaera* now holds 18 recognised species of which only 3 were assigned to it by Gaarder & Heimdal (1977). It has become a mixed bag, containing species exhibiting complete or incomplete caneloliths, dimorphism or monomorphism, dithecatism or monothecatism. But there is no easy solution, the creation of several new genera based on morphism, thecatism or canelolith-type would only produce smaller mixed bags which would inevitably add to the confusion. In addition the exothecal cyrtoliths are not always present in dithecate species and isolated caneloliths are often difficult to identify. It is therefore proposed to keep the genus as a group of species with variable morphology, related by the possession of caneloliths with or without cyrtoliths, but lacking the highly specialised polar coccoliths, found in *Michaelsarsia* and other syracosphaerid genera. So *Deutschlandia anthos* is transferred to the genus *Syracosphaera*.

**6) Utility of *Caneosphaera*.** *Syracosphaera molischii* and *S. halldalii* were transferred to a new genus, *Caneosphaera*, by Gaarder & Heimdal (1977) on the basis of the coccosphere being monothecate and the coccoliths lacking an intermediate continuous or beaded mid-wall flange. However, *C. molischii* has been observed, by a number of authors, (Okada & McIntyre, 1977; Nishida, 1979; Heimdal & Gaarder, 1981) with "deviating" (=exothecal) coccoliths around the flagellar field only (= pseudodithecatism) and the stomatal coccoliths of *C. halldalii* f. *dilatata* were described by Heimdal & Gaarder (1981) as bearing "...a ring of bead-like knobs like the stomatal coccoliths of *Syracosphaera exigua* Okada and McIntyre and all the endothecal coccoliths of *S. histrica* Kamptner", i.e. they possess a mid-wall flange. The reliability of the generic description is now uncertain and it is therefore proposed that the species of *Caneosphaera* be transferred back to *Syracosphaera*, and the new combination *S. halldalii* f. *dilatata* is proposed.

**7) New genus *Alveosphaera*.** In 1977 Okada & McIntyre described a new species which they tentatively assigned to *Calciosolenia*. This species, *C.? bimurata*, supposedly bore scapholith type coccoliths, although they were shaped like round-ended boats rather than parallelograms. Borsetti & Cati (1976) recognised the necessity for removing the species from the genus, and transferred it to *Syracosphaera*. However, they used the unpublished epithet "*duomura*" (from a preprint of Okada & McIntyre 1977) and thus their new combination, *Syracosphaera duomura*, was invalid. Its transfer to *Syracosphaera* also seems inappropriate as the coccoliths

differ from those found in other *Syracosphaera* species and it is therefore proposed to place it in a new genus, *Alveosphaera*.

**8) New family Papposphaeraceae.** Within the current classification system there are a number of genera which do not fit into the existing families. Some of these genera share common morphological characteristics and may therefore be tentatively separated into small families. It is proposed here that the two genera, *Papposphaera* and *Pappomonas*, bearing pappoliths (Norris, 1983) should be included together in the Papposphaeraceae. Norris (1983) showed that previous attempts to locate them within the Rhabdosphaeraceae (Parke & Green, 1976) and Halopappaceae (Tappan, 1980) were unsatisfactory and so he transferred these genera to the Deflandriaceae (= Prediscosphaeraceae). This assignment is also inappropriate as the family has left no fossil record since the Cretaceous and the coccoliths of the Prediscosphaeraceae radically differ in rim and process construction to those of the new family, the Papposphaeraceae.

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