

# Proposal for the Eriolaceae (Prymnesiophyceae, Haptophyta) fam. nov.

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**Abstract** The extant nannolith-bearing genera *Eriolus* and *Pileolosphaera* are distinguished by the possession of triradiate nannoliths with a very similar and highly distinctive structural pattern. The nannoliths display three symmetrically arranged rays that develop from a nannolith center but show no obvious affinities to any other currently known extant coccolithophore. On this basis, we propose the establishment of a new family, Eriolaceae fam. nov., to accommodate *Eriolus* and *Pileolosphaera*.

**Keywords** Coccolithophore, *Eriolus*, *Pileolosphaera*, systematics

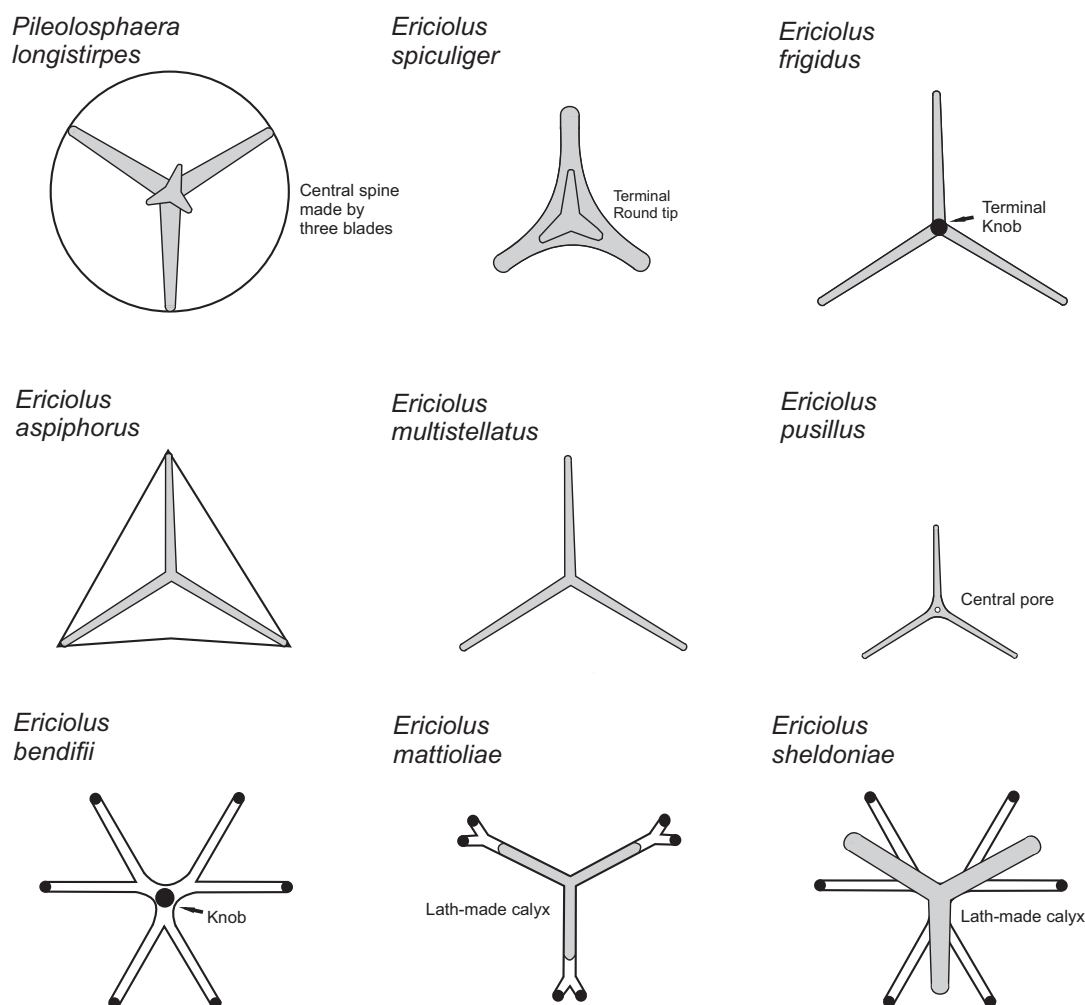
## 1. Introduction

The nannolith-bearing genera *Eriolus* Thomsen emend. Archontikis & Young and *Pileolosphaera* Meier, Kinkel, & Young are taxonomically ambiguous and, at present, informally classified as ‘nannolith *incertae sedis*’ (Archontikis et al., 2023; Young et al., 2023). Both genera include species with monomorphic and monothecate coccospheres showing one type of triradiate nannoliths. *Eriolus*, as recently revised by Archontikis et al. (2023), is used as a broad but coherent taxonomic group of at least eight morphologically different species: *Eriolus spiculiger* Thomsen, *E. frigidus* Thomsen, *E. aspiphorus* (Thomsen & Østergaard) Archontikis & Young, *E. multistellatus* (Thomsen & Østergaard) Archontikis & Young, *E. pusillus* (Thomsen & Østergaard) Archontikis & Young, *E. bendifii* Archontikis, Millán, Winter, & Young, *E. matioliae* Archontikis, Millán, Winter, & Young, and *E. sheldoniae* Archontikis, Millán, Winter, & Young (Figure 1), with a wide biogeographical range, having been recorded in polar surface waters and the lower photic zone of sub-

tropical environments (Thomsen et al., 1995; Thomsen & Østergaard, 2015; Archontikis et al., 2023). Conversely, *Pileolosphaera* is a monospecific genus. Its type species, *P. longistirpes* Meier, Kinkel, & Young, was described from the surface waters of the southwestern Baltic Sea (Meier et al., 2014), whilst occurrences of the species are also reported from the northwestern Pacific Ocean, the Irish and North Seas (Tanimoto et al., 2003; Meier et al., 2014), and the Adriatic Sea (Cerino et al., 2017; Godrijaan et al., 2023).

## 2. Discussion

As discussed in Archontikis et al. (2023), nannoliths of *Eriolus* and *Pileolosphaera* are structurally closely related showing three-fold symmetry and a radial growth of elements (Figure 1) developing from the nannolith center rather than a rim. In *Eriolus*, the nannoliths are remarkably small and can have either a) three radiating elements arranged parallel to the cell surface; b) four radiate elements with three of them parallel to the cell surface and one perpendicular to it; or c) three radiating units that



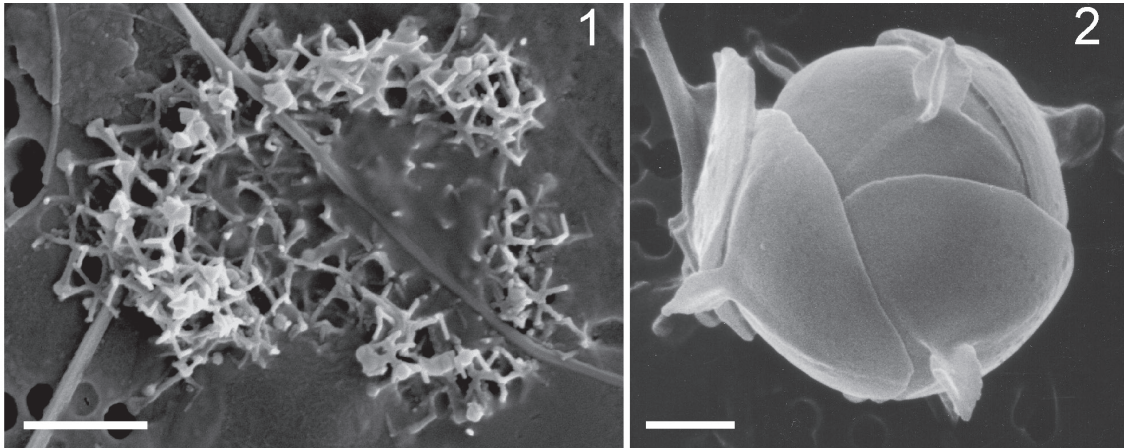
**Figure 1:** Schematic representation (not to the same scale) and diagnostic morphological features (three-fold symmetry, radial growth of elements) for all currently known members within the Eriolaceae fam. nov.

bifurcate and a distally oriented fourth element that develops into a central elongate spine with a terminal knob or a calyx (see Archontikis et al., 2023 for extended discussion). The nannoliths in *Pileolosphaera* similarly show three radiating elements that are parallel to the cell surface, and a central spine formed of three blades (Meier et al., 2014). Meier et al. (2014) showed via light microscopy observations that nannoliths of *Pileolosphaera* are composed exclusively of V-units and, therefore, have similar crystallographic properties to the nannoliths of the extinct genus *Discoaster* (Discoasteraceae, Discoasterales). Archontikis et al. (2023) further suggested potential affinities of both *Pileolosphaera* and *Eriolus* with the genus *Discoaster* on the grounds of all being characterised by a similar pattern of ray development and by similar morphology. *Discoaster* is an extinct genus; however, its last representatives only disappeared in the early Quaternary, ~1.8 million years ago. Although we do not have a

fossil record for *Eriolus*, given the current diversity within the genus, it would be reasonable to predict that it evolved some time ago. Therefore, evolution from the genus *Discoaster* is not inconceivable.

While nannoliths of *Pileolosphaera* are noticeably larger than those of *Eriolus* (~3.0–4.0  $\mu\text{m}$  versus 0.2–1.3  $\mu\text{m}$ ) and there are considerably fewer of them (6–8 versus 30–70) on the coccosphere (Meier et al., 2014; Archontikis et al., 2023), the similarity in nannolith structure and ray development (Plates 1 and 2) is notable and suggestive of a close taxonomic relationship between the two genera. This feature is also highly distinctive and further suggests a clear separation of *Eriolus* and *Pileolosphaera* from all other groups of living coccolithophores. As a result, we propose the establishment of a new family, Eriolaceae fam. nov., to accommodate *Eriolus* and *Pileolosphaera*. This principle has previously been followed by Jordan & Young (1990) and Andrulleit & Young (2010)

## Plate 1



**Plate 1:** Scanning electron microscope images of *Eriolus* (1) and *Pileosphaera* (2) coccosphere types. Scale bars = 1  $\mu$ m. 1. *Eriolus bendifii* (image code: 199–21, Station 69–11, MATER-II cruise, northwestern Mediterranean & Alboran Seas, R/V *Hesperides*, October 1999). 2. *Pileosphaera longistirpes* (image code: 93856-2, Station W3, Kieler Förde, R/V *Polarfuchs*, 11 September 2009).

who, respectively, erected and expanded the family Papposphaeraceae Jordan & Young (1990) emend. Archontikis & Young (2010) for the analogous cases of the genera *Papposphaera* and *Pappomonas*, as well as *Picarola*, *Vexillarius*, and *Kataspinifera* based on a set of shared morphological features. However, molecular genetic analyses are currently unavailable for the Eriolaceae to help elucidate familial-level phylogenetic relationships; therefore, we suspend taxonomic treatment at an ordinal level.

### 3. Systematic Taxonomy: Proposal of a new family

Family **ERICIOLACEAE** fam. nov.

Plates 1, 2

**Diagnosis:** Coccosphere monothecate and monomorphic consisting of nannoliths with three-fold symmetry. The nannoliths show three radiating elements that develop from the nannolith center.

**Type genus:** *Eriolus* Thomsen in Thomsen et al. (1995, p. 30) emend. Archontikis & Young in Archontikis et al. (2023, p. 184)

**Type species:** *Eriolus spiculiger* Thomsen in Thomsen et al. (1995, pp. 30–31)

#### 3.1. Taxonomic Appendix

No new formal taxonomy is proposed. Here we include the recommended terminology for all currently known extant taxa within the Eriolaceae.

Genus *Eriolus* Thomsen in Thomsen et al. (1995)

emend. Archontikis & Young in Archontikis et al. (2023)

**Type species:** *Eriolus spiculiger* Thomsen in Thomsen et al. (1995)

*Eriolus spiculiger* Thomsen in Thomsen et al. (1995)

*Eriolus frigidus* Thomsen in Thomsen et al. (1995)

Plate 2, fig. 7

*Eriolus aspiphorus* (Thomsen & Østergaard, 2015)

Archontikis & Young in Archontikis et al. (2023)

Plate 2, fig. 4

*Eriolus multistellatus* (Thomsen & Østergaard, 2015)

Archontikis & Young in Archontikis et al. (2023)

Plate 2, fig. 6

*Eriolus pusillus* (Thomsen & Østergaard, 2015)

Archontikis & Young in Archontikis et al. (2023)

Plate 2, fig. 8

*Eriolus bendifii* Archontikis et al. (2023)

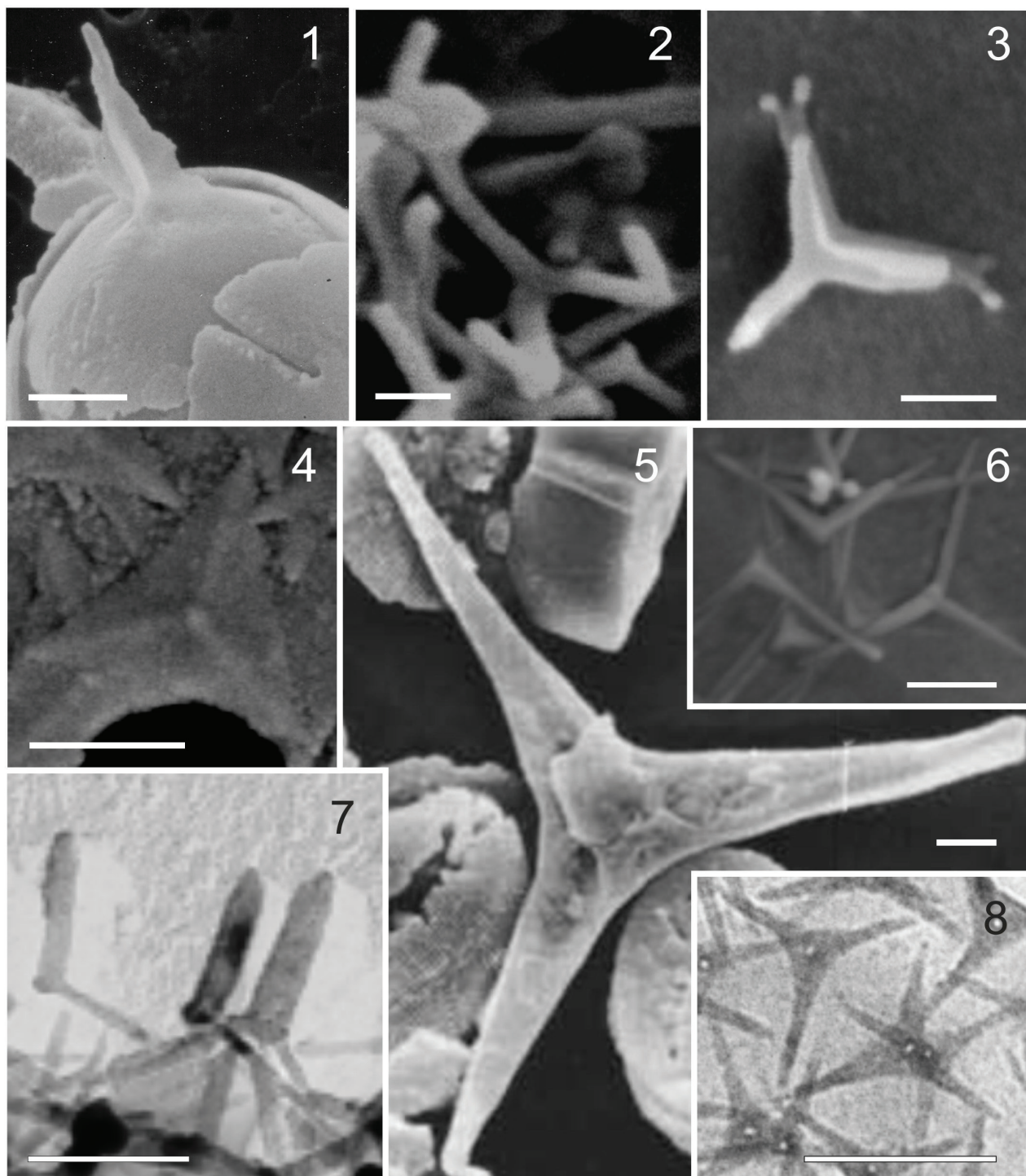
Plate 1, fig. 1; Plate 2, fig. 2

*Eriolus mattioliae* Archontikis et al. (2023)

Plate 2, fig. 3

*Eriolus sheldoniae* Archontikis et al. (2023)

## Plate 2



**Plate 2:** Scanning (1–6) and transmission (7–8) electron microscope images of the nannolith ultrastructure observed in *Pileolosphaera* (1), *Ericiolus* (2–4, 6–8), and *Discoaster* (5). Scale bars = 1  $\mu\text{m}$  (Figs. 1, 5) and 0.25  $\mu\text{m}$  (Figs. 2–4, 6–8). 1. *Pileolosphaera longistirpes* (image code: 00000, Station Bellevue pier, Kieler Förde, November 2012). 2. *Ericiolus bendifii* (image code: 193–76, Station 69–11, MATER-II cruise, northwestern Mediterranean & Alboran Seas, R/V *Hesperides*, October 1999). 3. *Ericiolus mattioli* (image code: 285–31, Station CTD089, AMT18 cruise, R/V *James Clark Ross*, South Atlantic Ocean, November 2008). 4. *Ericiolus aspiphorus* (image code: OA330–404, Station 69–6, MATER-II cruise, northwestern Mediterranean & Alboran Seas, R/V *Hesperides*, October 1999). 5. *Discoaster triradiatus* Tan 1927 (reprinted from Samtleben, 1978, plate 5, fig. 4). 6. *Ericiolus multistellatus* (image code: 291–49, Station CTD089, AMT18 cruise, South Atlantic Ocean, R/V *James Clark Ross*, November 2008). 7. *Ericiolus frigidus* (image code: 11304b, Station EPOS #159 ANT VII/3 ‘EPOS II’ cruise, R/V *Polarstern*, Weddell Sea, December 1988; reprinted from Thomsen & Østergaard, 2015, fig. 16). 8. *Ericiolus pusillus* (image code: SC330, Station EPOS #163, ANT VII/3 ‘EPOS II’ cruise, R/V *Polarstern*, Weddell Sea, December 1988; reprinted from Thomsen & Østergaard, 2015, fig. 12).

Genus *Pileolosphaera* Meier et al. (2014)

**Type species:** *Pileolosphaera longistirpes* Meier et al. (2014)

*Pileolosphaera longistirpes* Meier et al. (2014)

Plate 1, fig. 2; Plate 2, fig. 1

## Disclosure Statement

At least one of the authors is a member of the editorial board of *Journal of Nannoplankton Research*. The peer-review process was guided by an independent editor, and the authors also have no other competing interests to declare.

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