

A PRACTICAL GUIDE TO OPTICAL STUDIES OF CALCAREOUS NANNOFOSSILS

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ABSTRACT: This study examines the optical properties of calcareous nannofossils and their application in taxonomic classification. Calcareous nannofossils, microscopic plankton with calcium carbonate skeletons, are essential for biostratigraphy and palaeoceanographic reconstructions. However, their accurate identification is challenging due to their small size and subtle morphological variations. This study argues that integrating optical properties with traditional morphological analysis significantly enhances the accuracy and precision of calcareous nannofossil classification.

This article presents a comprehensive taxonomic revision of calcareous nannofossils, proposing four new orders, Ceratolithales, Polycyclolithales, Sphenolithales, and Zygrhablithales, five new suborders Calcidiscineae, Eiffelithineae, Reticulofenestrineae, Stephanolithionineae, and Zygodiscineae and two new families Perchnielsenaceae and Miculaceae.

Additionally, eighteen new genera are described: *Asynithistostoichos*, *Bowmania*, *Chontriefanisi*, *Davidhakania*, *Diplotsekouri*, *Erlendmartinia*, *Helenemanivitia*, *Isespetrinesaspides*, *Kahvecia*, *Mikriexoterikiaspida*, *Pennalithus*, *Ravdotodiskolithos*, *Sarmania*, *Scoteinimorfi*, *Swapansahooia*, *Symmetrikiexafanisi*, *Trachylithos*, and *Velonalithus*.

Forty-two new species are introduced, including *Bowmania hawkeriae*, *Coccolithus gracejacovidesiae*, *Cyclagelosphaera paez-rayesii*, *Davidhakania partingtonii*, *Diplotsekouri francisjosephii*, *Diplotsekouri indianica*, *Discoaster akinolgunii*, *Discoaster misofengaro*, *Erlendmartinia komposchedio*, *Erlendmartinia svastika*, *Erlendmartinia trachyschedio*, *Helenemanivitia colombiana*, *Helicosphaera consimilis*, *Helicosphaera dyotrypes*, *Helicosphaera epimikeisporous*, *Helicosphaera kilida*, *Helicosphaera pteryga*, *Isespetrinesaspides foteinokentro*, *Mauriceblackia katejacovidesiae*, *Micula vekshinae*, *Mikriexoterikiaspida fionajacovidesiae*, *Neochiastozygus alabamaensis*, *Neochiastozygus dyomisa*, *Neochiastozygus gammation*, *Neochiastozygus kallanxhia*, *Perchnielsenella ismailkoselii*, *Pontosphaera erythralassanica*, *Pontosphaera lowei*, *Pontosphaera paynei*, *Pontosphaera wondersii*, *Quadrum blairiae*, *Reticulofenestra dennei*, *Reticulofenestra looseae*, *Rotelapillus tesserisbares*, *Sphenolithus didymikoryfi*, *Symmetrikiexafanisi cubaensis*, *Symmetrikiexafanisi magnifica*,

Trachylithos nuryaziciae, *Velonalithus emelinesalleyae*, *Zygodiscus segmentatus*, *Zygodiscus selahattinkanlii* and *Zygodiscus skoteinigefyra*

Furthermore, thirty-six new combinations are introduced, including *Asynithistostoichos coxalliae*, *Bowmania murus*, *Bowmania prinsii*, *Bowmania svabenicka*, *Bowmania swastica*, *Chontriemfanisi apomnemoneumus*, *Coccolithus supremus*, *Corollithion msakya*, *Cribrocentrum ornatum*, *Cribrocentrum retiformis*, *Davidhakanian eosaepes*, *Davidhakanian imbriei*, *Davidhakanian saepes*, *Dictyococcites scissurus*, *Erlendmartinia insignita*, *Perchnielsenella oweinaensis*, *Helicosphaerella bramlettei*, *Helicosphaerella orientalis*, *Helicosphaerella pacifica*, *Helicosphaerella philippinensis*, *Helicosphaerella robinsoniae*, *Helicosphaeroides ampliaperta*, *Helicosphaeroides magnifica*, *Helicosphaeroides muelleriae*, *Helicosphaeroides watkinsii*, *Kahvecia dispar*, *Pennalithus rioi*, *Pennalithus rugosus*, *Pontosphaera apocresis*, *Pontosphaera rorsa*, *Ravdotodiskolithos parvus*, *Reticulofenestra bukryi*, *Sarmania partitum*, *Scoteinimorfi aquilus*, *Swapansahooia maghredaswampensis* and *Symmetrikiexafanisi furcatolithoides*.

These classifications are based on detailed observations using light microscopy, including phase contrast, brightfield illumination for morphology, and cross-polarized settings for optical properties. The study provides comprehensive descriptions of the unique optical characteristics of each new taxon, including extinction patterns and elongation properties. These optical features are proposed to serve as diagnostic criteria for distinguishing between closely related species.

The findings of this study have significant implications for improving the accuracy and consistency of future taxonomic work on calcareous nannofossils, ultimately contributing to a more refined understanding of their evolutionary relationships and ecological significance.