AN HIERARCHICAL DESCRIPTIVE CHECKLIST FOR CALCAREOUS NANNOFOSSILS

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INTRODUCTION

Whilst discussing the application of coccolith terminology at the Terminology Workshop in London (April 8-10th, 1992), it became apparent that the terminology document (Young *et al.*, in prep.) could be summarised to produce a checklist for the standardisation of nannofossil descriptions. At present, many nannofossil descriptions are ambiguous, even when accompanied by a photomicrograph! By using a standard checklist each time a taxon is described, the description is made immediately intelligible to the reader (at whom it is aimed), and the systematic approach (using standard terminology in a standard order) makes the description easier to translate into other languages, promotes thoroughness whilst taking the strain off the author to remember to describe everything (in a logical order), and provides a standard format for database input.

So, below we have compiled a preliminary checklist, each section followed by a *pro forma* example. This first draft, however, is meant as a prompt for comment. We would like a response to the general idea, the format, the contents, anything you strongly disagree with, so that a checklist could be produced and circulated that would be widely accepted and used. Please note, however, that we do not wish to hear about terminology gripes (send those to Jeremy, if you must!). The purpose of this document is to define descriptive procedure only.

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It may be worthwhile to consider making more use of schematic representation of the taxon being described, i.e. instead of, or as well as, a written description, a comprehensively-labelled diagram(s) (or photo(s)) of the taxon could be incorporated. Graphic representation often conveys more meaning than text and does not need to be translated, and so gives less scope for confusion. It is also recommended (and we are not alone in thinking this) that we move away from describing taxa from either an SEM or LM photomicrograph. This approach promotes ambiguity and synonymy, and is not as rigorously scientific as it should be. O.K., so you want the fame and fortune (!) that comes with naming a new species, but perhaps first you should earn it by taking the time to provide a variety of good-quality photos. If you have not got the time or access to an SEM, why not ask someone who has to help you out?

N.B. This checklist does not attempt to be utterly comprehensive. Also it is basically intended for fossil heterococcoliths. Descriptions of living species, holococcoliths or nannoliths would need modified checklists.

1. BACKGROUND INFORMATION

The following headings are already widely used. It is suggested that they appear at the top of the descriptive section, since they contain the most important data for the majority of database entries. This list could be extended to include synonyms, paratypes etc.

1.1 NAME	:	give full taxonomic citation according to rules of ICBN
1.2 DERIVATION OF NAME	:	not essential but, interesting, and aids memory
1.3 HOLOTYPE	:	reference numbers and repository of holotype specimen. If a photomicrograph, indicate whether LM, SEM or TEM, distal, proximal or side view
1.4 TYPE LOCALITY	:	geographical source of holotype
1.5 TYPE LEVEL	:	lithostratigraphical horizon from which type sample was collected

1.6 HOLOTYPE AGE	:	modern interpretation of age of horizon of holotype, with reference to chrono- &/or biostratigraphy. If possible give nanno zone.
1.7 REMARKS	:	specify whether coccolith (hetero-/holo-), nannolith, nannoconid
	:	describe differences/similarities to related taxa
	:	comment on preservation
	:	comment on geographical/stratigraphical occurrence outside type locality, if known

E.g. *Watznaueria barnesae* (Black *in* Black & Barnes 1959) Perch-Nielsen 1968
Derivation of name: After Barbara Barnes, early nannopalaeontologist.
Holotype: No.3068, Sedgwick Museum, Cambridge University; Pl.9, fig.2 (TEM, proximal) in Black & Barnes (1959).
Type Locality: Weston Colville, Cambridgeshire, south-eastern England.
Type Level: English Chalk, Holaster planus macrofossil Zone
Holotype Age: Turonian, nannofossil zone CC12.
Remarks: This coccolith differs from *W. fossacincta* & *W. ovata* in having a closed or very small central opening; from *W. britannica* & *W. biporta* in not possessing a bar spanning the central area; from *W. manivitae* in being smaller; & from *W. quadriradiata* in not possessing a central axial cross.

Very resistant to preservational effects, which can sometimes result in apparently monospecific assemblages.

Geographically & stratigraphically widespread, with a cosmopolitan occurrence from the Bajocian (Middle Jurassic) to Maastrichtian (Late Cretaceous).

2. DESCRIPTION OF FOSSIL COCCOSPHERE

2.1 COCCOLITH DISTRIBUTION	:	monomorphic, dimorphic, polymorphic, varimorphic
	:	monothecate, dithecate (define endothecal and exothecal layers), multilayered
2.2 COCCOSPHERE SHAPE	:	spherical, ovoid, ellipsoidal, cylindrical, fusiform, pyriform
2.3 APPROXIMATE NO. OF COCCOLITHS		
2.4 COCCOLITH ARRANGEMENT	:	overlapping, non-overlapping, interlocking, non-interlocking
2.5 FLAGELLAR OPENING	:	presence/absence of possible flagellar opening, nature of circum-flagellar coccoliths.

E.g. *Watznaueria barnesae* (Black) Perch-Nielsen
A monomorphic, monothecate, spherical coccosphere with approximately 10, interlocking coccoliths. No apparent flagellar opening.

3. DESCRIPTION OF HETEROCOCCOLITHS

3.1 DIAGNOSIS

3.1.1 RIM

SIZE	:	give size range in microns, and/or use descriptive terms - very small, small, medium, large, very large (defined in Young *et al.*, in prep.)
OUTLINE	:	give Axial Ratio, and/or use descriptive terms - circular, subcircular, broadly/normally/ strongly elliptical, oblong, polygonal, reniform, asymmetrical
TYPE	:	bi-shield/tri-shield placolith, murolith, planolith

	: plano-convex, concavo-convex, tapering, parallel-sided, flaring
	: low, normal, high elevation
3.1.2 CENTRAL AREA	
TYPE	: planiform, vaulted, conical, elevated
STRUCTURE	: boss, blanket, plate, longitudinal/ transverse/diagonal bar, grill, net, axial/diagonal cross, foot, longitudinal/ diagonal/lateral arm, crossbar
	: spine - long/medium/short, tapering/ straight/flared, with/without calyx.

E.g. *Lotharingius crucicentralis* (Medd) Grun & Zweili
Lotharingius crucicentralis coccoliths are small- to medium-sized, broadly elliptical, concavo-convex, bi-shield placoliths with a central area spanned by a planiform axial cross & lateral arms, which may support a medium-length, tapering spine.

3.2 DESCRIPTION OF RIM

3.2.1 ENTIRE RIM	
VIEW	: distal, proximal; SEM, LM (Xp/PC/BF), TEM
CONSTRUCTION	: outer/middle/inner/distal/proximal shield (cycle), outer/middle/inner tube (cycle), wall, flange, collar, crown, wing
3.2.2 EACH CYCLE	
ELEMENT FORM	
- SHAPE	: tile, lath/petaloid lath/ray, rod, block, wedge
- MODIFICATIONS	: hole, node, keel, ridge, spine, tooth, slit, kink, perforation, depression, notch
ELEMENT RELATIONS	
- IMBRICATION	: sinistral, non-imbricate, dextral
- IMBRICATION ANGLE	: high, low
- PRECESSION	: sinistral, radial, dextral
- CURVATURE	: laevogyre, straight, dextrogyre
CRYSTALLOGRAPHY	: strongly/moderately/weakly/non- birefringent
	: isogyre appearance, sharp/diffuse
CRYSTAL ORIENTATION	: V, R, T units can be labelled on a diagram/ photomicrograph

E.g. *Lotharingius crucicentralis* (Medd) Grun & Zweili
In distal SEM view, the rim is composed of 3 visible cycles. The outermost cycle (distal shield cycle) is the broadest, it is constructed from low-angle, dextrally-imbricate tiles joined along straight sutures with sinistral precession. The middle cycle (middle tube cycle) is constructed from tiles with near-radial, straight sutures. The innermost cycle (inner tube cycle) is constructed from tiles joined along radial & vertical sutures.

In proximal SEM view, the proximal shield can be seen to be slightly smaller than the distal shield, & is composed of only 1 cycle (proximal shield cycle), formed from non-imbricate, kinked tiles, joined along sutures with laevogyre curvature & sinistral precession. Detailed SEM analysis has shown that the distal shield, inner tube and proximal shield cycles form a single crystal-unit.

In the LM (Xp), the rim appears strongly birefringent & is crossed by sharp isogyres. The distal shield/ inner tube/proximal shield cycle crystal-unit is birefringent, and has been interpreted as an R-unit (Young & Bown 1991). The middle tube cycle is weakly/non-birefringent and has been interpreted as a V-unit. In the LM (PC), the coccolith is bright.

3.3 DESCRIPTION OF CENTRAL AREA

VIEW	:	distal, proximal; SEM, LM (Xp/PC/BF), TEM
RELATIVE WIDTH	:	wide, normal, narrow
OUTLINE	:	circular, subcircular, broadly/normally/ strongly elliptical, oblong, polygonal, reniform, asymmetrical
	:	open, closed
CENTRAL STRUCTURE		
- POSITION	:	basal, elevated
- CONSTRUCTION	:	compound, simple, disjunct, conjunct
- TYPE	:	boss, blanket, plate, longitudinal/ transverse/diagonal bar, grill, net, axial/diagonal cross, foot, longitudinal/ lateral/diagonal arm, crossbar
	:	spine - tapering/straight/flared with/without calyx; blocky/-granular/lath-like, hollow/solid, long/medium/short stem
	:	description of elements (same terms as for rim elements)
- CRYSTALLOGRAPHY	:	strongly/moderately/weakly/non- birefringent

E.g. *Lotharingius crucicentralis* (Medd) Grun & Zweili
In distal SEM view, the central area is wide, broadly elliptical & open. It is spanned by a basal, disjunct, compound, axial cross with 3-4 lateral arms in each open quadrant. The cross may support a medium-length, tapering, compound spine, with no calyx.

In the LM (Xp), the cross is birefringent when orientated parallel to the polarising direction. The lateral arms are usually weakly/non-birefringent.

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