

A QUATERNARY NANNOFOSSIL RANGE CHART

Jeremy R. Young, *The Natural History Museum, London*

Quaternary nannofossils have been carefully and intensively studied over the past twenty years (references below) resulting in a zonation scheme which is remarkable in at least three ways. First, it has very fine resolution, around 200,000 years. Second, the zonation appears to be very reliable throughout low latitudes. This is indicated both by consistency of sequence of events (compare e.g. Matsuoka and Okada 1989 and Rio et al 1990) and by correlations with oxygen isotopes and magnetostratigraphy (e.g. Backman & Shackleton 1983, Thierstein et al 1977). Third, it is based on rather subtle events, there is no great change in nannofloras during the Pleistocene.

The range chart (Figure 1) summarises the development of quaternary nannofossil assemblages and the zonation based on this development. The diagram is almost entirely based on published work with limited input from my own experience.

DISTRIBUTION NOTES

Reticulofenestra spp. - this includes all reticulofenestrid coccoliths without slits or bridge (common names *R.minutula*, *Crenalithus doronicoides*, *Dictyococcites productus*, etc.). Range of large (56.5-9 μ m) variety from Pujos (1985 = *G.doronicoides* var.3), Takayama & Sato (1986 = *Reticulofenestra* sp. A), Matsuoka & Okada (1989 = *Reticulofenestra* sp. A).

Pseudoemiliania lacunosa - during the Pleistocene the larger circular forms of this species become more abundant relative to smaller elliptical forms e.g. Gartner (1977), Matsuoka & Okada (1989). A detailed study of this trend is in preparation (Negri et al in press).

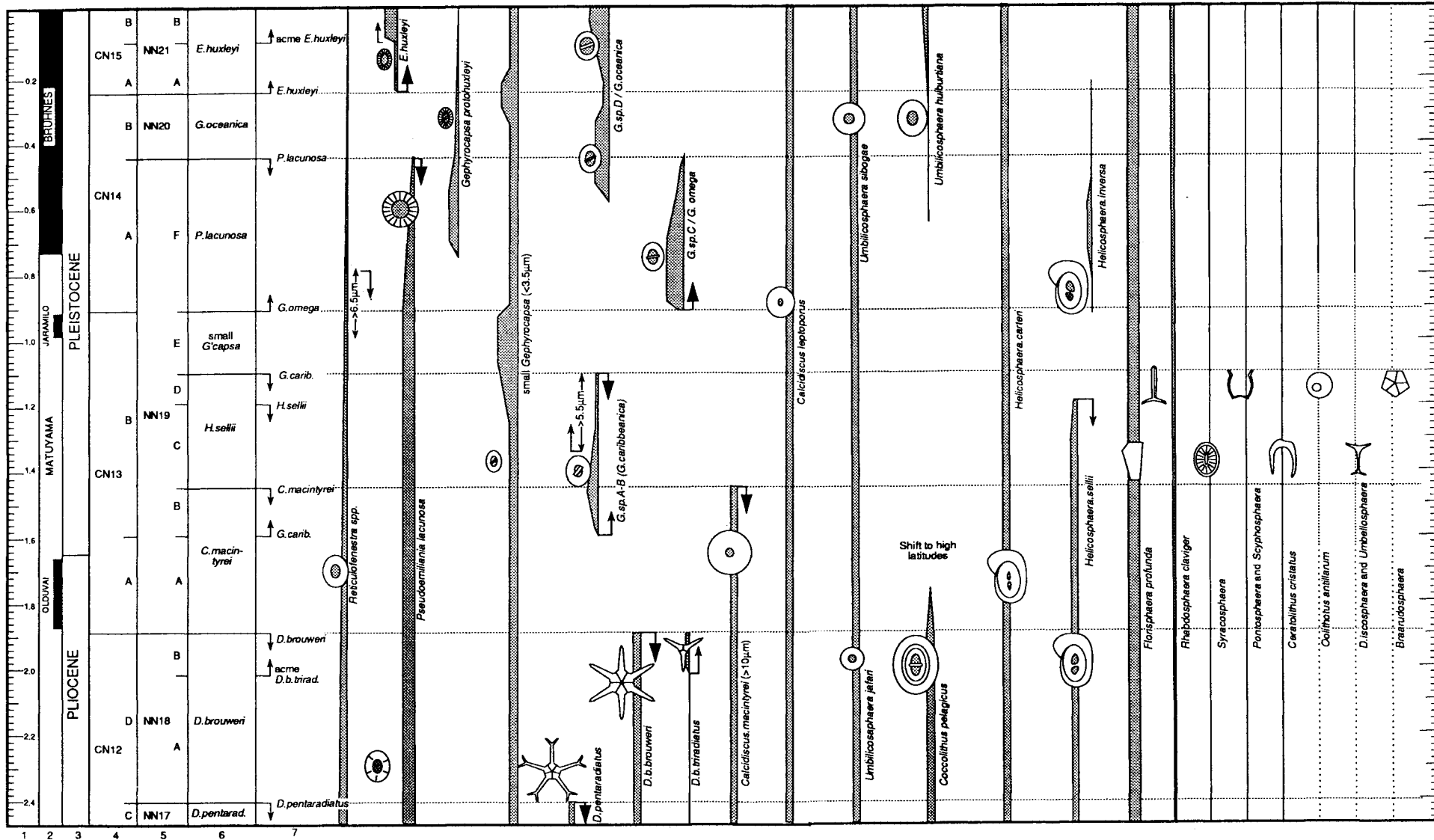
G.protohuxleyi - different authors give rather varying distribution patterns for this taxon so acmes of it may not be stratigraphically useful.

Small *Gephyrocapsa*- general grouping of *Gephyrocapsa* species <3.5 μ m, such as *G.aperta*, *G.ericsonii*, and *G.sinuosa*, can include *G.protohuxleyi* (N.B. More sophisticated definitions of the group are possible, see Matsuoka & Okada 1990). The acme around the NN20/21 boundary is based Verbeek (1990), with support from Pujos-Lamy (1977), Breheret (1978) and Matsuoka & Okada (1990). It is now well established that the group occurs down to the mid-Pliocene (e.g. Driever 1989).

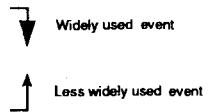
Larger *Gephyrocapsa* species - Matsuoka and Okada (1990) suggested that three evolutionary cycles of development of larger *Gephyrocapsa* could be recognised in the Pleistocene, and there is abundant confirmatory evidence for the pattern they describe in other studies (Samtleben 1980, Rio 1982, Bergen 1984, Takayama & Sato 1986, Rio et al 1990). It is thus possible to use phylogenetic definitions of the species (cf. Young 1990 fig. 7/C). In any given larger *Gephyrocapsa* assemblage a range of morphotypes occurs but the presence of characteristic end member morphotypes enables most assemblages to be rapidly assigned to one of the evolutionary cycles/species. On the chart I have used the designations of Matsuoka & Okada (*Gephyrocapsa* spp. A-D) and the species names which seem most appropriate/valid, short synonymies are given below for them and outlines of their characteristics.

Calcidiscus macintyreii - Various criteria have been proposed for subdividing the genus *Calcidiscus*, for the purpose of Quaternary stratigraphy separation of specimens >10 μ m across, as *C.macintyreii*, has proven most successful (e.g. Rio et al 1990).

Umbilicosphaera - The medium sized (4-8 μ m) species *U.sibogae* (syn *U.mirabilis*) is rather characteristic of the Pleistocene but appears to evolve gradually from the small (2-4 μ m) Neogene specie *U.jafari*. (my. obs.).



- 1 - Time in million years - correlations mainly after Matsuoka & Okada 1990, Rio et al (1990).
- 2 - Magnetostratigraphy
- 3 - Chronostratigraphy
- 4 - Zonation of Okada & Bukry (1980).
- 5 - Zonation of Martini (1971), with Mediterranean sub-zones of Rio et al (1990), and Driever (1988).
- 6 - Zonation of Gartner (1977)
- 7 - Biostratigraphic events used in zonation schemes.



Quaternary Nannofossil Biostratigraphy
J.R. Young 1991

The elliptical species *U.hulburtiana* has only occasionally been recorded (e.g. Biekart 1989, Matsuoka & Okada 1989), so its range is uncertain.

Coccolithus pelagicus - the shift to higher latitudes (>35° cf. Nishida 1980) of this species has been widely noted, e.g., McIntyre & Be (1967), Raffi & Rio (1979), Nishida (1980). Pujos (in press) discusses possible interpretations of occasional lower latitude occurrences.

Helicosphaera inversa - This species was described by Gartner (1977), the restricted range in the late Pleistocene is confirmed by e.g. Takayama & Sato (1986), and Matsuoka & Okada (1989). It is distinguished from *H.sellii* by having a bar which points toward the wing.

TAXONOMIC NOTES - LARGER *GEPHYROCAPSA* SPECIES

N.B. Taxonomic references for the other species can be found in Perch-Nielsen (1985).

G. spp. A & B / Gephyrocapsa caribbeanica Boudreaux & Hay 1967

Gephyrocapsa caribbeanica Boudreaux & Hay, in Hay et al 1967, p.447, pls.12-13/1-4; Samtleben 1980, p.110, pl.14/9-14, Takayama & Sato 1986, p.691.

Gephyrocapsa lumina Bukry 1973 p.678, pl.3/1-4.

Gephyrocapsa spp. A & B Matsuoka and Okada 1990, p.260, pl.1/17-18, 2/1-11

Gephyrocapsa spp. 1 & 2 Rio 1982, p.329, pl.2/1-12.

Characteristic morphotype; Bridge steeply inclined (40-60°) to the transverse axis, central opening narrow to nearly closed. Coccolith length up to 7µm. The group is often divided into *G.caribbeanica* and *G.oceanica* on the basis of central opening size.

G. sp. D / Gephyrocapsa oceanica Kamptner 1943

Gephyrocapsa oceanica Kamptner 1943 p.45, figs.4-5; Samtleben 1980, p.111, pl.15/5-8.

Gephyrocapsa margerelii Breheret 1978, p.447, pl.2/1-2.

Gephyrocapsa sp.D Matsuoka & Okada 1990, p.260, pl.3/1-11.

Characteristic morphotype; Bridge at moderate angle (20-40°) to transverse axis, lower angle in later forms. Central opening wide. Coccolith length up to 6µm.

G. sp. C / Gephyrocapsa omega Bukry 1973

Gephyrocapsa omega Bukry 1973, p.679, pl.3/5-11; Bergen 1984, p.432, pl.7/17.

Gephyrocapsa oceanica ssp *rodela* Samtleben 1980, p.112, pl.15/9-11.

Gephyrocapsa parallela Hay & Beaudry 1973, p.672, pl.1/10-12.; Takayama & Sato 1986, p.691, pl.3/8.

Gephyrocapsa sp. 3 Rio 1982, p.330, pl.3/1-10, Rio et al 1990, p.526.

Gephyrocapsa sp. C Okada & Matsuoka 1990, p.206, pl.4/1-10.

Characteristic morphotype; Bridge at low angle (15-30°) to transverse axis. Central opening moderately wide. Coccolith length up to 5µm.

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