Correlation of the nannoplankton zones with planktonic foraminiferal zones

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foraminiferal species for the Pacific area. He points out that the ability to locate some datum levels depends on the original geographic distribution of the various species and on the amount of micropaleontological research done in a certain area. BERGGREN (1969, 1970) also advocates the use of datum levels based on planktonic foraminifera for the subdivision of the Tertiary. Datum levels based on nannoplankton have not yet been defined. MARTINI (1969) points out that his "*Cyclococcolithus formosus* boundary" can be found worldwide; it has to be considered a datum level even if it was not formally designated as such. In fig. 17 several nannoplankton and foraminiferal species suitable for defining datum levels are shown with their distribution. Lowest occurrences (if possible lowest evolutionary occurrences) are more reliable datum levels than highest occurrences because nannofossils in particular have a propensity to be reworked into younger sediments and because some species become very rare towards the end of their range and are thus difficult to find. Planktonic foraminiferal datum levels are taken from the literature, mainly from the range charts in BAUMANN & ROTH (1969), BLOW (1969), and BERGGREN (1969).

The following important nannoplankton datum levels are based on species that can be identified in the light microscope:

1. Top *Discoaster barbadiensis* (= Eocene-Oligocene boundary).
3. Top *Cyclococcolithus formosus* (= close to the boundary of Lower and Middle Oligocene).
5. Base *Sphenolithus distentus* (Upper part of Middle Oligocene).
6. Base *Sphenolithus ciperoensis* (Middle-Upper Oligocene boundary).
7. Base *Triquetrorhabdulus carinatus* (upper part of the Upper Oligocene).
8. Base *Sphenolithus belemnos* (approximates the Oligocene-Miocene boundary).
9. Base *Helicopontosphaera ampliaperta* (Lower Miocene not much above the Oligocene-Miocene boundary).
10. Base *Discoaster druggi* (not much above the base of the Miocene).

The datum level close to the Oligocene-Miocene boundary can not be defined more accurately until the exact relation to the *Globigerinoides* datum is known.

The following datum levels are based on species which can only be recognized in the electron microscope. They are based on the lowest occurrence of these species and are thus more reliable than others based on the highest occurrence of a species.

2. Base *Cyclococcolithus margaritae* (closely below the Lower-Middle Oligocene boundary).
4. Base *Reticulofenestra laevis* (upper part of middle Oligocene).

5. CORRELATION OF NANNOPLANKTON ZONES WITH PLANKTONIC FORAMINIFERAL ZONES

A correlation of nannofossil zones with planktonic foraminiferal zones was presented for the Monte Cagnero Section, Italy, by BAUMANN & ROTH (1969) and is summarized here on figures 1 and 17. Correspondence of the *Triquetrorhabdulus carinatus–Sphenolithus belemnos* Zone with the *Globorotalia kugleri* Zone is only based on Trinidad material.

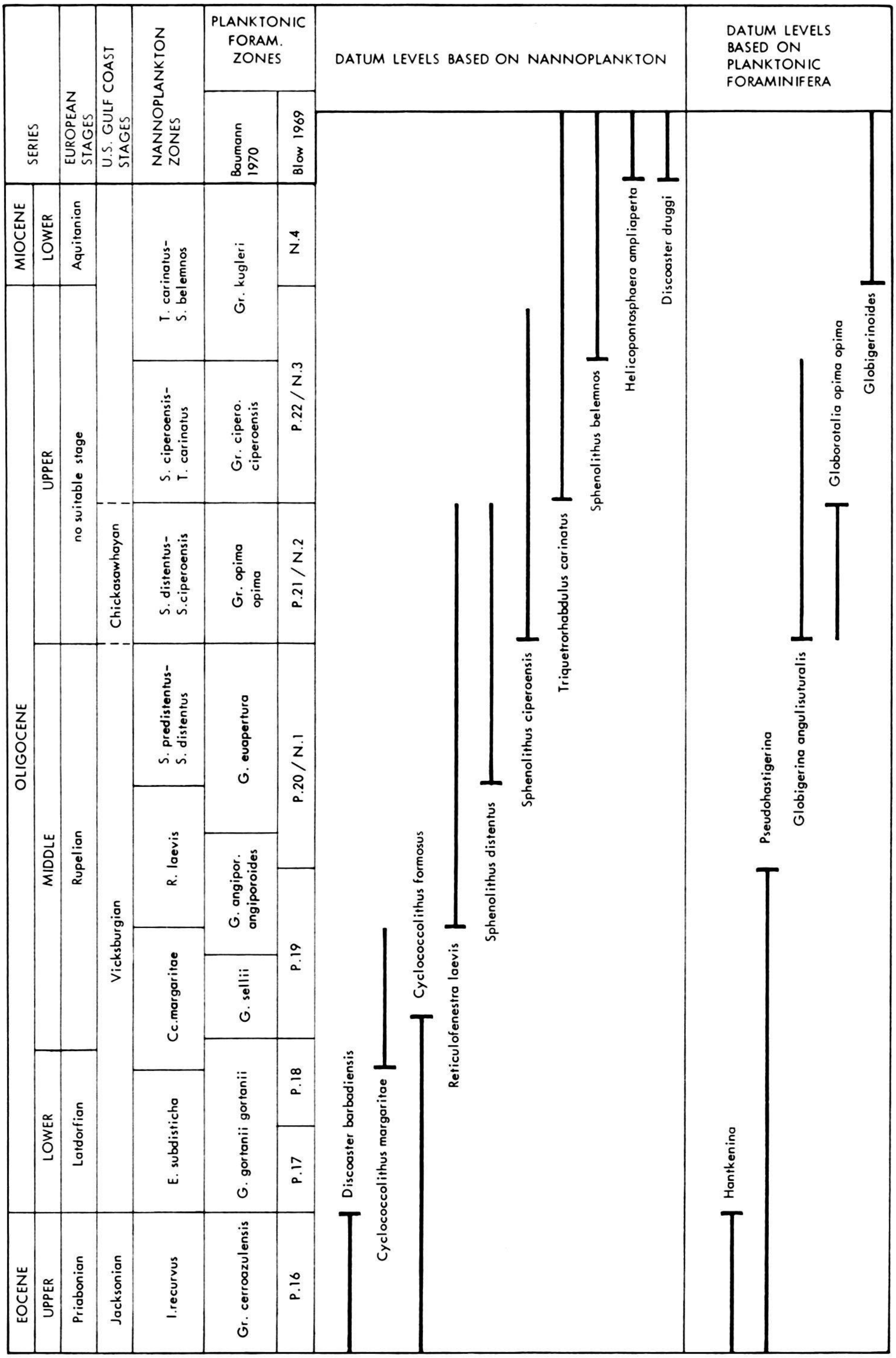

Fig. 17. Upper Eocene-Lower Miocene stages, planktonic formainiferal and nannoplankton zones and datum levels. Tentative relation of planktonic foraminiferal and nannoplankton datum levels is shown.

For some of the sections, samples, or formations studied, information on the planktonic foraminiferal content and zonal assignement of these sediments was taken from the literature. These data are sometimes scanty and imprecise. Thus the correlations that are discussed below are less certain than those with BAUMANN'S zonation of the Monte Cagnero section. DEBOO (1965) found *Cribrohantkenina inflata* in the Yazoo Clay which belongs to the *Isthmolithus recurvus* Zone (see LEVIN & JOERGER, 1967). BLOW (1969) mentioned that the Yazoo Clay of Alabama belongs to his Zone P. 16 (*Cibrohantkenina inflata* Zone). The type sample of BLOW'S Zone P. 18 (*Globigerina tapuriensis* Zone), from the Bath Member of the Oceanic Formation, Bath Cliff, Barbados, lies at a level that belongs to the upper part of the *Ericsonia subdistiacha* Zone. Higher samples from the Bath Cliff section still within Zone P. 18 must be assigned to the *Cyclococcolithus margaritae* Zone. The Red Bluff Formation and the lower part of the Marianna Limestone of Alabama belong to Zone P. 18; the nannoplankton indicates the presence of the *Ericsonia subdisticha* and lower *Cyclococcolithus margaritae* Zone for these beds. The upper part of the Marianna Limestone belongs to Zone P. 19 (*G. sellii* Zone) according to BLOW (1969, fig. 25). It lies within the *Cyclococcolithus margaritae* Zone. BLOW'S Zone P. 19 is present in the Boom Clay of Belgium were the nannofossils indicate the *Reticulofenestra laevis* Zone to *Sphenolithus predistentus* Zone. Thus, BLOW'S Zone P. 19 covers the interval of the upper *Cyclococcolithus margaritae* Zone, the *Reticulofenestra laevis* Zone and, perhaps, the base of the *Sphenolithus predistentus–Sphenolithus distentus* Zone. For the Upper Oligocene zones there is little divergence between planktonic foraminiferal and nannoplankton zonations but the lack of known continuous sections through this interval makes accurate correlations difficult. A sample from the *Globigerina ampliapertura* Zone of Trinidad was found to belong to the *Sphenolithus predistentus–Sphenolithus distentus* Zone; the type sample of the *Globorotalia opima opima* Zone lies within the *Sphenolithus distentus–Sphenolithus ciperoensis* Zone; the type sample of the *Globigerina ciperoensis ciperoensis* Zone contains a nannoflora typical for the *Sphenolithus ciperoensis–Triquetrorhabdulus carinatus* Zone; a sample from the *Globorotalia kugleri* Zone can be assigned to the *Triquetrorhabdulus carinatus–Sphenolithus belemnos* Zone.

6. CORRELATION OF THE OLIGOCENE STAGES WITH THE NANNOPLANKTON ZONES

A discussion of problems of the European Oligocene stratigraphy is presented on pp. 808–811.

An attempt to determine the extent of the classical European stages in terms of nannofossil zones was made by BAUMANN & ROTH (1969).

6.1. Latdorfian

The Silberberg Formation in the Coal Pit Treue IV, which contains the same nannoflora as mollusc fillings from Latdorf (see MARTINI & RITZKOWSKI, 1968), belongs to the *Ericsonia subdisticha* Zone. The lower part of the Silberberg Formation in the Clay Pit of the Silberberg can also be assigned to the *Ericsonia subdisticha* Zone