Biostratigraphic datum levels

of the original zone below the first occurrence of *Helicopontosphaera ampliaperta* (BRAMLETTE & WILCOXON) n.comb. [= *Helicosphaera ampliaperta* BRAMLETTE & WILCOXON, 1967, p. 105, pl. 6, figs. 1–4] and *Discoaster druggi* BRAMLETTE & WILCOXON. Sample PR 67* from the San Fernando by-pass in Trinidad with a planktonic foraminiferal fauna characteristic for the *Globorotalia kugleri* Zone was found to belong to this zone. It was collected close to the surface and therefore it is slightly weathered and not very rich. A sample from the type locality of the *Globorotalia kugleri* Zone of BOLLI (1957) examined only in the light microscope, is assigned to the *Triquetrorhabdulus carinatus- Sphenolithus belemnos* Zone. This zone is also present in a sample from JOIDES Hole 3 (270′ below sea floor) where small specimens of *Sphenolithus belemnos* were seen in the electron microscope.

The presence of the *Triquetrorhabdulus carinatus–Sphenolithus belemnos* Zone in Europe has not yet been established.

Until the relation of the Oligocene-Miocene boundary to the *Globorotalia kugleri* Zone is defined, it cannot be decided whether the *Triquetrorhabdulus carinatus–Sphenolithus belemnos* Zone belongs to the Oligocene or to the Miocene or straddles the boundary.

4. BIOSTRATIGRAPHIC DATUM LEVELS

There is growing recognition of the usefulness of datum levels in addition to zones for correlation. A datum level is defined as the surface connecting all the points marked by a certain event in different sections. Events may be the range limits of fossils, geophysical events (e.g. paleomagnetic reversals), lithologic and other stratigraphic marker horizons (e.g. ash beds) or other well defined changes. Ideally these surfaces connecting points marked by events are parallel isochronous planes. In reality this is not always the case as most events observable in nature will not take place everywhere on this planet nor will they necessarily be contemperaneous everywhere. The origin of a new species happens at a distinct time but its first occurrence at different places is not simultaneous due to the spreading time and to ecological barriers which can hinder or prevent migration into areas other than that of the original appearance. Since datum levels are essentially means of dating and correlation, they should be attached to events which are believed to have occurred in the same manner and at the same time in widely spaced areas, and not to a single observation point. Datum levels can only be applied reliably after careful study of many sections and after the overall fossil composition has been taken into consideration. A certain species can be absent or very rare at a certain level and reappear or become more abundant again higher up in the section. This can either be caused by adverse ecological conditions, solution of delicate forms after or during deposition, winnowing by fluctuating currents, or recrystallisation in the sediment. A certain species can also become so rare at a certain level that it can not be detected in a sample of average size. Zones can often be recognized even if the marker species are absent by using other characteristic species. Datum levels can be combined into informal units as suggested by HORNIBROOK (in press). Datum levels form very flexible means for subdivision of strata and long distance correlation. JENKINS (1966) suggested a great number of datum levels based on planktonic

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.