Correlation of the oligocene stages with the nannoplankton zones

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

but the uppermost part of these deposits belong to the *Cyclococcolithus margaritae* Zone. For practical purposes the Latdorfian or Lower Oligocene can be considered identical with the *Ericsonia subdisticha* Zone.

6.2. Tongrian

MARTINI & MOORKENS (1969) showed that the Sands of Grimmertingen, type of the lower Tongrian belong to the *Ericsonia subdisticha* Zone. Latdorfian and Tongrian fall into the same nannoplankton Zone and are thus of approximately the same age.

6.3. Rupelian

Two samples from the Rupelton of the Clay Pit Alversdorf near Helmstedt belong to the *Cyclococcolithus margaritae* Zone. A short section through the Boom Clay in the Clay Pit "De Roeck & Verstrepen" near Boom collected by Prof. H. Schaub in 1961 contains in the lower part a nannoflora typical for the *Reticulofenestra laevis* Zone; in the upper part the occurrence of *Sphenolithus predistentus* together with *Sphenolithus distentus* indicates the presence of the *Sphenolithus predistentus–Sphenolithus distentus* Zone. The Rupelian as a whole covers the interval from the *Cyclococcolithus margaritae* Zone through the *Sphenolithus predistentus–Sphenolithus distentus* Zone. BRAMLETTE & WILCOXON (1967) mentioned the concurrence of the *Sphenolithus predistentus* and *Sphenolithus distentus*, assigning part of the Boom Clay to their *Sphenolithus distentus* Zone. If the emended definitions for the upper Oligocene Zones are used only the presence of *Sphenolithus ciperoensis* would prove a correlation of the upper part of the Boom Clay with the *Sphenolithus distentus–Sphenolithus ciperoensis* Zone.

6.4. Chattian

Selected samples from the Chattian section near Glimmerode (see p. 32) were studied and the lower part proves to be assignable to the *Reticulofenestra laevis* Zone, the upper part of the *Sphenolithus predistentus–Sphenolithus distentus* Zone. The markers are rare, the preservation of the nannoflora is rather poor and the admixture of reworked Cretaceous coccoliths is great. At least part of the Chattian is of the same age as the Rupelian in the type area. The Chattian does not seem very suitable as a stage since planktonic organisms which are most useful for worldwide correlations are very rare and because it is mostly of the same age as the Rupelian.

6.5. Uppermost Oligocene

A suitable stage for the Upper Oligocene (*Sphenolithus distentus–Sphenolithus ciperoensis* Zone to *Triquetrorhabdulus carinatus–Sphenolithus belemnos* Zone) is still missing. BLOW & SMOUT (1968) suggested resurrecting the Bormidian of PARETO (1856). However, the Bormidian type section contains many reworked fossils and consists mainly of coarsely arenaceous sediments; it is hardly suitable as a standard for international use. The Neochattian is partly of the same age but its type section lies so

far in the north that it is difficult to correlate it with tropical and subtropical sediments. Calcareous plankton fossils are rare in the Neochattian and the rich benthonic fauna is not yet usable for worldwide correlation. Thus, the Neochattian, apart from its unacceptable name, is not very useful as an Upper Oligocene stage either.

6.6. Vicksburgian

The Vicksburg deposits of Alabama, which can be correlated with the type Vicksburg of Mississippi (see DEBOO 1965) contain the nannoflora of the *Ericsonia subdisticha*, *Cyclococcolithus margaritae* and *Reticulofenestra laevis* Zones. Preservation of the nannofossils is good and planktonic foraminifera are present along with larger foraminifera, molluscs, echinoids, ostracods. The Vicksburgian seems to be the best Oligocene stage available.

6.7. Chickasawhayan

The *Sphenolithus distentus–Sphenolithus ciperoensis* Zone was found in the Chickasawhay Limestone of Alabama. The Chickasawhay sequence thickens towards the western part of the Gulf Coast and might contain more than one nannoplankton zone.

7. SYSTEMATIC PALEONTOLOGY

Of a total of 122 species encountered in the Oligocene sections studied, 29 species are new, 25 new combinations are made and remarks are presented on 23 species because of differences in species concepts. The remaining 49 species are not described in this paper because they were well covered in previous literature. For those species not described in this paper the author presents a check list (pp. 871–872) where the type reference, other good illustrations, and descriptions are mentioned. Mainly electron micrographs of carbon replicas of the new species are presented here because some species prove to be too small to obtain light micrographs which could be assigned to the same species with certainty. The method described by PERCH-NIELSEN (1967) which allows examination of the same specimen in the light and electron microscope was not used because it was published after the greater part of the electron microscope work for this paper was already finished. For the suprageneric classification the system proposed by PARKE & DIXON (1964) for recent algae is mainly followed here. It differs considerably from the one used by HAY & al. (1967).

Kingdom Plantae
Subkingdom Contophora
Division Chromophyta
Class Haptophyceae, Christensen, 1962
Unicellular flagellates which possess a haptonema.
Order Prymnesiales, Christensen, 1962
Motile phase with an obvious haptonema.