De belangrijkste algemene gezichtspunten die uit bovenstaande beschouwingen te putten zijn lijken mij:

1. De temperaturen in de nabijheid van de bron, in vergelijking met de luchttemperatuur en die van benedenloop en stilstaande wateren, in de zomer relatief laag en in de winter relatief hoog zijn.
2. Het dagamplitude in de buurt van de bron, en het jaaramplitude in de benedenloop haar grootste waarde aanneemt.

FORAMINIFERA FROM THE CRETACEOUS OF SOUTH LIMBURG, NETHERLANDS. XXXIX.

ARGUMENTS FOR A LOWER PALEOCENE AGE OF THE SEDIMENT ABOVE THE UPPER Md IN THE QUARRY OF CURFS, NEAR HOUTHEM.

J. HOFKER

In the Natuurhist. Maandblad, vol. 44, 1955, p. 78, the author has published for the first time about a sediment found over the upper Md (zone with *Lockhartia roestae* and *Siderolites laevigata*), relatively rich in glauconite, which sediment he considered of the same age as the Lower Paleocene described by Brotzen from Southern Sweden (Brotzen, Sver. geol. Unders., C, 493, 1948).

In the meantime, that sediment could be found also in following localities:

Above the Upper Md, Canal Albert, near Vroenhoven, Belgium.
In the holes of the Poudingue de la Malogne in the quarry André, near Mons, Southern Belgium.
In holes in the Upper Md and the overlying sediments near Houthem, at the Aquarium.
In some holes at the top of the quarry Van der Zwaan, Jekerdal, St. Pietersberg (somewhat questionable).
In the outcrop in the Ravensbos, near Geulhem.
In the mine-shaft Maurits III, near Geleen.
In several of the States-Mine drill-holes in the vicinity of the Mine Maurits.
In the entrance of a grotto at the way Berg-Terblijt.

In the vicinity of Geleen, the sediment, with a thickness of about 5 m, is found above a real hard ground separating the sediment from the underlying Kunrade Chalk; the top of that Kunrade Chalk contains all the typical reworked fossils of the Uppermost Md, so that we may stipulate that near Geleen the sediment is found above a sediment which in time must be of Md-time or even younger (Fig. 1). While in Curfs and in Vroenhoven the sediment is covered by much later Oligocene sands, in the vicinity of Geleen it is invariably covered by a second hard ground, separating this sediment from typical Tuffeau de Ciply (regarding the lithology as well as its fossiliferous contents); above the Tuffeau de Ciply typical Calcaire de Mons is found here, and at the top the Thanetian

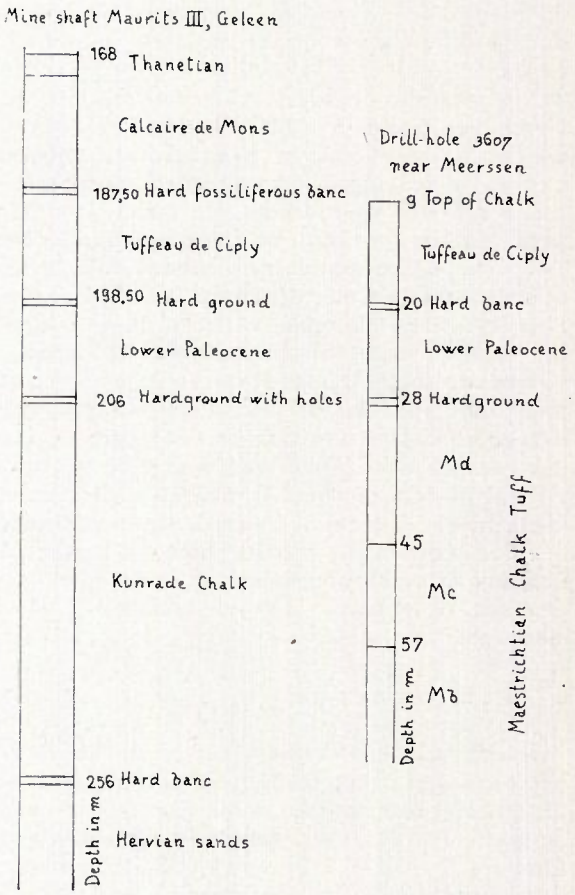

Fig. 1. Stratigraphy of part of the Mine-shaft Maurits III, which will be published in extenso in a larger paper on the Upper Cretaceous and Lower Tertiary, now in press, and of a drill-hole in the vicinity of Meerssen, North of the Saint Pietersberg, both in Southern Limburg. The mine Maurits is situated near Geleen, North of Meerssen. In both these localities the Brotzen's Paleocene (Lower Paleocene) stratigraphically finds its accurate position between the Tuffeau de Ciply (Montian) and the upper Maestrichtian Chalk Tuff or its equivalent, the Kunrade Chalk.

is found in a brackish sediment totally comparable with what is found over the Calcaire de Mons in the Basin of Mons in Belgium („lagunar Montian") and with the fauna of the Thanetian of Southern Engeland.

In this way, the sediment in question, which from now on I will indicate as „Brotzen's Paleocene", stratigraphically is so determined: it is found between the uppermost Md and the Tuffeau de Ciply. It is a very striking fact, that in the hollows of the Poudingue de la Malogne in the Mons Basin, the fossils found in Brotzen's Paleocene also occur, just below the base of the Tuffeau de Ciply. This occurrence indicates that in the Basin of Mons the Montian transgression destroyed Brotzen's Paleocene but for its remains in the hollows of the Poudingue de la Malogne. So, equal phenomena are found here as were detected by the author in the hard grounds in Northern Belgium and South Limburg separating the Campanian from the Maestrichtian: in the hollows are found the rests of those stages which were swept away by later transgressions.

We can be sure, that Brotzen's Paleocene, as found in Holland and Belgium, must be somewhat older that the Tuffeau de Ciply.

We will now argue firstly about the age of the Tuffeau de Ciply, the type of the „Montian". In a recent paper, Loeblich and Tappan have given their views on that much discussed stage, Journal of Paleontology, vol. 31, No. 6, 1957, p. 1119:

> "The Montian was described from Mons, Belgium, where it occurs as local deposits in the eroded surface of the chalks. It is considered to represent a transgressive stage, appearing in the central regions of Europe, which have no "Danian" deposits. A decidedly Tertiary-appearing fauna of *Cerithium* and *Turritella* occurs in the soft limes, and whereever this distinctive gastropod is found the Montian has been recognised. As mentioned above, the Danskekalk formation (type Danian of Denmark) also has a "*Cerithium* limestone" as its basal member. This basal Danian *Cerithium* represents a distinct species and thus is not an indication in itself of exact time equivalency, but it nevertheless represents a facies similar to that of the type Montian. Material from the Tuffeau de Ciply (lower part of the type Montian) was sent to us by Dr. J. Troelsen of Copenhagen, Denmark, and contains the following planctonic species: *Globigerinoides daubjergensis* and *Globigerina triloculinoides*."

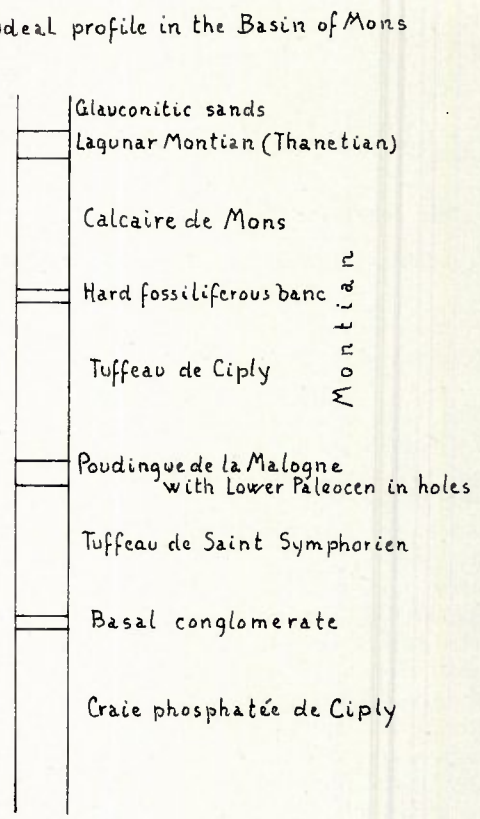

Fig. 2. Ideal profile in the Basin of Mons. The Tuff. de Ciply is overlying in the Basin of Mons the Tuff. de Saint Symphorien, or rests on the Craie phosphatée de Ciply, or, according to the different stratigraphic structures of the Basin, on Craie de Spiennes; here the author only has considered its position of those localities in which it is found over the Tuffeau de Saint Symphorien (Eastern part of the Basin). This position can be seen in one locality nowadays, viz. in a quarry called Caillaux, near Ciply. But in several drill-holes this situation also was stated. In all cases studied, the Tuffeau de Ciply rests on a hard banc, with a thickness up to 2 m, pierced by many holes; in those holes often a fauna was detected which corresponds with the Lower Paleocene (Brotzen's Paleocene) found at the top of the chalks in the quarry of Curfs, near Houthem, Holland. So, identifying the Tuffeau de Saint Symphorien with the Maestrichtian Chalk Tuff, we come to the conclusion that the Lower Paleocene in the Basin of Mons is situated just in the same way as it is in Holland in the district North of Saint Pietersberg. At the base of the Tuffeau de Saint Symphorien one finds a basal conglomerate, absolutely identical in its contents with the Ma in Holland. The Craie phosphatée de Ciply at its top contains the fossils as found in the Cr 4.

"The occurrence of the *Cerithium* fauna in the type Danian, and *Nautilus danicus* in Montian equivalents, the species of the *daubjergensis-compressa* faunal zone represented in both type Danian and type Montian and their equivalents over the world, the identical stratigraphic position of the Danian and the Montian, each unconformable on the Cretaceous, and underlying the Landenian sediments, and the fact that they are never found together, leads inescapably to the conclusion that the Danian and Montian are merely different lithologic and faunal facies of identical geologic age. We suggest that the term Danian be used to include the Montian also, inasmuch as the type Danian includes beds of both facies. The Danian should be used as a stage name within the Paleocene."

We will now consider these arguments of Loeblich and Tappan's. The author has made several gatherings of series of samples in the Mons Basin through the underlying Cretaceous, the hard layer Poudingue de la Malogne, and the Tuffeau de Ciply above (in one quarry at Ciply 18 m of that Tuffeau). But there are no basal or other "Layers of *Cerithium* and *Turritella*"; these were only mentioned from one locality, at the top of the Tuffeau de Ciply near Cuesmes, and here also material was sampled. It seems to be the hard fossiliferous layer separating the Tuffeau de Ciply from the Calcaire de Mons, and also was found in the shaft Maurits III (Fig. 2). But the species differ, as the author believes from literature, from those found in the type Danian of Denmark. The author studied carefully the foraminiferal contents of all localities in which Tuffeau de Ciply was found; the Tuffeau in some localities is found lying on the Calcaire phosphatée de Ciply, which shows fossils which indicate the age of Upper Cr 3 c and lower Calc. tuffoide of Northern Belgium; in other localities it is overlying the Tuffeau de Saint Symphorien, which is by all means identical with the Mb to Lower Md of the Tuffeau de Maestricht. On the other hand, the type Danian (Faxe, Stevns Klint, etc.) is separated from the Upper Maestrichtian (always the *Pseudotextularia*-zone of it) by a trangressional layer (and not by a typical "Poudingue") the Fiskeler, which contains only reworked specimens from the underlying Cretaceous, whereas the Poudingue de la Malogne invariably contains the fauna of Brotzen's Paleocene. So, the stratigraphic conditions of the base of the

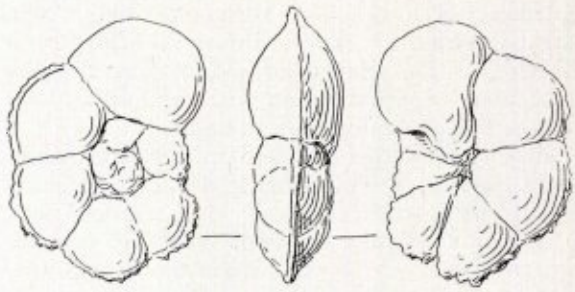

Fig. 3. *Globorotalia pseudomenardii* Bolli (*Globorotalia membranacea* of authors). Sample Hofker 525, quarry Caillaux (André), Ciply; × 70; a common species in the whole Tuffeau de Ciply, in which *Globigerina daubjergensis*, contrarily to the belief of Loeblich and Tappan's, could not be found. The occurrence of this species suggests that the type-Montian is not the lower Paleocene, but Middle-to Upper Paleocene, as is in accordance with its occurrence in Holland on top of the Lower Paleocene and below the Thanetian.

Tuffeau de Ciply and the type Danian are by no means identical, as Loeblich and Tappan suggest. When analysing the planctonic Foraminifera in my accurately gathered series of samples, I found results quite differing from those mentioned by Loeblich and Tappan: in the hollows of the Poudingue de la Malogne, and also just at the base of the Tuffeau de Ciply, but never more than 30 cm above the Poudingue, I found abundantly *Globig. daubjergensis* and *Gl. triloculinoides*, together with *Gl. pseudobulloides*. But in the Tuffeau de Ciply itself, in all 18 m analysed, none of these species were found, but quite another association, in which *Globorotalia pseudomenardii* Bolli (*Globorotalia membranacea* Ehrenberg of authors) culminated (Fig. 3).

With that result in mind, we are certain, that the sample given by Troelsen to Loeblich and Tappan, and given in their paper as typical Tuffeau de Ciply, was no Tuffeau de Ciply but derived from fillings in hollows of Poudingue de la Malogne; and so the whole identification by Loeblich and Tappan is based on an error. Moreover, when we consider the condensed analysis of the stratigraphic results with planctonic Foraminifera in their paper (Unites States Mus. Bulletin, No. 215, 1957, p. 175, fig. 27) we find, that the Danian of Denmark is placed at the base of the Paleocene,

whereas the zone with *Globorotalia pseudomenardii* Bolli is found at the top of the Paleocene, above the Wills Point Formation and equivalent with the Hornerstown Formation and the Vincentown Formation (Fig. 4). The other species of the rich foraminiferal fauna of the Tuffeau de Ciply corroborate fully with the view, that the Tuffeau de Ciply, the lower part of the Montian, is not lowest Paleocene, but already Middle Paleocene, slightly older that the Thanetian which is Upper Paleocene. The benthonic fauna of the Tuffeau de Ciply and the just overlying Calcaire de Mons shows a striking resemblance with the Paleocene of Cuba; the following species are found in both Holland and Cuba:

Thalmanninella madrugaensis (Cushman et Bermudez)
"Eponides" vanbelleni (Van den Bold)
Boldia madrugaensis Cushman et Bermudez
Boldia cubensis Cushman et Bermudez.

This is wholly in accordance with the Middle Paleocene age of the formation.

We have already one absolutely certain result: the Montian, the Tuffeau de Ciply, type of the lower part of the Montian, is not at all identical with the Danian, but identical with the Hornerstown Formation of Alabama, or even with the Vincentown Formation, of which it has many Foraminifera in common.

On the other hand, we may now analyse the fauna of the sediment, Brotzen's Paleocene, in Mons and in Holland underlying the true Tuffeau de Ciply. Its stratigraphic position indicates it as older than the Montian. The following species of Foraminifera occur both in the sediment detected by the author in the quarry Curfs, and the sediment found by Brotzen in Southern Sweden and compared by Brotzen with the Naheola-Formation of Alabama, described by Plummer and others. Loeblich and Tappan place that formation in the Lower Paleocene. Species in common:

Spiroplectammina cf. *laevis* (Roemer)
Arenobulimina cuskleyae Jennings
Triloculina inflata d'Orbigny
Lenticulina oblonga (Franke)
Robulus inornatus (d'Orbigny)
Robulus klagshamnensis Brotzen (= *Robulus degolyeri* Plummer)
Robulus discus Brotzen
Astacolus paleocenicus Brotzen
Citharina plummoides (Plummer)
Palmula robusta Brotzen
Globulina gibba d'Orbigny
Globulina inaequalis Reuss
Globulina lacrima Reuss
Globulina arenacea Brotzen
Pyrulina fusiformis Roemer

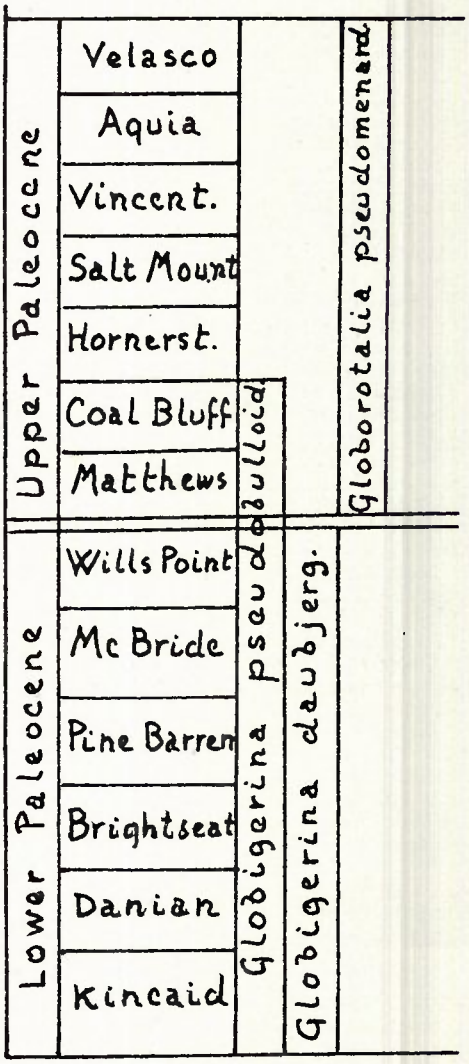

Fig. 4. Occurrence of the species involved here in the scheme, given by Loeblich and Tappan, U.S. Mus. Nat. Hist., Bull. 215, 1957, p. 175. In this scheme, the Tuffeau de Ciply has to be placed somewhere equivalent to the Hornerstown or Vincentown Formations, which corresponds exactly with the fossils found in the Tuffeau de Ciply.

Guttulina communis d'Orbigny
Guttulina problema d'Orbigny
Guttulina hantkeni Cushman et Ozawa
Pseudopolymorphina paleocenica Brotzen
Pseudopolymorphina geyeri Brotzen
Sigmomorphina soluta Brotzen
Sigmomorphina brotzeni Hofker
Sigmomorphina pseudoregularis Cushman et Thomas
Bolivinita selmensis Cushman
Buliminella parvula Brotzen
Bulimina aspera-aculeata Brotzen
Bulimina rosenkrantzi Brotzen
Virgulina sandegreni Brotzen
Siphogenerinoides eleganta (Plummer) (not *Bolivina applinae* Plummer as Brotzen indicated)
Spirillina recta Brotzen
Elphidiella prima (ten Dam)
Protoelphidium spec.
Patellina spec.
Rosalina ystadensis Brotzen
Rosalina koeneni Brotzen
Gavelinella lellingensis Brotzen
Gyroidinoides octocamerata Cusham et Hanna
Gyroidinoides pontoni Brotzen
Eponides lunata Brotzen
Eponides toulmini Brotzen
Cibicides proprius Brotzen
Cibicides succedens Brotzen
Gavelinella ekblomi (Brotzen)
Gavelinella simplex (Brotzen)
Cibicides burlingtonensis Jennings
Gavelinella umbilicata (Brotzen)
Gavelinella danica (Brotzen)
Gavelinella acuta (Plummer)
Globigerina triloculinoides Plummer
Globigerina daubjergensis Brönnimann
Globigerina compressa Plummer
Globorotalia lobata (Brotzen)
Alabamina midwayensis Brotzen
Pulsiphonina prima (Plummer)
Coleites reticulosus (Plummer)
Coleites danicus Brotzen
Karreria fallax Rzehak
Allomorphina halli Jennings
Gavelinella aspera (Brotzen)

Only some of the species with aragonitic tests, mentioned by Brotzen from his Paleocene, are lacking totally; but that is due to the calcareous sediment, as in such sediments aragonitic tests mostly are dissolved. But just underneath, in some layers of the Upper Md, and in some of the underlying Kunrade Chalk in the mining district, also *Höglundina scalaris* (Franke) was detected.

So there cannot be any doubt as to the identity of the Paleocene, as described by Brotzen, and the sediment in discussion here. They must be identical in age, as to the striking resemblance of the faunae. But, there is more yet.

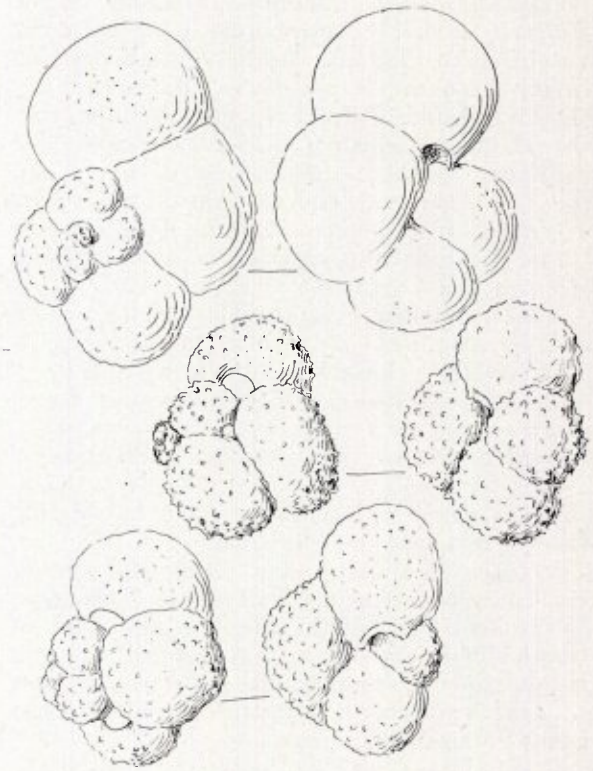

Fig. 5. The *Globigerina daubjergensis*-group. Above: specimen from Faxe, Denmark, Danske Chalk, the type-locality of the species *G. daubjergensis* Brönnimann (Ecl. geol. Helv., vol. 45, No. 2, 1952), and also identical with the figures given by Troelsen (U.S. Mus. Nat. Hist., Bull. 215, pl. 30, fig. 1). The species in this development stage does not show, even with high magnification, the openings at the dorsal sutures, so that Troelsen called it *Globigerina* and not *Globigerinoides*.
Middle row; specimen of what has been determined by Loeblich as *Globigerinoides daubjergensis*, from the Lower Paleocene (Brotzen's Paleocene) in the outcrop Curfs, Houthem, Holland. The species is much rougher than the type, and shows the dorsal sutural openings.
Lower row. Specimen from the fillings of the holes beneath the Tuffeau de Ciply, quarry Liénard, Ciply. These specimens, found in a whole fauna which is identical with that of the Lower Paleocene of Curfs, but not at all with the overying Tuffeau de Ciply, must have given rise to the error, made by Loeblijich and Tappan, when they identified the Montian with Danian. All figures enlarged × 170.

We have already stipulated, that Loeblich and Tappan identified the Danian of the type-localities, Faxe and Stevns Klint, with the Lower Paleocene, and thus with the Paleocene as described by Brotzen and found over the Upper Md or the Upper Kunrade Chalk in Holland, and in the Poudingue de la Malogne in Southern Belgium. This identification by Loeblich and Tappan is based mainly on the occurrence of *Globigerina daubjergensis* Brönnimann, occurring according to Loeblich in the Paleocene Brotzen's, in the Danian of the type-localities of Denmark, and in the Paleocene overlying the the Upper Md in Curfs. So, we will first study that remarkable planctonic species.

The species *Globigerina daubjergensis* was detected by Brönnimann in the Danian of Daubjerg and that of Hjerm, both in Jutland, Denmark. (Brönnimann, Eclog. geol. Halv., vol. 45, 1953, p. 340, fig. 53). It was described once more from the localities Stevns Klint, Faxe, Ostra Torp in Sweden, Bögelund, by Troelsen (U.S. Nat. Mus. Bull. 215, 1957, p. 128, pl. 30, fig. 1, 2). Loeblich and Tappan describe it from many localities of the Lower Paleocene of America (same paper) and they stipulate, that it shows accessorial apertures at the sutures, as in the genus *Globigerinoides*. Yet Troelsen, on describing it carefully from the Danian, places the species with emphasis in *Globigerina*, and he does not figure those extra apertures, nor does Brönnimann on several occasions. So, there must be something with those apertures (Fig. 5).

The author had all the material of all the localities mentioned by Troelsen, from the Danian of Denmark; he extracted many Globigerines from those materials, and studied them carefully; all other species, also mentioned by Troelsen, were found by the author: *G. compressa, G. triloculinoides, G. pseudobulloides*. But he also found, carefully studying those species with high magnifications and in oil, that they differ from the species which are in reality found in the type locality of Plummer's from the Kincaid Formation, as their pores as well as their total aspect are different. I will not now enter in those differences, and only give the results of the study of the species in question, *G. daubjergensis*. In all specimens observed from the type-Danian of Denmark, and from Ostra Torp in Sweden, they rarely show the extra openings as mentioned by Loeblich and Tappan. So Troelsen was right in placing the species named by Brönnimann, in the genus *Globigerina*. In the Lower Danian, the dorsal openings never occurred, only in the uppermost Danian, the *Crania* Chalk, very small openings were found in some of the specimens.

On the other hand, most specimens studied from the Paleocene of Holland (Brotzen's Paleocene), distinctly showed the extra apertures at the junctions of the dorsal sutures, and do not differ from those described from tthe Paleocene of Alabama by Loeblich and Tappan.

Such small Globigerines with spinose wall and more or less trilocular test and small aperture, not differing from the original figure by Brönnimann, occur in the Md, underlying the sediment in question in Holland; I have figured them (Natuurhist. Maandblad, vol. 46, p. 58, fig. 5 and 8) as *Globigerina primitiva* Finlay and *G. pseudobulloides* Plummer, from the Lower Md in the quarry Curfs; moreover, from the Upper Md, as *G. linaperta* (Maandbl. vol. 45, 1956, p. 55, fig. 15); the typical *G. daubjergensis* as described by Loeblich and Tappan, in the same paper, fig. 19 and 20, from the Paleocene above the Md, also from Curfs.

When comparing the specimens from the Md with those found in the zones A, B and C of the Danian of Denmark, we come to the conclusion, that they are absolutely identical, both missing the extra apertures at the dorsal sutures; whereas when we compare the specimens from the Paleocene in the quarry Curfs with those found in the Paleocene of America, we invariably find the small dorsal openings.

So it is obvious, that the generalising method used by Loeblich and Tappan brought them to the identification of the Danian, in reality stratigraphically older than the Brotzen Paleocene, with the Paleocene, whereas Troelsen, though also inclined to that view, was more cautious, and did not, in the Danian material, figure the dorsal openings, thus giving strength to the view, that the Danian in reality was not identical in age with the Paleocene.

We can conclude the analysis of the planctonic forms as follows:

Tuffeau de Ciply	*Globorotalia pseudomenardii*-zone
Lower Paleocene	*Globigerinoides daubjergensis* zone (with dorsal apertures)
Mc-Md of the Maestrichtian Tuff Chalk	*Globigerina linaperta-primitiva* zone (without dorsal apertures)
Danian of Denmark	*Globigerina linaperta-primitiva* zone (without dorsal apertures; thus being also *Gl. daubjergensis* Brönnimann).

The other species of Globigerines from the Danske Chalk (Danian of Denmark), *G. triloculinoides* Plummer, *G. pseudo-bulloides* Plummer, are doubtful, since they do not agree exactly with the specimens from the type-locality especially in respect to the diameters of their pores; they also occur in the Maestrichtian Chalk Tuff, as I have mentioned and figured them in the papers mentioned above; *Globigerina compressa* Plummer already was found by me in very typical specimens in the Upper Mb from Ransdaal and the Upper Mb underlying the real Kunrade Chalk in the quarry of Schunck, near Kunrade, South Limburg; these specimens do not differ either from those, found in the Danske Chalk and also described by Troelsen 1957; I must stipulate here, that contrarily to Loeblich and Tappan, that species is not a *Globorotalia* but a true *Globigerina,* since it lacks the marginal poreless keel, typical for real *Globorotalia.*

So it is obvious, just from the planctonic Foraminifera, that the typical Maestrichtian Chalk (also Mc-Md) is of Danian age, whereas the overlying, and thus younger Paleocene, identical with Brotzen's Paleocene of Sweden, is of Lower Paleocene age, and the typical Montian (Tuffeau de Ciply) is of the age of the Hornerstown Formation, thus being already Middle Paleocene, which is in accordance with its total fauna and its stratigraphic position.

I will once again point to my paper in the Natuurhist. Maandblad, vol. 45, 1956, For. Cret. Southern Limburg, XXI, Pores of Gavelinellidae, diagram; here I found that the pore-diameters indicate that the Mb, possibly also the Mc, are of Danian age, whereas the Montian, as found at that time in the Beatrix drill-holes, together with the Tuffeau de Ciply from Mons, distinctly were much younger than the Danian of Denmark, and also younger than the Lower Paleocene as found in the quarry Curfs. In this way, the very reliable pore-diameter analysis, which in the Upper Cretaceous of Germany and Belgium has given so accurate results, here again points to the same conclusions as attained by the analysis of the planctonic Foraminifera and the other faunal data.

The fauna of the type Danian of Denmark, though laid down in a sediment which is in some ways comparable with both the Maestrichtian Chalk Tuff and the overlying Lower Paleocene, differs greatly from the Dutch Paleocene, as it shows nearly no common species; on the other hand, a remarkable amount of species from the type Danian also is found in the, however tropical, Maestricht Chalk Tuff; this is the more remarkable, since the two sediments are utterly different in origin: the Maestrichtian Chalk Tuff has nearly all its tropical riffal forms in common with the Dordonian of South Western France, as the author will demonstrate in another paper on that formation; but the forms, occurring in the Maestrichtian Chalk Tuff, which are not found in the Dordonian for the larger part, are strikingly similar to the forms found in the type-Danian. Some species of the latter group are:

Parrella lens Brotzen (Mb)
Mississippina binkhorsti (Reuss) (Mb - Md)
Gavelinopsis involuta (Reuss) (Cr_4 - Me)
Gavelinella umbilicatiformis Hofker (Cr_4 - Me)
Gavelinella danica (Brotzen) (Cr_3C - Tuff. de Ciply)
Gavelinopsis proprius Brotzen (Md - Calc. de Mons)
Sigmomorphina brotzeni Hofker (Md - Calc. de Mons)
Cibicides compressus Hofker (Cr_4 - Tuff. de Ciply)
Textularia faujasi Reuss (Mb - Calc. de Mons)
Pseudoparrella alata (Marsson) (Cr_3C - Tuff. de Ciply)
Cibicides bosqueti (Reuss) (Cr_4 - Calc. de Mons)
Eponides toulmini Brotzen (Cr_4 - Calc. d. Mons)
Eponides lunata Brotzen (Cr_3C - Tuff. de Ciply)
Gyroidinoides pontoni Brotzen (Cr_4 - Md)
Globulina globulus (Md - Tuff. de Ciply)
Cibicides burlingtonensis Jennings (Mc - Tuff. de Ciply)
Alabamina dorsoplana Brotzen Cr_3C - Mb)
Alabamina midwayensis Brotzen Cr_3C - Tuff. de Ciply)
Allomorphina halli Jennings (Mb - Me or Pal.)

Karreria fallax Rzehak (Md - Tuff. de Ciply)
Orbignyna frankei (Brotzen) (Cr4 - Mb)
Textularia agglutissima Hofker (Cr4 - Mb)
Coleites reticulosus (Plummer) (Cr_3C - Mb, once again in Pal.)
Gaudryina supracretacea Hofker (Cr4 - Mb).

and many other forms, especially from the Polymorphinidae and Lagenidae. And, all these species show in the Danian and in the Maestrichtian Chalk Tuff the characteristic stage of development, as I have pointed out already for several of them, so that especially those stages of development give an accurate time-equivalent for Maestrichtian Chalk Tuff with Danian.

I will give here some instances, above the diameter-development of the pores in the Gavelinellidae:

a. *Coleites reticulosus* (Plummer) forms a straight development line from a typical *Pseudoparrella* test with sutural aperture in the Cr3C up to a typical *Coleites* in the Lower Paleocene and the Tuffeau de Ciply; in the Lower Mb the species begins to form the areal aperture typical for the *Coleites*-form; in the Mc-Md it vanishes, obviously due to the higher temperature, to return in the Me; in the mean time, the apertural condition has changed in the totally areal stage; just that changement takes place during the Danian in my Danian samples, where the species remained in the sea, the climate being there more moderate. This is a strong indication for the Danian age in which the Mc-Md were sedimented. (See: Hofker, Nat. Maandbl., vol. 45, 1956, pp. 75—78).

b. During Mb-Md, the species *Mississippina binkhorsti* (Reuss) develops from small and very flat types to bulky and strongly ornamented forms in the Upper Md; the same development takes place during the Danian; in the Lower Danian the types are flat without distinct dorsal ornamentation; in the Upper Danian the same bulky types appear with their strong ornamentation. (See: Hofker, Natuurhistorisch Maandblad, vol. 47, 1958, p. 101—103).

c. *Karreria fallax* Rzehak shows a very typical development from the Lower Md on to the Tuffeau de Ciply; the typical first stages of development, found in the Maestrichtian Chalk, also are found in the type-Danian. (See Hofker, Natuurhist. Maandbl., vol. 46, 1957, pp. 98—100).

d. *Textularia (Gaudryina) faujasi* Reuss develops in Holland from the Mb upwards into the Tuffeau de Ciply; in the Mc-Md this species shows three forms, one as a *Gaudryina* (the B-form); this triangular form then is common; during the Brotzen Paleocene and the Tuffeau de Ciply-time this triangular form becomes rare and vanishes; but in the Danian of Denmark, where this species also is common, it shows the *Gaudryina* form just as in the Mc-Md.

e. *Sigmomorphina soluta* Brotzen begins in the Cr 4, and gradually develops during the Maestrichtian Chalk into the large and typical forms found in the Lower Paleocene or in the Me; *Sigmomorphina brotzeni* Hofker begins in the Lower Md, where it does not show the forms with chambers which at their base are much inflated and in which the test is very elongate; that form develops during Lower Paleocene and the Tuffeau de Ciply-Calcaire de Mons (Montian); in the Danian the two species occur together in the forms occuring in the Lower Md. (See: Hofker, Natuurhist. Maandbl., vol. 46, 1957, pp. 16—19).

f. *Orbignyna frankei* (Brotzen) shows three forms in the Cr 4; but in the Maestrichtian Tuff Chalk it develops into a totally apogamic form, very much elongate; in the Lower Paleocene it does not occur any more; in the Danian it occurs mostly in the apogamic form (See: Hofker, Natuurhist. Maandbl., vol. 45, pp. 17—19).

g. *Osangularia lens* Brotzen is found from the Lower Maestrichtian (our Cr 3 b) on; it develops more and more a flange along the periphery and becomes more and more flattened; the flattening attained in the Mb, at the end of which zone it disappears, is the same as found in the lower half of the Danian of Denmark.

h. *Bolivinoides polonica* Pozaryska is found in many samples from the upper Md; it is typical for the Polish Danian; but it is not refound in the overlying Lower Paleocene. (See Hofker, Natuurhist. Maandbl., vol. 45, 1956, pp. 28—29). There are several other data which have to be considered here in respect to the parallelisation of Danian (Danske Chalk) and Maestrichtian Chalk Tuff.

In the Danian of Denmark, several "Cretaceous groups" continue their last development stages; *Stilostomella spinosa* Hofker is abundant; *Osangularia lens* Brotzen is common; there are in the Danske Chalk several species of *Neoflabellinae* which seem not to have been

reworked from the Cretaceous; these *Neoflabellinae* also are signalled from the Tethys-Danian (Marie, Reiss, Wicher), and could be studied also by the author; *Bolivinoides paleocenica* (Brotzen) in a stage slightly more advanced than that found in the *Pseudotextularia*-zone, is abundant; most of the small Globigerines found in the Danian also occur in the Maestrichtian Chalk, from the Cr 4 on. It is, as if the Cr 4 from Holland and the *Pseudotextularia*-zone in Stevns Klint continue, after a short gap, their evolution in Maestrichtian Chalk Tuff and in Danian; when one would place the Danske Chalk on top of the Cr 4, one would observe only a very mild change in the fossils.

There are many authors who consider the Danske Chalk to be the end of the Cretaceous; only the faunal break of the planctonic Foraminifera, at the top of the Cr 4 as well as at the top of the *Pseudotextularia*-zone at Stevns Klint, assigns the end of the Cretaceous and the beginning of the Tertiary.

Loeblich and Tappan emphasize that in the Maestrichtian Chalk Tuff *Rugoglobigerina, Globotruncana, Heterohelix* are found; but in the case that they occur, they are found there just as scattered and rarely as they are found in the Danske Chalk; why not mention them from the Danske Chalk? Troelsen, however, 1957, 1, c., mentions also *Rugoglobigerina* and *Heterohelix* from the Danske Chalk (and the author found them also), which he believes there to be reworked; with the same strength of argument I can here postulate that the scattered occurrence of those groups in the Maestrichtian Chalk Tuff only regards reworked specimens (only in the transgressional zones), the more so, since the deposits of the Maestrichtian Chalk Tuff strongly point to a very restless sea with often heavy streams and turbulations; often one would think, when studying the contents of the Chalk Tuff, especially in the Md, that one has to do with some Flysch. So, the possibility of reworking of those tiny, air-filled species is obvious, and I will consider those occurrences in a special paper.

When we will be more certain about the real stratigraphic place of the Lower (Brotzen's) Paleocene, we will have to compare the stratigraphic conditions found in Scandinavia with those of Holland and Belgium. In Holland and Belgium we have the following sequence on the top of the Cretaceous and at the base of the Tertiary:

Basin of Mons, Southern Belgium	*Northern Belgium*
Tuffeau de Ciply	Missing
Poudingue de la Malogne	Missing
with Brotzen's Paleocene in holes	Brotzen's Paleocene
Tuffeau de St. Symphorien	Tuffeau de Maestricht
Basal conglomerate	Basal conglomerate (?) or Ma
Calcaire phosphatée de Ciply	Calcaire tuffoide or Cr 4
Missing	Calcaire grise à silex noirs and craie tigre.
Holland, South Limburg, South of the Geul	*Holland, South Limburg, vicinity of Bunde-Geleen*
Missing	Tuffeau de Ciply
Brotzen's Paleocene	Brotzen's Paleocene
hard ground with holes (not always)	hard ground with holes
Maestrichtian Chalk Tuff	Maestrichtian Chalk Tuff or in the mining district, Kunrade Chalk.
Basal conglomerate or Ma	basal conglomerate or missing
Cr 4 or Tuffoid Chalk	Cr 4 or missing
Tiger-Chalk, upper part of the Cr 3 c	Cr 3 C or missing

When we analyse the faunae in these different formations, we find that the oldest formation is in this sequence the Craie tigre or Tiger chalk, with a poor foraminiferal fauna which, in many of its Foraminifera proves to be of a slightly younger age than the top of the quarry Hemmoor in Germany, so that this formation must be of Upper Maestrichtian age, but not the lowest part of it (See: Hofker, 1956, Ann. Soc. géol. Belgique, vol. 80, pp. B. 191—233; Idem, 1958, vol. 81, pp. B. 467—493). Over the Tiger chalk lies the Cr 4 or craie tuffoide in Northern Belgium and in South Limburg in Holland, which is still younger Maestrichtian, with the highest developed forms of the *Bolivinoides gigantea* and *Neoflabellina reticulata*-forms. Between the tiger chalk and the craie tuffoide (Cr 4) invariably is found a hard layer, a typical hard ground, which was detected in the drill-hole of Glons (l.c. Ann. Soc. Belg., 1958, p. B 473), but can also be seen near Petit Lanaye in Belgium, just at the bridge in the border of the highway. The change of the facies, though not large, is very conspicuous: suddenly many planctonic elements appear, such as *Biglobigerinella, Rugoglobigerina* and several species of *Globotruncana* from the highest Maestrichtian, and *Gümbelina*. This formation at its top suddenly ends and in many places in South Limburg, in the whole triangle between the rivers Mosa and Geul, a very remarkable thin regression-transgression layer is found, the well-known Ma (Pietersberg, Savelsbos, Wylre, Bossenhuysen). That layer invariably contains many reworked species from the underlying Maestrichtian, fish-dents, coprolites, glauconitic grains, etc. It is always a thin layer, mostly with a thickness not over 20 cm, often thinner.

In the Basin of Mons this basal conglomerate is found, just with the same contents, at the base of the Tuffeau de Saint Symphorien; this basal conglomerate here once again has a thickness of about 20 cm. Over that conglomerate, which in the Basin of Mons we may absolutely identify with the Ma in Northern Belgium and Holland, lies near Mons the Tuffeau de Saint Symphorien, with the foraminiferal fauna of the Maestrichtian Chalk Tuff. In Holland the Ma is covered by the Maestrichtian Chalk Tuff, and in the Eastern part such a conglomerate can also be found at the base of the Kunrade Chalk ("fossiliferous layer"). The Kunrade Chalk contains many reworked species from the Maestrichtian Chalk (mostly from Md), together with not-reworked species of a Danian type, or identical with Danian species (See: Hofker, Natuurhist. Maandbl., vol. 47, 1958, pp. 64—66).

We will now trace the stratigraphy as found in the rocks at Stevns Klint, Denmark. We find here the following sequence:

Stevns Klint, Denmark

Danian (Danske chalk)
clayish layer, called "Fiskeler"
Pseudotextularia-zone of the white chalk
hard bank
white chalk (Skrivekridt).

When we analyse the foraminiferal faunae, we find at the upper part of the skrivekridt a bryozoic chalk in which the fauna is nearly identical with the poor fauna of the craie à silex noir or the tiger chalk in Belgium and Holland. The pore-diameters of the Gavelinellidae in it has been analysed in the range-chart of my paper (Nat. Maandbl., vol. 45, 1956, pp. 99—110); it corresponds absolutely with that of the tiger-chalk. Just as in the case of the boundary tiger chalk-Cr 4, we find here a hard ground, and then the *Pseudotextularia*-zone starts, with, just as in the Cr 4, suddenly much more planctonic forms. I have analysed that fauna of the *Pseudotextularia*-zone (Paläontol. Zeitschrift, vol. 30, 1956, pp. 59—79). Not only is that fauna younger than the skrivekridt which must be of the time of the tiger-chalk, but it contains all of the species which are also characteristic of the Cr 4, though the latter fauna is poorer in planctonic species. Not only the pore-indices of the Gavelinellidae are identical with those found in the Cr 4, but also the highest forms of two of the development series which are found in both formations, show the identical height of development: *Bolivinoides gigantea* and *Neoflabellina postreticulata*. So there cannot be any doubt as to the time-identity of the two formations, Cr 4 and *Pseudotextularia*-zone. And both formations show at their top identical phenomena, viz. a thin regression-transgression

zone, with fish-dents ("Fiskeler"), coprolites, glauconite grains and Foraminifera reworked from underlying Cretaceous. More than that: the reworked Foraminifera from the Fiskeler are identical with those found in the Ma. Both regression-transgression zones are thin zones, and they are identical in their contents. I do not hesitate to identify both zones, as not only their stratigraphic position is the same, but they are both identical with a zone which E d g e l l described from the Australia-region, where just such a zone, thin, with regression and transgression features, is found over the uppermost Maestrichtian with totally comparable fossils, including the last formed forms of the *Bolivinoides*-sequence. I studied material of Australia and the zones are quite comporable.

Above this Fiskeler-zone, the Danian (Danske chalk) begins, with, as I have pointed out on the quoted range-chart, pore-indices identical with those of the Maestrichtian chalk tuff. When we disregard the tropical invasion with the fauna from the Dordonian (which fauna is also much more advanced in evolution than the upper Dordonian of South Western France) the fauna of the Danian at Stevns Klint and the fauna of the Maestrichtian chalk tuff in Holland and Northern Belgium (and that of the Tuffeau de Saint Symphorien) only form the continuation of the faunae of the *Pseudotextularia* zone, the Cr 4 or craie tuffoide, or the craie phosphatée in the Mons Basin. There is but a slight jump in that development series at the Ma, basal conglomerate of the Tuffeau de Saint Symphorien or the Fiskeler at Stevns Klint. That small jump can be read off in the range chart mentioned. It corresponds with the time of regression-transgression, indicated by the Ma and Fiskeler. Only, the Craie phosphatée of Mons must be somewhat older than the top of the Cr 4, since the jump is somewhat larger.

And so we may conclude with the identity in time of the following formations:

Tuffeau de Saint Symphorien	Tuffeau of the Maestrichtian chalk	Danske chalk
Basal conglomerate	Ma	Fiskeler
	Cr 4 or Craie tuffoide	*Pseudotextularia*-zone
	hard ground	hard ground
Craie phosphatée de Ciply	Craie tigre or tiger chalk	skrivekridt just under the *Pseudotextularia*-zone.

This is of considerable importance for our problem: the B r o t z e n Paleocene above the Maestrichtian chalk tuff cannot be of Danian age, but is a younger zone, since the Danian in Holland and Belgium is represented in time by what is called the Maestrichtian chalk tuff or the Tuffeau de Saint Symphorien.

It seems, that the Maestrichtian Chalk Tuff, so unique for its whole fauna, consists of the mingling of two faunae, one derived from the South and much connected to the fauna of the Dordonian (Tethys-fauna), the other from the North, a typical Danian fauna.

But on the other hand, we know of Belemnites, Ammonites, Mosasaurs and Rudists in the same Maestrichtian Tuff Chalk. Yet it may be that we have to consider these megalofossils with some caution: a *Scaphites constrictus*, sampled by Dr. M. Meyer in the Canal Albert outcrop, from the Md, showed in its matrix

(all *Scaphites* known from the Tuff are casts!) the fauna from the Md, but the cast itself showed a typical fauna as is found in the boundary Cr 4-Mb. So we have to reckon with reworking of such megalofossils.

When we consider all the planctonic forms (and also many of benthonic forms) found in the Maestrichtian Chalk Tuff we find that most of them do not have a Cretaceous character, but a Danian one; only the tropical forms from the riffal fauna show strong connections with the Upper Cretaceous forms of the Tethys; but a close analysis proves, that all of them have a more advanced development than the highest known Dordonian, as will be shown in another paper. Moreover, not the last forms of a development series give us the boundary of a stage, but the first forms of such a series. And just in the Maestrichtian Chalk Tuff those first forms of the Tertiary planctonic groups are found. This brings me to a critical review given by Loeblich and Tappan in the above mentioned paper 1957 (Journ. Pal., pp. 1115—1116). They state:

"The lowest zone of the Maestrichtian (Ma) at the type locality, ENCI quarry at St Pietersberg, south of Maastricht, contained *Biglobigerinella* and *Heterohelix;* zone Mb contains abundant *Heterohelix* and *Biglobigerinella* and rare *Rugoglobigerina* and *Globotruncana;* zone Mc contains abundant *Heterohelix* and *Guembelitria,* common *Biglobigerinella* and *Rugoglobigerina* and rare *Globotruncana;* and the base of Md contains *Heterohelix.* In de Burgerwacht quarry, St Pietersberg North, the base of Md contains *Rugoglobigerina* and rare *Heterohelix* and *Guembelitria;* Middle Md contains *Heterohelix, Guembelitria* and *Biglobigerinella;* and the top of Md contains abundant *Guembelitria* and *Heterohelix* spp., rare *Globotruncana* and poorly preserved *Rugoglobigerina.* At Chateau Nedercanne, between Maastricht and Eben Emael, Zone Mc contains *Globotruncana, Guembelitria, Heterohelix* spp. and rare *Rugoglobigerina.* In the Biebosch quarry near Falkenburg, Netherlands, Zone Mb contains *Rugoglobigerina, Heterohelix,* and *Biglobigerina;* Mc contains *Heterohelix* and Zone Md contains *Heterohelix, Guembelitria, Biglobigerinella* and *Rugoglobigerina.*"

The author sampled carefully all those localities and many others also. The only form found of what Loeblich and Tappan call *Heterohelix,* is *Guembelina striata* Ehrenberg in types which resemble strongly *G. ultimatumida* White; all are extremely small; they have been figured by the author (l.c. 1957, fig. 1); but this small form is not at all characteristic for Cretaceous; in all strongly moved sediments later than Cretaceous they are abundant in the Netherlands, even in recent sediments, as all investigators know. They are, in those cases, reworked; in one sample of a handfull of Tertiary sediment one can detect often hundreds of these small Guembelinae; the author will review these forms in a later paper in this series.

No *Rugoglobigerina* ever came to hand in all the samples (over 3000) from the Maestrichtian Chalk Tuff; but it may be that another species, *Globigerina supracretacea* Hofker, common in the Mb, rare in higher zones, gave rise to this determination Loeblich and Tappan's (Hofker, l.c. 1956, p. 55, fig. 8). *Rugoglobigerina* is abundant at the Cr 4-Ma boundary, but higher up it vanishes totally to the knowledge of the author.

Globotruncanae, not only of types with a single keel, were found by the author only in the transgressional layers of the different zones: base of the Mb, zone Mb/Mc, base and top of Md; they all show reworking characters and are extremely rare; so they cannot be given as base for the Cretaceous age of the sediment.

Guembelitria is common in upper Mc and Md, and has been figured by the author (l.c., 1957, p. 58, fig. 2, 3); but all forms found have the character of *G. mauriciana* Cole, typical for Lower Tertiary habitats. *Guembelitria* even occurs in recent planctonic samples of the Pacific, where the author found them often in quantities. *Biglobigerinella* was found by the author in the very typical form, *Globigerina biforaminata* Hofker, only in the Cr 3 b, Cr 3 c, the Cr 4 and the basal layers of the Mb; there are, however, very small forms of Foraminifera resembling this species but differing from it by the extremely thin and smooth surface, and not having a double aperture, but a single, very broad one. They very much resemble *Globigerina iota* Finlay, from the Paleocene and Eocene of New Zealand and Australia; this reminds me of another typical species, *Globigerina compacta* Hofker, of which very similar specimens

occur in the lowest Danian of the Giralia Anticline of Australia. G. *compacta* is found in the Md and Me, and rarely, in the Lower Paleocene. It also occurs in the „Danian" just above the Cretaceous in Northern spain. No *Biglobigerinella biforaminata* was found by the author in any sample higher than Lower Mb.

So, the author does not agree with these arguments of Loeblich and Tappan's; there must have been errors in their determinations, and it is very disconcerting, that they add: "No attempt is made here to identify these forms specifically".

The author rejects the conclusions by Loeblich and Tappan; on the other hand he once more points to the number of species with tertiary characters found in the Maestrichtian Chalk Tuff, (see also: Visser, Thesis, Leiden 1950, who figured a typical *Globigerina triloculimoides* from the Lower Md of Burgerwacht), including several real *Globorotalia* species (Hofker, l.c. 1957, p. 58, fig. 9; l.c. 1956, p. 56, fig. 12; Nat. Maandbl., 1957, p. 59, 60). Loeblich and Tappan argue, that *Globorotalia mosae* is not a *Globorotalia* at all; this too is rejected by the author, who could prove in another paper (in press) that not only the type of *Truncorotalia* often has a closed umbilicus, but also that the new species must be closely allied to *Truncorotalia*.

Conclusions:

1. The Maestrichtian Chalk Tuff may have been deposited during Danian time;
2. The Me above the Upper Md contains a transitional fauna between the Maestrichtian Chalk Tuff and the overlying Lower Paleocene; so the gap between those two must be a small one (Hofker, Natuurhistorisch Maandblad; vol. 46, 1957, pp. 121—123);
3. The Lower Paleocene (Brotzen's Paleocene) on top of the chalk in the quarry Curfs and other localities is identical with the Lower Paleocene of Sweden as described by Brotzen, and is younger than the type-Danian;
4. The Tuffeau de Ciply from the Basin of Mons and the many localities in the Mining District of Southern Limburg is younger than the Lower Paleocene and has nothing to do with the Danian stage; it is already Middle Paleocene.

BOEKBESPREKINGEN

Vliesvleugelige insekten — Hymenoptera V. angeldragers — aculeaten, graafwespen (Sphecoidea) door P. Benno. Wetenschappelijke mededelingen. Kon. Nederl. Natuurhist. Ver. no 28, 1958.

Wederom is een deeltje verschenen van deze zeer nuttige serie, die al enige jaren door de K.N.N.V. wordt uitgegeven en waarmee zij hoopt te bereiken dat vooral de jongeren onder ons, de dierenwereld, plantenwereld en aardkunde van ons land beter leert kennen en waarderen.

Het nu verschenen deeltje behandelt de graafwespen en is het 12de deeltje, dat over insekten reeds is uitgegeven. Dit is een zeer verblijdend teken, omdat als regel de insekten, vooral enige orden, nogal stiefmoederlijk behandeld werden tot op heden. De Hymenoptera hebben nu hun 4de deeltje reeds, terwijl een 5de (mieren) op komst is, waardoor dan alle angeldragers (Aculeata) hun beurt hebben gehad.

De naam van de auteur staat er borg voor dat hier een zeer gedegen overzicht wordt geleverd. In de inleiding wordt een en ander verteld over de levenswijze van de solitaire wespen in het algemeen, de approviandering, de nesten en de terreinen, waar ze voorkomen, worden hierin besproken. Daarna volgt een overzicht van de plaats in het systeem en de onderverdeling in 3 families, waartoe de graafwespen behoren. Op p. 4 is een zeer goed en handig systematisch overzicht gegeven van de verschillende geslachten met opgave van het aantal in Nederland voorkomende soorten, hun nestplaatsen en de aard van het proviand.

Een determinatietabel van de geslachten uit de 3 families wordt gegeven op p. 6 en p. 20. Het aantal en de namen van de verschillende bekende soorten behorende tot een bepaald genus worden daarna uitvoerig aangegeven. Dit alles geïllustreerd met goede, instructieve tekeningen. Alles bijeen genomen wederom een zeer waardevol nummer, waarmee ik de redaktie van harte gelukwens, en dat ik gaarne in handen zou willen zien van jongere entomologen, die met behulp van deze diverse uitgaven, zoveel gemakkelijker kunnen werken in hun liefhebberij dan wij, de oudere generatie, dit ooit hebben kunnen doen. De prijs (ƒ 2.05 of ƒ 2,45) mag zeker geen bezwaar zijn. Er is op dit gebied reeds veel bekend, maar nog steeds een en ander te onderzoeken, zodat de liefhebbers nog volop gelegenheid wordt geboden om nieuwe observaties te doen of de reeds bekende feiten zelf te controleren of uit te breiden.

C. Willemse.

Heinrich Grupe:

A: *Naturkundliches Wanderbuch,* 16 Auflage. XXII, 831 Seiten. Mit zahlreichen Abbildungen Ganzleinen. D.M. 14,—.

B: *Kleines Naturkundliches Wanderbuch.* Band 1: Vorfrühling 146 S., D.M. 3,60; Band 2: Frühling, 340 S., D.M. 6,40; Band 3: Sommer/Herbst, 254 S., D.M. 4,80; Band 4: Winter, 226 S., D.M. 4,80.

C: *Bauernnaturgeschichte.* Band 1: Vorfrühling, 172 S., D.M. 6,—; Band 2: Frühling, 304 S., D.M. 8,80;