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MEMOIRE 17

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And of subjacent strata in the "Mons Well 1969" with a review of Belgian Paleocene Stratigraphy

by

Thierry **L. MOORKENS**

Études sur le Stratotype du Montien a Mons réalisées sous la direction de
René MARLIERE
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TOME II

MINISTÈRE DES AFFAIRES ÉCONOMIQUES
ADMINISTRATION DES MINES

Service Géologique de Belgique
Rue Jenner, 13
1040 BRUXELLES

MINISTERIE VAN ECONOMISCHE ZAKEN
BESTUUR VAN HET MIJNWEZEN

Belgische Geologische Dienst
Jennerstraat, 13
1040 BRUSSEL

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(x) Text of Ph. D.
Thesis. submitted at the University of Utrecht, and defended in December 1972.

CONTENTS

SUMMARY

Over a hundred taxa of foraminifera have been recorded from 54 samples of the cored "Mons well 1969" (1) in the Mons basin, the upper samples of the analysed sequence (between 12 and 26 m depth) belonging to the Montian stratotype.

Seven benthonic species were described as new : *Discorbis ? lenae, Discorbis ? renemarlierei, Rotorbinella pozaryskae, Pararotalia godfriauxi, Pararotalia obourgensis, Eponides robaszynskii* and *Scarificatina szczechurae*. Some species and varieties were left in open nomenclature. An earlier *nomen nudum* of the literature, *Scarificatina reinholdi* MARIE, has here been validated, and the species has been designated type species for that genus.

The Lower Tertiary calcarenite sequence (here called Obourg calcarenites) of the Mons well 1969, which overlies lowermost Maastrichtian sediments at 80 m, is very poor in planktonic foraminifera. This is explained by assuming a very shallow environment during deposition. Benthonics, mainly Rotaliidae and Discorbidae, though ill preserved, are abundant and strongly diversified.

The rich benthonic assemblages of the Obourg calcarenites mainly consist of long ranging Paleocene taxa. They are thought to be strongly facies bound, but they allow the recognition of three assemblage zones of importance for correlations in Belgium and in the Maastricht area. The Belgian Paleocene stratigraphy is reviewed on the basis of foraminiferal assemblages.

Much of the faunal changes are probably due to gradual shifts of environments. However, there is a major break in the middle of the Paleocene, with Danian - Montian assemblages below it and Heersian - Landenian associations above. This faunal break probably corresponds to an important gap in the record, which is partly represented by non-marine deposits, except in the Mechelen-aan-de-Maas well where a transitional marine assemblage has been recorded, and where the sedimentary gap appears to be much smaller.

The benthonic faunas indicate that the typical Tuffeau de Ciply could reach down lower into the Lower Tertiary than the Obourg calcarenites. There is practically no doubt that the type Montian is younger than the Tuffeau de Ciply in its type section, but that it is older than the typical Heersian.

The benthonic zonation of the Obourg calcarenites does not allow correlations beyond the Mons - Maastricht area. For correlations to Denmark one has to rely on the planktonics. *Globigerina triloculinoides, Globorotalia* sp. aff. *G. varianta, G.* sp. cf. *G. imitata, G. pseudobulloides* and *G.* sp. cf. *G. compressa* are scarce. Specimens of *Globigerina daubjergensis* are less rare, yet not sufficiently numerous to treat populations statistically, as was done by HANSEN (1970 a) on Danish Danian material. From the two hundred specimens recovered from the Obourg calcarenite sequence of the "Mons well 1969" an increasing test size from older to younger samples was observed. This is in agreement with the data from Denmark.

From the average maximal test size of the *G. daubjergensis* specimens it again follows that the type Calcaire de Mons (= Montian stratotype) is younger than the Tuffeau de Ciply in its type section and also younger than the Middle Danian of Denmark, which incorporates the Danian stratotype at Faxe.

It is uncertain whether the Montian stratotype is a lateral equivalent of the "Upper Danian"

(1) The well has originally been called "Obourg well" ; later the colleagues of the Faculté Polytechnique de Mons, however, changed its name to "Sondage de Mons 1969", because of its exact geographic location.

deposits of Denmark (e.g. the Danske Kalk at Hvallose), or partly slightly younger. However, the Montian stratotype is certainly not younger than the extinction level of the *Globigerina daubjergensis-kozlowskii* lineage, as this group ranges into the stratotype section. This group does not occur anymore in the Type Heersian, which is considerably younger.

RESUME

Dans les 54 échantillons du "Sondage carotté de Mons 1969" (1), effectué dans le Bassin de Mons, plus de cent taxons de foraminifères ont été observés. La partie supérieure de nos échantillons (entre 12 et 26 m de profondeur) appartiennent à la section type du Montien.

Les espèces suivantes sont considérées comme nouvelles : *Discorbis ? lenae, Discorbis ? renemarlierei, Rotorbinella pozaryskae, Pararotalia godfriauxi, Pararotalia obourgensis, Eponides robaszynskii, Scarificatina szczechurae*. Quelques variétés nouvelles sont laissées en nomenclature ouverte. Un *nomen nudum* de la littérature, *Scarificatina reinholdi* MARIE est validé.

La séquence des tuffeaux du Tertiaire basal du "sondage de Mons 1969" (ici appelée les tuffeaux d'Obourg), qui recouvre le Maastrichtien Inférieur à 80 m, est pauvre en foraminifères planctiques, ce qui est dû aux conditions marines très peu profondes, pendant la sédimentation. Les benthiques, bien que mal conservés, sont abondants et fortement diversifiés, surtout les Rotaliidae et les Discorbidae.

La plupart des taxons Paléocènes provenant de ces associations riches en benthiques des tuffeaux d'Obourg, appartiennent à des espèces dont la distribution verticale est longue. La plupart des formes sont probablement liées au facies, mais la composition des associations permet de distinguer trois zones qui facilitent les corrélations en Belgique et dans la région de Maastricht. Partant des associations de foraminifères, la stratigraphie du Paléocène de la Belgique est passée en revue.

La plupart des changements faunistiques sont probablement dûs aux changements graduels écologiques. Néanmoins, on peut observer un changement faunistique important dans le Paléocène Moyen, les associations Daniennes-Montiennes se trouvant en-dessous et les associations Heersiennes-Landéniennes se trouvant au-dessus de la coupure.

Ce grand changement faunistique correspond à une lacune importante dans la sédimentation marine, lacune qui est, en partie, remplie par des sédiments non-marins, sauf dans le sondage de Mechelen/Maas où la série est plus complète, comprenant des sédiments marins avec une faune de transition.

Les faunes benthiques indiquent que le Tuffeau de Ciply - dans sa section type - se trouve probablement plus bas dans la succession que les tuffeaux du Tertiaire basal du Sondage de Mons 1969. Il est en tous cas certain que la section type du Tuffeau de Ciply est plus âgée que le Montien type, tandis que le Heersien type est certainement plus jeune que ce dernier.

La zonation de la séquence des tuffeaux du sondage de Mons 1969, basée sur les associations de foraminifères benthiques, ne permet pas de présenter des corrélations plus lointaines que celles intéressant les régions de Mons et de Maastricht. Pour suggérer des corrélations avec le Paléocène du Danemark, il nous faut considérer les rares foraminifères planctiques. *Globigerina triloculinoides, Globorotalia* sp. aff. *G. varianta, G.* sp. cf. *G. imitata, G. Pseudobulloides* et *G.* sp. cf. *G. compressa* sont rares.

Les exemplaires de *Globigerina daubjergensis* sont moins rares que ceux appartenant à d'autres foraminifères planctiques, mais ils ne sont pas suffisamment fréquents pour permettre une analyse statistique, comme celle de HANSEN (1970 a), faite sur du matériel Danien - Sélandien du Danemark.

Pour autant qu'on puisse conclure des deux cents exemplaires trouvés dans la séquence des

(1) Originalement le sondage avait été appelé "sondage d'Obourg", plus tard, les collègues de la Faculté polytechnique de Mons ont changé son nom en "sondage de Mons, 1969", ce qui correspond à la réalité géographique.

tuffeaux du sondage d'Obourg, les dimensions des tests s'accroissent vers le haut.

Ces résultats concordent donc avec ceux du Danemark.

A nouveau nous pouvons conclure que le Calcaire de Mons dans sa localité type (= Montien type) est plus jeune que le Tuffeau de Ciply dans sa section type, et que - si nous pouvons utiliser ces résultats pour des corrélations plus lointaines - le Montien type est plus jeune que le Danien moyen du Danemark, qui incorpore à son tour le stratotype du Danien à Faxe.

Il n'est pas certain si le stratotype du Montien est un équivalent latéral du "Danien supérieur" du Danemark (p.e. du Danske Kalk à Hvallose) ou s'il est en partie légèrement plus jeune. Néanmoins, on peut dire avec certitude que le Montien type n'est pas plus jeune que la date de disparition de la lignée *Globigerina daubjergensis - kozlowskii* puisqu'on a trouvé des exemplaires de ce groupe jusque dans la section type du Montien. Le Heersien type ne les contient plus ; il est considérablement plus jeune.

ZUSAMMENFASSUNG

Aus 54 Proben der fortlaufend gekernten "Bohrung Mons 1969" (1) (Becken von Mons) konnten über 100 Arten bzw. Unterarten von Foraminiferen nachgewiesen werden. Die oberen Proben der untersuchten Schichtfolge (Teufenbereich zwischen 12 und 26 m) entsprechen dem Stratotyp des Mont.

Die folgenden sieben benthonischen Arten wurden neu beschrieben : *Discorbis ? lenae, Discorbis ? renemarlierei, Rotorbinella pozaryskae, Pararotalia godfriauxi, Pararotalia obourgensis, Eponides robaszynskii* und *Scarificatina szczechurae*. Einige Arten und Varietäten wurden in offener Nomenklatur behandelt. Ein in der Literatur bestehendes *nomen nudum, Scarificatina reinholdi* MARIE, wurde verfügbar gemacht und die Art zur Typus-Art dieser Gattung bestimmt.

Die alttertiäre Kalkarenit-Folge in der "Bohrung Mons 1969" (hier "Obourg calcarenites" genannt), überlagert bei 80 m Teufe Schichten des basalen Maastricht und ist sehr arm an planktonischen Foraminiferen. Als Grund hierfür werden sehr flache Ablagerungs-Bedingungen während der Sedimentation angenommen. Benthonische Arten, insbesondere der Familien Rotaliidae und Discorbidae, sind trotz schlechter Erhaltung individuen- und artenreich.

Die reichen benthonischen Faunen-Vergesellschaftungen der Kalkarenite in der Bohrung Mons 1969 bestehen überwiegend aus langlebigen paläozänen Formen. Sie werden als stark faziesgebunden gedeutet, gestatten jedoch die Erkennung von drei Faunen-Zonen, die von Bedeutung sind für Korrelationen in Belgien und im Raum von Maastricht. Die Stratigraphie des Paläozän von Belgien wird besprochen aufgrund von Foraminiferen-Vergesellschaftungen.

Viele Faunen-Wechsel haben wahrscheinlich ihre Ursache in allmälich verlaufenden Veränderungen der Ablagerungs-Bedingungen. Demgegenüber läßt sich ein starker Schnitt im mittleren Teil des Paläozän feststellen mit Dano/Mont-Vergesellschaftungen unterhalb und Heers/Landen-Vergesellschaftungen oberhalb des Schnittes. Dieser Faunen-Schnitt entspricht wahrscheinlich einer wichtigen Schichtlücke, die teilweise durch nichtmarine Ablagerungen vertreten wird außer in der Bohrung Mechelen-aan-de-Maas, wo eine marine Vergesellschaftung von Übergangs-Charakter nachgewiesen worden ist.

Die benthonischen Faunen zeigen an, daß der typische Tuffeau de Ciply tiefer in das Untere Tertiär reichen könnte als die Kalkarenite in der Bohrung Mons 1969. Es besteht kein Zweifel, daß das Typus-Mont stratigraphisch jünger ist als der Tuffeau de Ciply in seiner Typlokalität jedoch älter als das typische Heers.

Die Zonierung der Kalkarenite von Obourg nach bentonischen Foraminiferen gestattet keine Korrelation über das Gebiet von Mons-Maastricht hinaus. Für Korrelationen mit Dänemark müssen planktonische Foraminiferen zu Hilfe genommen werden. *Globigerina triloculinoides, Globorotalia* sp. aff. *G. varianta, G.* sp. cf. *G. imitata, G. pseudobulloides* und *G.* sp. cf. *G. compressa* sind selten. Stücke von *Globigerina daubjergensis* sind weniger selten, jedoch nicht zahlreich genug, um die Population statistich zu behandeln, wie HANSEN (1970 a) es an dänischem Material aus dem Dan durchgeführt hat. An den 200 in den Kalkareniten von Obourg gefundenen Stücken konnte eine Zunahme der Gehäuse-Größe von den stratigraphisch älteren zu jüngeren Proben beobachtet werden. Diese Aussage stimmt überein mit den Beobachtungen Dänemark.

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(1) Diese Bohrung hieß ursprünglich "Bohrung Obourg". Zwischenzietlich wurde die Gemeinde von Obourg zur Stadt Mons eingemeindet. Die Kollegen der Faculté Polytechnique de Mons nannten diese Bohrung dann um in "Bohrung Mons 1969", da diese ihrer geo-graphischen Lage entspricht.

Nach der durchschnittlichen maximalen Gehäuse-Große der Stücke von *G. daubjergensis* zeigt sich erneut, daß der Typus Calcaire de Mons (Stratotyp des Mont) jünger als der Tuffeau de Ciply in seinem Typus-Profil und ebenfalls jünger als das Mittlere Dan von Dänemark ist, das den Stratotyp des Dan in Faxe darstellt.

Es ist unsicher, ob der Stratotyp des Mont eine laterale Vertretung der Ablagerungen des "Oberen Dan" in Dänemark (z.B. des Danske Kalk in Hvalløse) oder etwas jünger ist. Jedenfalls ist der Stratotyp des Mont gewiß nicht jünger als das zeitliche Verlöschen der Linie *Globigerina daubjergensis-kozlowskii*, da diese Gruppe in das Stratotypus-Profil hineinreicht. Diese Gruppe ist im Typus Heers nicht mehr anwesend. Der letztgenannte Stratotyp ist wesentlich jünger.

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1. INTRODUCTION.

Since the Puits Goffint (1865) was abandoned, only a few samples were available of the Montian stratotype and their exact depth was not known in most of the cases. This was also the case for most of the samples of the more recent Puits Coppée drilled in its neighbourhood.

A recently cored well (1969) was drilled in the village of Obourg, near Mons, at approximately 10 m distance from the classical Puits Goffint, to sample the Calcaire de Mons (and the Montian stratotype, characterized by the same type section) at its typelocality, as well as to study underlying deposits.

At 12 m below topographic level, this well reached the top of the Calcaire de Mons, here overlain by a lateral equivalent of the Tuffeau d'Angres (?), glauconiferous deposits of the Landenian.

From 12 m on, a succession of calcarenites was recovered reaching the Cretaceous - Tertiary boundary at 80 m local depth.

Below the depth of 80 m, chalk was observed, belonging to the lithologic unit of the Craie de Spiennes, which is of Early Maastrichtian Age in this locality.

53 samples from this well were analysed as to their foraminiferal content. 51 out of 53 were situated between the local Cretaceous - Tertiary boundary (80 m) and the top of the Calcaire de Mons (12 m). One sample of the underlying Craie de Spiennes was analysed (at 83 m local depth) and another one of the overlying Paleocene sediments (at 11.60 m local depth).

The scientific aims of drilling this cored well were the following :

a) To obtain a series of accurately situated samples of the Montian stratotype (= type section of the Calcaire de Mons) for paleontological and sedimentological analyses.

b) To allow a comparison between the fossils of this stratotype and those of the stratotypes of other Paleocene stages.

c) To study the local geology regarding strata underlying the Montian stratotype. Prior to this study, the local thickness of the Calcaire de Mons and the local depth of the Cretaceous-Tertiary boundary were unknown for this locality.

d) To give an answer to the question whether the Calcaire de Mons (in its type section) is a lateral equivalent of the Tuffeau de Ciply (of Danian Age in its type section), or whether it is younger, as generally suggested in Belgian stratigraphic literature.

Earlier publications describing foraminifera of the Calcaire de Mons are those of P. MARIE (1950, 1964) and those of J. HOFKER (1961a, 1962, 1966e, and other papers). They either give schematic drawings or no pictures of the microfossils. New genera and species erected by P. MARIE (1964) were not described by that author and hence, have to be considered as *nomina nuda*. Some of them have here formally been described.

2. VARIOUS LINES OF STRATIGRAPHIC REASONING.

2.1. GENERAL OUTLINE.

The Danian Stage was formally erected by DESOR (1847, p. 181), who considered the "Calcaire de Faxoe" (= Dansk Kalk at Faxe, = Fakse) and the limestone at Stevns Klint to be stratigraphical equivalents of the "Calcaire pisolithique" in the Paris basin. For DESOR (loc. cit.) these chalky sediments of Denmark (the Danske Kalk) were definitely younger than the previously erected Senonian of d'ORBIGNY. Previously DUMONT (1832) had studied the chalky sediments and calcarenites of the Maastricht area, and he concluded (1849) that also at Pietersberg, near Maastricht, sediments were present, younger than the Senonian of d'ORBIGNY. DUMONT formally erected the term Maastrichtian in 1849, after having used the terms "Craie" and "Calcaire de Maastricht" in his prior

publication of 1832. In 1849, the term "Craie" he altered to "Système Sénonien", whereas the term "Calcaire de Maastricht" (Pietersberg) formed the type of his newly erected "Système Maastrichtien". The study of megafossils and microfossils later provided a series of biostratigraphic arguments to consider the type localities of the Maastrichtian and Danian Stages to be of definitely different age. Although the lithology of both stratotypes is somewhat similar, indeed, their paleontological content is quite different. For instance, an important extinction wave, mainly affecting the planktonic and pelagic organisms, occurred after the deposition of the Tuffaceous Chalk of Maastricht, i.e. the Maastrichtian type section, and before the deposition of the Danske Kalk of the Danian stratotype.

This, however, has not been observed immediately. Authors have considered for a long time both Maastrichtian and Danian to be Upper Cretaceous stages, till GROSSOUVRE (1897) observed that the greatest paleontological change occurred before the Danian, and not following it. This observation has later been corroborated by many other paleontologists.

It may explain why, in the Mons basin, the "Calcaire grossier de Mons", a sequence of calcarenites, observed and originally described from the Puits Goffint at Obourg by CORNET & BRIART (1865), has long been considered the lowermost Tertiary deposit.

The Montian Stage (DEWALQUE 1868, p. 125), defined on the same well section (Puits Goffint) as the type section of the Calcaire de Mons, was placed in the lowermost Tertiary, due to the Tertiary aspect of its mollusc content.

At this time, the Tuffeau de Ciply, another sequence of calcarenites in the central part of the Mons basin, was still considered to belong to the Maastrichtian Stage by d'ARCHIAC (1851), VAN DEN BINCKHORST (1859), CORNET & BRIART (1866 a, b, 1877), BRIART & CORNET (1870, 1873, 1880). This interpretation of a Maastrichtian Age was mainly based on the (reworked) Late Cretaceous fossils in the basal conglomerate bed of the Tuffeau de Ciply, the Poudingue de la Malogne.

The study of the molluscs of this Tuffeau de Ciply and the accurate field observations of RUTOT & VAN DEN BROECK (1885 a, b, 1886 a, b, c, d, e) led to the present day interpretation that the Tuffeau de Ciply is younger than Maastrichtian, i.e. of Danian Age, while the Montian would be still younger.

The voluminous literature on the Maastrichtian, Danian and Montian stratigraphy in the regions of their stratotypes was extensively reviewed by BERGGREN (1964).

2.2. PLANKTONIC MICROFOSSILS.

In earlier times, larger invertebrates (Molluscs, Brachiopods, Echinoderms) were used for long distance correlations. Recently, biozonations of planktonic microfossils have proved to be more reliable and more practical. We shall therefore restrict our biostratigraphical discussion to the zonations elaborated to these groups of microfossils. First, the biozonation of the planktonic foraminifera was established. More recently, the value of the calcareous nannoplankton biozonation was recognized by several authors.

2.2.1. PLANKTONIC FORAMINIFERA.

LOEBLICH & TAPPAN (1957 b, c) were the first to discover *Globigerina daubjergensis, Globigerina triloculinoides* and *Globorotalia pseudobulloides* in the Tuffeau de Ciply. Later MEIJER (1969) added the guide fossil *Globorotalia compressa* to this list, arguing that the Tuffeau de Ciply is of

Late Danian Age and that Lower Danian deposits are at least partly absent at Ciply.

From the enumerated publications (* in list of references), the ranges of the following species seem to be important for the subdivision of the Danian and for its upper boundary.

- *Globigerina* (vel *Globoconusa*) *daubjergensis* and *G. kozlowskii* (these two species in this order form successive evolutionary stages of what will be called the *G. daubjergensis* lineage in this text).

- *Globorotalia pseudobulloides* and *G.quadrata, Globigerina* (?) *varianta* and *Globigerina* (vel *Subbotina*) *triloculinoides* (their first appearance).

- *Globigerina spiralis* (its first appearance).

- *Globorotalia inconstans, G. praecursoria* and *G. uncinata* (their first appearance).

- *Globorotalia angulata* (its first appearance).

- *Globorotalia imitata, Globorotalia compressa, Globorotalia emilei* and *Globorotalia ehrenbergi* (their first appearance and extinction level).

- *Globorotalia danica*, (*nomen nudum*, BANG, 1969) (its complete range is still uncertain but it may have some stratigraphic value).

The Danian of Denmark is characterized by the presence of *Globigerina* (vel *Globoconusa*) *daubjergensis* s.l. The range of this group covers the whole stage and (when including *G. kozlowskii*) extends even into the younger (overlying) deposits of the so-called Selandian.

The range of *Globorotalia compressa* covers only the upper part of the Danian in Denmark according to TROELSEN (1957) and to BERGGREN (1960 b, 1962, e). According to BANG (1969) it would cover the larger part of the Danian in the Storebaelt region of Denmark, but possibly the Lower Danian is missing in this region. This could not be checked by means of the Tylocidaris Zonation of the typical Danian (cf. also HANSEN, 1970 b).

The Tuffeau de Ciply in the Mons basin and the Tuffeau de Houthem (= Tuffeau de Vroenhoven) of eastern Belgium and the SE Netherlands (the Maastricht area) are characterized by the same planktonic foraminiferal assemblage as the Danian of Denmark, but including *Globorotalia compressa,* which suggests that these deposits are of Late Danian Age, and that Lower Danian sediments may be completely lacking in these regions.

Some of the planktonic foraminifera listed by HOFKER (1961 a, 1962, 1966 e and several other notes, cited in the bibliography of the latter publication) which would cause a different age assignment of various deposits, are considered to be based on erroneous determinations. This applies mainly to his *Globorotalia* spp. cited from the type Maastrichtian and those from the Montian stratotype and the Tuffeau de Ciply. Probably, the forms considered, belong to benthonic foraminifera, as will be discussed in the systematic descriptions. This applies to the *Globorotalia uncinata* specimens, which HOFKER cited from the Calcaire de Mons (Puits Coppée).

This is also true of some determinations of EL-NAGGAR (1967 c, 1969 a), which unfortunately are not accompanied by descriptions or figures. *Globorotalia inconstans* SUBBOTINA, which that author claims to be abundant in the type Heersian, is most probably an erroneously identified benthonic form,possibly *Gyroidinoides voluptus,* described by HAYNES, from the type Thanetian.

Globorotalia angulata was cited by EL-NAGGAR (1969 a) from the Calcaire de Mons of the Givry well 318. We had no opportunity to study material from that well, but from none of the fifty-one samples from the Calcaire de Mons at its type locality or from subjacent layers was this species recovered. Possibly EL-NAGGAR mistook an *Eponides* species of the group *Eponides toulmini-robaszynskii* for *Globorotalia angulata*.

A third form listed by EL-NAGGAR (1967 c) as "*Globigerina eocaenica* TERQUEM" SUBBOTINA and given as an indication for the Late Paleocene Age of the marine Landenian in Belgium, is probably an *Allomorphina* (recte *Quadrimorphina*) *halli* JENNINGS, a benthonic species which occurs frequently in the Swedish Paleocene (cf. BROTZEN, 1948) and in the Belgian Lower Landen Formation and more rarely in the Heers Formation of Belgium.

2.2.2. CALCAREOUS NANNOPLANKTON.

The study of this group of microfossils has been carried out later than that of the planktonic foraminifera.

The great change of the calcareous nannoplankton assemblage at the Maastrichtian - Danian boundary was emphasized by BRAMLETTE & MARTINI (1964). They showed that this boundary with a profound change in the calcareous nannoplankton assemblage is more valuable as a Cretaceous-Tertiary boundary than any zonal boundary higher up in the succession.

Moreover, they proved that this great change in the calcareous nannoplankton occurred between the base of the type Danian in Denmark and the top of the type Maastrichtian in Limburg, the SE Netherlands. This fact further substantiates the conclusions based on planktonic foraminifera, and it proves that the parallelism of the type Maastrichtian and type Danian suggested by HOFKER (1961 a, 1962, 1966 e) is erroneous.

Recently a more detailed study of the Maastrichtian, the Danian, and the Lower Selandian of Denmark by PERCH-NIELSEN (1969) yielded the following nannoplankton zonation for the Danian in Denmark from top to bottom :

(2) - *Cruciplacolithus tenuis* Zone (NP2 Zone).

(1) - *Markalius astroporus* Zone (NP1 Zone) or *Biantolithus sparsus* Zone.

Samples from the Lower Selandian only yielded (reworked) Upper Cretaceous and (reworked ?) Danian species ; no new species appeared in these deposits according to PERCH-NIELSEN (1969) which lack of change is astonishing compared to the newly introduced planktonic foraminifera (*Globorotalia angulata, G. emilei*) cited by HANSEN (1968).

The calcareous nannoplankton assemblage of the type Heersian has not yet been studied in detail. In addition to abundant reworked Campanian - Maastrichtian forms, we observed some Paleocene species which will probably allow a more accurate age determination in the near future. This work is being carried out in collaboration with P. ČEPEK.

According to BRAMLETTE & SULLIVAN (1961) and HAY & MOHLER (1967), the type Thanetian yields a calcareous nannoplankton assemblage belonging to the *Heliolithus riedeli* Zone.

The Lower Landen Formation ("marine Landenian") in the Mechelen-aan-de-Maas well, which overlies sediments of the Heers Formation (Middle Paleocene, Heersian), also contains an assemblage belonging to the *H. riedeli* Zone (MARTINI, personal communication). The Tuffeau de

Lincent sampled at Wansin (WA) yields a similar association of calcareous nannoplankton, belonging to the *H. riedeli* Zone. (ČEPEK, personal communication).

The type Landenian based on the Upper Landen Formation ("continental Landenian") cannot be situated in the planktonic zonations because of the type of sediments.

The Lower part of the Ypresian in the reference section Kortemark (quarry de Simpel) yields calcareous nannoplankton belonging to the *Discoaster binodosus* Zone, whereas the upper part belongs to the *Marthasterites tribrachiatus* Zone according to HAY & MOHLER, 1967.

Data on the Belgian "Middle Paleocene" part of the succession (Montian, Heersian) are still lacking.

The calcareous nannoplankton of the Montian stratotype as well as that of the Tuffeau de Ciply in its type locality is presently under study (Miss D. NOEL). Unfortunately, the lithology is rather unfavourable for calcareous nannoplankton (1).

Between the stratotype of the Danian (Lower Paleocene), the top of which belongs to the *Cruciplacolithus tenuis* Zone according to PERCH-NIELSEN (1969) (or, perhaps to the *C. danicus* Zone in MARTINI's (1971) zonation of the Paleocene), and the stratotype of the Thanetian (Upper Paleocene), and the stratotype of the Thanetian, which belongs to the *Heliolithus riedeli* Zone according to BRAMLETTE & SULLIVAN, 1961, the Middle Paleocene should cover the following nannoplankton zones of MARTINI (1971) :

(4) - *Discoaster gemmeus* Zone (NP 7 Zone)
(3) - *Heliolithus kleinpelli* Zone (NP 6 Zone)
(2) - *Fasciculithus tympaniformis* Zone (NP 5 Zone)
(1) - *Ellipsolithus macellus* Zone (NP 4 Zone)

It is probable that the type Heersian corresponds to the higher zone(s), the Montian stratotype to the lower zone(s).

2.3. REVIEW OF CHRONOSTRATIGRAPHIC UNITS.

Before starting the discussion of stages, some remarks have to be given on the term Paleocene.

2.3.1. PALEOCENE.

To the four-fold division of the Tertiary given by LYELL in 1833, SCHIMPER (1874) added the term Paleocene, a concept which was supposed to cover the time interval of the lower part of LYELL's Eocene, whereas the remaining younger part of the LYELL's Eocene (s.l.) was redefined as Eocene (s.s.).

The term Paleocene has been defined as the time period in which the fresh water sediments of Sézanne were deposited in the Paris basin.

Unfortunately, contradictions already occurred in the original definition of the term (cf. POMEROL, 1968, p. 447) and different opinions exist today regarding the position of the Paleocene - Eocene boundary. In this work, we consider the base of the Ypresian (= base of the Clay of Ieper (= Ypres)

(1) It appears that most samples are devoid of calcareous nannoplankton, bur P. CEDEK (pers. comm.) determined a specimen of C. danicus in the Calcaire de Mons.

in its type region) to be the base of the Eocene. Hence, the Thanetian (and its Belgian equivalent, the marine Landenian) are considered to be of Late Paleocene Age, whereas the Danian is considered to be Early Paleocene ; the part in between, younger than the top of the Danian in Denmark and older than the base of the Lower Landenian (Tuffeau de Lincent) is considered to represent the Middle Paleocene.

2.3.2. MAASTRICHTIAN.

This stage has been erected by DUMONT (1849-1850) on sediments of the Pietersberg near Maastricht. Critical reviews of DUMONT's definition were given by VAN DER HEIDE (1954) and by MARLIERE (1957b, in Lex. strat. int.).

- Type locality :

The type section is in the ENCI quarry of the St. Pietersberg, (in the neighbourhood of Maastricht) which is presently classified as a monument. It shows the Tuffaceous Chalk of Maastricht in its various calcarenites (Ma, Mb, Mc, Md of the Dutch literature). VISSER (1951) listed the foraminifera of the type Maastrichtian ; a more extensive study was published by HOFKER (1966 e, and many earlier publications).

Upper Cretaceous planktonic foraminiferal index species have been recovered from below the base of the type-section, but the type-section itself is such a shallow water deposit that planktonic foraminifera are very scarce.

- Planktonic microfossils :

The planktonic foraminifera listed by HOFKER (1962, 1966 e) as *Globigerina daubjergensis*, other *Globigerina* spp. and *Globorotalia* spp. are probably small *Rugoglobigerina* spp. and partly benthonic foraminifera (cf. also BERGGREN, 1960).

In the Tuffaceous Chalk of Maastricht, not from the type locality, but from the Mechelen-aan-de-Maas well (at 330 m depth) at some 20 km north of the type locality, we found the same benthonic association as in the type locality, but here it was accompanied by the following planktonic genera and subgenera : *Globotruncana, Rugoglobigerina* (*Trinitella*), *Gublerina* (?), *Heterohelix* and *Globigerinelloides*, all indicating a Late Cretaceous Age (MOORKENS, 1971). It shows that the Tuffaceous Chalk of Maastricht is older than the base of the Danian in Denmark (Stevns Klint).

Typical Danian planktonic foraminifera were discovered in the Maastricht area, in the lithological unit overlying the Tuffaceous Chalk of Maastricht. The top of the Tuffaceous Chalk of Maastricht is characterized by a hardground. The more or less glauconitic sediment overlying this hardground and filling its "perforations" belongs to the lithological unit of the Calcarenite (= Tuffaceous Chalk) of Houthem. It has been designated with the symbol Me by HOFKER (1962, 1966 e and other publications). HOFKER (1956 f, 1966 e and MEIJER (1959) observed the following Danian planktonic foraminifera in the sections of Geulhem near Houthem (Curfs quarry) and of Vroenhoven (Albert Canal at km pole 23.800) ; *Globigerina* (vel *Globoconusa*) *daubjergensis, Globigerina* (vel *Subbotina*) *triloculinoides, Globorotalia pseudobulloides* and *Globorotalia compressa.*

The latter species indicates a Late Danian Age according to TROELSEN (1957), BERGGREN (1960) and HANSEN (1970 a, b).

In the Mechelen-aan-de-Maas well, we observed that the Calcarenites (= Tuffaceous Chalk) of Maastricht is also overlain by the Calcarenite (= Tuffaceous Chalk) of Houthem, which yielded *G.*

daubjergensis. Higher up in the well, this species is accompanied by *G. varianta, G. pseudobulloides, G. compressa, G. triloculinoides*, whereas the specimens of *G. daubjergensis* have larger dimensions than in the underlying deposits (MOORKENS, 1971).

2.3.3. DANIAN.

When erecting the Danian Stage, DESOR (1847) considered it to be the topmost Cretaceous. At the moment, most paleontologists place the Danian at the base of the Tertiary and Paleogene. The first author to publish this opinion was A. de GROSSOUVRE (1897). He had noticed that important groups of mesozoic fossils, e.g. the Ammonites and the Belemnites, became extinct before deposition of the sediments of the type Danian. The same break was later found to occur in other pelagic groups ; many genera and species of the planktonic foraminifera and of the calcareous nannoplankton flora also disappeared before Danian times. DESOR (loc. cit.) originally designated the deposits of Faxoe (also spelled Faks(e) or Fax(e) in the literature) as type for the Danian. He tentatively correlated them with the sections observed in the classical localities of Laversines and Vigny of the Paris basin.

- Type locality :

In the literature, Faxoe is generally considered the type section for the Middle Danian, and for the Danian in general, whereas Stevns Klint is generally referred to as the reference section for the Lower Danian.

- Planktonic microfossils :

TROELSEN (1957) and BERGGREN (1960 b, 1962 a) studied the distribution of planktonic foraminifera in the Danian deposits of Denmark. In 1955 TROELSEN had recognized the Late Maastrichtian Age of the deposits underlying the Danian in its type region, as he had recovered *Globotruncana contusa* below the lower boundary.

BANG (1962, 1969) also studied planktonic foraminifera of Danian deposits in Denmark and she gave the stratigraphic distribution of some planktonic species in the Størebaelt.
The fact that *Globorotalia compressa* occurs in the larger part of the succession, suggests that Lower (to Middle ?) Danian is missing in the Størebaelt sections. The local absence of *G. daubjergensis* (and/or *G. kozlowskii*) and *G. "danica"* BANG (a form which has still to be described by its author) in parts of the succession may be due to ecological conditions, or could indicate that the upper part of the carbonate sediments is of Post Danian Age.

HANSEN (1970 b) remarked that the species distribution of BANG is not readily to be compared with that of the more typical Danian, because correlation with the *Tylocidaris* Zonation is lacking. TROELSEN's zonation is therefore more valuable.

By means of biometric study, HANSEN (1970 a) furthermore investigated the idea expressed by HOFKER (1962, 1966) and confirmed by BERGGREN (1962 a, 1964) that evolutionary trends occur in the successive populations of *Globigerina daubjergensis* leading to the final "large stage", here called *G. kozlowskii* stage. The statistical investigations of HANSEN corroborated the existence of part of HOFKER's ideas, i.e. that a general trend of size increase occurs in successive population of *G. daubjergensis* during Danian and Post-Danian (Lower Selandian, Montian ?) times.

This trend enables an approximate correlation between the Danian and Lower Selandian of Denmark and the succession in the "Mons well 1969" of the Mons basin.

The calcareous nannoplankton of the main classical outcrops of the Danian in Denmark was analysed by PERCH-NIELSEN (1969) who confirmed the conclusions of BRAMLETTE & MARTINI (1964), that the Danian contains assemblages of the *Markalius astroporus* Zone and the *Cruciplacolithus tenuis* Zone.

2.3.4. MONTIAN.

The Tertiary age of the Calcaire de Mons, discovered and described by CORNET & BRIART (1865) had been known for some years when the term Montian was introduced by DEWALQUE (1868, p. 185). The Tertiary Age of these deposits had mainly been deduced from the mollusc assemblage.

Although the type locality and type stratum were unambiguously designated when the Montian concept was erected, its interpretation (mainly its upper and lower limit) varied widely amongst authors, as was reviewed by BERGGREN (1964).

Already in 1880, CORNET & BRIART expanded the original limits of the Montian by adding at the upper side the freshwater deposit, which is overlying the Calcaire de Mons in the central part of the Mons Basin, ("Calcaire lacustre à *Physa*" discribed in 1877 a), and below, the lithologic unit underlying the Calcaire de Mons, which was called the "Calcaire de Cuesmes à grands Cérithes "by CORNET & BRIART, (1877 b).

At that time, the Tuffeau de Ciply was still considered to belong to the Maastrichtian ; this erroneous idea was mainly based on reworked Upper Cretaceous fossils found at the base of the Tuffeau de Ciply in the so-called "Poudingue de la Malogne", which is the basal conglomerate of the Tuffeau de Ciply.

The Tertiary age of the latter deposit was first recognized by RUTOT & VAN DEN BROECK (1885 a, b, 1886 a, c) who had carefully studied the lithology and the molluscs of the outcrop sections in Ciply and Cuesmes. These authors also included the Tuffeau de Ciply in the Montian. However, the Danian Age of the Tuffeau de Ciply has been proved several years later ; RASMUSSEN (1962, 1965) claimed the Tuffeau de Ciply to be of Danian age because of certain index species in the megafossil content. LOEBLICH & TAPPAN (1957 b) recovered *Globigerinoides daubjergensis, Globorotalia pseudobulloides* and *Globigerina triloculinoides* from the type section of the Tuffeau de Ciply, thus confirming the Danian Age.

The most accurate age determination of the Tuffeau de Ciply in its type locality, is that of MEIJER (1969) who recovered, in addition to the above-cited planktonic foraminifera, also *Globorotalia compressa* (PLUMMER) which indicates a Late Danian Age, as this species seems to be restricted to the *Tylocidaris vexilifera* Zone of the Upper Danian of Denmark, according to TROELSEN (1957), BERGGREN (1960 b, 1962a) and HANSEN (1970 b, p. 25).

MARLIERE (1957 a, 1958) was the first to present a paleontological zonation of the Montian in the sense of that time, i.e. including the Tuffeau de Ciply, based on ostracod assemblages. At Mons, in the well of the Ecole des Mines, three zones were found superposed :

(3) - Upper Zone with *Triginglymus* ; this faunal assemblage was also recorded from the Calcaire de Mons in the stratotype of the Montian of the Puits Goffint.

(2) - Middle Zone with *Cytheretta.*

(1) - Lower Zone with *Cytherelloidea* ; the latter faunal assemblage has also been found in the Tuffeau de Ciply, sampled at its locality where we know the sediments to be of Late Danian Age (see above).

There is a possibility that this succession has no chronostratigraphic value (except within the Mons basin). Because the ostracod assemblages are probably environment-bound, their areal and vertical distribution may have been influenced by local changes in ecological conditions. For instance a partial transgression and/or regression may have caused the migration of these assemblages.

The foraminifera of the Tuffeau de Ciply, and of some scattered samples of the Calcaire de Mons (from the Puits Goffint, and from the neighbouring Puits Coppée) have partly been determined and/or pictured by MARIE (1964). He gave good figures of a number of characteristic benthonic species from the Puits Coppée. Unfortunately, he gave no description of his "new species" among the fossils. Although his figures are very clear the new names are to be considered *nomina nuda.* For one of them a description is given in our systematic discussion.

HOFKER (1959 a, 1961 a, 1962, 1966 e) described foraminifera from the Tuffeau de Ciply and the Calcaire de Mons (from samples of the Puits Coppée) with some schematic pictures. The fact that the microfossils are generally strongly recrystallized, probably explains why some benthonic forms belonging to *Pararotalia globigeriniformis* (several keeled and non keeled, truncate and non truncate varieties) and to *Eponides toulmini - robaszynskii* (some varieties) were erroneously determined as species of *Globorotalia.*

POZARYSKA (1965, 1966) listed some species from the Calcaire de Mons and of the Tuffeau de Ciply in her descriptions of the analogous faunal assemblages of the Post-Danian ("Montian") of Poland, which was mainly derived from the Pamietowo well.

POZARYSKA & SZCZECHURA (1968) discussed the distribution of Paleocene faunal communities of NW and W Europe. The migration of "Warmer water foraminiferal faunas" and the probable climatic changes (on world scale) which possibly caused those migrations, were discussed by these authors. Similar migrations had been suggested before by VAN BELLEN (1946 a) on the base of assemblages this author recovered in the Bunde wells.

VAN BELLEN (1946 a) had erroneously determined the Bunde fauna to be of Middle Eocene Age ; his mistake is to be explained by the fact that foraminifera of the Montian stratotype had not yet been described at that time. Description of Paleocene faunas from Poland and Germany, as well as from Ukraine and Crimea are all of a later date.

MARIE (1947) immediately recognized the Paleocene ("Montian") Age of the fauna from the Bunde wells. Later HOFKER (1966e) reviewed and corrected VAN BELLEN's determinations and descriptions and equated the Bunde fauna with that of the Calcaire de Mons, sampled in the Puits Coppée, and with another fauna of the Maurits III mine shaft of the Netherlands Limburg, placing all these assemblages in the R-Zone of his letter zonation.

For local correlations, we think that the foraminiferal assemblage, characteristic of HOFKER's R-Zone is certainly practical, but the absence of that peculiar fauna in the Danish Paleocene does not prove that sediments of the same age are missing in the latter succession. This fauna of the Calcaire de Mons probably depended on special environmental conditions, possibly those of warm shallow water, rich in calcareous material, suggested by the rich calcareous foraminiferal content and the calcarenitic sediment.

- Type locality :

In his definition of the stage, DEWALQUE (1868) referred to the Calcaire de Mons described by CORNET & BRIART (1865) from the Puits Goffint (= Goffin), a pit at Obourg, near Mons, in the central part of the Mons basin.

The Montian is unambiguously based on the uppermost interval of the Calcaire de Mons in the Puits Goffint. According to MARLIERE (personal communication) the Calcaire de Mons had been observed in the puits Goffint between 6,85 m depth and the base of the pit. Some 14,5 m of calcarenitic sediments had there been penetrated.

Unfortunately, the material has been accessible during a very short time only and a few samples, without exact depth indication were afterwards available at the "Faculté Polytechnique de Mons". From the neighbouring pit (the Puits Coppée) some more material was available, but this material was not sufficient to study the macrofauna and microfauna of the Calcaire de Mons in this reference section.

The recent "Mons well 1969" (originally called "Obourg well" was drilled to obtain new and better material.

This well, drilled at a distance of 14 m approximately at the south of the Puits Goffint, went deeper than the original pit, in order to observe the strata underlying the Calcaire de Mons. The well reached the top of the Cretaceous (Lowermost Maastrichtian) at a depth of 80 m below the topographic level. Hence, Lower Tertiary calcarenites - here called "Obourg calcarenites" (partly belonging to a probably not yet named lithologic unit) (1) were found beneath the Montian stratotype, and overlying the lowermost Maastrichtian chalk.

- Planktonic foraminifera :

The only group of planktonic microfossils mentionned so far in the literature from the Montian stratotype and from the type section of the Tuffeau de Ciply, is that of the planktonic foraminifera. Unfortunately, some of the forms probably refer to incorrectly determined benthonic species.

HOFKER(1961 a) listed, at first without pictures, later (1962, 1966 e) with some schematic drawings, a number of planktonic foraminifera of stratigraphic value. His *Globorotalia pseudomenardii* is probably a flat, keeled *Pararotalia* species. From the uppermost samples of the Tuffeau de Ciply (CA 25), we recovered similar specimens easily to be mistaken for *G. pseudomenardii*, but distinguishable from *Globorotalia* by the calcareous plug in the umbilicus, indicating more affinity to *Pararotalia* and related forms than to the Globigerinacea.

MEIJER (1969) came to the conclusion that HOFKER (1962, 1966 e) had most likely mistaken another benthonic species belonging to *Epistominella (Pseudoparrella)* for *Globorotalia pusilla laevigata.*

It is probable that also EL-NAGGAR (1969 a) mistook benthonic species for planktonic ones, as we found none of the species he listed, in our material from the same localities.

2.3.5. HEERSIAN.

In 1851, DUMONT divided the Landenian Stage (which was created in 1839) into two parts. The lower part was the new Heersian Stage, whereas the upper part was referred to as Landenian s.s.

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(1) After completion of this text, Prof. MARLIERE kindly informed me that it is now called the "Couches de Ghlin" (GODFRIAUX & MARLIERE, in press). Our term "Obourg calcarenites" had not been intended as a formal name of a rock unit.

- Type locality :

The author of the Heersian Stage did not indicate a precise section in the field which should be considered the type section.

As was usual in DUMONT's notes, the new concept was characterized by a lithological unit. The Heersian was thus characterized by the Marls of Gelinden. The village Gelinden is situated close to Heers, and the classical, abandoned quarry of Mr. Thewis in the hamlet of Overbroek is now generally considered to be the type locality of the Marls of Gelinden and at the same time the stratotype of the Heersian Stage (cf. de HEINZELIN & GLIBERT, 1957 *in* Lex. Strat. Int.).

- Paleontology :

According to LERICHE (1912) the Heersian is characterized by the presence of *Cyprina morrisi*, and the absence of *Pholadomya oblitterata (= P. koninckı)* and *Cyprina scutellaria*, which pelecypods are indicative for the younger, Landenian (s.s.) deposits.

Furthermore, rich paleobotanical remains, were described by SAPORTA & MARION in 1878, from the Marls of Gelinden.

- Planktonic microfossils :

EL-NAGGAR (1967 c, 1969 a) listed some planktonic foraminiferal species from Overbroek. He claimed that the"flooding of *Globorotalia inconstans* (SUBBOTINA)" showed the Middle Paleocene Age of the Heersian stratotype. In terms of planktonic foraminiferal zonations he identifies the type Heersian with the *G. inconstans* Zone, which he thinks to be a lateral equivalent of the *G. angulata* Zone. However, his *Globorotalia inconstans* is very probably a misidentified *Gyroidinoides voluptus* HAYNES, a benthonic species with granular calcitic wall, originally described from the type Thanetian. At first sight some specimens of this species resemble planktonic foraminifera, as the chambers are generally globose.

The calcareous nannoplankton of the type Heersian has not been investigated, but in some preparations we observed a nannoplankton flora, in which reworked Upper Cretaceous (Campanian - Maastrichtian) species are prevailing (work in collaboration with P. CEPEK). Yet, some rare Tertiary forms will provide, in future, an accurate means for correlating the type Heersian with the nannoplankton zonation.

2.3.6. LANDENIAN.

DUMONT erected the Landenian Stage in 1839, defining it by the continental deposits of the Lignites (or Sands) of Landen.

Later, this Landenian (s.l.) was subdivided into Ypresian (DUMONT, 1849), Landenian s.s. and Heersian (DUMONT, 1851).

The first stage corresponds to the upper part of the earlier Landenian concept, wheras the third chronostratigraphic concept equals the lowermost part of the earlier Landenian (s.l.) Stage.

The remaining middle part of the Landenian (s.l.) was defined again as Landenian s.s;

- Type locality :

DUMONT did not indicate a type section for the Landenian.

The continental Lignites (or Sands) of Landen were cited as a characteristic lithologic unit and the type section of this lithologic unit is still to be seen in Landen. It is the section of the abandoned quarry Frisson (C F), close to the station of Landen. This stratotype unfortunately refers to continental deposits only, which did not yield any useful fossils to localize this section in the biozonations of planktonic microfossils.

In this locality of Landen, the Lower Landenian (= so-called "marine Landenian") was reached by some shallow wells of less than 10 m.

These underlying marine deposits were studied from some outcrops in the neighbourhood of Landen and they yielded a foraminiferal assemblage which shows strong affinities with the microfauna of the Thanetian of Kent, in Great Britain.

- Planktonic microfossils :

Planktonic foraminifera occur in some samples of the marine (= Lower) Landenian of eastern Belgium, although they are rare ; the recovered forms are generally small nonkeeled *Globorotalia* species. Keeled *Globorotalia*'s, which are indicative for the planktonic foraminiferal zonations in tropic, subtropic and warm temperate regions, are lacking. EL-NAGGAR (1967 c, 1969 a) listed some planktonic foraminiferal species, and claimed that the occurrence of "*Globorotalia eocaenica* TERQUEM", as figured by SUBBOTINA (1953), is characteristic. (1).

The calcareous nannoplankton of the marine (= Lower) Landenian has not yet been studied from outcrops of the neighbourhood of Landen. From the Mechelen-aan-de-Maas well MARTINI studied some samples, and he found (personal communication) an assemblage of the *Heliolithus riedeli* Zone from a sample near the base of the Lower Landen Formation at 220 m depth. Assemblages of the same zone had earlier been recorded from the type Thanetian by BRAMLETTE & SULLIVAN (1961), and later by HAY & MOHLER (1967). Thus it is likely that the marine Lower Landenian may be correlated with the Thanetian. P. CEPEK (personal communication) recovered an analoguous assemblage in the Lower Landenian neostratotype at Wansin (WA).

2.3.7. THANETIAN.

This chronostratigraphic unit has been defined by RENEVIER (1873). The definition was based on that of the lithologic unit of the Thanet Sands (PRESTWICH, 1852, cf. Lex. Strat. Int. 1958, 1, 3 a XII).

- Type locality :

The Thanet Sands are outcropping along the coast of Kent, at Ramsgate. At the moment this locality is generally considered to be the stratotype of the Thanetian Stage.

- Paleontology :

The foraminifera of the Thanet Sands, the Pegwell Marls, and the Reculver Silts have been described from Pegwell Bay and from Reculver by BURROWS & HOLLAND, 1897 ; HAYNES, 1954, 1955, 1956, 1958 a, b, c ; WOOD & HAYNES, 1957.

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(1) Probably the misidentified benthonic, *Allomorphina halli* BROTZEN.

- Planktonic microfossils :

Planktonic foraminifera have been described for the first time by HAYNES (1955, 1956). The fact, however, that part of the forms is reworked, was observed later. LUTERBACHER & PREMOLI-SILVA (1964) were the first to claim that the specimen, determined as *Globorotalia velascoensis* by HAYNES, actually was a reworked, probably single keeled, *Globotruncana.* The fact that several planktonic foraminifera recovered from the type Thanetian, actually were reworked Upper Cretaceous forms, was also stated by HAYNES & EL-NAGGAR (1964) and by BARR & BERGGREN (1965).

Some Tertiary forms, however, do occur, but it is difficult to make out which of these forms are in place and which of them have been reworked, as was stated by EL-NAGGAR (1967 b, 1969 a).

The calcareous nannoplankton, however, allows to correlate the type Thanetian more precisely with its zonation. BRAMLETTE & SULLIVAN (1961) and later HAY & MOHLER (1967) recovered an assemblage of the *Heliolithus riedeli* Zone from the type Thanetian.

2.3.8. EYSDENIAN.

For the sake of completeness, we also mention the abandoned chronostratigraphic concept Eysdenian, which once was used to designate some Belgian Paleocene deposits.

This term was used for the first time by STAINIER (1931), but it was refuted by HALET (1932), because he considered it to be a lateral equivalent of the "continental" (= Upper) Montian.

- Type locality :

In the mine shaft n° 2 of Eisden (= Eysden), in eastern Belgium, the interval between 210 m and 231 m depth below topographic level was given as type of the stage.

This stratotype overlies sediments of (Upper ?) Danian Age and it is overlain by sediments of Heersian Age.

- Paleontology :

The author of the Eysdenian Stage did not give any paleontological arguments to prove that it was of different age than Danian, Heersian or Montian.

The study of the molluscs of the Eysdenian in its type section by VINCENT (1930 a), prior to STAINIER's (1931) note, lead VINCENT to the conclusion that these sediments (his Couches à Cyrènes du Paléocène du Limbourg) should be regarded as of Heersian Age, notwithstanding the fact that they are underlying sediments, which lithostratigraphically may be correlated with the basal layers of the Heers Formation in the type area, i.e. the Sands of Orp-le-Grand.

HALET prefers to follow STAINIER in his correlation of the sediments between 210 m and 231 m in the Eisden Mine shaft n° 2 with the "continental Montian" of the Mons basin, but he disagrees with that author in that they deserve a new chronostratigraphical term. According to HALET, the paleontological arguments are not sufficient, and in his opinion the type locality of a new stage should at least yield fully marine fossils, the geographical distribution of which would allow correlations over long distances. Hence, fresh water to brackish deposits yielding amongst others abundant *Cyrena* specimens are inadequate for a new stage.

3. LOCALITY DETAILS

Only those Paleocene localities are described, which either may be compared with parts of the "Mons well 1969", which have been correlated earlier with the Tuffeau de Ciply or the Calcaire de Mons, or which are being considered in the stratigraphic discussion. The two main regions to be reviewed, are the Mons basin and NE Belgium (together with the adjacent area in the SE Netherlands). (fig. 1, 2, 7, 8).

3.1. THE MONS BASIN.

The type section of the Tuffeau de Ciply and that of the Calcaire de Mons are to be found in the so-called Cuve de Mons (fig. 2) (cf. also MARLIERE, 1964 a, 1969). The only existing outcrop of the Calcaire de Mons farther west, the socalled Tranchée de Hainin, at 13 km west of Mons, is to be found in the Cuve de St. Ghislain, the middle synclinal structure.

The succession of stratigraphic units of the Lower Tertiary and Upper Cretaceous of Mons and its neighbourhood is given in an approximately S-N oriented cross section (fig. 3 a-b). It shows the type sections of the Tuffeau de Ciply, SW of Mons, and the classical sections of the Calcaire de Mons in wells NE of Mons. In some wells in the town of Mons, e.g. the well of the Ecole des Mines (E.M.), both lithologic units have been observed superposed with possibly a transitional layer in between.

The cross section of the Mons basin, across the town of Mons, has been published several times with minor consecutive corrections because of the sections observed in new wells in the Mons basin (e.g. CORNET & BRIART, 1866 a, f. 1 ; F.L. CORNET, 1886, f. 1 ; J. CORNET, 1927, p. 86, f. 17 ; MARLIERE e.g. *in* GULINCK & VAN VOORTHUYSEN, 1961). The earlier correlations of this section were based on a combination of lithological and some paleontological data ; the later ones were mainly based on molluscs and ostracods.

The figures of MARLIERE (1958, 1961) are given in our fig. 3 a, b ; the stratigraphic interpretation based on the foraminiferal assemblages of the Mons well 1969 has been added. According to MARLIERE (1957, 1962, 1964 a) the Calcaire de Mons has been recorded as overlying the Tuffeau de Ciply.

Lithological correlations and those based on ostracod faunas have suggested a superposition of these units with a gradual transition in lithology in between, e.g. in the well of the Ecole des Mines. These transitional strata may possibly be equated with the Calcaire (à grands Cérithes) de Cuesmes.

However, it is theoretically possible that at least the upper part of the Tuffeau de Ciply is a lateral equivalent of the lower part of the Calcarenite sequence in the "Mons well 1969" at Obourg. Such a conclusion would be permissable from the distribution of the planktonic foraminifera.

The difference of lithology is no doubt the result of different conditions of deposition. Provided that the shallower Calcaire de Mons environment gradually spread from north to south, this caused the Tuffeau de Ciply to be overlain by the Calcaire de Mons, e.g. in the Ecole des Mines well (cf. fig. 3b).

It is important to remind that the fact, that some benthonic foraminifera are restricted to the Calcaire de Mons everywhere in the Mons Basin, never having been recovered from the Tuffeau de Ciply, does not give them a definite chronostratrigraphic value. Their restriction to the Calcaire de Mons may be linked to special ecological conditions which possibly did not occur in the environment of deposition of the Tuffeau de Ciply. Such environment-bound occurrence may also be true for other benthonic organisms, such as molluscs, ostracods, and bryozoans. Therefore, it is preferable to base chrono-stratigraphic correlations primarily on planktonic microfossils from which we may be able to conclude

whether the stratigraphic distribution of some other groups, such as the benthonic foraminifera has a time value or not.

3.3.1. CIPLY, CARRIÈRE ANDRÉ (CA).

The location of the abandoned quarries in Hyon-Ciply (called Carrière Caillaux, or Carrière Bernard, or Carrière des Gaillies, a.s.o.), presently belonging to Dr. VAN DAMME, are shown in fig. 2. The Carrière André shows the type section of the Tuffeau de Ciply. (A type section for that rock unit had not been formally suggested before, but is here considered most logic).

We sampled two sections in these quarries during the autumn of 1964 and spring of 1966 and of 1970. The section in the northern part of the quarry has since then been covered with rubble.

The section CA is located in the northern part of the quarries (which has since been filled). The ostracods of this section were previously studied by MARLIERE (1958) and the planktonic foraminifera were listed by MEIJER (1969). The upper part of the Tuffeau de Ciply (about 18 m) was sampled in 1966. It shows the basal part of the Tuffeau de Ciply, which disconformably overlies various units of the uppermost Cretaceous (Maastrichtian).

The base of the Tuffeau de Ciply is formed by a conglomerate, the Poudingue de la Malogne, resting transgressively on the hardground at the top of various Cretaceous deposits.

As a small augerboring showed this hardground to lie some 5 to 6 m below the base of section CA a, it follows that the sections CA a and CA b approximately supplement each other, so that probably the full thickness of the Tuffeau de Ciply was sampled in this locality. The section was sampled nearly every 50 cm (cf. fig. 4), with some samples taken in between.
The various lithostratigraphic units of the Carrière André are from top to bottom :

- Tuffeau de Ciply : A rather coarse grained, white, locally yellowish, calcarenite ; microfossils are strongly recrystallized ; local thickness of this unit may reach some 24 m.

- Poudingue de la Malogne : Thin basal conglomerate (20 to 50 cm thick) of the Tuffeau de Ciply, yielding phosphate nodules and reworked Upper Cretaceous megafossils and microfossils.

- Hardground : Hardened layer of maximally 40 cm thickness (sometimes with holes of dissolved particles of 1-2 cm diameter) forming the truncated top of several tilted Upper Cretaceous lithologic units, some of which wedge out from north to south.

- Tuffeau de St. Symphorien : Brown, coarse-grained calcarenite, containing some phosphate concretions ; a lot of megafossils occur. This unit overlies the Craie de Ciply ; il wedges out in the quarries. The rock unit is less than 1 m thick in the sampled section CA c.

- Craie (phosphatée) de Ciply : Grey to sometimes brownish chalk, with minute phosphatic concretions of brown colour. The contact of this member with the underlying unit, the Craie de Spiennes is accompanied by brown, "rootlike perforations" (French : "racines"), which extend into the top of the underlying unit.

- Craie de Spiennes : White to yellowish medium grained chalk, not very coherent ; the base of this unit was not observed in this quarry.

- Craie de Nouvelles : Fine, pure, white chalk, locally hardened to a micritic fine-grained limestone. This unit is only to be seen in the most southern part of the quarry, where its high occurrence is due to a fault

directed NW - SE.
The megafossil *Magas pumilus* has been recorded here from this layer.

3.1.2. CIPLY, CARRIÈRE LIÉNARD (LI).

The location of this abandoned quarry, lying in the neighbourhood of the previous one, is given in fig. 2. Some sections were sampled in December, 1963 and January, 1964. From these sections only the one showing 8 m of the Tuffeau de Ciply is of importance for the present investigation (LI a). The base of the Tuffeau de Ciply is formed by the Poudingue de la Malogne, which overlies a hardground at the top of the Craie (phosphatée) de Ciply, which is similar to the one observed in Carrière André (CA b). The section was sampled every 50 cm (cf. fig. 5).

Lithology : The lithology of the units is about the same as that in the neignbouring CA quarry.

- Tuffeau de Ciply : A yellow coarse calcarenite ; microfossils and megafossils generally strongly recrystallized.

- Poudingue de la Malogne : Thin conglomerate (20 to 30 cm thickness) in hardened limestone, containing frequent reworked Upper Cretaceous megafossils ; it overlies the local hardground which forms the top of Upper Cretaceous deposits.

- Hardground : Hardened layer with large holes, local thickness 30 to 50 cm.

- Craie (phosphatée) de Ciply : Grey to yellowish, rather coarse-grained chalk with relatively high phosphate content.
  Belemnites and other Upper Cretaceous megafossils are quite frequent.

3.1.3. OBOURG, PUITS GOFFINT (GOF) AND PUITS COPPÉE (COP).

CORNET & BRIART (1865, 1866 a) described the sediments and listed some fossils of the Calcaire de Mons from both pits. The Puits Goffint showed some fourteen metres approximately of Calcaire de Mons below the younger Paleocene and Quaternary sediments. The abrupt lithological change between the Calcaire de Mons, and the glauconitic Sands (possibly a lateral equivalent of the Tuffeau d'Angres, considered Upper Paleocene, marine Landenian) points out that the top of the Calcaire de Mons and possibly continental deposits overlying it (as observed in wells in the central part of the Mons basin) were eroded here before the Landenian transgression.

In the Puits Coppée, lying some 50 m east of the Puits Goffint, the top of the Calcaire de Mons was reached at a depth of 3.50 m ; 21.50 m of Calcaire de Mons were observed.

At that time the thickness of the Calcaire de Mons was unknown, as the base had not been reached in any outcrop or well.

The location of both pits is given in fig. 2. The 14.50 m of Calcaire de Mons observed in the Puits Goffint form the type section of the Calcaire de Mons. DEWALQUE (1868) designated the same section as stratotype of the Montian Stage.

Lithology : The Paleocene deposits consist of :

- Glauconiferous decalcified sands, possibly a lateral equivalent of the Tuffeau d'Angres (MARLIERE, personal communication).

- Calcaire de Mons : Coarse-grained ("calcaire grossier"), yellow to reddish calcarenite, in some places indurated. Very fossiliferous in foraminifera and locally in molluscs, bryozoans and ostracods. The porosity of the rock may be quite large due to the coarse sedimentary grains and abundant shell material. Studied samples come from the collection of the Faculté Polytechnique de Mons. They are from the Calcaire de Mons, without depth indications.

3.1.4. OBOURG, "SONDAGE DE MONS, 1969" (= SONDAGE D'OBOURG, = MONS WELL 1969, = OBOURG WELL) (OB).

The recently drilled well, entirely cored ("Mons well 1969", previously called "Obourg well"), provided samples of the Calcaire de Mons very near to its type section (distance approximately 14 m) and thus undoubtedly from the Montian stratotype. Furthermore, material of underlying strata of the Tertiary and lower down from the Upper Cretaceous was sampled.

Foraminifera were studied from 53 samples of this well.

Lithology : The lithology of the section may be summarized as follows. (depths are given below topographic level). The samples are located on the distribution chart, table 1.

(3) Interval between 0 level and 11.60 m : Quaternary and Upper Paleocene sediment, the latter are clayey glauconitic sands, forming possibly a lateral equivalent of the Tuffeau d'Angres (?).

Only the lowermost sample of this interval, OB 11.60 m was analysed ; the foraminifera are strongly corroded and are considered to be reworked from the (underlying) Calcaire de Mons.

(2) Interval between 12 m and 80 m : In the upper part of this interval, the Calcaire de Mons is recognizable as a coarse grained calcarenite of yellow colour, yielding abundant benthonic foraminifera with thick calcareous recrystallized tests. Lower down in this succession, the sediment gradually changes to a more fine-grained whitish-bluish calcarenite.
Some very hard calcareous concretions occur, as well as flint. The foraminiferal fauna is somewhat poorer both in number of specimens and of species. All tests are very strongly recrystallized.

The lowermost sample (80 m) yields a Tertiary foraminiferal assemblage identical to that of the overlying samples, but Upper Cretaceous (Lower Maastrichtian) reworked (greyish) foraminifera are quite frequent. (see Table 1).

(1) Below 80 m depth : White chalk was recovered belonging to the Craie de Spiennes. Only one sample was analysed from 83 m. The foraminifera indicate an Early Maastrichtian Age.

3.1.5. MONS, SONDAGE DE L'ECOLE DES MINES (EM).

This well was drilled in 1903. Its lithology was described by CORNET in 1907. Its location is given in fig. 2.

The ostracods have been described in detail by MARLIERE (1958), who established a zonation for the Danian - Montian interval of this well.

This well is important as it shows a superposition of the Calcaire de Mons overlying the Tuffeau de Ciply. The base of the Tertiary is formed by a fine calcarenite showing close ressemblance in lithological characteristics with the Tuffeau de Ciply. Moreover, the ostracods of this interval, analysed

by MARLIERE, show a good relationship with the assemblage found in the type section of the Tuffeau de Ciply (*Cytherelloidea* Zone). Upwards in the succession, the lithology gradually changes, and calcarenites become somewhat coarser. The ostracod fauna is characterized by the abundance of another genus, *Cytheretta.* These sediments seem to be transitional to those of the Calcaire de Mons ; they may possibly be equated with the Calcaire (à grands Cérithes) de Cuesmes and with the lower part of the calcarenite sequence in the "Mons well 1969".

Higher up in the succession, the sediment gradually changes into a coarser calcarenite which reminds of the Calcaire de Mons in its type section. Also the ostracod assemblage changes gradually going upward in the succession. In this higher interval, the assemblage is characterized by the abundance of the genus *Triginglymus.* A similar ostracod association has been found in some samples from the Calcaire de Mons at its type locality (Puits Goffint).

Referring to the well of the Ecole des Mines, POZARYSKA (1966) gave a chart of the foraminiferal distribution in nine samples, which she compared with the foraminiferal assemblage of the Tuffeau de Ciply in its type section. Most of the foraminiferal species seem to range through the different ostracod zones of this well.

Lithology : According to the original description of CORNET (1907).

0 to 4 m : Rubble.
4 to 6.5 m : Sands of Mons-en-Pévèle : upper part of Formation of Ieper (= Ypres).
6.5 m to 26.70 m : Clay of Ieper (= Ypres) , lower part of formation of Ieper, the latter two rock units are of Early Eocene Age (Ypresian).
26.70 m to 61.60 m : (Possibly Tuffeau d'Angres ?) ; glauconiferous marine calcareous clayey sands, decalcified in the upper part of this interval (Landenian).

61.60 m to 69 m : Marls of the Paternostre well ; the definition of this rock unit is given in a footnote on page 28 (Upper Middle or Lower Upper Paleocene).
69 m to 151.25 m : limestones and calcarenites.
The upper part (69 m to 73.50 m) corresponds probably to the Calcaire de Mons (a lateral equivalent of that rock unit) in the Puits Goffint.
The lower part (73.50 m to 151.25 m) is mainly grey - bluish and finely calcarenitic (= "tuffeau" in the original sense). Hence, it resembles the sediment of the interval between 50 m and 80 m depth in the "Mons well 1969".
151.25 m to 157 m : Tuffeau de St. Symphorien ; calcarenite with Maastrichtian macrofauna and some small phosphatic accretions.
157 m to 160 m : Craie phosphatée de Ciply : calcarenite with some small accretions.
160 m to 170 m (T.D.) : Craie de Spiennes ; white chalk. (Lower Maastrichtian).

3.1.6. MONS, THE LABOR WELL (LA).

This well was drilled for the brewery Labor in 1950 ; its location is indicated in fig. 2. The lithology was described by R. Legrand (notes of 1951, in the archives of the Geol. Survey of Belgium, Brussels).

Eleven out of 24 samples studied from the Paleocene part of this well, were found to contain foraminifera.

Lithology : (depths are given below topographic level).

0 m to 5 m : fluvial Quaternary deposits.

5 m to 20 m : Sands of Mons-en-Pévèle ; upper part of the Ieper Formation (Lower Eocene, Ypresian).

20 m to 35 m : Clays of Ieper ; Lower part of the Ieper Formation (Lower Eocene, Ypresian).

35 m to 55 m : Lignitic Sands of Erquelinnes ; (probably a lateral equivalent of the Lignites of Landen), upper part of the Landen Formation, continental deposits (Upp. Paleocene).

55 m to 82 m : Tuffeau d'Angres (?) or a lateral equivalent ; lower part of the Landen Formation, marine glauconiferous sands.

82 m to 90 m : Marls of the Paternostre well ; the sediments of this interval consist of dark glauconiferous marls, yielding quartz grains, pyrite, particles of flint, and reworked calcarenite fragments. This lithologic unit has no name in the literature. Generally it has been referred to as "Heersian" or "infra - Landenian", names which suggest an age but which do not define a rock unit. Here we shall call these sediments the "Marls of the Paternostre well" (1), because they were for the first time observed and extensively described from that well.

The interval between 90 m and 110 m has not been sampled and it is unknown to which rock unit these sediments belong.

110 m to 150 m : Calcareous deposits of continental origin, probably belonging to the Calcaire lacustre à *Physa*, the rock unit which has its type section in the Tranchée de Hainin (see TH). Charophytes and fresh water molluscs belonging to the genus *Physa* indicate the continental character of this deposit.

150 m to 170 m : Calcaire (grossier) de Mons ; calcarenites with abundant thick-shelled foraminifera ; the foraminifera are badly preserved and strongly recrystallized.

170 m to 186 m : Tuffeau de St. Symphorien ; a coarse fossiliferous calcarenite.

3.1.7. HAININ, TRANCHÉE DE HAININ (TH).

This outcrop is to be found in the Cuve de St. Ghislain, at the station of Hainin (Railway line Mons-Quiévrain), some 13 km west of Mons. The location is indicated in fig. 1.

The first to figure this section was DUMONT in his unpublished notes of 1848. In a schematic drawing the succession of the layers was shown. The only error of this drawing is the age given to the calcarenite which DUMONT thought to be of Maastrichtian Age, but which was later proved to be of younger age (Paleocene).

A quite different drawing was given later by CORNET & BRIART (1866), but it was found to be erroneous by RUTOT (1886) who gave an accurate account of the measured section (op. cit. p. 128) and a correlation with a shallow well in the neighbourhood.

(1) Type section of this new rock unit : Interval between 57 m and 70 m below totpographic level in the Paternostre well at Mons. Descriptions of the sediments in this well were given by CORNET (1907), and by MARLIERE (1958, 1969). The location was given by MARLIERE (1969, p. 55 and fig. 2, point 1). Samples of this rock unit in its type section were stored and partly analysed in the geological collection of the "Ecole des Mines" (Fac. Polytechn. de Mons, Belgium). The age of this rock unit is not known with certainty. Its foraminiferal assemblage mainly consists of benthonic forms which are known from the Heers Formation (e.g. the type Heersian) and the Landen Formation (e.g. the Tuffeau de Lincent at Wansin) in Eastern Belgium. Other groups of fossils are needed, to decide whether the age is Heersian or Landenian s.s. (= Thanetian). According to MARLIERE the molluscs of the section in the Paternostre well determined by RUTOT and VINCENT, would indicate a Heersian Age.

As during the last years, the outcrop has been covered by vegetation, we needed RUTOT's data to sample the section in detail. Samples were taken in a series of augerborings all of approx. 1 m depth, directed horizontally in the outcrop section. All borings were placed 1.70 m above the level of the rails in the southern side of the railway cut. These samples were taken on April 29, 1967. The section is pictured in fig. 6.

Lithology : The layers are all dipping to the east. The following lithologic units were encountered :

(5) Tuffeau d'Angres (?) or a lateral equivalent : Glauconiferous, dark, clayey sands, at least partly decalcified. Some reworked Upper Cretaceous planktonic foraminifera occur.

(4) A grey-brown to black clay, probably of continental origin. This lithologic unit has not yet been named separately in the literature as these sediments are generally included together with the underlying continental limestone in the so-called "Montien continental". The latter name however, is misleading as it indicates an age instead of a rock unit.

(3) Calcaire lacustre à *Physa* : This rock unit was named by le HARDY de BEAULIEU, in 1861. The type locality of this unit is possibly the here described outcrop, or an outcrop in the immediate neighbourhood. A soft fresh-water limestone (*Physa*) probably of Middle Paleocene Age, containing Charophytes.

(2) Calcaire de Mons : yellow to whitish, coarse-grained calcarenite to soft limestone, very rich in strongly recrystallized foraminifera. The facies as well as the foraminiferal assemblage (e.g. *Scarificatina reinholdi*) show much more affinity with the Calcaire de Mons in its type section than with the Tuffeau de Ciply in its type locality, but the lower part of the section is according to foraminifera, probably older than the Calcaire de Mons. This last statement is in agreement with ostracod results. (MARLIERE, personal communication).

(1) Fine-grained white chalk, belonging to the Craie de Trivières (or Craie de St. Vaast). The age of this deposits is Middle to Early Senonian (approximately Early Campanian or possibly Late Santonian) according to MOORKENS (1969, pp. 443, 444, 457). We now believe that an Early Campanian Age of this microfauna is most probable.

3.2. NE BELGIUM AND SE NETHERLANDS.

The location of the outcrops and wells, discussed hereafter, is shown in fig. 7, 8.

This area has to be taken into consideration too, for the stratigraphic discussion concerning the "Mons well 1969", as it is possible that the succession of Paleocene sediments in this area is more complete than that observed in the Mons basin.

There is, however, no continuous marine succession of the Paleocene in this region. Between the Tuffaceous Chalk of Maastricht (typical for the Maastrichtian in its stratotype) and the Formation of Heers (which typifies the Heersian in its stratotype), there are layers which may be correlated with the Tuffeau de Ciply or with the Calcaire de Mons of the Mons basin.

Unfortunately, only in one locality both microfaunal assemblages occur clearly in superposition, i.e. in the Maurits III mine shaft. In part of the other localities it appears that the younger assemblage, which shows affinities with that of the Calcaire de Mons, is missing, possibly due to erosion, or to the lack of samples (Mechelen-aan-de-Maas well).

Other outcrops or wells do not reach deep enough to show the older assemblage with affinities to that of the Tuffeau de Ciply (Bunde wells, Vroenhoven outcrop).

3.2.1. BUNDE, THE BUNDE WELLS.

VAN BELLEN (1946 a) described the foraminiferal fauna of the Bunde Kalk in four wells in the neighbourhood of Bunde, a village in Dutch Limburg. Most of his species had at that time not yet been recovered from western European Paleocene deposits. Some of the species showed affinities to Paleocene foraminifera of Cuba, and some others had been observed from the Lutetian of the Paris basin only.

As VAN BELLEN did not know which sediments were underlying the Bunde Limestone, and as this lithological unit was overlain by Lower Oligocene deposits, it was difficult to date these sediments. Regarding VAN BELLEN's text, it seems that he hesitated between Paleocene and Middle Eocene. Finally, he thought that a Middle Eocene Age was most probable. MARIE (1949), who studied the foraminifera of Lower to Middle Paleocene sediments in the Paris basin and in the Mons basin, recognized the Paleocene Age of the Bunde microfauna, which, indeed, shows a very great affinity with the foraminiferal assemblage of the Calcaire de Mons in its type section.

As several species, typical of the Calcaire de Mons in its type section were originally described by VAN BELLEN (1964 a) from these Bunde wells, we studied the part of his collection stored in the Geol. Inst., of the Univ. of Utrecht.

Recently, HOFKER (1966 e) studied foraminifera from samples of the same Bunde wells. The benthonic foraminifera allowed him to record his letter Zones Q (cf. Tuffeau de Ciply) and R (cf. Calcaire de Mons).

Unfortunately, the planktonic foraminifera seem to be quite rare in this material, as VAN BELLEN only found three specimens of *Globigerina* sp. (probably belonging to the lineage *G. daubjergensis* - *G. kozlowskii*).

3.2.2. GELEEN, THE MAURITS III MINE SHAFT.

The location and the description of the section of this mine shaft in the neighbourhood of Geleen, Netherlands Limburg, is given by HOFKER (1966 e, p. 276, f. 136, 137, table 56). He recorded the presence of his Zones Q and R.

We had the opportunity to see some material from the latter interval. The benthonic foraminiferal assemblage is identical with the one from the type section of the Calcaire de Mons. Unfortunately, no planktonic foraminifera were recorded from the interval. From 178 and 180 m depth we analysed some samples kindly provided by Dr. Hofker and Dr. Plumhoff. The species recorded are all present in the type section of the Calcaire de Mons : a list is given on p. 51.

3.2.3. VROENHOVEN, CUTTING (OR TRENCH) OF THE ALBERT CANAL (VR).

The Calcarenite of Houthem, the base of which is slightly glauconiferous, overlies a discontinuous hardground forming the top of the Tuffaceous Chalk of Maastricht (Maastrichtian).

The calcarenitic rock units of Paleocene and Upper Cretaceous Age are disturbed by a fault (probably the fault of Hees) occurring at "km pole" 23.800 of the east side of the Albert Canal, which does not affect the Oligocene. Hence, the fault was formed in Eocene or Late Paleocene Time.

The location of the series of outcrops is given in fig. 8 and the position of the sampled sections is given in fig. 9. The northern part of the section (North of the fault of Hees) was sampled at 23.887 (section VR c). The section VR g was sampled at "km pole" 23.575.

Lithology : The Tertiary and Uppermost Cretaceous sediments observed are from top to bottom the following :

(4) Sands of Grimmertingen and/or Neerrepen (Lower Tongeren Formation) : It was not possible to distinguish both lithologic units in this outcrop. The glauconiferous locally clayey sands of these units overlie disconformably a series of calcarenites which are dipping slightly to the north.

(3) Bunde Kalk (= Bunde Limestone) : Coarse yellowish to white calcarenite (3 m), rich in foraminifera which are strongly recrystallized. Some fine brown layers occur which do not follow the stratification accurately but which are probably due to (recent ?) infiltration of iron oxyde, a pedological phenomenon.

The lithology and the foraminiferal assemblage indicate that these deposits resemble the Calcaire de Mons as observed in its type section and also the uppermost layers of the Bunde Kalk in the four wells studied by VAN BELLEN (1946 a).

The sediments considered are definitely younger than the Calcarenite of Houthem as observed for instance in this outcrop to the south of the fault of Hees.

The Bunde Kalk is found at the eastern side of the Albert Canal in outcrop VR c in a section of 3 meters thickness between the "km poles" 24.000 and 23.825, at the north of the fault of Hees.

(2) Calcarenite of Houthem ROMEIN, 1962, p.77 ; 1963 ; (= Tuffeau de Vroenhoven, MARLIERE, 1968, table 1).
This term was given as Chalk of Geulhem by MEIJER (1965), who had, in an earlier publication (1959), proved the Late Danian Age of the deposits in the Vroenhoven outcrops.

The sediment consists of rather coarse, white to yellow calcarenite, which yields a lot of glauconite at its base and which may show a greenish colour in the lowermost part of this unit. It overlies the hardground which forms the top of the underlying (Uppermost Cretaceous) rock unit, the Tuffaceous Chalk of Maastricht. Since this hardground has obviously been perforated by boring organisms before the deposition of the Calcarenite of Houthem, sediment of the latter penetrated into these perforations and the Calcarenite of Houthem shows root-like appendages which extend into the top of the Tuffaceous Chalk of Maastricht.

(1) Tuffaceous Chalk of Maastricht (= Calcaire de Maestricht = Tuffeau de Maestricht = Tufkrijt van Maastricht) :
White calcarenitic chalk of a somewhat finer texture than the overlying Tertiary calcarenites. The top is formed by a hardground of some 20 cm. The type section of this rock unit is the same section as that of the Maastrichtian stratotype, the section of the St. Pietersberg, to be observed in the E.N.C.I. quarry, south of Maastricht.

3.2.4. ORP, THE QUARRY DUPONT (ORP) (RUE DU CHAUFOUR, ORP-LE-GRAND).

The abandoned quarry of Miss J. Dupont (against n° 17, rue du Chauffour, Orp-le-Grand) is the

classical locality where the Sands of Orp (lower member of the Heers Formation) are visible. We suggest that the lower two meters above the road level in this section are considered the type section of the Sands of Orp. The section is pictured in fig. 10.

The location of this outcrop is given in fig. 8 (see also GULINCK & VAN VOORTHUYSEN 1961, Chapter "Landenian of Hesbaye" fig. 3).

Lithology :

(2) Tuffeau de Lincent (?) : White to yellowish hardened marls, to very finely granulated calcarenite sediments which somewhat resemble the Marls of Gelinden, but better the Tuffeau de Lincent in the outcrop of Overbroek, Gelinden (OV, see below).

(1) Sands of Orp : Alternating thin clayey to marly layers and fine clayey brown sands with some glauconite. This rock unit is thought to form the lower member of the Formation of Heers, the upper member, the Marls of Gelinden are not distinctly present in this locality.

3.2.5. GELINDEN, THE QUARRY THEWIS, AT OVERBROEK (OV).

The abandoned quarry of Mr. Albert Thewis is situated in the hamlet of Overbroek, village of Gelinden. The location is given in fig. 8. It lies at some 3 km of the village of Heers.

In its lower part, the section shows the Marls of Gelinden, here considered type section of this lithostratigraphic unit, and also the stratotype of the Heersian Stage. It is depicted in fig. 11.

In the upper part of the section the Tuffeau de Lincent (Lower Landen Formation) crops out.

Lithology :

(2) Tuffeau de Lincent : A grey to whitish, fine-grained calcarenite which contains a lot of glauconite at its base. The concentration of this mineral diminishes strongly 50 cm above the base of the Tuffeau de Lincent.

(1) Marls of Gelinden : Grey to white marls, very rich in small thin walled hyaline autochtonous benthonic foraminifera and very small recrystallized reworked Upper Cretaceous planktonic foraminifera. According to P. CEPEK (personal communication) the calcareous nannoplankton assemblage of these sediments consists mainly of Campanian to Maastrichtian reworked elements, but some younger Paleocene forms are also present.

3.2.6. EISDEN, (= EYSDEN) THE MINE SHAFT OF EISDEN, N° 2.

Although continous marine successions covering the whole Paleocene are probably not existent in Belgium, the section observed in the mine shaft of Eisden seems to be somewhat more complete than those of other outcrops and wells.

A lithologic unit, hitherto unknown from outcrops, was observed overlying the Calcarenite of Houthem and underlying the Sands of Orp.

This unit has generally been referred to in the literature as "Infra-Heersian" or "Couche à Cyrènes du Paléocène du Limbourg". In a publication of VINCENT (1930 a), this unit was attached to the Heersian. This interpretation was mainly based on the molluscs. However, STAINIER (1931) correlating it with the continental deposits of the Mons basin (Montien Continental) designated it as the stratotype

of a new stage, the Eysdenian. The validity of this new stage was doubted by HALET (1932) who claimed that a stratotype should at least be chosen in fossiliferous marine deposits, in order to allow correlations over longer distances. Afterwards the term has not been used any more. From other wells and mine shafts of the region, the lithologic unit has been reported several times, and it was then generally recorded as "Infra-Heersian" or "Montian" in the Belgian literature.

No sediment samples were available from the section of the mine shafts at Eisden, but material was analysed from a cored well at Mechelen-aan-de-Maas (MM), which is in the neighbourhood of Eisden. The location of the mine shaft is given on fig. 8.
The lithology is described by M. GULINCK and J. VAN VOORTHUYSEN,(1961, chapter 8, pl. 3).

3.2.7. MECHELEN-AAN-DE-MAAS, THE MECHELEN-AAN-DE-MAAS WELL (MM)

This well was entirely cored in the here considered interval.

Some 60 samples from the Upper Maastrichtian-Paleocene succession in this well were analysed, as it was thought that for this area this well showed the smallest gaps in the record.

Unfortunately, some 10 m of sediment, between 297 m and 307 m, have not been sampled due to difficulties in the course of drilling. The peculair foraminiferal assemblage of the Calcaire de Mons has not been recovered from this succession, but it cannot be excluded that this is due to this gap in the sampling. However, the littoral fauna of the Calcaire de Mons may be absent from this well for ecological reasons or due to a sedimentary gap.

The location of this well (according to Ir. M. GULINCK personal communication) is given in fig. 8. The section is pictured in fig. 12.

Lithology : (Partly according to an unpublished description by GULINCK, 1957, Archives of the Geological Survey of Belgium).

Above 213 m depth. Lower Tongeren Formation (Lower Oligocene) and younger deposits.

Interval between 213 m and 225 m : Formation of Landen (lower part only) (unnamed clay unit). Compact grey to greenish clay of marine origin, containing phosphatic nodules. It is possible that this clay member is a lateral equivalent of the Clay of Louvil in the Hainaut province (SW Belgium) and the adjacent part of northern France ; however, because of the large distance (more than 120 km) and the absence of analogous sediments of the Lower Landen Formation in the area in between, a direct correlation is not warranted. These clays will probably have to be described and named as a separate unit for eastern Belgium and SE Netherlands. At the base, it is rich in sponge spicules according to GULINCK and A. HACQUAERT (1954).

Interval 225 m to 253 m (Formation of Heers) Marls of Gelinden.
Grey to white marls, hardened and fissured. Some silicified wood fragments occur. At their base the marls become rich in glauconite.

Interval 253 m to 272 m. (Formation of Heers) Sands of Orp.
Glauconiferous homogeneous clayey sands containing some calcarenitic fragments with sponge spicules ; bioturbation. At the base, a hardened shell bed yielded numerous oysters. These fossils together with a quartzitic pebble bed indicate very shallow conditions, and possibly a transgression, above the sedimentary gap at 272 m.

The upper part of this interval (253 m - 266 m) is decalcified and does not contain foraminifera.

Interval 272 m to 297 m. Calcarenite of Mechelen-aan-de-Maas. This interval is considered to be the type section of this rock unit, the name of which is introduced here.
Hardened, grey sandy calcarenite with abundant molluscs, locally with lignite fragments. At the base the sediments become more clayey and they are finely stratified. The foraminiferal fauna, however, indicates fully marine neritic conditions : the benthonic assemblage is transitional between typical "Danian-Montian" and "Heersian-Landenian" microfaunas of Belgium.

Interval 297 m to 307 m. : no samples.
Within this interval the underlying Calcarenite of Geulhem may gradually change upwards into deposits of the Bunde Kalk, as it was also observed in the four Bunde wells in Netherlands Limburg studied by VAN BELLEN (1946 a).

Interval 307 m to 320 m. Calcarenite of Houthem. White to yellow calcarenite, rather coarse grained, not strongly coherent. According to the description of GULINCK a dark hardened layer occurs at approximately 315 m, the origin of which might be accretioning as in a hardground. Deeper in the samples studied (at 320 m depth approximately) such a hardground layer occurs. We think the latter may be a lateral equivalent of the hardground observed at Vroenhoven (VR) at the top of the Calcarenite (= Tuffaceous Chalk) of Maastricht.

Interval 320 m to 357 m (and possibly lower down) Tuffaceous Chalk of Maastricht. Light yellow calcarenite sometimes glauconiferous, and yielding locally echinoid fragments as well as *Turritella.* Lower down in the section (below 347 m) a hardened chalk was observed.

3.2.8. QUARRY OF WANSIN, WANSIN (WA).

The location is given on fig. 7. The section is depicted in fig. 13.

This section, showing the Tuffeau de Lincent, is still to be seen in the abandoned quarry.

It is here defined as new type section for the Tuffeau de Lincent, since this unit is not to be seen any more at Lincent. Furthermore this section is here indicated to represent the neostratotype of the Lower (= Marine) Landenian s.s. (here Landenian is used as Upper Paleocene, excluding the Heersian).

Lithology :

Tuffeau de Lincent : A section of approximately 4 m of light brown calcarenites ; horizontally stratified hard layers (silicified ?), with in between thin marly (clayey) deposits, and loose calcarenites may be distinguished.

The foraminiferal assemblage is very similar to that of the Thanetian of Kent (cf. HAYNES 1954 - 1958 c) and differs only very slightly from that of the type Heersian.

The calcareous nannoplankton assemblage contains a distinct Upper Paleocene assemblage, probably belonging to the *H. riedeli* Zone (CEPEK, personal communication).

The underlying deposits are not known in this locality.

4. REVIEW OF FORAMINIFERAL ASSEMBLAGES IN THE "MONS WELL 1969".

The stratigraphic distribution of foraminifera in the "Mons well 1969" is given in a distribution chart (Table 1). Although the material is rich in species, it is evident from this chart that there are no clear cut boundaries for biostratigraphic subdivision of the Lower Tertiary calcarenites of this well. At the Cretaceous-Tertiary boundary there is a clear cut limit with a lowermost Maastrichtian assemblage below, and a Middle Danian assemblage above. Within the sequence of the Lower Tertiary calcarenites of the "Mons well 1969", there seems to be a gradual shift in the benthonic faunal composition, corresponding to a slight change in the lithology. In the upper part of this calcarenite sequence, calcarenites are coarser than in the lower part, whereas in the middle part a gradual change occurs in the lithology. In the higher part of this sequence the calcarenites are yellowish, whereas in the lower part, which comprises some flints, they are whitish to bluish.

The foraminifera are strongly recrystallized throughout this sequence, and generally have the same colour as the calcarenites. Some rare yellow forms of foraminifera, recovered from the lower samples, were therefore considered to be due to caving, (as indicated on Table 1) although this well has been cored throughout.

Some very rare typical Cretaceous species were recovered in the Lower Tertiary calcarenites. These reworked forms, mainly occurring in the basal part of the sequence are generally darker grey (probably pyritised at their surface) but some Early Tertiary species show sometimes darker tests too.

We distinguished the three local Zones A, B, C, in the calcarenite succession ; the limits between these zones are rather arbitrary as changes in the foraminifera assemblages are gradual, and as no typical faunal breaks occur. Other limits might have been chosen, and the entire sequence might have been taken as a single Zone. Although HOFKER, (1966 e) established his letter zonation mainly for the Limburg area (SE Netherlands and the adjacent part of NE Belgium) it stands very well a comparison to our benthonic foraminifera zonation for the Mons Basin. Our Zone A corresponds probably to a part of HOFKER's (1966 e) Zone Q and our Zone C covers a part of his Zone R. The here considered Zone B is thought to be transitional between his Zones Q and R.

This suggested threefold subdivision of the Lower Tertiary calcarenite sequence of the "Mons well 1969" may be applied when correlating in the Mons basin, and the succession of foraminiferal assemblages in E Belgium and dutch Limburg seems to be analogous also, as far as we could see from our samples of that region.

4.1. ASSEMBLAGE ZONES IN THE "MONS WELL 1969" (SEE TABLE 1).

The lowest sample analysed, OB 83, yields a typical Upper Cretaceous assemblage belonging to the lowermost Maastrichtian (or possibly to the uppermost Campanian).

The presence of *Bolivina incrassata gigantea* is thought to indicate a Maastrichtian Age, whereas the occurrence of *Gavelinella clementiana* and *Neoflabellina rugosa* would rather point to a very Late Campanian Age ; the latter two species were thought by HILTERMANN & KOCH (1962) to be restricted to the Campanian. Taken together this assemblage with numerous *Globotruncana cretacea* (slightly keeled as well as non-keeled specimens) is thought to indicate layers transitional between Campanian and Maastrichtian.

Following assemblages were distinguished in the Lower Tertiary calcarenite sequence :

Zone A

The lowermost benthonic foraminiferal assemblage zone, named Zone A, coincides with the interval between OB 80 and OB 56.20. *Globigerina daubjergensis* is the only planktonic form recovered in this interval. The benthonic taxa which appear at the base or in the course of this interval have nearly all been recovered from the higher levels as well. Hence, there are no distinct guide fossils for this zone. The species *Cibicides* sp. 1, *Siphonina prima*, *Pararotalia praepseudomenardii* and *Coleites reticulosus* are restricted to this interval or nearly so (of the latter species a single large specimen was found in OB 12) ; however, *Siphonina prima* and *Coleites reticulosus* are known to range higher in other localities, and *Pararotalia praepseudomenardii* is a rare species. *Baggatella ? aenigmatica* and *Eponides robaszynskii* are more frequent than higher up.

Zone B

This assemblage zone corresponds to the interval between OB 56.20 and OB 32.40. A number of benthonic foraminifera make their first appearance in the course of this interval.

Discorbis bundensis VAN BELLEN
Thalmannita madrugaensis (CUSHMAN & BERMUDEZ)
Nonion ornatum VAN BELLEN
Rotalia bundensis VAN BELLEN
Boldia sp. cf. *B. cubensis* CUSHMAN & BERMUDEZ
Pararotalia obourgensis n. sp.
Glabratella sp. cf. *G. polonica* POZARYSKA & SZCZECHURA
Discorbis ? *renemarlierei* n. sp.
Valvulina limbata TERQUEM
Clavulina pseudoparisiensis HOFKER
Valvulammina sp. cf. *V. globularis* (d'ORBIGNY)

The planktonic foraminifera appearing in this zone are *Globorotalia* sp. cf. *G. imitata*, *Globorotalia* sp. aff. *G. varianta*. *Globorotalia pseudobulloides* and *Globigerina triloculinoides* occur also in this interval but only a few specimens were recovered. Some rare specimens of the lineage *G. daubjergensis-kozlowskii* occur in some samples.

The only benthonic species the range of which is nearly restricted to this interval, are *Discorbis* ? *renemarlierei* and *Glabratella* sp. cf. *G. polonica*, whereas all others cited range higher into Zone C.

In Zone B some species start to become more frequent : *Rotalia marginata*, *Pararotalia globigeriniformis* and *Rotorbinella montiana* with their respective variants.

As in Zone A, *Scarificatina szczechurae* occurs, but it is not yet accompanied by its descendent *S. reinholdi* except for the uppermost few samples.

Zone C

This assemblage zone which covers the Montian stratotype and some subjacent samples, ranges from OB 32.20 to OB 12.

Apart from a number of single occurrences of species, only *Pararotalia godfriauxi*, *Lamarckina naheolensis* and *L. limbata* appear to be restricted to this zone. *Pararotalia saxorum* and *Scarificatina*

reinholdi reach their acme, whereas *Cibicides* sp. cf. *C. umbilicatus* and *Pararotalia praepseudomenardii* are amongst the species that are absent from the zone.

Some rare specimens of the *Globigerina daubjergensis - kozlowskii* group occur as high as OB 20. A single specimen of *Globorotalia* sp. cf. *G. compressa* occurs at the base of the zone.

Upper Paleocene (?)

Some azoic glauconitic sands (possibly a lateral equivalent of the Tuffeau d'Angres) were recovered overlying the Calcaire de Mons in this well. A number of yellow corroded foraminifera was found at the base of this rock unit (OB 11.60) all of them occurring also in the underlying Calcaire de Mons. They are considered to be reworked from the upper layers of the Calcaire de Mons.

4.2. BIOSTRATIGRAPHIC CORRELATIONS IN THE MONS BASIN AND WITH THE MAASTRICHT AREA.

The fauna recoverd in OB 83 (Craie de Spiennes) is of very Early Maastrichtian (Or Late Campanian) Age, which is indicated by the presence of *Gavelinella clementiana* and *Neoflabellina rugosa*, species which are generally supposed to range to the top of the Campanian, together with *Bolivina incrassata gigantea* which is thought to appear in Early Maastrichtian time (HILTERMANN & KOCH, 1962).

Planktonic foraminifera mainly belong to non-keeled or vaguely keeled *Globotruncana* ? *cretacea* (d'ORBIGNY).
A similar planktonic and benthonic foraminiferal assemblage has been recovered from the Craie de Spiennes at CA.

In the "Mons well 1969" these lowermost Maastrichtian deposits are directly overlain by Danian deposits ; hence, younger Maastrichtian deposits like the Craie phosphatée de Ciply and the Tuffeau de Saint Symphorien, with different foraminiferal assemblages (as recovered at CA) are not represented in the "Mons well, 1969").

Lower Danian deposits, comparable to the Lower Danian at Stevns Klint in Denmark, are equally missing, and the Lower Tertiary calcarenites in the "Mons well, 1969" start with the Middle Danian according to the planktonic foraminiferal assemblage ; mainly the *G. daubjergensis* test size has here been considered.

The faunal composition of the Tuffeau de Ciply (at CA, LI cf. Table 1, below) does not closely resemble that of any part of the "Mons well 1969", although all its species occur at the base of the Tertiary calcarenites of the "Mons well 1969". In the lower part of this calcarenite sequence, however, a number of species was found which were not recovered from our samples of the Tuffeau de Ciply (see basal part of Table 1). These species were found to range throughout the calcarenite sequence in Obourg ; they comprise *Rotorbinella montiana* (only very rare in the upper part of the Tuffeau de Ciply), *Scarificatina szczechurae, Spirillina striatogranulosa, Pararotalia* sp. cf. *P. tuberculifera, Epistominella* sp. cf. *E. limburgensis, Triloculina natchitochensis.* Hence, it is possible that the typical Tuffeau de Ciply is older than the basal part of the Obourg calcarenites, but the absence of these species in Ciply may as well be explained by different ecological conditions during deposition. Indeed, the average test size of *Globigerina daubjergensis* in the Tuffeau de Ciply at CA is similar to that in the lower part of the calcarenite sequence in the "Mons well 1969" at Obourg.

Our assemblage Zones A en B have not been recognized in any outcrop section of the Mons basin, but they may be present in the lower part of the Lower Tertiary calcarenites in the (as yet insufficiently analysed for its foraminifera) Ecole des Mines well (EM) and in the Calcaire (à grands Cérithes) de Cuesmes, not yet analysed in its type section.

The assemblages Zone C, typical for the Calcaire de Mons in its type section, could be recognized in the upper part of the calcarenite sequence in the Tranchée de Hainin (cf. TH in Table 1, below). It has also been recovered from the upper part of the Calcaire de Mons in the Puits Coppée (COP) and in the upper part of the calcarenite sequence in the Ecole des Mines well (EM).

In the Maastricht area (SE Netherlands and NE Belgium) Upper Cretaceous and Lower Tertiary deposits can be correlated with those of the Mons area as follows :

The Upper Gulpen Chalk, known from several outcrops and wells is of Early Maastrichtian Age and it is generally considered to be a lateral equivalent of the Craie de Spiennes and the Craie phosphatée de Ciply.

The Tuffaceous Chalk of Maastricht in the E.N.C.I. quarry (Maastrichtian stratotype) is of Late Maastrichtian Age, and it is younger than most of the Upper Cretaceous deposits of the Mons area, although the Tuffeau de Saint Symphorien may possibly be correlated with the lower part of the Upper Maastrichtian in the type area.

In the Maastricht area Lower Danian deposits have not been recovered so far and the Calcarenite of Houthem is thought to be a lateral equivalent of the Tuffeau de Ciply in the Mons basin. The foraminiferal assemblages of the Calcarenite of Houthem in its type section (CU) and in the trench of the Albert-canal at Vroenhoven (VR, south of the fault of Hees) yield mainly the same species as the Tuffeau de Ciply. This is true also for the interval MM 307 - 320 in the Mechelen-aan-de-Maas well, and the interval called Zone Q by HOFKER (1966 e) e.g. in the Maurits III mine shaft.

The successive appearance of a number of characteristic species in our Zone B of the Obourg well has also been observed in a higher part of the Maurits III mine shaft by HOFKER (1966 e) close to the transition of his Zones Q and R.

From the Maurits III mine shaft we were able to analyse two samples from the higher part of the calcarenite sequence localized at 180 m and 178 m depth (courtesy of Dr. HOFKER and Dr. PLUMHOFF respectively). We observed the following species :

Textularia bundensis VAN BELLEN.
Valvulammina sp. cf. *V. globularis* (d'ORBIGNY).
Discorbis bundensis VAN BELLEN.
Vacuovalvulina keijzeri (VAN BELLEN).
Rotorbinella montiana POZARYSKA & SZCZECHURA.
Rotorbinella sp. cf. *R. mariei* (VAN BELLEN).
Rotalia sp. cf. *R. trochidiformis* (LAMARCK).
Rotalia marginata d'ORBIGNY (and its var. 1).
Pararotalia saxorum (d'ORBIGNY).
Pararotalia sp. cf. *P. tuberculifera* (REUSS).
Eponides robaszynskii n. sp.
Gavelinella danica (BROTZEN).
Cibicides succedens (BROTZEN).

This assemblage shows very much similarity to that of the Calcaire de Mons in the Mons basin.

Several of the species of our Zones B and C appear approximately halfway the intervals of the Bunde Kalk (Bunde Limestone) analysed by VAN BELLEN (1946 a) in the Bunde wells 1954, 1955 and 1957.

At Vroenhoven (VR) in the section of the Albert Canal a microfauna belonging to our Zones B or C was recovered north of the Fault of Hees, in the calcarenite of the Albert Canal, which we think to be a lateral equivalent of the upper part of the Bunde Kalk.

The Calcarenite of Mechelen-aan-de-Maas in the well of the same name (MM 297 to MM 272) yields a foraminiferal assemblage which shows some similarities with that of the type Montian (Calcaire de Mons) with the occurrence of *Pararotalia saxorum, Globulina* sp. cf. *G. tuberculata, Pararotalia globigeriniformis* and *Globorotalia* sp. cf. *G. compressa* (strongly compressed forms) but it yields also some species which are characteristic for the overlying Heersian (Marls of Gelinden and Sands of Orp). Stratigraphically it may thus be transitional between the type Montian and the type Heersian, or it may represent a deeper water assemblage of the same age as the Calcaire de Mons in its type section.

The Heersian stratotype contains a foraminiferal assemblage which is entirely different (see next chapter) from that of the type Montian ; the type Heersian is definitely younger, also according to its planktonic microfossil assemblage.

5. SUCCESSIVE FORAMINIFERAL ASSEMBLAGES IN THE MAASTRICHTIAN AND PALEOCENE OF BELGIUM.

Before reviewing the Paleocene assemblages of Belgium we shall briefly enumerate some species which are characteristic for the Upper Cretaceous and some of which do not cross the Cretaceous-Tertiary boundary.

5.1. MAASTRICHTIAN ASSEMBLAGES IN THE MONS BASIN.

The Craie de Spiennes, here considered to be mainly of Early Maastrichtian Age, yields following species at CA :

Stensioeina pommerana BROTZEN.
Neoflabellina rugosa (d'ORBIGNY).
Bolivinoides decoratus (JONES).
Bolivinoides delicatulus CUSHMAN.
Cibicides voltzianus (d'ORBIGNY).
Gyroidinoides pontoni (BROTZEN).
Buliminella sp.
Karreria fallax RZEHAK.
Gavelinella danica (BROTZEN).
Reussella cimbrica (TROELSEN).
Bulimina pseudoacuta MARIE.
Globotruncana globigerinoides BROTZEN.
Globotruncana ? cretacea (d'ORBIGNY).
Anomalinoides spp.

Some species recovered in the Craie de Spiennes of the Mons well 1969 are given in Table 1, below (OB 83). *Bolivina incrassata gigantea* WICHER indicates a very Early Maastrichtian Age.

The Craie phosphatée de Ciply (= "Craie grise") contains following species at CA, LI, ML : (ML = Malplaquets, see f. 2.)

Bolivinoides decoratus giganteus HILTERMANN & KOCH.
Cibicides voltzianus (d'ORBIGNY).
Karreria fallax RZEHAK.
Pararotalia saxorum (d'ORBIGNY).
Alabamina sp. cf. *A. obtusa* (BURROWS & HOLLAND).
Rotalia sp. cf. *R. trochidiformis* (LAMARCK).
Siphonina prima PLUMMER.
Gavelinella danica (BROTZEN).
Eponides robaszynskii n. sp.
Stomatorbina binkhorsti (REUSS).
Coleites reticulosus (PLUMMER).
Pararotalia globigeriniformis (VAN BELLEN).
Reussella cimbrica (TROELSEN).

A single specimen of *Goupillaudina* ? *fleuriausi* (d'ORBIGNY) has been recovered from Malplaquets ML 4, 5, uppermost samples of the Maastrichtian deposits in this section (50 cm below the base of the Tuffeau de Ciply).

The Tuffeau de Saint Symphorien, sampled at CA c yields following species :

Stensioeina pommerana (BROTZEN).
Cibicides voltzianus (d'ORBIGNY).
Bolivinoides sp. cf. *B. decoratus giganteus* HILTERMANN & KOCH.
Heterohelix sp.
Globotruncana ? *cretacea* (d'ORBIGNY).
Rotalia sp. cf. *R. trochidiformis* (LAMARCK).
Tappanina selmensis (CUSHMAN)
Eponides robaszynskii n. sp.

5.2. MAASTRICHTIAN ASSEMBLAGES IN E BELGIUM AND DUTCH LIMBURG.

The Gulpen Chalk underlying the Tuffaceous Chalk of Maastricht is of Early Maastrichtian Age, and yields an assemblage which is similar to that of the Lower Maastrichtian of the Mons area.

In the area of Maastricht some other typical Cretaceous benthonic foraminifera, such as *Siderolites calcitrapoides* LAMARCK, *Hellenocyclina visserae* (HOFKER), *Omphalocyclus macroporus* (LAMARCK), *Lepidorbitoides minor* (SCHLULMBERGER), *Orbitoides apiculata* SCHLUMBERGER, *Goupillaudina* ? *fleuriausi* (d'ORBIGNY), and *G.* ? *labanae* (VISSER) are restricted to the Tuffaceous Chalk of Maastricht.

The absence of these forms in the Mons area indicates that most of the Upper Maastrichtian is lacking in that area. A relatively large number of benthonic species crosses the Maastrichtian-Danian boundary. But with planktonic foraminifera, it is easy to distinguish Maastrichtian from Danian deposits in the Maastricht area (cf. MOORKENS, 1971).

An extensive list of species of the Maastrichtian stratotype was given by VISSER (1951) and it was later completed by HOFKER (1966 e).

5.3. THE CRETACEOUS-TERTIARY BOUNDARY.

In all studied sections there is a sedimentary gap at the Maastrichtian-Danian boundary in Belgium and in the SE Netherlands, but the gap is larger in nortnern and central Belgium than in the Maastricht area and in the Mons area.

In the Mons basin one observes a disconformity between the Maastrichtian and the Middle Danian.

At CA the Tuffeau de Ciply overlies the Craie phosphatée de Ciply in the southern part of the quarry and the Tuffeau de Saint Symphorien in the northern part. In the Obourg well the Lower Tertiary calcarenites overly directly the lowermost Maastrichtian Craie de Spiennes. In the Tranchée de Hainin (TH) Lower Tertiary calcarenites directly cover the Campanian chalk. In north central Belgium the Formation of Heers overlies the Maastrichtian to Campanian chalks. Equivalents of the Tuffeau de Ciply and the Calcaire de Mons are missing in the Kallo well and in the Turnhout well (both wells are localized on f. 1). The same is true for the Landen area.

In the Maastricht area the Upper Maastrichtian sediments (Tuffaceous Chalk of Maastricht) are overlain by Danian sediments (the Calcarenite of Houthem) which are lateral equivalents of the Tuffeau de Ciply.

In all analysed sections the top of the Upper Cretaceous (Maastrichtian or older) is formed by a hardground which probably originated from (a) partial dissolution of the carbonatic sediments and (b) a reprecipitation of carbonates afterwards (after the "CO_2-catastrophe"). The chemical analysis of some samples of a hardground in the Maastricht area has shown that the hardground is richer in Ca CO_3 than under- and overlying chalks and calcarenites (GILARD, 1926, p. 48).

5.4. ASSEMBLAGE OF THE TUFFEAU DE CIPLY.

The Tuffeau de Ciply (CA, LI) and the Calcarenite of Houthem (CU, VR, MM) are thought to be of Middle Danian Age, although the (rare) occurrence of *Globorotalia compressa* (PLUMMER) in both would point to a slightly younger age according to some authors (TROELSEN, 1957 ; BERGGREN, 1960 b ; HANSEN, 1970 b). The *Globigerina daubjergensis* BRÖNNIMANN population with an average test size of 160 μ would suggest a correlation with the Middle Danian of Denmark.

Following benthonic species which were rare in the Maastrichtian become frequent in the Tuffeau de Ciply (CA, LI) :

Rotorbinella pozaryskae n. sp.
Pararotalia praepseudomenardii (HOFKER)
Vacuovalvulina keijzeri (VAN BELLEN)
Rotalia sp. cf. *R. trochidiformis* (LAMARCK)
Pararotalia saxorum (d'ORBIGNY) (mainly small forms, cf. *Rotalia hensoni* SMOUT)
Pararotalia globigeriniformis (VAN BELLEN)
Siphonina prima PLUMMER
Gavelinella danica (BROTZEN)
Textularia bundensis VAN BELLEN
Coleites reticulosus (PLUMMER)
Eponides robaszynskii n. sp.
Baggatella ? aenigmatica POZARYSKA & SZCZECHURA
Cibicides umbilicatus BROTZEN

Cibicides sp. 1
Cibicides succedens BROTZEN

Following species are not known from the Upper Cretaceous but they appear in the Tuffeau de Ciply (Danian).

Rotalia marginata d'ORBIGNY (and its variants)
Rotorbinella montiana POZARYSKA & SZCZECHURA (and its variants).

Planktonic foraminifera which do not occur in the Upper Cretaceous but which appear in the Tuffeau de Ciply are :

Globigerina daubjergensis BRÖNNIMANN
Globigerina triloculinoides PLUMMER
Globorotalia pseudobulloides (PLUMMER)
Globorotalia compressa (PLUMMER) (very rare)

5.5. ASSEMBLAGES OF THE LOWER PART OF THE OBOURG CALCARENITES ; THE CALCAIRE (A GRANDS CERITHES) DE CUESMES.

Although possibly slightly younger than the Tuffeau de Ciply, our Zone A in the "Mons well 1969" and possibly an indefinite part of our Zone B contain assemblages fitting in best with the combination of the Tuffeau de Ciply.

The benthonic foraminiferal assemblage yields the following combination of species :

Baggatella ? aenigmatica POZARYSKA & SZCZECHURA
Rotalia sp. cf. *R. trochidiformis* (LAMARCK).
Pararotalia saxorum (d'ORBIGNY)
Vacuovalvulina keijzeri (VAN BELLEN)
Rotorbinella pozaryskae n. sp.
Rotorbinella sp. cf. *R. mariei* (VAN BELLEN)
Pararotalia globigeriniformis (VAN BELLEN)
Rotalia marginata d'ORBIGNY
Rotorbinella montiana POZARYSKA & SZCZECHURA
Pararotalia praepseudomenardii (HOFKER)
Eponides robaszynskii n. sp.
Karreria fallax RZEHAK
Gavelinella danica (BROTZEN)
Gavelinella minor POZARYSKA & SZCZECHURA
Cibicides sp. 1
Cibicides succedens BROTZEN
Siphonina prima PLUMMER
Scarificatina szczechurae n. sp.
Coleites reticulosus (PLUMMER)
Angulogerina europaea CUSHMAN & EDWARDS
Textularia bundensis VAN BELLEN
Sigmomorphina soluta BROTZEN

Among those species *Pararotalia praepseudomenardii* (HOFKER) and *Cibicides* sp. 1 are typical for the Tuffeau de Ciply and the Zones A and B in the Obourg well, as they do not range higher up.

Scarificatina szczechurae n. sp. occurs in Zone A of the "Mons well 1969", but does not occur in the Tuffeau de Ciply.

Planktonic foraminifera of the Zones A and B and of the Tuffeau de Ciply are :

Globigerina daubjergensis BRÖNNIMANN
Globigerina triloculinoides PLUMMER
Globorotalia pseudobulloides (PLUMMER)

Two species occur in the Mons well 1969 in Zone B, but were not found in the Tuffeau de Ciply or in Zone A of the Obourg calcarenites :

Globorotalia sp. cf. *G. imitata* SUBBOTINA
Globorotalia sp. aff. *G. varianta* (SUBBOTINA)

It is possible that Zones A and B correspond to the Calcaire (à grands Cérithes) de Cuesmes, a lithological unit situated between the Tuffeau de Ciply and the Calcaire de Mons, but we had no outcrop material at hand to check this possibility.

5.6. THE ASSEMBLAGE OF THE CALCAIRE DE MONS.

No clear cut boundary can be drawn between Danian assemblages, i.e. assemblages of the lower part of the Obourg calcarenites and those of the Calcaire de Mons (Montian stratotype) in that well. However the presence of a number of additional species allows for correlations with the latter assemblage. This assemblage, characterizing Zone C, can be equated with that of HOFKER's (1966 e) Zone R.

Several characteristic additional species which appear in the course of Zone B, persist in Zone C :

Discorbis bundensis VAN BELLEN
Nonion ornatum VAN BELLEN
Globulina sp. cf. *G. tuberculata* d'ORBIGNY
Pararotalia obourgensis n. sp.
Rotalia bundensis VAN BELLEN
Valvulina limbata TERQUEM
Clavulina pseudoparisiensis HOFKER
Boldia sp. cf. *B. cubensis* CUSHMAN & BERMUDEZ

In the upper part of Zone B following species are added :

Discorbis renemarlierei n. sp.
Epistomaria bundensis (VAN BELLEN)

They hardly range into Zone C.

In Zone C the following species are added :

Scarificatina reinholdi MARIE
Pararotalia godfriauxi n. sp.
Lamarckina naheolensis CUSHMAN & TODD

Lamarckina limbata CUSHMAN & TODD
Rotorbinella papillata POZARYSKA & SZCZECHURA

The planktonic foraminifera are very rare in the assemblage of Zone C, but we observe that following species occur :

Globorotalia sp. cf. *G. compressa* (PLUMMER) (very rare, strongly compressed)
Globigerina ex. gr. *daubjergensis* BRÖNNIMANN - *kozlowskii* BROTZEN & POZARYSKA (some very rare specimens, most of them large).

5.7. ASSEMBLAGE OF THE CALCARENITE OF HOUTHEM (= TUFFEAU DE VROENHOVEN).

Some benthonic species which occur already in Upper Maastrichtian deposits persist in the Danian Calcarenite of Houthem :

Coleites reticulosus (PLUMMER)
Gavelinella danica (BROTZEN)
Rotalia sp. cf. *R. trochidiformis* (LAMARCK) (becoming frequent)
Guttulina sp.
Textularia bundensis VAN BELLEN
Vacuovalvulina keijzeri (VAN BELLEN)
Cibicides voltzianus (d'ORBIGNY)
Stomatorbina binkhorsti (REUSS)
Pararotalia sp. cf. *P. tuberculifera* (REUSS)
Pararotalia saxorum (d'ORBIGNY)
Cibicides succedens BROTZEN
Eponides robaszynskii n. sp.
Karreria fallax RZEHAK
Siphonina prima PLUMMER

Following species appear in the Calcarenite of Houthem and were not recovered in older deposits of the Maastricht area :

Rotalia marginata d'ORBIGNY
Sigmomorphina soluta BROTZEN
Paralabamina lunata (BROTZEN)
Gyroidinoides pontoni BROTZEN
Pararotalia globigeriniformis (VAN BELLEN) frequent)
Rotorbinella montiana POZARYSKA & SZCZECHURA
Cibicides sp. 1
Anomalinoides sp. cf. *A. umbilicatus* (BROTZEN)

This combination shows most affinities with that of the Tuffeau de Ciply in the Mons basin.

5.8. ASSEMBLAGE OF THE BUNDE KALK (= BUNDE LIMESTONE)

The Bunde Kalk has been analysed by VAN BELLEN (1946 a) from four Bunde Wells, and by HOFKER (1960 e) in the Maurits III mine shaft.

Following benthonic species appear approximately halfway in the course of the analysed intervals of the Bunde wells :

Rotorbinella sp. cf. *R. mariei* (VAN BELLEN)
Globulina sp. cf. *G. tuberculata* d'ORBIGNY
Discorbis bundensis VAN BELLEN
Nonion ornatum VAN BELLEN
Pararotalia obourgensis n. sp. (given as *Rotalia armata* by VAN BELLEN, 1946 a)
Rotalia bundensis VAN BELLEN
Clavulina pseudoparisiensis HOFKER
Valvulammina sp. cf. *V. globularis* d'ORBIGNY
Valvulina limbata TERQUEM
Boldia sp. cf. *B. cubensis* CUSHMAN & BERMUDEZ
Epistomaria bundensis (VAN BELLEN)
Scarificatina reinholdi MARIE (given as *Terquemia lobata* by VAN BELLEN, 1946 a, and as *Boldia madrugaensis* by HOFKER, 1966 e).

Some species of this combination occur also in the Calcarenite of the Albert Canal north of the fault of Hees (at VR).

This combination shows most affinities to the assemblage of Zone C, which characterizes the Calcaire de Mons in the Mons basin.

5.9. ASSEMBLAGE OF THE CALCARENITE OF MECHELEN-AAN-DE-MAAS.

The Calcarenite of Mechelen-aan-de-Maas (= Infra Heersian of GULINCK, in his interpretation of this well) contains a foraminiferal assemblage which consists partly of components of the Calcarenite of Houthem, partly of species which are characteristic of the overlying Formation of Heers ; hence, this assemblage is transitional between that of the Danian and that of the Heersian.

Following species, which do not occur any more in the Sands of Orp or in the Marls of Gelinden (Heersian) are still present in the Calcarenite of Mechelen-aan-de-Maas :

Globulina sp. cf. *G. tuberculata* d'ORBIGNY
Eponides robaszynskii n. sp.
Pararotalia saxorum (d'ORBIGNY) (small forms only)
Pararotalia globigeriniformis VAN BELLEN (smooth walled variants)

These are all species which occur already in the Calcaire de Mons and/or in the Tuffeau de Ciply.

Following species occur in the Calcarenite of Mechelen-aan-de-Maas and persist in the overlying deposits of the Formation of Heers (Sands of Orp, Marls of Gelinden) :

Astacolus platypleurus (JONES)
Gyroidinoides danvillensis (HOWE & WALLACE)
Eponides toulmini BROTZEN
Bulimina trigonalis TEN DAM (slender forms only)
Gyroidinoides voluptus HAYNES
Nonion graniferum (TERQUEM) (= *Protelphidium hofkeri* HAYNES)
Rosalina ystadiensis BROTZEN
Siphonina prima PLUMMER
Nonion sp. cf. *N. scaphum* (d'ORBIGNY)
Karreria fallax RZEHAK
Cibicides succedens BROTZEN

Some of these species appear in the Calcarenite of Mechelen-aan-de-Maas (e.g. *Bulimina trigonalis* TEN DAM, *Gyroidinoides voluptus* HAYNES, *Gyroidinoides danvillensis* HOWE & WALLACE)and range higher in Heersian and Lower Landenian strata.

The planktonic foraminifera are rare, but following species were recognized :

Globigerina ex. gr. *daubjergensis* BRÖNNIMANN - *kozlowskii* BROTZEN & POZARYSKA (mainly large specimens)
Globigerina triloculinoides PLUMMER
Globorotalia pseudobulloides (PLUMMER)
Globorotalia sp. aff. *G. varianta* (SUBBOTINA) (spinose forms)
Globorotalia sp. cf. *G. compressa* (PLUMMER) (strongly compressed forms)

The planktonic foraminifera are mainly those of our Zones B and C.

The benthonic assemblage is transitional between that of the Calcaire de Mons and that of the Formation of Heers. Hence, these marine deposits, which we call Calcarenite of Mechelen-aan-de-Maas, are possibly lateral equivalents of the continental deposits of the Mons basin, which overlie conformably the Calcaire de Mons and which yield Charophytes and *Physa* shells. The Calcarenite of Mechelen-aan-de-Maas is also overlain by some azoic sediments with carbonized wood fragments, which suggest that also in this place a regression occurred before the deposition of the Formation of Heers.

5.10 ASSEMBLAGE OF THE FORMATION OF HEERS IN NE BELGIUM.

The Sands of Orp and Marls of Gelinden were analysed in their type sections (ORP and OV respectively) and they were found overlying each other in the Mechelen-aan-de-Maas well. Their foraminiferal assemblages are practically the same and consist of following species :

Heterolepa scanica (BROTZEN) (= *Pninaella scanica* BROTZEN, = *Hollandina pegwellensis* HAYNES). This species which is not present in the Calcarenite of Mechelen-aan-de-Maas appears abruptly in the overlying Formation of Heers, where it is frequent to abundant in all analyzed samples.
Alabamina obtusa (BURROWS & HOLLAND)
Bulimina trigonalis TEN DAM (= *B. thanetensis* CUSHMAN)
Praeglobobulimina ovata (d'ORBIGNY)
Gyroidinoides danvillensis HOWE & WALLACE
Gyroidinoides voluptus HAYNES
Gavelinella sp. cf. *G. midwayensis* (PLUMMER)
Gavelinella nobilis (BROTZEN)
Quadrimorphina halli (JENNINGS)
Ceratobulimina sp.
Hoeglundina scalaris (FRANKE)

A number of these species already occur in the underlying Calcarenite of Mechelen-aan-de-Maas but most of them are absent in the Calcaire de Mons and its lateral equivalent, the Bunde Kalk. This assemblage of the Heersian ranges higher in the Lower Landenian. Most of its species were also recovered in the Thanetian of Kent (type region of the Thanetian) by HAYNES (1954-1958), and in the "Swedish Paleocene" (Selandian deposits overlying the Danian in southern Sweden) by BROTZEN (1948).

The foraminifera of the Formation of Heers are relatively well preserved (not recrystallized like those of the Tuffeau de Ciply and those of the Calcaire de Mons) ; generally their tests are transparent hyaline. Some reworked planktonic foraminifera of the Upper Cretaceous are recrystallized (*Heterohelix* and *Rugoglobigerina*). The benthonic assemblage indicates that the Formation of Heers was probably deposited in middle neritic conditions. The Rotaliidae and Discorbidae which were abundant in the littoral deposits of the Calcaire de Mons and the Bunde Kalk have all disappeared from these assemblages.

The abrupt appearance of frequent *Heterolepa scanica* (BROTZEN) is considered characteristic for the onset of the Heersian in Belgium. The species was recovered from the type section of the Sands of Orp and that of the Marls of Gelinden, and it occurs abundantly in the same rock units in the Mechelen-aan-de-Maas well.

Some rare specimens of *Quadrimorphina halli* (JENNINGS) were only recovered from the Sands of Orp in ORP. This species is known to become frequent in the sediments of the overlying Lower Landen Formation.

5.11 ASSEMBLAGE OF THE LOWER LANDEN FORMATION IN E BELGIUM.

Most species of the Heersian range higher up into the Lower Landenian e.g. in the Tuffeau de Lincent at Wansin (WA), and in the unnamed clay unit of the Lower Landenian in the Mechelen-aan-de-Maas well (MM 213 to MM 225). Some species become more frequent, such as *Quadrimorphina halli* (JENNINGS). As a whole, the benthonic foraminiferal fauna of the Lower Landenian (as well as that of the Heersian) is very similar to the one of the type Thanetian as described by HAYNES (1954-1958) and by WOOD & HAYNES (1957).

Following species occur in the Lower Landenian, and do not range higher in the Ypresian :

Eponides toulmini BROTZEN
Heterolepa scanica (BROTZEN)
Bulimina trigonalis TEN DAM (mainly short obtuse forms resembling HAYNES' var. *hengisti*)
Cibicides umbilicatus BROTZEN
Quadrimorphina halli (JENNINGS)
Angulogerina europaea CUSHMAN & EDWARDS
Angulogerina cuneata BROTZEN
Gyroidinoides voluptus HAYNES
Gyroidinoides danvillensis HOWE & WALLACE
Baggatella ? aenigmatica POZARYSKA & SZCZECHURA
Praeglobobulimina ovata (d'ORBIGNY)
Ceratobulimina sp.
Sigmomorphina soluta BROTZEN
Pullenia quaternaria (REUSS)
Gavelinella nobilis (BROTZEN)
Gavelinella midwayensis (PLUMMER)
Globigerina triloculinoides PLUMMER

Following long ranging species are also present :

Nonion affine (REUSS)

Fissurina orbignyana SEGUENZA
Siphonina prima PLUMMER
Globulina gibba d'ORBIGNY
Hoeglundina scalaris (FRANKE)
Guttulina problema d'ORBIGNY
Dentalina sp.

The higher levels of the Lower Landenian consist of glauconitic sands which yield some rare foraminifera of the enumerated species, and some reworked fossils of the Upper Cretaceous. The Upper Landen Formation is continental and contains no foraminifera.

5.12 ASSEMBLAGE OF THE FORMATION OF THE PATERNOSTRE WELL.

This Formation (Heersian or Landenian) overlies continental deposits in the central part of the Mons basin.

From the Labor well (LA) we analysed some samples between 80 m and 192 m depth. The assemblage of the samples LA 175 to LA 190 contains a rather badly preserved microfauna, characteristic for our assemblage Zones B and C. The Calcaire de Mons is here overlain by a brackish to limnic interval where foraminifera become rare and disappear entirely higher up ; in LA 111 we recovered charophytes and *Physa* shells indicating that fresh water deposits occur. These continental sediments are overlain by glauconitic clayey deposits belonging to the "Heersian of Hainaut" (cf. MARLIERE 1969), deposits which we consider to belong to the Formation of the Paternostre well. In the interval LA 86 to LA 81 m a relatively rich assemblage was observed yielding among others following species :

Gavelinella nobilis BROTZEN
Gavelinella midwayensis (PLUMMER)
Cibicides umbilicatus BROTZEN
Cibicides succedens BROTZEN
Quinqueloculina sp.
Guttulina sp. cf. *G. hantkeni* CUSHMAN & OZAWA
Globulina sp.
Sigmomorphina soluta BROTZEN
Nonion graniferum (TERQUEM)
Karreria falax RZEHAK
Siphonina prima PLUMMER
Astacolus platypleurus (JONES)
Gyroidinoides danvillensis HOWE & WALLACE
Alabamina obtusa (BURROWS & HOLLAND)
Angulogerina cuneata BROTZEN
Bulimina trigonalis TEN DAM (and its var. *hengisti* HAYNES)

All species recovered occur in the Formation of Heers of E Belgium, but most of them range also higher in the Lower Landenian and hence, it cannot be ascertained from the foraminifera that these deposits are of Heersian Age or younger.

5.13. ASSEMBLAGE OF THE LOWER LANDEN FORMATION IN W BELGIUM.

The Lower Landenian deposits of this region are treated very briefly. A number of outcrops near Tournai (cf. f.1) have not been listed in our locality descriptions as nearly all samples were found to be barren. The Clay of Louvil, the Tuffeau d'Angres and the Sands of Grandglise do not contain any foraminifera in their type sections. Only in the type section of the Tuffeau de Chercq (quarry Le Cornet, at Chercq near Tournai) a relatively rich foraminiferal fauna was observed yielding among others following species :

Guttulina problema d'ORBIGNY
Cibicides succedens BROTZEN
Siphonina prima PLUMMER
Bulimina trigonalis TEN DAM (and its var. *hengisti* HAYNES)
Pullenia quinqueloba (REUSS)
Alabamina obtusa (BURROWS & HOLLAND)
Gyroidinoides danvillensis HOWE & WALLACE
Textularia sp.
Karreria fallax RZEHAK
Gyroidinoides voluptus HAYNES
Sigmomorphina soluta BROTZEN
Gavelinella midwayensis (PLUMMER)
Guttulina lactea (WALKER & JACOB)
Praeglobobulimina ovata (d'ORBIGNY)
Angulogerina cuneata BROTZEN
Heterolepa scanica (BROTZEN)
Nonion graniferum (TERQUEM)
Gavelinella nobilis (BROTZEN)
Astacolus sp.
Bolivina ex. gr. *anglica* CUSHMAN
Quadrimorphina halli (JENNINGS) (in the highest sample only) and numerous reworked Upper Cretaceous species.

This combination fits in best with that of the Lower Landen Formation of E Belgium, although most species also occur in the Heers Formation.

5.14. ASSEMBLAGE OF THE LOWER EOCENE (YPRESIAN).

According to the species lists of KAASSCHIETER (1961) the following benthonic taxa make their appearance in the Clay of Ypres (Lower Eocene) which have not been recovered from any Paleocene sample :

Textularia smithvillensis CUSHMAN & ELLISOR
Spiroplectammina mexiaensis LALICKER
Trochammina sp. cf. *T. inflata* (MONTAGU)
Eponides plummerae CUSHMAN

Anomalina ? *acuta* PLUMMER var. *ypresiensis* (TEN DAM)
Hanzawaia ? *producta* (TERQUEM)
Asterigerina wilcoxensis CUSHMAN & GARRET
Uvigerina batjesi KAASSCHIETER
Cibicides proprius BROTZEN var. *acutimargo* TEN DAM
Angulogerina abbreviata (TERQUEM)
Turrilina brevispira TEN DAM
Asterigerina sp. cf. *A. guerrai* (BERMUDEZ)
Planulina burlingtonensis (JENNINGS) var. *neeli* (JENNINGS)
Anomalina auris Y. LE CALVEZ
Elphidium latidorsatum (REUSS)
Bulimina parisiensis KAASSCHIETER
Guttulina pulchella d'ORBIGNY
Nonionella spissa CUSHMAN
Cancris subconicus (TERQUEM)
Bolivina crenulata CUSHMAN
Reussella elongata (TERQUEM)

Planktonic foraminifera occurring in the Ypresian deposits are (MOORKENS, 1968) :

Globigerina aquiensis LOEBLICH & TAPPAN (1)
Globigerina sp. cf. *G. quadritriloculinoides* CHALILOV (1)
Globigerina ex. gr. *soldadoensis* BRÖNNIMANN
Globigerina ex. gr. *mckannai* WHITE - *gravelli* BRÖNNIMANN
Globigerina stonei WEISS vel *G. simplex* SUBBOTINA
Globorotalia "esnaensis" LOEBLICH & TAPPAN (non LEROY), small specimens
Globorotalia strabocella LOEBLICH & TAPPAN and *G. irrorata* LOEBLICH & TAPPAN
Globorotalia sp. cf. *G. whitei* WEISS given by us (1968) as
Globigerina sp. cf. *G. tribulosa* LOEBLICH & TAPPAN

The base of the Ypresian in Belgium forms the base of the Eocene.

(1) Some specimens have secundary "globigerinoidal" apertures at the spiral side.

6. CONCLUSIONS AND STRATIGRAPHIC DISCUSSION

After the review of the foraminiferal assemblages recovered from the samples of the "Mons well 1969", and those of other classical localities and wells of the Belgian Paleocene, it is possible to draw some conclusions concerning stratigraphy and paleoecology.

6.1. PLANKTONIC FORAMINIFERA.

Specimens of this group are rare in all our samples of the Tertiary in the "Mons well 1969", except in OB 72.10 in which 148 specimens of *Globigerina daubjergensis* were recovered. At the moment it seems that this group provides the best possibility for correlation with Denmark and Poland.

Although the group of *G. daubjergensis - G. kozlowskii* is scarce in most samples of the "Mons well 1969", the recovered specimens confirm the general trend of increasing test size, observed by HOFKER and BERGGREN, and substantiated by an accurate biometric analysis of HANSEN (1970 a).

The arbitrary "limit" between the two chronospecies was situated at the value of the average maximal diameter of 185 μ (MOORKENS, 1971).

In the lower part of the Tertiary calcarenites of the "Mons well 1969" (OB 80 to OB 62) the 148 specimens of sample OB 72.10 with an average diameter of 148 μ indicate the presence of *G. daubjergensis*, as do the 23 specimens found between OB 70 and OB 62, with an average maximal diameter of 138 μ. In the higher part (between OB 56.20 and OB 20) 54 specimens have an average maximal diameter of 189 μ, which rather points to *Globigerina kozlowskii*. (see Fig. 15).
The type locality of the Calcaire de Mons, which is also the stratotype of the Montian Stage corresponds to this upper part of the latter interval (as well as some higher samples which do not yield any planktonic foraminifera) the original Puits Goffint containing a sequence of 14 m of the Calcaire de Mons, occurring below Upper Paleocene decalcified glauconiferous sands. Hence, the Montian stratotype is approximately represented by our samples OB 12 to 26.

HANSEN (1970 a) observed that the *G. daubjergensis - kozlowskii* lineage ranges above the top of the Danian Stage in Denmark, covering part of the younger Paleocene, Lower Selandian Stage.

On the base of this lineage the Montian stratotype would be younger than the Middle Danian of Denmark (Zone III of HANSEN). According to TROELSEN (1957, p. 126), SORGENFREI (1957, p. 11) and HANSEN (1970, a) the Middle Danian of Denmark incorporates the Danian stratotype (Fakse).

It is, however, not sure whether the Montian stratotype is a lateral equivalent of the Upper Danian of Denmark, as represented by the highest calcareous sediments of the Danske Kalk at Hvalløse (Danian, Zone IV of HANSEN) or whether it is slightly younger.

Globorotalia angulata, a typical Middle Paleocene species, which was observed by HANSEN (1968) in "Lower Selandian" deposits of Denmark, has not been recovered by us from any sample of the Calcaire de Mons. (1)

(1) EL-NAGGAR (1967 c ; 1969 a) who studied one sample, of unknown depth of the Givry well 318 in the neighbourhood of Mons, claimed to have recovered *Globorotalia angulata*. As we did not find this species in any of our samples of the "Mons well 1969", we think that his argument is of minor importance. Moreover, it is thought possible that he mistook a benthonic species for *Globorotalia angulata*, possibly an *Eponides* of the group *E. toulmini-robaszynskii*.

However, the Montian stratotype cannot be younger than the extinction level of the *G. daubjergensis - kozlowskii* lineage as specimens of this group range into the type section.

6.2. BENTHONIC FORAMINIFERA.

Although benthonic foraminifera form the larger part of the microfossil content of the Lower Tertiary calcarenites of the "Mons well 1969" and although the assemblages are very rich in species, we think that this group provides only few possibilities for long distance corelations. Indeed, most of the species recovered seem to be strongly facies-bound.

Several species viz *Baggatella ? aenigmatica*, *Scarificatina* (vel *Boldia*) *reinholdi* s.l., *Epistominella* sp. cf. *E. limburgensis*, some species of *Rotorbinella*, and others, which had previously been thought to have stratigraphic value to distinguish Danian (Lower Paleocene) from "Montian" deposits (POZARYSKA, 1965 ; POZARYSKA & SZCZECHURA, 1968, 1970) have now been found in definitely older (Danian) deposits, as they appear already in the lower part of the calcarenite sequence of the "Mons well 1969". It is possible that these species appear later in Poland than in Belgium, but this fact would only emphasize that they are strongly facies bound or that their migration went slowly ! (1)

When considering the range chart of the "Mons well 1969" (Table 1) we observe that some benthonic species have now been found in the Calcaire de Mons or that their range is restricted to our assemblage Zones B and C, e. g. *Glavulina pseudoparisiensis*, *Boldia* sp. cf. *B. cubensis* or *Valvulina inflata.* Again such distribution may be environment controlled, the species being restricted to the very shallow water environment thought to correspond to the upper part of the Calcarenite section of this well.

When considering the occurrence of these species in other wells and outcrops in Belgium and in the SE Netherlands one observes, however, that within the considered area they probably provide good correlation tools.

The occurrence of some well preserved specimens of *Lamarckina naheolensis* and *L. limbata* in strongly recrystallized assemblages of other benthonic foraminifera, in the lower samples of the Calcaire de Mons, is puzzling. Indeed, TROELSEN (1954) and HANSEN (1970 b) have stated that these aragonitic tests are generally absent in calcareous sediments, like the Danske Kalk due to the fact that aragonite is generally less well preserved when solution and-or recrystallization occurs. BROTZEN (1948) and POZARYSKA (1965) had claimed that *Lamarckina naheolensis* is a valuable guide fossil, appearing after Danian times in Sweden and Poland respectively, but this late appearance is (in our opinion) more probably bound to the different solution characteristics of aragonite and calcite.
Thus, although the occurrence of well preserved aragonitic tests in the Calcaire de Mons is puzzling, we prefer not to consider these *Lamarckina* species as guide fossils for the "Middle Paleocene" or "Montian" of authors.

6.3. PALEOECOLOGY.

Planktonic foraminifera, already scarce in most samples of the basal part of the Tertiary calcarenites of the "Mons well 1969", (1 % or less except for the sample at OB 72.10) practically disappear in the Calcaire de Mons higher up. Evidently the environment of deposition became gradually shallower.

(1) A slow, "climate-bound" migration of some benthonic "warm-water" foraminifera has been suggested previously by W. & K. POZARYSKI, 1959, POZARYSKA, 1965 ; POZARYSKA & SZCZECHURA, 1968, 1970 ; SZCZECHURA & POZARYSKA, 1971. Appearance of these species therefore does not have a stratigraphic value for correlations over longer distances, but may provide interesting paleoecological and paleogeographical indications.

Parallel with the disappearance of planktonic foraminifera, changes occur in the benthonic foraminiferal association. A number of genera and species occur for the first time in sample OB 56 or higher up. The increase in abundance of *Rotalia* species and of some Miliolids, and the first occurrence of some *Valvulina* and *Clavulina* species and affiliates, suggest that the environment of deposition changed from inner neritic, for the lower part of the calcarenites, to littoral, for the higher part (including the Calcaire de Mons). A single oogonium of a Charophyte was recovered from OB 13.90, but it is probably not *in situ* as the foraminiferal assemblage is still fully marine in this sample, (and not brackish as would suggest an assemblage of charophytes without foraminifera).

The gradual change in the benthonic foraminiferal association goes together with the appearance of new and abundant bryozoan and ostracodal assemblages, while the highest part of the Calcaire de Mons, previously sampled in the Puits Goffint and Coppée, yielded numerous molluscs. Yet the environment remained fully marine. During the deposition of these relatively coarse calcarenites with a large amount of organic calcareous debris, it is probable that the water was approximately saturated with calcium carbonate.

In the "Mons well 1969" and in the Puits Coppée the top of the Calcaire de Mons has obviously been eroded. However, in the central part of the Mons basin, a gradual change from littoral marine, into brackish and even freshwater deposits, (with numerous Charophytes and *Physa* shells) has been observed, e. g. in the Labor well (LA). In the whole area considered, marine deposits were followed by distinctly regressive sediments.

The Tuffeau de Ciply was deposited in a shallow environment which, however, was slightly deeper than of the Calcaire de Mons, according to P/B ratio and to the benthonic assemblage.

The environment of deposition of Heersian and Lower Landenian sediments was considerably deeper than that of the Tuffeau de Ciply, and that of the Calcaire de Mons, but benthonic foraminifera are still dominating. The climate became colder.

6.4. CORRELATIONS IN THE MONS BASIN AND BETWEEN MONS AND THE SE NETHERLANDS.

Correlations suggested partly by the lithology, partly by the foraminiferal assemblages have been summarized in Table 2.

The main correlations are here briefly reviewed :

The Calcarenite of Houthem (CU) and its equivalent at Vroenhoven (VR, south of the Fault of Hees) may be correlated with the Tuffeau de Ciply of the Mons basin.

The Bunde Kalk of the Bunde wells and of the Maurits III mineshaft may be correlated with the Calcaire de Mons in the Puits Goffint and Coppée and in the Ecole des Mines and Mons 1969 wells. A lateral equivalent is also found in the Tranchée de Hainin (TH).

Some deposits which are transitional between the Tuffeau de Ciply and the Calcaire de Mons were found in the "Mons well 1969" and in the Ecole des Mines well (EM).

The calcarenite which crops out in the Albert canal section at Vroenhoven (VR) at the north of the Fault of Hees is younger than that at the south of that fault and it may be correlated with the Bunde Kalk and with the Calcaire de Mons.

The Calcarenite of Mechelen-aan-de-Maas is a subsurface formation, the microfaunal content of which is trantitional between that of the Calcaire de Mons, and that of the Heers Formation. It may well be a lateral equivalent of the continental deposits which overlie the Calcaire de Mons in the central part of the Mons basin.

The rock units of the Formation of Heers as observed in outcrops viz. the Sands of Orp (at ORP) and the Marls of Gelinden (at OV) were found superposed in the Mechelen-aan-de-Maas well. In that well the Heers Formation is directly overlain by the Lower Landen Formation, deposits which may be correlated with the Tuffeau de Lincent at Wansin (WA) and the Tuffeau de Chercq (LC).

The stratigraphic position of the Formation of the Paternostre well remains uncertain as its foraminiferal assemblage shows similarities with that of the Formation of Heers as well as with that of the Lower Landen Formation of NE Belgium.

6.5. SOME REMARKS ON THE PALEOCENE PALEOGEOGRAPHY OF W EUROPA.

All over the Paris basin, northern France, southeastern England, Belgium and the SE Netherlands a break in the sedimentation has been observed between the Upper Cretaceous (Campanian or Maastrichtian) and Paleocene (Danian and younger).

In the Mons basin Middle to Upper Danian strata overlie disconformably layers of Early to Middle Maastrichtian Age. In the neighbourhood of Maastricht the Danian transgression probably started at approximately the same time, its sediments covering here Upper Maastrichtian deposits. Also in the Paris basin the Danian transgression probably took place at about the same time. This Early Tertiary transgressive period lasted until the early part of the Middle Paleocene, both in the Mons basin, where the Calcaire de Mons was deposited, and in the area of Maastricht, where the Limestone of Bunde was formed. It is not sure, whether Middle Paleocene layers (i.e. younger than the Danian) have been deposited in the Paris basin, because planktonic foraminifera are too rare to check the age of the deposits.

In the Mons basin the Danian-Montian transgression was followed by a period of slow regression giving rise to gradually changing environments : at first shallow marine, littoral, then brackish to freshwater.

After the deposition of these regressive sediments there has obviously been a period of non-sedimentation and erosion. Marine deposits of Middle Danian to Early Middle Paleocene Age once covered relatively wide areas in NW Europe. Today's distribution of such deposits is very restricted : this is true in the Paris basin, as well as in the Mons basin, with a distribution in two smaller areas, the syncline of Mons and farther east the syncline of St. Ghislain. Small remnants of such deposits are left also in NE Belgium, in the SE Netherlands, and in the adjacent area of Germany, in the region of Krefeld.

The present patchy distribution of Danian to Lower Middle Paleocene deposits is clearly illustrated by the fact that the sediments of Laversinnes and Vigny in the Paris basin are at 150 km from the nearest sediments of that age in the Mons basin. The latter are again separated from those in the vicinity of Maastricht by an area of approximately 120 km length, in which deposits of this age are unknown. Because of this patchy distribution it is not possible to deduce how the transgression and regression during this period took place. Although the remnants of Lower Paleocene deposits in the Paris basin, in the Mons basin, in the Maastricht area in the Krefeld region are few and small, it can now be ascertained that the transgression during Danian (to Middle Paleocene ?) times must have been much more extensive than what is seen from today's occurrence of its deposits. Indeed, all these sediments were deposited under fully marine conditions (some planktonic foraminifera !). The removal of all the sediments in the areas between the small remnants obviously took place during the Middle Paleocene, as both the remaining Danian-Montian deposits and the areas in between, are generally covered by Upper Middle Paleocene deposits

(Heersian) or Upper Paleocene sediments (Lower Landenien). Hence, the Middle Paleocene break in the record probably corresponds to a relatively long time interval in the Mons basin as a substantial erosion has taken place during this period. In NE Belgium and the adjacent part of the Netherlands this regression period was probably somewhat shorter. This is shown by the succession observed in the Mechelen-aan-de-Maas well. The Uppermost Cretaceous in this well is represented by the Tuffaceous Chalk of Maastricht in a facies very similar to that of the Maastrichtian type section and with the same microfaunistic assemblage. The Calcarenite of Houthem of Middle to Late Danian Age overlies with a paraconformity this Late Maastrichtian calcarenite. The Bunde Kalk has not been observed but it possibly corresponds to the interval between MM 307 and 297, from which no samples were available. The overlying Calcarenite of Mechelen-aan-de-Maas (interval 297 m to 272 m) is a glauconiferous sediment which is possibly in part contemporaneous but probably partly younger than the Bunde Kalk and the Calcaire de Mons. Above it, some 6 meters of azoic glauconiferous sediments with lignitic fragments suggest more regressive conditions. The latter deposit is in turn overlain by the Formation of Heers, which yields foraminiferal and nannofossil assemblages very similar to those of the Heersian stratotype. The Formation of Heers is here overlain by the Lower Landen Formation, which is represented by an unnamed clayey deposit (comparable to the Clay of Louvil) with a foraminiferal fauna and nannofossil assemblage (*Heliolithus riedeli* association) similar to those of the Tuffeau de Lincent at Wansin (WA) and the Type Thanetian.

The transgression in NE Belgium to which corresponds the Formation of Heers is thought to have come from northern direction. It arrived considerably later in the Mons basin where the Formation of the Paternostre well (a glauconiferous clayey deposit) was deposited during either the Late Middle Paleocene (Heersian) or the Early Late Paleocene (Early Landenian). This transgression probably reached the Paris basin farther south, not before the Late Paleocene. During the Late Paleocene a large regression occurred in the Paris basin, Belgium and the SE Netherlands. Upper Landenian continental deposits occur in the Paris basin, in the Mons basin (Sands of Erquelinnes and/or of Jeumont) in NE Belgium (Sands and Lignites of Landen). After this regression the Lower Eocene (Ypresian) transgression coming from the North, covered a large part of northern Belgium and the Netherlands.

6.6. CORRELATIONS WITH DENMARK AND POLAND.

Equivalents contemporaneous with the Lower Danian in Denmark (e.g. the layers to be observed directly above the "junction" in Stevns Klint) were not found in the Mons basin nor in the area of Maastricht. It seems that the Danian transgression occurred later in these regions than in Denmark.

The Tuffeau de Ciply in its type section (CA) and in other sections (LI, CB, ML) as well as its lateral equivalents in NE Belgium and the SE Netherlands, the Calcarenite of Houthem, are all of Middle to Late Danian Age as can be deduced from the occurrence of the populations of *Globigerina daubjergensis.* The associations of benthonic foraminifera are thoroughly different from those of the Danish Danian, probably due to strongly different environmental conditions during deposition. The higher frequency of planktonic foraminifera in most of the Danian deposits of Denmark indicates relatively deeper, open marine conditions. Only for the type locality, Faxe, abundant bryozoans and other organisms living in shallow water, indicate an inner neritic environment not deeper than 20 m.

BANG (1969) described the Danian to basal Selandian succession from several cored wells in the Storebaelt region. She claimed to have recovered a continuous sequence from Lower to Middle Paleocene, i. e. from Danian to Selandian. According to HANSEN (personal communication) continuous sedimentation has not been observed in outcrops in Seland or Jutland, but there is a gap between the Danske Kalk (Limestone or Chalk facies) and the overlying glauconiferous sandy to clayey deposits.

The Lower Selandian was found by HANSEN (1968) to contain *Globorotalia angulata* and *G. emilei*, and he deduced from the occurrence of the former species that the Lower Selandian is of Middle

Paleocene Age. The same author (1970, a) stated also that the final stage of the *G. daubjergensis* lineage crosses the Danian - Selandian boundary, ranging upwards into Lower Middle Paleocene strata. The average maximal diameter of a large population of these forms was found to be (1) larger than that of Upper Danian populations, (2) similar to that of the topotypes of *G. kozlowskii* of Polandi ; (3) probably comparable to the youngest forms from the Calcaire de Mons in the "Mons well 1969".

In Poland POZARYSKA (1965) and later POZARYSKA & SZCZECHURA (1968, 1970) investigated the Pamietowo well and they decided that Montian layers were present in this and in other wells.

Correlations over such wide distances preferably should not be based on benthonic foraminifera which are known to be strongly facies-bound, but the planktonic foraminifera apparently support their correlation, if one accepts the HANSEN lineage (increasing size) to be valid for a large area. *G. kozlowskii* described from the "Montian" part of the Pamietowo well is very probably younger than the (ancestran) *G. daubjergensis* populations from the type Danian.

6.7. SUBDIVISION OF THE PALEOCENE IN BELGIUM.

In the stratigraphic literature the Paleocene has been differently subdivided, either twofold or threefold.

When following a twofold subdivision it would be best to incorporate the Montian within the Lower Paleocene, and the Heersian within the Upper Paleocene in Belgium. The subdivision would then be relatively easy in the Belgian stratigraphy, as there occurs a considerably long regression period between Early and Late Paleocene transgressions. Sediments and foraminiferal assemblages are completely different below and above this break in the record. Only in one locality (the Mechelen-aan-de-Maas well) a transitional calcarenite unit occurs which yields a foraminiferal assemblage transitional between that of the Lower Tertiary calcarenites and that of Heersian deposits. Its planktonic foraminifera would rather point to the Lower Paleocene side of the balance.

However, in several papers on planktonic microfossil zonations of the Paleocene a threefold subdivision of this subepoch has been chosen by a number of authors. If we adapt this threefold subdivision to the Belgian stratigraphy, we would equate the typical Lower Paleocene with the Danian, and the Upper Paleocene with the Landenian (or the type Thanetian, which may be approximately correlated with it). The remaining part in between would be considered to belong to the Middle Paleocene.

The Montian stratotype probably corresponds to the lowermost part of the Middle Paleocene as here considered, whereas the Heersian stratotype probably only covers the uppermost part of this Middle Paleocene. A relatively large part of the Middle Paleocene, in between these two stratotypes, would be missing in the marine succession of most of the Belgian sections ; it is represented in some places by continental deposits, or in most by a considerable sedimentary gap.

6.8. THE RELATIVE POSITION OF SOME EUROPEAN STRATYPES IN PLANKTONIC ZONATIONS.

In Table 3 we tentatively correlate some Western European stratotypes with the integrated zonation of planktonic foraminifera and calcareous nannoplankton. Since the planktonic foraminiferal zonation, elaborated in tropical to warm temperate regions, is not readily applicable to Western Europe - many important taxa are missing in this colder area - we have given some local planktonic foraminiferal datum planes which give a basis to apply the planktonic foraminiferal zonation to our area. Some paleontologic arguments mainly compiled from literature for this interpretation have been dealt with in Chapter 2, except for the Montian which has been discussed in the previous alinea.

7. SYSTEMATIC DESCRIPTIONS.

General remarks :

First benthonic foraminifera are dealt with (7.1), afterwards the planktonics (7.2). Genera are listed according to the classification of LOEBLICH & TAPPAN 1964, as far as possible. Nodosariidae and Polymorphinidae have generally been determined to the generic level only. It is possible that within the genera *Gavelinella, Anomalinoides* and *Cibicides* a further splitting would be possible, but then determinations become too uncertain (due to the strong variability in this group) to be of value for stratigraphic purposes.

The genus *Scarificatina* MARIE, which was a *nomen nudum* until now, has here been validated, as well as its -here indicated- type species *S. reinholdi.*

Species belonging to the genera *Rotalia* and *Pararotalia* have so far only been determined according to their external features ; however a detailed study of their internal structures is thought to be of great taxonomic value. The material of the "Mons well 1969" is rich in *Rotalia* individuals but unfortunately most specimens are strongly recrystallized.

Pictures have only been given of new taxa and of relatively well preserved specimens.

The numbers following the "occurrence in the Mons well 1969" in the descriptions, indicate the number of the species on Table 1.

7.1. BENTHONIC FORAMINIFERA.

Genus *TEXTULARIA* DEFRANCE, 1824

Textularia bundensis VAN BELLEN

Pl. 4, f. 1

1946 *Textularia bundensis* VAN BELLEN, Meded. Geol. Sticht. C, 5, 4, p. 26, pl. 1, f. 4-7.
1965 *Spiroplectammina baudouiniana* (d'ORBIGNY), POZARYSKA Palaeont. Polon, *14*, p. 48, pl. 2, f. 5 a-b (non *Textularia baudouiniana* d'ORBIGNY, Mémoires sur les Foraminifères ..., p. 46, pl. 4, f. 29, 30).

Remarks : The initial part of the test could not be studied in our material because of the bad state of preservation. Hence, it cannot be ascertained whether the species has to be assigned to *Textularia* or to *Spiroplectammina.* Our material, as well as POZARYSKA's figure of *S. baudouiniana*, differs from *Textularia baudouiniana* d'ORBIGNY by the more blunt sides ; d'ORBIGNY's species has sharp edges and keels.

Occurrence :

1) "Mons well 1969" (57) : between OB 76 and OB 12.
2) Other localities : Maastrichtian deposits in CA at Ciply and in the ENCI quarry, type Maastrichtian. Calcaire de Mons at COP, Calcarenite of Houthem at VR, Tuffeau de Ciply at CA. HOFKER (1966 e) recovered the species under the name *T. faujasi* REUSS from his Zones Q and R.

Known Range :

Maastrichtian, Danian, reaching the top of the Montian stratotype.

Genus *VACUOVALVULINA* HOFKER, 1966

Vacuovalvulina keijzeri (VAN BELLEN)

Pl. 1, f. 1 ; Pl. 4, f. 2 (both var. 1)

1946 *Marssonella keijzeri* VAN BELLEN, Meded. Geol. Sticht. C. *5*, 4, p. 30, pl. 2, f. 3-5.
1964 *Conicovalvulina keijzeri* (VAN BELLEN) P. MARIE, Mém. B.R.G.M., 28, 2, p. 1083, pl. 1, f. 3 a-c. (genusname is *nomen nudum*)
1966 *Vacuovalvulina keijzeri* (VAN BELLEN) ; J. HOFKER, Palaeontographica, Suppl. 10, p. 250, pl. 49, f. 1-7.
1968 *Vacuovalvulina keijzeri* (VAN BELLEN) ; K. POZARYSKA & J. SZCZECHURA, Palaeont. Polon. 20 (1968), p. 36, pl. 3.

Remarks : MARIE (1964) was the first to observe that this species did not belong to *Marssonella* and he close the name *Conicovalvulina*. However, as he did not give a description of this genus and did not indicate a type species, it is the name erected later by HOFKER (1966 e, p. 249) that is valid. The specimens figured by POZARYSKA & SZCZECHURA (1968) are less conical and smaller. They might represent a different variety or subspecies. They have been entered separately as *V. keijzeri* var. 1 (50) in the range chart. (Pl. 1, f. 1 ; Pl. 4, f. 2).

Occurrence :

1) "Mons well 1969" (49,50) : the range covers nearly the whole interval between the Cretaceous-Tertiary boundary (78 m) and the top of the Calcaire de Mons (12 m).
2) Other localities : the species occurs frequently in the Tuffeau de Ciply (CA, LI) and in the Calcarenite of Houthem (VR, MM). It was found in the Calcaire de Mons (LA, TH) and in the Calcarenite of Mechelen-aan-de-Maas (type section of this newly defined unit) of the MM well (MM 272 to 297). The species was not observed in sediments younger than the top of that rock unit ; it has not been found in the Formations of Heers and of Landen.

Some similar specimens occur in Maastrichtian sediments (Tuffaceous Chalk of Maastricht in MM well, Craie phosphatée de Ciply, LI outcrops, and in the Tuffeau de St. Symphorien, CA), but it will have to checked whether the latter belong to the same taxonomic unit, as we did not study their inner structure (cf. HOFKER, 1966 e, p. 249). In the studied region, the species occurs with certainty in the Tuffeau de Ciply and lateral equivalents (Upper Danian) and it is abundant in the slightly younger deposits of the Calcaire de Mons and the Bunde Kalk, where the specimens are generally somewhat larger. The occurrence in sediments older than the Danian is still uncertain.

Known range :

According to MARIE (1964) on the Paris Basin, HOFKER (1966 e) on the Maastricht area, and POZARYSKA & SZCZECHURA (1968) on the Pamietowo well in Poland, the species is only found in Lower to Middle Paleocene strata.

Genus *VALVULINA* d'ORBIGNY, 1826

Valvulina limbata TERQUEM

Pl. 4, f. 3

1882 *Valvulina limbata* TERQUEM, Mém. Soc. Géol. France, 3, (2), p. 102, pl. 11, f. 7.
1946 *Valvulina triangularis* VAN BELLEN (non d'ORBIGNY) Meded. Geol. Sticht. C, 5, 5, p. 28, pl. 1, f. 20-22.
1952 *Valvulina limbata* TERQUEM, Y. LE CALVEZ, Mém. Expl. Carte Géol. France, IV, p. 10, pl. 1, f. 4.
1964 *Pyramidovalvulina limbata* (TERQUEM) ; P. MARIE, Mém. B.R.G.M., 28, 2, p. 1083, pl. 1, f. 1. (generic name is a *nomen nudum* as no description was given nor a type species indicated).
1966 *Valvulammina limbata* (TERQUEM) ; J. HOFKER, Palaeontographica, Suppl. 10, p. 251, pl. 50, f. 8-10.

Remarks : According to the classification of LOEBLICH & TAPPAN (1964) *Valvulina* differs from *Valvulammina* by the number of chambers in the last whorl : three and more than three respectively. HOFKER (1966 e, p. 250) claims that the inner structure (tooth plates) of both genera forms a better feature to separate them.

Occurrence :

1) "Mons well 1969" (104) : the species was recovered from the Calcaire de Mons in its type section and some samples lower down (OB 46.30 to OB 12). In this well it appears to be restricted to the youngest deposits, but this may be due to environmental conditions.
2) Other localities : This species has only been recovered from sediments which are here considered to be lateral equivalents of the Calcaire de Mons and which, moreover, were deposited under conditions nearly identical to those during the deposition of the Calcaire de Mons in its type section ; a shallow, littoral, warm marine, Calcium-saturated environment.

Known range :

The species is known from Paleocene and Middle Eocene deposits (Lutetian of Paris basin). Its range probably covers a much longer time interval.

Valvulina triangularis d'ORBIGNY

Pl. 4, f. 7.

1826 *Valvulina triangularis* d'ORBIGNY, Ann. Sc. Nat. 7, p. 270 ; Prodrome 1850, 2, p. 408, nvs 1331.
1882 *Valvulina triangularis* d'ORBIGNY ; TERQUEM, Mém. Soc. Géol. France, 3, 2, p. 101, pl. 11, f. 4.

Remarks : Our forms resemble well TERQUEM's figured type.

Occurrence :

1) "Mons well 1969" : These rare forms have not been entered in the range chart ; two specimens were recovered in OB 26.
2) Other localities : Not observed.

Known range :

Upper Danian, to Middle Eocene.

Genus *CLAVULINA* d'ORBIGNY, 1826

Clavulina pseudoparisiensis HOFKER

Pl. 4, f. 4

1946 *Clavulina parisiensis* d'ORBIGNY ; R.C. VAN BELLEN, Meded. Geol. Sticht. C, 5, 4, p. 29, pl. 2, f. 2. (non 1826, *Clavulina parisiensis* d'ORBIGNY, Ann, Sci. Nat. 7, p. 268, n° 3, mod. 66).
1964 *Helicovalvulina* aff. *pupa* (d'ORBIGNY) ; P. MARIE, Mém. B.R.G.M. 28, 2, p. 1083, pl. 1, f. 5 indicate a type species for the new genus).
1966 *Clavulina pseudoparisiensis* HOFKER ; Palaeontographica, Suppl. 10 p. 248, pl. 51, f. 19.

Remarks : It is possible that some other *Clavulina* species cited by VAN BELLEN and by HOFKER are conspecific with this species. Also the single specimen determined by VAN BELLEN (1946) as *Clavulinoides szaboi* (HANTKEN) the last chamber(s) of which were obviously broken off, might belong to this species. The same may apply to VAN BELLEN's *Pseudogaudryina jacksonensis*. According to VAN BELLEN's figures (pl. 1, f. 14-17) the apertural features of holo- and paratype of *Gaudryina bundensis* VAN BELLEN are quite different from those of the species discussed here.

Occurrence :

1) "Mons well 1969" (107) : This species is stratigraphically restricted to the Calcaire de Mons in the "Mons well 1969" (type section and some samples below it) ranging from OB 44.30 to OB 12.
As for several other relatively large and thick shelled foraminifera, this restriction may solely be due to environmental conditions during deposition of these calcarenites, which are considered to have been formed in shallow inner neritic to littoral environments.

2) Other localities : We did not observe the species in any other locality. It was recorded however, from the upper part of the calcarenites in the Bunde wells by VAN BELLEN i.e. from layers we think to be lateral equivalents of the Calcaire de Mons. Furthermore, HOFKER (1966 e) recovered the species from his "Zone R" (assemblage comparable to that of the Calcaire de Mons) in the Maurits III mine shaft.

Known range :

For the time being the species has only been recorded from the Calcaire de Mons and deposits which are thought to be lateral equivalents. However, considering the possible environmental linkage, this species may at the moment not be considered a stratigraphic marker.

Genus *VALVULAMMINA* CUSHMAN 1933

Valvulammina globularis (d'ORBIGNY)

Pl. 4, f. 6

1826 *Valvulina globularis* d'ORBIGNY ; Ann. Sci. Nat. 7,p. 270, f. 6.

Remarks : Resembles the original picture fairly well. This form is much more elongate than those, more frequent, given by us as *V.* sp. cf. *V. globularis.*

Occurrence :

1) "Mons well 1969" : the rare specimens have not been entered in the range chart. The species occurs in OB 32.40.

2) Other localities : Not observed.

Known range :

Previous to this study the species was mainly known from Eocene (Lutetian) deposits.

Valvulammina sp. cf. *V. globularis* (d'ORBIGNY)

Pl. 4,f. 5 ; Pl. 13, f. 1, 2

cf. 1826 *Valvulina globularis* d'ORBIGNY ; Ann. Sci. Nat. 7, p. 270, f. 6.

? cf. 1946 *Valvulammina globularis* (d'ORBIGNY) ; R.C. VAN BELLEN, Meded. Geol. Sticht. C. 5, 4, p. 30, pl. 2, f. 6-9.

cf. 1964 *Valvulina inflata* MARIE ; P. MARIE, Mém. B.R.G.M. 28, 2, p. 1096, pl. 1, f. 2 (*nomen nudum*, no description).

pars 1966 *Valvulammina globularis* (d'ORBIGNY) ; J. HOFKER, Palaeontographica, Suppl. 10, p. 251, pl. 50, f. 11, 12 (non pl. 50, f. 13-16).

Remarks : The characteristic feature of this species is the broad cone with an apex larger than 90°. In the early part of the cone, the section is triangular. The chambers in the final whorl are more inflated. As they are more than three in the last whorl (genus *Valvulammina*) the triangular form is no longer found in the later part of the test. Possibly this form is a new species, because these features are not characteristic for *V. globularis* (d'ORBIGNY). However, our material did not yield enough specimens to decide. According to their figures the specimens recovered by MARIE, VAN BELLEN and HOFKER are slightly more slender with a conical angle smaller than 90°. We do not think that this form represents another generation of elongated triserial forms as it is claimed by HOFKER (1966 e, p. 251). Possibly our specimens form the transition between the genus *Valvulina* and the genus *Valvulammina* which is thought to have occurred during the Paleocene.

Occurrence :

1) "Mons well 1969" (88) : Specimens of this species were recovered only from the upper part of the calcarenite series in the "Mons well 1969" ; hence, the species is restricted to the interval of the Calcaire de Mons in its type section and just below (OB 46.30 to OB 12).

2) Other localities : This species was also recovered from the only samples of the Maurits III mine shaft we studied (depth 178, 180 m).

Known range :

Valvulina globularis was described from the Eocene of the Paris basin ; the specimens we encountered in the Calcaire de Mons have a triangular section in their early part. Such forms are probably restricted to the Paleocene. In our sections, the (cf.) species was only recovered from the Montian stratotype, but this restriction may result from the fact that the occurrence of this

species is linked to special environmental conditions (shallow, littoral, warm conditions). Very similar forms have been reported from the Bunde wells at comparable stratigraphic levels (VAN BELLEN, 1946 a, MARIE 1964).

Genus *TRILOCULINA* d'ORBIGNY, 1826

Triloculina ? natchitochensis HOWE

Pl. 4, f. 9

1939 *Triloculina natchitochensis* HOWE, Louisiana Dept. Cons. Geol. Bull. 14, p. 38, pl. 3, f. 3-5.

1951 *Triloculina natchitochensis* HOWE ; J.A. CUSHMAN, Geol. Surv. Prof. Pap. 232, p. 12, pl. 3, f. 3.

1966 *Miliola natchitochensis* (HOWE) ; J. HOFKER, Palaeontographica. Suppl. 10, p. 240, pl. 49, f. 55 ; p. 252, pl. 51, f. 24-27, pl. 52, f. 30.

Remarks : It is difficult to assess the genus to which this species belongs. Although typical triloculine tests were observed, some specimens show a tendency to a quinqueloculine test. The latter resemble *Quinqueloculina crassicosta* TERQUEM (1882, Mém. Soc. Géol. France, 3, 2, p. 185, pl. 20, f. 14 not 15, 16, 17) from the Middle Eocene of the Paris basin. The latter's type, refigured by Y. LE CALVEZ (1947, pl. 1, f. 10-12) shows a transitional stage between triloculine and quinqueloculine. Hence, it could be conspecific with part of our material. As it has been described as being a typical *Quinqueloculina* and as our specimens show more affinity to *Triloculina*, we preferred the name of HOWE's species.
The cribrate aperture which HOFKER (1966 e, p. 252) claimed to be well preserved in part of his material from the Netherlands (Maurits III mine shaft) was not observed in our material. The little holes near the aperture in our scanned specimen are thought to be due to the bad preservation of the material. Small holes occur in other parts of the test as well. The tooth of our figured specimen is probably broken out.

Occurrence :

1) "Mons well 1969" (61) : This species has been observed mainly in the upper part of the Tertiary calcarenites in the "Mons well 1969" with scattered specimens lower down : OB 62 to OB 18.

2) Other localities : We did not observe this species at other localities in Belgium.

Known range :

HOFKER (1966 e) stated that this species already appeared in his Me (= layers directly overlying the top of the Tuffaceous Chalk of Maastricht), in his Zone N.
CUSHMAN (1951) only observed it in one Paleocene locality of the Gulf Coast Region (Wilcox County, Ala.) occurring together with *Globorotalia acuta* TOULMIN, which probably indicates a Late Paleocene Age.
The range of this species covers at least part of the Paleocene, and possibly part of the Eocene, if we consider the material of Y. LE CALVEZ (1947) to belong to the same species.

Genus *SPIROLOCULINA* d'ORBIGNY, 1826

Spiroloculina alabamensis CUSHMAN

Pl. 4, f. 8

1944 *Spiroloculina alabamensis* CUSHMAN, Cushm. Lab. Foram. Res. Contrib. 20, p. 31, pl. 5, f. 8.
1951 *Spiroloculina alabamensis* CUSHMAN ; CUSHMAN, Geol. Surv. Prof. Pap. 232, p. 11, pl. 3, f. 1 a-b.
1966 *Spiroloculina alabamensis* CUSHMAN ; HOFKER, Palaeontographica, Suppl. 10, p. 252, pl. 51, f. 25.

Remarks : Our specimens resemble HOFKER's (1966 e) pictures very well. They are somewhat slenderer than CUSHMAN's holotype. The latter is approximately twice as long as broad, whereas our specimens, and HOFKER's according to his description, are approximately 3 times as long as broad. CUSHMAN, however, said the L/B ratio varied between 2 and 2 1/2 in his original material, and some of our specimens therefore are within the range of variation of CUSHMAN's material.

Occurrence :

1) "Mons well 1969" (112) : Rare specimens between OB 40.20 and 27.80.

2) Other localities : We did not recover this species from other localities, but it has been cited by HOFKER (1966 e) from the Bunde Kalk in the Bunde wells.

Known range :

Paleocene of the Gulf Coastal Region (U.S.A.)

Genus *QUINQUELOCULINA* d'ORBIGNY, 1826

Quinqueloculina sp.

Remarks : Smooth forms of *Quinqueloculina* were especially found in the higher part of the Obourg calcarenites. Their preservation does not allow a good specific determination. Similar specimens described and figured by POZARYSKA (1965), occur in the Polish Paleocene.

Occurrence :

"Mons well 1969" (98) : between OB 48 and OB 12.

Genus *GLOBULINA* d'ORBIGNY, 1839

Globulina sp. cf. *G. tuberculata* d'ORBIGNY

Pl. 5, f. 1 ; Pl. 13, f. 3, 4

cf. 1846 *Globulina gibba* d'ORBIGNY var. *tuberculata* d'ORBIGNY ; Foraminifères fossiles du Bassin de Vienne, p. 230, pl. 13, f. 21, 22.
1946 *Globulina gibba* d'ORBIGNY var. *tuberculata* d'ORBIGNY ; VAN BELLEN, Meded. Geol. Sticht. C. 5, 4, p. 38, pl. 3, f. 7.
? 1964 *Globulina tuberculata* d'ORBIGNY ; J. HOFKER, Foraminifera from the Cretaceous ... LXXX, Natuurhist. Maandbl. 54, p. 117, text. fig. 13 a-c, probably not 14 a-c.
1966 *Globulina tuberculata* d'ORBIGNY ; J. HOFKER, Palaeontographica Suppl. 10, p. 255, pl. 53, f. 66.
1968 *Globulina* cf. *tuberculata* d'ORBIGNY ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, (1968), p. 42, pl. 3, f. 6.

Remarks : In our material sutures could never be distinctly identified and hence, it is not certain that the specimens belong to *Globulina.*
POZARYSKA & SZCZECHURA (1968) observed that the specimens recovered from the "Montian" part of the Pamietowo well differ from HOFKER's (1964) figures by the more irregular filling of the surface with more numerous, blunt spines.

This applies to our material too, and hence the species was given with a cf. notation. The fact, however, that HOFKER's (loc. cit.) figures could be schematic might possibly account for this difference. It is not to be excluded that some forms pictured by VISSER (1951) determined by her as *Globulina lacrima* REUSS var. 1 (1951, p. 242, pl. 1, f. 12) are equally identical.

Occurrence :

1) "Mons well 1969" (84) : This species was recovered from OB 56.20 upwards to the top of the Calcaire de Mons (OB 13.90). Hence, it is known from Upper Danian strata and from the Montian stratotype.

2) Other localities : In the Mechelen-aan-de-Maas well this species (with smaller and blunter spines) was recovered from the Calcarenite of Mechelen-aan-de-Maas (MM 273). The "smaller" spines may be explained by the fact that the specimens are worn. However, the latter form may be closer to *Globulina gibba* d'ORBIGNY var. *punctata* d'ORBIGNY.

Known range :

According to HOFKER (1966 e), this species occurs from his Zone N upwards (Me, probably corresponding to the Upper Danian) to the end of Zone R (Calcaire de Mons and its lateral equivalents). Similar specimens were pictured from the Eócene (CUSHMAN, 1930, U.S.N.M. Proc. 77, 6, p. 68, pl. 17, f. 6, 7 ; CUSHMAN, 1935, U.S.G.S. Prof. paper, 181, p. 26) and the Miocene (d'ORBIGNY, 1846, original description of *G. gibba* var. *tuberculata*).

Globulina multistriata POZARYSKA & SZCZECHURA

1968 *Globulina gibba multistriata* POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, p. 41, pl. 3, f. 8.

Remarks : Only a few relatively well preserved specimens.

Occurrence :

1) "Mons well 1969" (72) : Between OB 48.10 and 72.10 ; not observed in the higher part of the calcarenite sequence.

2) Other localities : Not recovered in other samples, but mentioned from the Paleocene of Belgium and Dutch SE Limburg by POZARYSKA & SZCZECHURA (1968).

Known range :

Upper Danian, Montian.

Globulina sp.

Remarks : Our smooth specimens are rather large ; they are not transparent and as the sutures are not depressed they are not visible. Specific determination is impossible. *Globulina prisca* (REUSS) as pictured by VISSER (1959) resembles some of our forms, as does *Globulina ampulla* (JONES) of VAN BELLEN (1946 a, pl. 3, f. 2).

Occurrence :

"Mons well 1969" (64) : Well represented between OB 74.30 and OB 12.

Genus *GUTTULINA* d'ORBIGNY, 1839

Guttulina spp.

Remarks : Most of our ill-preserved specimens are rather large. Some resemble *Guttulina adhaerens* OLSZEWSKI, whereas others are similar to *Guttulina communis* d'ORBIGNY, though being more elongate.

Occurrence :

"Mons well 1969" (53) : From OB 78 to OB 12.

Genus *SIGMOMORPHINA* CUSHMAN & OZAWA, 1928

Sigmomorphina soluta BROTZEN

Pl. 6, f. 5

1948 *Sigmomorphina soluta* BROTZEN, Sver. Geol. Unders. C., 42, 2, p. 53, pl. 8, f. 6-10 ; text-f. 10, n° 16.
1965 *Sigmomorphina soluta* BROTZEN ; POZARYSKA Palaeont. Polon. 14, p. 90, pl. 12, f. 7.
1966 *Sigmomorphina soluta* BROTZEN ; HOFKER, Palaeontographica Suppl. 10, p. 71, pl. 12, f. 19 ; p. 90, pl. 15, f. 33, 34 ; p. 119, pl. 19, f. 39 ; p. 137, pl. 20, f. 32 ; p. 153, pl. 23, f. 127 ; p. 181, pl. 31, f. 40 ; p. 195, pl. 36, f. 28 ; p. 221, pl. 42, f. 54, 55 ; p. 242, pl. 47, f. 11.

Remarks : Our specimens are within the range of variation given by BROTZEN (1948) in the original description of the species.

Occurrence :

1) "Mons well 1969" (71) : Between OB 70 and OB 21.80 ; some scattered specimens have been observed.

2) Other localities : The species was recovered from the Maastrichtian (Ghlin well 49 m, Kallo well near Antwerp 490 m) from the Tuffeau de Ciply (ML, CA 6, LA 175), from the Calcaire de Mons (TH 18, COP 1), from the Calcarenite of Houthem (VR 1, MM 310), and from the Calcarenite of Mechelen-aan-de-Maas (MM 278). It was also found in younger Paleocene deposits : from the Paternostre well Formation (at LA 84), OV 1 (Heers Formation) and from WA 1 and Le Cornet Quarry, near Tournai, 14 (Lower Landen Formation).

Known range :

Maastrichtian, Danian, and younger Paleocene deposits.

Genus *BAGGATELLA* HOWE, 1939

Baggatella ? aenigmatica POZARYSKA & SZCZECHURA

Pl. 13, f. 5, 6

1970 *Baggatella aenigmatica* POZARYSKA & SZCZECHURA ; Acta Palaeont. Polon. 15, 1, p. 103, pl. 1, f. 1-2.

Remarks : The aperture is high but not always loop-shaped as in the type species of the genus *Baggatella.* The apertures of the holotype and paratype pictured by the Polish authors are similar to those observed in our material. Hence, it is not sure that the holotype of the species belongs to *Baggatella*.

Possibly *Globigerina compacta* HOFKER, described by its author from the Tuffaceous Chalk of Maastricht in the SE Netherlands is conspecific with this species. (HOFKER, 1956, XIX, Nat. Hist. Maandblad 45, p. 53, f. 16, 17, 21). Pending a better description and more accurate figures this identity cannot be established.

Occurrence :

1) "Mons well 1969" (17) : The range of this species covers the interval between the Cretaceous-Tertiary boundary at 80 m and a level close to the top of the Calcaire de Mons (OB 16.10).

2) Other localities : The species occurs in the Tuffeau de Ciply (CA).

Known range :

POZARYSKA & SZCZECHURA mention the species from the "Montian" interval of Pamietowo well and the Calcaire de Mons in "an Artesian well of the central part of the Mons basin", probably the Ecole des mines well (EM) in the city of Mons. They claim it to be a good guide fossil for the "Montian", but probably they rather want to emphasize that it is a good paleoecologic indicator, typical for the shallow warm water deposits like the Calcaire de Mons of the Mons basin.

The fact we observed it in the Tuffeau de Ciply indicates that its range covers at least the Middle Danian as well ; possibly it already occurs in the Maastrichtian.

Genus *VALVOBIFARINA* HOFKER, 1951

Valvobifarina paleocenica HOFKER
Pl. 6, f. 3

1966 *Valvobifarina paleocenica* HOFKER ; Palaeontographica, Suppl. 10, p. 250, pl. 57, f. 120.

Remarks : As far as can be seen the test has a calcitic, non-agglutinated wall with coarse pores, resembling that of *Bolivina* and especially *Bolivina eocenica* TERQUEM, 1882 of the Lutetian of the Paris basin. The latter species has a sharp to keeled margin. Some specimens with a sharper margin have been entered separately in the chart (117) as *Bolivina* ? cf. *B. eocenica* TERQUEM. Our *V. paleocenica* differs from *Bolivina oedumi* BROTZEN (1948), by the more inflated chambers and the less slender form of the test. As stated by LOEBLICH & TAPPAN

(1964), *Valvobifarina* is not an arenaceous genus.

Occurrence :

1) "Mons well 1969" (75) : Some rare specimens in the lower part of the Obourg calcarenites : OB 70 and OB 60. *B* ? sp. cf. *B. eocenica* (117) occurs in the higher part between OB 36.10 and OB 32.40.

2) Other localities : None.

Known range :

HOFKER (1966 e) recorded the species mainly from his Zone R, but he also found some rare specimens in his Zone P ; hence, the species occurs in the Middle to Upper Danian and Montian deposits.

Genus *"BIGENEROPLIS"* MARIE, 1951

"Bigeneroplis vanrijsingei" MARIE

Pl. 6, f. 6

1964 *Bigeneroplis vanrijsingei* MARIE, Mém. B.R.G.M., 28, pl. 2, f. 1, 2. (genus and species names are *nomina nuda*).

Remarks : The genus name *Bigeneroplis* has been published in 1950 by MARIE as a *nomen nudum* ; the figure published in 1964 is clear and it allows a certain determination of our specimens, but as a description is still lacking both genus and species are to be considered *nomina nuda* at the moment. These forms are biserial in their early part, later uniserial, costate throughout. As we recovered only a few specimens which are not too well preserved we prefer not to validate these taxonomic units in this paper, although they are believed to belong to MARIE's species. The material is calcareous, probably not agglutinated, but this cannot be ascertained as the material is strongly recrystallized. *Bigeneroplis* would differ from *Bigenerina* by its stellate aperture and probably by the wall structure, which is agglutinated in *Bigenerina.* In our material the aperture was round, areal terminal.

Occurrence :

1) "Mons well 1969" (111) : A couple of specimens recovered at OB 30 and OB 40.20.

2) Other localities : The species has not been recovered from other localities so far, except for the figured specimen of MARIE (1964) found in the Calcaire de Mons (COP).

Known range :

Upper Danian and Montian

Genus *ANGULOGERINA* CUSHMAN, 1927

Angulogerina europaea CUSHMAN & EDWARDS

Pl. 14, f. 7, 8

1937 *Angulogerina europaea* CUSHMAN & EDWARDS ; Contr. Cushman Lab. Foram. Res. 13, 2, p. 61, pl. 8, f. 17 a-b, 18.

1948 *Angulogerina europaea* CUSHMAN & EDWARDS ; BROTZEN, Sver. Geol. Unders. C, 493, Arsb. 42, 2, p. 64, pl. 6, f. 9.

1958 *Uvigerinella europaea* (CUSHMAN & EDWARDS) ; HAYNES, Contr. Cushman Found. Foram. Res.,9, 3, p. 74, pl. 16, f. 16.

non 1966 *Reussella europaea* (CUSHMAN & EDWARDS) ; HOFKER, Palaeontographica, Suppl. 10,p. 242, pl. 49, f. 58.

1968 *Angulogerina europaea* CUSHMAN & EDWARDS ; POZARYSKA & SZCZECHURA, Palaeont. Polon., 20, (1968), p. 48, pl. 1, f. 1-7.

Remarks : Only occasional small specimens were found and the variation of the species in our material could therefore not be evaluated.

Occurrence :

1) "Mons well 1969" (55) : Scattered occurrences throughout the calcarenite sequence (OB 78 - OB 12).

2)Other localities : Mechelen-aan-de-Maas well (MM) between 273 m and 290 m in the Calcarenite of Mechelen-aan-de-Maas.

Known range :

Rare from the Lower Paleocene (Danian) to the Upper Paleocene (Thanetian).

Angulogerina sp. cf. *A. cuneata* BROTZEN

cf. 1948 *Angulogerina cuneata* BROTZEN, Sver. Geol. Unders. C, 42, 2, p. 64, pl. 6, f. 10.

cf. 1965 *Angulogerina cuneata* BROTZEN ; POZARYSKA, Palaeont. Polon. 14, p. 99, pl. 15, f. 7 a-b.

Remarks : Our material is given a cf. notation because the few, small, atypical specimens have blunt edges without keels.

Occurrence :

1) "Mons well 1969" (68) : Rare specimens from OB 72.10 to OB 32.40.

2) Other localities : none.

Known range :

Danian to Montian of Poland ; rare in the Post-Danian Paleocene of Sweden.

Genus *DISCORBIS* LAMARCK, 1804

Discorbis bundensis VAN BELLEN

Pl. 14, f. 1, 2

1946 *Discorbis bundensis* VAN BELLEN ; Meded. Geol. Sticht. C, 5, 4, p. 47, pl. 4, f. 19-24.

Remarks : As our specimens are generally strongly recrystallized it was not possible to observe the aperture and the umbilical structure accurately. In some specimens the aperture was observed at the base of the final chamber, close to the umbilicus or in the umbilicus itself. The specific determination of our material is mainly based on the limbate and strongly curved sutures of the final whorl at the spiral side. HOFKER's figured specimens (1966 e, p. 258, pl. 54, f. 88 - 90) are much less conical than the holotype and paratype, figured by VAN BELLEN. They probably belong to another taxon.

Occurrence :

1) "Mons well 1969" (92) : This species was found in the type section of the Calcaire de Mons and in some samples below it (56.20 m to 12 m depth).

2) Other localities : The species has not been observed by us from other localities in Belgium.

Known range :

VAN BELLEN described this species from the upper layers of the Bunde Kalk, a sediment which is a lateral equivalent of the Calcaire de Mons (Montian).

The fact that it has not been encountered in other Paleocene sediments of Belgium, may result of peculiar ecological conditions during deposition of both the Calcaire de Mons and the Bunde Kalk.

Discorbis quadrata (TERQUEM)

1882 *Rosalina quadrata* TERQUEM, Mém. Soc. Géol. France, 1882, 3, 2, p. 98, pl. 10, f. 12.
1949 *Discorbis quadrata* (TERQUEM) ; Y. LE CALVEZ, Mém. Carte Géol. France, 1949, p. 25, pl. 2, f. 21-23.
1961 *Discorbis quadrata* (TERQUEM) ; KAASSCHIETER, Verh. Kon. Belg. Inst. Nat. 147, p. 208, pl. 10, 17 a-c.
1968 *Discorbis quadrata* (TERQUEM) ; POZARYSKA & SZCZECHURA, Paleont. Polon. 20, p. 49, pl. 2, f. 3.

Remarks : The strongly recrystallized specimens are poorly preserved. Some of them are less flat, and their general shape is close to that of *Rosalina brotzeni* HOFKER, 1961 and to that of the forms ascribed to the latter taxon by POZARYSKA & SZCZECHURA (1968, p. 51, pl. 2, f. 1). The apertural and umbilical features could not be observed in our specimens.

Occurrence :

1) "Mons well 1969" (93) : Ranging from OB 56.20 to OB 24.

2) Other localities : Except for some dubious specimens in the Tuffeau de Ciply (CA) the species has not been observed.

Known range :

Paleocene to Middle Eocene. (Paris Basin)

Discorbis ? lenae n. sp.

Pl. 1, f. 2 ; Pl. 14, f. 3, 4, 5, 6

Holotype : N° 1 of collection of the Faculté Polytechnique de Mons. Specimen figured pl. 1, f. 2.

Paratypoids : N° 2, 3 in the same collection of Mons.

Type level : Calcarenite member underlying the Calcaire de Mons in its type section, Middle to Upper Danian.

Type locality : "Mons well 1969" (approximately 14 m south of the classical Goffint Pit) at Obourg, sample OB 74, near Mons, Belgium.

Name : Named in honour of Mrs. Lena Moorkens-Lepee who gave considerable help in the routine analysis of the material.

Deposition of specimens : Collection of Geol. Inst., Faculté Polytechnique, Mons, Belgium.

Diagnosis : Trochoid form with a strongly convex spiral side, which shows a highly raised spiral suture, concave chamber walls and five chambers in the last whorl ; periphery lobate.

Description : The calcareous test is strongly trochoid, the high, convex spiral side is completely evolute with clearly limbate sutures, the spiral suture strongly protruding. There are approximately five chambers in the last whorl. The umbilical side is nearly flat, the umbilicus is vaguely depressed, the highly arched aperture lies close to the umbilicus. At the spiral side the sutures are almost radial ; the periphery which is bordered by a strong keel, is lobate the chamber form at the spiral side is not elongate or crescent-shaped but has approximately the form of a circle segment. The sutures at the umbilibal side are slightly depressed and probably radial. The wall is smooth.

Remarks : As the aperture is not a typical *Discorbis*-aperture the generic determination remains uncertain. This species has only 5 chambers in the last whorl, whereas *Discorbis bundensis* VAN BELLEN has 7 to 10 chambers in the last whorl. The sutures are nearly radial in *D. lenae*, whereas they are strongly curved backward in *D. bundensis.* In the latter species the chamber form at the spiral side is crescent-shaped, whereas it is not crescent-shaped in *D. lenae.* The periphery is lobate in the new species ; in *D. bundensis* the periphery is not lobate at all.

Occurrence :

1) "Mons well 1969" (74) : This species was recovered from nearly the whole interval between the local Maastrichtian-Danian boundary (OB 74) and the top of the Calcaire de Mons (12 m).

2) Other localities : This species has not yet been encountered in other localities in Belgium.

Known range :

At the moment the species is known only from Middle - Upper Danian and from the type section of the Calcaire de Mons in the "Mons well 1969" (Montian).

Measurements :

in : mm.	Holotype	Paratypoids 1	2
Max. diam.	0.23	0.25	0.24
min. diam.	0.20	0.20	0.21
thickness	0.16	0.15	0.13

Discorbis ? *renemarlierei* n. sp.

Pl. 1, f. 3 ; Pl. 15, f. 5, 6

Holotype : N° 4 of collection of the Faculté Polytechnique de Mons, Belgium. Specimen figured pl. 1, f. 3.

Paratypoids : N° 5, 6 in the same collection of Mons.

Type level : Calcaire de Mons in its type section (= Montian Stratotype), sample OB 32.40 in the Obourg well.

Type locality : "Mons well 1969", 14 m south from the classical Puits Goffint, Obourg, Belgium.

Name : Named in honour of Prof. Dr. R. MARLIERE, Geol. Institute Faculté Polytechnique, Mons, Belgium.

Deposition of specimens : Collection of Geol. Inst., Faculté Polytechnique, Mons, Belgium.

Diagnosis : A trochoid form with peculiar ornamentation at the spiral side : each chamber is ornamented by a circular rib which surrounds a field with coarse pores ; the "circular ribs" of the different chambers do not touch each other.

Description :

Calcareous test, trochospiral, rather conical, evolute at spiral side with typical ornamentation : each chamber (at least those of the last whorl) shows a circular to oval rib which follows the sutures and the keel of that chamber at the inner side and which leaves a depressed central part of the chamber with few, but coarse pores. The ornaments of the different chambers of the last whorl do not touch each other ; they are less clear in previous whorls.
The umbilical side is flat, with radial flush sutures. The aperture lies very close to the shallow umbulicus, at the base of the apertural face following this base to half-way the radius of the umbilical side. The final whorl counts approximately eight chambers. The periphery is only vaguely lobate, and bordered by a keel. Except for the ornamentation and the large pores at the spiral side, the wall is smooth.

Measurements :

in : mm.	Holotype	Paratypoids 1	2
max. diam.	0.26	0.26	0.23
min. diam.	0.23	0.24	0.21
thickness	0.15	0.15	0.12

Remarks : The generic determination is uncertain as the aperture is not a typical *Discorbis* aperture. This species differs further from other *Discorbis* species by its ornamentation of the spiral side.

Occurrence :

1) "Mons well 1969" (100) : This species was only recovered from 46.40 m - 32 m.

2) Other localities : The species has not been recognized elsewhere in Belgium.

Known range :

From its range in the "Mons well 1969", it seems that this species is restricted to the Upper Danian. However this restricted distribution may be due to ecology.

Genus *ROTORBINELLA* BANDY, 1944

Several species have here been assigned with some doubt to *Rotorbinella*. It is thought that they all may belong to another genus not yet described. Characteristic for all these forms is the central part of the umbilical side, filled with numerous knobs, and the place of the aperture near this centre.

At the spiral side chambers are often inflated, hemispherical, but forms with flatter chambers occur as well. Earlier workers have assigned most of these species to *Discorbis* (e.g. *Discorbis corrugata* of VAN BELLEN, non CUSHMAN). Our material is too poorly preserved to describe a new genus.

It is thought that in addition to our Paleocene species given as *Rotorbinella*, also the Middle Eocene *Rosalina parisiensis* d'ORBIGNY (given as *Rosalina* by Y. LE CALVEZ, 1970 ; as *Discorbis* by KAASSCHIETER, 1961) belongs to this group.

The genus differs from *Discorbis* and from *Rosalina* described in LOEBLICH & TAPPAN, (1964) by the numerous knobs filling the central part of the umbilical side.

Rotorbinella montiana POZARYSKA & SZCZECHURA

Pl. 1, f. 4 ; Pl. 2, f. 1 ; Pl. 5, f. 4, 5, 6, 7

1946 *Discorbis corrugata* (CUSHMAN & BERMUDEZ) ; VAN BELLEN, Meded. Geol. Sticht. C., 5, 4, p. 49, pl. 5, f. 7-13 (non *Anomalina corrugata* CUSHMAN & BERMUDEZ 1937, Contr. Cushman Lab. Foram. Res. 13, p. 27 ; pl. 2, f. 57-59).

? 1960 *Boldia carinata* var. 1, DROOGER, Proceed. Kon. Ned. Akad. Wet. Ser., B, 63, 4, p. 454, pl. 1, f. 11 a-c.

1966 *Rotorbinella corrugata* (CUSHMAN & BERMUDEZ) ; HOFKER (non *A. corrugata* CUSHMAN &

BERMUDEZ) Palaeontographica Suppl. 10, p. 258, pl. 54, f. 85-87.

1968 *Rotorbinella montiana* POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, (1968), p. 55, pl. 6, f. 5-6.

Remarks : In addition to a large number of typical forms almost identical with the figured holotype, we recovered a number of specimens with the chambers less inflated at the spiral side (var. 1). In others the chambers are not globulous, but elevated as cones ; the summit of the "cones" is generally broken off (var. 2). This feature is to be seen on our figured specimen, Pl. 2, f. 1. These variants could not be found in the literature.

Occurrence :

1) "Mons well 1969" (34,60 63) : The typical form and both variants occur throughout the Paleocene calcarenites of this well.

2) Other localities : This species was recovered from the Tuffeau de Ciply (CA) and from its lateral equivalent, the Calcarenite of Houthem (MM, VR) where only the typical form was met with (inflated chambers at spiral side).

Known range : Middle ? to Upper Danian, Montian.

This species has not been found in Maastrichtian or older sediments. It was not found either in the lower part of the type section of the Tuffeau de Ciply, or in sediments younger than the top of the Calcaire de Mons in OB.
The fact that this species is already found from 80 m upwards in the "Mons well 1969" (i. e., from the local Maastrichtian - Danian boundary onward) together with "primitive" *G. daubjergensis* populations of Middle (?) Danian Age, indicates that this species cannot be considered a stratigraphic "guidefossil" for the "Montian" but as has been claimed by POZARYSKA & SZCZECHURA (1968) it is a good paleoecological indicator. INDANS (1965, p. 13) cites this species as *Discorbis corrugata* from the Paleocene of the Krefeld region (Niederrheinische Bucht) together with the characteristic *Rotalia* species of the Calcaire de Mons (Montian)

Rotorbinella sp. cf. *R. mariei* (VAN BELLEN)

cf. 1946 *Parrella mariei* VAN BELLEN, Meded. Geol. Sticht. C., 5, 4, p. 70, pl. 10, f. 1-6.

cf. 1957 *Rotorbinella mariei* (VAN BELLEN) ; HOFKER, Natuurhist. Maandbl. 46, 9-10, p. 123, text. - f. 2 (not text - f. 1).

cf. 1964 *Pozaryskaia mariei* (VAN BELLEN), MARIE, Mém. B.R.G.M., 28, 2, p. 1098, pl. 2, f. 5 a-c (genus name is *nomen nudum).*

cf. 1966 *Rotorbinella mariei* (VAN BELLEN) ; HOFKER, Palaeontographica Suppl., 10, p. 257, pl. 54, f. 91-93.

cf. 1968 *Rotorbinella mariei* (VAN BELLEN) ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, (1968), p. 54, pl. 4, f. 1-3, pl. 17, f. 1-4.

Remarks : This species possibly is another variant of *R. montiana*. The majority of our specimens differ from the described and figured ones by the absence of knobs or spines, and of limbate sutures on the spiral side. Only some of our specimens show these features clearly, whereas the numerous other specimens have a nearly smooth side. The smooth surface, may be due to corrosion ; this would explain why the spiral side is rough and badly preserved. However, the characteristic knobs in the central part of the umbilical side, are present and they fill the central

part of the umbilical side which indicates that there is more affinity with *P. mariei* than with other *Rotorbinella* species. This feature was figured for holotype and paratype by VAN BELLEN (1946) and it was also pictured by MARIE (1964) for his hypotype of the Bunde Kalk.

Occurrence :

1) "Mons well 1969" (70) : The range of *R.* sp. cf. *R. mariei* covers the interval of the Calcaire de Mons and a large part of the underlying Tertiary sediments ; the lowest occurrence in the "Mons well 1969" is at 72.10 m.

2) Other localities : The species had not been recovered from other localities studied in Belgium before, except for samples of the Calcaire de Mons in the neighbourhood of Obourg (COP).

Known range : Middle ? to Upper Danian, Montian.

This species is only known from the Lower Tertiary calcarenites of the "Mons well 1969" and the Bunde Kalk in the SE Netherlands.

Rotorbinella papillata POZARYSKA & SZCZECHURA

Pl. 5, f. 3

1968 *Rotorbinella papillata* POZARYSKA & SZCZECHURA ; Palaeont. Polon., 20, (1968), p. 56, pl. 6, f. 11.

Remarks : This species shows great affinity with *Rotorbinella montiana* POZARYSKA & SZCZECHURA, from which it differs only in the rough, pitted surface. Perhaps it is only an ecological variety of that species.

Occurrence :

1) "Mons well 1969" (130) : Found only in one sample (13.90) of the Calcaire de Mons.

2) Other localities : Some rare specimens were recovered from the upper part of the Calcarenite of Houthem (VR).

Known range : Upper Danian to Montian.

The species had been recognized by POZARYSKA & SZCZECHURA from the Calcaire de Mons and from the Bunde Kalk (Montian). As we recovered some specimens from the Calcarenite of Houthem (VR) which is of Danian Age, it seems that this species cannot be used as a guide-fossil to distinguish sediments of Post-Danian Age from Danian deposits, as had been claimed by POZARYSKA & SZCZECHURA (1968).

Rotorbinella pozaryskae n. sp.

Pl. 2, f. 2

Holotype : N° 7 of collection Faculté Polytechnique de Mons.
Specimen figured Pl. 2, f. 2.

Paratypoids : N° 8, 9 of same collection.

Type stratum : Lower part of the Lower Tertiary calcarenite sequence in the "Mons well 1969", sample OB 64.20.

Type level : Danian, probably Middle Danian.

Type locality : "Mons well 1969" at Obourg, approximately 14 m south of the classical Puits Goffint, near Mons, Belgium.

Diagnosis : A planoconvex *Rotorbinella* species with some six chambers in the last whorl, a lobate periphery, chambers slightly inflated at the spiral side.

Description : Test planoconvex, occasionally somewhat concave at the umbilical side ; six chambers in the last whorl. At the umbilical side the sutures slightly depressed, especially those between the last chambers.
The chambers at the spiral side are smooth, slightly inflated, but less so than in typical forms of *R. montiana*. The periphery is keeled and lobate, mainly in the last chambers ; the aperture is a slit at the umbilical side at the base of the final chamber, not extending to the periphery.
The wall is probably smooth, but recrystallized.

Measurements :

in : mm.	Holotype	Paratypoids 1	2
max. diam.	0.45	0.43	0.34
min. diam.	0.35	0.33	0.28
thickness	0.20	0.18	0.15

Remarks : The chambers increase more rapidly in size in the last convolution than in *R. montiana* ; a further distinction with this species is possible by the lobate periphery in *R. pozaryskae*.

Name : The name has been given in honour of Professor Dr. Krystyna POZARYSKA, Warszawa.

Occurrence :

1) "Mons well 1969" (43) : Only present in the lower part of the calcarenite sequence ; OB 79 to OB 64.20 and a single specimen in OB 40.

2) Other localities : This species occurs already in the deeper samples of the Tuffeau de Ciply, where it is the only *Rotorbinella* species recovered ; in the higher samples it is replaced by *R. montiana* without lobate periphery and with more inflated chambers.

Known range :

Middle Danian into part of the Upper Danian, not extending into the Calcaire de Mons (Montian).

Genus *EPISTOMINELLA* HUSEZIMA & MARUHASI, 1944

Epistominella sp. cf. *E. limburgensis* (VISSER)

Pl. 15, f. 3, 4

cf. 1951 *Pseudoparrella limburgensis* VISSER ; Leidse Geol. Meded. 16, p. 278, pl. 7, f. 10.
cf. 1961 *Pseudoparrella limburgensis* VISSER ; HOFKER, Foraminifera from the Cretaceous ... LIII,Natuurhist. Maandbl. 50, p. 67, text - f. 9-10.
cf. 1965 *Pseudoparrella limburgensis* VISSER ; POZARYSKA, Palaeont. Polon. 14, (1965), p. 113, pl. 16, f. a-c.
pars 1966 *Pseudoparrella limburgensis* VISSER ; HOFKER, Palaeontographica, Suppl. 10, p. 231, pl. 46, f. 143, 144 ; p. 245, pl. 47, f. 18.
non 1966 *Pseudoparrella limburgensis* VISSER ; HOFKER, Palaeontographica, Suppl. 10, p. 95, pl. 16, f. 46 ; p. 141, pl. 20, f. 36 ; p. 169, pl. 29, f. 66 ; p. 187, pl. 34, f. 109.
1968 *Epistominella* cf. *limburgensis* (VISSER) ; POZARYSKA & SZCZECHURA, Palaeont. Polon., 20, (1968), p. 50, text - f. 11, 1-5.

Remarks : Our abundant material has only tentatively been determined as *E. limburgensis*, because it is difficult to judge from VISSER's (1951) figures whether our specimens resemble the holotype of the species. Our specimens would differ from the pictured specimens of HOFKER (1961) and from part of the specimens figured in his 1966 e paper, in the umbilicus, which is closed and without a plug. Our specimens resemble POZARYSKA & SZCZECHURA's schematically pictured forms (1968, text-fig. 11, 1-5) better ; from POZARYSKA's (1965) figured specimen they differ in their stronger keel, that borders the entire periphery.
It is possible that the Paleocene forms pictured by POZARYSKA & SZCZECHURA (1968) and our specimens which are almost identical, belong to a new species.
As we did not see the types selected by VISSER for *Pseudoparrella limburgensis* and *P. meeterenae*, which according to her figures show some affinity with our material, we prefer to leave these specimens provisionally in open nomenclature.

Occurrence :

1) "Mons well 1969" (31) : The range covers the whole interval between the local Maastrichtian-Danian boundary and the top of the Calcaire de Mons.

2) Other localities : The species was observed in the Tuffeau de Ciply (CA). It also occurs in NE Belgium and the SE Netherlands in the Calcarenite of Houthem (Middle to Upper Danian) ; it is not sure whether the specimen figured by VAN BELLEN (1946) as *Eponides minimus* (CUSHMAN) belongs to *E.* cf. *limburgensis* as claimed by POZARYSKA & SZCZECHURA (1968, p. 50), as the aperture is not said to be loop-shaped.

Known range :

As we do not know whether our material is identical with the Maastrichtian species described by VISSER, it is not sure that the range of this form starts in the Upper Maastrichtian, or whether it is restricted to the Tertiary. This form is present in the Danian of Denmark and Belgium, the Tuffeau de Ciply (CA) and the Calcarenite of Houthem (in the quarry Curfs, CU) according to hofker (1961, 1966 e). It has now been found in the type Montian.
According to POZARYSKA & SZCZECHURA it even ranges higher up in the Paleocene (Thanetian).

Genus *ROSALINA* d'ORBIGNY, 1826

Rosalina selandiana POZARYSKA & SZCZECHURA

1968 *Rosalina selandiana* POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, p. 52, pl. 2, f. 4.

Remarks : Our specimens are generally more evolute than the holotype, and the chambers are generally less elongate at the spiral side.

Occurrence :

1) "Mons well 1969" (96) : Some rare specimens in the middle part of the Obourg calcarenite sequence (OB 48.10 to 46.40).

2) Other localities : We did not recover the species from any other locality, but HOFKER (1966 e) recovered it in the Curfs quarry (CU) in his Zone P.

Known range :

POZARYSKA & SZCZECHURA (1968) mention a range from the Montian of Poland to the Thanetian in W Europe. If HOFKER's (1966 e) *Neoconorbina (Rosalina) parisiensis* is included in the species, as suggested by the Polish authors, its range would also cover the Danian.

Rosalina elegans HANSEN

1970 *Rosalina elegans* HANSEN, Meded. Grønl. 193,2, p. 77, pl. 8, f. 9-11, pl. 20, f. 1-6.

Remarks : In addition to specimens resembling the holotype some more inflated forms and some with a more rounded periphery were found.

Occurrence :

1) "Mons well 1969" (80) : This species ranges from OB 63.80 to OB 36.10 (Upper Danian).

2) Other localities : Some dubious, poorly preserved specimens in the Tuffeau de Ciply (CA).

Known range :

Upper Danian of West Greenland and of Belgium.

Genus *SIPHONINA* REUSS, 1850

Siphonina prima PLUMMER

Pl. 6, f. 1

1926 *Siphonina prima* PLUMMER, Texas Univ. Bull. 2644, p. 148, pl. 12, f. 4.
1948 *Pulsiphonina elegans* BROTZEN, Sver. Geol. Unders., 42, 2, p. 107, pl. 17, f. 5 a-c.
1951 *Siphonina prima* PLUMMER ; CUSHMAN, Geol. Surv. Prof. Pap. 232, p. 55, pl. 15, f. 7-9.
1956 *Pulsiphonina prima* (PLUMMER) ; HAYNES, Contr. Cushman Found. Foram. res. 7, 3, p. 96, pl. 17, f. 9.
1960 *Siphonina prima* PLUMMER ; DROOGER, Proceed. Kon. Ned. Akad. Wet. B, 63, 4, p. 452, pl. pl. 1, f. 4.
1961 *Siphonina prima* PLUMMER ; KAASSCHIETER, Verh. Kon. Belg. Inst. Nat., 147, p. 230, pl. 15, f. 2.

1965 *Siphonina prima* PLUMMER ; POZARYSKA, Palaeont. Polon. 14, (1965), p. 111, pl. 16, f. 3, 6.

1966 *Siphonina prima* PLUMMER ; HOFKER, Palaeontographica. Suppl. 10, p. 209, pl. 40, f. 71 ; p. 230, pl. 42, f. 77-78 ; p. 314 also pl. 83, f. 207-208.

Occurrence :

1) "Mons well 1969" (40) : The species has only been recovered from the basal samples (OB 79) and OB 76) of the Lower Tertiary calcarenites, but its absence in higher layers is probably due to unfavourable ecological circumstances. It was also only recovered from the lower samples of the Lower Tertiary calcarenites in the EM well (POZARYSKA, 1965). The species is probably linked to deeper neritic conditions as it was not recovered from littoral deposits like the Calcaire de Mons and the Bunde Kalk (VAN BELLEN, 1946).

2) Other localities : Craie phosphatée de Ciply (CA) ; Lower Maastrichtian deposits of the Ghlin well at 61,5 m depth ; Tuffeau de Ciply (CA, CB, ML 5, uppermost sample, LI upper samples) ; Calcarenite of Houtem (VR) ; Heers Formation, Sands of Orp (ORP) ; Tuffeau de Chercq (LC) ; Lower Landen Formation (WA) ; Formation of the Paternostre well (LA) ; Mechelen-aan-de-Maas, well (MM 289,5-219) covering Calcarenite of Mechelen-aan-de-Maas, Heers Formation and Lower Landen Formation.

Known range :

Rare in the Maastrichtian ; frequent in the whole Paleocene and Lower Eocene. Similar forms occur in the Middle Eocene of Belgium and the Paris basin.

Genus *EPISTOMARIA* GALLOWAY, 1933

Epistomaria bundensis (VAN BELLEN)

Pl. 6, f. 2

1946 *Ceratobulimina bundensis* VAN BELLEN, Meded. Geol. Sticht. C, 5, 4, p. 68, pl. 9, f. 13-18.

1966 *Epistomaria bundensis* (VAN BELLEN) ; HOFKER, Palaeontographica, Suppl. 10, p. 261, pl. 53, f. 74-76 ; pl. 54, f. 77-79.

Remarks : This *Epistomaria* species somewhat resembles the Eocene *Epistomaria rimosa* (PARKER & JONES, 1865) (= *Epistomaria semimarginata* (d'ORBIGNY, 1882)). However, tests are higher at the umbilical side, and they are thicker in *E. bundensis.*

Occurrence :

1) "Mons well 1969" (95) : Rare specimens between OB 30 and OB 38.20 ; a single specimen recovered in OB 48.10 is possibly due to caving as it is yellow in white to gray sediment.

2) Other localities : We did not recover the species from other localities, but HOFKER (1966 e) recorded it in his Zone R from the Bunde Limestone in several Bunde wells and also in the Geleen mineshaft. VAN BELLEN had observed it in the higher part of the Bunde Limestone in two Bunde wells.

Known range :

Upper Danian to Montian.

Genus *SPIRILLINA* EHRENBERG, 1843

Spirillina striatogranulosa TERQUEM

Pl. 6, f. 4

1882 *Spirillina striato-granulosa* TERQUEM . Mém. Soc. Géol. France, 3, 2, p. 33, pl. 1, f. 30.
1882 *Spirillina nodifera* TERQUEM ; Mém. Soc. Géol. France, 3, 2, p. 33, pl. 1, f. 32 a-b.
1909 *Spirillina selseyensis* HERON-ALLEN & EARLAND ; Journ. Roy. Micr. Soc., pl. 18, f. 6-7.
1948 *Spirillina nodifera* TERQUEM ; BROTZEN, Sver. Geol Unders. C, 42, 2, p. 67, pl. 10, f. 12.
1949 *Spirillina striato-granulosa* TERQUEM ; Y. LE CALVEZ, Mém. Carte Géol. France, Révision des Foram. Lutétiens II, p. 11, pl. 1, f. 3-4.
1951 *Spirillina selseyensis* HERON-ALLEN & EARLAND ; CUSHMAN, Geol. Surv. Prof. Pap. 232, p. 47, pl. 13, f. 13, 14.
1968 *Spirillina* cf. *nodifera* TERQUEM ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, p. 58, pl. 3, f. 1-3.
1970 *Spirillina striatogranulosa* TERQUEM ; HANSEN, Meddel. Grønl. 193, 2, p. 81, pl. 19, f. 5-6.

Remarks :

The synonymy of *S. striatogranulosa* TERQUEM, *S. nodifera* TERQUEM and *S. selseyensis* HERON-ALLEN & EARLAND has been discussed by Y. LE CALVEZ (1949). With the exception of the figured specimen of OB 16.10 the state of preservation of our material is poor and the ornamentation is in most cases obscure.

Occurrence :

1) "Mons well 1969" (45) : Scattered specimens from nearly the entire calcarenite sequence between OB 79 and OB 16.10.

2) Other localities : Some dubious recrystallized specimens in the Tuffeau de Ciply (CA).

Known range :

This cosmopolitan species ranges from at least the Upper Danian to the Middle Eocene.

Genus *PATELLINA* WILLIAMSON, 1858

Patellina paleocenica (HOFKER)

Pl. 15, f. 1, 2

1948 *Patellina* sp. ; BROTZEN, Sver. Geol. Unders. C, 193, Arsb. 42, 2, p. 71, pl. 9, f. 6.
1962 *Discobolivina paleocenica* HOFKER ; Foraminifera of the Cretaceous .... LVII, Natuurh. Maandbl. 51, 1, p. 11, f. 9 a-c.
1966 *Discobolivina paleocenica* HOFKER ; HOFKER, Palaeontographica Suppl. 10, p. 224, pl. 45, f. 134.
1968 *Patellina* sp. ; POZARYSKA & SZCZECHURA, Palaeont. Polon., 20 (1968), p. 57, pl. 3, f. 4, 5.

Remarks : LOEBLICH & TAPPAN (1964, p. c. 603) consider the genus *Discobolivina* HOFKER to be a junior synonym of the genus *Patellina* WILLIAMSON. In the few specimens recovered from the

"Mons well 1969", the initial part of the hyaline transparent test consists of the spherical proloculus and an embracing second chamber which follows the outside of the proloculus over approximately half its circumference.
This feature is typical for the genus *Patellina*, whereas HOFKER's genus *Discobolivina* was described for species without such an embracing second chamber. All the other features of this specimen, however, point to HOFKER's (1962) species *Discobolivina paleocenica.*

Occurrence :

1) "Mons well 1969" (113) : Single specimens from 38.20 to 16.10 m depth.

2) Other localities : We did not recover this species from other Belgian or Dutch localities.

Known range :

Rare in the Swedish and the North American Middle to Upper Paleocene (= younger than Danian). Rare in the Polish Middle Paleocene ("Montian") according to the specimen of *Patellina* sp. figured by POZARYSKA & SZCZECHURA.

Genus *ROTALIA* LAMARCK, 1840

Only external features have been considered in our analysis of the *Rotalia-Pararotalia* group, the state of preservation of our material being too poor to analyse the specimens in thin sections. For the external features we used as much as possible the terminology summarized by PARVATI (1971).

Rotalia sp. cf. *R. trochidiformis* (LAMARCK)

Pl. 7, f. 1 ; Pl. 16, f. 1, 2

cf. 1804	*Rotalites trochidiformis* LAMARCK, Ann. Mus. 5, p. 184.
cf. 1806	*Rotalites trochidiformis* LAMARCK ; LAMARCK, Ibid. 8, pl. 14, f. 8, a-b.
1946	*Rotalia trochidiformis* (LAMARCK) ; VAN BELLEN, Meded. Geol. Sticht. C, 5, 4, p. 82, pl. 9, f. 4-9.
? 1951	*Eponides hemisphaericus* (REUSS) ; A.M. VISSER, Leidse Geol. Meded. 16, p. 273, pl. 6, f. 1 a-c.
1955	*Rotalia trochidiformis* (LAMARCK) ; HOFKER, Foram. of the Cretaceous ... XI, Natuurhist. Maandbl. 44, (11-12) pp. 119-120, text - f. a-c.
cf. 1963	*Rotalia trochidiformis* (LAMARCK) ; VAN HINTE, Jb. Geol. Bundesanst. Sond. 8, p. 122, pl. 20, f. 1 a-b.
1966	*Rotalia trochidiformis* (LAMARCK), HOFKER, Palaeontographica, Suppl. 10,pp. 170, 190, 199, 262, 292, pl. 28, f. 42 a-c ; pl. 34, f. 96 a-b ; pl. 35, f. 20 ; pl. 42, f. 71, pl. 47, f. 19 ; pl. 55, f. 98-100.
? 1968	*Rotalia trochidiformis* (LAMARCK) ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, (1968), p. 62, pl. 5, f. 10 a-b.
1968	*Rotalia trochidiformis* (LAMARCK) ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, (1968), p. 62, pl. 17, f. 5-8.

Remarks :

We compared our material with a few topotype specimens of *R. trochidiformis* from the Lutetian at Grignon in the Paris basin. It seems that our specimens are probably flatter than those from Grignon. However, a large variation occurs for this feature in the populations of the

Calcaire de Mons (in OB, LA).
It seems that the specimens of the Calcarenite of Houthem (in VR, MM) are somewhat flatter than those of the Bunde Kalk (collection VAN BELLEN, Utrecht).
Our material has not been analysed for the internal structures and for the structure of walls and septa.
In the Belgian Paleocene specimens, the feathered grooves of the sutures persist to the vicinity of the centre, whereas in the Middle Eocene specimens, the sutural grooves occur only near the periphery, and the central area is filled with an amount of irregular plugs, in which the pattern of the sutures cannot be discerned anymore. Again, this may be due to environment or age of the respective individuals.

Occurrence :

1) "Mons well 1969" (19) : The range of this species covers the whole interval from the Maastrichtian-Danian boundary (80 m) to the top of the Calcaire de Mons (12 m).

2) Other localities : (CA) Tuffeau de Ciply (Middle to Upper Danian), frequent, (LA) Calcaire de Mons, frequent, (VR, MM) Calcarenite of Houthem (Middle to Upper Danian) frequent, (MM) Tuffaceous Chalk of Maastricht (Upper Maastrichtian) (below 320 m in this well) rare.

Known range :

R. cf. *trochidiformis* is rare in the Upper Maastrichtian (Tuffaceous Chalk of Maastricht in the type-locality of the stage) according to VISSER (who recorded the species as *Eponides hemisphaericus*), becoming more frequent in the upper part (Mc, Md) according to HOFKER (1966 e). HOFKER (1966 e) claims that this species appears in the Santonian of France.
In the Paleocene of Belgium and SE Netherlands, it is not known to occur higher than the top of the Calcaire de Mons and its equivalent the Bunde Kalk ; it is not known from the Belgian Heersian or Landenian deposits, but this may be due to ecological conditions, as the species is known to reappear in the northern regions during Middle Eocene times (Paris basin).

Rotalia bundensis VAN BELLEN

Pl. 16, f. 3, 4

1946 *Rotalia bundensis* VAN BELLEN ; Meded. Geol. Sticht. C, 5, 4, p. 61, pl. 8, f. 1-4.
non 1966 *Gavelinopsis bundensis* (VAN BELLEN) ; HOFKER, Palaeontographica, Suppl. 10, p. 259, pl. 56, f. 112, 119 ; pl. 57, f. 133.

Remarks : VAN BELLEN figured a clearly conical form ; in our material, however, most specimens are lenticular and nearly biconvex. The spiral side is generally slightly more convex than the umbilical side ; when studying the specimens more accurately one observes the pillars or fissured plug at the umbilical side.

The aperture could not be detected with certainty in our material due to recrystallization. Probably the intercameral foramen extends along the base of the apertural face from approximately halfway the radius towards the periphery or even slightly over the periphery, thus reaching the outer margin of the spiral side.

Rotalia septifera (TERQUEM) of the Middle Eocene of the Paris basin resembles *Rotalia bundensis* quite well. This possible descendant differs from the latter species by the series of

protruding knobs along the sutures of the spiral side. The fissured umbilical plug, clearly to be seen in several of our specimens, point to *Rotalia* and affiliated genera, and not to *Gavelinopsis* as it was claimed by HOFKER. The specimens he figured probably do not belong to *R. bundensis*.

Occurrence :

1) "Mons well 1969" (79) : The range of this species covers a large part of the Tertiary calcarenite up to the top of the Calcaire de Mons (from OB 48.30 to OB 12), Zone B and C.

2) Other localities : This species has not yet been recovered from other localities in Belgium, although it is present in the lateral equivalent of the Calcaire de Mons in the Bunde wells.

Known range :

Based on the occurrences in the "Mons well 1969" and in the Bunde wells, the range of this species is restricted to Upper Danian and Montian.
This restricted occurrence may be due to ecological conditions.

Rotalia marginita d'ORBIGNY.

Pl. 2, f. 3 ; pl. 7, f. 2, 3

1826 *Rotalia marginata* d'ORBIGNY ; Ann. Sci. Nat., p. 106 (272), N° 9.
1946 *Rotalia marginata* d'ORBIGNY ; VAN BELLEN, Meded. Geol. Sticht. C., 5, 4, p. 63, pl. 8, f. 11-13.
? 1946 *Discorbis pseudodiscoideus* VAN BELLEN ; Meded. Geol. Sticht. C., 5, 4, p. 53, pl. 6, f. 10-15.
? 1966 *Discorbis pseudodiscoideus* VAN BELLEN ; HOFKER, Palaeontographica, Suppl. 10, p. 244, pl. 47, f. 17 a-c, pl. 55, f. 95, 96 (cited as *Gavelinopsis pseudodiscoideus* in legend of plates).
1968 *Rotalia marginata* d'ORBIGNY ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 20 (1968), p. 60, pl. 5, f. 2, 5-9 ; pl. 18, f. 1-4.

Remarks : Although the state of preservation of the specimens in the collection VAN BELLEN (Geol. Inst. Utrecht) is bad, we think that *D. pseudodiscoideus* VAN BELLEN is conspecific with *R. marginata*. This seems also to be the case for HOFKER's (1966 e) specimens recorded as *Discorbis pseudodiscoideus* or *Gavelinopsis pseudodiscoideus*.

Occurrence :

1) "Mons well 1969" (38) : The range of this species covers the whole interval between the Maastrichtian-Danian boundary (80 m) and the top of the Calcaire de Mons (12 m).
This species is especially frequent in the higher part of the section. Variants with a protruding umbilical plug (Pl. 2, f. 3) have been recorded separately (65).

2) Other localities : Rare in the Tuffeau de Ciply (CA) and its lateral equivalent the Calcarenite of Houthem (VR).

Known range :

Rare in the Upper Danian ; it has not been found higher than the top of the Calcaire de Mons. To our knowledge, it has not been recorded from Maastrichtian or older strata in Belgium and the SE Netherlands. The specimen figured by d'ORBIGNY was probably recovered from Eocene deposits of the Paris basin.

Genus *PARAROTALIA* Y. LE CALVEZ, 1949

N.B. : See remarks on the genus *Rotalia* LAMARCK

Pararotalia saxorum (d'ORBIGNY)

Pl. 7, f. 5

1826 *Rotalia saxorum* d'ORBIGNY ; Ann. Sci. Nat. p. 106 (272). (*nomen nudum*).
1850 *Rotalia saxorum* d'ORBIGNY ; A. ORBIGNY, Prodrome de Paléont ... p. 407, f. 5.
1882 *Rotalia perovalis* TERQUEM ; Mém. Soc. Géol. France, Sér. 3, 2, p. 70, pl. 6, f. 5.
1946 *Rotalia saxorum* d'ORBIGNY ; VAN BELLEN, Meded. Geol. Sticht. C., 5, (4), p. 64, pl. 8, f. 17-19.
1952 *Rotalia perovalis* (TERQUEM) ; Y. LE CALVEZ, Mém. expl. Carte Géol. France, (1952), p. 49, pl. 4, f. 47, 48.
1966 *Rotalia saxorum* d'ORBIGNY ; HOFKER, Palaeontographica, Suppl., 10, p. 263, pl. 55, f. 94, p. 246, pl. 47, f. 20 a-c.
1966 *Rotalia perovalis* d'ORBIGNY ; HOFKER, Palaeontographica, Suppl., 10, p. 263, pl. 55, f. 97.
1968 *Rotalia saxorum* d'ORBIGNY ;POZARYSKA & SZCZECHURA, Palaeont. Polon., 20, (1968), p. 61, pl. 5, f. 1, 3, 4 ; pl. 18, f. 5-9.

Remarks : Small specimens, considered to be juvenile forms, were found abundantly in all samples, in which larger *P. saxorum* specimens were recovered too.
The Paleocene forms recorded as *P. perovalis* are considered to be equally juvenile specimens of this species. Some *Discorbis* species figured by VAN BELLEN such as *Discorbis discoides* (d'ORBIGNY) may also be conspecific with *P. saxorum*, but the bad state of preservation of his material prevents this statement to be ascertained. Possibly our small specimens had better be referred to *Rotalia hensoni* SMOUT. That species could also be synonymous with *P. saxorum*.

Occurrence :

1) "Mons well 1969" (21) : The range of *P. saxorum* covers the whole interval from the Maastrichtian - Danian boundary (80 m) to the top of the Calcaire de Mons (12 m).

2) Other localities : (CA) Tuffeau de Ciply (Upper to Middle Danian) ; furthermore in the Craie de Spiennes and the Craie phosphatée de Ciply (Maastrichtian). (MM, VR) Calcarenite of Houthem (Middle to Upper Danian), (LA) Calcaire de Mons.

Known range :

In contrast with HOFKER's statement, *P. saxorum* occurs, though rarely, in Maastrichtian sediments ; we observed some specimens in the Uppermost Cretaceous (Maastrichtian) of the Kallo well ; furthermore, it was observed in the Craie phosphatée de Ciply and in the Craie de Spiennes (both sampled in CA). The fact that it was not recovered from the type Maastrichtian may probably be explained by ecological conditions.

The species is common in (Upper) Danian sediments of our region and its highest occurrence in Belgium is at the top of the Calcaire de Mons and its lateral equivalent, the Bunde Kalk. The species was not found in Belgian Eocene sediments by KAASSCHIETER (1961) but it occurs in the Eocene of the Paris basin, recorded as *R. perovalis* (TERQUEM) (cf. Y. LE CALVEZ, 1952), a species thought to be conspecific with *P. saxorum*.

Pararotalia godfriauxi n. sp.

Pl. 2, f. 4 ; Pl. 3, f. 1 ; Pl. 7, f. 4

Holotype : N° 10 of collection of the Faculté Polytechnique de Mons, Belgium, specimen figured Pl. 2, f. 4.

Paratypoids : N° 11, 12 in the same collection of Mons, Pl. 3, f. 1.

Type level : Calcaire de Mons in its type section (= Montian stratotype), sample OB 13.90 in the Mons well 1969.

Type locality : "Mons well 1969", approximately 14 m south of the classical Puits Goffint at Obourg, near Mons, Belgium.

Name : Named in honour of Dr. Y. GODFRIAUX, Géol. Institute, Faculté Polytechnique, Mons, Belgium.

Deposition of specimens : Collection of Geol. Inst., Faculté Polytechnique, Mons, Belgium.

Diagnosis : A thick biconvex *Pararotalia* species with broadly rounded, not lobate periphery, a fissured plug surrounded by a deep spiral fissure, sutures fissured at the umbilical side as far as the periphery ; aperture a basal slit at the periphery extending to the umbilical side.

Description : Test almost equally biconvex, thickness approximately half the maximal diameter. A fissured plug fills the umbilicus and it is surrounded by a deep spiral depression ; sutures are entirely fissured to the periphery, with a slight fish-bone pattern along the sutures between the older chambers. The wall is generally covered with pustules or beads over the whole surface. At the spiral side the evolute sutures are fissured only close to the periphery, the chambers are either covered with small beads, or smooth with coarse pores ; the earlier whorls are not clearly visible.

The periphery is rounded, not lobate. The aperture is probably a slit at the base of the apertural face from the periphery extending in umbilical direction.

Measurements :

in : mm.	Holotype	Paratypoids	
		1	2
max. diam.	0.49	0.69	0.41
min. diam.	0.44	0.58	0.33
thickness	0.28	0.37	0.21

Remarks : This species somewhat resembles *R. choctawensis* CUSHMAN & Mc GLAMERY described from the Oligocene of America ; it is smaller, somewhat thicker, and its periphery is more rounded.

Occurrence :

1) "Mons well 1969" (129) : The species occurs only in the uppermost samples of the calcarenite sequence (Calcaire de Mons, type section) between OB 20 and OB 13.90.

2) Other localities : Not observed.

Known range :

Montian.

Pararotalia obourgensis n. sp.

Pl. 6, f. 7

1946 *Rotalia armata* d'ORBIGNY ; VAN BELLEN, Meded. Geol Sticht. C., 5, 4, p. 60, pl. 7, f. 16-18 (non *Rotalia armata* d'ORBIGNY, (1826), Ann. Sci. Nat., 7, p. 273, 22, mod. 70).

1946 *Rotalia choctawensis* CUSHMAN & Mc GLAMERY ; VAN BELLEN, Med. Geol. Sticht. C., 5, 4, p. 62, pl. 8, f. 5-7. (non *Rotalia choctawensis* CUSHMAN & Mc GLAMERY, 1938, U.S. Geol. Surv. Prof. Pap. 189 d, p. 110, pl. 27, f. 4).

Holotype : N° 13 of collection of the Faculté Polytechnique de Mons, Belgium, figured Pl. 6, f. 7.

Paratypoids : N° 14, 15 in the same collection of Mons.

Type level : Calcaire de Mons in its type section. Obourg well sample OB 27.80.

Type locality : "Mons well 1969" at approximately 14 m south of the classical Puits Goffint at Obourg, near Mons, Belgium.

Name : Named after the locality of the studied well, at Obourg near Mons, Belgium.

Deposition of specimens : Collection of Geol. Inst., Faculté Polytechnique, Mons, Belgium.

Diagnosis : A flat *Pararotalia* species with a sharp, keeled, lobate periphery, the keel following the arcuate sutures of the spiral side ; chambers ornamented at both sides with pustules or beads, especially at the spiral side on the older whorls ; a fissured plug surrounded by a deep spiral depression.

Description : Test flat, almost equally biconvex, thickness approximately 1/3 of maximal diameter. At the umbilicus side only the last whorl is visible and the umbilicus is filled with a large, beaded plug, surrounded by a deep spiral fissure ; the sutures are depressed and straight at the umbilical side and some scattered pustules occur with larger beads around the spiral depression.

At the spiral side the sutures are raised and limbate because the keel of the individual chambers continues inward to the spiral suture.

Only some chambers of the last whorl can be discerned, all earlier chambers are obscure, due to the ornamentation which is strongest in the central part of the spiral side.
The periphery is sharp, keeled, lobate in most specimens.

The aperture is a slit at the base of the apertural face, halfway between the periphery and the umbilical plug, reaching neither of them.

Measurements :

in : mm.	Holotype	Paratypoids 1	2
max. diam.	1.06	0.60	0.98
min. diam.	0.88	0.50	0.85
thickness	0.35	0.28	0.35

Remarks : *P. obourgensis* differs from *R. armata* d'ORBIGNY by the evenly rounded periphery of the individual chambers. The holotype of *Rotalia armata* was pictured very schematically by its author, but one observes distinct angles at the periphery of each chamber ; this feature was better pictured by TERQUEM (1882, *Rotalina armata*, p. 67, pl. 5, f. 14-15) who observed tubulospinate chamber edges in Middle Eocene specimen of the Paris basin. The latter feature has not been observed in our material. The single specimen assigned by VAN BELLEN (1946) to *R. choctawensis* CUSHMAN & Mc GLAMERY has a sharper periphery than the holotype of that species. Its periphery is less lobate than it is in the majority of specimens of *P. obourgensis*, but variation in the latter includes specimens like that of VAN BELLEN.

Occurrence :

1) "Mons well 1969" (82) : OB 50 to OB 13.90.

2) Other localities : except for the specimens recorded by VAN BELLEN (1946) from the Upper half of the analyzed intervals in the Bunde wells, the species has not been observed in the studied area.

Known range :

Upper Danian and Montian.

Pararotalia globigeriniformis (VAN BELLEN)

Pl. 3, f. 2, 3 ; Pl. 7, f. 7.

1946 *Globorotalia globigeriniformis* VAN BELLEN, Meded. Geol. Sticht. C., 5, 4, p. 71, pl. 10, f. 10-12.

1961 *Pararotalia globigeriniformis* (VAN BELLEN) ; HOFKER, Natuurhist. Maandbl., 50, (7-8), p. 68, text - f. 2 a-c.

1962 *Pararotalia globigeriniformis* (VAN BELLEN) ; MOORKENS, Licentiate thesis. Univ. of Ghent, (MS) p. 83, pl. 2, f. 14 a-c, 15 a-c.

1966 *Pararotalia globigeriniformis* (VAN BELLEN) ; HOFKER, Palaeontographica, Suppl. 10, p. 233, pl. 44, f. 123 a-c.

1968 *Globorotalia globigeriniformis* VAN BELLEN ; POZARYSKA & SZCZECHURA, Palaeont. Polon., 20, (1968), p. 65, pl. 7, f. 11-19.

Variability :

As the species is abundant in most samples of the Tuffeau de Ciply and its equivalent, the Calcarenite of Houthem as well as in the Calcaire de Mons and its equivalent, the Bunde Kalk (VAN BELLEN collection), it has been possible to study the variation, which is quite large in this group. Variation has been observed for the following features :

- test form : Trochoid test with flat dorsal side ; sometimes the chambers of the last whorl are more globular than the previous ones, sometimes they are flattened or truncated with angular periphery.

- umbilicus : Generally deep, in most cases filled with one or several small plugs (when these are broken out, specimens with globulous chambers may be mistaken for *Globigerina* or *Acarinina*).

- aperture : Normally a slit of comma shape along (or reaching) the base of the apertural face. As the last chamber is broken off in most specimens, it is not the aperture which is seen, but an intercameral foramen ; the latter's position is areal in many specimens, not reaching the base of the apertural face.

- chamberform and periphery : The chamberform may be very strongly variable in one sample ; the chambers may be globulous (pl. 3, f. 3), truncated (var. 2, pl. 3, f. 2) keeled and drawn out in radial direction (var. 1), as if leading to a tubolospinate chamberform, sometimes showing an angular protrusion on the spiral side (cf. pl. 3, f. 2) ; the periphery varies together with the chamberform, lobate or nonlobate, with pointed protrusions or without, keeled or not keeled.

- spiral side : Generally flat ; in some specimens with globulous chambers, it may be slightly inflated.

- umbilical side : Generally a rather deep umbilicus ; at the umbilical side the chambers are generally more inflated (with deeply depressed sutures) than at the spiral side.

- wall : The wall is smooth, spinose or nodose.

Remarks : Some specimens of this species resemble *Globigerina* and *Globorotalia* (*Acarinina* of authors).

Pararotalia specimens may generally be distinguished from these genera of the Globigerinacea, by the presence of one or more umbilical plugs, which are a characteristic feature for some Rotaliidae, whereas a plug has, to our knowledge, never been observed in the superfamily of the planktonic Globigerinacea. Our specimens thus belong to the benthonic genus *Pararotalia*, which we consider to differ from *Rotalia* by the different umbilical structures, the areal intercameral foramen and also by the globulous chamberform, which generally causes a strongly lobate periphery.

VAN BELLEN figures the presence of one or more plugs and mentions this feature in his description. Also, POZARYSKA & SZCZECHURA (1970) mention and figure the plugs in their material. Their specimens therefore certainly belong to *Pararotalia* and not to *Globorotalia*.

Most of the varieties distinguished by differences in the above mentioned features range throughout the Tuffeau de Ciply and the Calcaire de Mons.

However, smooth walled tests (with or without globulous chambers and lobate periphery) are rare in the Obourg calcarenites, but they are the only variety present in the calcarenite of

Mechelen-aan-de-Maas (MM interval between 272 m and 297 m). At the base of the Heers Formation the species disappears almost completely. The individuals found in the Tuffeau de Ciply (CA) and those of the Calcarenite of Houthem (MM and VR) are generally strongly spinose to nodose, but relatively smooth tests were observed as well. As the specimens of these calcarenites are generally strongly recrystallized, it is not certain whether smooth-walled forms were more common in these sediments before recrystallization.

Occurrence :

1) "Mons well 1969" (28, 42, 66) : The *Pararotalia globigeriniformis* group ranges throughout the interval between the Maastrichtian-Danian boundary (80 m) and the top of the Calcaire de Mons (12 m). The truncate variant (var. 2) is much less frequent or absent (above OB 30) in the higher part of the sequence.

2) Other localities : *P. globigeriniformis* is abundant in the Tuffeau de Ciply (CA), the Calcarenite of Houthem (VR, MM), the Calcaire de Mons (LA, COP) and the Bunde Kalk (VAN BELLEN collection), and frequent in the Calcarenite of Mechelen-aan-de-Maas (MM).

Known range :

We only observed one specimen below the Maastrichtian - Danian boundary which was found in the Craie phosphatée de Ciply (LI) at some 13 m below the Poudingue de la Malogne : it seems that this group is already present in the Maastrichtian although being very rare. *Pararotalia globigeriniformis* ranges throughout the Lower Paleocene (Danian) and the Calcaire de Mons (Montian). Its absence in younger Paleocene deposits of Belgium may be due to ecological conditions. *Pararotalia canui* (CUSHMAN) observed by KAASSCHIETER (1961) in the Belgian Eocene and in the Oligocene by BATJES (1957) is probably a descendant of this species.

Pararotalia praepseudomenardii (HOFKER)

Pl. 7, f. 6

1961 *Globorotalia praepseudomenardii* HOFKER ; Natuurhist. Maandbl. 50, (7-8) p. 85, text-f. 1, a-d.

1962 *Globorotalia praepseudomenardii* HOFKER ; HOFKER, Journ. Paleont., 36, 5, p. 1082, text-f. 26 A.

1966 *Globorotalia praepseudomenardii* HOFKER ; HOFKER, Palaeontographica, Suppl. 10, p. 233, pl. 43, f. 105 ; pl. 46, f. 140.

1968 *Globorotalia praepseudomenardii* HOFKER ; POZARYSKA & SZCZECHURA, Palaeont. Polon., 20 (1968), p. 66, pl. 6, f. 7-10.

Remarks : HOFKER (1961) mentions and pictures "highly developed tena" at the umbilical side, near the umbilicus, which feature would suggest a relationship with some *Globorotalia* species (*G. lehneri*, *G. velascoensis*). In our opinion this feature is quite common in the genus *Pararotalia* in which the umbilical plug is often surrounded by smaller knobs of calcareous matter. In the Tuffeau de Ciply (CA) we recovered specimens with and without umbilical plugs. This species may be another variant of *P. globigeriniformis*. In their description and figures of *Globorotalia praepseudomenardii*, POZARYSKA & SZCZECHURA clearly demonstrate the presence of an

umbilical plug.

Occurrence :

1) "Mons well 1969" (47) : Some specimens were observed resembling HOFKER's original figure, but they are generally somewhat higher ; these forms range between 79 m and 36 m.

2) Other localities : Some specimens, practically identical with HOFKER's figures were found in the Tuffeau de Ciply (CA).

Known range :

Upper Danian.

Pararotalia sp. cf. *P. tuberculifera* (REUSS)

Pl. 8, f. 1

cf. 1862 *Rotalia tuberculifera* REUSS ; Die Foraminiferen des Kreidetuffes von Maastricht ; Sitzber. K. Akad. Wiss., 44, p. 313, pl. 2, f. 2.

1946 *Rotalia armata* VAN BELLEN (non d'ORBIGNY), Meded. Geol. Sticht. C., 5, 4, p. 60, pl. 7, f. 16-18.

cf. 1951 *Rotalia tuberculifera* REUSS ; VISSER, Leidse Geol. Meded., 16, p. 274, pl. 5, f. 14 ; pl. 10, f. 9-10.

cf. 1957 *Pararotalia tuberculifera* (REUSS) ; HOFKER, Natuurhist. Maandbl., 46, (3-4), p. 32, text - f. 2-13.

1957 *Pararotalia tuberculifera* (REUSS) ; HOFKER, Natuurhist. Maandbl., 46, (3-4), p. 32, text - f. 14-16.

non 1957 *Pararotalia tuberculifera* (REUSS) ; HOFKER, Natuurhist. Maandbl. 46, (3-4), p. 32, text - f. 17-18.

1965 *Pararotalia tuberculifera* (REUSS) ; POZARYSKA, Palaeont. Polon., 14, (1965), p. 118, pl. 20, f. 3 a-c.

cf. 1966 *Pararotalia tuberculifera* (REUSS) ; HOFKER, Palaeontographica, Suppl. 10, p. 157, pl. 24, f. 137, 149 ; p. 170, pl. 28, f. 40, 41 ; p. 190, pl. 33, f. 70-73 ; p. 262, pl. 56, f. 114, 116 ; (non f. 113 = *R. bundensis*) ; p. 292, pl. 62, f. 76, pl. 63, f. 106.

1968 *Pararotalia tuberculifera* (REUSS) ; POZARYSKA & SZCZECHURA, Palaeont. Polon., 20 (1968) p. 59, pl. 7, f. 1-10 ; text - f. 13.

Remarks : There is a rather wide variation in this species. The species was originally described from Maastrichtian strata. Some variants seem to be restricted in time. In some specimens of *P. tuberculifera* of the Maastrichtian population costellae-like ridges near the periphery are characteristic (cf. Pl. 8, fig. 2, 3). The larger and stronger tubulospinate chamberform at the periphery (cf. Pl. 8, f. 1) appears with the Paleocene specimens. Notwithstanding these differences between Maastrichtian and Paleocene populations, a large number of specimens in both show none of these described features. Furthermore, the Paleocene forms may be somewhat flatter than the Maastrichtian ones. HOFKER (1957 b) claims that the average size of the specimens increased with time ; our material is insufficient for such observations.

Occurrence :

1) "Mons well 1969" (32) : Rare specimens were found covering the interval between the Maastrichtian - Danian boundary (80 m) to the top of the Calcaire de Mons (12 m).

2) Other localities : The species occurs frequently in the Tuffaceous Chalk of Maastricht (in the MM well ; in the E.N.C.I. Quarry) ; in the Calcaire de Mons (LA, OB) and in the Bunde Kalk (VAN BELLEN collection) similar forms are rare.

Known range :

In Belgium and the SE Netherlands the species ranges throughout the Tuffaceous Chalk of Maastricht from Mb to near its top. Hence, its range covers a large part of the Upper Maastrichtian. The species has neither been recovered from the Tuffeau de Ciply nor from its lateral equivalent, the Calcarenite of Houthem (Danian). It is present again in the Calcaire de Mons and its equivalent in NE Belgium and the SE Netherlands, the Bunde Kalk. Presence or absence of the species is apparently linked to ecological conditions. The local depth of the sea may have been important. In addition, changes in climatic conditions (which possibly made the species migrate to the south at the close of Maastrichtian times, and which made it reappear in Late Danian times) might be responsible. In the studied region, the species has not been recovered from sediments younger than the top of the Calcaire de Mons or its eastern equivalent, the Bunde Kalk (Montian).

Pararotalia minimalis HOFKER

Pl. 8, f. 4, 5

1966 *Pararotalia minimalis* HOFKER, Palaeontographica, Suppl. 10, p. 26, pl. 49, f. 60 a-c.

Remarks : Only some rare and badly preserved recrystallized specimens were found. Their outline resembles that of HOFKER's figured type.

Occurrence :

1) "Mons well 1969" (120) : some rare specimens at OB 30 and OB 32.40.

2) Other localities : Vroenhoven (VR), Calcarenite of Houthem. HOFKER (1966 e) cites this species from his Zone P (rare) and his Zone Q (abundant).

Known range :

Middle to Upper Danian.

Genus *THALMANNITA* BERMUDEZ, 1952

Thalmannita madrugaensis (CUSHMAN & BERMUDEZ)

Pl. 8, f. 10

1947 *Rotalia madrugaensis* CUSHMAN & BERMUDEZ ; Contr. Cushman Lab. Foram. Res. 13, 1, p. 24, pl. 5, f. 4 a-c (fide J.A. CUSHMAN, 1951).

1951 *Rotalia madrugaensis* CUSHMAN & BERMUDEZ ; CUSHMAN, U.S. Geol. Surv. Prof. Pap., 232, p. 55, pl. 15, f. 12 a-c.

1961 *Thalmannita madrugaensis* (CUSHMAN & BERMUDEZ) ; HOFKER, Foraminifera from the Cretaceous ... LVI, Natuurhist. Maandbl. 50, (11-12), p. 124, text - f. 4 a-c.

1966 *Thalmannita madrugaensis* (CUSHMAN & BERMUDEZ) ; HOFKER, Palaeontographica, Suppl. 10, p. 234, pl. 46, f. 146 a-b ; pl. 53, f. 55-60.

Remarks : Our specimens are smaller than the holotype described from Cuba.

Considerable variation was observed in the ornamentation of our specimens. The longitudinal costae vary from quite strong to rather vague. Most specimens are slightly trochoid, some may be almost planispiral. Larger, distinctly costate specimens clearly belong to *T. madrugaensis* (N° 85 in the chart, Table 1). Smaller and less distinctly costate forms have been given a cf. notation (N° 54 in chart).

The genera *Thalmannita* BERMUDEZ, 1952 and *Cuvillierina* DEBOURLE, 1955, were both erected for forms with slightly asymmetrical tests ; the former was said to be slightly trochoid, whereas the latter was described as "planispiral, but slightly asymmetrical" (cf. description of the genera, according to A.R. LOEBLICH & H. TAPPAN, 1964).

The ornamentation, consisting of pillars in the umbilical region(s) and longitudinal costae covering the lateral sides and the periphery are also more or less similar.

However, in *Cuvillierina* the ornamentation shows a chevron pattern along the sutures, whereas this feature does not occur in the type species of *Thalmannita*. Our material strongly resembles *T. madrugaensis* which is the type species of the genus *Thalmannita*, so we consider our specimens to belong to *Thalmannita*.

C. ? *pomeraniana* of POZARYSKA & SZCZECHURA (1968) shows better resemblance with *Cuvillierina* as stated by its authors. Indeed, the chevron shaped pattern of ornamentations is clearly to be seen in their figures.

The state of preservation of the material, both Polish and Belgian, may play an important role in the appearance of the ornamentation. In general, the specimens recovered from the uppermost samples of the Calcaire de Mons (OB 12) only show a vague pattern of costae : this might be due to the fact that these foraminifera have been rolled by the surf, or to corrosion of the surface.

It is possible that the specimen figured by MARIE (1964, pl. 2, f. 3 a-b) as *Nonion ornatum* VAN BELLEN also is a *T. madrugaensis*, the costae of which were very vague. We did not study the inner structure of our specimens, most of them being recrystallized.

Occurrence :

1) "Mons well 1969" (54, 85) : This species was recorded from a large part of the section ; the lowest occurrence of resembling forms (54), which are more asymmetric, is at 78 m, 2 m above the local Maastrichtian - Danian boundary ; and the species occurs as high as the highest sample (12 m) of the Calcaire de Mons. Typical forms (85) were found only from OB 56 to OB 12.

2) Other localities : In the Vroenhoven section (VR), the species occurs in the section north of the fault of Hees, in the calcarenite of the Albert Canal.
As stated by HOFKER (1966 e and other publications) this northern part of the section represents a lateral equivalent of the Bunde Kalk and of the Calcaire de Mons.

Known range :

Upper Danian to Montian.

CUSHMAN (1951) recorded the species from Paleocene deposits in Cuba. According to planktonic foraminifera observed in the same sample, the age of the type level is Late Paleocene. In Belgium and in the SE Netherlands, the species is known from (Upper) Danian deposits as it appears in the higher layers of the Calcarenite of Houthem. It is not known to range higher than the top of the Calcaire de Mons in these countries. HOFKER (1961 g) recovered the species from the Curfs quarry (CU) in the type section of the Calcarenite of Houthem in Dutch Limburg. The sediments of this section are considered to be of (Late) Danian Age, because of the planktonic foraminifera recovered by MEIJER (1959).

In Madagascar the first *Thalmannita* ex. gr. *madrugaensis* appear together with the first *Globorotalia angulata* and hence, they only occur in sediments younger than the Danian deposits of that country (cf. M. LYS, 1960).
HOFKER (1966 e) recorded it from his zone R in the Bunde wells and in the Maurits III mine shaft.

Genus *ELPHIDIUM* de MONTFORT, 1808

Elphidium ? sp. cf. *E. lamarcki* (d'ORBIGNY)

Pl. 8, f. 6

cf. 1826 *Nonionina lamarckii* d'ORBIGNY, Ann. Sci. Nat., p. 128, (294) (*nomen nudum*).
cf. 1904 *Nonionina lamarckii* d'ORBIGNY ; C.R. FORNASINI, Mém. R. Acad. Sci. Bologna, pl. 3, f. 1.
1968 *Elphidium* cf. *lamarcki* (d'ORBIGNY) ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, p. 63, pl. 9, f. 1-5.

Remarks : Our specimens agree well with POZARYSKA & SZCZECHURA's (1968) figured specimens except that the papillae were also found along the sutures in our material. Practically no sutural pores have been noticed. The generic position of these forms is obscure. *Nonion geleenense* VAN BELLEN (1946, p. 42, pl. 3, f. 22-25) may be a related form.

Occurrence :

1) "Mons well 1969" (56) : Some rare specimens in the lower part of the Tertiary calcarenites (Danian), a single occurrence in OB 12.

2) Other localities : Similar specimens were found in the Mechelen-aan-de-Maas well, (calcarenite of Mechelen-aan-de-Maas).

Known range :

Middle to Upper Danian and Montian and in Belgium, the SE Netherlands and Poland.

Genus *ELPHIDIELLA* CUSHMAN, 1936

Elphidiella ? sp. cf. *E. prima* (TEN DAM)

Pl. 8, f. 7

cf. 1944 *Eliphidium primum* TEN DAM ; Meded. Geol. Sticht., C, 5, 3, p. 109, pl. 3, f. 15.
cf. 1948 *Elphidiella prima* (TEN DAM) ; BROTZEN, Sver. Geol. Unders. C, 42, 2, p. 70, pl. 8, f. 2, text - f. 18.
cf. 1965 *Elphidiella prima* (TEN DAM) ; INDANS, Forsch. Land. Nordrhein-Westf. 1484, p. 12, pl. 1, f. 6.
cf. 1968 *Elphidiella prima* (TEN DAM) ; POZARYSKA & SZCZECHURA, (1968), Palaeont. Polon. 20, p. 64, pl. 9, f. 16-19.

Remarks : The state of preservation of our specimens is bad. Instead of two clear rows of sutural openings typical for the genus *Elphidiella*, one observes an irregular pattern of sutural openings possibly belonging to two rows, as has been described by TEN DAM for this species. The generic position is therefore situated between *Elphidium* and *Elphidiella*. The pattern is even more irregular in our forms than in TEN DAM's figure. Polish specimens of this species (and our specimens) are not synonymous with *N. multisuturatum* VAN BELLEN as suggested by POZARYSKA & SZCZECHURA (1968) as the latter species has slightly depressed sutures instead of flush sutures, and it has no sutural openings at all.

Occurrence :

1) "Mons well 1969" (115) : A couple of specimens in OB 38.20.

2) Other localities : Not observed so far in Belgium.

Known range :

Danian to Middle Paleocene, possibly also Upper Paleocene of Sweden (BROTZEN, 1948) ; Upper Paleocene of the Netherlands (TEN DAM, 1944).

Genus *EPONIDES* MONTFORT, 1808

Eponides robaszynskii n. sp.

Pl. 3, f. 4

1946 *Eponides gratus* (REUSS) ; VAN BELLEN, Meded. Geol. Sticht. C., 5, 4, p. 57, pl. 7, f. 4-9 (non *Rotalia grata* REUSS, 1865, p. 47, pl. 4, f. 17.)
1965 *Eponides toulmini* BROTZEN ; POZARYSKA, Palaeont. Polon., 14, (1965), p. 110, pl. 17, f. 4 a-c. (non *Eponides toulmini* BROTZEN. , 1948 Sver. Geol. Unders. C, (493), Arsb., 42, 2, p. 78, pl. 10, f. 16).
1966 *Eponides toulmini* BROTZEN ; HOFKER, Palaeontographica, Suppl. 10, p. 261, pl. 54, f. 83-84.
1968 *Eponides toulmini* BROTZEN ; POZARYSKA & SZCZECHURA, Palaeont. Polon., 20, (1968), p. 72, pl. 15, f. 1-4.

Holotype : N° 16 of collection of the Faculté Polytechnique de Mons. Specimen figured pl. 3, f. 4.
Paratypoids : N° 17, 18 in the same collection of Mons.

Type level : Basal part of the calcarenite sequence at Obourg.

Type locality : "Mons well 1969" at Obourg. Sample at 78 m below topographic level.

Name : The species was named in honour of Dr. F. Robaszynski, Faculté Polytechnique, Mons, Belgium.

Deposition of specimens : Collection of Geol. Inst., Faculté Polytechnique, Mons, Belgium.

Diagnosis : A robust plano-convex *Eponides* form with approximately five chambers in the last whorl, and flush or slightly depressed sutures.

Description :

Test slightly oval in ventral view ; outline not or only slightly lobate at the last chamber ; umbilical side high ; umbilicus not depressed or only very slightly so ; spiral side nearly flat ; sutures at spiral side not depressed ; sutures at umbilical side not or slightly depressed between the last chambers. Sutures radial or slightly curved at umbilical side ; chambers in crescent form at spiral side. Earlier whorls generally not visible, which is due to recrystallization. Aperture a narrow slit along the base of apertural face at the umbilical side, neither reaching the periphery nor the umbilicus ; wall smooth to coarsely perforated.

Measurements :

in : mm.	Holotype	Paratypoids	
		1	2
max. diam.	0.45	0.50	0.53
min. diam.	0.40	0.43	0.43
thickness	0.33	0.31	0.31

Remarks : The difference between this form and *Eponides toulmini* BROTZEN is the following :

The average test size is larger in *E. robaszynskii* ; range from 0.40 to 0.55 mm, whereas the *E. toulmini* figured holotype is approximately 0.24 mm. BROTZEN gives the diameter to be no more than 0.3 mm. The new species has a higher and more robust form ; the height/diameter ratio is probably higher than in the populations of typical *E. toulmini*. The spiral side is always flat or nearly so, whereas the figured type of *E. toulmini* is equally biconvex, though BROTZEN mentioned some variation of this feature.

The new species generally has 5 chambers in the last whorl, whereas the figured type of *E. toulmini* shows 6 or 7 chambers in the last whorl. BROTZEN mentions 6 to 8 chambers. *Eponides dorsoplana* BROTZEN, 1940 differs by the rounded, not lobate periphery.

In our material, the form is more oval and the periphery slightly lobate, at the last chambers.

Eponides polygonus Y. LE CALVEZ, 1949 from the Lutetian of Grignon, shows affinity with our material, but the periphery is more lobate, also at the older chambers of the last whorl. It is also much larger (diameter holotype 1 mm), but apart from these differences, there is a striking resemblance. The affinity of the microfauna of the Calcaire de Mons with that of the Calcaire grossier of the Paris basin (type Lutetian) has already been emphasized by several authors. Ecological (including climatic) conditions probably have been quite similar.

Eponides lunata BROTZEN, 1948, belongs to the genus *Paralabamina* according to HANSEN (1970 b) ; it is a smaller form (up to 0.25 mm), it has a sharper periphery and more curved sutures.

Occurrence :

1) "Mons well 1969" (23) : This species ranges from the local Maastrichtian - Danian boundary up to the top of the Calcaire de Mons.

2) Other localities : Apart from its occurrence in the Calcaire de Mons (LA) this species is quite frequent in the Tuffeau de Ciply (CA, LA, TH) and the Calcarenite of Houthem (VR, MM). The species occurs (although more rarely) in the Maastrichtian (LI, CA, E.N.C.I. quarry in Md layers). It was not found in sediments younger than the top of the Calcaire de Mons ; in the Formations of Heers and of Landen, it is replaced by the typical forms of *E. toulmini*, which are quite small and better preserved (transparent). The latter species was found in the Eocene of Belgium by KAASSCHIETER (1961).

Known range :

Middle to Upper Danian and Montian. Rare in the Upper Maastrichtian strata.

Eponides toulmini BROTZEN

1948 *Eponides toulmini* BROTZEN, Sver. Geol. Unders. C. 42, 2, p. 78, pl. 10, f. 16.

Remarks : These biconvex *Eponides* specimens which resemble BROTZEN's figured type, possibly intergrade with the planoconvex and more robust form we named *E. robaszynskii*, and which is much more frequent in the Obourg calcarenites.

Occurrence :

1) "Mons well 1969" (22) : The range covers nearly the complete calcarenite series from OB 80 to OB 20.

2) Other localities : Typical specimens were mainly found in younger Paleocene deposits of the Heers (OV, ORP) and Landen Formations (WA). Some were found in the Calcarenite of Mechelen-aan-de-Maas (MM).

Known range :

Danian to Eocene.
According to BROTZEN (1948) the species occurs in numerous Post-Danian Paleocene deposits of Sweden. KAASSCHIETER (1961) recorded the species from the Belgian Eocene.

Genus *CIBICIDES* MONTFORT, 1808

Cibicides sp. cf. *C. umbilicatus* BROTZEN

cf. 1948 *Cibicides umbilicata* BROTZEN, Sver. Geol. Unders. C, 42, 2, p. 84, pl. 13, f. 6.
? 1966 *Gavelinella umbilicata* (BROTZEN) HOFKER, Palaeontographica, Suppl. 10, p. 227, pl. 42, f. 83-84.
1968 *Anomalina umbilicata umbilicata* (BROTZEN) ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, (1968), p. 89, pl. 13, f. 5-7.

Remarks : Our specimens differ from BROTZEN's figured type by the less deep umbilicus, but this depth is variable in our material. BROTZEN's specimens may also be somewhat flatter than ours.

Some of our individuals resemble *Anomalina umbilicata costata* POZARYSKA & SZCZECHURA, 1968 (Paleont. Polon. 20, p. 89, pl. 13, f. 8-10), but they are thought to be within the range of variation of the group.

HOFKER's (1966 e) figured specimens have a less acute periphery than ours.

Occurrence :

1) "Mons well 1969" (29) : In several samples between OB 80 and OB 42.30.

2) Other localities : Calcaire de Mons (COP) ; Tuffeau de Ciply (LA 190, 175 ; LI ; CA 17-23 upper layers) ; Formation of the Paternostre well (LA 86) ; Marls of Gelinden, Heers Formation (OV) and Tuffeau de Lincent (WA) ; Mechelen-aan-de-Maas well between MM 290.5 and 221 covering the Calcarenite of Mechelen-aan-de-Maas, the Heers Formation and the Lower Landen Formation.

Known range :

Lower to Middle Paleocene, and at least part of the Upper Paleocene (Lower Landenian).

Cibicides succedens BROTZEN

Pl. 8, f. 8, 9

? 1944 *Cibicides cryptomphalus* (REUSS) var. *hercegovinensis*, DE WITT-PUYT ; TEN DAM, Meded. Geol. Sticht. C. 5, 3, p. 132, pl. 5, f. 9.
1948 *Cibicides succedens* BROTZEN, Sver. Geol. Unders. C, 42, 2, p. 80, pl. 12, f. 1,2.
1957 *Cibicides (Cibicidina) succedens* BROTZEN; WOOD & HAYNES, Contr. Cushman Found. Foram. Res. 8, 2, p. 50, pl. 5, f. 6-7.
1960 *Cibicides (Cibicidina) succedens* BROTZEN ; ROUVILLOIS, Mém. Mus. Nat. Hist. Nat., C, 8, p. 76, pl. 4, f. 59.
1965 *Cibicides succedens* BROTZEN ; POZARYSKA, Palaeont. Polon. 14, p. 136, pl. 28, f. 1-5.
1966 *Cibicides succedens* BROTZEN ; HOFKER, Palaeontographica, Suppl. 10, p. 228, 244, 259 ; pl. 43, f. 93 ; pl. 56, f. 118 ; pl. 47, f. 29 ; pl. 85, f. 230-239.
1968 *Cibicides succedens* BROTZEN ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, (1968), p. 79, f. 18.
1970 *Cibicides succedens* BROTZEN ; HANSEN, Meddel. Grønl. 193, 2, p. 91, pl. 23, f. 4-6.

Remarks : Relatively flat specimens may belong to *C. ekblomi* BROTZEN, 1948, but they have no curved sutures typical for that species (here given with a cf. notation in the plates).

Small specimens which show relatively high cones but which possibly intergrade with those of *C. succedens* have been entered separately in the chart (27) as *Cibicides* sp. cf. *C. voltzianus*. Only the less high forms, resembling the holotype of *C. succedens*, were here assigned to that species. *Cibicides* sp. 1 (26) is larger and has a higher cone.

Occurrence :

1) "Mons well 1969" (30) : The species was recorded from nearly all samples of the calcarenite sequence (OB 80 to OB 12).

2) Other localities : Generally together with flatter specimens (resembling *C. ekblomi*) the species was recovered from numerous samples : Tuffeau de Ciply (LA 190, ML, LI, CA), Calcaire de Mons (TH), Tuffeau de Chercq (LC), Sands of Orp (ORP) and Marls of Gelinden (OV), Tuffeau de Lincent (WA), Mechelen-aan-de-Maas well (MM 290.5 - 219) in the Calcarenite of Mechelen-aan-de-Maas, the Heers Formation and the Lower Landen Formation.

Known range :

Lower, Middle and at least part of the Upper Paleocene.
The occurrence of this species in the Danian of Denmark and Greenland has been reported by HANSEN (1970 b, p. 26,91), but according to his remarks, these forms resemble BROTZEN's paratype, not the holotype.

Cibicides sp. 1.

Description :

A *Cibicides* form with rounded periphery, a flat spiral side and high conical umbilical side ; the height of the specimens is generally somewhat more than half the maximal diameter.
Our material is too strongly recrystallized to trace the sutures of the last whorl and hence the number of chambers in the last convolution cannot be given.

Remarks : Although we did not find this species in the literature, we leave it in open nomenclature as our material is too poorly preserved to describe a new species. It resembles *Cibicides cuvillieri* POZARYSKA & SZCZECHURA, 1968 (non ROUVILLOIS) by its high conical shape, but the cone is generally higher than in the Polish specimen. ROUVILLOIS' (1960) holotype of *C. cuvillieri* is flatter than the Polish specimen and much flatter than ours.

Occurrence :

1) "Mons well 1969" (26) : This taxon was only observed in the lower samples of the Obourg calcarenites from OB 80 to OB 72.10.

2) Other localities : The species is frequent in the Tuffeau de Ciply CA, LI.

Known range :

As far as can be concluded from our samples, the species only occurs in the Middle to Upper Danian of Belgium.

Genus *PALLAIMORPHINA* TAPPAN, 1957

Pallaimorphina minuta HANSEN

1970 *Pallaimorphina minuta* HANSEN. Meddel. Gronl. 193, 2, p. 95, pl. 10, f. 10-12, pl. 25, f. 2-5.

Remarks : Only some strongly recrystallized specimens were observed, assigned to this taxon because of their general shape.

Occurrence :

1) "Mons well 1969" (86) : Ranging from OB 63.80 to 44.30.

2) Other localities : not observed.

Known range :

Only recorded so far from the Upper Danian of West Greenland and from the Middle and Upper Danian of Belgium.

Genus *NONION* MONTFORT, 1808

Nonion graniferum (TERQUEM)

Pl. 16, f. 5, 6 (from MM 287)

1882 *Nonionina granifera* TERQUEM ; Mém. Soc. Géol. France, 3, 2, p. 42, pl. 2, f. 8-9.
1948 *Nonion* cf. *graniferum* (TERQUEM) ; BROTZEN, Sver. Geol. Unders. C. 42, 2, p. 69, pl. 8, f. 1.
1950 *Nonion graniferum* (TERQUEM) ; Y. LE CALVEZ, Mém. Carte Géol. France, 1950, p. 53, pl. 4, f. 58-59.
1965 *Nonion graniferum* (TERQUEM) ; POZARYSKA, Palaeont. Polon. 14, p. 93, pl. 21, f. 5 a-b.
1966 *Nonion graniferum* (TERQUEM) ; HOFKER, Palaeontographica, Suppl. 10, p. 224, pl. 42, f. 57-58.
1968 *Nonion graniferum* (TERQUEM) ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, (1968), p. 81, pl. 9, f. 10-12, f. 19 (1-7).

Remarks : The genus *Protelphidium* HAYNES is thought to differ from *Nonion* by its radial hyaline instead of granular test, and by its aperture consisting of multiple foramina, whereas *Nonion* has a slit at the base of the apertural face.

The strongly recrystallized Obourg specimens could not be checked as to the wall features ; their aperture is slit-like, although this cannot be ascertained for all forms. In our better preserved material of the Mechelen-aan-de-Maas well (MM 287) some hyaline specimens are built of radial calcite and some show a series of foramina instead of a slit in the penultimate chamber. Some forms with a slit-like aperture occur in the same population.

In HAYNES' collection (British Museum Natural History) some of the specimens of the Thanetian (in its type region) show a multiple aperture in the last chamber ; the latter feature may be the best characteristic to distinguish *Protelphidium* from *Nonion*. As this could not be ascertained in the Obourg material, the specimens are assigned with some doubt to *Nonion graniferum*.

Occurrence :

1) "Mons well 1969" (37) : Scattered specimens in the entire calcarenite sequence (OB 80 - OB 12).

2) Other localities : Numerous samples from the Paleocene : Tuffeau de Ciply (LA 175) ; Calcarenite of Mechelen-aan-de-Maas (MM 290.5 - 273), Tuffeau de Chercq (LC 19) ; Calcarenite of Houthem (HOFKER, 1966 e Curfs quarry, CU) ; Formation of Paternostre well (LA 84).

Known range :

Grossly covering the Paleogene, starting in the Middle Danian.

Nonion multisuturatum VAN BELLEN

Pl. 9, f. 1

1946 *Nonion multisuturatum* VAN BELLEN. Meded. Geol. Sticht. C. 5, 4, p. 44, pl. 4, f. 3-6.
1966 *Nonion multisuturatum* VAN BELLEN ; HOFKER, Palaeontographica, Suppl. 10, p. 256, pl. 52, f. 52, pl. 57, f. 130 a-b.

Remarks : There is a relatively wide variation in the size of the specimens.

Occurrence :

1) "Mons well 1969" (76) : Covering a large part of the Lower Tertiary calcarenites from OB 70 to OB 12.

2) Other localities : Not recovered from any other sample in Belgium.

Known range :

HOFKER (1966 e) reports the species from his zone Q and R, which is in agreement with the occurrences in the "Mons well 1969". Hence the range probably covers Middle Danian to the top of the Calcaire de Mons (Montian).

Nonion ? *ornatum* VAN BELLEN

Pl. 9, f. 2

1946 *Nonion ornatum* VAN BELLEN, Meded. Geol. Sticht. C, 5, 4, p. 44, pl. 4, f. 7-10.
1964 *Nonion ornatum* VAN BELLEN ; MARIE, Mém. B.R.G.M. 28, pl. 2, f. 3, a-b.
1966 *Nonion ornatum* VAN BELLEN ; HOFKER, Palaeontographica, Suppl. 10, p. 256, pl. 52, f. 53.

Remarks : This species differs from all other *Nonion* species by its ornamentation all over the chambers and its sharp periphery. Its assignment to *Nonion* is considered doubtful. The figures of HOFKER and MARIE show a less sharp periphery than most of the specimens in our material.

Occurrence :

1) "Mons well 1969" (87) : Occurring only in the higher part of the Lower Tertiary calcarenites OB 48 to OB 16.10, some deeper occurrences are thought to be due to caving.

2) Other localities : Except for some specimens in the Calcaire de Mons of the Puits Coppee, the species has not been recovered by us from Belgian samples.

Known range :

HOFKER mentions this species only from his zone R and VAN BELLEN found it in the upper part of the Bunde Kalk. Hence, its range is uppermost Danian, ranging into the Calcaire de Mons typesection (Montian).

Nonion ? sp.

Pl. 9, f. 3

Description : Relatively large lenticular forms that are planispiral. The radial sutures are slightly depressed between the younger chambers and flush between older chambers. The periphery is rounded to subacute, not lobate. The number of chambers in the last whorl could not be counted. The aperture probably is a slit at the base of the apertural face. As far as could be seen the umbilicus is smooth and not depressed.

Remarks : This *Nonion* sp. differs from *N. multisuturatum* VAN BELLEN by its larger size (approximately 300 max. diameter) and the generally more rounded periphery.

Nonion geleenense VAN BELLEN somewhat resembles our forms but this species has a more acute periphery and less depressed sutures. Preservation of our material is such that even the generic designation is doubtful.

Occurrence :

1) "Mons well 1969" (58) : From OB 76 to OB 12.

2) Other localities : Tuffeau de Ciply at CA, ML and some other localities. It is possible that the species occurs also in Maastrichtian deposits (MM) in samples below 320 m.

Known range :

Danian, reaching the top of the Calcaire de Mons (Montian).

Genus *GLOBOROTALITES* BROTZEN, 1942

Globorotalites sp. cf. *G. granulatus* POZARYSKA & SZCZECHURA

cf. 1968 *Globorotalites granulatus* POZARYSKA & SZCZECHURA, Palaeont. Polon. 20, p. 67, pl. 8, f. 1-7.

Remarks : The few specimens of *Globorotalites* recovered from the Tertiary calcarenites of the "Mons well 1969" cannot be referred with certainty to *G. granulatus.* The specimens are recrystallized and it is not certain whether papillae (or granules) are present around the umbilicus, as the latter is filled with calcareous matrix.

Occurrence :

1) "Mons well 1969" (18) : Single specimens between OB 80 and OB 20.

2) Other localities : No specimens were recovered so far in Belgium.

Known range :

Middle Danian to Montian.
POZARYSKA & SZCZECHURA recovered their species from "Montian" sediments. Its presence in the (probably Danian) Bruderndorfer Feinsande of Austria was also ascertained by these authors.

Genus *GYROIDINOIDES* BROTZEN, 1942

Gyroidinoides subangulatus (PLUMMER)

1926 *Rotalia soldanii* (d'ORBIGNY) var. *subangulata*, PLUMMER, Bull. Texas Univ. 2644, p. 154, pl. 12, f. 1.
1951 *Gyroidina subangulata* (PLUMMER) ; CUSHMAN, U.S. Geol. Surv. Prof. Pap. 232, p. 51, pl. 14, f. 14-15.
1958 *Gyroidinoides subangulata* (PLUMMER) ; HOFKER, Foraminifera from the Cretaceous ... XXXIII, Natuurhist. Maandbl., 47, (3-4), p. 43, text-f. 7-8.
1965 *Gyroidinoides subangulata* (PLUMMER) ; POZARYSKA, Palaeont. Polon., 14, (1965), p. 108, pl. 18, f. 1.
1966 *Gyroidinoides subangulata* (PLUMMER) ; HOFKER, Palaeontographica, Suppl. 10, p. 139, pl. 21, f. 55 ; p. 207, pl. 39, f. 43, pl. 40, f. 72 ; p. 289, pl. 61, f. 64 ; p. 336, pl. 83, f. 203.

Remarks : This species has a higher ventral (= umbilical) side than *G. pontoni* BROTZEN. Furthermore, it has a larger and more distinct umbilicus than the *Gyroidinoides* form determined as *Gyroidina ? danvillensis* HOWE & WALLACE by HAYNES (1956, p. 93, pl. 17, f. 2) from the type Thanetian ; the spiral suture of our specimens is also somewhat more depressed.

Occurrence :

1) "Mons well 1969" (52) : It is rare in the lower part of the Lower Tertiary calcarenites.

2) Other localities : In the Mechelen-aan-de-Maas well this species ranges from 290.5 m to 219 m depth.

Known range : Maastrichtian to Paleocene.

According to POZARYSKA (1965) and to HOFKER (1958 b, 1966 e) the species' range covers the whole Maastrichtian. Furthermore, it covers the entire Paleocene.
HOFKER (1966 e) recovered this species also from the Danian of Denmark.

Gyroidinoides pontoni BROTZEN

1948 *Gyroidinoides pontoni* BROTZEN ; Sver. Geol. Unders. C., 42, 2, p. 76, pl. 11, f. 4, 5.
1965 *Gyroidinoides pontoni* BROTZEN ; POZARYSKA, Palaeont. Polon., 14, (1965), p. 108, pl. 18, f. 4.
1966 *Gyroidinoides pontoni* BROTZEN ; HOFKER, Palaeontographica, Suppl., 10, p. 75, pl. 13, f. 61 ; p. 93, pl. 16, f. 50 ; p. 139, pl. 20, f. 42 ; p. 148, pl. 23, f. 110 ; p. 227, pl. 42, f. 73 ; p. 243, pl. 47, f. 26. (non p. 289, pl. 64, f. 124, = *G. subangulatus* ; non p. 336, pl. 83, f. 201, = *G. subangulatus*).

Remarks : This relatively flat *Gyroidinoides* species resembles *Gyroidina ? danvillensis* HOWE & WALLACE from the type Thanetian (HAYNES, 1956, p. 63, pl. 17, f. 2). The latter species has a smaller and narrower umbilicus.

Occurrence :

1) "Mons well 1969" (51) : The species is rare ; its range covers the interval between the local Cretaceous - Tertiary boundary and 34.30 m.

2) Other localities : In the Mechelen-aan-de-Maas well this species is scarce in a number of samples between 290.5 m and 219 m. Moreover, it was recorded from the Tuffeau de Ciply (at quarry CA) and from the Calcarenite of Houthem (at quarry CU).

Known range :

Maastrichtian to Middle Paleocene.
HOFKER (1966 e) figured several specimens of this flat species from the Upper Maastrichtian and from Lower and Middle Paleocene deposits of eastern Belgium and the SE Netherlands.

Genus *BOLDIA* VAN BELLEN, 1946

Boldia sp. cf. *B. cubensis* CUSHMAN & BERMUDEZ

Pl. 9, f. 4

cf. 1948 *Boldia cubensis* CUSHMAN & BERMUDEZ ; Contr. Cushman Lab. Foram. Res., 24, 4, p. 74, pl. 11, f. 15-16.
cf. 1951 *Boldia cubensis* CUSHMAN & BERMUDEZ ; CUSHMAN, U.S. Geol. Surv. Prof. Pap., 232, p. 65, pl. 22, f. 13-14.
1966 *Boldia cubensis* CUSHMAN & BERMUDEZ ;HOFKER, Palaeontographica, Suppl., 10, p. 260, pl. 56, f. 104, 105.

Remarks : Our material differs from the figured type of this species in the following features :

1) The sutures are not depressed, and only vaguely to be seen ; when visible, they are not curved as was stated for the type material.

2) The periphery is not lobate.

3) The height of the chambers in the last whorl increases strongly from chamber to chamber ; the increase in size and in height of the chambers in the last whorl was stated to be small in the type material.

4) The stellate thickening observed in the umbilical region of the type material has not been observed in our specimens. In this very part of the test, HOFKER observed some small pustules in his material of the SE Netherlands and from the Puits Goffint, instead of the radial, stellate thickening. We did not observe pustules in our material, but it is rather recrystallized and the tests of the specimens found in the uppermost samples of the Calcaire de Mons are strongly worn.

Occurrence :

1) "Mons well 1969" (62) : The range of the species is restricted to the upper part of the calcarenites, it is frequent in the Calcaire de Mons and slightly deeper : to OB 42.30 m.

2) Other localities : The species has not yet been recovered from other outcrops or wells in the Mons basin. In the SE Netherlands and NE Belgium it was recovered from a few localities by HOFKER (1966 e). These deposits are considered lateral equivalents of the Calcaire de Mons.

Known range :

Mainly Montian, extending in the uppermost Danian.

The species was not recovered from the Tuffeau de Ciply or its lateral equivalents, neither was it found in the younger Paleocene deposits of Belgium (Heers Formation, Landen

Formation), but this may be due to ecological reasons.

Genus *SCARIFICATINA* MARIE, 1964 (here validated)

Type species *Scarificatina reinholdi* MARIE
(here validated as type species)

Remarks on the genus :

The term *Scarificatina reinholdi* was first used by MARIE in 1950 without description or pictures for either genus or species. Later, MARIE (1964) gave a schematic but clear picture, making it possible to recognize this taxon. Since this author omitted to give a description and to indicate a type species for the new genus, both genus and species remained *nomina nuda*.

POZARYSKA & SZCZECHURA (1970) gave a full description of *Boldia reinholdi* (MARIE) and thus validated the species *reinholdi*. However, they failed to observe that the species belongs to a genus differing from *Boldia* VAN BELLEN, 1946 (type species *Rotalina lobata* TERQUEM, 1882).
A historic review is given of various affiliated taxa in this group, as nomenclature has become rather confused.

Moreover a diagnostic description is given here to validate the genus *Scarificatina*, and differences with *Boldia* are pointed out.

Historical review of nomenclature details

1882 TERQUEM (1882) describes the species *Rotalina lobata* TERQUEM from the Eocene of the Paris basin ; when later reviewing his collection Y. LE CALVEZ (1952, p. 50, pl. 4, f. 40-41) gave a more accurate picture of the holotype specimen ; this specimen was also figured from three sides by LOEBLICH & TAPPAN (1964).

1946 VAN BELLEN (1946 a) erects the genus *Terquemia* with *Rotalina lobata* TERQUEM as the type species according to his definition of the new genus ; however, in the legend of his plates, he erroneously cited the (single) specimen he recovered from the Bunde wells, and which is figured (pl. 13, f. 13-15) as the "holotype of the new genus and new species". As stated by LOEBLICH & TAPPAN (1964), the holotype of the type species must be considered typical for the genus.
In the same year VAN BELLEN (1946 b) found out that there were two senior homonyms for the genus *Terquemia* and he chose a new name, *Boldia*, for his earlier erected genus *Terquemia* . Again he claimed the type species ("genotype") to be *Boldia lobata* (TERQUEM).

1946 VAN DEN BOLD (1946, Thesis, Utrecht) describing *B. vandersluisi* VAN DEN BOLD is likely to have been the first to discover another species of the genus *Boldia*.

1948 CUSHMAN & BERMUDEZ described two species from Cuba which they placed in the genus believe that both TERQUEM's type of *Rotalina lobata* TERQUEM and VAN BELLEN's "type" of

1950 MARIE (1950) published a name for a new Paleocene form *Scarificatina reinholdi* n. gen., n. sp., but as this taxon was not described, this generic name has to be considered a *nomen nudum*.

1960 HOFKER (1960 e, 1961 g) while reviewing the genus *Boldia* claims the specimen of VAN BELLEN to belong to another species than *R. lobata* TERQUEM (a fact with which we agree)

and he determines the forms of the Bunde Kalk as *Boldia madrugaensis* (we do not accept this determination, see below).

1961 BROTZEN & POZARYSKA (1961) studying Paleocene foraminifera of Poland, also remarked that the specimen described by VAN BELLEN from the Bunde Kalk, *Terquemia lobata* (TERQUEM), did not belong to the same species as the holotype of *Rotalina lobata* TERQUEM, and they erected a new species name for VAN BELLEN's type : *Boldia boldia*.They appeared to believe that both TERQUEM's type of *Rotalina lobata* TERQUEM and VAN BELLEN's "type" of *Terquemia lobata*belonged to the genus *Boldia*. Unfortunately, they chose a wrong name : according to the international Code of Zoological Nomenclature, 1964 (adopted by the 15 th International Congress of Zoology, London 1958) *tautonymy* (= same name for the genus and for the species) is only to be used in case the erected species is also the type species of the genus ("type by Linnean tautonymy").
BROTZEN & POZARYSKA used a tautonym for a species, which was supposed to be different from the type species of the genus (*R. LOBATA* TERQUEM). They cited *Boldia lobata* VAN BELLEN (non TERQUEM) as type for *Boldia boldia*.
They were probably mislead by the fact that VAN BELLEN had mentioned "holotype" in the legend of his plate, figuring his specimen.

1964 MARIE (1964, pl. 2, f. 4 a-c) figured one specimen of his new genus and species (*Scarificatina reinholdi*) he erected earlier, probably to be considered as the type species of the new genus, but not stated so by the author. This "indication" would have been sufficient to validate the previously cited *nomina nuda*, if it had happened before 1930, but, according to the Int. Code of Zoological Nomenclature, the new names *Scarificatina reinholdi* of MARIE (1950, 1964) are still to be considered *nomina nuda*, although his figures are detailed and clear enough to determine this new taxon.

1964 LOEBLICH & TAPPAN (*in* MOORE, 1964) described the genus *Boldia* in detail, based on the holotype of its species (= holotype of *Rotalina lobata* TERQUEM), and stated that VAN BELLEN's (1946 a) specimen probably belonged to another species, a fact with which we agree.

1970 POZARYSKA & SZCZECHURA (1970 b) compared material of the Bunde Kalk from the wells previously studied by VAN BELLEN (1946 a) and later by HOFKER (1966 e, and other publications), with material of the Calcaire de Mons, from a well in the town of Mons ("Puits artésien") and with similar forms recovered from the Paleocene of the Pamietowo well in Poland. They determined all this material to belong to the species *Boldia reinholdi* . Since they gave a full description of the species (*reinholdi*), which had previously been a *nomen nudum*, they validated MARIE's (1950, 1964) species.

Description of the genus *Scarificatina*

Test trochoid, with five to six chambers in the last whorl ; the spiral side is evolute and may bear a keel (which is the continuation of the limbate spiral suture, reminding of the spiral side of *Stensioeina*) or it may have a rounded periphery. In the latter specimens only the early whorls bear a raised spiral suture. At the umbilical side the periphery is always rounded, not lobate, and costae (3 to 6 on each chamber) parallel to the (radial) sutures cover the chambers of the last whorl. The central part of the umbilical side is covered by straight parallel costae, which in some cases may reach the periphery. The aperture is cribrate : small rounded openings bordered by circular lips cover a large part of the apertural face.

Differences between *Scarificatina* MARIE and *Boldia* VAN BELLEN

The main differences are :

1) Parallel costae in the central part of the umbilical side occur only in *Scarificatina*, not in *Boldia*.

2) A cribrate multiple aperture occurs only in *Scarificatina*, whereas *Boldia* has a slit-like aperture.

Further possible differences (not occurring in all specimens) are :

1) The raised sutures (of *Stensioeina* type) at the spiral side which may form a keel in the last whorl.

2) Radial costae oblique to the periphery covering the last whorl.

Our conclusions concerning *Scarificatina* and *Boldia.*

1) We consider the genus *Boldia*, typified by the holotype of TERQUEM's species *Rotalina lobata* to be a valid genus, observed in Middle Eocene (Lutetian) sediments of the Paris basin.

2) The genus *Scarificatina* MARIE (1950, 1964) has until now been a *nomen nudum*. It is validated by our description and the indication of the type species *Scarificatina reinholdi*, the species which was validated by POZARYSKA & SZCZECHURA (1970) under the name of *Boldia reinholdi*.

3) We consider *Boldia lobata* (TERQUEM) (= *Rotalina lobata* TERQUEM) and *Scarificatina reinholdi* MARIE, as validated by us (= *Boldia lobata* VAN BELLEN, non TERQUEM) to be two different species, belonging to two different genera.

Scarificatina reinholdi MARIE

Pl. 9, f. 5, 6, 7

1946 *Terquemia lobata* (TERQUEM) ; VAN BELLEN, Meded. Geol. Sticht. C., 5, 4, p. 86, pl. 13, f. 13-15. (non *Rotalina lobata* TERQUEM, 1882, Mém. Soc. Géol. France, 3, 2, p. 63, pl. 4, f. 10).

1946 *Boldia lobata* (TERQUEM) ; VAN BELLEN, Contr. Cushman Lab., 22, 4, p. 121.

1950 *Scarificatina reinholdi* MARIE ; Int. Géol. Congress, 18th Session, (1948) Great Britian report, 15, p. 50, (*nomen nudum*).

non 1946 *Boldia madrugaensis* CUSHMAN & BERMUDEZ, Contr. Cushman. Lab. Foram. Res. 24, p. 75, pl. 12, f. 4-6.

non 1951 *Boldia madrugaensis* CUSHMAN & BERMUDEZ ; CUSHMAN, Geol. Surv. Prof. Pap. 232, p. 65, pl. 22, f. 10-12.

1960 *Boldia madrugaensis* CUSHMAN & BERMUDEZ ; HOFKER, Contr. Cushm. Found. Foram. Res. 11, 2, p. 47, text - f. 1, 2, 3, 5, 6, 7. (non 4 = *S. szczechurae*).

1961 *Boldia boldia* BROTZEN & POZARYSKA, Rev. de Micropal., 4, 3, p. 157.

1962 *Boldia madrugaensis* CUSHMAN & BERMUDEZ ; HOFKER, Journ. Paleont. 36, 5, p. 1083, text - f. 27 B.

1964 *Scarificatina reinholdi* MARIE ; MARIE, Mém. B.R.G.M., 28, 2, pl. 2, f. 4 a-c (*nomen nudum*).

1966 *Boldia madrugaensis* CUSHMAN & BERMUDEZ ; HOFKER, Palaeontographica, Suppl. 10, p. 229, pl. 46, f. 142 ; p. 260, pl. 55, f. 101-103, pl. 57, f. 134-137.

1970 *Boldia reinholdi* (MARIE) ; POZARYSKA & SZCZECHURA, Acta Palaeont. Polon., 15, 1, p. 99, pl. 3, f. 3-4 (non fig. 1, 2).

Remarks : Among the variants of *Scarificatina reinholdi* one observes forms which show faint costae that cover the whole surface of the umbilical side (pl. 9, f. 6). It is possible that the specimen figured and described by VAN BELLEN (1946) as *Rotalia obesa* (TERQUEM) (VAN BELLEN 1946, p. 78, pl. 8, f. 14-16) is such a variant.
Scarificatina reinholdi MARIE differs from *Boldia madrugaensis*, by the parallel costae on its umbilical side. The latter species shows only radial costae-like ornaments, no parallel ribs. HOFKER's *Boldia madrugaensis* specimens of his R Zone in Limburg, are here considered to belong to *Scarificatina reinholdi* MARIE.
Differences between the typical forms of *Scarificatina reinholdi* and the new species *Scarificatina szczechurae* are given below, with the description of that new species.

Occurrence :

1) "Mons well 1969" (119) : Typical specimens of this species were only observed in the higher part of the Tertiary calcarenites (type section of the Calcaire de Mons and samples just underneath).
Its range covers the interval OB 36.10 - OB 13.90.

2) Other localities : (TH) Tranchée de Hainin, Calcaire de Mons ; (COP) Puits Coppée, Calcaire de Mons.

Known range :

Montian.
HOFKER (1962, 1966 e and other publications) recovered this form from his "Zone R" (= lateral equivalents of the Calcaire de Mons) in the Bunde wells, in the Maurits III mine shaft, in the Quarry Curfs and in the Calcaire de Mons of the Mons basin.
MARIE (1964) claims to have recovered specimens of this species in the Tuffeau de Ciply ; we did not observe this species in that rock unit ; probably MARIE's specimens belong to the ancestral form *Scarificatina szczechurae* n. sp. which occurs in older strata.

Scarificatina szczechurae n. sp.

Pl. 10, f. 1 ; pl. 10, f. 2 (var. 1)

? 1960 *Boldia carinata* var. 2, DROOGER, Proceed. Kon. Ned. Akad. Wet. Ser. B., 63, 4, p. 454, pl. 1, f. 12 a-c, 13 a-c.
1970 *Boldia reinholdi* (MARIE) ; POZARYSKA & SZCZECHURA, Palaeont. Polon. 15, 1, p. 99, pl. 3, f. 1, 2. (non fig. 3, 4).

Holotype : N° 19 of collection of the Faculté Polytechnique de Mons. Specimen figured Pl. 10, f. 1.

Paratypoids : N° 20, 21, (22 is the type of var. 1), collection of Mons.

Type level : Lower Tertiary calcarenite of "Mons well 1969", basal part ; Danian Age.

Type locality : "Mons well 1969" (approximately 14 m south of the classical Goffint Pit) at Obourg, OB 76, near Mons, Belgium.

Name : The name was given in honour of Dr. J. Szczechura, Polish Academy of Sciences, Warszawa.

Deposition of specimens : Collection of Geol. Inst., Faculté Polytechnique, Mons, Belgium.

Material : Some 30 specimens were found, scattered over the interval between the local Maastrichtian-

Danian boundary (80 m) and the top of the Calcaire de Mons in the "Mons well, 1969".

Diagnosis : A species of *Scarificatina* different from *S. reinholdi* in the following features :

1) the periphery is bordered by a strong keel,
2) the size is smaller, 280 μ against approx. 500 μ.
3) there are only two or three ribs in the umbilicus, whereas *S. reinholdi* MARIE has four to six costae at the umbilical side.

Description : Calcareous trochospiral test ; six to eight chambers in the last whorl ; umbilical side nearly flat, somewhat concave ; its central part covered by two or three acute parallel costae ; around this ornamented central part radial costae are to be observed which generally reach the periphery. The spiral side is nearly flat, the sutures are strongly limbate, mainly the spiral suture and the sutures between the chambers of the last whorl (as in *Stensioeina exsculpta*). The diameter of the test is wider at the spiral side than at the umbilical side, where the chambers are generally rounded. At the spiral side the periphery is sharp, generally keeled. The aperture of the last chamber was not observed ; in specimens the last chamber of which was broken off, there are cribrate, intercameral foramina ; each small areal opening is surrounded by a distinct lip. At the spiral side coarse pores occur mainly in the chambers of the last whorl. Along the periphery the costate pattern may be irregular ; instead of continuous costae, anastomosing and discontinuous costae may occur (cf. pl. 10, f, 2 ; *S. szczechurae* var. 1).

Measurements :

in : mm	Holotype	Paratypoids	
		1	2
max. diam.	0.28	0.26	0.26
min. diam.	0.24	0.21	0.23
thickness	0.15	0.15	0.13

Remarks : The diagnostic features of this species were also observed in juvenile forms of *Scarificatina reinholdi*. This may indicate that the species here described as *Scarificatina szczechurae* is a predecessor of *S. reinholdi*. Actually, the species occurs throughout the studied interval whereas *S. reinholdi* was recovered only in the higher part of the calcarenites of the "Mons well 1969". Possibly our *S. szczechurae* var. 1 (Pl. 10, f. 2) found only in the topmost sample of the "Mons well 1969", represent a further development of the group.

Occurrence :

1) "Mons well 1969" (69) : The range of this species covers nearly the whole interval between the local Maastrichtian-Danian boundary and the top of the Calcaire de Mons ; its lowest occurrence is situated at 76 m and its highest occurrence was observed at 12 m. *S. szczechurae* var. 1 was only observed in OB 12, uppermost sample of the Calcaire de Mons (Montian).

2) Other localities : Although the material was rather badly preserved the species seems to be present in the trench of the Albert Canal (VR), north of the fault of Hees.

Known range :

Middle Danian to Montian.
In Poland this species (recorded as *Boldia reinholdi* (MARIE) by POZARYSKA & SZCZECHURA, 1970) occurs in post Danian "Montian" sediments.
In the "Mons well 1969" it was found in Middle to Upper Danian deposits. It has not yet been recorded from the Tuffeau de Ciply nor from deposits younger than the Calcaire de Mons.

Genus GAVELINELLA BROTZEN, 1942

Gavelinella danica (BROTZEN)

Pl. 11, f. 1

1927 *Anomalina grosserugosa* GÜMBEL ; FRANKE, Dan. Geol. Und., 2, 46, p. 37, pl. 4, f. 3. (non *Truncatulina grosserugosa* GÜMBEL, 1868, Abh. K. Bayer. Akad. Wiss. (m. ph. cl.), 10, p. 660, pl. 2, f. 104.
1931 *Anomalina grosserugosa* (GÜMBEL) ; PLUMMER, Univ. Tex. Bull. 3101, p. 201, pl. 14, f. 9, a-c.
1940 *Cibicides danica* BROTZEN ; Sver. Geol. Unders. Arsb., 34, 5, p. 31, pl. 7, f. 2.
1946 *Anomalina granosa* (HANTKEN) ; VAN BELLEN, Meded. Geol. Sticht. C., 5, 4, p. 74, pl. 11, f. 4-6 (non *Truncatulina granosa* HANTKEN).
1948 *Anomalinoides danica* (BROTZEN) ; BROTZEN, Sver. Geol. Unders. C. 42, 2. p. 87, pl. 14, f. 1, text-f. 22.
1965 *Anomalina danica* (BROTZEN) ; POZARYSKA, Palaeont. Polon., 14, (1965), p. 128, f. 1-3.
1966 *Gavelinella danica* (BROTZEN) ; HOFKER, Palaeontographica Suppl. 10, p. 227, pl. 43, f. 86 a-c.
1968 *Anomalina danica* BROTZEN ; POZARYSKA & SZCZECHURA, Palaeont. Polon., 20, (1968), p. 86, pl. 14, f. 6-11.
1970 *Gavelinella danica* (BROTZEN) ; HANSEN, Meddel. Grønl. 193, 2, p. 108, text - f. 38 ; pl. 13, f. 4-6 ; pl. 28, f. 2-5.

Remarks : Forms recovered from chalky or calcarenitic sediments (e.g. Tuffaceous Chalk of Maastricht, Tuffeau de Ciply), show a rugose surface with protuberances near the umbilicus on the older chambers of the last whorl. In transparent (hyaline) forms derived from clayey or marly deposits (e.g. Marls of Gelinden) this part near the umbilicus is smooth as it is in the rest of the test. The pores of the specimens we observed in the "Mons well 1969" were quite large and the wall was coarse, thus resembling BROTZEN's specimens of the Swedish Paleocene. Very large specimens occur in Maastrichtian and Danian sediments as well as in the Calcaire de Mons ; no large specimens were recovered from younger (Heersian) sediments in Belgium.

Occurrence :

1) "Mons well 1969" (25) : The species was recovered from nearly all samples. Generally it is quite abundant.

2) Other localities : The species is abundant in a large number of samples, from uppermost Cretaceous and from Lower to Middle Paleocene.

- LA ; (Calcaire de Mons, Tuffeau d'Angres (?)).
- Kallo well (Tuffaceous Chalk of Maastricht).

- Quarry Le Cornet (near Tournai) (Tuffeau de Chercq).
- CA ; Craie phosphatée de Ciply (Maastrichtian) and Tuffeau de Ciply (Danian).
- E.N.C.I. quarry, St. Pietersberg (type Maastrichtian), from all layers.
- VR ; Calcarenite of Houthem (Danian).
- Ghlin well : Chalk member of Spiennes (Maastrichtian).
- LI ; Craie phosphatée de Ciply (Maastrichtian) and Tuffeau de Ciply (Danian).
- TH ; Calcaire de Mons and underlying Tuffeau ; not from the Campanian chalk underneath.
- MM ; in this well the species is abundant in the Tuffaceous Chalk of Maastricht, the Calcarenite of Houthem, the Calcarenite of Mechelen-aan-de-Maas (297 m to 272 m). It is rare in the overlying Heers Formation, and it was not found in the marine Lower Landenian.

Known range :

This species is known to occur abundantly in Maastrichtian (mainly Upper Maastrichtian) deposits in addition to its characteristic occurrence in Lower-Middle Paleocene (Danian and Selandian) deposits in Denmark and southern Sweden.
It occurs less frequently in the Heers Formation in Belgium. It was neither recorded from the type Thanetian (HAYNES, 1958, Distribution table) nor from the marine (= Lower) Landenian of Belgium.

Gavelinella minor (POZARYSKA & SZCZECHURA)

Pl. 17, f. 3, 4

1968 *Anomalina minor* POZARYSKA & SZCZECHURA ; Palaeont. Polon., 20, (1968), p. 87, pl. 14, f. 1-5, text-f. 21.

Remarks : The specimens are smaller than those of *G. danica* (BROTZEN). The periphery is less lobulate, as the chambers are less inflated than in BROTZEN's species.
As the aperture definitely lies at the umbilical side of our specimens we transferred this species to the genus *Gavelinella* BROTZEN. Such an aperture is also figured by POZARYSKA & SZCZECHURA (f. 3 c).

Occurrence :

1) "Mons well 1969" (41) : The range covers nearly the whole interval between the local Maastrichtian-Danian boundary (it appears at 79 m depth) and the upper part of the Calcaire de Mons (16.10 m depth).

2) Other localities : In the Mechelen-aan-de-Maas well (MM) this species occurs in Upper Maastrichtian, Danian and slightly younger deposits ; it disappears at the base of the Heers Formation (272 m).
From outcrops an analogous stratigraphical distribution was observed.

Known range :

POZARYSKA & SZCZECHURA (1968) recorded the species only from Middle Paleocene deposits (Montian of Poland and of the Mons basin). According to our analysis, its range would cover nearly the same interval as that of *Gavelinella danica* (cf. that species).

Gavelinella sp. cf. *G. acuta* (PLUMMER)

1926 *Anomalina ammonoides* REUSS var. *acuta* PLUMMER, Univ. Tex. Bull. 2644, p. 149, pl. 10, f. 2.

1948 *Anomalinoides acuta* (PLUMMER) ; BROTZEN, Sver. Geol. Unders. C., 42, 2, p. 87, pl. 14, f. 2 a-c.

Remarks : The specimens of our material are rather badly preserved. Therefore they cannot be determined with certainty. The number of chambers in the last whorl is not known but according to the vague lobulation of the periphery it might be 10. The figure of the holotype of this species, however, shows 15 chambers.

Occurrence :

1) "Mons well 1969" (33) : A typical specimen was found at 42.30 m depth ; similar specimens were found in several samples from the local Maastrichtian-Danian boundary up to OB 40.

2) Other localities : MM, Formation of Heers, and "Infra-Heersian" (272-297 m), and also in Danian and Maastrichtian deposits, but there it is rare.

Known range :

In Upper Maastrichtian, Danian and Middle Paleocene deposits in Sweden, Poland, and Russia, (if. *G. praeacuta* VASILENKO is included in this species).

Gavelinella ? sp. cf. *G. midwayensis* (PLUMMER)

Pl. 11, f. 2

1926 *Truncatulina midwayensis* PLUMMER, Texas Univ. Bull. 2644, p. 141, pl. 9, f. 7, pl. 15, f. 3 a-b.

1948 *Anomalinoides midwayensis* (PLUMMER) ; BROTZEN, Sver. Geol. Unders. C., 42, 2, p. 88, pl. 14, f. 3-4.

1951 *Anomalinoides midwayensis* (PLUMMER) ; CUSHMAN, Geol. Surv. Prof. Pap. 232, p. 62 pl. 17, f. 17-19.

1966 *Anomalinoides midwayensis* (PLUMMER) ; HOFKER, Palaeontographica, Suppl. 10, p. 289, pl. 64, f. 109.

Remarks : Our forms and those of other European occurrences have flush to slightly depressed sutures which are not limbate as pictured by PLUMMER and CUSHMAN for the early chambers of the last whorl in American specimens. Our material therefore resembles BROTZEN's (1948 ; pl. 14, f. 94) figured specimens better. This is true for the material of the "Mons well 1969" and also for that of younger deposits, e.g. in the Mechelen-aan-de-Maas well. Some specimens of the "Mons well 1969" (e.g. pl. 11, f. 2) show the distinct umbilical lips, mentioned by BROTZEN.

Occurrence :

1) "Mons well 1969" (39) : Some rare specimens were found between OB 79 and OB 36.10.

2) Other localities : Calcaire de Mons (COP), Tuffeau de Ciply (LA 190 and LA 175) (CA 6 and CA 23), Formation of the Paternostre well (LA 81 - LA 86), Tuffeau de Chercq (LC 7.5 - LC 26) ;

Heers Formation : Sands of Orp (ORP) and Marls of Gelinden (OV) ; Lower Landen Formation : Tuffeau de Lincent (WA).
Mechelen-aan-de-Maas well (MM) : Calcarenite of Mechelen-aan-de-Maas. Heers Formation and Lower Landen Formation, ranging between MM 290.5 and MM 220.

Known range :

The species ranges throughout the Paleocene ; probably it occurs only rarely in Upper Maastrichtian deposits (HOFKER, 1966 e, in his Zone O).

Genus *COLEITES* PLUMMER, 1934

Coleites reticulosus (PLUMMER)

Pl. 11, f. 3 ; Pl. 17, f. 1, 2

1926 *Pulvinulina reticulosa* PLUMMER ; Univ. Texas Bull., 2644, p. 152, pl. 12, f. 5 a-b.
1948 *Coleites reticulosus* (PLUMMER) ; BROTZEN, Sver. Geol. Unders. C., 42, 2, p. 109, pl. 18, f. 1 a-c.
1951 *Coleites reticulosus* (PLUMMER) ; CUSHMAN, U.S. Geol. Surv. Prof. Pap., 232, p. 54, pl. 15, f. 1-5.
1956 *Coleites reticulosus* (PLUMMER) ; HOFKER, Foraminifera from the Cretaceous of Southern Limburg ... XX, Natuurhist. Maandbl., 45, (7-8) p. 75, text-f. 1-8.
1960 *Coleites reticulosus* (PLUMMER) ; HILTERMAN & KOCH, Int. Geol. Kongr. 21 Sess. Norden, p. 73, text-f. 4.
1962 *Coleites reticulosus* (PLUMMER) ; HOFKER, Journ. Paleont., 36, 5, p. 1073, text-f. 17 a-g.
1965 *Coleites reticulosus* (PLUMMER) ; POZARYSKA, Palaeont. Polon. 14 (1965) p. 117, pl. 20, f. 1 a-c, 2 a-b.
1966 *Coleites reticulosus* (PLUMMER) ; HOFKER, Palaeontographica, Suppl. 10, p. 94, pl. 16, f. 49 ; p. 123, pl. 18, f. 21 ; p. 140, pl. 20, f. 43 ; p. 149, pl. 22, f. 105, pl. 23, f. 107 ; p. 208, pl. 39, f. 45 ; p. 230, pl. 42, f. 76, 79 ; pl. 44, f. 121 ; p. 245, pl. 47, f. 23 ; p. 313, pl. 70, f. 119.

Remarks : Some specimens recovered are large (800 μ max. diameter), whereas some small "primitive" specimens occur (370 μ max. diameter) which are less ornamented. Similar forms were found in the Tuffeau de Ciply (CA).
"Primitive" specimens with an apertural slit at the base of the apertural face reaching the periphery have been found in several samples. A single larger specimen (figured Pl. 11, f. 3) with areal aperture, looking more "evolved" according to the phylogenetic lineage suggested by HOFKER (1956 g), occurred in a Danian sample near the base of the calcarenite succession (OB 70) and suggests that "primitive" and "evolved" specimens may occur together.

Occurrence :

1) "Mons well 1969" (48) : Some specimens were recovered from the lower part of the Tertiary calcarenites not higher than OB 60 m, in addition to a single specimen in OB 12.

2) Other localities : The species was neither found by VAN BELLEN (1946 a) nor by HOFKER (1966 e) in the Bunde Kalk. Its near-absence in the Calcaire de Mons and Bunde Kalk might be the result of environmental conditions, as the species is equally absent from the higher

part of the Tuffaceous Chalk of Maastricht possibly because ecological conditions were similar to those during deposition at OB. The species is quite common in the Tuffeau de Ciply (CA, TH, LI) and in the Calcarenite of Houthem (MM, VR).
Furthermore, it was found in the Calcarenite of Mechelen-aan-de-Maas in the MM well (highest occurrence at 273 m) ; it was not recorded from the Formations of Heers and Landen.

Known range :

According to the literature, the species appears in Middle Maastrichtian times. In NW Europe its frequence diminishes at the end of Early Paleocene (Danian) or slightly later. In Poland, however, it was recorded from sediments of the Pamietowo well, correlated with the Montian stratotype by POZARYSKA & SZCZECHURA (1968).

Genus *KARRERIA* RZEHAK, 1891

Karreria fallax RZEHAK

Pl. 11, f. 4 ; Pl. 17, f. 5, 6

1891 *Karreria fallax* RZEHAK ; Ann. K. k. Natuurhist. Hofmuseum, 6, p. 4, pl. 7, f. 7 a-c, 8 a-b.
1948 *Karreria fallax* RZEHAK ; BROTZEN, Sver. Geol. Unders., C, 42, 2, p. 114, pl. 18, f. 3, text-f. 34, 35 (1-14), 36, 37.
1957 *Karreria fallax* RZEHAK ; HOFKER, Foraminifera from the Cretaceous ... XXVII, Natuurhist. Maandbl. 46, (7-8), p. 98, f. 1, 2.
1965 *Karreria fallax* RZEHAK ; POZARYSKA, Palaeont. Polon. 14, (1965), p. 138, pl. 19, F. 3, 4.
1966 *Karreria fallax* RZEHAK ; HOFKER, Palaeontographica, Suppl. 10, p. 193, pl. 37, f. 46 ; p. 202, pl. 38, f. 38, 39 ; p. 217, pl. 44, f. 113, 114, 115, pl. 45, f. 127 ; p. 240, pl. 48, f. 40, 41, 44 ; p. 334, pl. 84, f. 213, 214, 215.
1968 *Karreria fallax* ; RZEHAK ; POZARYSKA & SZCZECHURA, Palaeont. Polon., 20, (1968), p. 91, text-f. 22.
1970 *Karreria* sp. HANSEN, Meddel. Grønl., 193, 2, p. 112, pl. 13, f. 7-9 ; pl. 28, f. 6.

Remarks : Most specimens do not show an uncoiled stage ; the aperture always touches the base of the final chamber, it is not areal.

Occurrence :

1) "Mons well 1969" (24) : This species has been found from 80 m to 20 m in the calcarenite series at Obourg.

2) Other localities :
- Maastrichtian deposits in the Mons basin (CA, LI)
- Tuffeau de Ciply (CA, LI)
- Calcarenite of Houthem (VR)
- "Infra Heersian" in the MM well (interval 297 to 272 m)
- abundant in some younger Paleocene Landenian (Thanetian) deposits of the Mons basin (LA) and quarry "Le Cornet" at Chercq, near Tournai.

Known range :

The range of the species covers at least part of the Maastrichtian (HOFKER, 1966 e), Danian

and younger Paleocene (BROTZEN, 1948), Lower Eocene and part of the Middle Eocene (KAASSCHIETER, 1961).

Genus *LAMARCKINA* BERTHELIN, 1881

Lamarckina naheolensis CUSHMAN & TODD

Pl. 11, f. 5

1942 *Lamarckina naheolensis* CUSHMAN & TODD ; C.C.L.F.R. 18, p. 39, pl. 7, f. 5-7.
1948 *Lamarckina naheolensis* CUSHMAN & TODD ; BROTZEN, Sver. Geol. Unders. C. 42, 2, p. 122, pl. 17, f. 6 a-c.
1951 *Lamarckina naheolensis* CUSHMAN & TODD ; CUSHMAN, U. S. Geol. Surv. Prof. Pap., 232, p. 49, pl. 14, f. 4-6.
1965 *Lamarckina naheolensis* CUSHMAN & TODD ; POZARYSKA, Palaeont. Polon. 14, (1965), p. 115, pl. 20, f. 5 a-c.

Remarks : Some small relatively well preserved specimens have been observed in two samples in which the other foraminifera with calcitic tests are generally strongly recrystallized.

Occurrence :

1) "Mons well 1969" (122) : Two specimens recovered in OB 30 and a single one in OB 32.20 (Montian).

2) Other localities : We did not recover the species in any other Paleocene sample of Belgium.

Known range :

This species has been recorded from post-Danian Paleocene deposits of the U.S.A., Sweden, Denmark and Poland.
The fact that *Lamarckina* species and other taxa with aragonite tests have so far not been recovered from the Danian of Denmark or of other regions, has been explained by TROELSEN (1954) and HANSEN (1970 b) as the result of solution of aragonitic tests in calcitic sediments. It has to be noted that well preserved specimens have now been found in the calcarenites of the "Mons well 1969", together with other foraminifera that show relatively strong recrystallization. Hence, this occurrence in calcitic sediments is considered to be one of incidental preservation.

Lamarckina limbata CUSHMAN & TODD

Pl. 5 ; f. 9

1942 *Lamarckina limbata* CUSHMAN & TODD ; Contr. Cushman Lab. Foram. Res. 18, p. 39, pl. 7, f. 8-10.
1951 *Lamarckina limbata* CUSHMAN & TODD ; CUSHMAN, Geol. Surv. Prof. Pap. 232, p. 49, pl. 14, f. 1-3.

Remarks : This species is close to *Lamarckina rugulosa* but differs by the limbate sutures at the (spinose) spiral side.

Occurrence :

1) "Mons well 1969" (124) : A single well preserved specimen was recorded from OB 30 (Montian).

2) Other localities : Not recovered from any other sample.

Known range :

All American occurrences are thought to be Paleocene Age, younger than Danian. Its absence as a fossil in most Danian limestones may be explained, however, by easy solution of the aragonitic tests (cf. remarks on *Lamarckina naheolensis*).

Benthonic Foraminiferida (species diversa).

In the range chart a number of species have been entered which are extremely rare or atypical, and the determination of which is uncertain due to the poor state of preservation :

Valvulina guillaumei Y. LE CALVEZ (125)
Valvulina terquemi Y. LE CALVEZ (127)
Clavulina sp. (101)
Triloculina sp. (90)
Marginulina costulata HOFKER (123)
Lenticulina spp. (46)
Astacolus sp. (103)
Nodosaria spp. (73 and 109)
Pseudopolymorphina geijeri var. *angusta* BROTZEN (81) (Pl. 5, f. 2)
Dyofrondicularia sp. (110)
Lagena spp. (67 and 105)
Sigmomorphina pseudoregularis CUSHMAN & THOMAS (89)
Guttulina hantkeni CUSHMAN & OZAWA (91)
Bulimina sp. cf. *B. pseudoacuta* MARIE (36)
Bolivina sp. cf. *B. eocenica* (TERQUEM) (117)
Reussella sp. (94)
Fissurina sp. (118)
Tappanina sp. cf. *T. selmensis* (CUSHMAN) (114) (small specimens)
Conorbina ? sp. (59)
Discorbis sp. (77)
Discorbis limbata (TERQUEM) (128)
Rosalina crenulata HOFKER (121)
Alabamina sp. cf. *A. obtusa* (BURROWS & HOLLAND) (35)
Alabamina sp. cf. *A. wilcoxensis* TOULMIN (99)
Glabratella sp. cf. *G. polonica* POZARYSKA & SZCZECHURA (97)
Lamarckina ? sp. (102)
Paralabamina lunata (BROTZEN) (116)
Anomalinoides sp. (20)
Cibicides sp. cf. *C. voltzianus* (d'ORBIGNY) (27)
Cibicides asteroides POZARYSKA & SZCZECHURA (44)
Cibicides elongatus var. *limburgensis* VAN BELLEN (83)
Nonion sp. cf. *N. scaphum* (d'ORBIGNY) (106)
Planulina sp. (108)
Anomalinoides mississippiensis (CUSHMAN) (126)
Anomalinoides bundensis VAN BELLEN (78)

Moreover, some very poorly preserved specimens have been recovered which were not entered in the chart :

A specimen of *Stomatorbina* sp. was recovered in OB 13.90.
Of *Frondicularia biformis* a single specimen was recovered at OB 72.10 and a specimen of *Loxostomum* in OB 72.10 not showing the sutural pattern of *L. applinae* (PLUMMER).

7.2. PLANKTONIC FORAMINIFERA

The description and stratigraphic distribution of planktonic foraminifera in the interval from Uppermost Cretaceous to Lower Eocene have been dealt with by a great number of authors. All publications which were of special importance for our determinations and/or for our zonation of the Paleocene, are accompanied by an asterisk in the bibliography at the end.
References to each of the planktonic species only contain literature data pertinent to the correct concept of the species.

Genus *GLOBIGERINA* d'ORBIGNY, 1826

Globigerina daubjergensis BRÖNNIMANN

Pl. 12, f. 3 ; Pl. 18, f. 1, 2

1953 *Globigerina daubjergensis* BRÖNNIMANN, Eclog. Geol. Helv. 45, (1952), 2, p. 340, text-f. 1.

Remarks : As was explained in an earlier paper (MOORKENS, 1971) *G. kozlowskii* BROTZEN & POZARYSKA (as emended by us) is considered to be a species different from *G. daubjergensis*.

For the distinction of both species, populations of 50 or more specimens have to be measured. When the average maximal test size (maximal diameter) is smaller than 185 μ the population is considered to belong to *G. daubjergensis*, whereas a population with an average test size larger than 185 μ is considered to belong to *G. kozlowskii.* The latter species is believed to be post-Danian in age and restricted to the lower part of the Middle Paleocene. Hence, *G. daubjergensis* and *G. kozlowskii* represent two different chronospecies of the lineage *G. daubjergensis - G. kozlowskii*. The increase of average maximal test size with time, and its explanation as an evolutionary lineage were put forward by HOFKER (1960 b, 1962, 1966 e) and by BERGGREN (1962 a). The first to investigate this lineage on a biometrical basis was HANSEN (1970 a), who discovered that a population of tototypes of *G. kozlowskii* (from the "Montian" of the Pamietowo well in Poland) showed a significantly larger average maximal diameter than the populations he investigated from the Danian of Denmark. An analogous larger size population was found in the Selandian strata overlying the Danian in Denmark. The population of topotypes of *G. kozlowskii* is also for this reason considered to be younger than those of the Danian.

Measurements on Belgian material

The material in Belgium is not as rich in planktonic foraminifera as were the samples of the Danian of Denmark, investigated by HANSEN (1970 a).

1) Tuffeau de Ciply, sampled in CA (= type locality). MEIJER (1969) analysed the planktonic foraminifera of this locality. In most of his samples he recovered some fifty specimens of *G. daubjergensis.* The average maximal diameter of his populations is said to be approximately 160 μ (MEIJER, 1969, p. 415).

2) "Mons well 1969", only in a single sample in the lower part of the Tertiary calcarenite section (OB 72.10), a relatively large population of planktonic foraminifera could be recovered. One hundred and forty-eight specimens of the *Globigerina daubjergensis* group have been measured. The measurements of the specimens of this sample are given in the histogram of figure 15. The average of the maximal diameter of these specimens amounts to 148 μ. According to HANSEN (1979 a) populations with an analogous average test size would occur in the Middle Danian of Denmark (Danian III).

In the other samples we generally observed only two or three specimens of this group of planktonic foraminifera. Measurements of the maximal diameter of these specimens are given in figure 15.

The average test size of 54 specimens recovered from the interval OB 20 - OB 56.20 is 189 μ. According to HANSEN (1970 a) the population of topotypes of *Globigerina kozlowskii* (Pamietowo well 263.80 m) averages 198 μ, whereas the one from the Upper Danian of Denmark (Danian IV at Hvallϕse) averages 172 μ.

It seems that the "population" recovered from the "Mons well 1969" in the interval between OB 20 and OB 56.20 is intermediate between both these populations of HANSEN. Unfortunately planktonic foraminifera are very rare in the Montian stratotype (OB 12 - OB 26), so that no accurate value can be given for the average test size of the *G. daubjergensis* - *G. kozlowskii* group in this interval. In the interval OB 62 - OB 70 only twenty-three specimens could be recovered. Their test sizes average 138 μ ; this "population" may again be compared with the *G. daubjergensis* population of the Middle Danian of Denmark (Danian III) of HANSEN's (1970 a) material.

Interpretation of the measurements.

Although the number of recovered specimens in every single sample is too small to compare populations directly with HANSEN's data from the Danian of Denmark, the general trend of increasing average test size seems to be applicable to the material of our section.

The sample at 72.10 m with its 148 specimens shows an average test size of 148 μ. From the Middle Danian of Denmark (Danian III) populations have been recorded by HANSEN (1970 a, p. 349) ranging from 131 μ to 150 μ ; hence, the Obourg sample OB 72.10 is probably of Middle Danian Age. The same may be said for the small number of specimens from the samples of the lower part of the section (OB 62 to OB 70).

In the higher part of the section (OB 20 to OB 56.20) the average test size of 54 specimens is larger (189 μ) and this group of specimens shows more affinities with Late Danian to post-Danian (Early Middle Paleocene) populations studied by HANSEN (1970 a). Unfortunately the number of our specimens is small. However, if we assume that the hypothesis of a general trend of increasing test size, going from the Danian to Lower Middle Paleocene is correct, and that biometrical results in Denmark and in Belgium are comparable, then, it may be accepted that this "population" is younger than that of the type Danian (Faxe), which is of Middle Danian Age, according to Danish literature (TROELSEN, 1957, SORGENFREI, 1957).

Occurrence :

1) "Mons well 1969" (140) : *Globigerina daubjergensis* occurs in sample OB 72.10 and in the lower part of the Tertiary calcarenite section below OB 56.20.

Possibly it extends higher, but the number of specimens recovered is too small to evaluate the average test size for single samples.

2) Other localities : In the Tuffeau de Ciply, sampled at its type locality (MEIJER, 1969) as well as in the Calcarenite of Houthem in the Albert Canal section (VR) and in the quarry Curfs (MEIJER, 1959). Furthermore the species occurs in the Calcarenite of Houthem in the Mechelen-aan-de-Maas well (MM) interval between 320 m and 300 m (MOORKENS, 1971), and possibly in some of the higher strata of this well.

Known range :

The *daubjergensis-kozlowskii* lineage ranges apparently higher than the Danian in Europe and N. Africa : L. Selandian in Denmark according to HANSEN ; Middle Paleocene ("Montian") of Poland according to POZARYSKA, 1965 and POZARYSKA & SZCZECHURA, 1968 ; Middle Paleocene (*G. uncinata* Zone) of Spain according to HILLEBRANDT, 1965 ; Middle Paleocene (*G. angulata* Zone) of Egypt according to EL-NAGGAR, 1969 a. In America it has so far only been recorded below the appearance of *G. uncinata* and *G. angulata* according to BOLLI, 1957; below the appearance of keeled *Globorotalia*'s according to LOEBLICH & TAPPAN, 1964.

Globigerina kozlowskii BROTZEN & POZARYSKA

Pl. 12, f. 4 ; Pl. 18, f. 3, 4.

1961 *"Globigerina" kozlowskii* BROTZEN & POZARYSKA ; Rev. Micropal., 4, 3, p. 162, pl. 1, f. 1-14 pl. 2, f. 1-17 ; pl. 3.

Remarks : *G. kozlowskii* represents the final stage of the *daubjergensis* lineage. It would occur after the close of Danian time. Although the number of recovered specimens in the "Mons well 1969" is rather low, the trend of increasing test size may be concluded from the data on the samples OB 20 - OB 56.20 (cf. figure 15, and remarks on *G. daubjergensis*). In this lineage evolution is thought to have occurred gradually, so that the limit between both chronospecies *G. daubjergensis* and *G. kozlowskii* is arbitrary. In an earlier paper (MOORKENS, 1971) we considered populations with an average test size smaller than 185 μ to belong to *G. daubjergensis*, whereas populations with an average test size larger than this value were determined as *G. kozlowskii*.

The value of 185 μ as a "morphological limit" between both chronospecies has been chosen because it is halfway between the average test size of the population of *G. daubjergensis* from the Upper Danian of Denmark (172.10 μ, HANSEN, 1970 a, p. 349, Table II) and that of a population of topotypes of *G. kozlowskii* (197.50 μ, HANSEN, loc. cit. p. 349, Table II).

Occurrence :

1) "Mons well 1969" (141) : Only a relatively small number of specimens of the *G. daubjergensis-kozlowskii* group could be recovered from the material we had at hand. Unfortunately the Montian stratotype between OB 12 and OB 26, yielded practically no planktonic foraminifera. The 54 specimens occurring in the highest part of the calcarenite section have an average test size of 189 μ, which value is very close to the arbitrary limit between the chronospecies *G. daubjergensis* and *G. kozlowskii*. However, it is probable that this group of specimens is more advanced, than populations recovered from the Upper Danian of Denmark ; hence, we determined this "population" to belong to *G. kozlowskii*.

2) Other localities : The number of specimens recovered from other localities (MM well ; Maurits III mine shaft, VAN BELLEN's collection of the Bunde wells) has been too small to distinguish between populations of *G. daubjergensis* and *G. kozlowskii*.

Known range : Montian.

In Denmark *Globigerina kozlowskii* (as emended by MOORKENS, 1971) is restricted to Selandian strata, younger than the Danian. In Poland *Globigerina kozlowskii* was originally described by BROTZEN & POZARYSKA from "Montian" strata, thought to be younger than the Danian by Pozaryska (1965) and by HANSEN (1970 a). A von HILLEBRANDT (1965, p. 16) recovered "very large *G. daubjergensis* specimens, equal to *G. kozlowskii*" together with *G. inconstans* and *G. uncinata* in his Zone B in N Spain. He equals his Zone B with the *G. inconstans* Zone of ALIMARINA (1963) and the *G. uncinata* Zone of BOLLI (1957) and these zones are thus thought to correspond to the Montian stratotype.

Globigerina triloculinoides PLUMMER
Pl. 12, f. 2, 5 ; Pl. 18, f. 9, 10

1926 *Globigerina triloculinoides* PLUMMER, Univ. Texas Bull. 2644, p. 134, pl. 8, f. 10 a-c.

Remarks : The reticulate surface of this species enables the differentiation from the hispid to spinose *Globigerina daubjergensis*.
The form figured bu BROTZEN (1948, pl. 17, f. 2) is slightly more trochoid and probably belongs to another species or subspecies. Further details concerning the distinction of this species and of *Globigerina triloculinoides parva* EL-NAGGAR, have been discussed in an earlier paper (MOORKENS, 1971).

Occurrence :

1) "Mons well 1969" (142) : In OB 30 and OB 48, some rare specimens have been observed, which resemble the figured holotype of the species very well.

2) Other localities : The species has been recovered from the Tuffeau de Ciply (CA) at Ciply in strata of Upper (to Middle ?) Danian Age ; furthermore it was observed in the Danian deposits of the Calcarenite of Houthem.
In the Mechelen-aan-de-Maas well it occurs in the same lithologic unit (MM 300 - 320) as well as in younger layers (MM 290.50 - MM 277) in the Calcarenite of Mechelen-aan-de-Maas.

Known range :

This species appears in the Danian. In Denmark it starts its range in Middle Danian deposits according to TROELSEN (1957), and to BERGGREN (1960 b). According to most authors it ranges throughout the Paleocene.
Some specialists (e.g. SUBBOTINA, 1953) believe that it ranges into the Lower Eocene or possibly even higher. KAASSCHIETER (1961, pl. 16, f. 7) cited this species from the Ypresian of Belgium ; however, his figured specimen probably belongs to another reticulate species, *Globigerina patagonica* TODD & KNIKER. This might also apply to the Lower to Middle Eocene specimens, SUBBOTINA ascribed to this species. Probably the range of *G. triloculinoides* is restricted to the Paleocene.

Genus *GLOBOROTALIA* CUSHMAN, 1927

Globorotalia pseudobulloides (PLUMMER)
Pl. 12, f. 1, 6.

1926 *Globigerina pseudobulloides* PLUMMER, Univ. Texas Bull., 2644, p. 133, pl. 8, f. 9 a-c.

Remarks : Our rare specimens resemble the holotype quite well. The surface of the test is finely reticulate, whereas reticulation of the test is coarser in *G. triloculinoides.*

Occurrence :

1) "Mons well 1969" (145) : A couple of specimens occur in OB 32.40.

2) Other localities : The species was recorded from the Calcarenite of Mechelen-aan-de-Maas, in the MM well (MM 287). MEIJER (1959, 1969) recorded the species from the Tuffeau de Ciply (CA) and from the Calcarenite of Houthem (Vr).

Known range :

Lower Paleocene (Danian) to Middle Paleocene, possibly part of the Upper Paleocene.

Globorotalia sp. aff. *G. varianta* (SUBBOTINA)

Pl. 12, f. 7, 8 ; Pl. 18, f. 5, 6.

pars 1953 *Globigerina varianta* SUBBOTINA ; Foraminifères fossiles d'U.R.S.S., Globigerinidae, Globorotaliidae, Hantkeninidae. Trudy V.N.I.G.R.I., S.S.S.R., 76, (fide translation SIGAL, B.R.G.M. n° 2239), p. 75-77, pl. 3, f. 8 a-c, 9 a-c, 12 a-c.

non 1953 *Globigerina varianta* SUBBOTINA, loc. cit., pl. 3, f. 5 a-c, (holotype of *G. varianta*).

Remarks : *G. varianta* differs from *G. daubjergensis* and *G. kozlowskii* by its flat spiral side. When describing *Globigerina varianta*, SUBBOTINA (1953) gave no details about the wall structure, but she pictured several forms that differ from each other in the surface of their test wall. As far as can be seen from the picture, the holotype has a reticulate wall, whereas some paratypes, e.g. the one figured pl. 3, f. 8, have a spinose test. According to the indications given by SUBBOTINA, the latter specimen was recovered from a stratigraphical level younger than that of the holotype. We share the opinion of BERGGREN (1962 a, p. 93) that the specimen pictured by SUBBOTINA in her pl. 3, f. 8 a-c belongs to a species, differing from *G. varianta* by its spinose test wall. This species probably was never given a separate name nor was it described and pictured properly. It is possible that part or all of the specimens pictured by BANG (1969) as *Globorotalia danica* BANG, belong to this species, but as yet the name *G. danica* is a *nomen nudum*, since BANG did not describe her new species. BANG (1971) again pictured a number of specimens under the name *Globigerina danica* BANG, probably referring to *Globorotalia danica* BANG 1969. These figures show smooth to reticulate, as well as spinose or hispid wall structures. Possibly the specimen pictured by SAMUEL & SALAJ (1968, pl. 1, f. 4) as *G. varianta* belongs to our spinose species as well. Our material consists of but a few specimens from the "Mons well 1969" and therefore we prefer to leave our species in open nomenclature.

Occurrence :

1) "Mons well 1969" (143) : Two well preserved specimens were recovered in OB 36.10. In OB 32.20 and OB 38.20 two additional specimens were found. One dubious specimen was recovered in OB 48.

2) Other localities : This species has not been observed in other samples of our material.

Known range :

It is difficult to assess the range of this species. For the range of *Globigerina varianta* (including spinose types) SUBBOTINA (1953) gives Danian to Lower Eocene. The paratype (pl. 3, f. 8 a-c) is either of Paleocene (not including Danian) or Early Eocene Age, whereas the reticulate holotype is of Danian Age. SAMUEL & SALAJ (1968) recovered their forms in Paleocene sediments younger than Danian.
BANG (1969) gives a different range for *Globorotalia danica* (p. 63, f. 4) as she recovered he. species in Lowermost Danian (Danian I) and Uppermost Danian to Selandian.
The species was not recovered from the Middle Danian (Danian II and III) and part of the Upper Danian (lower part of Danian IV).

Globorotalia sp. cf. *G. compressa* (PLUMMER)

Pl. 12, f. 9 ; Pl. 18, f. 7-8

cf. 1926 *Globigerina compressa* PLUMMER, Univ. Texas Bull, 2644, p. 135-136, pl. 8, f. 11.

pars 1957 *Globorotalia pseudomenardii* LOEBLICH & TAPPAN (non BOLLI) U.S. Nat. Mus. Bull. 215, p. 193, pl. 45, f. 10 a-c.

Remarks : The specimen recovered in OB 32.40 seems to be transitional to *Globorotalia ehrenbergi* BOLLI, 1957, (U.S. Nat. Mus. Bull. 215, p. 77, pl. 20, f. 18-20).
The last chambers of our specimen pictured, show a subacute periphery, with a vague keel (only to be seen when the specimen is wetted) and with a sharper edge than it is found in the holotype of *Globorotalia compressa.* However, this subacute periphery is probably somewhat less sharp-edged than it is in *Globorotalia ehrenbergi* BOLLI, and hence, our material may be considered transitional between both species. *Globorotalia compressa* (PLUMMER) has been recovered from the Tuffeau de Ciply (Middle to Upper Danian) and its lateral equivalent in eastern Belgium and Dutch Limburg, the Calcarenite of Houthem. The last chamber of the latter specimens is less acute than that of the specimen figured from the "Mons well 1969".

A number of pictured forms of the literature resemble our material quite well, such as SUBBOTINA's (1953) specimens of "*G. membranacea* (EHRENBERG)" (pl. 16, f. 8 a-c, 9 a-c, 10 a-c), whereas other specimens of that author are referable to either *G. compressa* (pl. 16, f. 7 a-c) or *G. pseudomenardii* (pl. 16, f. 11 a-c, 12 a-c, 13 a-c).

Also the specimen given by SAMUEL & SALAJ (1968, pl. 9, f. 4 a-c) as *G.* cf. *chapmani* resembles ours quite well. It is possible that our material belongs to *G. haunsbergensis* GOHRBANDT (1963, p. 53, pl. 6, f. 10-12) but according to the figure of the holotype of that species its periphery is slightly more acute.

Von HILLEBRANDT (1964) pictured a similar form (p. 196, f. 2) as *G.* cf. *ehrenbergi*, also considered to be transitional between *Globorotalia compressa* and *G. ehrenbergi*, and living during his Zone C (probably Early Middle Paleocene).

However, we analysed a population of topotypes of *Globorotalia compressa* (PLUMMER) kindly loaned by Dr. R. SCHMIDT (Utrecht) and observed some specimens which are quite similar to the one discussed, but no keel or poreless margin was to be seen. Unless larger populations can be analysed, it seems impossible to distinguish *G. ehrenbergi* clearly from *G. compressa* in our material.

Occurrence :

1) "Mons well 1969" (146) : A single specimen in OB 32.40.

2) Other localities : a comparable specimen was observed in the Mechelen-aan-de-Maas well (MM 290.50).

Known range :

This transitional form between *G. compressa* (PLUMMER) and *G. ehrenbergi* BOLLI probably occurs in uppermost Danian and Lower Middle Paleocene layers, as Von HILLEBRANDT (1964) recorded it from his Zone C. BANG (1969, p. 63) recorded probably similar forms as *G. ehrenbergi* from the basal layers of the Seland Beds (Kerteminde Clay, Lellinge greensand) overlying the Danske Kalk in the Størebaelt region.

Globorotalia sp. cf. *G. imitata* SUBBOTINA

cf. 1953 *Globorotalia imitata* SUBBOTINA ; Foraminifères fossiles d'U.R.S.S., Globigerinidae, Globorotaliidae, Hantkeninidae. Trudy V.N.I.G.R.I. - S.S.S.R., 76, (fide translation SIGAL, B.R.G.M. n° 2239), p. 239, pl. XVI, f. 14 a-c, 15 a-c, 16 a-c.

1965 *Globorotalia imitata* SUBBOTINA ; BERGGREN. Some problems of Paleocene-Lower Eocene planktonic foraminiferal correlations, Micropaleontology, 11, 3, p. 291, text-f. 8, a-f.

1968 *Globigerina imitata* (SUBBOTINA) ; SAMUEL & SALAJ, Microbiostratigraphy and Foraminifera of the Slovak Carpathian Paleogene, p. 117, pl. 1, f. 5 a-c.

Remarks : The specimen recovered from the sample OB 40 resembles the pictured specimens of BERGGREN and SAMUEL & SALAJ better than the holotype and paratypes figured by SUBBOTINA, because its last chamber is less compressed and the higher arched aperture is situated more umbilically.

Occurrence :

1) "Mons well 1969" (144) : Only one specimen in sample OB 40.

2) Other localities : The species has not been found in any other locality in Belgium.

Known range :

SUBBOTINA (1953) reported this species from the Danian (*G. trivialis* Zone) and from the Middle Paleocene (*G. inconstans* Zone). BERGGREN (1965) thinks that this species is restricted to strata younger than the Danian (*G. uncinata* Zone, *G. pusilla* Zone, and *G. pseudomenardii* Zone), SAMUEL & SALAJ (1968) observed the species only in layers of the *G. inconstans praecursoria* Zone.

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INDEX OF GENERA, SPECIES AND VARIETY NAMES.

Species or Genera names in italics have been discussed in the systematic descriptions ; the others have only been mentioned in the text.

PLATES

1 - 18

PLATE 1

Pencil drawings

1. *Vacuovalvulina keijzeri* (VAN BELLEN) var. 1. (OB 21.80) type, x 85.
   a. apertural face
   b. side view
   c. conical side, apex

remark : broader cone than in typical *Vacuovalvulina keijzeri*.

2. *Discorbis* ? *lenae* n. sp. (OB 74) holotype, x 200.
   a. umbilical side
   b. side view
   c. spiral side

remark : spiral suture is strongly limbate.

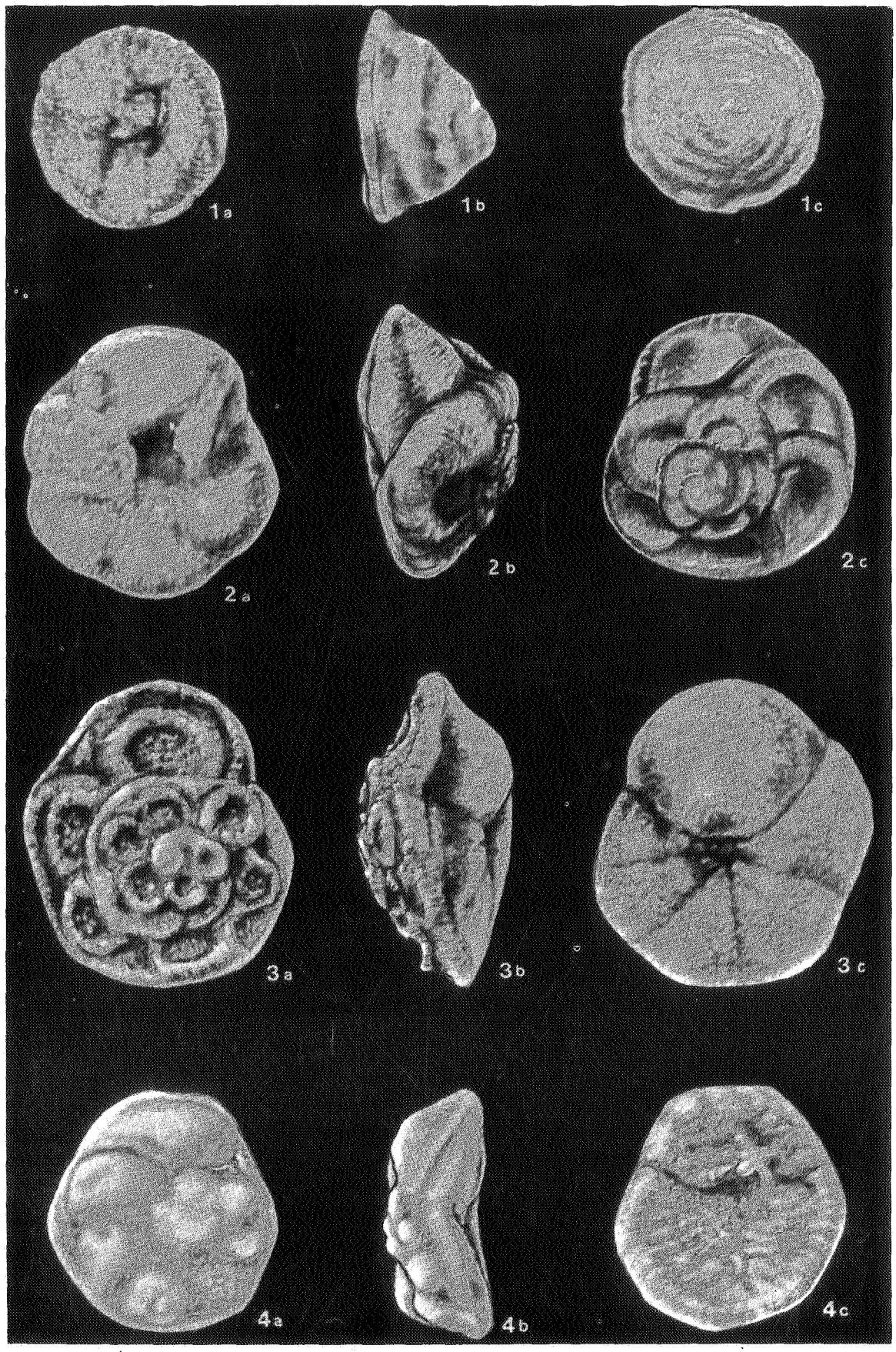
3. *Discorbis* ? *renemarlierei* n. sp. (OB 32.40), x 200, holotype.
   a. spiral side
   b. side view
   c. umbilical side

remark : observe circular ridges around chambers at spiral side and large pores within the areas surrounded by the ridges.

4. *Rotorbinella montiana* POZARYSKA & SZCZECHURA var. 1 (OB 21.80), x 80, type.
   a. spiral side
   b. side view
   c. umbilical side

PLANCHE 1

PLATE



Thierry Leon MOORKENS

PLATE 2

Pencil drawings

1. *Rotorbinella* ? *montiana* POZARYSKA & SZCZECHURA var. 2 (OB 32.40), x 130, type
   a. spiral side
   b. side view
   c. umbilical side

remark : the variety differs from typical *R. montiana* by the "conical" forms of the chambers at spiral side.

2. *Rotorbinella pozaryskae* n. sp. (OB 64.20), x 85, holotype
   a. spiral side
   b. side view
   c. umbilical side

3. *Rotalia marginata* d'ORBIGNY var. 1 (OB 42.30), x 65, type
   a. umbilical side
   b. side view
   c. spiral side

remark : this variety differs from typical *R. marginata* by the protruding mass in the umbilicus.

4. *Pararotalia godfriauxi* n. sp. (OB 13.90), x 85, holotype.
   a. umbilical side
   b. side view
   c. spiral side

PLANCHE 2

PLATE

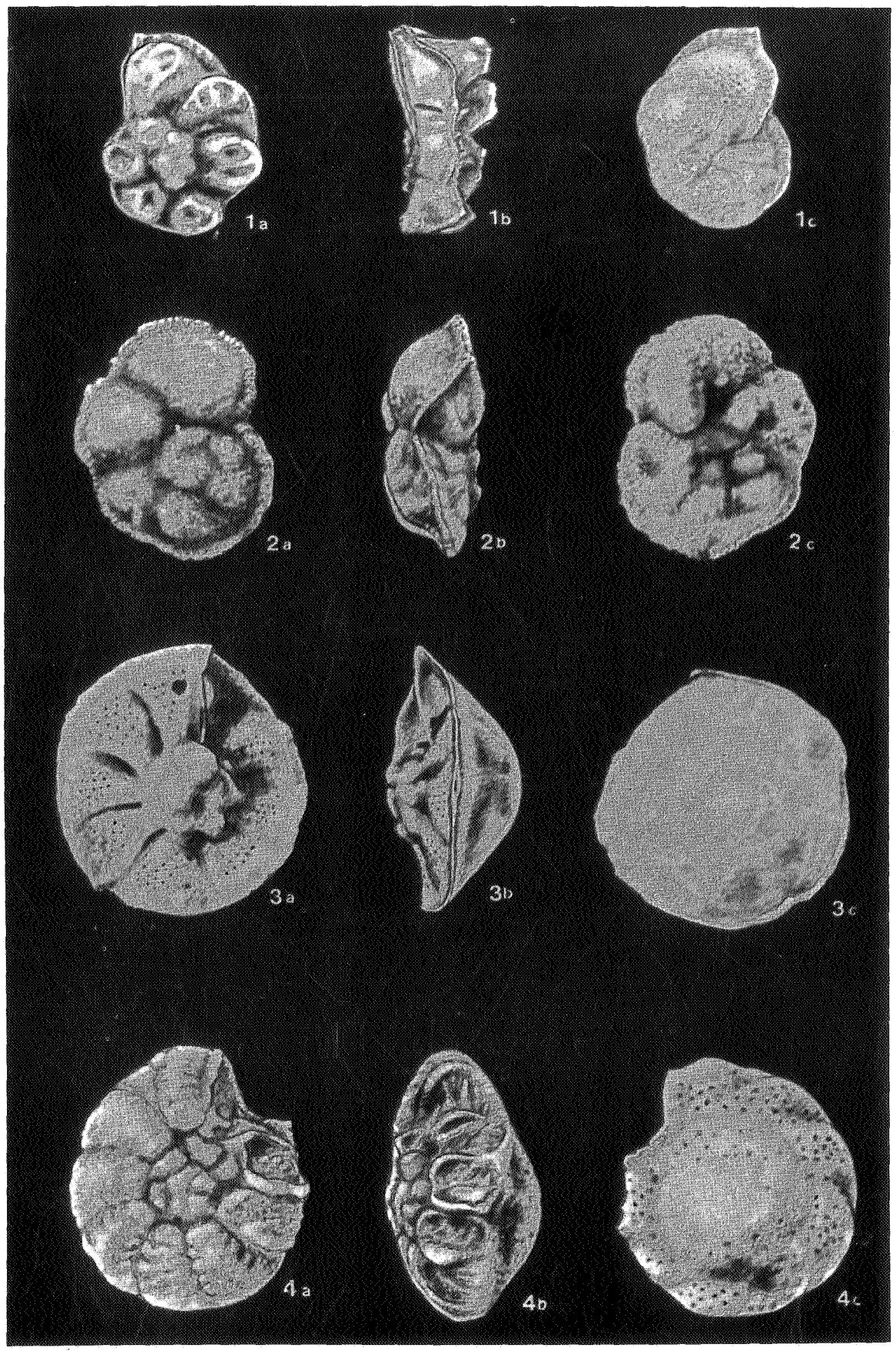


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PLATE 3

Pencil drawings

1. *Pararotalia godfriauxi* n. sp. (OB 16.10), x 65, paratypoid
   a. umbilical side
   b. side view
   c. spiral side

2. *Pararotalia globigeriniformis* (VAN BELLEN) var. 1 (OB 36.10), x 130, type.
   a. umbilical side
   b. side view
   c. spiral side

remark : observe truncate periphery near spiral side.

3. *Pararotalia globigeriniformis* (VAN BELLEN) var. 2 (OB 48), x 200, type.
   a. spiral side
   b. side view
   c. umbilical side

remark : observe umbilical plug.

4. *Eponides robaszynskii* n. sp. (OB 78), x 85, holotype.
   a. spiral side
   b. side view
   c. umbilical side

remark : observe plano-convex test form.

PLANCHE 3

PLATE

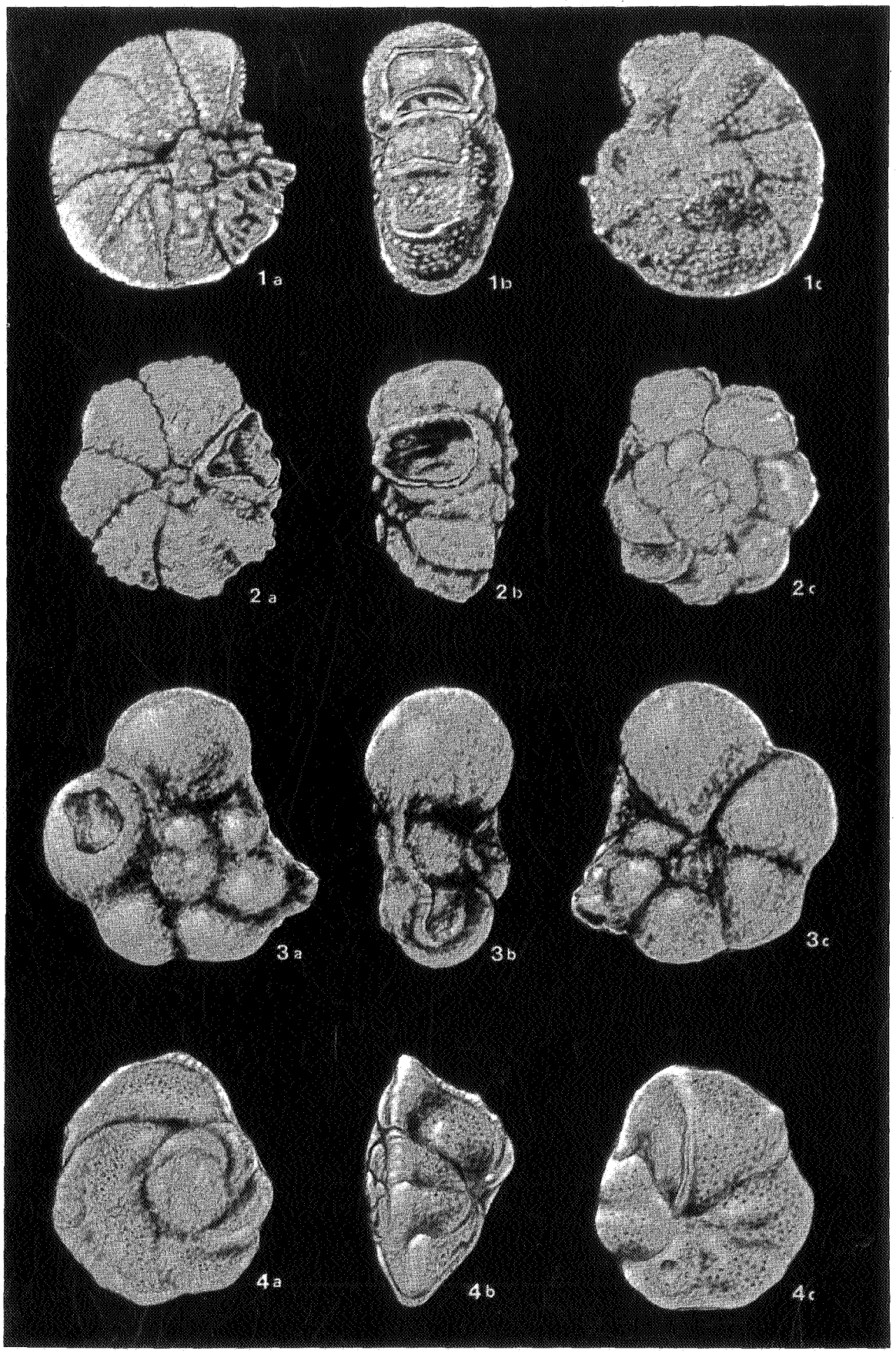

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PLATE 4

Scanning Electromicrographs

1. *Textularia bundensis* VAN BELLEN (OB 74.30), x 65, side view.

2. *Vacuovalvulina keijzeri* (VAN BELLEN) var. 1 (MM 273), x 208, side view.

3. *Valvulina limbata* TERQUEM (OB 32.40), x 33.
   a. side view
   b. apertural face

4. *Clavulina pseudoparisiensis* HOFKER (OB 12), x 60, side view.

5. *Valvulammina* sp. cf. *V. globularis* (d'ORBIGNY) (OB 30), x 130, side view

6. *Valvulammina globularis* (d'ORBIGNY) (OB 32.40), x 33, side view

7. *Valvulina triangularis* d'ORBIGNY (OB 26), x 35
   a. apertural face
   b. side view
   c. apex : early chambers broken off

8. *Spiroloculina alabamensis* CUSHMAN (OB 30)
   a. apertural view, x 130
   b. side view, x 65

9. *Triloculina natchitochensis* HOWE (OB 29.80)
   a. apertural view, x 95
   b. side view, x 84
   c. side view, x 60

PLANCHE 4

PLATE

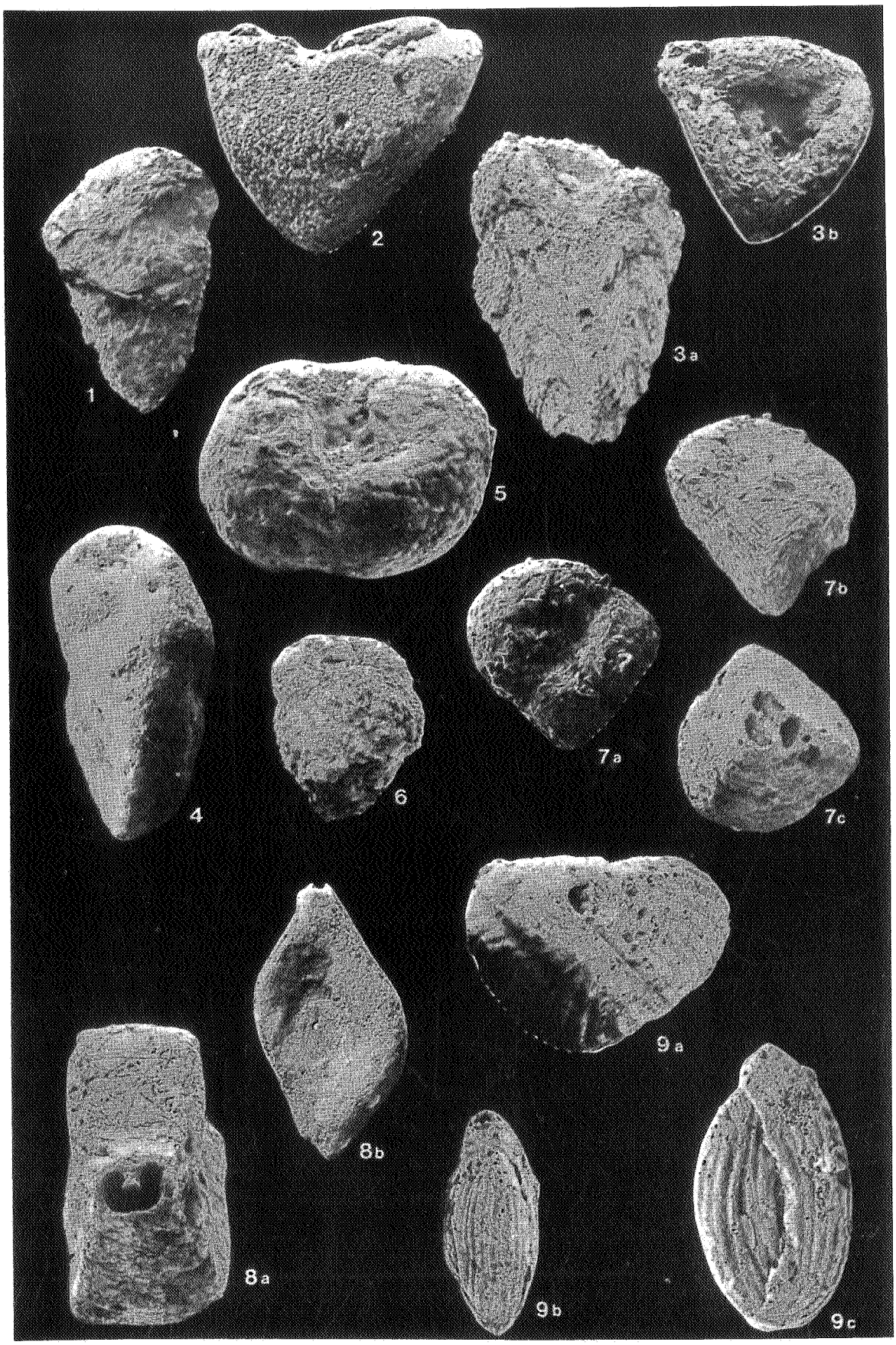

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PLATE 5

Scanning Electromicrographs

1. *Globulina* sp. cf. *G. tuberculata* d'ORBIGNY (MM 273), x 160 side view

2. *Pseudopolymorphina geijeri var. angusta* BROTZEN (OB 42.30)
   a. side view, x 33
   b. apertural view, x 75

remark : our form is slenderer and nearly symmetrical like a *Frondicularia*.

3. *Rotorbinella papillata* POZARYSKA & SZCZECHURA (VR f 5), x 170, spiral side

4. *Rotorbinella montiana* POZARYSKA & SZCZECHURA (OB 12), x 100, spiral side

5. *Rotorbinella montiana* POZARYSKA & SZCZECHURA var. 2 (COP 2), x 80, umbilical side.

6. *Rotorbinella montiana* POZARYSKA & SZCZECHURA (OB 12), x 100, spiral side

7. *Rotorbinella montiana* POZARYSKA & SZCZECHURA (COP 2), x 120, umbilical side

8. *Discorbis* ? *lenae* n. sp. (OB 20), x 155, paratypoid spiral side

9. *Lamarckina limbata* CUSHMAN (OB 30), x 140
   a. spiral side
   b. side view
   c. umbilical side

PLANCHE 5
PLATE

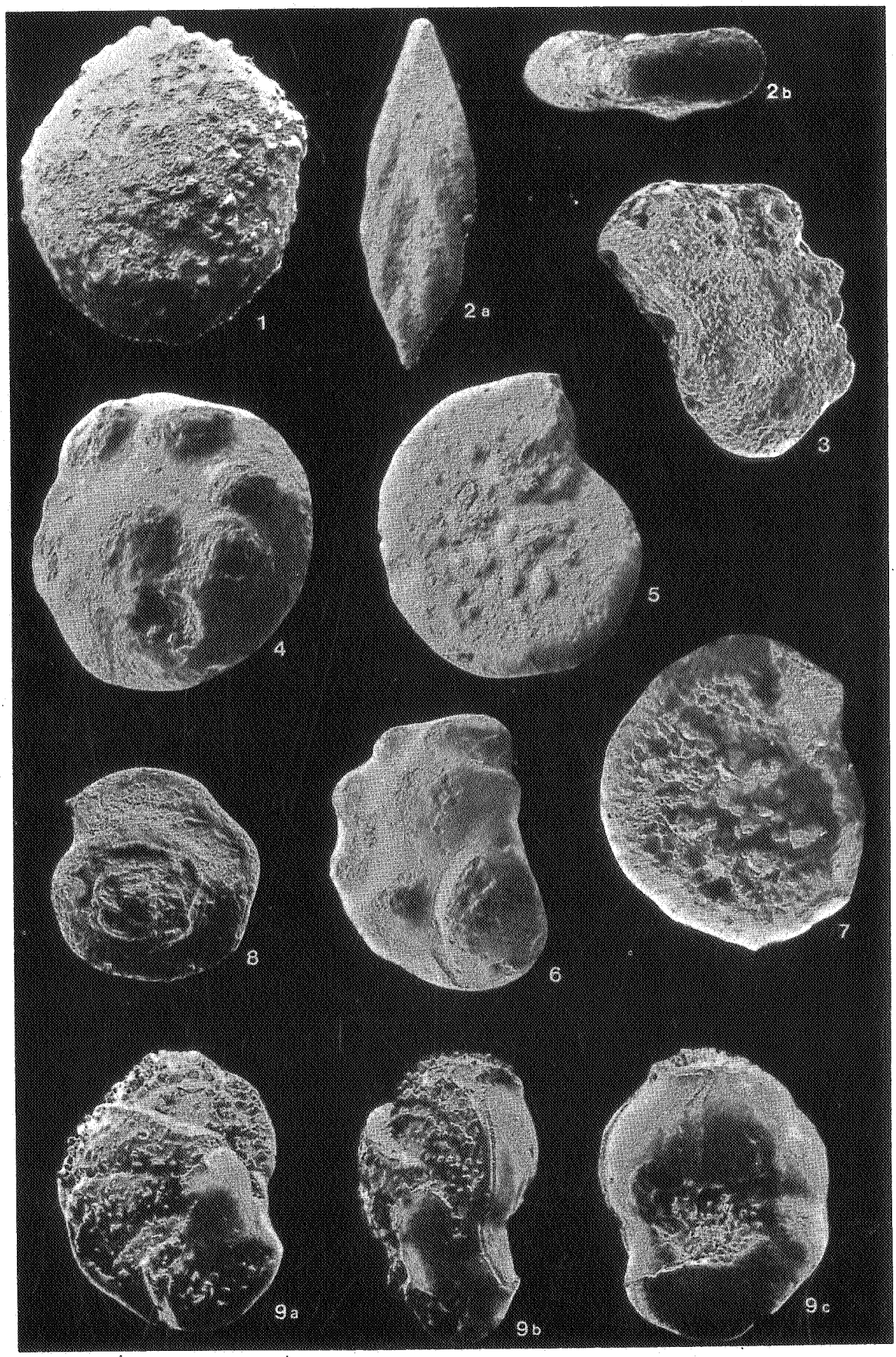

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PLATE 6

Scanning Electromicrographs

1. *Siphonina prima* PLUMMER (OB 79), x 140
   a. spiral side
   b. side view
   c. umbilical side

2. *Epistomaria bundensis* (VAN BELLEN) (OB 32,40), x 65
   a. umbilical side, observe slits near the periphery
   b. side view, with aperture
   c. spiral side

remark : the form of the slits is different from those of *E. rimosa* (PARKER & JONES)

3. *Valvobifarina paleocenica* HOFKER (OB 32.40), x 130
   a. side view
   b. apertural view

4. *Spirillina striatogranulosa* TERQUEM (OB 16.10)
   a. concave side, x 130
   b. convex side, x 130
   c. side view, with aperture, x 325

5. *Sigmomorphina soluta* BROTZEN (OB 30), x 65, side view

6. *"Bigeneroplis vanrijsingei"* MARIE (OB 40.20), x 65
   a. apertural view
   b. side view

7. *Pararotalia obourgensis* n. sp. (OB 27.80), holotype, x 33
   a. umbilical side
   b. side view
   c. spiral side

remark : this species differs from *P. tuberculifera* by the absence of tubulospinate chamberform, by its flatter form, and by the limbate sutures at the spiral side. (cf. Pl. 8, f. 1, 2, 3)

PLANCHE 6

PLATE

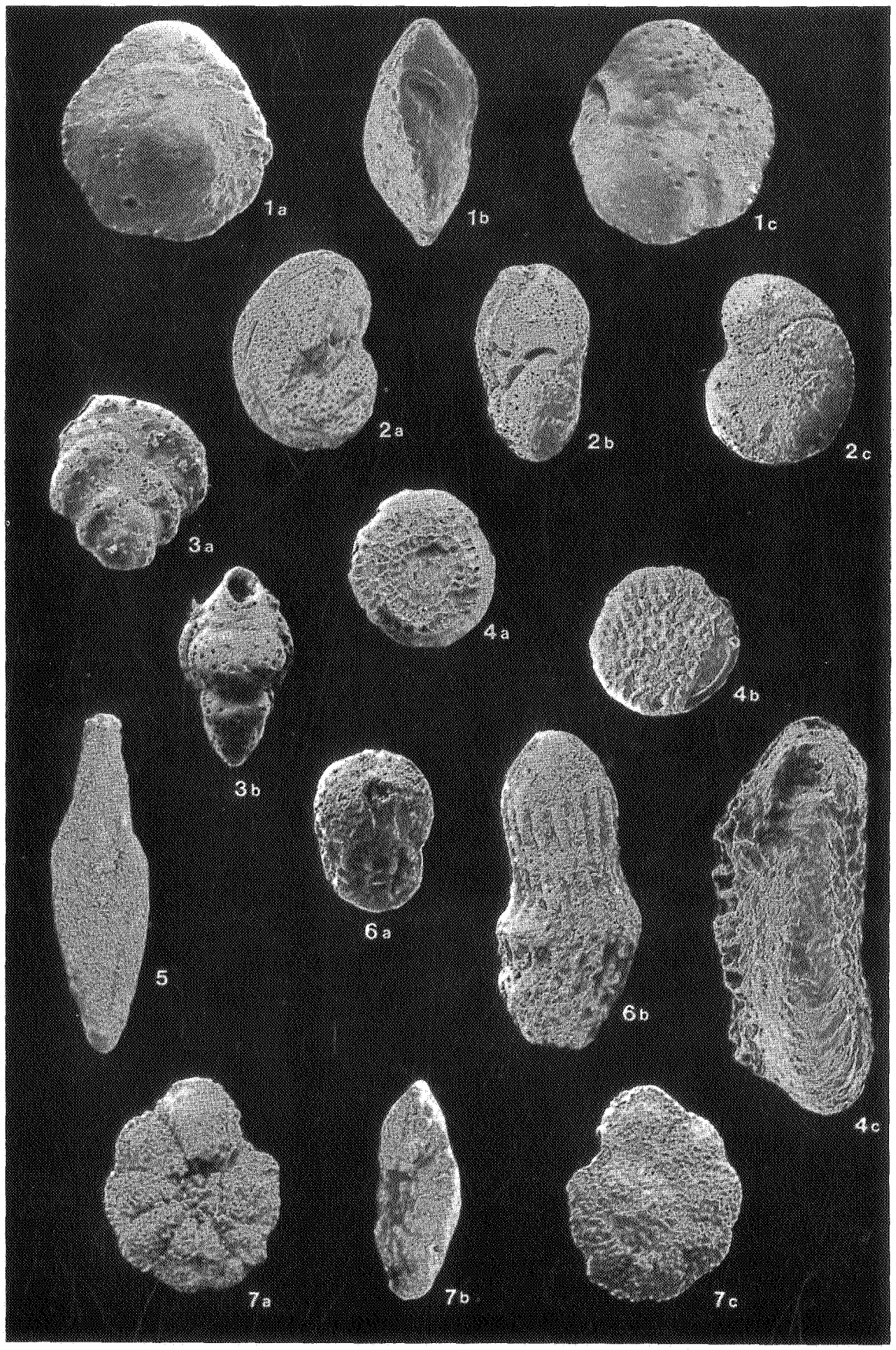

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PLATE 7

Scanning Electromicrographs

1. *Rotalia* sp. cf. *R. trochidiformis* (LAMARCK) (LA 175), x 40
   a. umbilical side
   b. spiral side

2. *Rotalia marginata* d'ORBIGNY (OB 12), x 65, umbilical side

3. *Rotalia marginata* d'ORBIGNY (OB 42.30), x 85
   a. spiral side
   b. side view
   c. umbilical side

4. *Pararotalia godfriauxi* n. sp. (OB 12), paratypoid, x 130, umbilical side

5. *Pararotalia saxorum* (d'ORBIGNY) (OB 12), x 65
   a. side view
   b. umbilical side

6. *Pararotalia praepseudomenardii* (HOFKER) (MM 290.50), x 65, umbilical side

7. *Pararotalia globigeriniformis* (VAN BELLEN) (OB 21.80), x 130.
   a. umbilical side
   b. side view

PLANCHE 7

PLATE

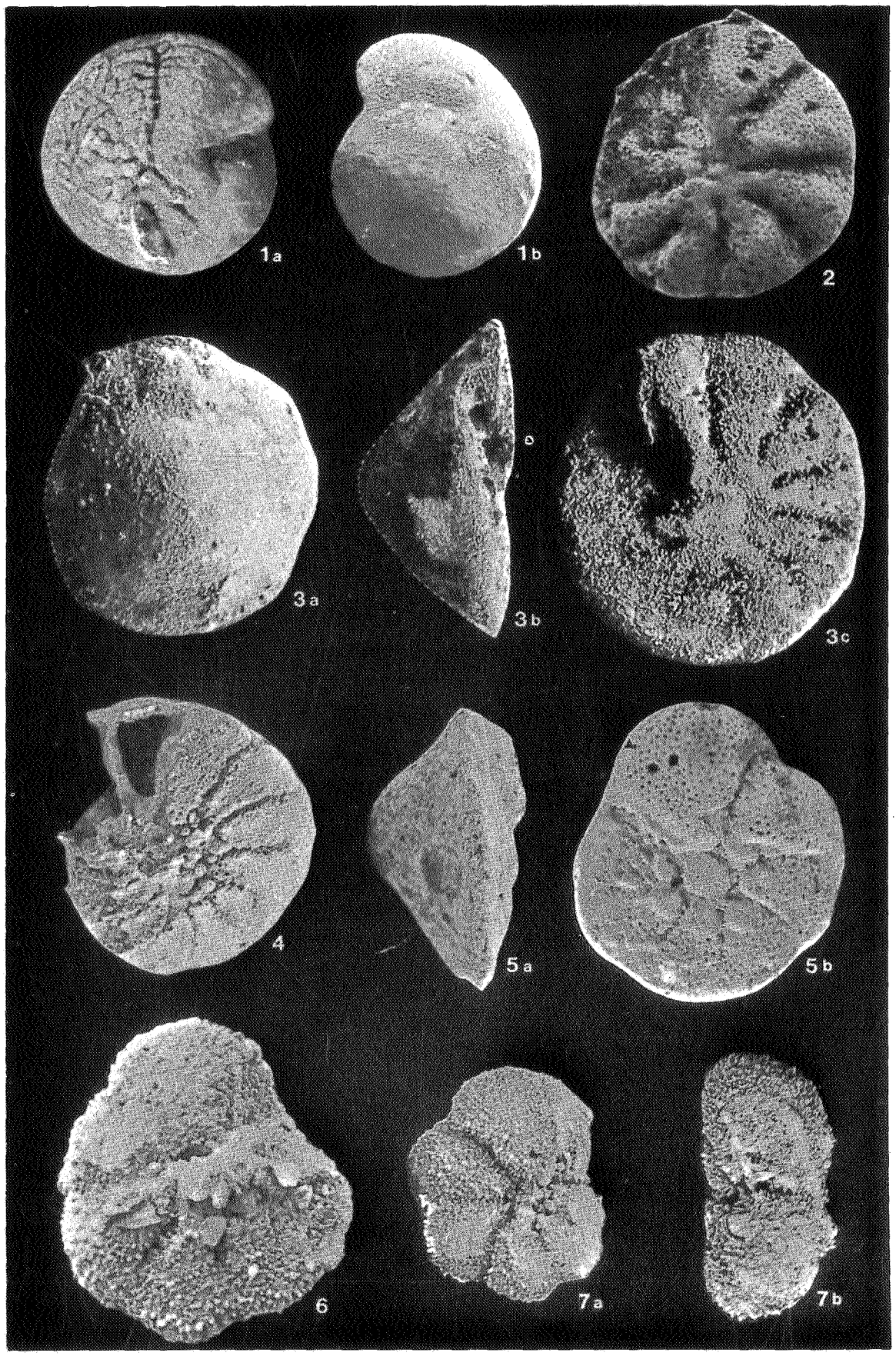

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PLATE 8

Scanning Electromicrographs

1. *Pararotalia* sp. cf. *P. tuberculifera* (REUSS) (OB 12), x 75, umbilical side
2. *Pararotalia tuberculifera* (REUSS) (E.N.C.I., Mc), x 80, spiral side (type Maastrichtian)
3. *Pararotalia tuberculifera* (REUSS) (E.N.C.I., Mc), x 80, umbilical side (type Maastrichtian)
4. *Pararotalia minimalis* HOFKER (VR f 5), x 175, spiral side
5. *Pararotalia minimalis* HOFKER (OB 16.10), x 130
   a. umbilical side
   b. spiral side
6. *Elphidium* ? sp. cf. *E. lamarcki* (d'ORBIGNY) (OB 70), x 130
   a. apertural view
   b. side view
7. *Elphidiella* ? sp. cf. *E. prima* (TEN DAM) (OB 38.20), x 130
   a. apertural view
   b. side view
8. *Cibicides succedens* BROTZEN (OB 12), x 200, umbilical side
9. *Cibicides* sp. cf. *C. succedens* BROTZEN (OB 12), x 160, spiral side
10. *Thalmannita madrugaensis* CUSHMAN & BERMUDEZ (OB 12), x 100, side view

PLANCHE 8

PLATE

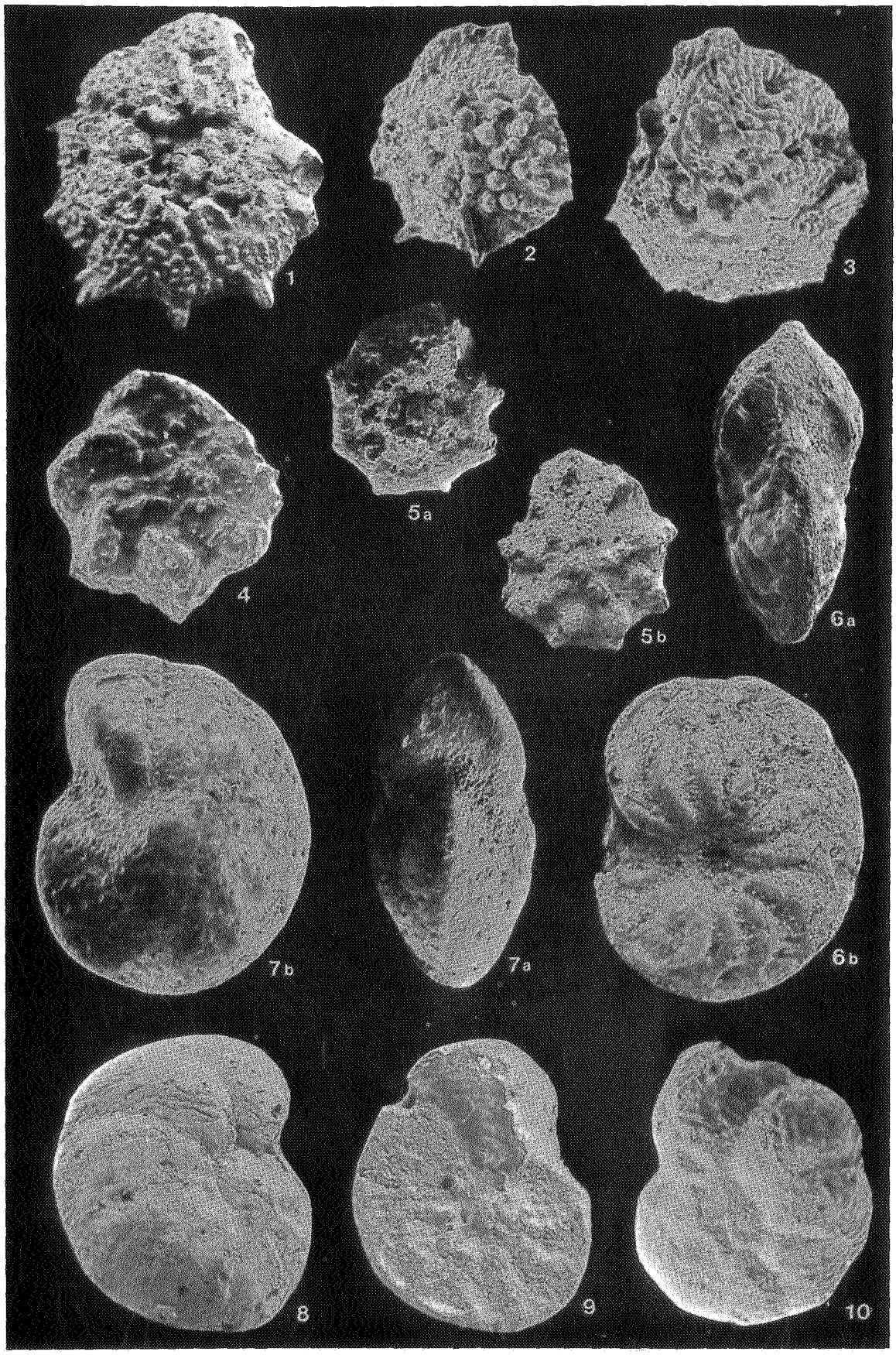

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PLATE 9

Scanning Electromicrographs

1. *Nonion multisuturatum* VAN BELLEN (OB 30), x 130
   a. apertural view
   b. side view

2. *Nonion* ? *ornatum* VAN BELLEN (OB 30), x 67
   a. apertural view
   b. side view

3. *Nonion* sp. (OB 12), x 200, side view

4. *Boldia* sp. cf. *B. cubensis* CUSHMAN & BERMUDEZ (OB 12)
   a. side view, x 100
   b. apertural face, x 65
   c. spiral side, x 80

5. *Scarificatina reinholdi* MARIE (OB 12)
   a. umbilical side, x 100
   b. oblique view, x 100

6. *Scarificatina reinholdi* MARIE (OB 12), x 130, umbilical side

7. *Scarificatina reinholdi* MARIE (TH 19)
   a. umbilical side, x 125
   b. detail of umbilicus, x 385

PLANCHE 9

PLATE

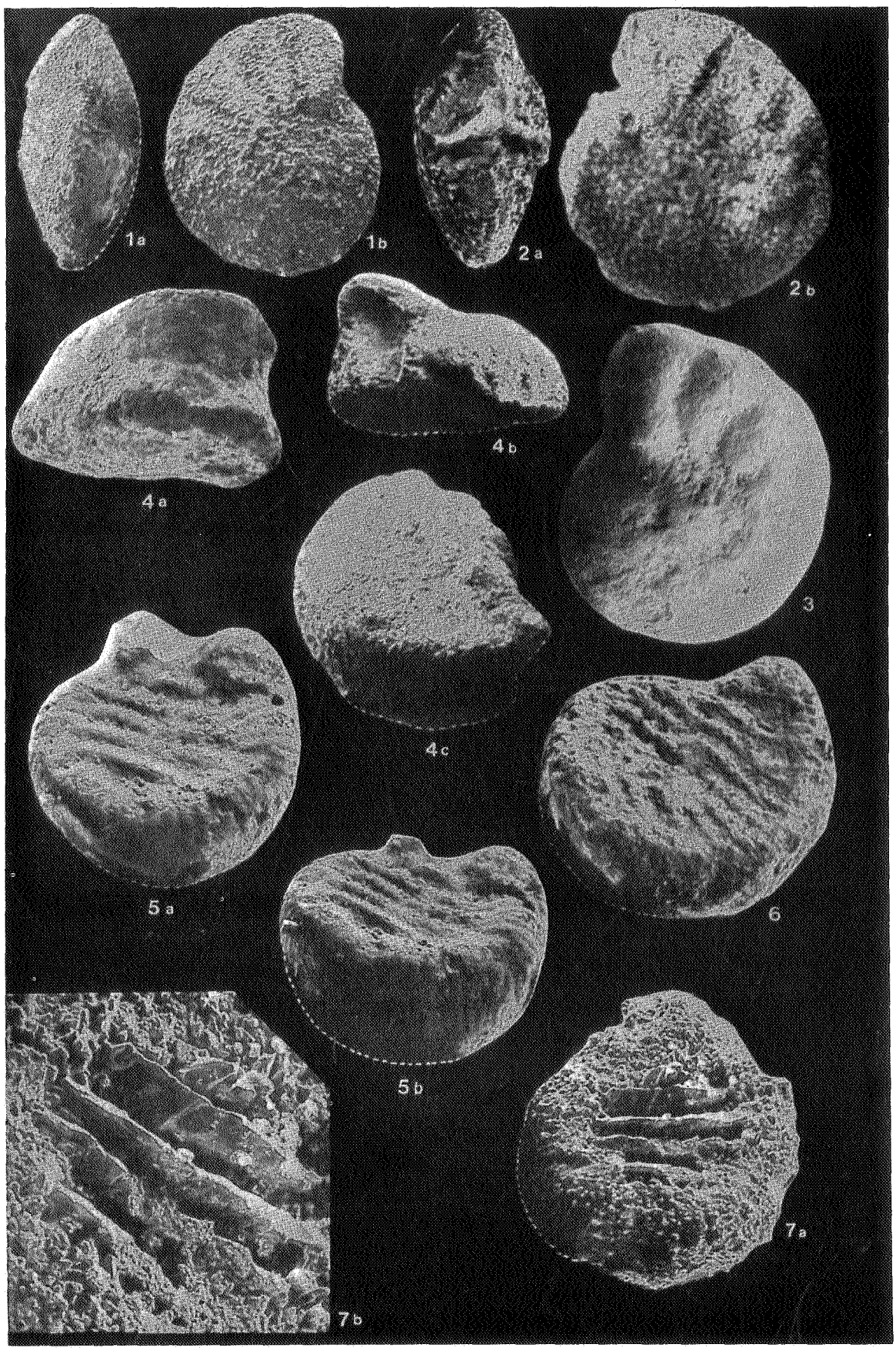

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PLATE 10

Scanning Electromicrographs

1. *Scarificatina szczechurae* n. sp. (OB 76), holotype
   a. spiral side, x 240

remark : observe *Stensioeina*-like limbate sutures and spire
   b. oblique view, x 180
   c. side view, with last chamber, x 180
   d. side view, x 165
   e. umbilical side, with 3 parallel costae in the umbilicus, x 160
   f. apertural face, x 180

2. *Scarificatina szczechurae* var. 1 (OB 12), type
   a. oblique view, showing umbilicus, x 165
   b. side view, with last chamber, x 140
   c. side view, with anastomosing costae, x 165
   d. spiral side, with *Stensioeina*-like sutures and spire, x 160
   e. side view, showing cribrate foramina of penultimate chamber, x 155
   f. umbilical side, showing 3 parallel costae in the umbilicus, x 165.

PLANCHE 10
PLATE

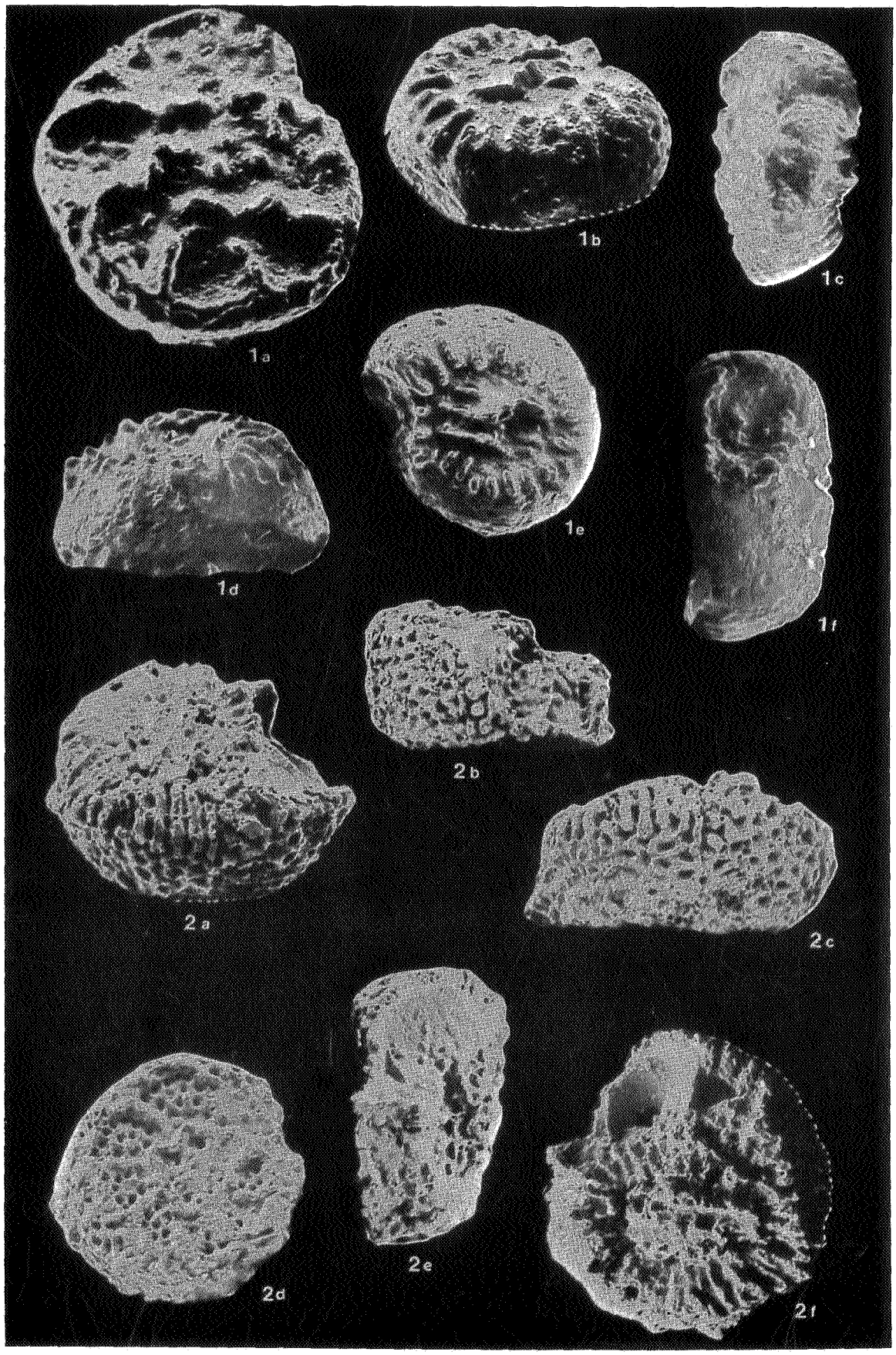

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PLATE 11

Scanning Electromicrographs

1. *Gavelinella danica* (BROTZEN) (OB 42.30), x 83
   a. spiral side
   b. apertural view
   c. umbilical side

2. *Gavelinella* sp. cf. *G. midwayensis* (PLUMMER) (OB 72.10), x 160
   a. spiral side
   b. side view, with apertural face
   c. umbilical side

3. *Coleites reticulosus* (PLUMMER) (OB 70), x 160
   a. umbilical side
   b. side view, with terminal aperture
   c. spiral side

4. *Karreria fallax* RZEHAK (LI 8), x 98, umbilical side

5. *Lamarckina naheolensis* CUSHMAN & TODD (OB 30), x 160
   a. umbilical side
   b. side view
   c. spiral side

PLANCHE 11

PLATE

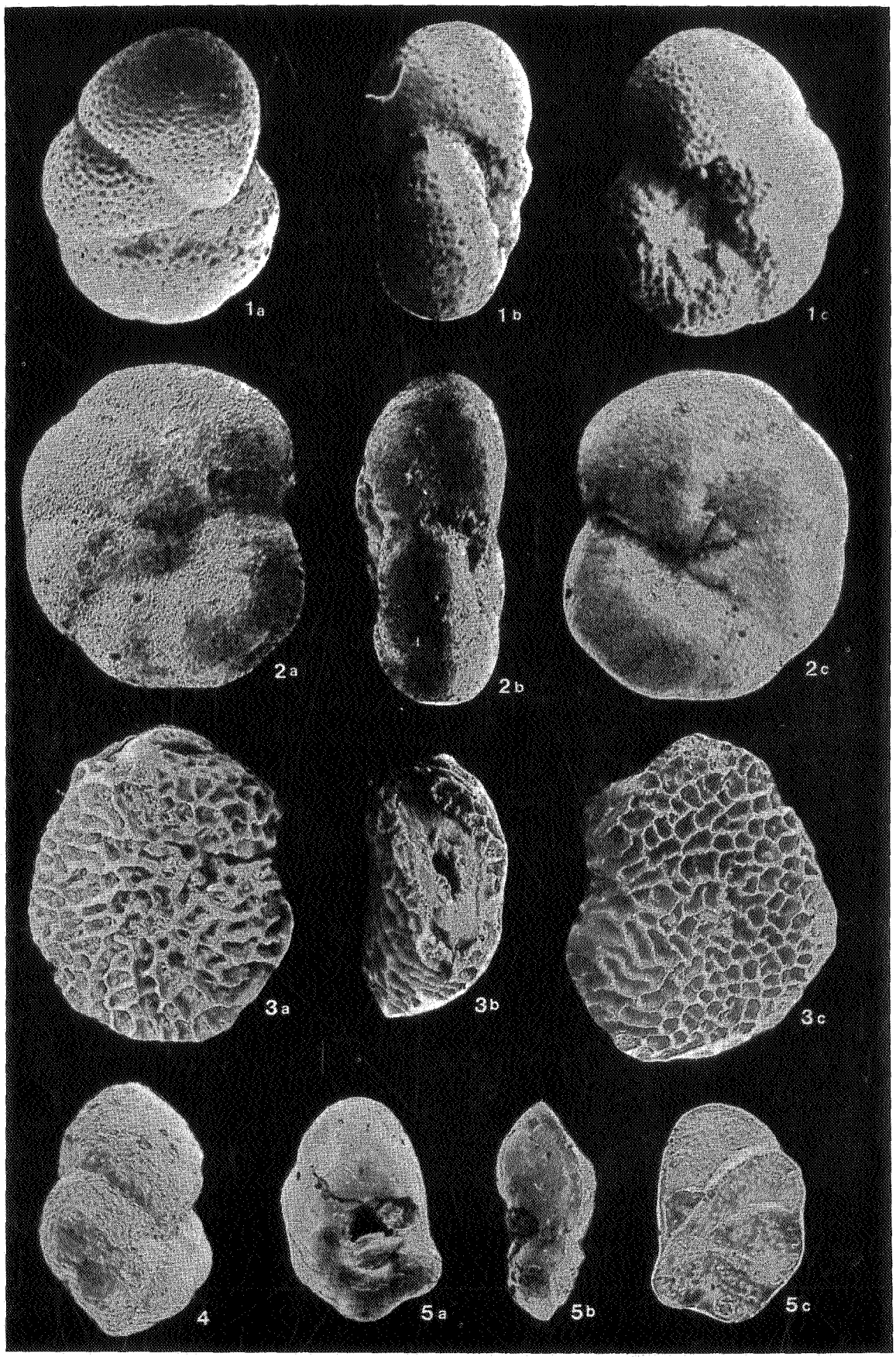

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PLATE 12

Pencil drawings

1. *Globorotalia pseudobulloides* (PLUMMER) (MM 287), x 120
   a. spiral side
   b. side view
   c. umbilical side

2. *Globigerina triloculinoides* PLUMMER (MM 287), x 120
   a. spiral side
   b. side view
   c. umbilical side

3. *Globigerina daubjergensis* BRÖNNIMANN (OB 72.10), x 270
   a. umbilical side
   b. side view
   c. spiral side

4. *Globigerina kozlowskii* BROTZEN & POZARYSKA (OB 42.30), x 175
   a. umbilical side
   b. side view
   c. spiral side

remark : a large specimen of the *G. daubjergensis - G. kozlowskii* lineage.

5. *Globigerina triloculinoides* PLUMMER (OB 48), x 180
   a. spiral side
   b. side view
   c. umbilical side

6. *Globorotalia pseudobulloides* (PLUMMER) (OB 32.40), x 180
   a. umbilical side
   b. side view
   c. spiral side

7. *Globorotalia* sp. aff. *G. varianta* (SUBBOTINA) (OB 38.20), x 180
   a. spiral side
   b. side view
   c. umbilical side

8. *Globorotalia* sp. aff. *G. varianta* (SUBBOTINA) (OB 36.10), x 120
   a. spiral side
   b. side view
   c. umbilical side

9. *Globorotalia* sp. cf. *G. compressa* (PLUMMER) (OB 32.20), x 180
   a. umbilical side
   b. side view
   c. spiral side.

PLANCHE 12
PLATE

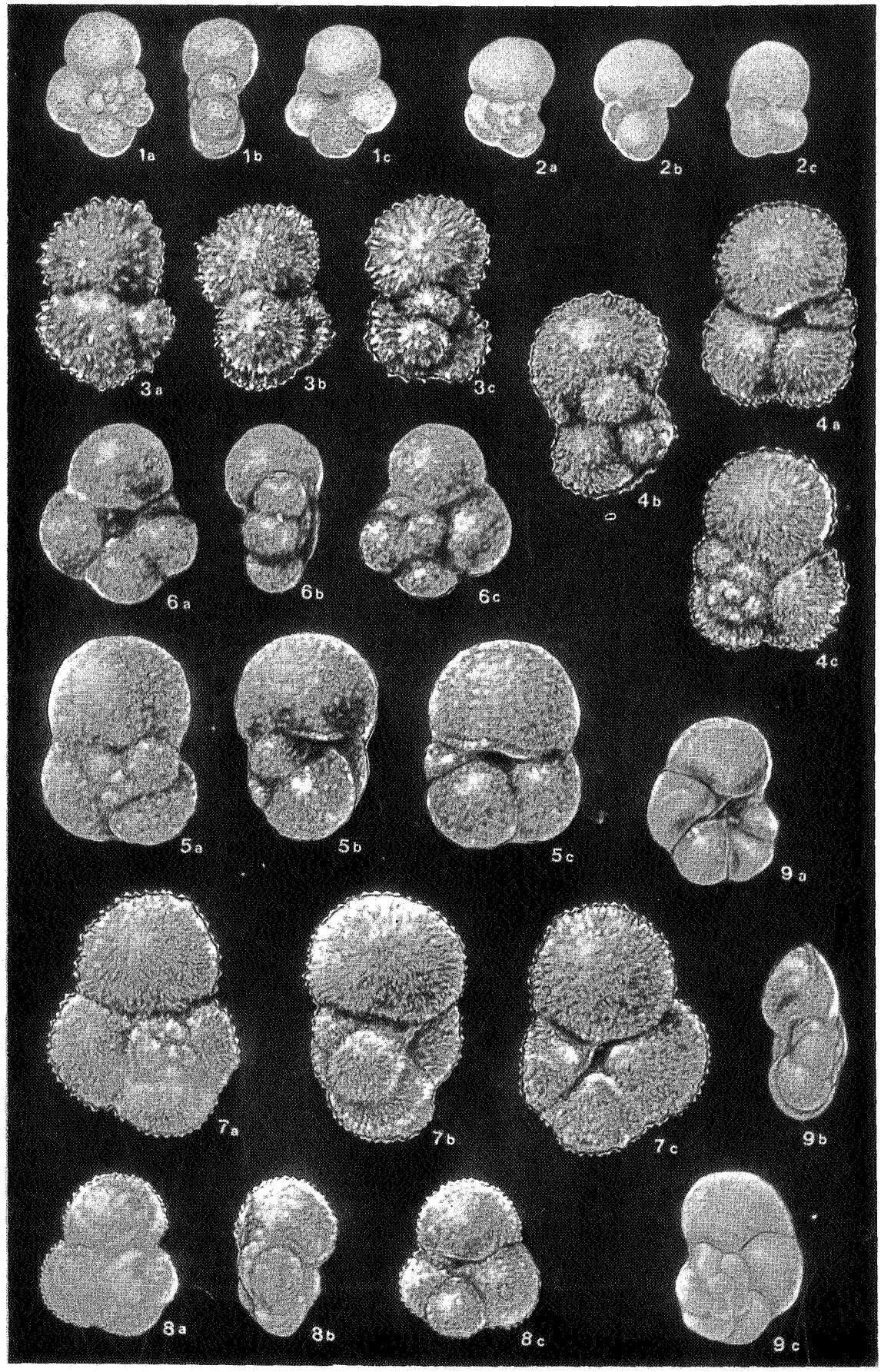

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PLATE 13

Photographs and ink-drawings

1. *Valvulammina* sp. cf. *V. globularis* (d'ORBIGNY) (OB 30), x 55
   a. umbilical side
   b. side view
   c. spiral side

2. a - c. same specimen, ink-drawings, x 55

3. *Globulina* sp. cf. *G. tuberculata* d'ORBIGNY (OB 30), x 60
   a, b. side views

4. a, b. same specimen, ink-drawings, x 60.

5. *Baggatella* ? *aenigmatica* POZARYSKA & SZCZECHURA (OB 65.90), x 53.
   a. spiral side
   b. side view
   c. umbilical side

6. a - c. same specimen, ink-drawings, x 53.

PLANCHE 13

PLATE

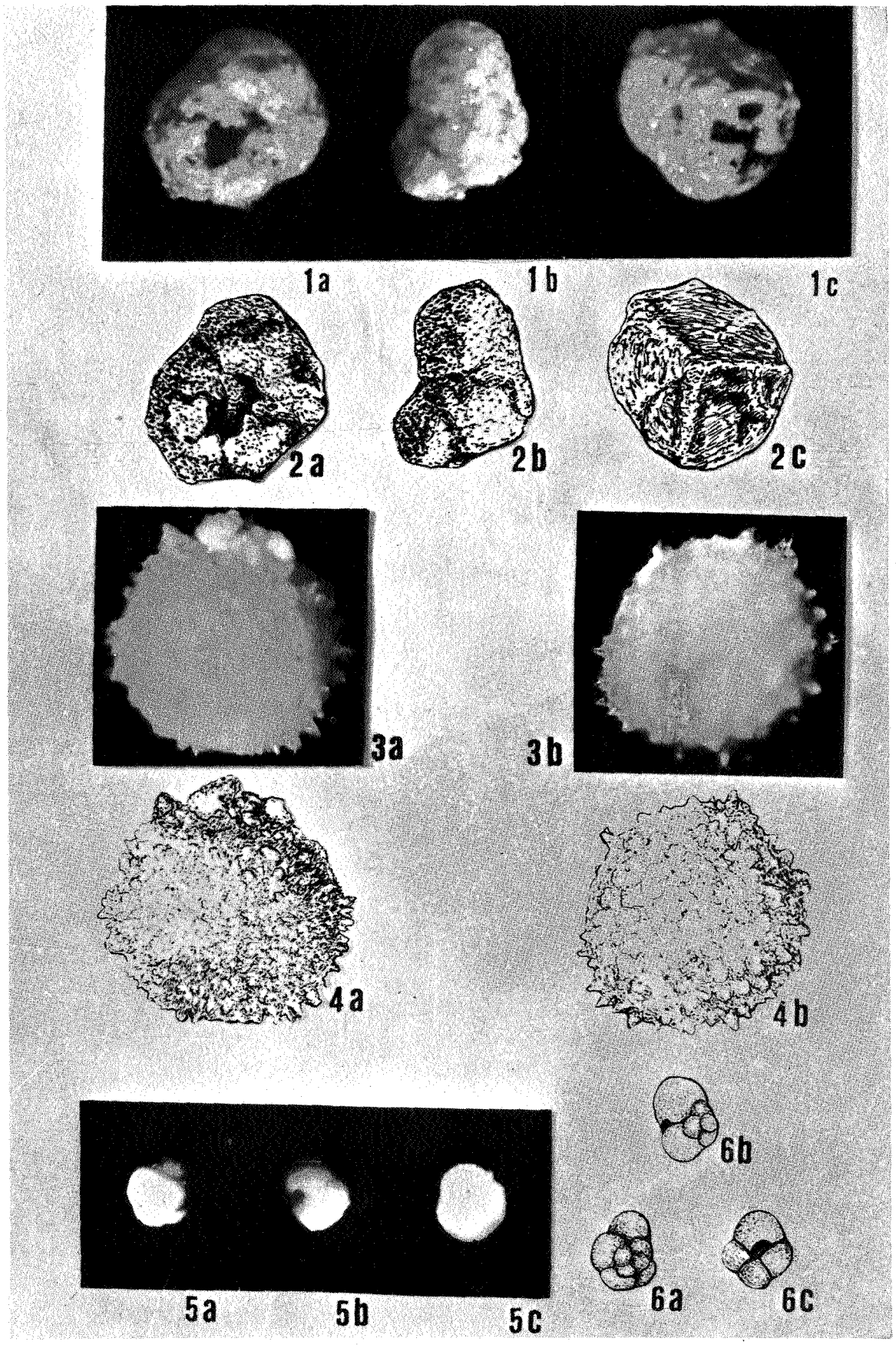

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PLATE 14

Photographs and ink-drawings

1. *Discorbis bundensis* VAN BELLEN (OB 30), x 90
   a. spiral side
   b. side view
   c. umbilical side

2. a - c. same specimen, ink-drawings, x 90

3. *Discorbis* ? *lenae* n. sp. (OB 74), x 90, holotype.
   a. umbilical side
   b. side view
   c. spiral side

4. a - c. same specimen, ink-drawings, x 90

5. *Discorbis* ? *lenae* n. sp. (OB 20) paratypoid, x 88
   a. umbilical side
   b. spiral side

6. a, b. same specimen, photographs, x 88

7. *Angulogerina europaea* CUSHMAN & EDWARDS (OB 32.40), x 90
   a. side view
   b. apertural view
   c. other side view

8. a - c. same specimen, ink-drawings, x 90.

PLANCHE 14

PLATE

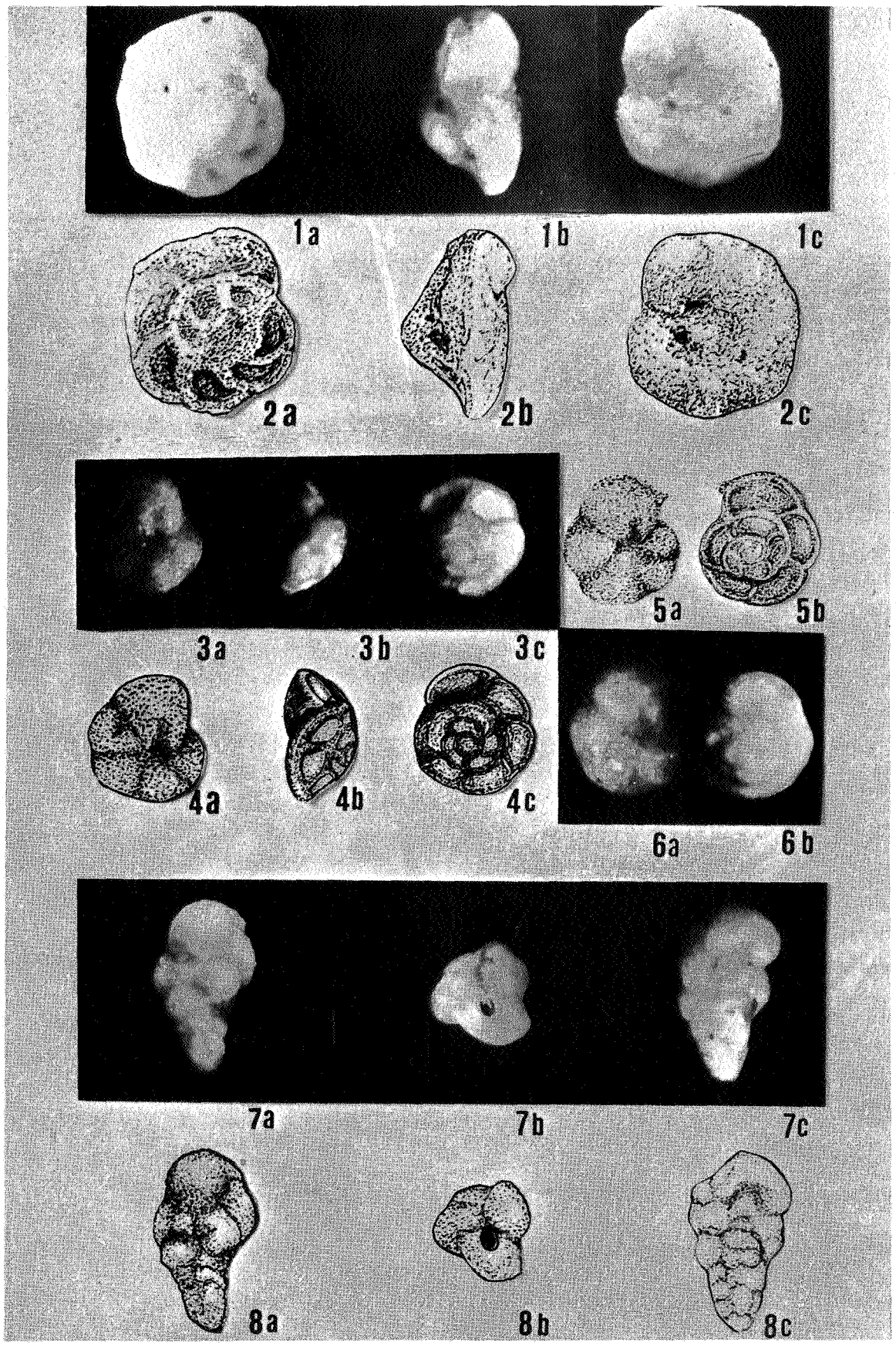

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PLATE 15

Photographs and ink-drawings

1. *Patellina paleocenica* (HOFKER) (OB 12), x 100
   a. spiral side
   b. side view
   c. umbilical side

2. a - c. same specimen, ink-drawings, x 100

3. *Epistominella* sp. cf. *E. limburgensis* (VISSER) (OB 32.20), x 96
   a. umbilical side
   b. side view
   c. spiral side

4. a - c. same specimen, ink-drawings, x 96

5. *Discorbis* ? *renemarlierei* n. sp. (OB 32.40), x 100, holotype
   a. spiral side
   b. side view
   c. umbilical side

6. a - c. same specimen, ink-drawings, x 100.

PLANCHE 15

PLATE

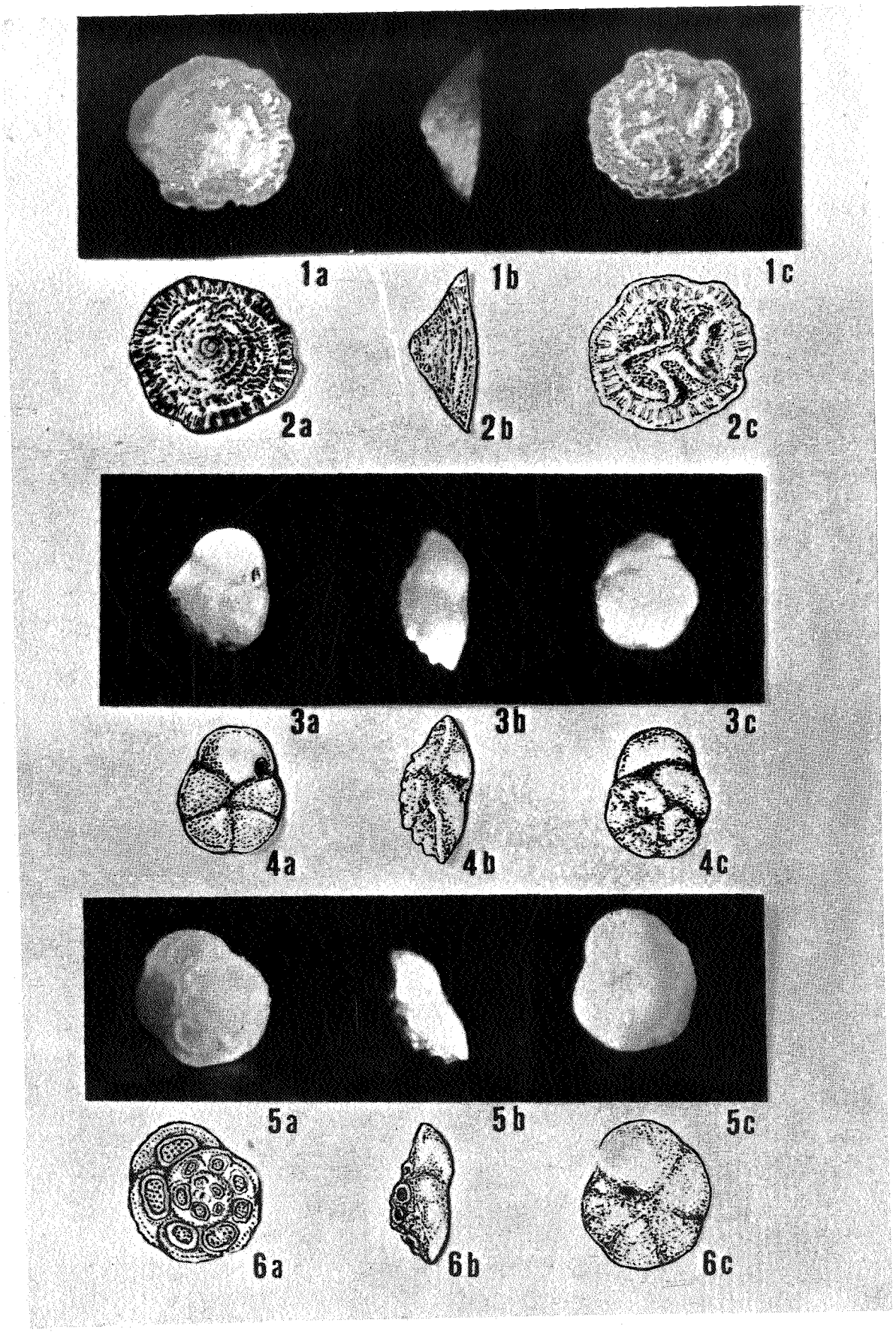

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PLATE 16

Photographs, ink-drawings and pencil drawings

1. *Rotalia* sp. cf. *R. trochidiformis* (LAMARCK) (OB 30), x 33
   a. umbilical side
   b. side view
   c. spiral side

2. a - c. same specimen, ink-drawings, x 33

3. *Rotalia bundensis* VAN BELLEN (OB 30), x 100
   a. umbilical side
   b. side view
   c. spiral side
   d. side view, other orientation

4. a - d. same specimen, ink-drawings, x 100

5. *Nonion graniferum* (TERQUEM) (MM 287), x 200, pencil drawing
   a. side view
   b. apertural view

6. *Nonion graniferum* (TERQUEM) (MM 287), x 200, pencil drawing
   a. apertural view
   b. side view

remark : specimen with an intercameral foramen of the penultimate chamber consisting of a series of semicircular apertures instead of a slit.

PLANCHE 16

PLATE

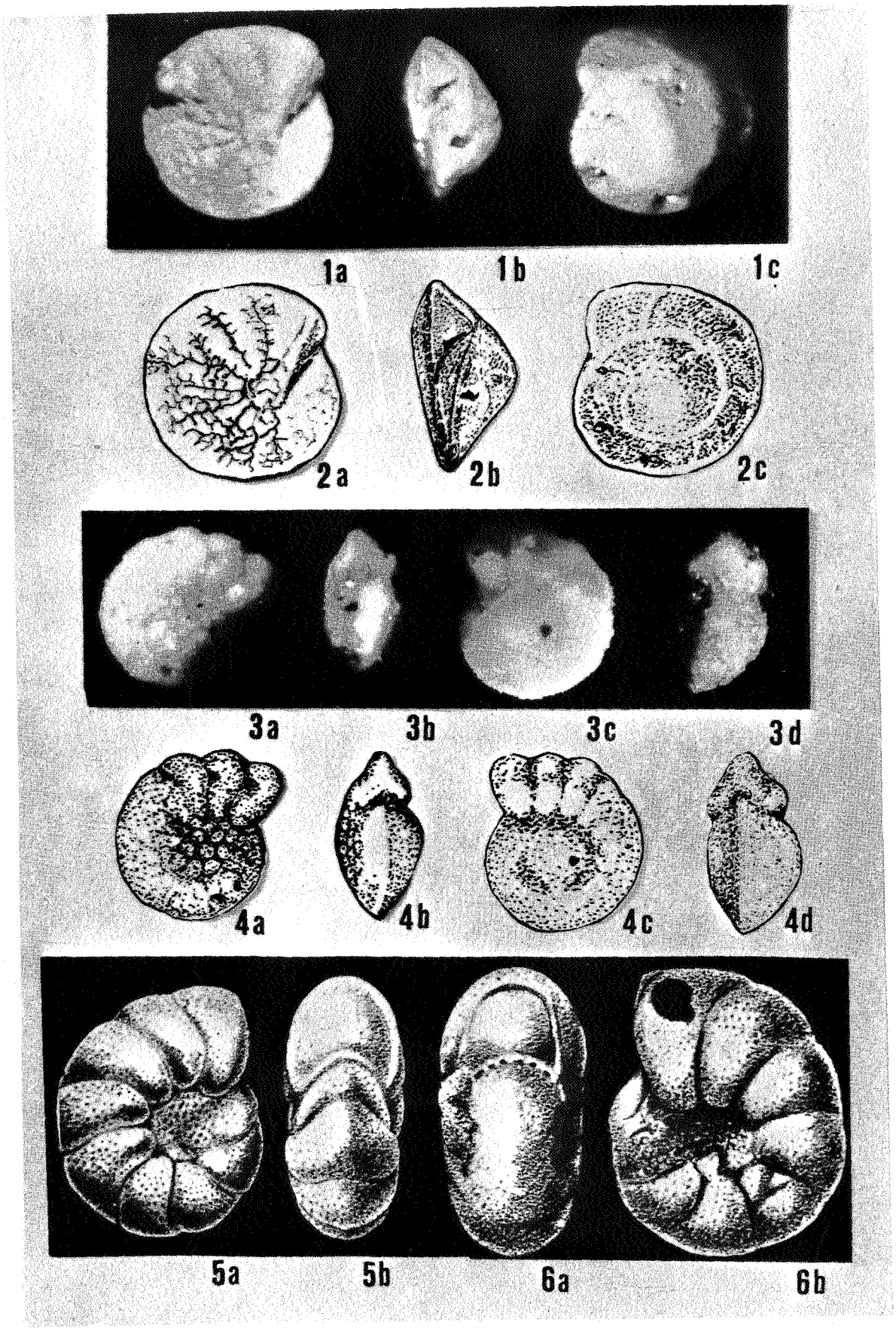

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PLATE 17

Photographs and ink-drawings

1. *Coleites reticulosus* (PLUMMER) (OB 64.20), x 54
   a. umbilical side
   b. side view
   c. spiral side

2. a - c. same specimen, ink-drawings, x 54

3. *Gavelinella minor* (POZARYSKA & SZCZECHURA) (OB 32.40), x 100
   a. umbilical side
   b. side view
   c. spiral side

4. a - c. same specimen, ink-drawings, x 100

5. *Karreria fallax* RZEHAK (OB 42.30), x 100
   a. umbilical side
   b. side view
   c. spiral side

6. a - c. same specimen, ink-drawings, x 100

PLANCHE 17

PLATE

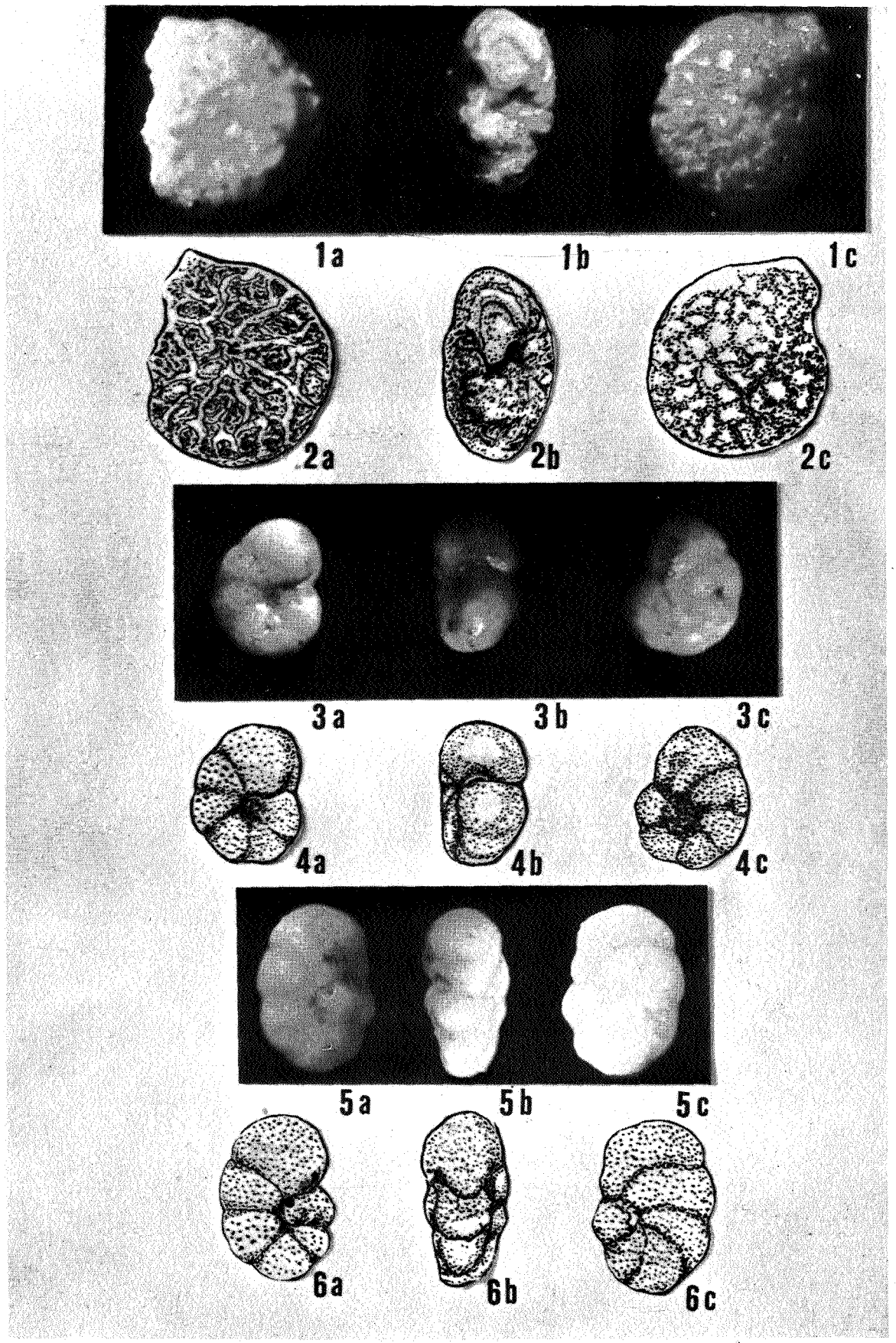

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PLATE 18

Photographs and ink-drawings

1. *Globigerina daubjergensis* BRÖNNIMANN (OB 72.10), x 120
   a. spiral side
   b. side view
   c. umbilical side

2. a - c. same specimen, ink-drawings, x 120

3. *Globigerina kozlowskii* BROTZEN & POZARYSKA (OB 32.40), x 85
   a. umbilical side (with bulla-like last chamber)
   b. side view
   c. spiral side

4. a - c. same specimen, ink-drawings, x 85

5. *Globorotalia* sp. aff. *G. varianta* (SUBBOTINA) (OB 36.10), x 85
   a. spiral side
   b. side view
   c. umbilical side

remark : observe the spinose test.

6. a - c. same specimen, ink-drawings, x 85

7. *Globorotalia* sp. cf. *G. compressa* (PLUMMER) (OB 32.20), x 95
   a. umbilical side
   b. side view (with pinched last chamber)
   c. spiral side

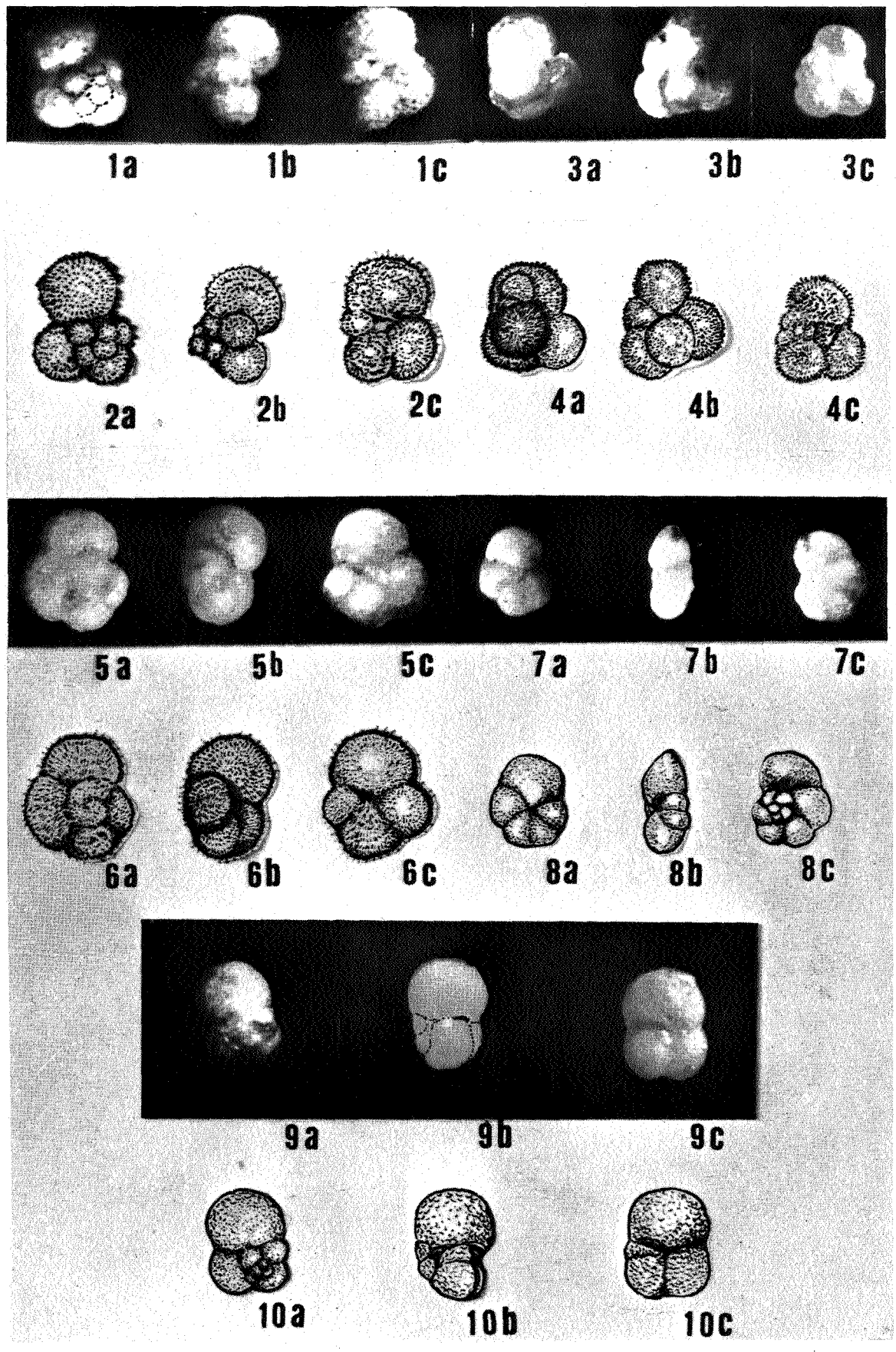
8. a - c. same specimen, ink-drawings, x 95

9. *Globigerina triloculinoides* PLUMMER (OB 48), x 95
   a. spiral side
   b. side view
   c. umbilical side

10. a - c. same specimen, ink-drawings, x 95.

PLANCHE 18

PLATE



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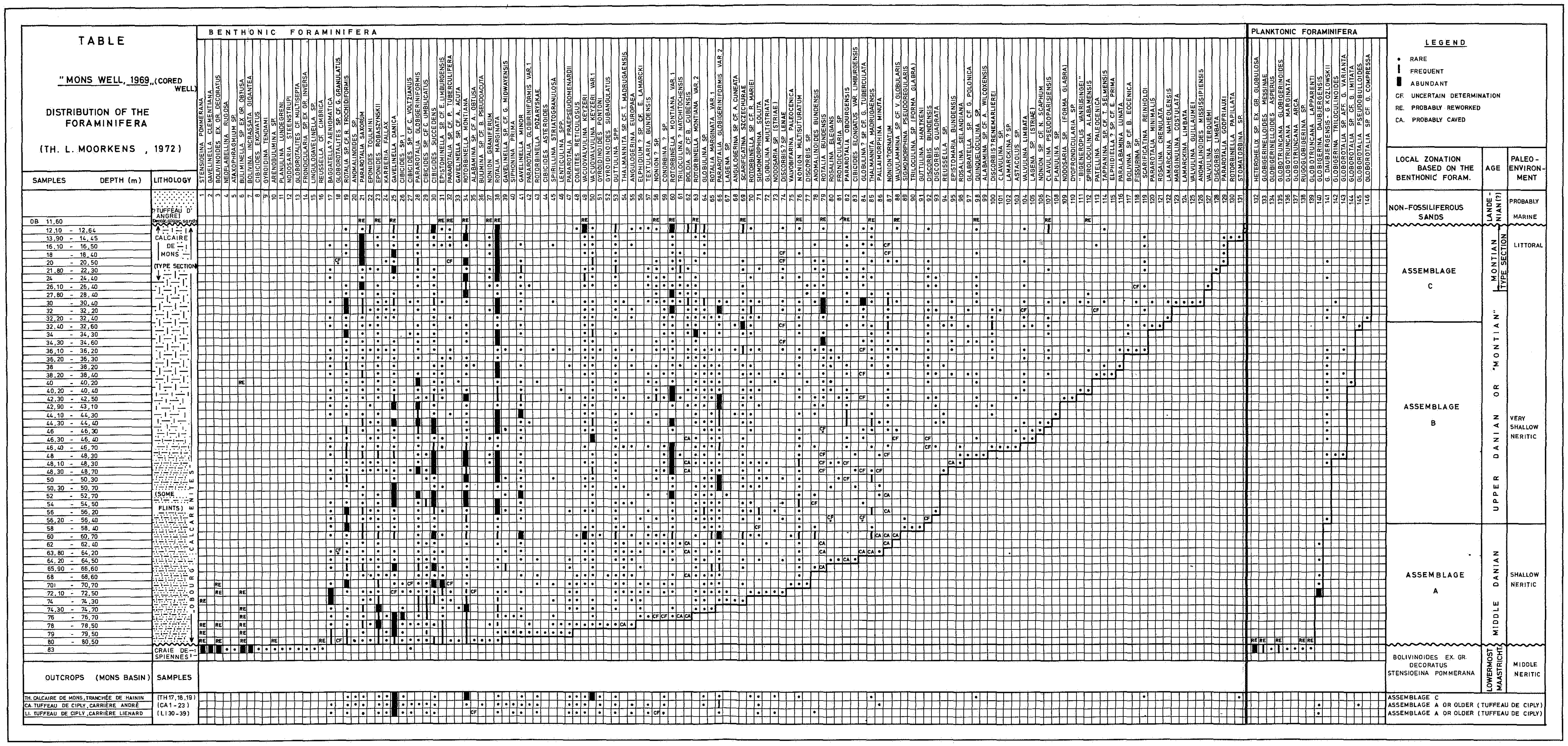


TABLE
"MONS WELL, 1969" (CORED WELL)
DISTRIBUTION OF THE FORAMINIFERA
(TH. L. MOORKENS , 1972)
SAMPLES
DEPTH (m)
LITHOLOGY
OB 11.60
12.10 - 12.64
13.90 - 14.45
16.10 - 16.50
18 - 18.40
20 - 20.50
21.80 - 22.30
24 - 24.40
26.10 - 26.40
27.80 - 28.40
30 - 30.40
32 - 32.20
32.20 - 32.40
32.40 - 32.60
34 - 34.30
34.30 - 34.60
36.10 - 36.20
36.20 - 36.30
38 - 38.20
38.20 - 38.40
40 - 40.20
40.20 - 40.40
42.30 - 42.50
42.90 - 43.10
44.10 - 44.30
44.30 - 44.40
46 - 46.30
46.30 - 46.40
46.40 - 46.70
48 - 48.30
48.10 - 48.30
48.30 - 48.70
50 - 50.30
50.30 - 50.70
52 - 52.70
54 - 54.50
56 - 56.20
56.20 - 56.40
58 - 58.40
60 - 60.70
62 - 62.40
63.80 - 64.20
64.20 - 64.50
65.90 - 66.60
68 - 68.60
701 - 70.70
72.10 - 72.50
74 - 74.30
74.30 - 74.70
76 - 76.70
78 - 78.50
79 - 79.50
80 - 80.50
83
TUFFEAU D'ANGRE
Decalcified sands
CALCAIRE DE MONS (TYPE SECTION)
(SOME FLINTS)
OBOURG CALCARENITES
CRAIE DE SPIENNES
OUTCROPS (MONS BASIN)
SAMPLES
TH. CALCAIRE DE MONS, TRANCHÉE DE HAININ (TH 17, 18, 19)
CA. TUFFEAU DE CIPLY, CARRIÈRE ANDRÉ (CA 1 - 23)
LI. TUFFEAU DE CIPLY, CARRIÈRE LIENARD (LI 30 - 39)
BENTHONIC FORAMINIFERA
1 STENSIOEINA POMMERANA
2 GAVELINELLA CLEMENTIANA
3 BOLIVINOIDES EX. GR. DECORATUS
4 NEOFLABELLINA RUGOSA
5 ATAXOPHRAGMIUM SP.
6 BULIMINELLA SP. EX GR. OBTUSA
7 BOLIVINA INCRASSATA GIGANTEA
8 CIBICIDES EXCAVATUS
9 GYROIDINA TENDAMI
10 ARENOBULIMINA SP.
11 PLANULINA LUNDEGRENI
12 NODOSARIA STEENSTRUPI
13 GLOBOROTALITES CF. MULTISEPTA
14 FRONDICULARIA SP. EX GR. INVERSA
15 LINGULOGAVELINELLA SP.
16 REUSSELLA CF. CIMBRICA
17 BAGGATELLA? AENIGMATICA
18 GLOBOROTALITES SP. CF. G. GRANULATUS
19 ROTALIA SP. CF. R. TROCHIDIFORMIS
20 ANOMALINOIDES SP.
21 PARAROTALIA SAXORUM
22 EPONIDES TOULMINI
23 EPONIDES ROBASZYNSKII
24 KARRERIA FALLAX
25 GAVELINELLA DANICA
26 CIBICIDES SP. 1
27 CIBICIDES SP. CF. C. VOLTZIANUS
28 PARAROTALIA GLOBIGERINIFORMIS
29 CIBICIDES SP. CF. C. UMBILICATUS
30 CIBICIDES SUCCEDENS
31 EPISTOMINELLA SP. CF. E. LIMBURGENSIS
32 PARAROTALIA SP. CF. P. TUBERCULIFERA
33 GAVELINELLA SP. CF. A. ACUTA
34 ROTORBINELLA MONTIANA
35 ALABAMINA SP. CF. A. OBTUSA
36 BULIMINA SP. CF. B. PSEUDOACUTA
37 NONION GRANIFERUM
38 ROTALIA MARGINATA
39 GAVELINELLA SP. CF. G. MIDWAYENSIS
40 SIPHONINA PRIMA
41 GAVELINELLA MINOR
42 PARAROTALIA GLOBIRINIFORMIS VAR. 1
43 ROTORBINELLA POZARYSKAE
44 CIBICIDES ASTEROIDES
45 SPIRILLINA STRIATOGRANULOSA
46 LENTICULINA SPP.
47 PARAROTALIA PRAEPSEUDOMENARDII
48 COLEITES RETICULOSUS
49 VACUOVALVULINA KEYZERI
50 VACUOVALVULINA KEYZERI VAR. 1
51 GYROIDINOIDES PONTONI
52 GYROIDINOIDES SUBANGULATUS
53 GUTTULINA SPP.
54 THALMANNITA SP. CF. T. MADRUGAENSIS
55 ANGULOGERINA EUROPAEA
56 ELPHIDIUM ? SP. CF. E. LAMARCKI
57 TEXTULARIA BUNDENSIS
58 NONION ? SP.
59 CONORBINA ? SP.
60 ROTORBINELLA MONTIANA VAR. 1
61 TRILOCULINA ? NATCHITOCHENSIS
62 BOLDIA SP. CF. B. CUBENSIS
63 ROTORBINELLA MONTIANA VAR. 2
64 GLOBULINA SP.
65 ROTALIA MARGINATA VAR. 1
66 PARAROTALIA GLOBIGERINIFORMIS VAR. 2
67 LAGENA SP.
68 ANGULOGERINA SP. CF. A. CUNEATA
69 SCARIFICATINA SZCZECHURAE
70 ROTORBINELLA SP. CF. R. MARIEI
71 SIGMOMORPHINA SOLUTA
72 GLOBULINA MULTISTRIATA
73 NODOSARIA SP. (STRIAE)
74 DISCORBIS? SP. LENAE
75 VALVOBIFARINA PALEOCENICA
76 NONION MULTISUTURATUM
77 DISCORBIS SP.
78 ANOMALINOIDES BUNDENSIS
79 ROTALIA BUNDENSIS
80 ROSALINA ELEGANS
81 FRONDICULARIA SP.
82 PARAROTALIA OBOURGENSIS
83 CIBICIDES ELONGATUS VAR. LIMBURGENSIS
84 GLOBULINA? SP. CF. G. TUBERCULATA
85 THALMANNITA MADRUGAENSIS
86 PALLAIMORPHINA MINUTA
87 NONION? ORNATUM
88 VALVULAMMINA SP. CF. V. GLOBULARIS
89 SIGMOMORPHINA PSEUDOREGULARIS
90 TRILOCULINA SP. (FORMA GLABRA)
91 GUTTULINA HANTKENI
92 DISCORBIS BUNDENSIS
93 DISCORBIS QUADRATA
94 REUSSELLA SP.
95 EPISTOMARIA BUNDENSIS
96 ROSALINA SELANDIANA
97 GLABRATELLA SP. CF. G. POLONICA
98 QUINQUELOCULINA SP.
99 ALABAMINA SP. CF. A. WILCOXENSIS
100 DISCORBIS? RENEMARLIEREI
101 CLAVULINA SP.
102 LAMARCKINA? SP.
103 ASTACOLUS SP.
104 VALVULINA LIMBATA
105 LAGENA SP. (STRIAE)
106 NONION SP. CF. N. SCAPHUM
107 CLAVULINA PSEUDOPARISIENSIS
108 PLANULINA SP.
109 NODOSARIA SP. (FORMA GLABRA)
110 DYOFRONDICULARIA SP.
111 "BIGENEROPLIS VANRIJSINGEI"
112 SPIROLOCULINA ALABAMENSIS
113 PATELLINA PALEOCENICA
114 TAPPANINA SP. CF. T. SELMENSIS
115 ELPHIDIELLA? SP. CF. E. PRIMA
116 PARALABAMINA LUNATA
117 BOLIVINA SP. CF. B. EOCENICA
118 FISSURINA SP.
119 SCARIFICATINA REINHOLDI
120 PARAROTALIA MINIMALIS
121 ROSALINA CRENULATA
122 LAMARCKINA NAHEOLENSIS
123 MARGINULINA COSTULATA
124 LAMARCKINA LIMBATA
125 VALVULINA GUILLAUMEI
126 ANOMALINOIDES MISSISSIPIENSIS
127 VALVULINA TERQUEMI
128 DISCORBIS LIMBATA
129 PARAROTALIA GODFRIAUXI
130 ROTORBINELLA PAPILLATA
131 STOMATORBINA SP.
PLANKTONIC FORAMINIFERA
132 HETEROHELIX SP. EX. GR. GLOBULOSA
133 GLOBIGERINELLOIDES MESSINAE
134 GLOBIGERINELLOIDES ASPERUS
135 GLOBOTRUNCANA GLOBIGERINOIDES
136 GLOBOTRUNCANA MARGINATA
137 GLOBOTRUNCANA ARCA
138 RUGOGLOBIGERINA SP.
139 GLOBOTRUNCANA LAPPARENTI
140 GLOBIGERINA DAUBJERGENSIS
141 G. DAUBJERGENSIS - G. KOZLOWSKII
142 GLOBIGERINA TRILOCULINOIDES
143 GLOBOROTALIA SP. AFF. G. VARIANTA
144 GLOBOROTALIA SP. CF. G. IMITATA
145 GLOBOROTALIA PSEUDOBULLOIDES
146 GLOBOROTALIA SP. CF. G. COMPRESSA
LEGEND
• RARE
FREQUENT
ABUNDANT
CF. UNCERTAIN DETERMINATION
RE. PROBABLY REWORKED
CA. PROBABLY CAVED
LOCAL ZONATION BASED ON THE BENTHONIC FORAM.
AGE
PALEO-ENVIRONMENT
NON-FOSSILIFEROUS SANDS
LANDENIAN (?)
PROBABLY MARINE
ASSEMBLAGE C
MONTIAN TYPE SECTION
LITTORAL
ASSEMBLAGE B
UPPER DANIAN OR "MONTIAN"
VERY SHALLOW NERITIC
ASSEMBLAGE A
MIDDLE DANIAN
SHALLOW NERITIC
BOLIVINOIDES EX. GR. DECORATUS
STENSIOEINA POMMERANA
LOWERMOST MAASTRICHT.
MIDDLE NERITIC
ASSEMBLAGE C
ASSEMBLAGE A OR OLDER (TUFFEAU DE CIPLY)
ASSEMBLAGE A OR OLDER (TUFFEAU DE CIPLY)

	Generalized Terminology	Symbols of Geological map of Belgium 1:40000	Western Belgium and adjacent area in N. France	Symbols of Geological map of Belgium 1:40 000	Eastern Belgium and adjacent area in the S. E. Netherlands	Symbols used in Stratigraphic literature of the S.E. Netherlands
third tr. c.	Formation of Ypres (=Ieper)	Y 1d Y 1c Y 1a-b	Sands of Mons-en Pévèle Clay of Ypres ((6)) (local sandy deposits)		(gap in the sedimentation or erosion)	
			(gap in the sedimentation)			
	Upper Landen Formation	L 2	Sands of Erquelinnes (=Sands of Jeumont)	L 2	Sands of Dormaal (Orsmaal) and Sands or Lignites of Landen ((5))	
second transgressive cycle	Lower Landen Formation	L 1	Sands of Grandglise Tuffeau de Chercq (and / or T. d'Angres) Clay of Louvil and,	L 1 b,c (L 1)	Sands of Racour; - an unnamed clay unit (observed in MM 209 - 220m) Tuffeau de Lincent ((4))	
	Formation of Heers		Formation of the — ? — Paternostre well ("Heersian of Hainault" of authors)	L 1 a (Ha - d)	Marls of Gelinden ((3)) Sands of Orp	
				?		
First transgressive cycle	Formation of Mons in W. Belgium (unnamed Fm in E. Belgium)	(Mt 3) Mtc	Calcaire lacustre (à Physa) de Hainin (and other continental deposits)	-	(azoic sediments) Couches à Cyrènes du Paléocene du Limbourg Calcarenite of Mechelen a/d Maas	
		(Mt 2) Mtb	Calcaire de Mons ((2))	-	- Limestone of Bunde	
		(Mt 1) Mta	Calcaire de Cuesmes (à grands Cérithes) Tuffeau de Ciply	-	Calcarenite of Houthem (or of Geulhem) (=Tuffeau de Vroenhoven)	Pa & Me
	Formation of Maastricht in E. Belgium and S. E. Netherlands (unnamed Fm in W. Belgium	M	Tuffeau de St. Symphorien Craie (ph.) de Ciply Craie de Spiennes	M	Tuffaceous Chalk (=Calcarenite) of Maastricht ((1)) Gulpen Chalk (upper part)	Md | Ma Cr 4 Cr 3

Table 2

Location of stratotypes:
- ((1)) Maastrichtian stratotype
- ((2)) Montian stratotype
- ((3)) Heersian stratotype
- ((4)) Lower Landenian (Neostratotype)
- ((5)) Upper Landenian stratotype
- ((6)) Ypresian stratotype

CHRONOSTRATIGRAPHY (Suggested Subdivision of the Paleocene: threefold)			PLANKTONIC FORAMINIFERAL ZONATION (compiled from different authors, mainly H.M. BOLLI, 1951, 1957, 1966)	PLANKTONIC FORAMINIFERAL DATUM PLANES (in W. Europe)	CALCAREOUS NANNOPLANKTON ZONATION (according to E. MARTINI, 1971 and P. ČEPEK & W.W. HAY 1969)	SOME STRATOTYPES IN EUROPE
CENOZOIC	EOCENE	Early Eocene	G. marginodentata G. subbotinae	+G. marginodentata +G. subbotinae +G. wilcoxensis +P. wilcoxensis	M. tribrachiatus D. binodosus	
	PALEOCENE	Late Paleocene	G. velascoensis G. pseudomenardii	+G. pseudomenardii -G. ehrenbergi	M. contortus D. multiradiatus H. riedeli	
		Middle Paleocene	G. pusilla G. angulata G. uncinata	-G. kozlowskii +G. angulata +G. ehrenbergi +G. kozlowskii – transition -G. daubjergensis	D. gemmeus H. kleinpelli Fasciculithus tympaniformis E. macellus	
		Early Paleocene	G. compressa G. daubjergensis – G. pseudobulloides	+G. compressa +G. quadrata +G. triloculinoides +G. pseudobulloides +G. daubjergensis	C. danicus & Cruciplacolithus tenuis Markalius astroporus	
MESOZOIC	CRETACEOUS	Late Cretaceous	G. contusa (or G. mayaroensis or R. varians) G. gansseri	-Rugoglobigerina -Pseudotextularia -Racemiguembelina -Heterohelix -Globotruncana -Globotruncanella -Globigerinelloides -Hedbergella	Nephrolithus frequens	

MAASTRICHTIAN · DANIAN · MONTIAN · HEERSIAN · LOWER LANDENIAN · UPPER (continental) LANDENIAN · THANETIAN · ILERDIAN · YPRESIAN · CUISIAN · SELANDIAN

Table 3

+ appearance of species
- extinction of species

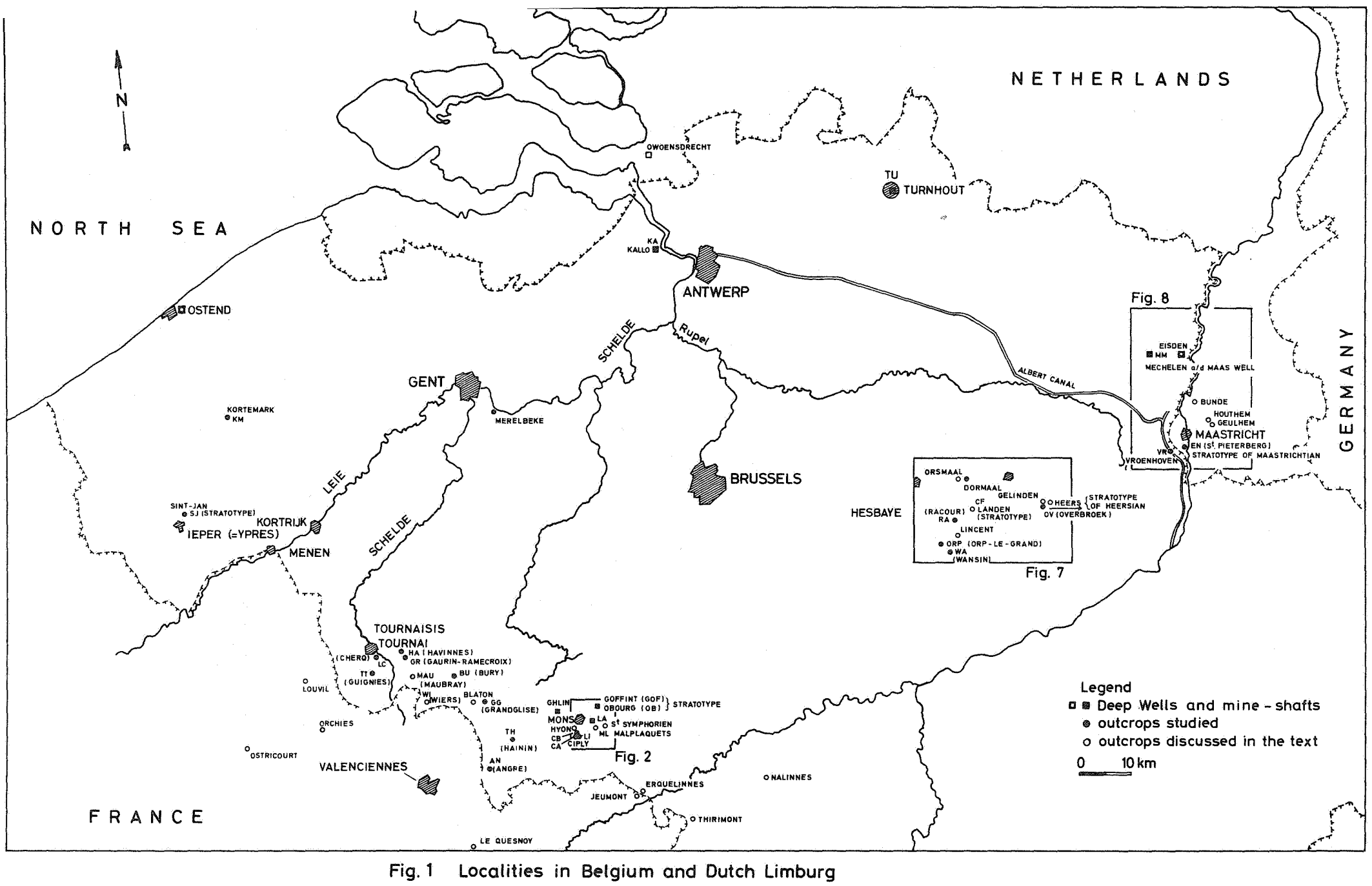


Fig. 1 Localities in Belgium and Dutch Limburg

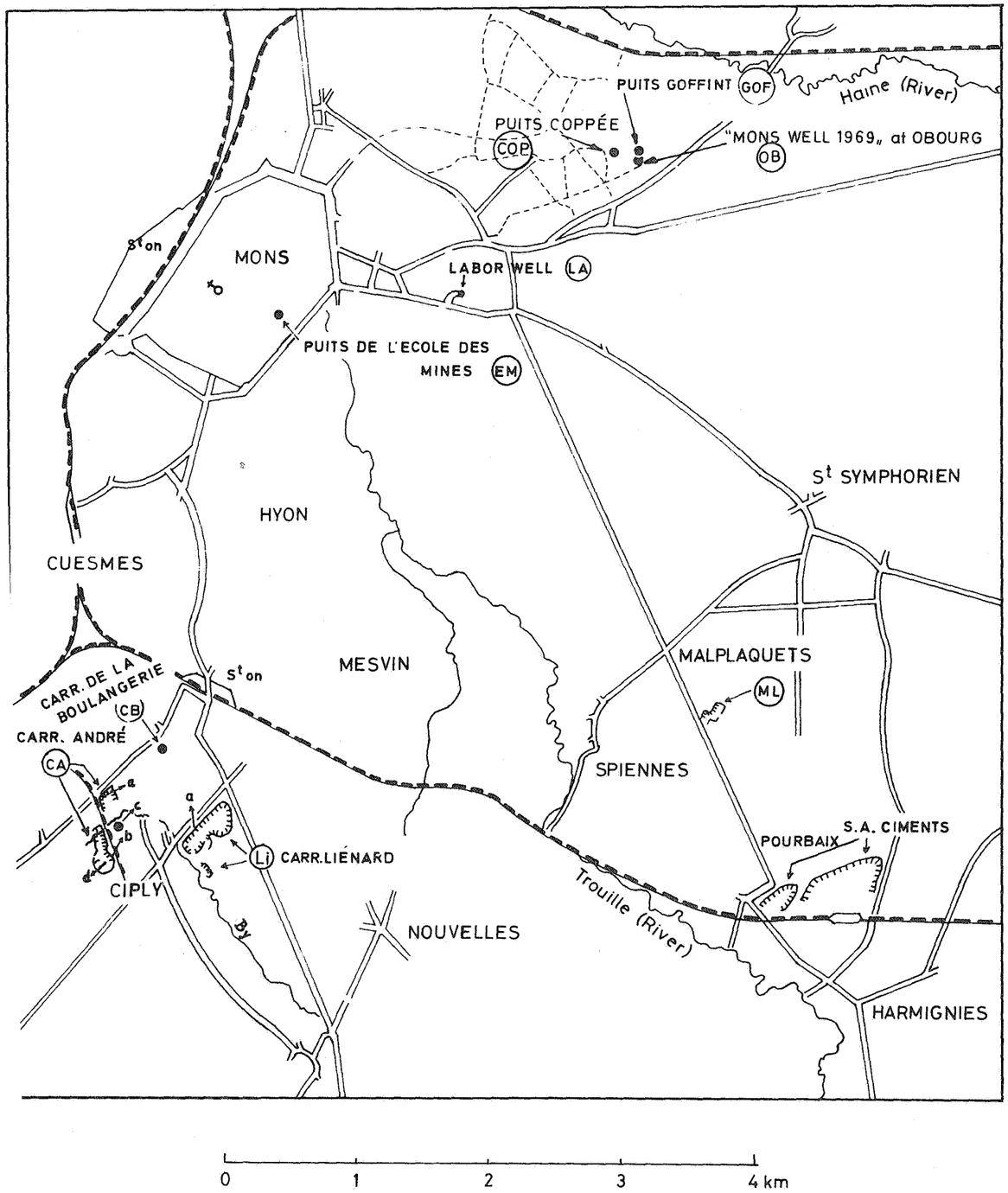


Fig. 2 The Mons Area

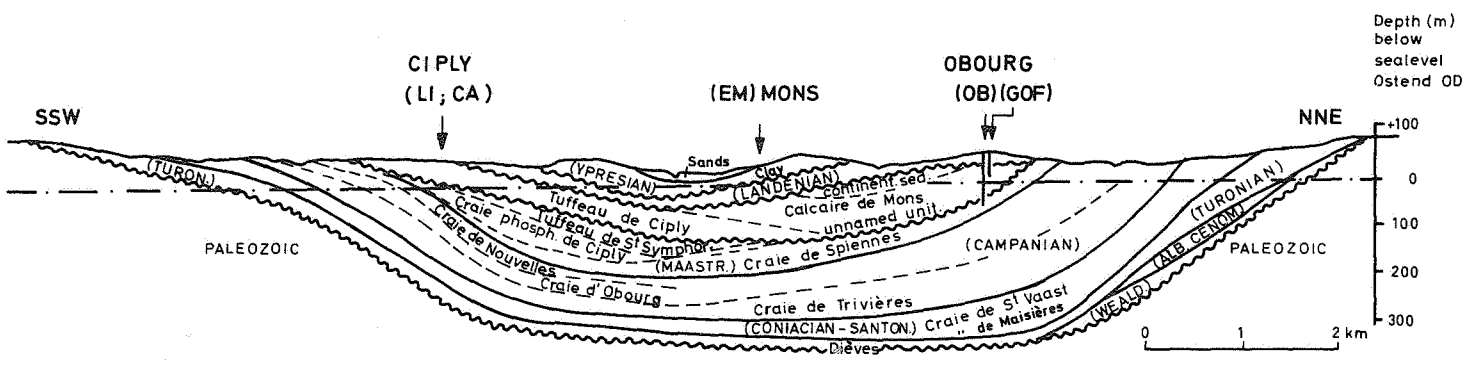


Fig. 3a - Cross section through the Mons Basin (Cuve de Mons) after MARLIERE , 1961, modified. The Puits Goffint and the "Mons Well '69„ have been added, although they are localized somewhat more eastwards .

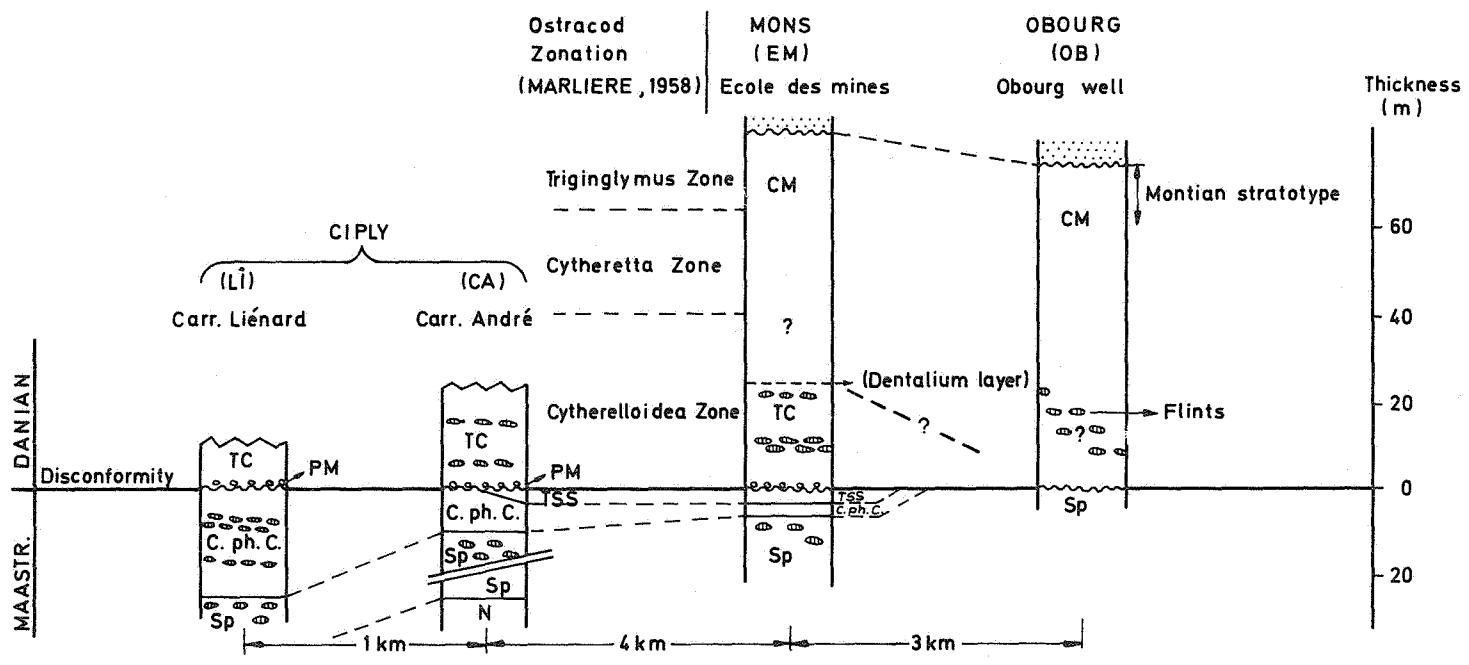


Fig. 3b - Correlations in the Area of Mons, partly after MARLIERE (1961); the " Mons Well 1969 „ at Obourg, has been added.

CM Calcaire de Mons
TC Tuffeau de Ciply
PM Poudingue de la Malogne
TSS Tuffeau de St Symphorien
C.ph.C. Craie phosphatée de Ciply
Sp Craie de Spiennes
N Craie de Nouvelles
? unnamed unit

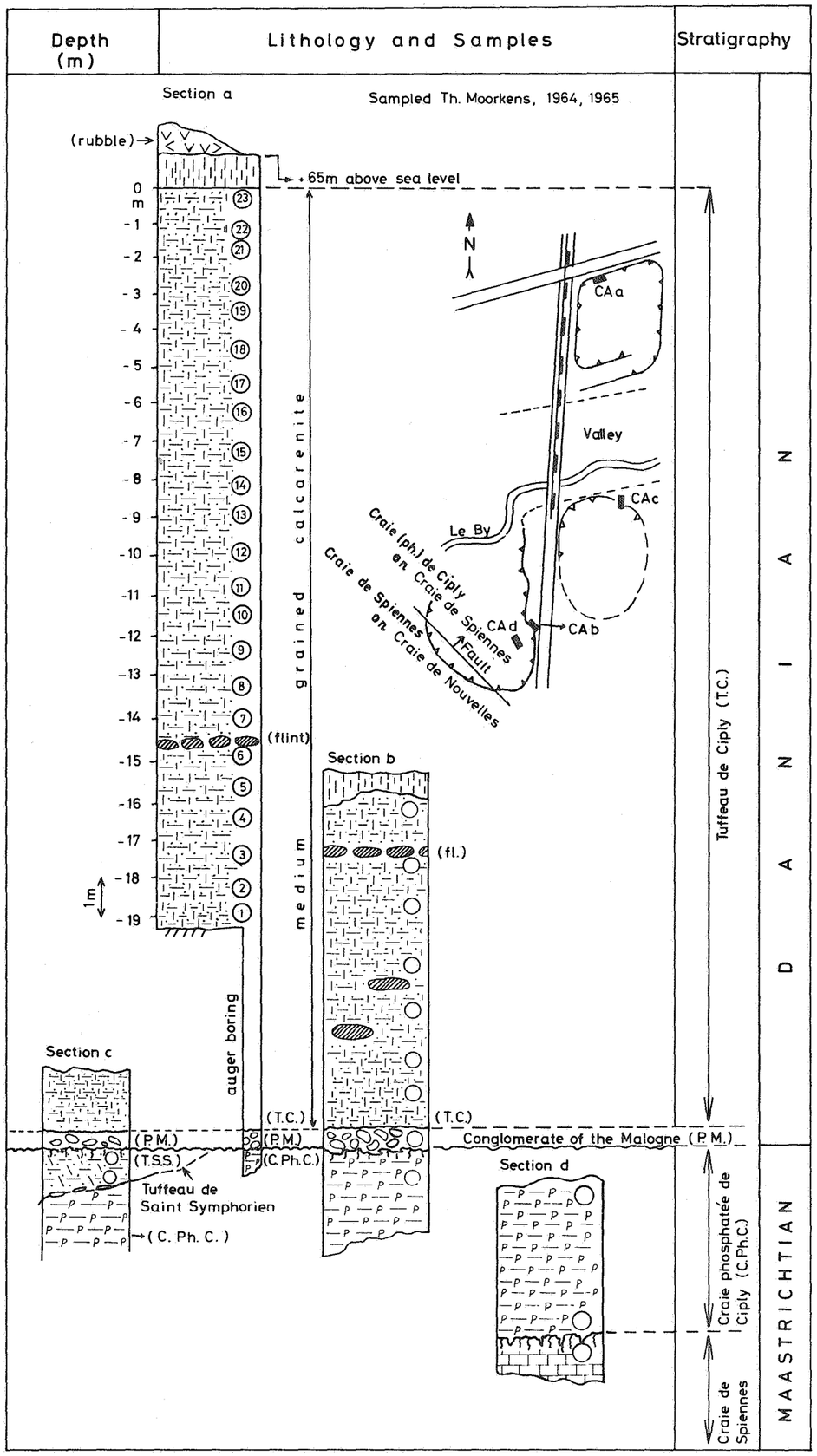


Fig. 4 - Ciply, Carrière André (CA)
Type Section of the Tuffeau de Ciply

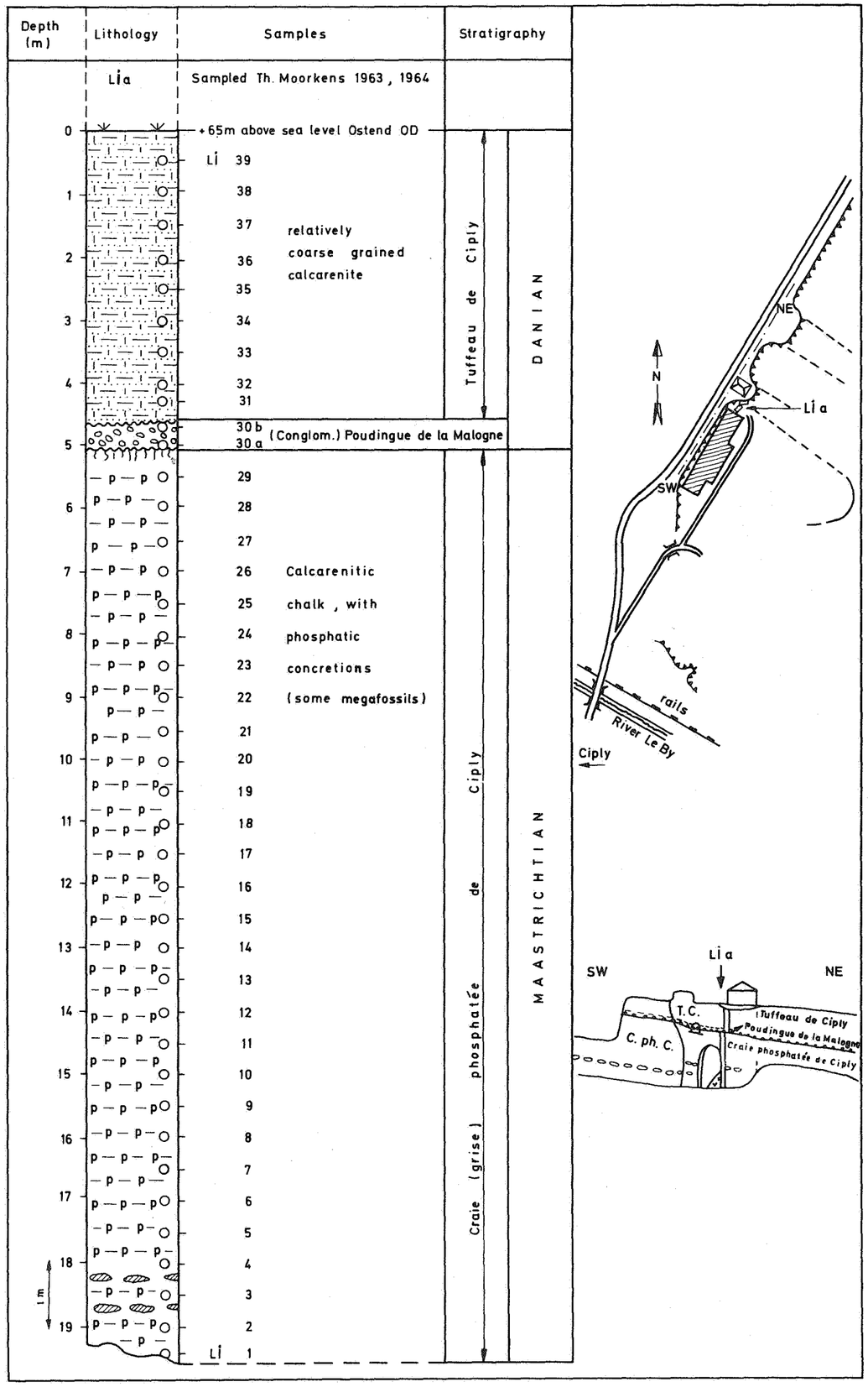
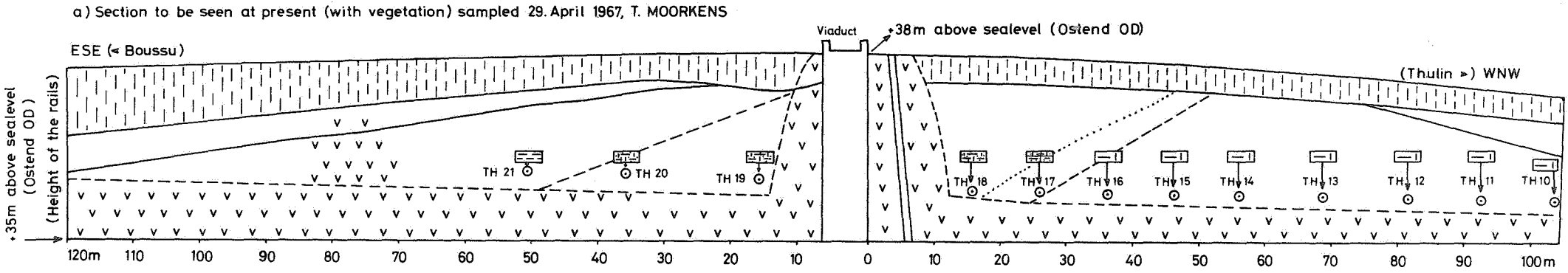


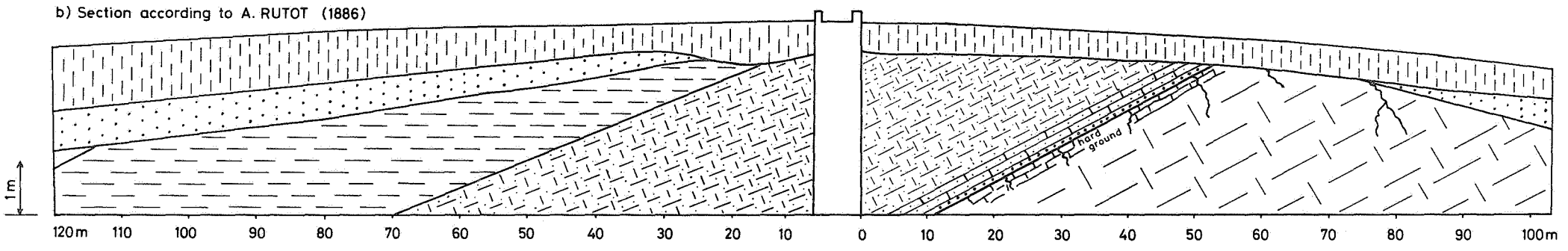
Fig. 5 - Ciply, Carrière Liénard (Li)

Fig. 6 TH. "Tranchée de Hainin," Railwaystation of Hainin. Southern side of the outcrop

a) Section to be seen at present (with vegetation) sampled 29. April 1967, T. MOORKENS



b) Section according to A. RUTOT (1886)



Loam (Quaternary)

Glauconiferous Sands (?Tuffeau d' Angre Upper Paleocene)

Grey Clay (Continental deposits of the Formation of Mons, Middle Paleocene)

Calcarenites (including the occurrence of the local Calcaire de Mons, shallow marine, and Calcaire de Hainin lacustre à Physa, continental deposit (TH 20))

White Chalk, marly in part (probably Craie de Trivières, Senonian)

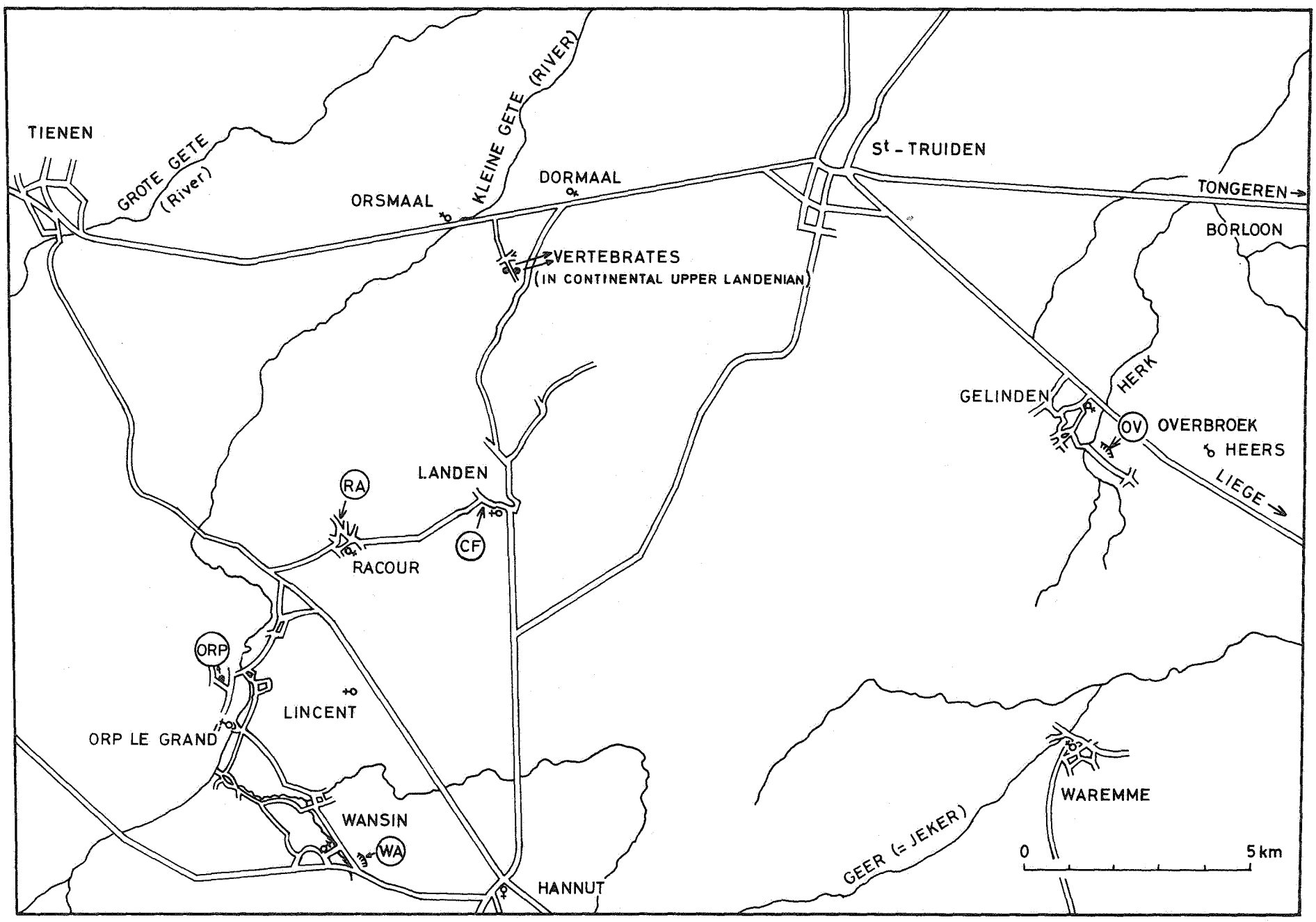


Fig. 7 The Landen Area

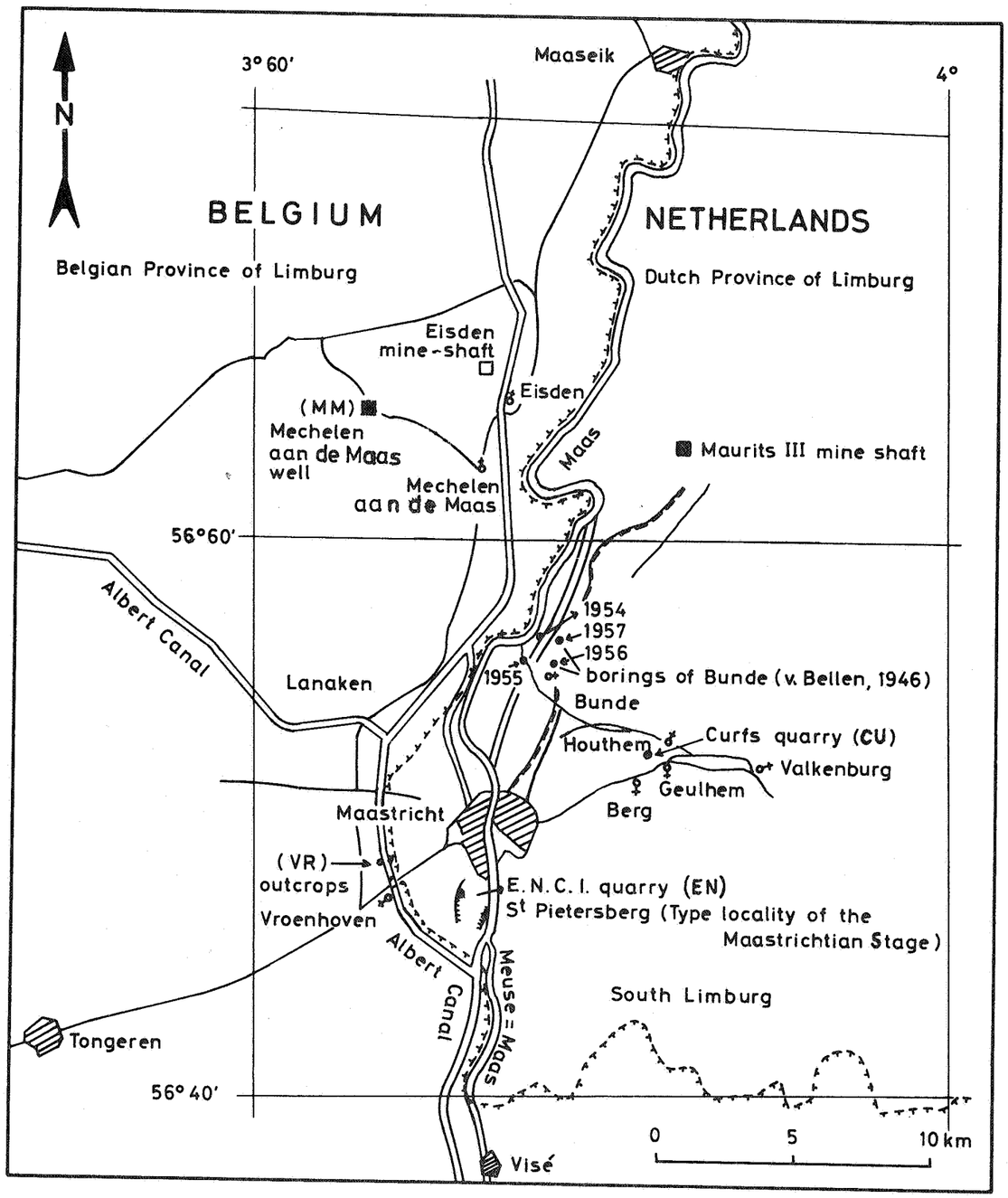


Fig.8 The Maastricht Area

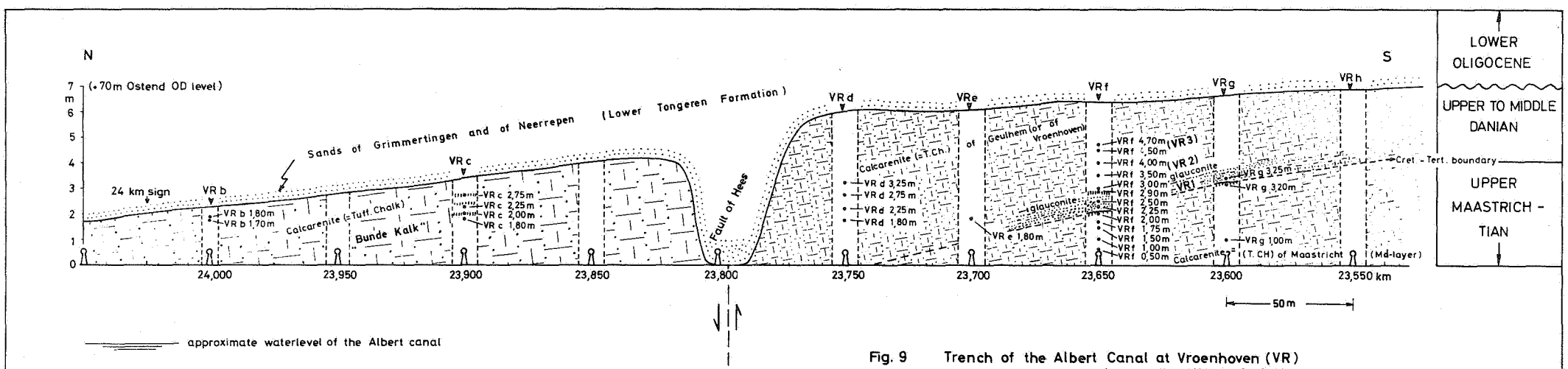


Fig. 9 Trench of the Albert Canal at Vroenhoven (VR)
(sampled T. L. MOORKENS 1970)

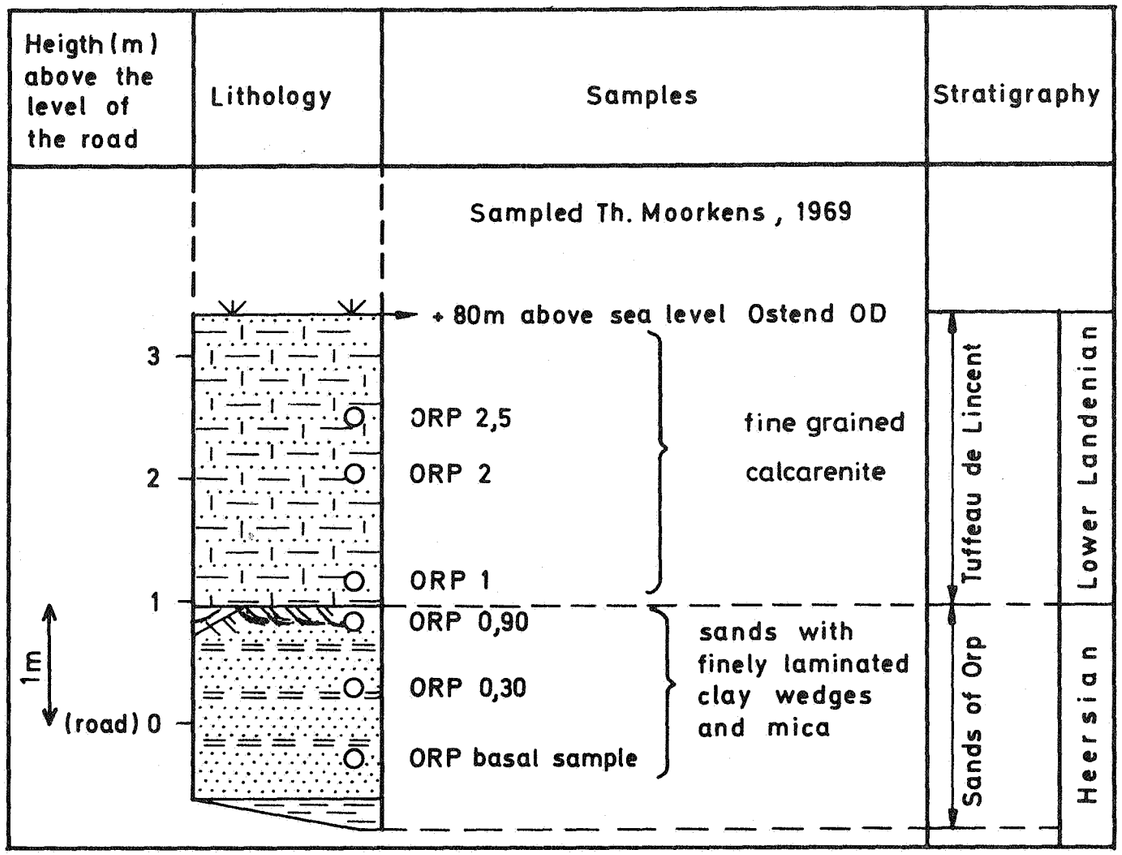


Fig. 10 - Orp - le - Grand , Quarry of Miss J. Dupont , rue du Chauffour (ORP)
Type Section of the Sands of Orp

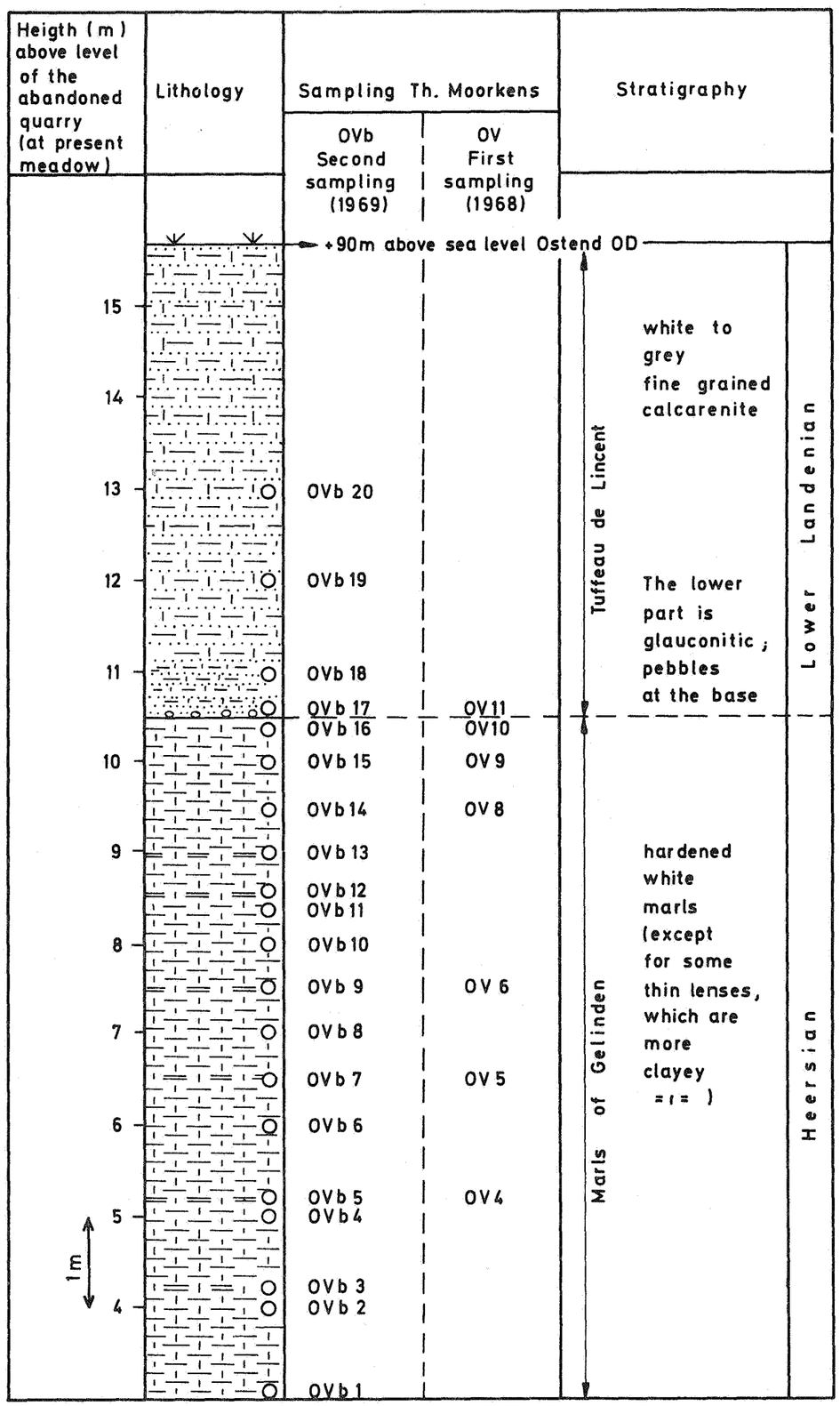


Fig. 11 - QUARRY OVERBROEK (Mr. Thewis , Gelinden) (OV)
Type Section of the Heersian Stage and of the Marls of Gelinden

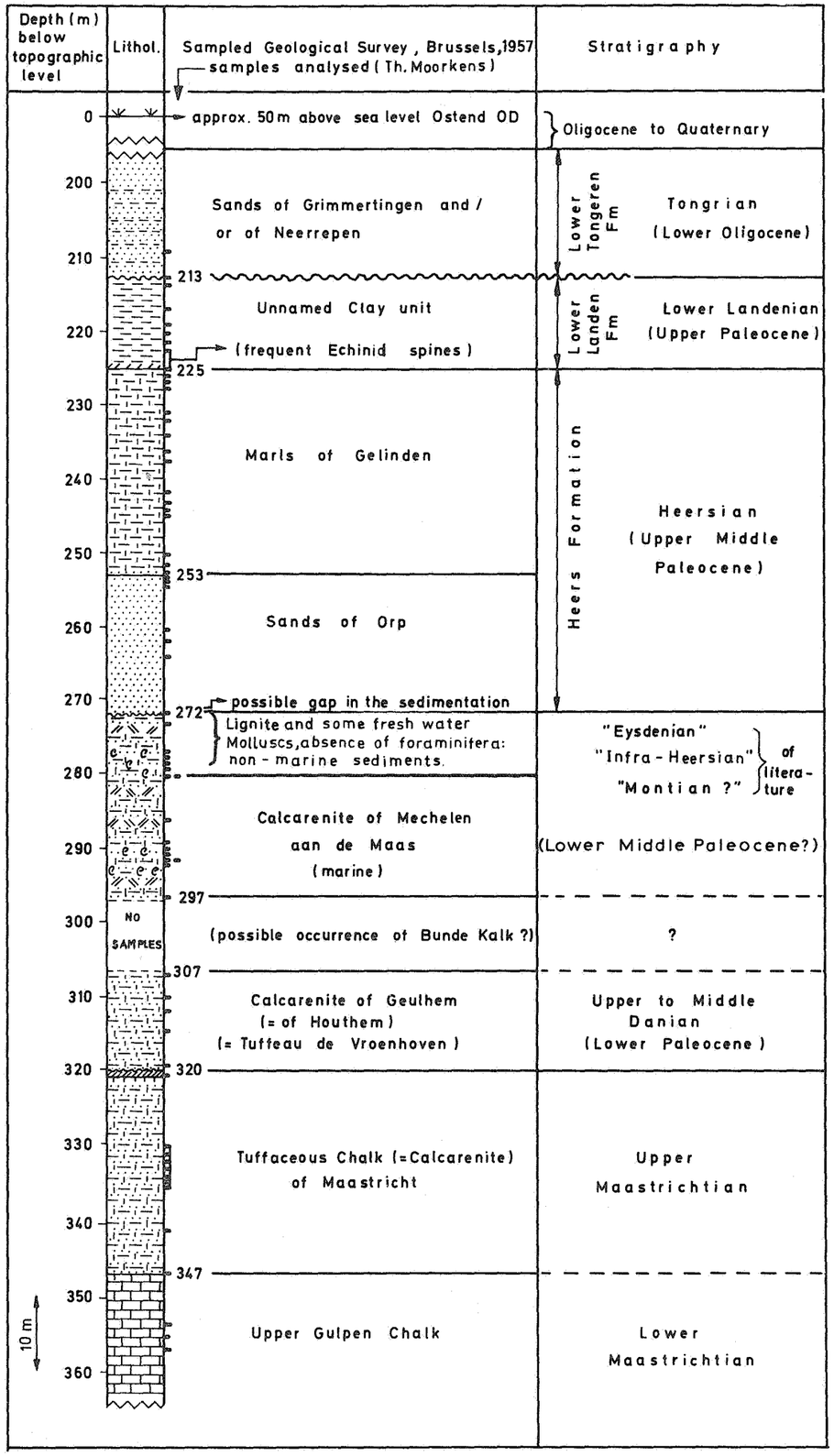


Fig. 12 - The Mechelen aan de Maas well (MM), 1957 Cored well
Lithologic description after M. GULINCK, unpublished
(Arch. Geol. Survey) (stratigraphy modified)

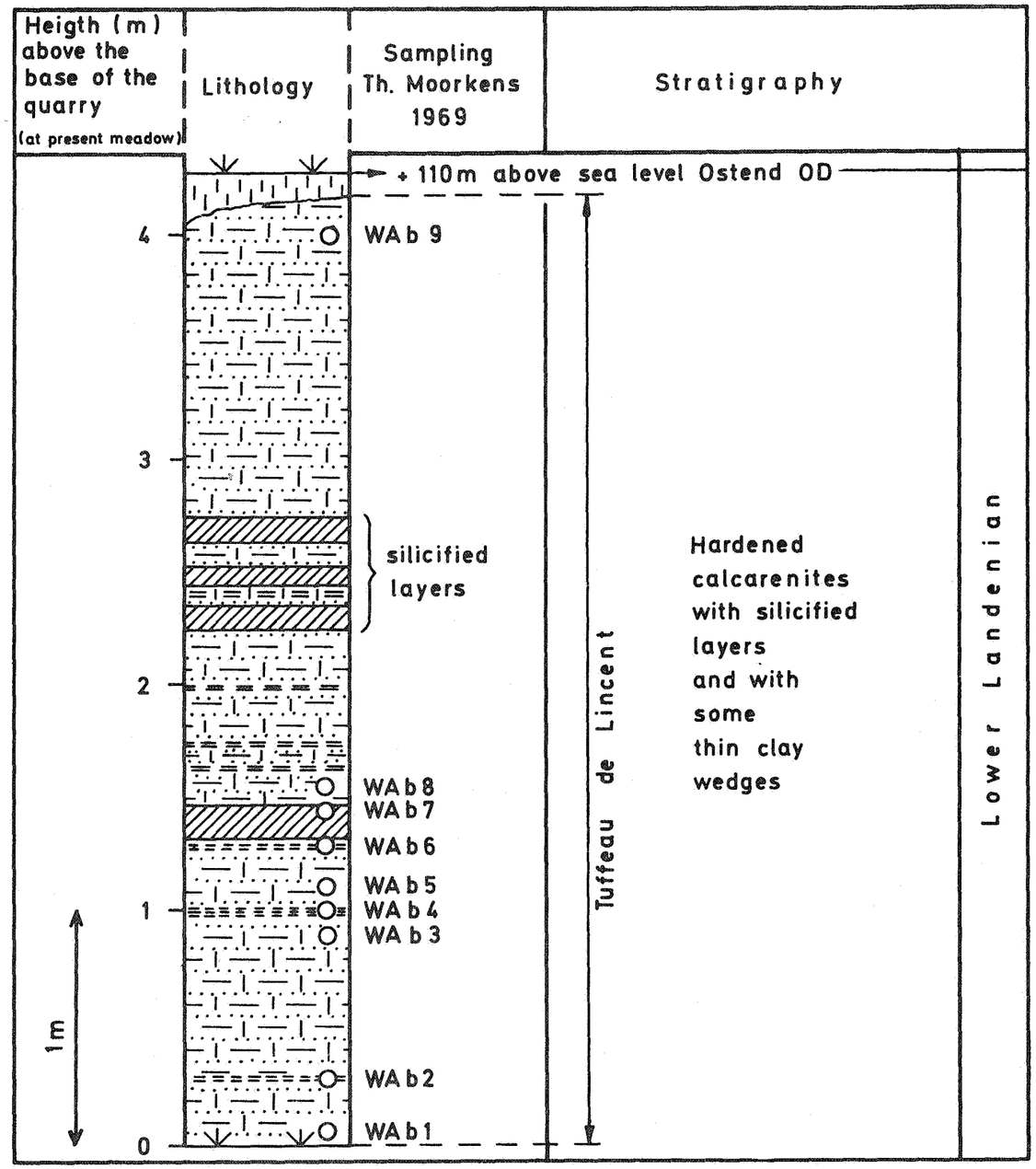
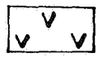
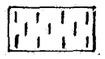


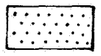
Fig. 13 - Wansin, Quarry of Wansin (WA). Suggested New Type Section of Tuffeau de Lincent and Neostratotype of the Lower Landenian Stage



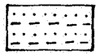
Rubble



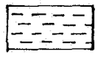
Loam



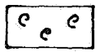
Sand



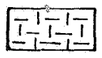
Clayey sand



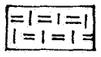
Clay



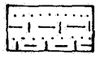
Molluscs



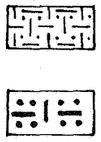
Marl



Clayey or marly intercalation
(clay wedge)

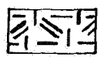


Calcarenite (fine grained)

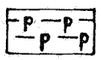


Calcarenite (coarse grained)

Calcarenite (glauconitic)



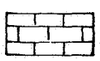
Lignitic calcarenite



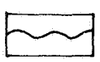
Phosphatic chalk or calcarenite

Flints - Flint beds

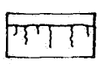
Silicified layer



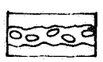
Limestone or chalk



Disconformity



Hardground



Conglomerate

Fig. 14 - Legend to lithology of the pictured sections.

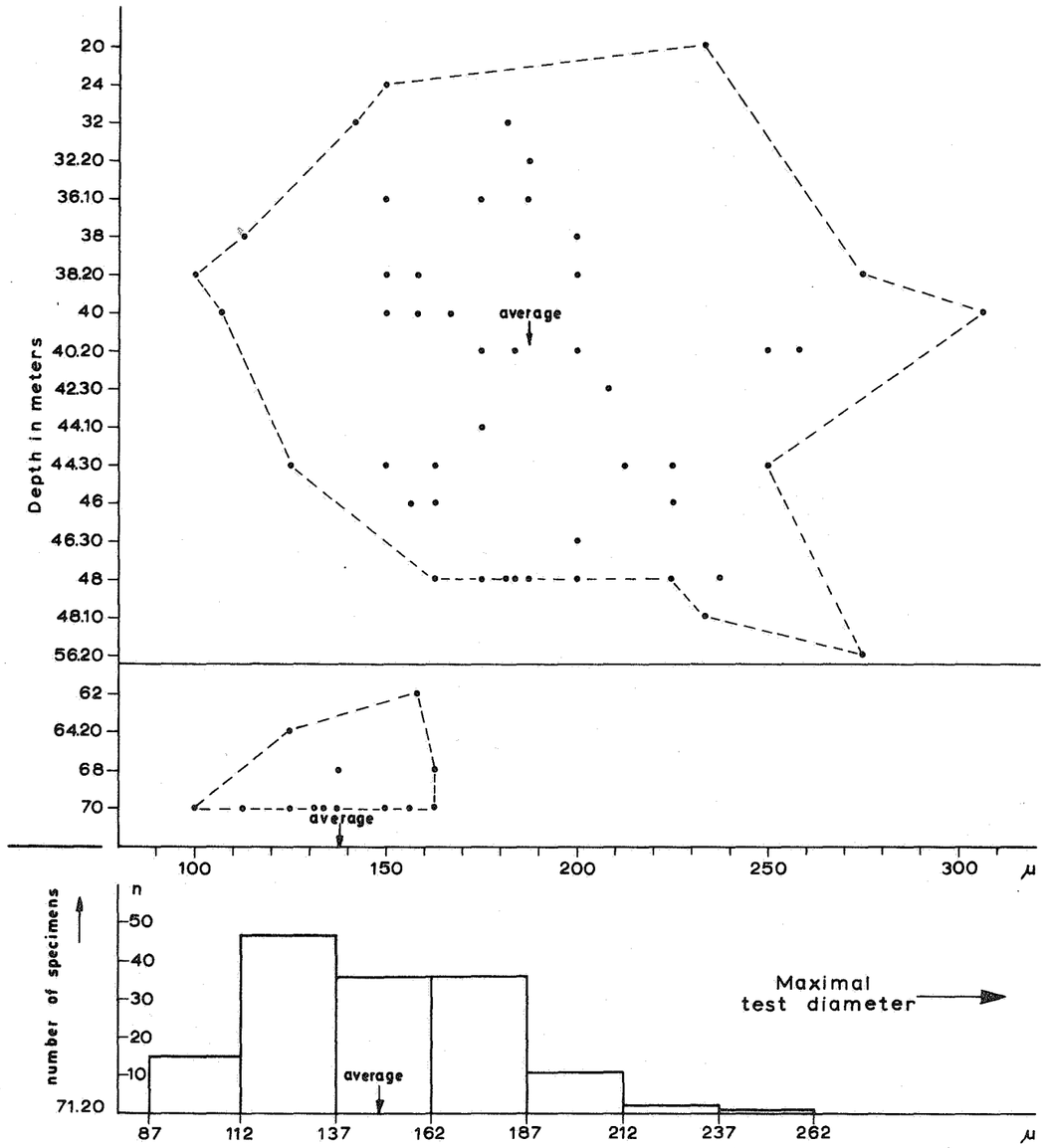


Fig.15 Measurements of tests of specimens of the Globigerina daubjergensis - kozlowskii lineage in the "Mons well, 1969„ at Obourg