

A FORAMINIFERAL FAUNA FOUND IN THE LOWER MEMBER OF THE DIEST FORMATION OF BORINGS OF THE ANTWERP KEMPEN (NE-BELGIUM).

P.G.H. LAGA & F.J.C. DE MEUTER

SUMMARY: A rich foraminiferal fauna was found in the fine facies of the Diest Formation in some borings in the Antwerp Kempen. The authors propose to introduce a distinct name for this fine facies, namely the *Dessel Sands Member*. Till now, only internal moulds and casts of shells have been mentioned from the Diest Formation. The found foraminiferal fauna is characterized by the planktonic dextrally coiled species *Globigerina pachyderma* and the benthonic species *Siphotextularia sculpturata*, *Uvigerina* sp., *Uvigerina* cf. *pygmaea*, *Elphidium antoninum*, *Heterolepa dutemplei praecincta* and "*Lagena*" *metzmacheri*. In the Neogene of Belgium the authors had found such a foraminiferal association only in the Deurne Sands. This discovery allows to correlate at least the Dessel Sands with the Deurne Sands and confirms the assumption of several authors that the Diest Formation constitute the eastern lateral continuation of the Deurne Sands. In the North Sea basin, the Deurne-Dessel fauna corresponds very well with that from the "Gram-Stufe" of NW Germany.

RÉSUMÉ: Dans quelques sondages de la Campine anversoise, les auteurs ont découvert une faune riche en foraminifères, confinée au faciès fin de la Formation de Diest, qu'ils proposent de dénommer: les *Sables de Dessel*. Jusqu'à présent, dans la Formation de Diest on n'avait mentionné que des moules internes et des empreintes de coquilles. Cette faune de foraminifères est caractérisée par l'espèce planctonique *Globigerina pachyderma*, forme dextre, et par les espèces benthiques *Siphotextularia sculpturata*, *Uvigerina* sp., *Uvigerina* cf. *pygmaea*, *Elphidium antoninum*, *Heterolepa dutemplei praecincta* and "*Lagena*" *metzmacheri*.

Dans le Néogène de la Belgique, on n'a trouvé une telle association que dans les Sables de Deurne. Cette découverte permet donc aux auteurs de corréler les Sables de Dessel et de Deurne, et confirme l'hypothèse de plusieurs autres à savoir que la Formation de Diest constitue, vers l'Est, la continuation latérale des Sables de Deurne. Dans le bassin de la Mer du Nord, les faunes des Sables de Deurne et de Dessel sont analogues à celles du "Gram-Stufe" du N-O de l'Allemagne.

I. Introduction

The Diest Sands, type of the "système Diestien" (DUMONT, 1839), consist of fairly coarse glauconiferous and ferruginous sands, mainly unfossiliferous, including layers of sandy ironstones. Their expansion is particularly important in the neighbourhood of the town of Diest (fig. 1). The "Lexique Stratigraphique International" mentions the fortifications of Diest as type-locality, but a type-section is not given (DE HEINZELIN & GLI-

BERT, 1957). Borings in the Kempen have demonstrated the considerable thickness of these Sands and have also revealed much finer, homogeneous and micaceous sands, named "facies fin", forming the lower part of this stratigraphic unit (GULINCK, 1963).

The ferruginous sands and sandstones of the hills of Flanders are traditionally attributed to the Diest Sands, but many authors have expressed their doubt on this subject. BONTE (1968) has shown that there is no valid argument for this correlation.

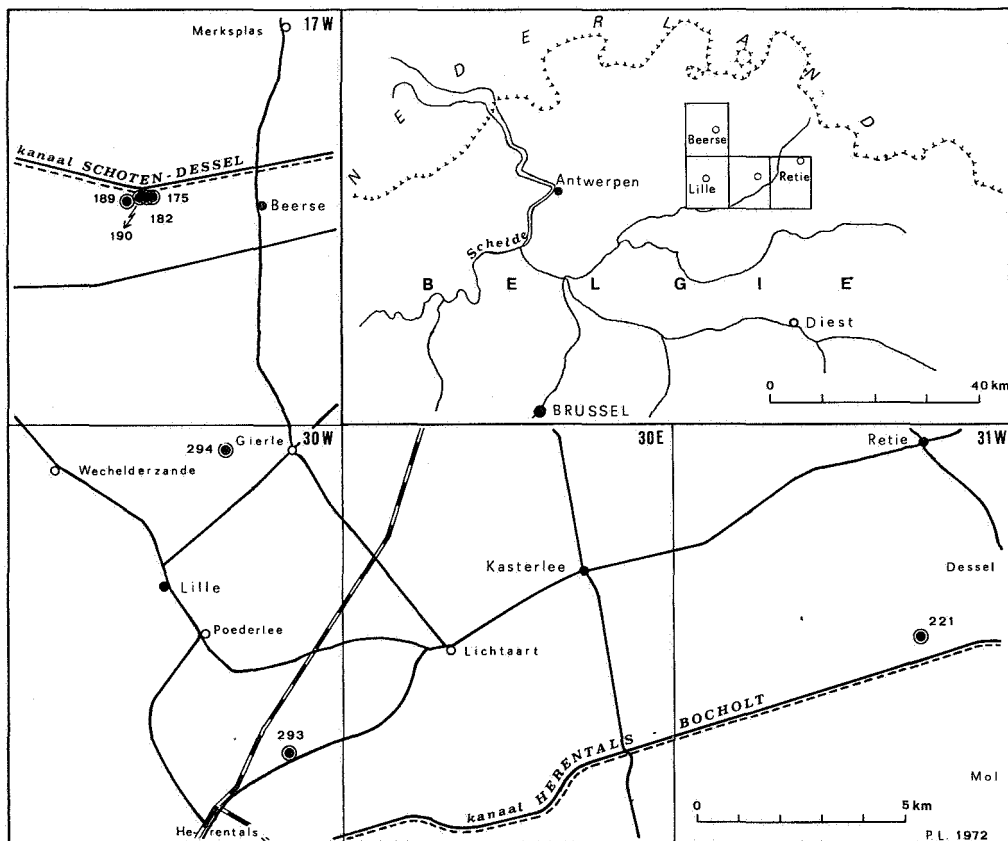


fig. 1

The thus far known fossil content of the Diest Sands was extremely poor and represented only by internal moulds (GLIBERT & DE HEINZELIN, 1955 — GLIBERT, 1963 — LAGA, 1972). One considered the microfauna as lacking.

These last years, several borings have been made in the Antwerp Kempen, reaching down to the fossiliferous Antwerpen Sands. Though they were not cored borings, different foraminiferal faunas have been distinguished in them, including a typical fauna from the lower part of the Diest Sands ("faciès fin").

II. Situation and description of the borings.

The base of the Diest Sands was reached in four borings at Beerse, near the factory of "Metallo-Chimique", situated along the canal Schoten-Dessel. Two other borings were made, one at Lichtaart and one at Lille (fig. 1).

Furthermore, the boring of Belchim — Mol, has been deepened and cored by the Geological Survey, and showed the same succession, according to the lithostratigraphical interpretation of GULINCK. Nevertheless VAN VOORTHUYSEN's interpretation of the stratigraphical succession, based on the foraminiferal association, is not in agreement with that of GULINCK (see GULINCK, GEETS & VAN VOORTHUYSEN, 1964). It will be reinterpreted in the biostratigraphical conclusions of this paper.

The lithological sequences in these borings are represented on fig. 2. A short description on the several lithological units is given below. A more detailed description, the geographical extension and the bibliographical data of these units is given in the papers read at the Symposium on the stratigraphy of the Northern Neogene, Gent 1961 (see TAVERNIER & DE HEINZELIN, 1963; GULINCK, 1963). The exact situation and the complete description

of these borings are kept in the Archives of the Geological Survey of Belgium, Brussels: sheet BEERSE 17 W nr 175, 182, 189, 190 (borings Beerse); sheet LILLE 30 W nr 293 (boring Lichtaart) — 294 (boring Lille); sheet RETIE 31 W nr 221 (boring Belchim).

The following lithological units are encountered successively in the mentioned borings:

CONTINENTAL deposits.

— The Kempen Clays and the Brasschaat Sands:

fine to medium coarse grayish sands with layers or lenses of brown and gray clay, sometimes lignitic or sideritic.

— The Mol Sands (only present in the boring Belchim — Mol):

white pure coarse sands with some lenses of a micaceous clay.

MARINE deposits.

— The Poederlee Sands: pale gray greenish fine slightly glauconiferous sands with many shell remains o.a. *Corbula gibba* and *Lyropecten opercularis*.

— The Kattendijk Sands (?): a thin layer of gray-green fine glauconitic sands.

The presumed correlation of this layer with a Formation of the Antwerpen region is only based on the lithological resemblance and on the stratigraphical position. The samples, obtained by a circulating drilling, do not allow a more exact determination.

— The Diest Sands: gray-green glauconitic sands, fairly coarse in the upper part (= "faciès grossier") and very fine and micaceous in the lower part (= "faciès fin"), apparently unfossiliferous. Only in the lower metres of one boring at Beerse (17 W nr 175), some macrofossils have been found: a piece of an *Ostrea*, and two valves of *Terebratula maxima* (?).

— The Antwerpen Sands: dark blackish fairly fine very glauconitic sands, with a few fine shell remains.

III. *The fine facies of the Diest Sands*

1. GULINCK (1963) has called attention to this particular facies of the Diest Sands, that had up till then never been distinguished from the coarse facies above. He considers it as the lateral continuation of the Deurne Sands, as shown in his West-East section from Antwerpen to Mol, since it occurs in several borings in this area. Till now, this facies seemed also to be unfossiliferous. Being lithologically fairly different from the Diest Sands in the type locality, it is considered as a separate lithostratigraphic unit. It is distinguished by the smaller and more homogeneous grain size and by the content of mica (see GULINCK et al., 1964). However, the absence of a clear boundary between the two facies tends to the conclusion that this separate unit belongs to the Diest Formation. Therefore, we designate this unit as a new Member, within the Diest Formation. We propose to call this Member the *Dessel Sands Member*. This Member has firstly been observed in the cored boring of Belchim — Mol, at Dessel, a locality north of Mol (see map fig. 1). The extension and thickness is clearly demonstrated by GULINCK (1963) and GULINCK et al. (1964).

2. The discovery of the mentioned macrofossils (boring 17 W nr 175) has revealed at the same time a very rich foraminiferal fauna, including many planktonic forms. After a detailed investigation of a number of borings, the same foraminiferal fauna was found in the lowermost metres of the Diest Formation in borings 17 W nr 189 & 190 and 30 W nr 294. These samples seemed macroscopically unfossiliferous. Also the sample 147 m of the boring Belchim - Mol (31 W nr 221) contains a similar foraminiferal fauna, but poorer. This fauna had already been found by VAN VOORTHUYSEN (GULINCK et al., 1964).

IV. *The foraminiferal faunas*

The sediments have been washed on a 74 μ screen, and the Foraminifera were obtained from the residu by the use of carbon

tetrachloride. The following three associations could be distinguished:

1. The *Poederlee Sands* yielded a very rich foraminiferal fauna. We could determine the including species thanks to our former investigations carried out on the "Plio-Pleistocene" deposits of the Antwerp Harbour Region, the results of which will be published in the near future, and with help of the publications of VAN VOORTHUYSEN (1958) and VAN VOORTHUYSEN & TOERING (1969). The association is characterized by the abundant occurrence of the benthonic species *Elphidiella hannaï* (CUSHMAN & GRANT, 1927), *Cibicides lobatulus* (WALKER & JACOB, 1798), *Cribronion excavatum* (TERQUEM, 1875) and *Cribronion haagensis* (VAN VOORTHUYSEN, 1950). The planktonic fauna is mainly represented by the scarce sinistrally coiled forms of *Globigerina pachyderma* (EHRENBERG, 1861), which occur also in the Belgian "Plio-Pleistocene" deposits, according to DE MEUTER & LAGA (1970). This association can also be compared with that from the Kallo and Merksem Sands (traditionally called the "Upper Scaldisian" and "Merksemian") of the Antwerpen area.

2. A second association is found in the lowermost metres of the borings and is sufficiently known by the publications of BATJES (1958) and VAN VOORTHUYSEN & TOERING (1969). *Asterigerina guerichi staeschei* (TEN DAM & REINHOLD, 1941) is very abundant. Among the other common benthonic species *Elphidium inflatum* (REUSS, 1861) and *Uvigerina tenuipustulata* VAN VOORTHUYSEN, 1950 are typical for the *Antwerpen Sands* in the type section at Antwerpen. Many distinguishable species of planktonic Foraminifera are represented. A preliminary examination of these forms by our colleague H. HOOYBERGHS reveals also an assemblage comparable with that of the Antwerpen Sands (see HOOYBERGHS & DE MEUTER, 1972).

3. The most important and the hitherto in Belgium nearly unknown foraminiferal association has been observed in the lowermost metres of the *Dessel Sands*. The fauna is rich in planktonic and benthonic foraminifera. This

has enabled us not only to draw up a list of the encountered species but also to give a quantitative idea of the components of the association, allowing some paleo-ecological conclusions.

a) 72 distinguishable forms could be listed (table 1). It is a very characteristic fauna with many species restricted to the traditional "Upper Miocene" deposits of the North Sea basin. We based our determinations mainly on the studies of LANGER (1963 a, b & 1969) and CLODIUS (1922) who have investigated the German "Miocene" deposits. We can mention following typical benthonic species: *Siphotextularia sculpturata* (CUSHMAN & TEN DAM, 1947), *Uvigerina* sp. LANGER, 1969, *Uvigerina* cf. *pygmaea* D'ORBIGNY, 1826, *Elphidium antoninum* (D'ORBIGNY, 1846), *Heterolepa dutemplei praecincta* (KARRER, 1868) and the very problematic Foraminifer "*Lagena*" *metzmacheri* CLODIUS, 1922, according to the determination by LANGER (1969). Further, the more than abundant occurrence of the dextrally coiled planktonic species *Globigerina pachyderma* (EHRENBERG, 1861) corresponds with the findings of DE MEUTER & LAGA (1970) in the *Deurne Sands* in the Antwerpen area.

The numerical data of the features (table 2), here investigated, are comparable with their results. Also the benthonic species from the *Deurne Sands* (still unpublished) and those from the here studied borings in the *Kempen* are the same. We can conclude that there is a close biostratigraphical relationship between the associations from the *Deurne Sands* and from the *Dessel Sands* (the fine facies of the *Diest Formation*).

The here studied association from the *Dessel Sands* has already been mentioned by VAN VOORTHUYSEN (see GULINCK, GEETS & VAN VOORTHUYSEN, 1964, p. 290) from the boring *Belchim* (depth 147 m). VAN VOORTHUYSEN considered this association as belonging to the "Anversian". However, reexamination of the same samples reveals a fauna corresponding with the here studied microfossils from the fine facies of the *Diest Sands*. His attribution of these beds to

the "Anversian" can be explained by the fact that VAN VOORTHUYSEN's "*Uvigerina acuminata*" is very probably an *Uvigerina* sp. LANGER, 1969. The former is considered as characteristic of the "Middle Miocene" of the North Sea basin whilst the latter seems to be restricted to the "Upper Miocene". The other mentioned forms also fit exactly in our extensive list. Thus the "Anversian" fauna of the boring Belchim is in fact typical for the Dessel — Deurne Sands. After a first investigation, the as "Houthalenian" considered section (152-167 m depth) of the boring Belchim contains a fauna more comparable with that of the Antwerpen Sands.

A comparison with the publications of LANGER (1963 a, b & 1969) dealing with the "Upper Miocene" of NW Germany, indicates a biostratigraphical correlation with the faunas of the "Gram Stufe" (table 1). The species, noted above as typical for the Deurne — Dessel Sands in the Belgian Neogene, occur together also in the "Gram Stufe" and are nearly all restricted to these beds.

Some typical species correspond also with the faunas of the "Upper Miocene" beds studied by TEN DAM & REINHOLD (1942) from the borings of the Peel region in the Netherlands. *Elphidium antoninum* (D'ORBIGNY, 1846) seems to be restricted to these beds.

b) The quantitative distribution (table 3) is based on countings of 100 benthonic individuals made on strewn flotation residues. The planktonic forms are recorded out of this sum and they amount to 50 to 150 individuals.

The foraminiferal fauna from the Dessel Sands is characterized by the frequent (> 10/100) species *Bulimina aculeata*, *Uvigerina* sp.,

Uvigerina cf. *pygmaea*, *Trifarina angulosa*, *Cassidulina* spp. and *Globocassidulina* spp. In general this association indicates an open marine stenohyaline environment with low energy on pelitic fine sediments. The high frequencies of planktonic individuals agree with the full marine conditions. Also the glauconite, being very probably authigenic, must have been formed in a similar environment with little sedimentary influx.

The most important difference between this association and that from the underlying Antwerpen Sands consists of the abundant occurrence of *Asterigerina guerichi staeschei* in the latter. Moreover, the genus *Uvigerina* and the species *Cassidulina laevigata* are less common. *Asterigerina guerichi staeschei* prefers mainly sandy deposits which is in accordance with the reduced number of the named species and with the sandy sediment.

Although the environment of the two formations seems not to be very different, this boundary is stratigraphically very important as has been demonstrated by the study of the planktonic forms by HOOYBERGHS & DE MEUTER (1972). The lowerlying Antwerpen Formation belongs to the Middle Miocene and the Diest Formation, probably to the Upper Miocene.

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Table 1

| The Foraminifera from the Dessel Sands of some borings in the Antwerp Kempen and their presence in the Deurne Sands and the "Gram-Stufe". | Deurne Sands (own determinations) | "Gram-Stufe" LANGER, 1963a, b & 1969 |
|---|-----------------------------------|--------------------------------------|
| 1. <i>Spiroplectammina deperdita</i> (D'ORBIGNY, 1846) | | |
| 2. <i>Spir. plectammina pectinata</i> (REUSS, 1850) | + | |
| 3. <i>Textularia abbreviata</i> D'ORBIGNY, 1846 | | + |
| 4. <i>Bigenerina nodosaria</i> D'ORBIGNY, 1826 | + | |
| 5. <i>Siphotextularia sculpturata</i> (CUSHMAN & TEN DAM, 1947) | + | + |
| 6. <i>Martinottiella communis</i> (D'ORBIGNY, 1846) | + | + |
| 7. <i>Quinqueloculina</i> n. sp. A. LANGER, 1969 | | + |
| 8. <i>Sigmoilina tenuis</i> (CZJEK, 1848) | | |
| 9. <i>Sigmoilopsis</i> cf. <i>schlumbergeri</i> (SILVESTRI, 1904) | | |
| 10. <i>Nodosaria longiscata</i> D'ORBIGNY, 1846 | | |
| 11. <i>Nodosaria pyrula</i> D'ORBIGNY, 1826 | + | |
| 12. <i>Nodosaria longicauda</i> D'ORBIGNY, 1826 | + | |
| 13. <i>Nodosaria hirsuta</i> D'ORBIGNY, 1826 | + | |
| 14. <i>Dentalina inornata</i> D'ORBIGNY, 1846 | | |
| 15. <i>Lagena elongata</i> (EHRENBERG, 1844) | + | |
| 16. <i>Lagena hexagona</i> (WILLIAMSON, 1848) | + | |
| 17. <i>Lagena pulchra</i> CLODIUS, 1922 | + | + |
| 18. <i>Lagena hispida</i> REUSS, 1863 | + | |
| 19. <i>Lagena striata</i> (D'ORBIGNY, 1839) | + | |
| 20. <i>Lagena tenuis</i> (BORNEMANN, 1855) | + | |
| 21. <i>Lenticulina crassa</i> (D'ORBIGNY, 1846) | | |
| 22. <i>Lenticulina inornata</i> (D'ORBIGNY, 1846) | + | |
| 23. <i>Lenticulina gibba</i> (D'ORBIGNY, 1826) | + | |
| 24. <i>Marginulina dingdeni</i> TEN DAM & REINHOLD, 1942 | | |
| 25. <i>Marginulinopsis ackneriana</i> (NEUGEBOREN, 1851) | | + |
| 26. <i>Marginulinopsis sylvensis</i> (CLODIUS, 1922) | | + |
| 27. <i>Globulina gibba</i> D'ORBIGNY, 1826 | + | |
| 28. <i>Globulina myristiformis</i> (WILLIAMSON, 1858) | + | |
| 29. <i>Guttulina problema</i> (D'ORBIGNY, 1826) | + | |
| 30. <i>Glandulina laevigata</i> D'ORBIGNY, 1826) | + | + |
| 31. <i>Oolina lineata</i> (WILLIAMSON, 1858) | | |
| 32. <i>Fissurina laevigata</i> REUSS, 1850 | + | |
| 33. <i>Fissurina orbignyana</i> SEGUENZA, 1862 | + | |
| 34. <i>Sphaeroidina bulloides</i> D'ORBIGNY, 1826 | + | |
| 35. <i>Bolivina imporcata</i> CUSHMAN & RENZ, 1944 | | + |
| 36. <i>Bolivina dilatata</i> REUSS, 1850 | | |
| 37. <i>Bolivina</i> cf. <i>fastigia</i> CUSHMAN, 1936 | | |
| 38. <i>Bulimina aculeata</i> D'ORBIGNY, 1826 | + | + |
| 39. <i>Uvigerina</i> sp. LANGER, 1969 | + | + |
| 40. <i>Uvigerina</i> cf. <i>pygmaea</i> D'ORBIGNY, 1826 | + | + |
| 41. <i>Trifarina angulosa</i> (REUSS, 1863) | + | |
| 42. <i>Trifarina bradyi</i> CUSHMAN, 1923 | + | |
| 43. <i>Epistominella oveyi</i> BHATIA, 1959 | | |
| 44. <i>Rosalina globularis</i> D'ORBIGNY, 1826 | + | |

| The Foraminifera from the Dessel Sands of some borings in the Antwerp Kempen and their presence in the Deurne Sands and the "Gram-Stufe". | Deurne Sands (own determinations) | "Gram-Stufe" LANGER, 1963a, b & 1969 |
|---|-----------------------------------|--------------------------------------|
| 45. <i>Discorbis mira</i> CUSHMAN, 1922 | | |
| 46. <i>Cancris auriculus</i> (FICHTEL & MOLL, 1803) | + | |
| 47. <i>Pararotalia ? nana</i> (REUSS, 1850) | | + |
| 48. <i>Elphidium antoninum</i> (D'ORBIGNY, 1846) | + | + |
| 49. <i>Protelphidium granosum</i> (D'ORBIGNY, 1846) | + | |
| 50. <i>Globigerina pachyderma</i> (EHRENBERG, 1861) | + | ? |
| 51. <i>Cibicides lobatulus</i> (WALKER & JACOB, 1798) | + | |
| 52. <i>Cibicides</i> cf. <i>scaldisiensis</i> TEN DAM & REINHOLD, 1941 | | |
| 53. <i>Planorbulina mediterraneensis</i> D'ORBIGNY, 1826 | + | |
| 54. <i>Cassidulina laevigata</i> D'ORBIGNY, 1826 | + | + |
| 55. <i>Cassidulina</i> cf. <i>punctata</i> REUSS, 1850 | + | |
| 56. <i>Globocassidulina crassa</i> (D'ORBIGNY, 1839) | + | |
| 57. <i>Globocassidulina subglobosa</i> (BRADY, 1884) | + | |
| 58. <i>Ehrenbergina healyi</i> FINLAY, 1947 | + | + |
| 59. <i>Astrononion perfossum</i> (CLODIUS, 1922) | + | + |
| 60. <i>Florilus boueanus janiformis</i> (JONES, 1897) | + | + |
| 61. <i>Nonionella adolfinae</i> (CLODIUS, 1922) | + | + |
| 62. <i>Nonionella aequalis</i> (CLODIUS, 1922) | + | + |
| 63. <i>Nonionella lobsannensis</i> (ANDREAE, 1884) | + | + |
| 64. <i>Pullenia bullcides</i> (D'ORBIGNY, 1826) | | |
| 65. <i>Pullenia quinqueloba</i> (REUSS, 1851) | + | |
| 66. <i>Oridorsalis umbonatus</i> (REUSS, 1851) | + | |
| 67. <i>Gyroidina</i> cf. <i>parva</i> (CUSHMAN & RENZ, 1941) | | |
| 68. <i>Anomalina reinholdi</i> CUSHMAN & TEN DAM, 1947 | | |
| 69. <i>Hanzawaia boueana</i> (D'ORBIGNY, 1846) | + | |
| 70. <i>Heterolepa pseudoungeriana</i> (CUSHMAN, 1922) | + | |
| 71. <i>Heterolepa dutemplei praecincta</i> (KARRER, 1868) | + | + |
| 72. <i>Melonis affinis</i> (REUSS, 1851) | | + |
| 73. " <i>Lagena</i> " <i>metzmacheri</i> CLODIUS, 1922 | + | + |

Table 2 Variations of *G. pachyderma* from the Dessel Sands. Countings on 100 specimens.

| 17 W 175 | D | S | NL | RL | 4 | 4½-5 |
|-----------|----|---|----|----|----|------|
| 136-137 m | 91 | 9 | 23 | 77 | 66 | 34 |
| 138-139 m | 94 | 6 | 19 | 81 | 65 | 35 |
| 140-141 m | 95 | 5 | 22 | 78 | 54 | 46 |

D: dextrally coiled forms
 S: sinistrally coiled forms
 RL: reduced last chamber
 NL; normal last chamber

4 : chambers in the last whorl
 4½-5: chambers in the last whorl

Table 3 Quantitative distribution of the benthonic foraminifera in the Dessel and Antwerpen Sands, Countings on 100 benthonic specimens.

| FORMATION — Member | ANTWERPEN SANDS | | | DIEST SANDS Dessel Sands | | | | | | |
|--|-----------------|-----------|---------|-----------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| | 30 W | 30 W | 30 W | 30 W | 17 W | 17 W | 17 W | 17 W | 17 W | 31 W |
| Sheet | | | | | | | | | | |
| N° Boring | 293 | 293 | 293 | 294 | 190 | 189 | 175 | 175 | 175 | 221 |
| depth in m | 101 - 102 | 101 - 101 | 94 - 95 | 101 - 102 | 136 - 137 | 138 - 139 | 140 - 141 | 138 - 139 | 136 - 137 | 146 - 148 |
| 1. <i>Spiroplectammina pectinata</i> | | | | | | | | 1 | | |
| 2. <i>Bigenerina nodosaria</i> | | | | | | | | 2 | 2 | |
| 3. <i>Siphotextularia sculpturata</i> | | | | 6 | | | | 1 | 1 | |
| 4. <i>Sigmoilopsis cf. schlumbergeri</i> | | | | | | | | | 1 | |
| 5. <i>Nodosaria</i> sp. | | | | | 1 | | | | | |
| 6. <i>Dentalina</i> sp. | | | 1 | | | | | | | |
| 7. <i>Lagena elongata</i> | | 1 | | | | | | | | |
| 8. <i>Lagena hexagona</i> | | | | | 1 | | | | | |
| 9. <i>Lenticulina</i> sp. | | | 1 | | | | | | | |
| 10. <i>Guttulina problema</i> | | 1 | | | | | | | | |
| 11. <i>Fissurina</i> sp. | | 1 | | | 2 | 1 | | | | |
| 12. <i>Sphaeroidina bulloides</i> | | | | | | 1 | | 1 | | |
| 13. <i>Bolivina imporcata</i> | 4 | 4 | 3 | | 1 | 1 | | 2 | 4 | 2 |
| 14. <i>Bolivina dilatata</i> | | 1 | | | | | | | | |
| 15. <i>Bulimina aculeata</i> | | | | 3 | 14 | 12 | 25 | 16 | 17 | 10 |
| 16. <i>Bulimina elongata</i> | 18 | 9 | 8 | | | | | | | |
| 17. <i>Bulimina dingdenensis</i> | | | 2 | | | | | | | |
| 18. <i>Uvigerina</i> sp. LANGER, 1969 | | | | 11 | 2 | 9 | 17 | 10 | 10 | 10 |
| 19. <i>Uvigerina cf. pygmaea</i> | | | | 11 | 14 | 10 | 8 | 11 | 1 | 15 |
| 20. <i>Uvigerina tenuipustulata</i> | | 3 | 5 | | | | | | | |
| 21. <i>Trifarina angulosa</i> | 5 | 4 | 3 | 15 | 6 | 21 | 14 | 12 | 13 | 10 |
| 22. <i>Trifarina bradyi</i> | | 1 | 1 | | 1 | 1 | | 2 | 1 | |
| 23. <i>Epistominella oveyi</i> | 1 | 1 | 1 | | 4 | 2 | | 3 | 1 | 4 |
| 24. <i>Cancris auriculus</i> | 1 | | | | | | | | | |
| 25. <i>Pararotalia ? nana</i> | | | | | | | | | 1 | 1 |
| 26. <i>Asterigerina guerichi staeschei</i> | 37 | 25 | 35 | | | | | | | |
| 27. <i>Elphidium antoninum</i> | | | | | | | | 1 | | |
| 28. <i>Elphidium inflatum</i> | 3 | 7 | 3 | | | | | | | |
| 29. <i>Cribronion hiltermanni</i> | 1 | 2 | 1 | | | | | | | |
| 30. <i>Protelphidium granosum</i> | | 2 | 3 | | | | | | | |
| 31. <i>Globigerina pachyderma</i> | | | | A | A | A | A | A | A | A |
| 32. Other planktonic forms | 19 | 12 | 10 | | | | | | | |
| 33. <i>Cibicides lobatulus</i> | 5 | 1 | 5 | 4 | 9 | 5 | 2 | 4 | 2 | 7 |

| FORMATION — Member | ANTWERPEN SANDS | | | DIEST SANDS | | | | | | | |
|---|-----------------|-----------|---------|--------------|-----------|-----------|-----------|-----------|-----------|-----------|------|
| | | | | Dessel Sands | | | | | | | |
| Sheet | 30 W | 30 W | 30 W | 30 W | 17 W | 17 W | 17 W | 17 W | 17 W | 17 W | 31 W |
| N° Boring | 293 | 293 | 293 | 294 | 190 | 189 | 175 | 175 | 175 | 175 | 221 |
| depth in m | 101 - 102 | 100 - 101 | 94 - 95 | 101 - 102 | 136 - 137 | 138 - 139 | 140 - 141 | 138 - 139 | 136 - 137 | 146 - 148 | |
| 34. <i>Cibicides</i> cf. <i>scaldisiensis</i> | | | | 1 | 4 | | 3 | 2 | 3 | | |
| 35. <i>Virgulina pertusa</i> | 1 | 1 | | | | | | | | | |
| 36. <i>Cassidulina</i> spp. | | | | 14 | 16 | 19 | 12 | 8 | 13 | 9 | |
| 37. <i>Globocassidulina</i> spp. | 15 | 15 | 9 | 14 | 15 | 13 | 8 | 12 | 19 | 23 | |
| 38. <i>Ehrenbergina healyi</i> | 1 | | 1 | 3 | 2 | 2 | 2 | | 1 | | |
| 39. <i>Astronionion perfossum</i> | | 2 | | | | | | | | | |
| 40. <i>Florilus boueanus dingdeni</i> | 4 | 3 | 6 | | | | | | | | |
| 41. <i>Nonionella</i> sp. | | | | | 1 | 1 | | | | | |
| 42. <i>Pullenia quinqueloba</i> | | | | | | | 1 | | | | |
| 43. <i>Pullenia bulloides</i> | | | | 4 | 1 | | 2 | 1 | 2 | 2 | |
| 44. <i>Oridorsalis umbonatus</i> | | | | 1 | | | | | | | |
| 45. <i>Gyroidina</i> cf. <i>parva</i> | | | | 1 | | 1 | | | 1 | 1 | |
| 46. <i>Hanzawaia boueana</i> | 4 | 7 | 2 | | 1 | | 1 | 3 | 3 | | |
| 47. <i>Heterolepa pseudoungeriana</i> | 3 | 6 | 5 | 5 | 3 | | 4 | 4 | 1 | 2 | |
| 48. <i>Heterolepa dutemplei peelensis</i> | | | 1 | | | | | | | | |
| 49. <i>Heterolepa dutemplei praecincta</i> | | | | | | | | 1 | | | |
| 50. <i>Melonis affinis</i> | | 2 | 3 | | | | | 1 | 2 | 1 | |
| 51. <i>Melonis pompilioides</i> | | 1 | 1 | | | | | | | | |
| 52. broken specimens | 7 | | | 6 | | | | | | | 3 |

nota: "*Lagena*" *metzmacheri* specimens were not counted in the quantitative distribution.

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