

# NEW PALAEOEOCOLOGICAL STUDIES IN BENTHONIC FORAMINIFERA FROM THE BRUSSELS SANDS FORMATION (LUTETIAN, MIDDLE EOCENE) IN BELGIUM

by *H.J.F. HOOYBERGHS*<sup>1</sup>

## ABSTRACT

The palaeoecology of the benthonic foraminifera from the Brussels Sands Formation (Middle Eocene) is studied in two outcrops : at St.-Stevens-Woluwe and at Neerijse. Using different palaeoecological factors, we can conclude that no distinct differences are observed between the palaeoecological environment of deposition of the Brussels Sands in the two localities. Although some small fluctuations of the sea level occur, the accumulation took place in a nearshore shelf area.

## RESUME

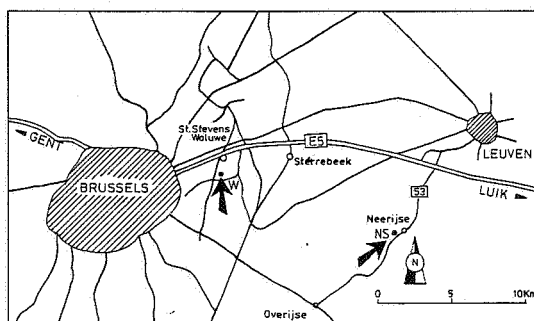
Cette contribution concerne la paléocéologie des foraminifères benthiques de la Formation de Bruxelles (Eocène moyen) en deux localités : St.-Steven-Woluwe et Neerijse. En utilisant plusieurs facteurs paléocéologiques, nous pouvons conclure qu'il n'existe pas une différence remarquable dans le milieu de déposition des Sables de Bruxelles dans les deux endroits. Quoiqu'il y ait des fluctuations de la mer, les caractères indiquent un milieu sublittoral.

## KEY WORDS

Benthonic foraminifera, palaeoecology, nearshore environment.

## MOTS CLES

Foraminifères benthiques, paléocéologie, milieu sublittoral.



*Figure 1* : Location map of the outcrop of the Brussels Formation at St.-Stevens-Woluwe (W), Lambert Grid coordinates X = 155.90 km ; Y = 171.55 km and at Neerijse (NS), X = 167.45 km ; Y = 167.15 km.

## 1. INTRODUCTION

Within the framework of the study of benthonic foraminifera from the Brussels Sands Formation (Lutetian, Middle Eocene), two supplementary outcrops have been sampled : at St.-Stevens-Woluwe and at Neerijse.

More information about the palaeoecology of the benthonic foraminifera from the Brussels Sands was required for a detailed sedimentological study of this deposit, worked out by Dr. R. Houthuys (1990), who called our attention to the two outcrops presented here.

The samples with calcareous microfossils were washed on a 0.074 mm sieve. In each dried residue, countings of up to 100 individuals were

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made. For a detailed systematic description of the taxa, we refer to Kaasschieter (1961).

## 2. LITHOLOGICAL DESCRIPTION OF THE SECTIONS

(Location map in fig. 1).

### 2.1. Description of the sections at St.-Stevens-Woluwe (log in fig. 2).

The Brussels Sands Formation at St.-Stevens-Woluwe contains fine greenish-yellow to gray sands. At different levels in the lower part of the section, thin sandstone concretions, more or less continuous, are developed. Rare individuals of *Ostrea* have been found near the base of the outcrop. The presence of small spots with white marls and also of gray to brown coloured spots, explained by bioturbation, attract attention. Just below level 9, we observe an erosion surface followed by gray sands with bioturbations and, above this, cross lamination. The presence of the erosion surface is explained by an important storm period. Also the top of the calcareous sands shows cross-beds. The upper part of the outcrop is completely decalcified. It contains an alteration of fine gray and yellow homogeneous sands without sandstone concretions.

We can situate this outcrop in the upper part of the Brussels Formation with fine sands developed in the centre of the Basin.

### 2.2. Description of the section at Neerijse (Log in fig. 3)

The Brussels Sands Formation at Neerijse contains fine yellow and gray sands. The upper part of the section with brown sands above sample NS 15 is completely decalcified. Sandstone concretions occur at different levels in the calcariferous part of the outcrop, besides more continuous sandstone beds. Also in this profile, we observed several small spots of white marls, probably traces of bioturbation. We can situate this part of the

Brussels Sands in the upper part of the formation, slightly higher than the section at St.-Stevens-Woluwe (personal communication R. Houthuys).

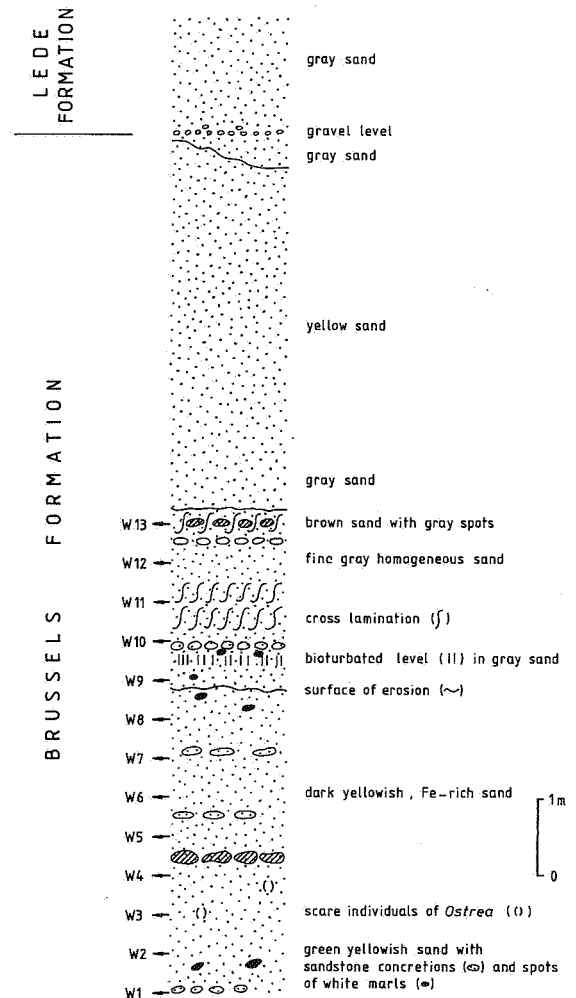


Figure 2 : Lithology of the Brussels Formation at St.-Stevens-Woluwe (W).



BRUSSELS FORMATION															SAMPLES	
NS1	NS2	NS3	NS4	NS5	NS6	NS7	NS8	NS9	NS10	NS11	NS12	NS13	NS14	NS15	TAXA	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Spiroplectammia carinata</i> (D'ORBIGNY, 1846)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Textularia agglutinans</i> D'ORBIGNY, 1839
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Karrerella siphonella</i> (REUSS, 1851)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Lenticulina</i> spp.
.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	<i>Dentalina inornata</i> D'ORBIGNY, 1846
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Nodosaria ludwigi</i> REUSS, 1866
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Lagena globosa</i> (MONTAGU, 1803)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Lagena hexagona</i> (WILLIAMSON, 1848)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Lagena isabella</i> (D'ORBIGNY, 1839)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Lagena striata</i> (D'ORBIGNY, 1839)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Entosolenia orbignyana</i> (SEGUENZA, 1862)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Guttulina irregularis</i> (D'ORBIGNY, 1846)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Guttulina lactea</i> (WALKER & JACOB, 1798)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Guttulina pulchella</i> D'ORBIGNY, 1839
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Globulina gibba</i> (D'ORBIGNY, 1846)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Globulina grava</i> (TERQUEM, 1878)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Pyrulina thouini</i> (D'ORBIGNY, 1865)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Bulimina parisiensis</i> KAASSCHIETER, 1961
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Reussella elongata</i> (TERQUEM, 1882)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Bolivina anglica</i> CUSHMAN, 1936
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Bolivina brabantia</i> KAASSCHIETER, 1961
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Bolivina carinata</i> TERQUEM, 1882
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Bolivina crenulata</i> CUSHMAN, 1936
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Trifarina muralis</i> (TERQUEM, 1882)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Trifarina wilcoxensis</i> (CUSHMAN & PONTON, 1932)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Nonion affinis</i> (REUSS, 1851)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Nonionella spissa</i> CUSHMAN, 1931
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Discorbis parisiensis</i> (D'ORBIGNY, 1865)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Eponides toulmini</i> BROTZEN, 1948
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Gyroidinoides octocameratus</i> (CUSHMAN & HANNA, 1927)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Cancris subconicus</i> (TERQUEM, 1882)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Cibicides proprius</i> BROTZEN, 1948
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Cibicides acutimargus</i> TEN DAM, 1944
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Cibicides lobatulus</i> WALKER & JACOB, 1798
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Cibicides</i> sp.cf. <i>C.tallahatensis</i> BANDY, 1949
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Cibicides</i> sp.cf. <i>C.tenellus</i> REUSS, 1865
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Cibicides westi</i> HOWE, 1939
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Cibicides mauricensis</i> HOWE & ROBERTS, 1939
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Hanzawaia boueana</i> (D'ORBIGNY, 1846)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Alabamina walterstorffi</i> (FRANKE, 1925)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Siphonina lamarckiana</i> CUSHMAN, 1927
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Lamarckina cristellaroides</i> (TERQUEM, 1882)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Elphidium laevum</i> (D'ORBIGNY, 1865)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Elphidium subnodosum</i> (ROEMER, 1838)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	<i>Pararotalia armata</i> (D'ORBIGNY, 1826)
23	15	12	12	27	24	19	18	18	15	13	20	14	14	15		

( • : very rare or less than 1%)

Table 2 : Distribution of benthonic foraminifera in the Brussels Formation at Neerijse.

populations. Several other calcareous perforated taxa are present in the associations, but only *Gyroidinoides octocameratus* (0 to 8%) reaches more than 2% of the populations.

### 3.2. Distribution of benthonic foraminifera in this section

Table 2 shows the quantitative distribution of the benthonic foraminifera in the calciferous part of the section at Neerijse. Sample NS 14 appears to be nearly decalcified. Only with CC 14 did we find rare individuals of some taxa.

At first sight, the associations are fairly homogeneous. Again we notice the complete absence of *Miliolacea* and the rarity of agglutinated foraminifera.

*Cibicides* dominates the group of calciferous perforated tests. *Cibicides* cf. *C. tenellus* is the most frequent species with 24 to 48% of the populations. Other important species are here *C. tallahatensis* (5 to 18%), *C. proprius* (5 to 25%), *C. mauricensis* (3 to 13%) and less frequently occur *C. westi* (0 to 3%) and *C. acutimargus* (0 to 5%).

*Elphidium* is the most important other genus in the group of calciferous perforated foraminifera (12

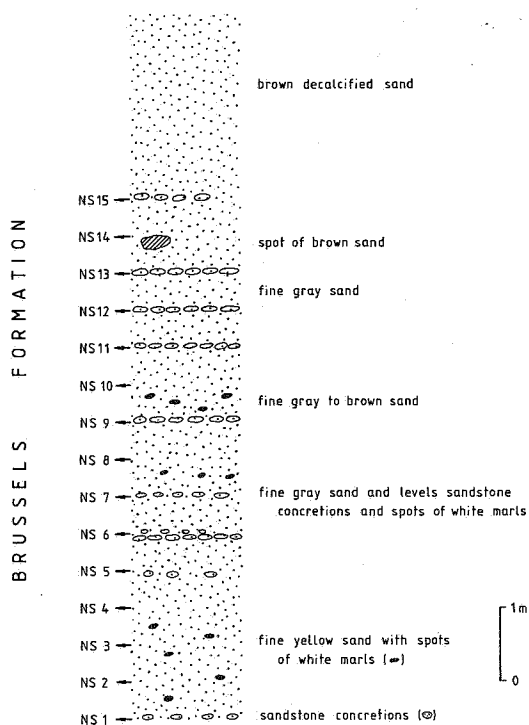


Figure 3 : Lithology of the Brussels Formation at Neerijse (NS).

to 27% for *E. subnodosum*, 0 to 2% for *E. laevum*). Several other genera occur, but only *Eponides toulmini* (0 to 3%), *Hanzawaia boueana* (0 to 5%), *Globulina gravida* (0 to 5%) and *Lagena hexagona* reach more than 2% through the section.

### 3.3. Triangular plot of suborders

The three suborders of benthonic foraminifera *Miliolina*, *Textulariina* and *Rotaliina* are plotted in the triangular diagram in which Murray (1973) marks out the field for the different possible ecological environments.

Since no porcelaneous taxa occur in both sections and agglutinated tests are also absent or very rare, the values for the different samples are situated on or very near to the *Rotaliina* corner.

Consequently, the observed populations of benthonic foraminifera can survive in hyposaline, hypersaline or normal marine marshes, in hypersaline lagoons and on the continental shelf.

### 3.4. Similarities (Sanders, 1960)

This method measures the similarity between the successive samples in a section. The populations in two compared samples are nearly identical

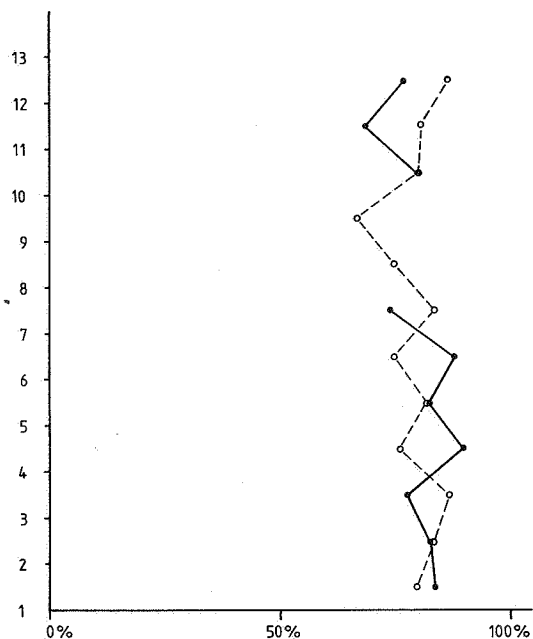


Figure 4 : Similarities between the succeeding samples of the outcrops at St.-Stevens-Woluwe (——), and at Neerijse (-----).

when the total value is higher than 80%. The associations differ progressively as the similarity index diminishes.

The similarity index for the succeeding samples in the sections is given in figure 4. In the St.-Stevens-Woluwe section, most of the values reach 80% or more, which underlines the homogeneity of the populations. Especially between sample W7 and W9 (74%), between samples W11 and W12 (69%) and between samples W12 and W13 (77%), the index lies below the 80%, which indicates yet some small differences between the populations of these samples.

Also in the Neerijse section, the values approach or reach 80%, indicating homogeneous populations. The lower similarity between samples NS9 and NS10 reflects a restricted change in the homogeneity of the populations.

### 3.5. Diversity or Fisher $\alpha$ index

In the base-graph, constructed by Fisher, Corbett & William (1943), the number of species is plotted against the number of individuals in successive samples (fig. 5). Wright & Murray (1972) and Murray (1973) indicate the different possible ecological environments corresponding to the various  $\alpha$  values.

In the St.-Stevens-Woluwe section, the  $\alpha$  values vary from 1.75 to 3.35, in the Neerijse section from 2 to 4.8.

These populations can survive in a hyposaline and nearshore shelf sea with a salinity lower than 32 per mille or in hypersaline marshes or lagoons.

### 3.6. Dominance index

Fig. 6 represents the number of species in 80 % of the populations in the successive samples (Wright, 1972).

In the St.-Stevens-Woluwe section, the dominance index varies from 3 to 5, in the Neerijse section from 4 to 5.

The variability of the dominance index is rather restricted, which shows no important change in the stability of the palaeoecological environment.

### 3.7. Percentage dominance (fig. 7)

The percentage dominance corresponds to the percentage of the most abundant species in a sample. Walton (1964) notes that this percentage dominance depends on the depth of the sea. It increases with decreasing depth.

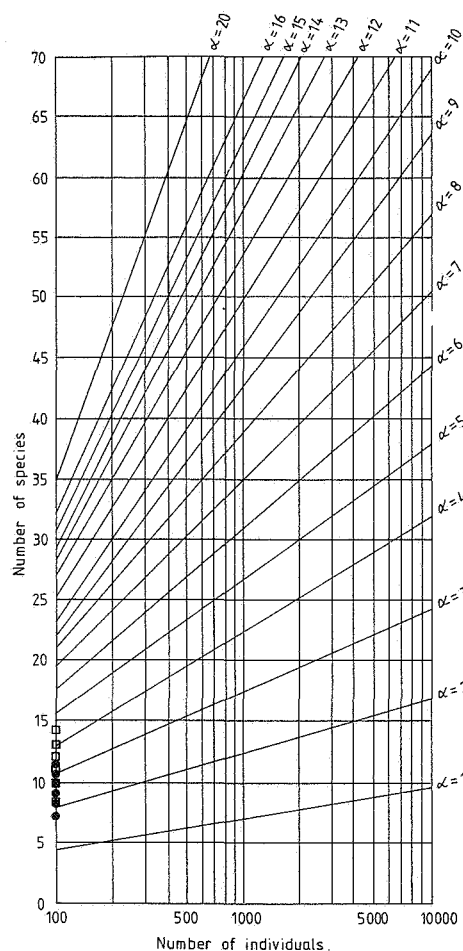


Figure 5 : Fisher  $\alpha$  index in the section at St.-Stevens-Woluwe (●) and at Neerijse (□).

The restricted variability of the percentage dominance in the lower part of the St.-Stevens-Woluwe section (W1 to W8) could reflect some small fluctuations of the sea level. The higher values of the percentage dominance in samples W11 and W13 possibly indicate a more distinct regression of the sea in the upper part of the Brussels Sands Formation.

In the greatest part of the Neerijse section, the percentage dominance is fairly high and it does not change significantly, except for the interval NS8 - NS11. The percentage dominance reflects a rather shallow sea with a small fluctuation of the sea level in the interval NS8-NS11.

### 3.8. Palaeoecological significance of benthonic foraminifera in the St.-Stevens-Woluwe and Neerijse sections

Different ecological factors certainly influence the frequency of the benthonic foraminifera. Several authors provide information about these (palaeo-)ecological conditions : Phleger (1960), Bandy (1960-1964), Walton (1964), Wright & Murray (1972), Wright (1972-1973), Murray & Wright (1974), Boltovskoy & Wright (1976), Gerits, Hooyberghs & Voets (1981) and Hooyberghs (1985a, 1986a and b).

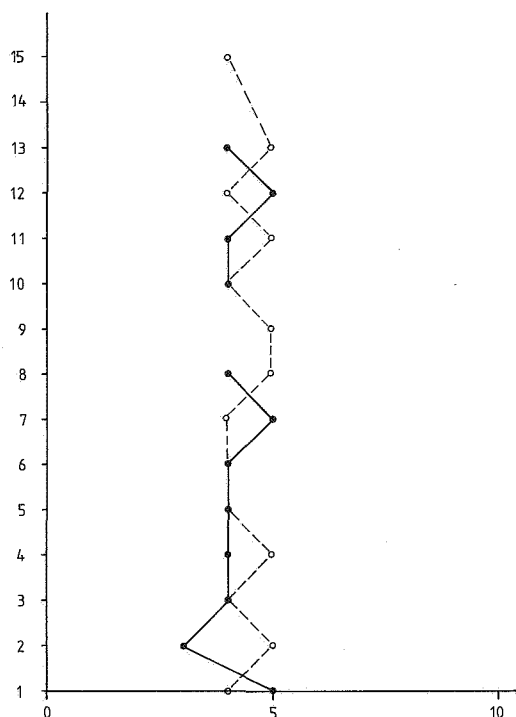


Figure 6 : Dominance index in the samples from St.-Stevens-Woluwe (—●—) and from Neerijse (---○---).

The most abundant genus *Cibicides* is a common inner shelf genus. It lives in a wide range of temperatures and salinities. Currently it is most abundant in temperate seas, where it is attached on all types of substrates.

The genus *Hanzawaia* lives normally on the continental shelf. *Elphidium* prefers a shallow inner shelf environment with oxygen-rich water and a close association with algae.

*Gyroidinoides* survives best in a shelf to bathyal environment of a normal marine sea.

*Lagena* preferably occurs in a normal marine sea with a muddy sediment at a depth of 0 to 180 m of the continental shelf in cold to tropical temperatures.

*Guttulina* and *Globulina* are inner shelf genera in a normal marine, tropical to subtropical temperature.

Small smooth species of *Bolivina* are found in rather shallow shelf conditions.

*Trifarina* prefers nearshore to middle bathyal depths especially on a sandy bottom.

*Eponides* likes a continental shelf of a normal marine sea with cold to temperate waters.

*Pararotalia* is an inner shelf genus which occurs mostly at a depth of 0 to 40 m.

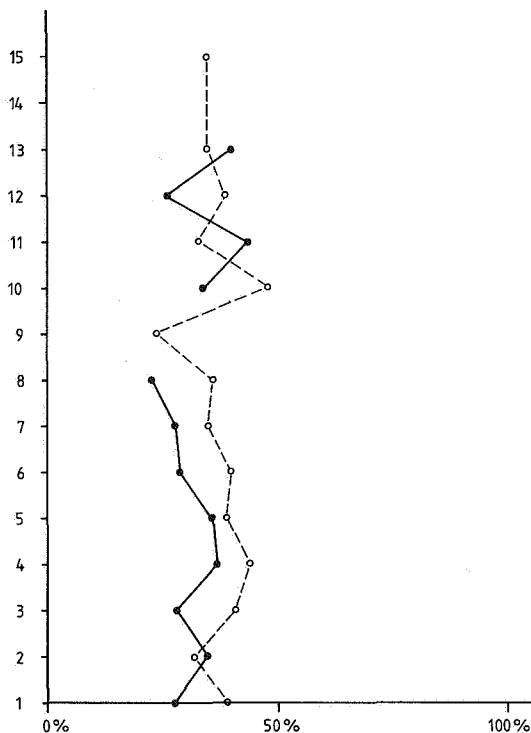


Figure 7 : Percentage dominance in the samples from St.-Stevens-Woluwe (—) and from Neerijse (---).

The complete absence of *Miliolina* can be explained by a fairly low salinity. *Quinqueloculina* e.g. does not salinities lower than 3‰. The presence of planktonic foraminifera in both sections supposes an environment with a connection to the open sea.

## 4. CONCLUSIONS

The Brussels Sands at St.-Stevens-Woluwe and at Neerijse accumulated in a hyposaline and nearshore shelf sea with a salinity lower than 32 per mille. Although some small fluctuations of the sea level occurred, no important changes took place in the evolution of the palaeoecological environment. The presence of planktonic foraminifera indicates a connection of the sedimentary basin with the open sea. The sea water was oxygen-rich and the sea bottom was probably overgrown with algae. A storm period explains the rarity of foraminifera in sample W9 of the St.-Stevens-Woluwe section. In other levels, the Brussels Sands are more or less decalcified.

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## PLATE I

**Figure 1** : *Spiroplectammina carinata* (d'Orbigny, 1846) - X 135.

**Figure 2** : *Spiroplectammina carinata* (d'Orbigny, 1846) - X 135.

**Figure 3** : *Textularia agglutinans* d'Orbigny, 1839 - X 95.

**Figure 4** : *Textularia agglutinans* d'Orbigny, 1839 - X 125.

**Figure 5** : *Karrerella siphonella* (Reuss, 1851) - X 140.

**Figure 6** : *Karrerella siphonella* (Reuss, 1851) - X 155.

**Figure 7** : *Lenticulina* sp. - X 155.

**Figure 8** : *Lenticulina* sp. - X 120.

**Figure 9** : *Dentalina inornata* d'Orbigny, 1846 - X 70.

**Figure 10** : *Dentalina inornata* d'Orbigny, 1846 - X 90.

**Figure 11** : *Nodosaria ludwigi* Reuss, 1866 - X 85.

**Figure 12** : *Lagena globosa* (Montagu, 1803) - X 130.

**Figure 13** : *Lagena globosa* (Montagu, 1803) - X 120.

**Figure 14** : *Lagena hexagona* (Williamson, 1848) - X 130.

**Figure 15** : *Lagena hexagona* (Williamson, 1848) - X 110.

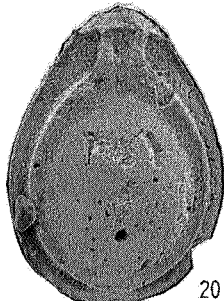
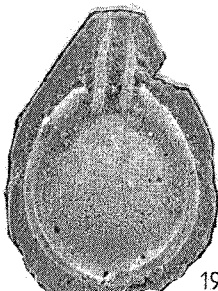
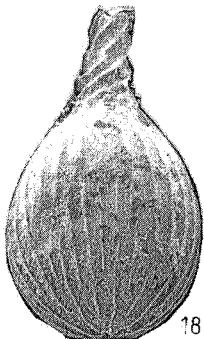
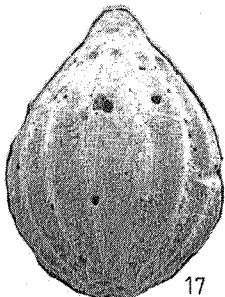
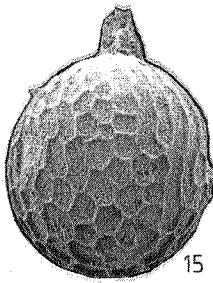
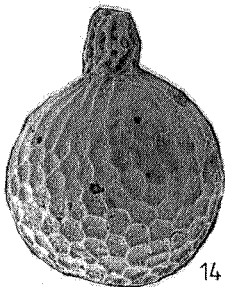
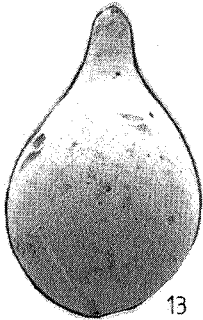
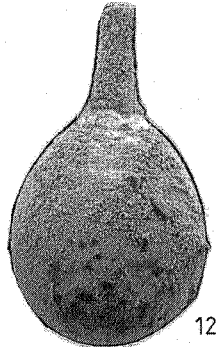
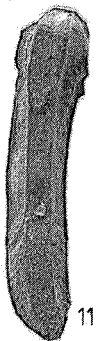
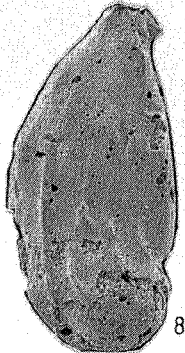
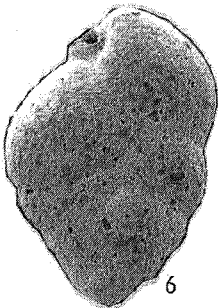
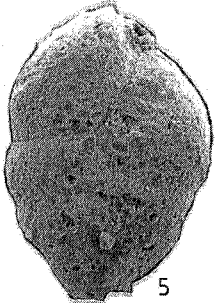
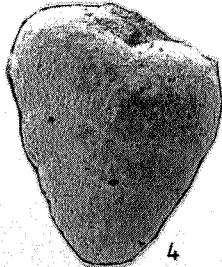
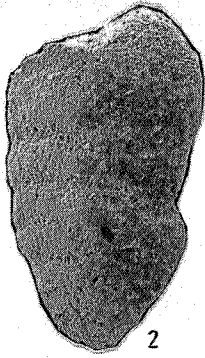
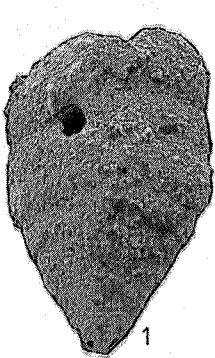
**Figure 16** : *Lagena isabella* (d'Orbigny, 1839) - X 170.

**Figure 17** : *Lagena isabella* (d'Orbigny, 1839) - X 170.

**Figure 18** : *Lagena striata* (d'Orbigny, 1839) - X 175.

**Figure 19** : *Entosolenia orbignyana* (Seguenza, 1862) - X 145.

**Figure 20** : *Entosolenia orbignyana* (Seguenza, 1862) - X 135.



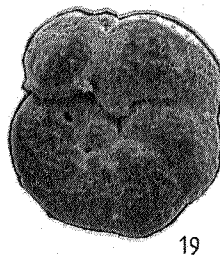
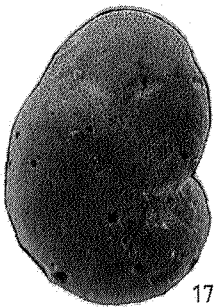
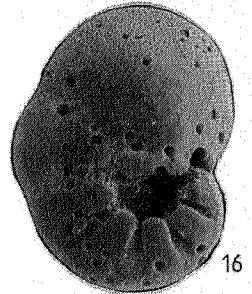
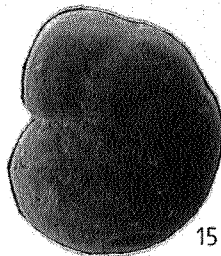
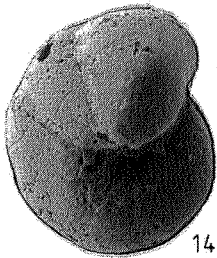
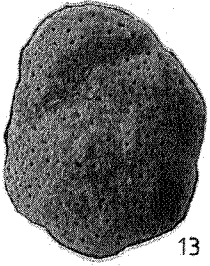
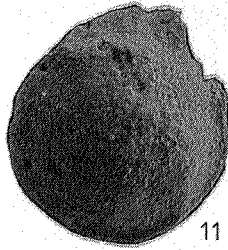
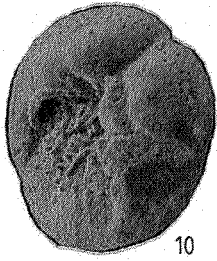
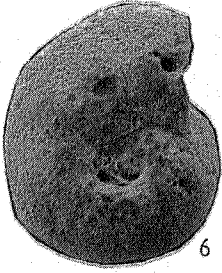
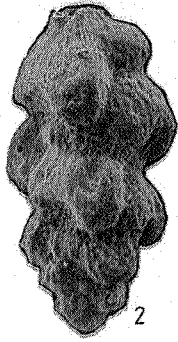
## PLATE II

- Figure 1:** *Guttulina irregularis* (d'Orbigny, 1846) - X 100.
- Figure 2:** *Guttulina irregularis* (d'Orbigny, 1846) - X 115.
- Figure 3:** *Guttulina lactea* (Walker & Jacob, 1798) - X 140.
- Figure 4:** *Guttulina lactea* (Walker & Jacob, 1798) - X 110.
- Figure 5:** *Guttulina pulchella* (d'Orbigny, 1839) - X 90.
- Figure 6:** *Guttulina pulchella* (d'Orbigny, 1839) - X 130.
- Figure 7:** *Globulina gibba* (d'Orbigny, 1846) - X 90.
- Figure 8:** *Globulina gibba* (d'Orbigny, 1846) - X 100.
- Figure 9:** *Globulina gravida* (Terquem, 1878) - X 110.
- Figure 10:** *Globulina gravida* (Terquem, 1878) - X 150.
- Figure 11:** *Pyrulina thouini* (d'Orbigny, 1865) - X 155.
- Figure 12:** *Pyrulina thouini* (d'Orbigny, 1865) - X 135.
- Figure 13:** *Bulimina parisiensis* Kaasschieter, 1961 - X 115.
- Figure 14:** *Bulimina parisiensis* Kaasschieter, 1961 - X 165.
- Figure 15:** *Reusella elongata* (Terquem, 1882) - X 140.
- Figure 16:** *Reusella elongata* (Terquem, 1882) - X 200.
- Figure 17:** *Bolivina anglica* Cushman, 1936 - X 150.
- Figure 18:** *Bolivina brabantia* Kaasschieter, 1961 - X 180.
- Figure 19:** *Bolivina brabantia* Kaasschieter, 1961 - X 140.
- Figure 20:** *Bolivina carinata* Terquem, 1882 - X 135.



## PLATE III

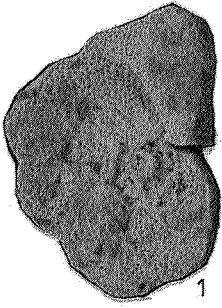
- Figure 1* : *Bolivina crenulata* Cushman, 1936 - X 175.
- Figure 2* : *Trifarina muralis* (Terquem, 1882) - X 200.
- Figure 3* : *Trifarina muralis* (Terquem, 1882) - X 180.
- Figure 4* : *Trifarina wilcoxensis* (Cushman & Ponton, 1932) - X 195.
- Figure 5* : *Trifarina wilcoxensis* (Cushman & Ponton, 1932) - X 175.
- Figure 6* : *Nonion affinis* (Reuss, 1851) - - X 120.
- Figure 7* : *Nonion affinis* (Reuss, 1851) - - X 110.
- Figure 8* : *Nonionella spissa* Cushman, 1931 - X 175.
- Figure 9* : *Nonionella spissa* Cushman, 1931 - X 140.
- Figure 10* : *Discorbis parisiensis* (d'Orbigny, 1865) - X 175.
- Figure 11* : *Discorbis parisiensis* (d'Orbigny, 1865) - X 130.
- Figure 12* : *Eponides toulmini* Brotzen, 1948 - X 175.
- Figure 13* : *Eponides toulmini* Brotzen, 1948 - X 185.
- Figure 14* : *Gyroidinoides octocameratus* (Cushman & Hanna, 1927) - X 130.
- Figure 15* : *Gyroidinoides octocameratus* (Cushman & Hanna, 1927) - X 130.
- Figure 16* : *Cancris subconicus* (Terquem, 1882) - X 125.
- Figure 17* : *Cancris subconicus* (Terquem, 1882) - X 95.
- Figure 18* : *Cibicides acutimargus* (Ten Dam, 1944) - X 90.
- Figure 19* : *Cibicides acutimargus* (Ten Dam, 1944) - X 90.
- Figure 20* : *Cibicides lobatulus* (Walker & Jacob, 1798) - X 80.



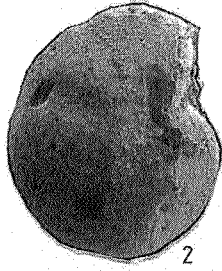
## PLATE IV

- Figure 1** : *Cibicides lobatulus* (Walker & Jacob, 1798) - X 60.
- Figure 2** : *Cibicides mauricensis* (Howe & Roberts, 1939) - X 135.
- Figure 3** : *Cibicides mauricensis* (Howe & Roberts, 1939) - X 135.
- Figure 4** : *Cibicides proprius* (Brotzen, 1948) - X 135.
- Figure 5** : *Cibicides proprius* (Brotzen, 1948) - X 125.
- Figure 6** : *Cibicides tallahatensis* Bandy, 1949 - X 135.
- Figure 7** : *Cibicides* sp. cf. *tenellus* (Reuss, 1865) - X 150.
- Figure 8** : *Cibicides westi* Howe, 1939 - X 130.
- Figure 9** : *Cibicides westi* Howe, 1939 - X 165.
- Figure 10** : *Hanzawaia boueana* (d'Orbigny, 1846) - X 115.
- Figure 11** : *Hanzawaia boueana* (d'Orbigny, 1846) - X 125.
- Figure 12** : *Alabamina wolterstorffi* (Franke, 1925) - X 90.
- Figure 13** : *Alabamina wolterstorffi* (Franke, 1925) - X 115.
- Figure 14** : *Siphonina lamarckana* Cushman, 1927 - X 125.
- Figure 15** : *Siphonina lamarckana* Cushman, 1927 - X 225.
- Figure 16** : *Siphonina lamarckana* Cushman, 1927 - X 160.
- Figure 17** : *Lamarckana cristellaroides* (Terquem, 1882) - x 115.
- Figure 18** : *Lamarckana cristellaroides* (Terquem, 1882) - x 145.
- Figure 19** : *Elphidium laevum* (d'Orbigny, 1865) - x 140.
- Figure 20** : *Elphidium laevum* (d'Orbigny, 1865) - x 160.
- Figure 21** : *Elphidium subnodosum* (Roemer, 1838) - x 120.
- Figure 22** : *Elphidium subnodosum* (Roemer, 1838) - x 130.
- Figure 23** : *Pararotalia armata* (d'Orbigny, 1826) - x 110.
- Figure 24** : *Pararotalia armata* (d'Orbigny, 1826) - x 150.





1



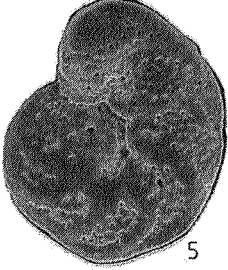
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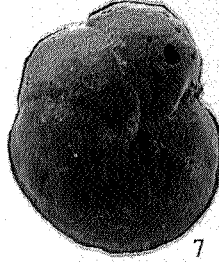
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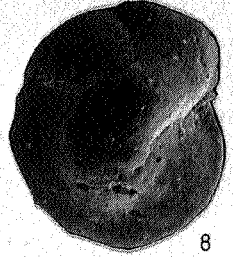
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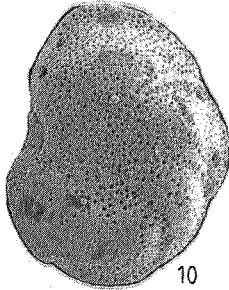
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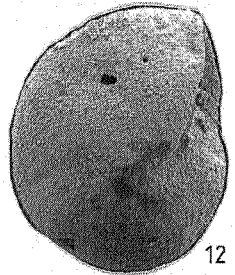
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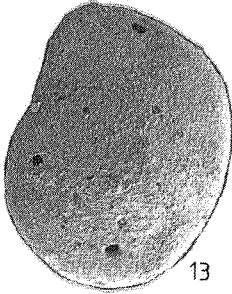
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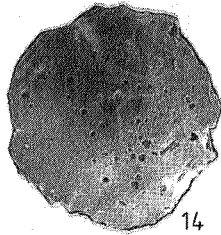
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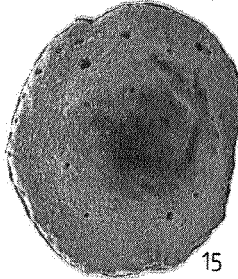
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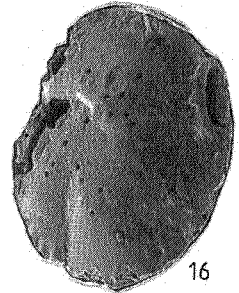
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15



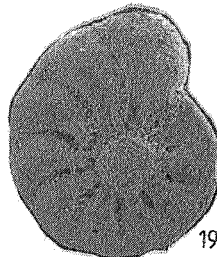
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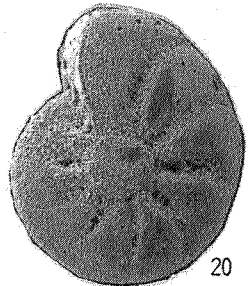
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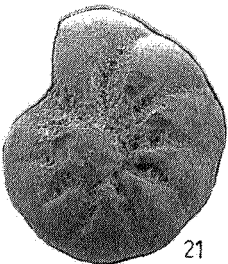
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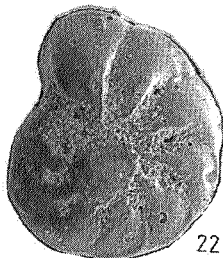
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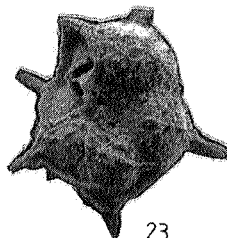
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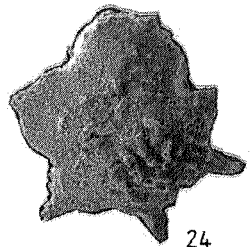
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