FOSSIL BRYOZOA REVEAL LONG-DISTANCE SAND TRANSPORT ALONG THE DUTCH COAST

BY

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CONTENTS

SUMMARY

The occurrence in Holocene and Recent Dutch coastal sands of minute specimens and fragments of Bryozoa belonging to tropical, subtropical and warm-temperate genera poses the problem of their origin. The hypothesis is advanced that they derive from submarine outcrops of tropical marine sediments of Eocene age on the sea floor off the Belgian coast or in the English Channel. A second group of fragmentary Bryozoa is undoubtedly of Pliocene age and derives from sediments that are still being eroded by tidal scour in the mouth of the River Scheldt estuary. In either case nett transport of fine, sand-size material in a northeastward direction over long distances along the coast is implied. This, in itself, is not a novel conception. Mass movement of sand from S to N along the Dutch coast has always featured in the various theories concerning the genesis of this coast. The novelty is to see Bryozoa function as "tracers" of the sand movement.

1. INTRODUCTION

Most of the sand-size bryozoan fragments that are a regular component of Dutch coastal sands belong to species that form part of the genuine bryozoan fauna of the southern North Sea. Fragmentary Bryozoa were first found in the estuarine sands of the Haringvliet (NOORTHOORN VAN DER KRUIJFF and LAGAAIJ, 1960), but recent investigations have shown them also to be present, often in large numbers, in other types of coastal sand.

On the other hand, occasional specimens and fragments of Bryozoa have kept turning up that are clearly out of place in the Recent North Sea fauna. Their occurrence, though fairly infrequent, has nevertheless been established so often and at such widely separated localities that it can no longer be ignored. So far, specimens have been found in the Haringvliet

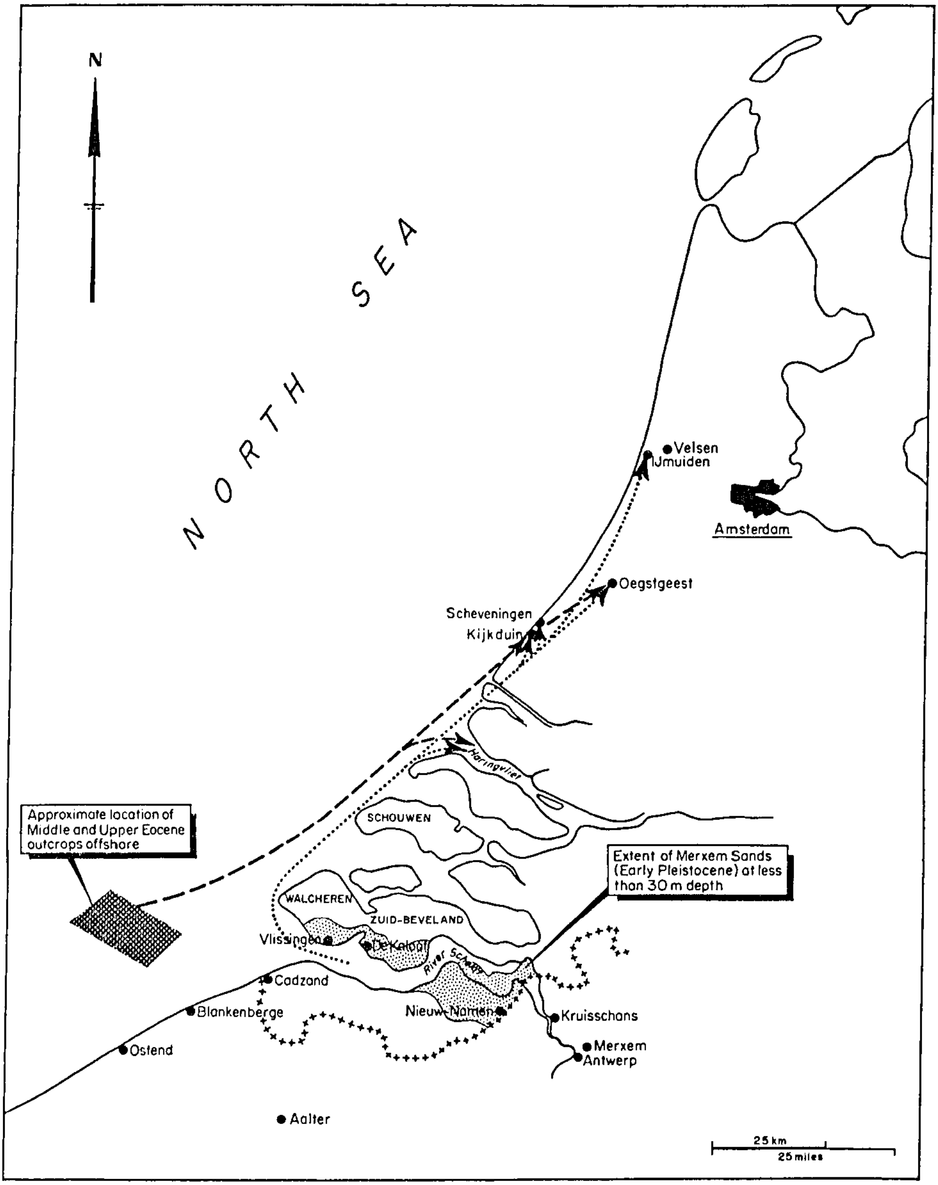


Fig. 1. Occurrences, direction of nett transport, and provenance of remanié fossil bryozoa in Dutch coastal sands

estuary, at Kijkduin, Scheveningen, Oegstgeest, IJmuiden and Velsen (fig. 1).

The investigator of this phenomenon faces a two-fold task: identifying the specimens and, when this has been satisfactorily accomplished, establishing their provenance. The material falls clearly into two categories, and these will therefore be dealt with separately.

2. Specimens of unchallenged Pliocene age

In the report on the occurrence of Bryozoa in the Haringvliet estuarine sands (*loc. cit.*, p. 720), mention has already been made of the presence of remanié sand-size Pliocene specimens in some samples. In the meanwhile, their occurrence in the Recent beach sand at Kijkduin and in Young Holocene barrier-face sand at Scheveningen, Oegstgeest and IJmuiden has also been established. We are here concerned with fragments of specimens belonging to the following species, whose Pliocene age has been established with certainty and whose provenance is to be sought in the estuary of the river Scheldt:

Melicerita charlesworthii Milne-Edwards	Plate 1, fig. 1
Metrarabdotos moniliferum (Milne-Edwards)	Plate 1, figs. 2–4
Schizostomella socialis (Busk)	Plate 1, figs. 5–6
Vittaticella sp.	Plate 1, figs. 7–8

The occurrence of the first two species in the subsurface Pliocene of Goes and that of the second in beds of the same age at Flushing were already known to Lorié (1885, 1903). The third species has also been encountered in a well near Flushing (Lagaaij, 1952 p. 121). That *Vittaticella* also occurs in the marine Pliocene of the Low Countries is new. The discovery of the small remanié specimens of this genus (Plate, figs. 7–8) prompted me to examine the 150–450 μ residue fraction of a number of Scaldisian samples, and numerous identical specimens (Plate, fig. 9) did indeed show up in two of the samples, one being from the "Sables de Luchtbal" and the other from the "1er coquiller scaldisien" of the Antwerp port area (Petroleum haven).

Since the Pliocene in Coralline Crag facies is present at only quite a shallow depth near Flushing (Van Voorthuysen, 1957, encls. 80, 85; Van Dam and Van Rummelen, 1960, text-fig. 13), since the tidal gully in the mouth of the Scheldt due south of Walcheren locally attains considerable depth (Van Rummelen, 1960, p. 694, mentions 50 metres below Amsterdam datum) and since, finally, the material washed up on the shore at the well-known locality, "De Kaloot", is very rich in Pliocene marine mollusks (Van Regteren Altena, 1937, p. 152), there can be no doubt that marine Pliocene is at present being eroded by tidal scour in the mouth of the Scheldt estuary.

A second, indirect, but certainly no less important source of sand-size marine Pliocene material is to be found in the Merxem Sands, fine-grained

INDEX TO PLATE I

1. *Melicerita charlesworthii* MILNE-EDWARDS
   Oks 2078. Haringvliet excavation.

2. *Metrarabdotos moniliferum* (MILNE-EDWARDS)
   Recent beach sand. Kijkduin.

3. *Metrarabdotos moniliferum* (MILNE-EDWARDS)
   Oks 2092. Haringvliet excavation.

4. *Metrarabdotos moniliferum* (MILNE-EDWARDS)
   Oks 2092. Haringvliet excavation.

5. *Schizostomella socialis* (BUSK)
   Oks. 67. Haringvliet excavation.

6. *Schizostomella socialis* (BUSK)—interior aspect of zooecium
   Oks 67. Haringvliet excavation.

7. *Vittaticella* sp.—frontal aspect
   Oks 2091. Haringvliet excavation.

8. *Vittaticella* sp.—dorsal aspect of same specimen
   Oks 2091. Haringvliet excavation.

9. *Vittaticella* sp.—frontal aspect; notice closure of orifice
   Lga 10. Scaldisian (Sables du Luchtbal). Antwerp.

10. *Vincularia* sp.
    Core hole Oegstgeest 10A. 4.37–4.42 m—surf.

11. *Vincularia* sp.—end view of same specimen
    Core hole Oegstgeest 10A. 4.37–4.42 m—surf.

12. *Nellia oculata* BUSK
    Oks 2094. Haringvliet excavation.

13. *Dittosaria* sp.—lateral aspect
    Core hole Scheveningen 11C. 8.70–8.75 m—surf.

14. *Dittosaria* sp.—frontal aspect of same specimen
    Core hole Scheveningen 11C. 8.70–8.75 m—surf.

15. *Poricellaria* sp.
    Recent beach sand. Kijkduin.

16. *Poricellaria* sp.
    Oks 2102. ? Calais Beds. Haringvliet excavation.

17. *Cothurnicella* sp.—Lateral aspect
    Sample no. 4. Velsen excavation. 3.40 m—Amsterdam datum.

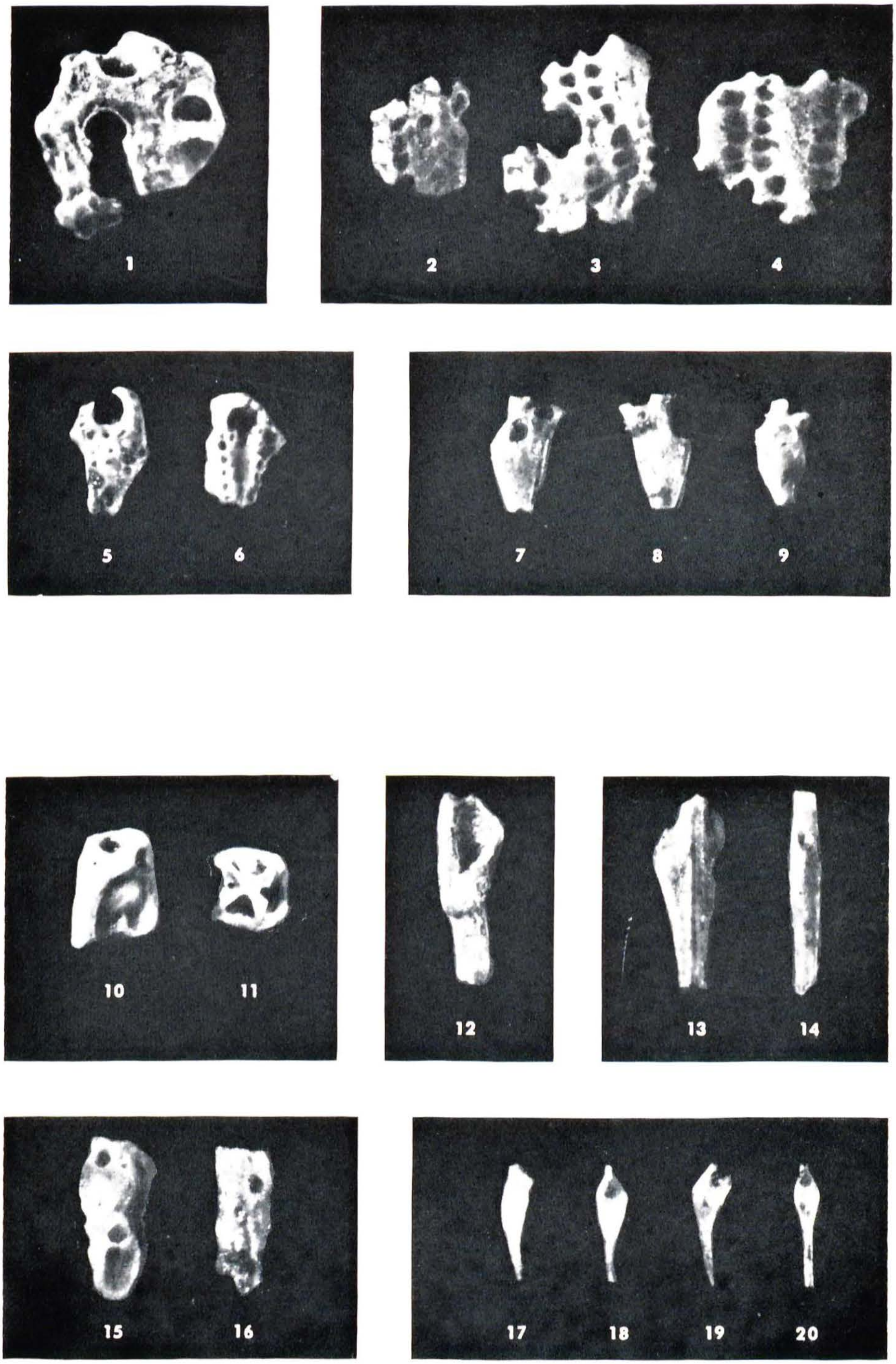
18. *Cothurnicella* sp.—frontal aspect of same specimen
    Sample no. 4. Velsen excavation. 3.40 m—Amsterdam datum.

19. *Cothurnicella pyriformis* BERTOLONI—latteral aspect
    Tertiary e5. Prupuh, East Java, Indonesia.

20. *Cothurnicella pyriformis* BERTOLONI—frontal aspect of same specimen
    Tertiary e5. Prupuh, East Java, Indonesia.

(all specimens × 40)

PLATE I



littoral deposits of Early Pleistocene age (formerly referred to as "Poederlian"), which overlie the Pliocene in the area. These deposits, which have been well exposed in recent years at the Kruisschans locality, north of Antwerp, and which also crop out at a single locality north of the Dutch/Belgian frontier, near the village of Nieuw-Namen, have a high content of remanié sand-size marine Pliocene debris. Samples from Kruisschans in particular have yielded abundant fragments of *Metrarabdotos moniliferum* and some of *Melicerita charlesworthii*.

There are potential outcrops of these Merxem Sands at the bottom of the Scheldt estuary over its entire width (Van Voorthuysen, 1957, encls. 81, 85; Van Dam and Van Rummelen, 1960, text-fig. 12) and these are thus even more exposed to erosion by tidal scour than the underlying marine Pliocene.

Owing to their northerly dip, these marine Pliocene and littoral Early Pleistocene deposits lie well out of reach of tidal action in the estuaries between the islands north of Walcheren. Nor are there outcrops of marine Pliocene or Early Pleistocene to be found upstream in the Rhine or Meuse valleys; fluviatile supply by rivers other than the Scheldt is therefore ruled out, and the estuary of this river is the source from which the Pliocene bryozoan fragments are most likely to have originated. The displacement involved is as much as 130 km.

Here the question arises whether outcrops of Pliocene in Coralline Crag facies or, more likely still, of the Merxem Sands are not also to be found offshore, on the floor of the North Sea itself, somewhere on a line connecting the Scheldt estuary with the coast of East Anglia (*cf.* Tesch and Reinhold, 1946, map 4). Apparently such offshore outcrops do not exist on the eastern part of the line. Tesch and Reinhold (*loc. cit.*), in a paper dealing with the geology of the southern North Sea, have reported the results of a study of the Foraminifera from a large number of punch cores and some twenty percussion borings most of which were located in and in front of the Scheldt estuary. They list five percussion borings and one punch core as having reached or almost reached the "Middle Pliocene" (i.e. the Merxem Sands), but all six of these borings were situated in the Scheldt estuary. On an earlier occasion, however, Tesch (1935, pp. 309–310) reported the occurence of fossils and associated rolled pebbles of Diestian (Upper Miocene) and Scaldisian (Pliocene) age in an area situated between the North Hinder Bank and the North Falls, which is roughly midway between the mouth of the Scheldt estuary and the town of Harwich.

3. Specimens of probably Eocene age

The provenance of the second group of extraneous Bryozoa was not immediately obvious. In the first place, the small size (150–450 μ) of the specimens and their fragmentary state in all but one case made it impossible to establish their specific identity. There was no difficulty in identifying the genera, however, which were as follows:

Vincularia (sensu stricto)	Plate 1, figs. 10–11
Nellia oculata Busk	Plate 1, fig. 12
Poricellaria	Plate 1, figs. 15–16

What was so surprising about these finds was that the Recent distribution of these genera is confined to tropical, sub-tropical or at most warm-temperate latitudes (figs. 2–4). These genera are therefore entirely out of place in the Recent North Sea fauna. Moreover, they do not even occur in the eastern part of the Atlantic. Here was a problem for which there was no immediate explanation.

The first solution that offered itself was that of long-distance transport by ships. This had rapidly to be abandoned as a reasonable answer, however, since ships could not have been responsible for the introduction of specimens dating from before 1600 A.D., the date at which commerce between The Netherlands and the East and West Indies began to flourish. And the specimens of *Vincularia* from Scheveningen (from 8.70–8.75 m below surface) and Oegstgeest (from 4.37 m below surface) and those of *Poricellaria* from the Haringvliet excavation (from 16.5 m below Amsterdam datum; ? Calais Beds) and Scheveningen (from 7.03–7.08 m below surface) are certainly from deposits laid down before 1600 A.D.

A much more plausible explanation is that these representatives of tropical and subtropical genera derive from outcrops of (tropical) fossiliferous marine sediments of Eocene age on the present sea floor in the southern North Sea, whence they have been transported northeastwards by the prevailing (flood) current. From figs. 2–4 it can be seen that, although *Vincularia*, *Nellia* and *Poricellaria* are completely absent from the eastern Atlantic today, all three genera had fossil representatives in the Eocene and Oligocene of Western Europe. What is more, all three are often found together in one locality and sometimes make up a considerable percentage of the total bryozoan assemblage of the sample. The co-occurrences in the Palaeogene of western Europe listed on p. 37 are worthy of note.

In the light of our problem, the Bruxellian and Ledian occurrences in Belgium are the most interesting. We have still to examine, however, whether marine fossiliferous formations of this age may be expected to crop out under the Recent sand cover in the southern North Sea.

The geological situation renders it most unlikely that this would be the case with beds of Bruxellian age. In Belgium no Bruxellian deposits are present to the West of Brussels, and in France they only reappear, poorly developed, as a single outlier in the hills of Cassel, ESE of Calais.

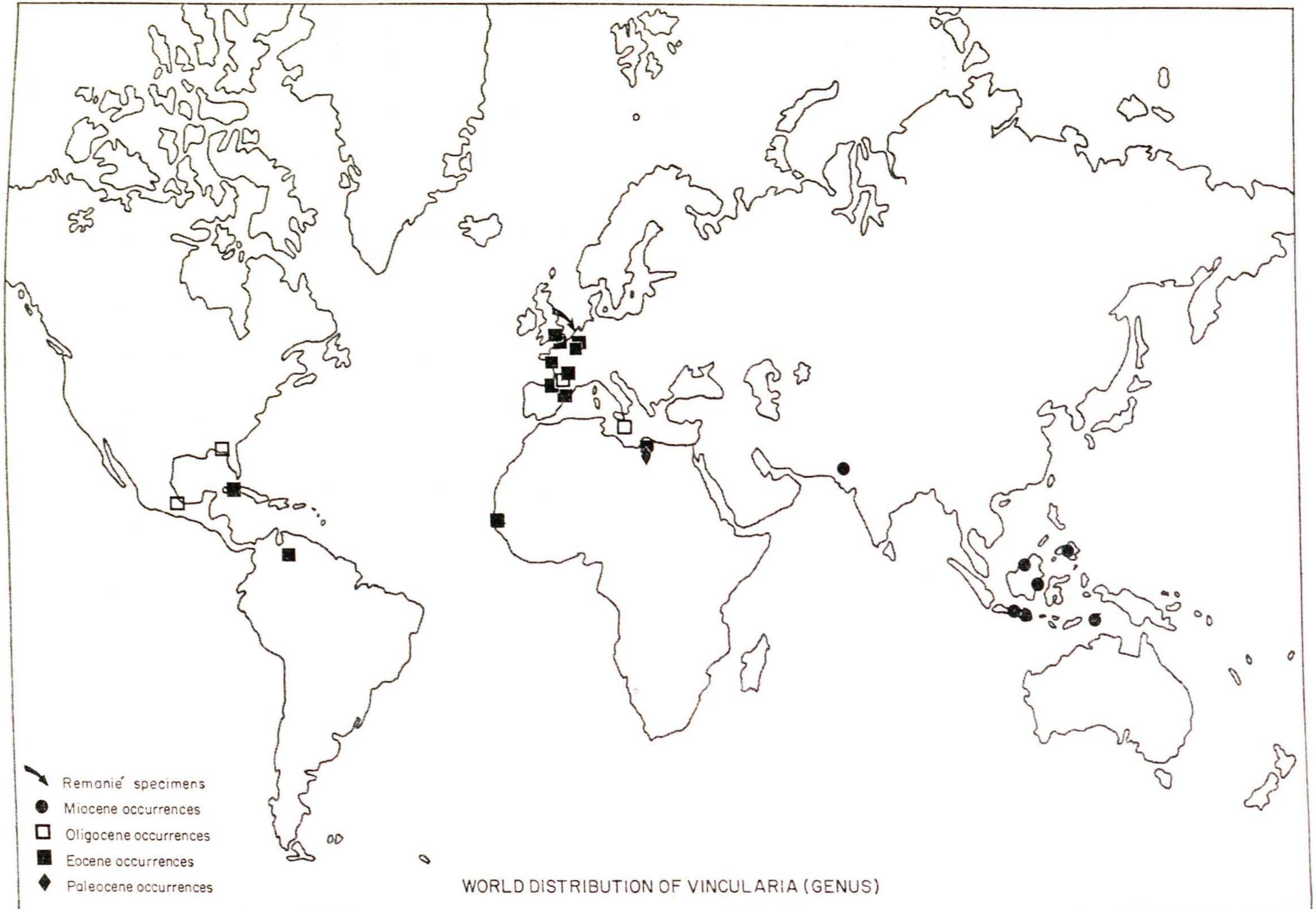
The fossiliferous Eocene formation which is known with certainty to crop out on the present sea floor, between Blankenberge and Ostend, off the Belgian coast, the "Sables d'Aeltre", is slightly older (Paniselian = Cuisean = Late Ypresian) than Bruxellian and it contains a different suite of Bryozoa, in which *Vincularia*, *Nellia* and *Poricellaria* are lacking

		Vincularia	*Nellia*	*Poricellaria*	*Dittosaria*
Oligocene	Stampian of Gaas, SW France (REUSS, 1869; CANU, 1914)	rare	common	rare	—*)
	Calcaire à Astéries, Carrière de la Souys, SW France (own observation)	abundant	common	common	—
Upper Eocene	Bartonian of Hampshire, England (ST. JOHN BURTON, 1929)	rare	rare	—	—
	Upper Bracklesham Beds Selsey, Sussex, England (DAVIS, 1934; CURRY, 1962)	+	common	+	+
Middle Eocene	Lower Bracklesham Beds, English Channel, south of the Isle of Wight (CURRY, 1962), and Southampton (DAVIS, 1934)	+	+	+	not uncommon
	Calcaire de Blaye, Carrière de l'Octroi, SW France (own observation)	abundant	common	rare	—
	Ledian**) of Forest, Belgium (own observation)	common	rare	rare	common
	Ledian**) of Bambrugge, near Lede, Belgium (own observation)	rare	rare	—	rare
	Lutetian of Campbon (Loire-Inférieure), W France (DARTEVELLE, 1937)	+	+	+	—
	Lutetian of Bois-Gouët (Loire-Inférieure), W France (BALAVOINE, 1959)	abundant	rare	rare	—
	Lutetian of Orglandes (Manche), Cotentin, W France (CANU, 1907–1910)	rare	rare	rare	—
	Lutetian of Parnes (Oise), Paris Basin, France (CANU, 1907–1910)	common	rare	rare	—
	Lutetian of Chaussy (Seine-et-Oise), Paris Basin, France (CANU, 1907–1910)	abundant	abundant	—	—
	Lutetian of Damery (Marne) Paris Basin, France (d'ORBIGNY, 1851–1854; CANU, 1907–1910; DAVIS, 1934)	+	—	+	+
	Lutetian of Gomerfontaine (Oise), Paris Basin, France (DARTEVELLE, 1934)	rather common	common	common	rare
	Bruxellian of Nalinnes, Belgium (own observation)	common	common	common	common
Lower Eocene	London Clay (Ypresian) England (DAVIS, 1934; CURRY, 1962)	—	+	—	abundant
	Ypresian of Mont St. Aubert, Belgium (own observation)	—	—	—	common

*) REUSS's record (1869, p. 468) of *Dittosaria prima* from Gaas referred to a specimen of *Pasythea*.

**) POMEROL (1961) has recently voiced the opinion that the Ledian in Belgium is to be correlated with the Upper Lutetian in the Paris Basin. The Ledian would thus be Middle Eocene, not Upper Eocene as the classical view would have it.

\+ = present
— = absent



WORLD DISTRIBUTION OF VINCULARIA (GENUS)

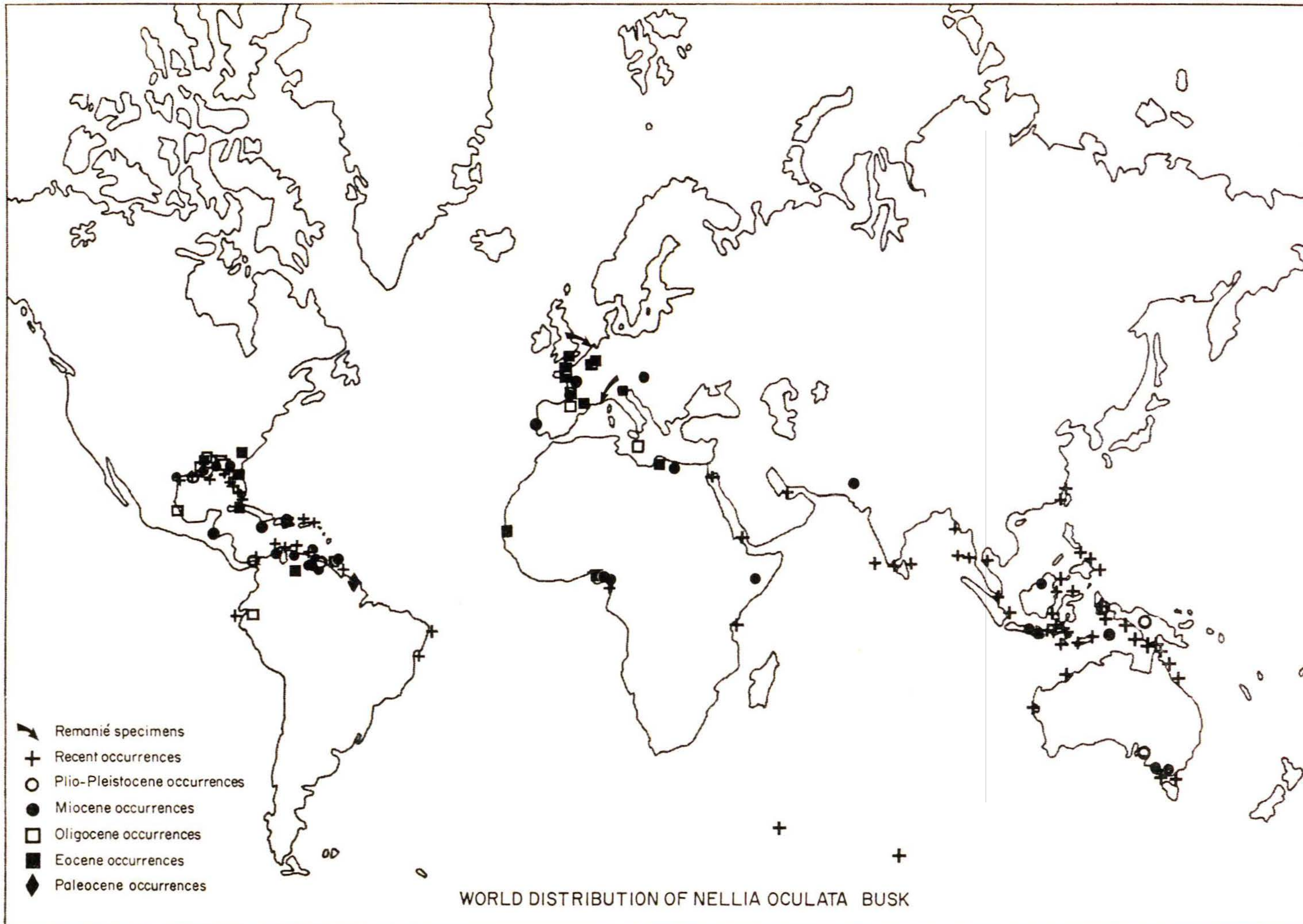

Remanié specimens
Recent occurrences
Plio-Pleistocene occurrences
Miocene occurrences
Oligocene occurrences
Eocene occurrences
Paleocene occurrences
WORLD DISTRIBUTION OF NELLIA OCULATA BUSK

Fig. 3.

WORLD DISTRIBUTION OF PORICELLARIA (GENUS) (see CANU and BASSLER, 1929 and DARTEVELLE, 1933; also checked by me on newly collected samples from the Aalter locality [1]).

Since Paniselian and Bruxellian beds are to be excluded, those of Ledian age remain the only possible source for our remanié specimens. Unfortunately, there is, to my knowledge, no straight-forward record of Ledian beds cropping out off the Belgian coast. TESCH and REINHOLD (1946, p. 81) state merely that Middle and Upper Eocene beds lie near or at the surface to the north of Blankenberge.

There is, theoretically, still the more remote possibility that the Dutch remanié specimens of *Vincularia*, *Nellia* and *Poricellaria* come from an even more distant source, viz. the English Channel. All three genera have been identified in samples from the Eocene outcrop of presumably Lower Bracklesham Beds in the English Channel, south of the Isle of Wight (CURRY, 1962). Derivation of the Dutch specimens from the Channel area would involve nett transport of sand-size material over several hundred kilometres. This assumption is not incompatible, however, with the general direction of present-day sand transport on the sea floor in the Channel and the southern part of the North Sea (STRIDE, 1963, text-fig. 10).

Summarising, we may say that the fragmentary specimens of *Vincularia*, *Nellia* and *Poricellaria* in Dutch coastal sands are most probably of Eocene age and derived from submarine outcrops of marine Eocene sediments located to the southwest. Beds of Ledian age, presumably cropping out to the north of Blankenberge off the Belgian coast, are the most likely source, but theoretically the English Channel cannot be entirely ruled out as a possible source area.

Some time after this theory had been developed, I had the good fortune to make a discovery which considerably enhances the theory's change of being correct. It was that of finding a fragmentary specimen of the genus *Dittosaria* (Plate, figs. 13–14) in a core hole at Scheveningen (8.70–8.75 m below surface). Unlike *Vincularia*, *Nellia* and *Poricellaria*, *Dittosaria* is an exclusively extinct genus, ranging from Eocene to Oligocene on either side of the Atlantic. The known occurrences are shown in fig. 5, and it is obvious from this figure that the Scheveningen find could only derive from an Eocene source. The remanié fragment closely matches the slender form which I collected, together with *Dittosaria lutetiana* DAVIS, from the Ledian of Forest, Belgium, in the absence of a keel, in having convex lateral contours and in measuring not more than 0.27 mm across a pair of zooecia. It may be presumed that this slender form corresponds to the *Dittosaria auversiana* of DAVIS (1934, p. 235), but unfortunately this is a nomen nudum.

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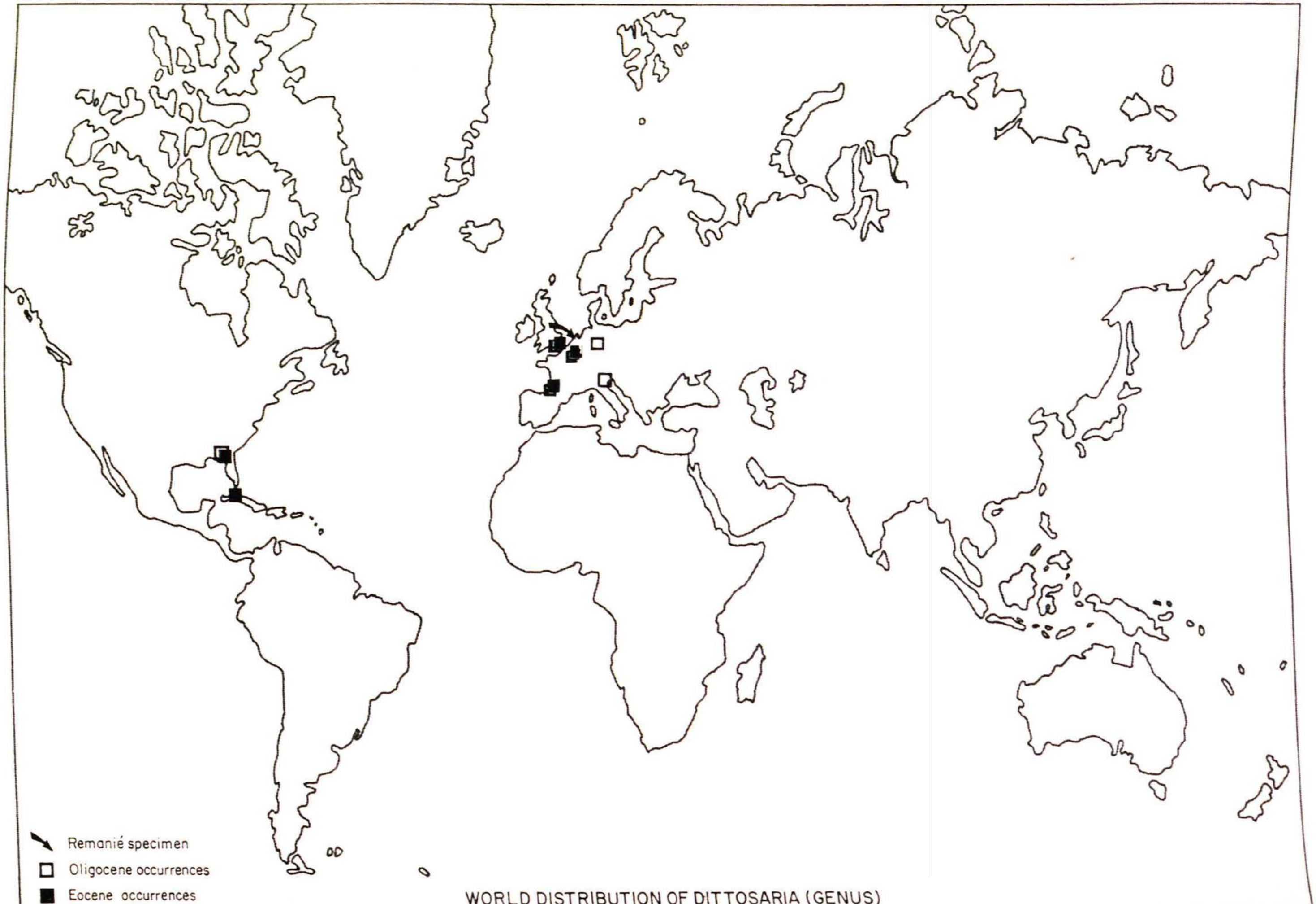
[1]) Paniselian molluscs from the Ostend area are reported to have reached the island of Schouwen, a nett displacement of some 80 kilometres (VAN REGTEREN ALTENA, 1937, p. 154).



WORLD DISTRIBUTION OF DITTOSARIA (GENUS)

4. A specimen of *Cothurnicella* from Velsen

From the late Holocene beds which were exposed in the tunnel excavation at Velsen (from 3.40 m below Amsterdam datum, and dating according to VAN STRAATEN (1957, p. 179) from about 2200 B.P.) a very curious minute bryozoan specimen was obtained that appears to belong to the genus *Cothurnicella* (Plate, figs. 17–18). *Cothurnicella* is a tropical to warm-temperature genus. Its single known species, *Cothurnicella pyriformis* BERTOLONI, has a Recent [1]) distribution in the Atlantic, the Mediterranean and the Indo-West Pacific (fig. 6). Its northernmost West European record is from Calvados, Normandy (BUSK, 1884). If the Velsen specimen also belongs to *C. pyriformis*, which is most likely, there is practically no other way of explaining its present, anomalous, occurrence but transport from the Channel area.

5. Changes in direction and intensity of the sand supply during the Holocene

The idea of longshore transport of fine, sand-size material in a northeastward direction over long distances along the Dutch coast is by no means new. As has been well brought out by KRUIT (1963, text-fig. 3), mass movement of sand from S to N along the Dutch coast has always featured in the various theories concerning the genesis of this coast. The novelty is to see Bryozoa function as 'tracers' of the sand movement.

VAN STRAATEN (1961, p. 387) has recently suggested that the ratio between transverse and longshore sand supply may have varied in the course of time; he intimated notably that the transverse supply may have been more important during the period of rapid rise in sea level (approx. 8000–5000 years B.P.), whereas longshore supply may have strongly predominated during the subsequent period of decelerating rise in sea level and rapid coastal advance by barrier accretion (approx. 5000–2500 years B.P.). The available data on remanié fossil Bryozoa do not contradict this hypothesis. With two exceptions, all remanié Pliocene and Eocene (?) specimens have been obtained from sands that were deposited in the last 5000 years (see Appendix I).

The situation in a core hole drilled at Oegstgeest is very suggestive in this connection. This core hole features a 10 metre thick section of coastal sands derived from the North Sea (4–13.80 m below Amsterdam datum). Bryozoan fragments occur persistently in large numbers throughout this sand section. Yet, the lower 8 metres, consisting of sands deposited during the phase of rapid rise in sea level, did not yield a single remanié fossil specimen. It is not until the upper two metres of fine-grained sand, which

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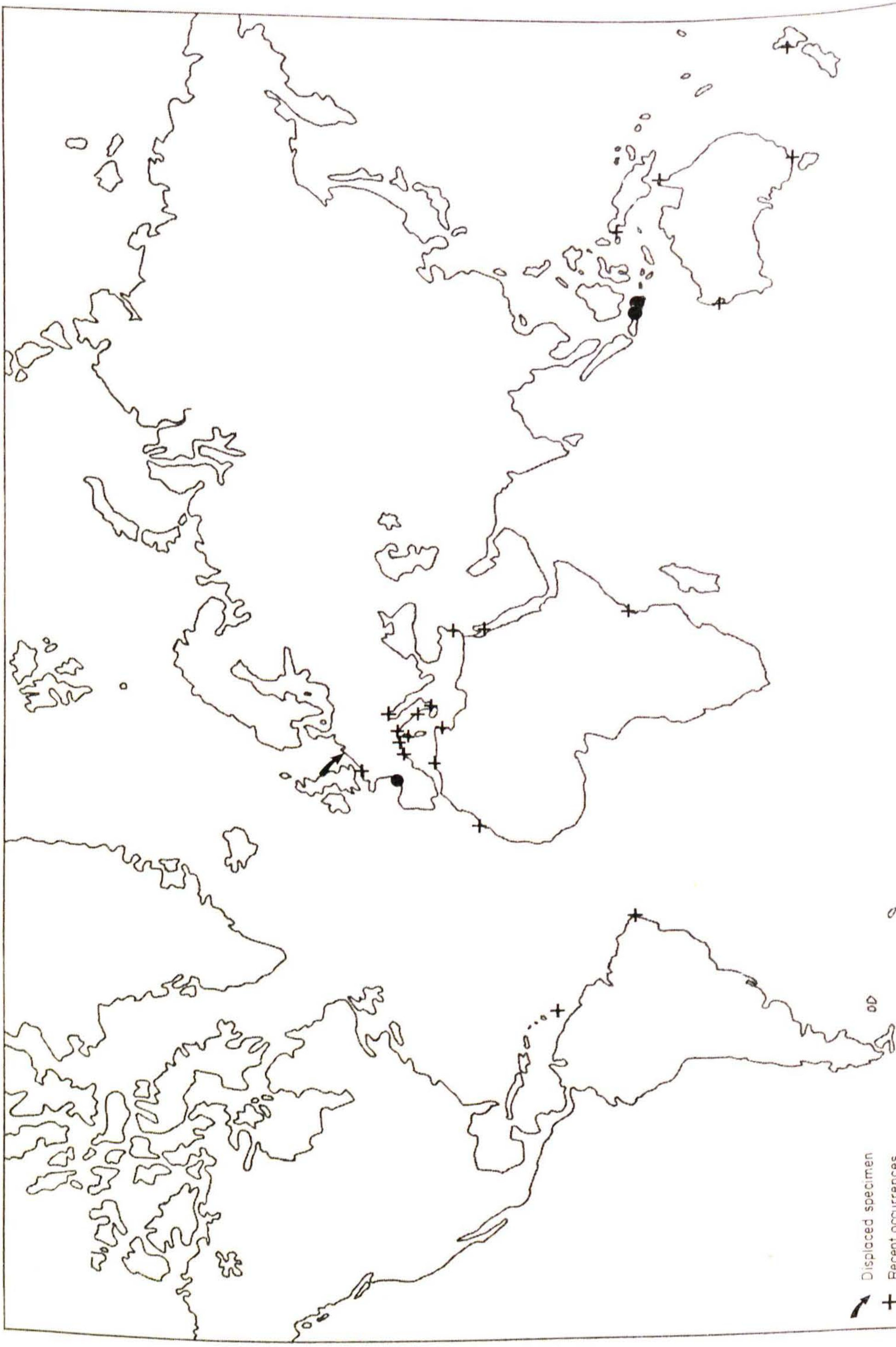
[1]) *Cothurnicella* can no longer be considered a purely Recent genus, as it has always been. I have recently found *C. pyriformis* in samples of Tertiary e5 (Lower Miocene) age from East Java and Madura (Plate, figs. 19–20), and in the Falun de Lariey ("Aquitanien supérieur"), near Saucats (Gironde), France.



WORLD DISTRIBUTION OF COTHURNICELLA PYRIFORMIS (BERTOLONI) according to present views were deposited as the lower part of the barrier face during the phase of rapid coastal accretion, that a sudden influx of both Pliocene and Eocene (?) remanié specimens is observed.

That the appearance of remanié specimens, particularly the Pliocene ones, in Dutch coastal sands is a relatively recent phenomenon is also made clear by other evidence. Until quite recently, well into historical times, the River Scheldt's course was much more northerly than its present one. From soil surveys in the central islands of the province of Zeeland and from archaeological evidence, it appears that the present location of the River Scheldt estuary is a post-Roman development (Steur and Ovaa, 1960; Edelman, 1962), and also that it reached considerable depth only after 700 a.d. (Van Rummelen, 1960, p. 694). It follows that the sources of Pliocene sand-size material were not fully tapped until after that date.

Another possible explanation for the relatively late appearance of remanié fossil Bryozoa in Dutch coastal sands is perhaps implied in the fact that a substantial part of the Quaternary cover of barren fluvioglacial and fluviatile sands had first to be flushed out of the southernmost part of the North Sea before the underlying fossiliferous marine Tertiary beds could start contributing their fossil content to the sediment drift moving northeastward over the bottom with the prevailing flood current.

6. Acknowledgements

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The photographs on Plate I were taken by Mr. J. W. Dimmendaal.

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Postscriptum

This is essentially the manuscript as I closed it in 1964, but the maps and Appendix II have been brought up to date to include recently published new records, or recently made observations of my own, resulting in one or two inconsistencies.

Thus it is no longer correct to state (p. 36) that *Nellia oculata* does not occur in the eastern Atlantic, since it has been found there recently near Fernando Poo and added on the map (Fig. 3).

Conversely, I have cancelled the Recent occurrence of *Vincularia* sensu stricto from the 1964 version of the map (Fig. 2), as I no longer consider that CANU and BASSLER (Bryozoa of the Philippine Region, 1929, p. 111) were correct in assigning their new species *pentagona* to the genus *Heterocella*, which is a junior synonym of *Vincularia* sensu stricto. Consequently, in the chain of reasoning in Chapter 3, *Vincularia* should not be grouped with *Nellia* and *Poricellaria*, but rather with *Dittosaria*.

APPENDIX I

Data concerning the specimens discussed in this paper

	Locality and age of remanié occurrences in Dutch coastal sands	Nearest known locality and age of in situ occurrences
Melicerita charlesworthii MILNE-EDWARDS	Haringvliet: Oks 2078, from post-1932 channel	Scaldisian of Antwerp; remanié in Merxem Sands of Antwerp, "Poederlian" of Dutch Flanders
Metrarabdotos moniliferum (MILNE-EDWARDS)	Haringvliet, Oks 67, 68, 2071, 2073, 2075, 2077, 2080, 2084, 2088, 2089, 2091, 2092, 2094, 2095, 2098, 2100, all from post-1932 channel; Oks 2103, from ? Calais beds; Kijkduin, from Recent beach sand; Scheveningen, 8.70–8.75 m – surf., 17.40–17.46 m – surf., both from Young Holocene sands; Oegstgeest, 4.37–4.42 m – surf., 4.65–4.67 m - surf., both from Young Holocene sands	ibidem
Schizostomella socialis (BUSK)	Haringvliet, Oks 67, from post-1932 channel	ibidem
Vittaticella sp.	Haringvliet, Oks 2091, from post-1932 channel; IJmuiden, Ole 339, 6.5 m – Amsterdam datum, from Young Holocene sands	Scaldisian of Antwerp
Vincularia sp.	Scheveningen, 8.70–8.75 m – surf.; Oegstgeest, 4.37–4.42 m – surf., both from Young Holocene sands	Ledian of Lede and Forest, Belgium
Nellia oculata BUSK	Haringvliet, Oks 2094, from post-1932 channel; Oegstgeest, 4.37–4.42 m – surf., from Young Holocene sands	Ledian of Lede and Forest, Belgium
Poricellaria sp.	Haringvliet, Oks 2102, from ? Calais beds; Scheveningen, 7.03–7.08 m – surf., from Young Holocene sands; Kijkduin, from Recent beach sand	Ledian of Forest, Belgium
Dittosaria sp.	Scheveningen, 8.70–8.75 m – surf., from Young Holocene sands	Ledian of Lede and Forest, Belgium
Cothurnicella sp.	Velsen, 3.40 m – Amsterdam datum, from Young Holocene sands	Recent: Calvados (Normandy), France (*C. pyriformis*)

APPENDIX II

Documentation of text-figures 2–6

The world distribution maps (test-figures 2–6) are based on data obtained from literature and on the author's own observations. Listed below are those occurrences that constitute new records.

Text-figure 2. World distribution of *Vincularia* (genus) sensu stricto

Miocene

Tertiary e5. Larat, Tanimbar Islands, Indonesia. FR. WEBER Coll.

Berili Marl (probably Tertiary g). My 1994. Malolos, Cebu Island, Philippines. W. V. MILROY Coll.

Tertiary f1. Bontang, East Borneo, Indonesia. Ex. Coll. Rijksmuseum van Geologie en Mineralogie, Leiden. J. WANNER Leg.

Tertiary f1. Mu 827. Approximate co-ordinates lat 3°58′44″ N, long 114°4′30″ E. Seria, State of Brunei. C. J. MULDER Coll.

Tertiary f3. Be 1421. Kali Ambunten, Madura Island, Indonesia.

Tuban Formation (Tertiary e5). h7 (5 m). Prupuh, East Java, Indonesia.

Sw 58. W. of Dadu, Raj River area, Kirthar Range, West Pakistan. H. STRUWE Coll.

Oligocene

Lower Coralline Limestone. Naxxar-2 deep test, Malta, 145–151′.

Calcaire à Astéries. Carrière de la Souys, Floirac (Gironde), France. A. J. KEIJ Coll.

Falun de Lesbarritz ("Stampian"). A 360. Gaas (Landes), France. C. W. DROOGER Coll.

Meson Formation. Between Moralillo and Meson, Veracruz, Mexico. Ex R. W. BARKER.

Eocene

B1–47, Gulf of Syrte are, SW Cyrenaica (Beda), Libya, 90–100′.

Sands of Brussels. Lga 26. Nalinnes, 10 km S. of Charleroi, Belgium = Stop 14 of 7th European Micropal. Colloquium 19161. R. LAGAAIJ Coll.

D 1206. Quebrada Bellaca, Edo. Barinas, Venezuela. Ex C. M. B. CAUDRI.

Jabaco Formation. B 322. 0.5 km S. of Ingenio Saratoga, Matanzas Province, Cuba. P. J. BERMUDEZ Coll.

Paleocene

B1–47, Gulf of Syrte area, SW Cyrenaica (Beda), Libya, 3142′.

The available data suggest that the genus became extinct in the Upper Miocene (probably Tertiary g). The Recent *Heterocella pentagona* CANU and BASSLER (Bryozoa of the Philippine Region, 1929. p. 111, pl. 9, figs. 13–16) from NE Borneo is probably not congeneric with *Vincularia* sensu stricto. This occurrence is, therefore, not shown on the map.

Text-figure 3. World distribution of *Nellia oculata* BUSK.

Reference is made to LAGAAIJ (Paleocene Bryozoa from a boring in Surinam; in the press) for a complete list of all the occurrences shown on this map.

Text-figure 4. World distribution of *Poricellaria* (genus).

The following records are new:

Recent

90.3.24.96 and 90.7.23.48 A.C. HADDON Station 2, Torres Straits, 20 miles NNW. of Warrior Island, 5½ fms. British Museum (Nat. Hist.).

T 1517. Gulf of Salwa, W. of Bahrein Island, Persian Gulf, 8 m. A. J. KEIJ Coll.

Miocene

Tertiary e5. Larat, Tanimbar Islands, Indonesia. FR. WEBER Coll.

Tertiary f3. Be 1421. Kali Ambunten, Madura Island, Indonesia.

Tuban Formation (Tertiary e5). h7 (5 m). Prupuh, East Java, Indonesia.

Marnes à Lépidocyclines ("Lower Aquitanian"). Petit Nid, W. of Sausset (Bouches-du Rhône), France. Ex I. M. VAN DER VLERK.

"Lower Aquitanian". La Brède (Gironde), France. Ex BIPM Stratotype Coll.

Oligocene

Lower Coralline Limestone. Naxxar-2 deep test, Malta, 145–151′.

Eocene

Asiut (Asyut), Nile valley, Egypt. Ex J. H. VAN VOORTHUYSEN.

Sands of Brussels. Lga 26. Nalinnes, 10 km S. of Charleroi, Belgium = Stop 14 of 7th European Micropal. Colloquium 1961. R. LAGAAIJ Coll.

San Fernando Formation. DB 321. Soldado Rock, Trinidad. D. A. J. BATJES Coll.

Jabaco Formation. B 322. 0.5 km S. of Ingenio Saratoga, Matanzas Province, Cuba. P. J. BERMUDEZ Coll.

Basal Red Bluff Marl. Shubuta Hill, Wayne County, Mississippi. Ex R. W. BARKER.

Text-figure 5. World distribution of *Dittosaria* (genus).

The following records are new:

Oligocene

Marianna Limestone. Mint Springs Member. Little Stave Creek, Clarke County, Alabama. Cf. O. L. BANDY (1949) samples 64, 65 and 66. D. D. BANNINK Coll.

Eocene

"Bartonian". Do 269. Etablissement des bains, Côte des Basques, Biarritz (Basses-Pyrénées), France = Stop 6 of 5th European Micropal. Colloquium 1957. J. E. DOLLÉ Coll.

Jabaco Formation. B 322. 0.5 km S. of Ingenio Saratoga, Matanzas Province, Cuba. P. J. BERMUDEZ Coll.

Basal Red Bluff Marl. Shubuta Hill, Wayne County, Mississippi. Ex R. W. BARKER.

REUSS's record (Zur fossilen Fauna der Oligocänschichten von Gaas. 1869. p. 468) of *Dittosaria prima* from the Oligocene of Gaas (Landes), France, is not shown on this map, because it most likely referred to a specimen of *Pasythea*.

Text-figure 6. World distribution of *Cothurnicella pyriformis* (BERTOLONI)

The following records are new:

Recent

88.4.16.39. on red algae cast up on beach between Recife and Olinda, Brasil. British Museum (Nat. Hist). RIDLEY Coll.

Stn. 1197. E. of Tobago Island, W.I. Top of core. 41 fms. Orinoco Shelf Expedition Coll., vide KOLDEWIJN (Sediments of the Paria-Trinidad Shelf. Rep. Orinoco Shelf Exped., III, 1958).

Miocene

Tertiary f1-2. Ct 5971. Arnih, Madura Island, Indonesia.

Tuban Formation (Tertiary e5), h7 (5 m). Prupuh, East Java, Indonesia.

Falun de Lariey ("Upper Aquitanian"), near Saucats (Gironde), France. Ex BIPM Stratotype Coll.