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PALEOCENE BRYOZOA FROM A BORING IN SURINAM

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SUMMARY

Two species of Bryozoa, identified as belonging to the genera *Nellia* and *"Vincularia"*, occur in some quantity in the Paleocene interval in the boring Alliance-28, drilled in the coastal plain of Surinam (Dutch Guiana). Both the *Nellia* and the *"Vincularia"* occur in assemblages virtually consisting of one single species. Recent assemblages in which *Nellia* makes up 80-100% of the total count indicate shallow inner-neritic (2-10 fathoms) conditions, coupled with slightly reduced salinities (<33‰). A similar environment is inferred for the Paleocene *Nellia* assemblage in the boring.

INTRODUCTION

During the microfaunal analysis by the Netherlands Geological Survey of core samples from the boring Alliance-28, drilled in the coastal plain of Surinam (Dutch Guiana), a few samples were found to contain specimens of Bryozoa. I am grateful to Dr. J.H. van Voorthuysen, the Survey's palaeontologist, for submitting this material to me, and thus giving me the opportunity to participate in this interesting team study. For the location of this boring and for its stratigraphy the reader is referred to Van Voorthuysen (1969). The specimens, which have been returned and are now kept in the Geological Survey collections under the registration numbers B 121 - B 127, all originate from the Paleocene interval (258.85–321.80 m) in the boring.

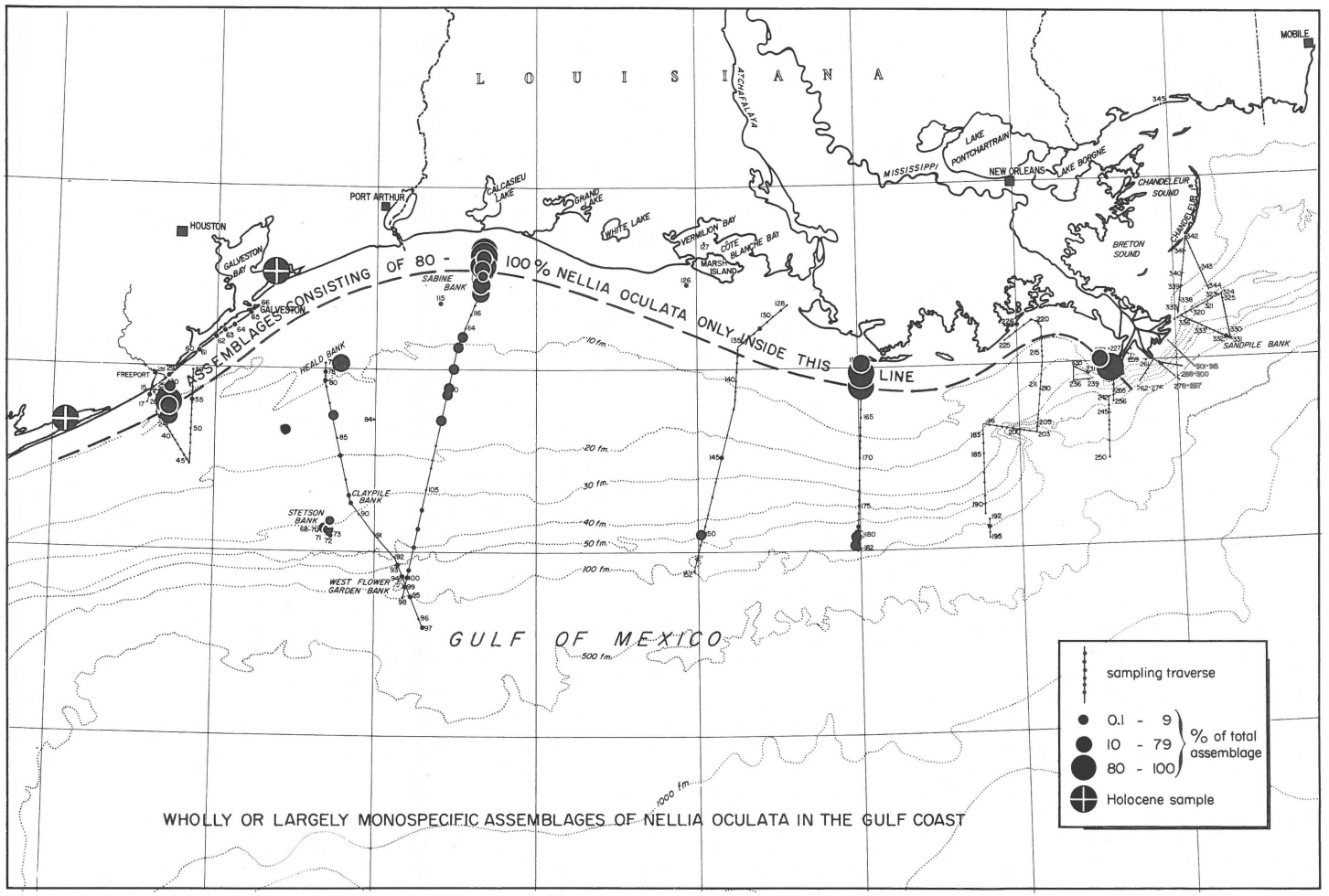
259.20 m	*Nellia oculata*	14 specimens
	indet. erect bilamellar anascan Cheilostome	2 specimens
303 m	indet., erect Cyclostome	1 specimen
303.70 m	*"Vincularia" cristata* sp. nov.	1 specimen
310 m	*"Vincularia" cristata* sp. nov.	12 specimens
311.90 m	*"Vincularia" cristata* sp.nov.	1 specimen
321.80 m	*Nellia oculata*	1 specimen

STRATIGRAPHICAL AND PALAEOECOLOGICAL IMPLICATIONS

The time-stratigraphical information one gathers from this small collection does not contradict the Paleocene age suggested for this interval by the Foraminifera. The genus *Nellia* has a known range of Paleocene (Midway) to Recent. *Nellia oculata* itself has been reported from beds as old as "Sparnacian" (Plaziat & Balavoine, 1964), and definitely dated as Ilerdian – lower Lutetian by the presence of the larger foraminiferal genus *Glomalveolina*. *"Vincularia"* of the general type of *"V." cristata* ranges from Upper Cretaceous to Paleocene (Midway). Its latest representative is *Smittipora midwayanica* Canu & Bassler from the Midway of the southern USA, to which *"V." cristata* bears a general resemblance. The association of the genera *Nellia* and *"Vincularia"*, whose ranges overlap in the Paleocene, would thus be entirely compatible with a Paleocene age for the Bryozoa-bearing interval in the Alliance-28 boring.

The palaeoecological information is equally positive. To this end one has to take into account that even the two most promising assemblages in this small collection (at 259.20 and 310 m) consist wholly or largely of a single species. Among groups of marine invertebrates it is quite uncommon for assemblages to consist of one single species. Yet such cases are of singular importance to the (palaeo-)ecologist in that they draw his attention to the existence of marine conditions that departed from normal. It is perhaps not too far-fetched to say that in many cases

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WHOLLY OR LARGELY MONOSPECIFIC ASSEMBLAGES OF NELLIA OCULATA IN THE GULF COAST

Fig. 1

one can find out just as much about ancient marine and paralic environments from these *unispecific* assemblages as from what are usually called the "rich" assemblages, i.e. those consisting of a great many specimens and species. Unispecific assemblages are particularly rare among the non-incrusting Bryozoa. However, a pertinent example of Recent assemblages dominated by *Nellia oculata* is available in the Gulf of Mexico.

Although *Nellia oculata* commonly occurs in both the northwestern and the eastern Gulf at depths of 2 to about 50 fathoms, only in a narrow zone along the coast between Freeport (Texas) and West Bay (Mississippi Delta) does it constitute more than 80% of the total count (fig. 1 and Appendix I). This is not only an area of shallow (2-10 fathoms) and turbulent water, but also of somewhat reduced (< 33‰) salinities (P a r r, 1935, text-fig. 10). In these recent samples the high percentage counts often coincide with a good number of specimens per sample (Plate I, fig. 1). This is also the case in two Holocene subsurface samples, one taken from the open-bay interval 10 ft below the present Colorado River delta surface in Matagorda Bay, Texas, and the other at 30 ft below East Bay (Galveston Bay), Texas (Plate I, fig. 2). These Holocene occurrences have also been included in fig. 1.

Recently, R u c k e r (1965) has reported small quantities of *Nellia tenella* (= *N. oculata*), unaccompanied by any other Bryozoa, from the nearshore silts and clays along the Orinoco delta – Guiana coastline. According to N o t a (1958, pp. 31, 38) the inshore waters where these silty pelites are being deposited are very shallow, from 10 to 20 fathoms, and characterised by "their rather low and variable salinity" (< 32.5‰).

Examples of older fossil bryozan assemblages consisting wholly of *Nellia oculata* occur in a number of scattered localities outside the Gulf Coast. In all cases shallow inner-neritic depths coupled with slightly reduced-salinity conditions are inferred:

1) In the Quaternary Paria Formation at 350′ depth in Compañía Shell de Venezuela boring Guanipa-2, Delta Amacuro, Eastern Venezuela (Plate I, fig. 3);
2) In the Late Miocene – Pliocene (Tertiary g) Miri Formation of a road-cut along the Brunei-Tutong road, Jerudong, Brunei, Borneo (Plate I, fig. 4);
3) In the Sarmatian (Late Miocene) of the Czechoslovakian part of the inner-alpine Vienna Basin (P o k o r n ý, 1945), in what P o k o r n ý termed "brackish neritic deposits"[1]);
4) In the subsurface Miocene at 7434′ depth in Shell-BP Petroleum Development Company boring Elelenwa-2, Nigeria (plate I, fig. 5).

It is by analogy with these Recent and fossil occurrences of wholly or largely unispecific *Nellia oculata* assemblages, that I venture to suggest that the Paleocene *Nellia oculata* assemblage from 259.20 m in the Alliance-28 boring was deposited in a slightly brackish shallow inner-neritic or open-bay environment.

SYSTEMATIC DESCRIPTIONS

Division MALACOSTEGA LEVINSEN, 1902
Genus *Nellia* Busk, 1852

Nellia oculata Busk
(fig. 2)

1852 *Nellia oculata* Busk, p. 18, pl. 64, fig. 6; pl. 65, fig. 4.
1920 *Nellia oculata* Busk: Canu & Bassler, p. 196, pl. 82, figs. 6-10.
1926 *Nellia oculata* Busk: Harmer, p. 240, pl. 14, figs. 18-20 (including var. *quadrilatera* d'Orbigny).
1962 *Nellia tenella* (Lamarck) Cheetham, p. 326, pl. 1, figs. 4-5.
1963 *Nellia tenella* (Lamarck) Cheetham, p. 59, pl. 1, fig. 14.

Material: B.127; 14 fragments, from 259.20 m (Plate I, fig. 6). B.126; 1 fragment, shown in fig. 2, from 321.80 m.

Remarks

The specimens from 259.20 m are poorly preserved and several of them consist only of regenerated zooecia. The single specimen from 321.80 m, on the

[1]) "seichte neritische Ablagerungen" (P o k o r n ý, 1945, p. 10). The lengthy discussion of this find (*loc. cit.*, p. 11-13) makes interesting reading in the light of the above observations. Since *Nellia oculata* had never been reported as occurring in waters of somewhat reduced salinity, Pokorný was at a loss to explain the presence of this allegedly marine species in the Vienna Basin part of the brackish Sarmatian inland sea.

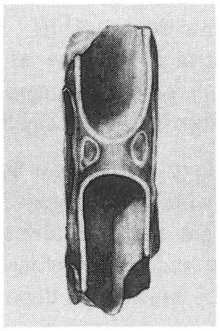


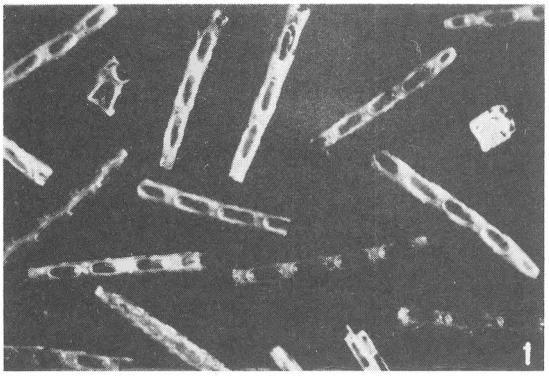
Fig. 2
Nellia oculata Busk. x50. Fragment of internode. Boring Alliance-28, 321.80 m.

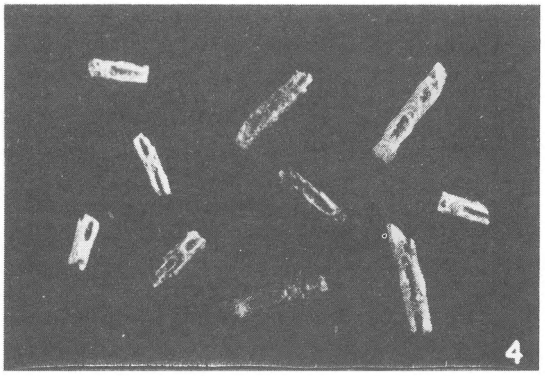
other hand, is in much better condition and shows (fig. 2) size and shape of the paired avicularia on the proximal gymnocyst and their position relative to the opesia, and also the v-shaped trough inside the opesia formed by the inward-sloping lateral walls. The opesia itself is slightly wider, and the whole aspect of the prismatic stem is slightly more robust than in geologically younger specimens of *Nellia oculata* (see also Plate I), but this difference, even if it is real, can hardly be considered of specific importance.

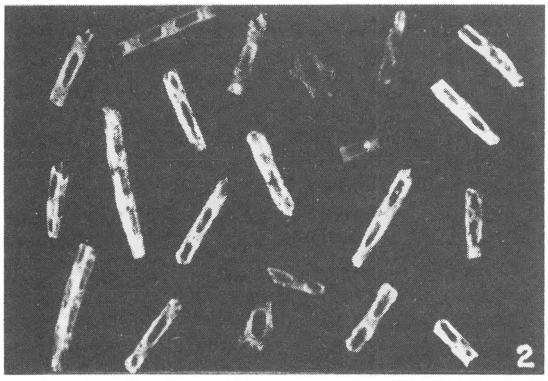
This is easily the oldest fossil record of this species, which in the Eocene had already spread to North America, Western Europe and North and West Africa. Fig. 3 summarises the present state of our knowledge of its fossil and Recent distribution, based on literature data and on my own observations. A list of the localities shown on this map is appended (Appendix II).

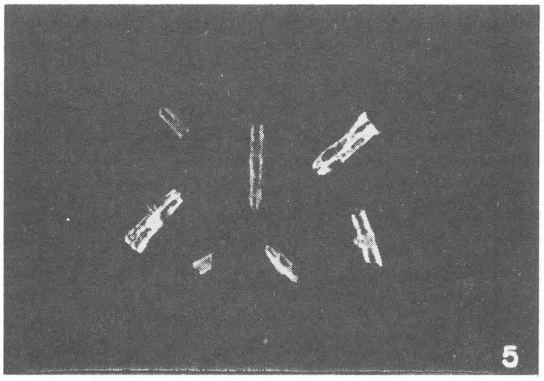
From a closer examination of this map some interesting zoogeographical conclusions can be drawn. There is the lack of Eocene and Oligocene records from Asia and Australia. It is difficult to assess how much of this is due to the lack of data pertaining to this part of the world and how much is real. The available data suggest that the distribution of *Nellia oculata* in Eocene and Oligocene times was largely identical: tropical amphi-Atlantic, although its occurrence in the Manta Shale of Ecuador is an interesting Oligocene outstep into the East Pacific. In the Miocene it had reached circum-tropical dimensions. From then onward it has remained essentially unchanged, except that already in the Pliocene the species had lost its hold in West and Central Europe and in the Mediterranean area.

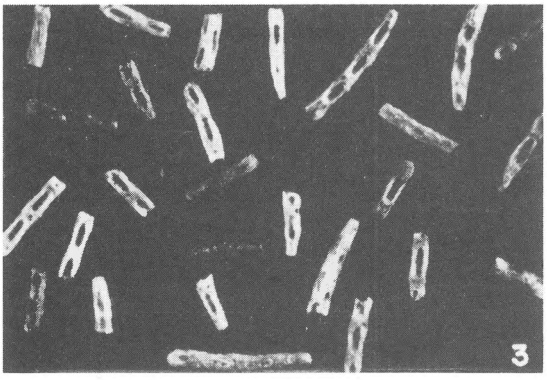
The present distribution of the species, an inheritance from a long geological past, is circum-tropical and -subtropical, with an extension into the southern Indian Ocean. It has lost much of its claim to exemplify a typical disjunct pattern, as H a r m e r thought in 1926, now that *Nellia oculata* has been found living in the East Atlantic, N. of Fernando Poo. The striking incongruity in the Recent distribution is that this species, which is so widely distributed in the shallow to moderately deep nearshore waters in the tropics and subtropics, occasionally ventures into deeper and much colder water. Its deepest record, from 210 fathoms, is from off Possession Island (B u s k, 1884), one of the Crozet Islands. This depth would correspond to a bottom water temperature at this locality of some 4°C (vide S v e r d r u p, J o h n s o n & F l e m i n g, 1960, Chart V). Another record, less deep but even farther South, is from Heard Island. This is S. of the Antarctic convergence, and would therefore equally represent a bottom water temperature of only a few °C. It is certainly remarkable that, if this species is capable of adapting itself to such low temperatures, it should not be more widely distributed in the higher latitudes. Obviously temperature is here not the main controlling factor. This impression is obtained both from the global picture and from relatively minor distributional details. Certainly temperature would not have prevented *Nellia oculata* from spreading northward – as did so many other elements of the West Indian warm-water fauna – towards the Beaufort, N.C., area and Bermuda. The Beaufort area, in particular, may be considered as sufficiently well investigated to state with some confidence that *Nellia oculata* is absent from its fauna. Also unexplained is the lone occurrence of the species near La Plata Island, Ecuador. Despite the enormous improvement, during the past decades, in our knowledge of the warm-water faunas along the West coast of the American continent, this has remained the only record from the East Pacific. The situation is suggestive of a relict occurrence in this case, originating from an Oligocene expansion into the area.











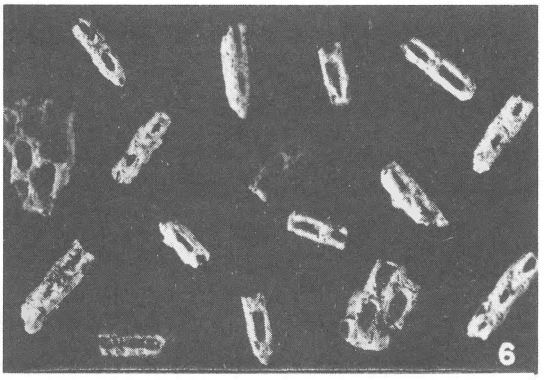


PLATE I

Wholly or largely unispecific assemblages of *Nellia oculata*

Fig. 1 – Recent. Locality number 125. Cavalier 1956 Station 286. Off Calcasieu Lake, Louisiana. Depth 32′.

Fig. 2 – Holocene. 30′ below present East Bay (Galveston Bay), Texas.

Fig. 3 – Quaternary. Parıa formation. C.S.V. well Guanipa-2, 350′. Delta Amacuro, Eastern Venezuela.

Fig. 4 – Late Miocene – Pliocene (Tertiary g). Miri formation. Road-cut along the Brunei-Tutong road, Jerudong, Brunei, Borneo.

Fig. 5 – Miocene. Shell-B.P. Petr. Dev. Comp. well Elelenwa-2, 7434′. Nigeria.

Fig. 6 – Paleocene. Boring Alliance-28, 259.20 m. Surinam (Dutch Guiana).

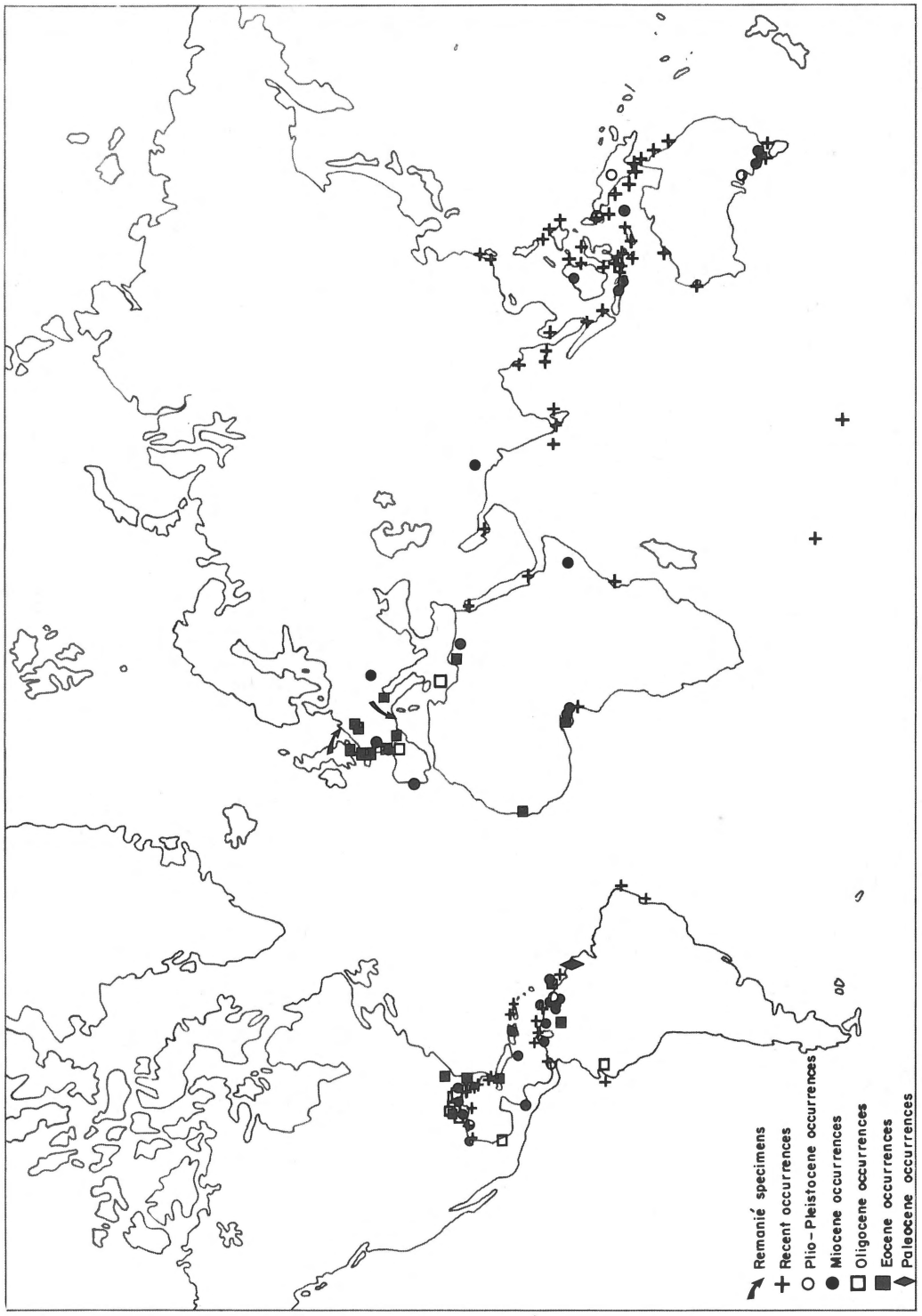


Fig. 3
World distribution of *Nellia oculata*

Division COILOSTEGA LEVINSEN, 1909

Genus "*Vincularia*" Auctt.

"Vincularia" cristata sp. nov.
(fig. 4)

Holotype: B.124; the fragment here shown as fig. 4, from 310 m.

Paratypes: B.123; the remaining 11 specimens from the sample, 310 m.

Other material: B.121 and B.122; two specimens from 303,70 m and 311.90 m respectively.

Description

Zoarium erect, consisting of long and delicate, 8- or 10-sided, prismatic stems, with the zooecia opening on all faces. Zooecia arranged quincuncially in longitudinal rows, narrow, elongate-hexagonal, indistinctly separated from one another by their joint raised rims. Opesia elongate-elliptical, at the extreme distal end of and occupying about two-fifths of the total length of the zooecium, the proximal lip bearing a very characteristic small pectinate denticle. Cryptocyst well-developed proximally, smooth, depressed in the middle and reaching its lowest point near the proximal lip of the opesia. Avicularia and ovicells lacking.

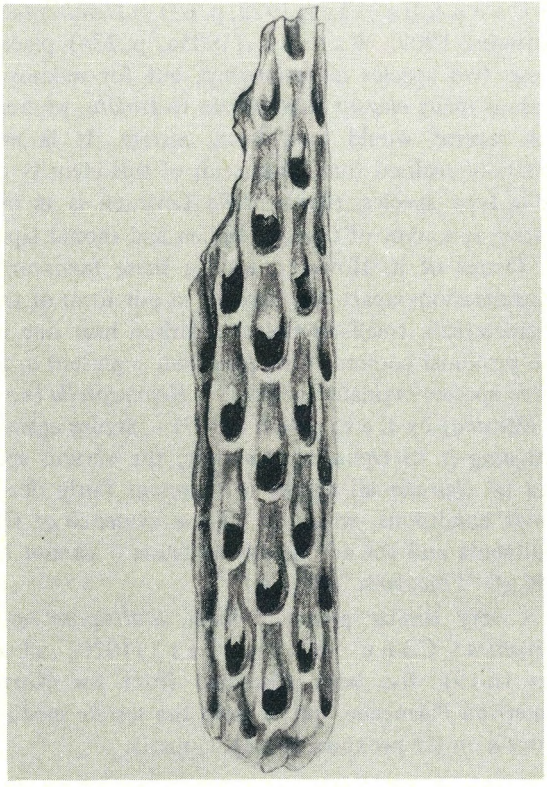


Fig. 4
"Vincularia" cristata sp. nov. x40. The holotype. Boring Alliance-28, 310 m.

Remarks

I follow V o i g t (1962, pp. 247-248) in his wide use of the term "*Vincularia*" for this group of Upper Cretaceous – Paleocene Coilostega with narrow rod-like zoaria, which J u l l i e n (1881) had previously included in his genus *Smittipora*. Eventually one or more new generic names will have to be given to this group, in order to avoid consusion with *Vincularia* sensu stricto, which is a Paleocene – Upper Miocene genus, well-defined by its type species *Vincularia fragilis* Defrance, and a senior synonym of *Heterocella* Canu, 1907 (B r o w n, 1952, p. 91).

The presence of the proximal denticle in the opesia of *"Vincularia" cristata* is reminiscent of conditions obtaining in three other Anascan genera, viz. *Biflustra* d'Orbigny, 1852, *Odontionella* Canu & Bassler, 1917 and *Ogivalia* Jullien, 1881. In *Biflustra* this structure is often present, e.g. in the type species, *B. ramosa* d'Orbigny (see B u g e, 1956), and notably in a number of species with narrow rod-like zooecia, such as *B. savartii* (Audouin) var. *cetrata* Harmer, *B. quadrata* (Canu & Bassler), *B. virgata* (Canu & Bassler) and *B. limosa* (Waters; see L e v i n s e n, 1909, pl. 22, fig. 5a). However, *"Vincularia" cristata* is not sufficiently membraniporoid, the distal progression of its cryptocyst is too far advanced, to justify its inclusion in *Biflustra*, or for that matter in *Odontionella*.

The third genus in which a proximal denticle can develop is *Ogivalia*. Admittedly there is no indication of this structure in the original figure of *Vincularia elegans* d'Orbigny, the type species from the Falkland Islands, but a later refiguration of d'Orbigny's figured specimen by W a t e r s (1905a, pl. 29, fig. 9) clearly shows it to be present in at least some of the zooecia. This new figure also shows the presence of small, unilateral, frontal avicularia and of a bridge across the opesia formed by the coalescence of two lateral processes. W a t e r s (1905a, 1905b) was thus able to prove the identity of *Vincularia elegans* with *Vincularia labiata* Busk, 1884, the genolectotype (selected

by Canu & Bassler, 1923, p. 69) of *Hemiseptella* Levinsen, 1909. Waters (1905a, p. 234) placed these two species in synonymy, but for unknown reasons made *elegans* subordinate to *labiata*, whereas the reverse would have been correct. It is not generally realised that, as a result of this identity of their type species, *Hemiseptella* Levinsen is an objective synonym of *Ogivalia* Jullien and should lapse in favour of it. However, leaving these taxonomic considerations apart, the absence in our form of the characteristic small frontal avicularium near one of the proximal corners of the zooecium – present in all three species orginally included in *Hemiseptella* (now = *Ogivalia*) by Levinsen (1909) – argues against assigning it to *Ogivalia*. Moreover, the various species of *Ogivalia* all appear to represent fairly deep-water conditions, which – on the evidence of the sediments and the accompanying fauna – cannot be said of *"Vincularia" cristata.*

A very similar prismatic form, *Smittipora midwayanica* Canu & Bassler (1920, pl. 4, figs. 16-19), has been described from the North American Paleocene, but it lacks the serrate median process on the proximal lip of the opesia.

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APPENDIX I

Occurrences of *Nellia oculata* Busk in the Northwestern Gulf of Mexico (as shown on fig. 1).

Recent

Locality no.	Lat. N.	Long. W.	Depth in ft	Description	Number of specimens in approx. 30 grammes	% of total assemblage
31	28°53′16″	95°15′30″	40	Cavalier 1956 Sta.2	1	6
35	28°47′57″	95°15′24″	62	Cavalier 1956 Sta.19	94	97
36	28°47′30″	95°15′24″	59	Cavalier 1956 Sta.20	6	16
37	28°45′16″	95°15′24″	64	Cavalier 1956 Sta.21	1	10
64			LWM	Galveston Island Beach near 8 mile road	1	–
67	28°40′	94°33′	90	Univ. of Houston samples no. 1-4	1	0.7
68	28°10′42″	94°15′	180	Vema-3 1954 Core no. 65	1	0.2
73	28° 8′42″	94°16′17″	191	Univ. of Houston sample no. 13	1	3
74	28°11′22″	94°15′30″	186	Univ. of Houston sample no. 5	1	0.3
77	29° 4′	94°14′	63	Heald Bank	6	11
83	28°43′44″	94°14′54″	90	Cavalier 1956 Sta. 326	1	4
88	28°20′	94° 9′	138	Cavalier 1956 Sta.322 (live specimens taken off large *Spondylus*)	14	
108	28°43′	93°34′45″	90	Cavalier 1956 Sta.302	2	1
109	28°49′	93°33′15″	74	Cavalier 1956 Sta.301	1	1
110	28°52′30″	93°32′	66	Cavalier 1956 Sta.300	1	0.8
111	28°59′15″	93°30′15″	67	Cavalier 1956 Sta.299	12	5
112	29° 6′	93°28′12″	66	Cavalier 1956 Sta.298	2	6
113	29°11′30″	93°26′	54	Cavalier 1956 Sta.297	3	2
118	29°23′48″	93°20′ 4″	39	Cavalier 1956 Sta.293	24	34
119	29°24′42″	93°20′	42	Cavalier 1956 Sta.292	76	48
120	29°26′24″	93°19′55″	24	Cavalier 1956 Sta.291	1	0.8
121	29°27′28″	93°19′50″	39	Cavalier 1956 Sta.290	3	17
122	29°30′21″	93°19′38″	40	Cavalier 1956 Sta.289	61	81
123	29°33′30″	93°19′26″	39	Cavalier 1956 Sta.288	15	79
124	29°36′45″	93°19′14″	35	Cavalier 1956 Sta.287	9	100
125	29°40′35″	93°19′40″	32	Cavalier 1956 Sta.286	87	97
150	28° 5′15″	91°58′	228	Cavalier 1956 Sta.278	1	0.1
153	29° 1′48″	90°59′36′	16	Cavalier 1956 Sta.248	2	17
155	28°58′31″	90°59′36′	26	Cavalier 1956 Sta.246	1	100
159	28°54′25″	90°59′36′	16	Cavalier 1956 Sta.242	1	100
179	28° 6′30″	91° 1′	225	Cavalier 1956 Sta.227	2	0.3
181	28° 4′	91° 1′	342	Cavalier 1956 Sta.229	11	4
228	29° 2′54″	89°28′26″	32	Cavalier 1956 Sta.128	1	25
230	28°59′18″	89°25′12″	13½	Cavalier 1956 Sta.123	55	100

Holocene

10′ below present Colorado River delta surface in Matagorda Bay, Texas	32	80
30′ below present East Bay (Galveston Bay), Texas	79	80

APPENDIX II

The following occurrences of *Nellia oculata* have been indicated on the map (fig. 3); those marked * constitute new records of the species.

Recent

1. Bass Strait (Levinsen, 1909)
2. Victoria (MacGillivray, 1880)
3. Queensland (Haswell, 1880)
4. Low Isles, Howick Is., etc., Great Barrier Reef (Hastings, 1932)
5. Cape Grenville
6. Torres Strait (Busk, 1852)
7. Lat. 9°59′S., long. 139°42′E. (Busk, 1884)
8. Lat. 8°56′S., long. 136°5′E. (Busk, 1884)
9. Aru Islands (Marcus, 1922)
10. Banda, Banda Sea (Harmer, 1926)
11. Seget, N. end of New Guinea (Harmer, 1926)
12. Nagubat Island, east coast of Mindanao, Philippines (Canu & Bassler, 1929)
13. Tacbuc Point, Leyte, Philippines (Canu & Bassler, 1929)
14. Lat. 11°37′N., long. 123°31′E. (Busk, 1884)
15. Formosa Strait (Silén, 1941)
16. Amoy (Hastings, 1932)
17. N. Ubian, Sulu Archipelago (Harmer, 1926)
18. Moearas Reef, E. Borneo (Harmer, 1926)
19. Kwandang Bay, N. Celebes (Harmer, 1926)
20. Borneo Bank, Strait of Makassar (Harmer, 1926)
21. Makassar, S.W. Celebes (Harmer, 1926)
22. Saleyer, S. of Celebes (Harmer, 1926)
23. Timor, E. (Harmer, 1926)
24. Samau Island, W. Timor (Harmer, 1926)
25. Nangamessi Bay, N. Sumba (Harmer, 1926)
26. Badjo Bay, W. Flores (Harmer, 1926)
27. Bima, Sumbawa, N. (Harmer, 1926)
28. Batjulmati, Java (Harmer, 1926)
29. Cape Jaubert (Marcus, 1921)
30. Sharks Bay (Marcus, 1939)
31. Gaspar Straits (Thornely, 1907)
32. Malacca Strait (Silén, 1941)
33. Siam (Levinsen, 1909)
34. Mergui Archipelago (Hincks, 1887)
35. Andaman Islands (Thornely, 1907)
36. Coast of Arracan (Busk, 1884)
37. Trincomalee, Ceylon (Busk, 1884)
38. Gulf of Manaar (Thornely, 1905)
39. Laccadive Islands (Robertson, 1921)
*40. Off Qatar, Persian Gulf, 21 m
41. Lat. 15°N., long. 41°E. (Waters, 1909)
42. Gulf of Suez (Balavoine, 1959)
43. Zanzibar (Waters, 1909)
44. Possession Island, Crozet Group (Busk, 1884)
45. Heard Island (Busk, 1884)
*46. N. of Fernando Poo, 26-42 fms
47. Off Bahía (Busk, 1884)
48. Recife (Marcus, 1939)
*49. Orinoco shelf, off mouth of Essequibo River, 37 fms
50. N. of Margarita Island (Osburn, 1947)
51. Tortuga Island, Venezuela (Osburn, 1947)
52. Curaçao (Osburn, 1927)
53. Cape la Vela, Colombia (Osburn, 1947)
54. Caledonia Bay, Panama (Osburn, 1947)
55. St. Thomas, West Indies (Levinsen, 1909)
56. Puerto Rico (Osburn, 1940)
*57. Off Triumph Reef, Florida, 45 fms
58. Tortugas, Florida (Osburn, 1914)
*59. Tampa Bay, Florida, 2-6 fms
60. Albatross 1885 Station D. 2405 (Canu & Bassler, 1928), lat. 28°45′N., long. 85°02′W.
61. Off Dog Island, Florida (Shier, 1964)
*62. West Bay, Mississipi Delta, 2 fms
*63. Off Calcasieu Pass, Louisiana, $5\frac{1}{2}$ fms
*64. Off Freeport, Texas, $10\frac{1}{2}$ fms
65. La Plata Island, Ecuador (Osburn, 1950)

Plio-Pleistocene

1. "Upper Pliocene", South Australia (Brown, 1956)
* 2. Boeroe Formation (post-Tertiary f), Star Mountains, New Guinea
* 3. Klasaman Formation (Tertiary g/h), Waileh, Salawati Island, opposite W. end of Bird Head's Peninsula, New Guinea
* 4. Paria Formation, Compañía Shell de Venezuela boring Guanipa-2, Delta Amacuro, Eastern Venezuela, 350′ (cuttings)
5. "Pliocene", Bocas Island, Almirante Bay, Panama (Canu & Bassler, 1928)
* 6. Federal Block A-72, Shell-Continental boring 'Neptune-2', long. 94°W., lat. 28°40′N., 1030-1060′; 2870-2900′ (cuttings)

Miocene

1. "Balcombian", Muddy Creek, near Hamilton, Victoria (MacGillivray, 1895)
2. Myaring Beds, Glenelg Group, Victoria (Brown, 1958)
* 3. Tertiary e5, Larat, Tanimbar Islands, Indonesia
* 4. Tertiary f3, Kali Ambunten, Madura Island, Indonesia
* 5. Tuban Formation (Tertiary e5), Prupuh, East Java, Indonesia
* 6. Miri Formation (Tertiary g), Brunei-Tutong Road, Brunei, Borneo
* 7. Lower Gaj Formation, W. of Dadu, Gaj River area, Kirthar Range, West Pakistan
* 8. "Lower Miocene", Sinclair Oil Corporation boring Oddo Alimo-1, Somalia, long. 42°25′8″E., lat. 0°4′16″N., 5272-5276′ (core)
9. "Helvetian", Mersa Matruh, Egypt (Canu, 1912)
10. "Sarmatian", Gbely (Egbell), Czechoslovakia (Pokorný, 1945)
*11. "Savignéan", Mirebeau (Vienne), France
12. "Aquitanian", La Brède (Gironde), France (Vigneaux, 1948)
13. "Aquitanian", Lisbon, Portugal (Galopim de Carvalho, 1962)
*14. Agbada Formation, Shell-BP Petroleum Development

Company boring Elelenwa-2, near Port Harcourt, Nigeria, 7343′ (core)
*15. "Miocene", 10 km N. of Tiko, E. of Mount Cameroon, Nigeria
*16. Savaneta Member, Springvale Formation, Springvale, Trinidad
*17. Oficina Formation, Compañía Shell de Venezuela boring Cerro Negro-1, Edo. Bolivar, Eastern Venezuela, 2593-2613′
*18. Officina Formation, Azul Member, Socony Mobil Oil Company boring Guario-1, Edo. Anzoátegui, Eastern Venezuela, 1647-1657′ (core)
*19. Carapita Formation, Creole Petroleum Corporation boring J-274, Edo. Monagas, Eastern Venezuela, 5305-5320′, 6475-6490′ (cuttings)
*20. Roblecito Formation, Caracas Petroleum Company boring Barbula-1, Edo. Guarico, Eastern Venezuela, 300-330′; 420-450′ (cuttings)
*21. Cubagua Formation, Socony Mobil Oil Company boring Cubagua-1, Cubagua Island, Eastern Venezuela, 218′
*22. La Rosa Formation, Shell Venezuelan Oil Concessions boring Quiroz-3, Edo. Zulia, Western Venezuela, 1700-1710′ (core)
*23. Tubará Formation, San Juan de Acosta, Depto. Atlantico, Colombia
24. Cercado Formation, Cercado de Mao, Santo Domingo (Canu & Bassler, 1919)
25. Bowden Formation, Bowden, Jamaica (Lagaaij, 1959)
*26. "Miocene", Livingston, Guatemala
*27. Chipola Formation, Alum Bluff, about 4 mi. N. of Bristol, Liberty County, Florida
*28. Chickasawhay Formation, "LC" locality, Limestone Creek, Wayne County, Mississippi
29. "Lower Miocene", Superior Oil Producing Company boring Hernandez no. 1, Acadia Parish, Louisiana, 7950-8543′ (McGuirt, 1941)
*30. "Miocene", Humble Oil & Refining Company boring E. Freeport St. 278 no. 2, Brazoria County, Texas, 7570-7580′ (cuttings)

Oligocene

* 1. Lower Coralline Limestone, British Petroleum Company boring Naxxar-2, Malta, 38-151′ (cuttings)
2. "Stampian", Gaas (Landes), France (Reuss, 1869, as *Vincularia hians*)
3. Marianna Limestone, Salt Mountain, 5 mi S. of Jackson, Alabama (Canu & Bassler, 1920)
4. Byram Marl, W. of Woodward, Wayne County, Mississippi (Canu & Bassler, 1920)
5. Byram Marl, Byram, Mississippi (Canu & Bassler, 1920)
6. Marianna Limestone, Vicksburg, Mississippi (Canu & Bassler, 1920)
7. Vicksburg Group, Rosefield, Catahoula Parish, Louisiana (McGuirt, 1941)
* 8. Meson Formation, between Moralillo and Meson, Veracruz, Mexico
* 9. Manta Shale, about 3 mi. W. of Manta, Ecuador

Eocene

* 1. "Bruxellian", Nalinnes, near Charleroi, Belgium
2. "Lutetian", Chaussy (Seine-et-Oise), France (Canu, 1908, as *Farcimia tenella*)
3. "Lutetian", Southampton, England (Davis, 1934)
4. "Lutetian", Orglandes (Manche), France (Canu, 1908, as *Farcimia tenella*)
5. "Lutetian", Bois-Gouët (Loire-Atlantique), France (Balavoine, 1959)
* 6. Calcaire de Blaye, Blaye (Gironde), France
7. "Sparnacian", Carla-de-Roquefort (Ariège), France (Plaziat & Balavoine, 1964, as *Nellia tenella*)
8. "Priabonian", Priabona, Italy (Braga, 1963, as *Nellia tenella)*
* 9. "Middle or Upper Eocene", Libya Shell boring B 1-47, West Cyrenaica, Libya, 90-100′, 280-290′ (cuttings)
*10. "Lower Eocene", Shell-BP Petroleum Development Company boring Gbekebo-1, Nigeria, 1900′ (core)
*11. "Upper Lutetian", Tabakali, Senegal (Gorodiski & Balavoine, 1961, as *Nellia tenella*)
12. McBean Formation, Richmond County, Georgia (Cheetham, 1962, as *Nellia tenella*)
13. Ocala Group, Florida (Cheetham, 1963, as *Nellia tenella*)
14. Jackson Formation, Tullos, La Salle Parish, Louisiana (McGuirt, 1941)
*15. Jabaco Formation, 0.5 km S. of Ingenio Saratoga, Matanzas prov., Cuba
*16. "Upper Eocene", Quebrada Bellaca, Edo. Barinas, Venezuela (identification questionable)
*17. San Fernando Formation, Soldado Rock, Trinidad, B.W.I.

Paleocene

* 1. "Paleocene", boring Alliance-28, Surinam, 259.20 m; 321.80 m (cores)

Remanié occurrences

* 1. Holocene sands, shallow core hole no. 113, 5 mi. N. of Les Saintes Maries de la Mer (Bouches-du-Rhône), France, 3-4 m – surface (core)
* 2. Recent sands filling post-1932 channel, excavation in Haringvliet estuary, The Netherlands