Meded. Werkgr. Tert. Kwart. Geol. | vol. 19(4) | pp. 127-140 | 1 fig., 3 pl. | Leiden, december 1982

NOTES ON BRYOZOA, 2. *MEMBRANIPORELLA GIGAS* N. SP., AND SOME OTHER ADDITIONS TO THE BRITISH CORALLINE CRAG BRYOZOAN FAUNA

by

G.C. Cadée
Texel

Cadée, G.C. Notes on Bryozoa, 2. *Membraniporella gigas* n. sp., and some other additions to the British Coralline Crag bryozoan fauna . - Meded. Werkgr. Tert. Kwart. Geol., 19(4), pp. 127-140, 1 fig., 3 pl. Leiden, December 1982.

Collections made during the International Bryozoology Association (IBA) post-conference fieldmeeting in September 1980 contained one undescribed species (*Membraniporella gigas*) and a number of species new for the British Coralline Crag [(*Crisia eburnea* (L.), *Crisia aff. strangulata* Buge, *Tubulipora subdisticha* Buge, *Diplosolen obelium* (Johnston), *Rhamphonotus spelaeus* Lagaaij, *Scrupocellaria elliptica* (Reuss), *Scrupocellaria* sp., *Vittaticella elegans zangheri* Neviani and *V. cippolai* Neviani)]. Particularly one locality, Crag Farm near Sudbourne, with crossbedded sediments deposited in a strong current environment, prooved to be rich in loose internodes of articulated catenicelliform and cellariform Bryozoa. These are species which due to the flexibility of their articulated colonies are adapted to live in a high energy environment.

Dr. G.C. Cadée, Waterweg 12, 1791 LH Texel, The Netherlands

Contents:

" ... *il s'était donné la fantasie des collections. Pour les médicins philosophes adonnés à l'étude de la folie, cette tendance à collectioner est un premier degré d'aliénation mentale, quand elle se porte sur les petites choses*".
Honoré de Balzac, 1842. Albert Savarus ed. Livre de Poche no 2339, p. 70 (1968)

INTRODUCTION

A large proportion of the carbonate fraction of the British Pliocene Coralline Crag is comprised by skeletal remains of bryozoans. They have attracted attention already long ago: Taylor (1830) published the first figures and Wood (1844) the first species list. At that time these Bryozoa were still regarded as corals, hence the name Coralline Crag. Busk (1859) monographed the British Crag Bryozoa. Almost one century later Lagaaij (1952) published his monograph on the Pliocene Bryozoa of The Netherlands (*s.lat.*) and revised most of the British material used by Busk. He also studied some new British material and added a number of species to the British Crag fauna. Recently this rich bryozoan fauna aroused renewed interest and apart from systematics (Cadée, 1981) attention was paid to the environment of deposition and paleobiology of the Bryozoa (Balson, 1981; Balson & Taylor, 1982).

During the International Bryozoology Association (IBA) postconference fieldmeeting we visited some East Anglian Coralline Crag exposures (Taylor, Larwood & Balson, 1980, 1981). The material I collected contained some species hitherto unknown from these deposits. Particularly one locality (Crag Farm) prooved to be rich in small fragile internodes of articulated bryozoans (*Crisia, Vittaticella, Scrupocellaria*), surprisingly preserved in a crossbedded sediment apparently deposited in a strong current environment (Balson, 1981, Taylor, Larwood & Balson, 1980, 1981). Due to recristallization finer details of these bryozoans were obliterated, which made identification to the species level sometimes difficult.

DESCRIPTION OF THE AREA, EXPOSURES AND METHODS

The following is based on information compiled by Taylor, Larwood & Balson (1980) in their fieldguide, a summary of which was published in 1981 by the same authors. During Middle Pliocene a small transgression inundated part of East Suffolk. This transgression took place across an eroded surface of London Clay depositing a skeletal calcarenite, the Coralline Crag. As seen today this consists of an elongate outcrop around Orford and Aldeburgh and some small outliers (text-fig. 1). Three distinct facies can be recognised: a sandwave facies (Sudbourne and Orford) probably representing an offshore sandbank parallel to the coast, a more silty lower energy facies landward of the sandbank and carbonate-rich sediments deposited seaward of the sandbank. Curry et al. (1978) correlate these deposits with the "Luchtbal Sands" (Scaldisian) of Antwerp.

IBA locality 19, Ramsholt Cliff on the banks of the river Deben (National Grid reference TM 298428) is an exposure of very fossiliferous bioclastic sands, resting unconformably on the London Clay.

IBA locality 20, Rockhall Wood (TM 304440) is a disused quarry in the vicinity of loc. 19, where 5.5 m of bioclastic bioturbated sands are exposed.

IBA locality 21, Crag Farm (TM 428523) is a quarry near Sudbourne, where 5 m of Coralline Crag is exposed showing large-scale cross-bedded calcarenites deposited by large sandwaves. These sandwaves were produced mainly by unidirectional currents of a SW direction (Balson, 1981).

IBA locality 22, Aldeburgh Hall (TM 452567) is a small quarry near Aldeburgh where 1.5 m of Coralline Crag is exposed. Large unabraded colonies of different bryozoans are common. The sediment and fauna indicate a more tranquil condition than prevailed at Crag Farm.

IBA loc. 19 and 20 belong to the lower energy facies landward of the sandbank; IBA loc. 21 belongs to the sandbank facies and IBA locality 22 to the facies seaward of the sandbank.

For all species given in this paper simple camera lucida drawings were prepared using a Wild M5 stereomicroscope with mirror. Whenever possible reference is made to better figures in the literature. Synonymy, however, is kept to a minimum. For systematic arrangement and terminology Bassler (1953) is followed. All material is kept in the Cadée collection, Texel, The Netherlands, except for the type material of *Membraniporella gigas* n. sp. which is deposited in the bryozoan collections of the Rijksmuseum van Geologie en Mineralogie, Leiden, The Netherlands.

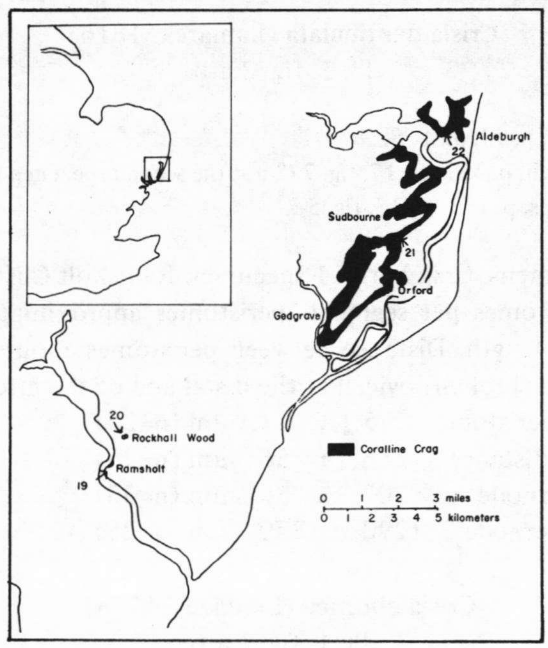


Fig. 1. Map showing surface outcrop of the Coralline Crag and localities visited (19 to 22). Redrawn from Taylor, Larwood & Balson (1980).

ACKNOWLEDGMENTS

The author is greatly indebted to drs P.S. Balson, G.P. Larwood and P.D. Taylor for their excellent guidance during the IBA postconference fieldmeeting September, 7-13, 1980. Thanks are also due to dr M. van den Boogaard (Rijksmuseum van Geologie en Mineralogie, Leiden = RGM) and mr. G. Spaink (Rijks Geologische Dienst, Haarlem = RGD) for their help and hospitality during my study of the bryozoan collections they take charge of, and to Mr A. van Assen (Rijksmuseum van Natuurlijke Historie, Leiden) for his help with the preparation of SEM photographs of *Membraniporella gigas* n. sp.

SYSTEMATIC PART

Order Cyclostomata Busk, 1852
Family Crisiidae Johnston, 1838
Genus *Crisia* Lamouroux, 1812

Approximately 150 internodes (segments) were collected in a small sample from Crag Farm. Wood (1844) mentioned *C. eburnea* Lamouroux and *C. luxata* ? Fleming; Busk (1859) described only *C. denticulata* (Lamarck) from the Coralline Crag. Lagaaij (1952) also mentioned only *C. denticulata* and suggested that the material mentioned by Wood (1844) was probably identical with *C. denticulata*. Bobies (1958: 161) warns that only well-preserved entire internodes can be identified with certainty to the species level.

The material collected can be separated in three groups: the majority of the material compares well with *C. identiculata* (Lamarck), some internodes belong probably to *C. eburnea* (Lamouroux) and three have affinities with *C. strangulata* Buge, 1957.

Crisia denticulata (Lamarck, 1816)
Pl. 1, fig. 2 a-b

1859 *Crisia denticulata* – Busk, p. 93, pl. 1, fig. 8
1952 *Crisia denticulata* – Lagaaij, p. 151, pl. 17, fig. 7 (? not the second specimen from left)
1958 *Crisia denticulata* – Bobies, p. 153, pl. 13, fig. 5-7

Materials – About 140 specimens, Crag Farm; 1 specimen, Ramsholt Cliff.
Remarks – Up to ten peristomes per segment, peristomes approximately 1/4 of segment width. Zooecia adnate along entire length. Distance between peristomes about the same as width of internode. Some specimens have a (broken) ovicell at the distal end of the internode.

Measurements –	Diameter peristome	75.1 ±	11.5	μm (n=25)
	Peristome distance	286	± 56	μm (n=25)
	Width internode	307	± 36	μm (n=33)
	Length internode	1290	± 270	μm (n=25)

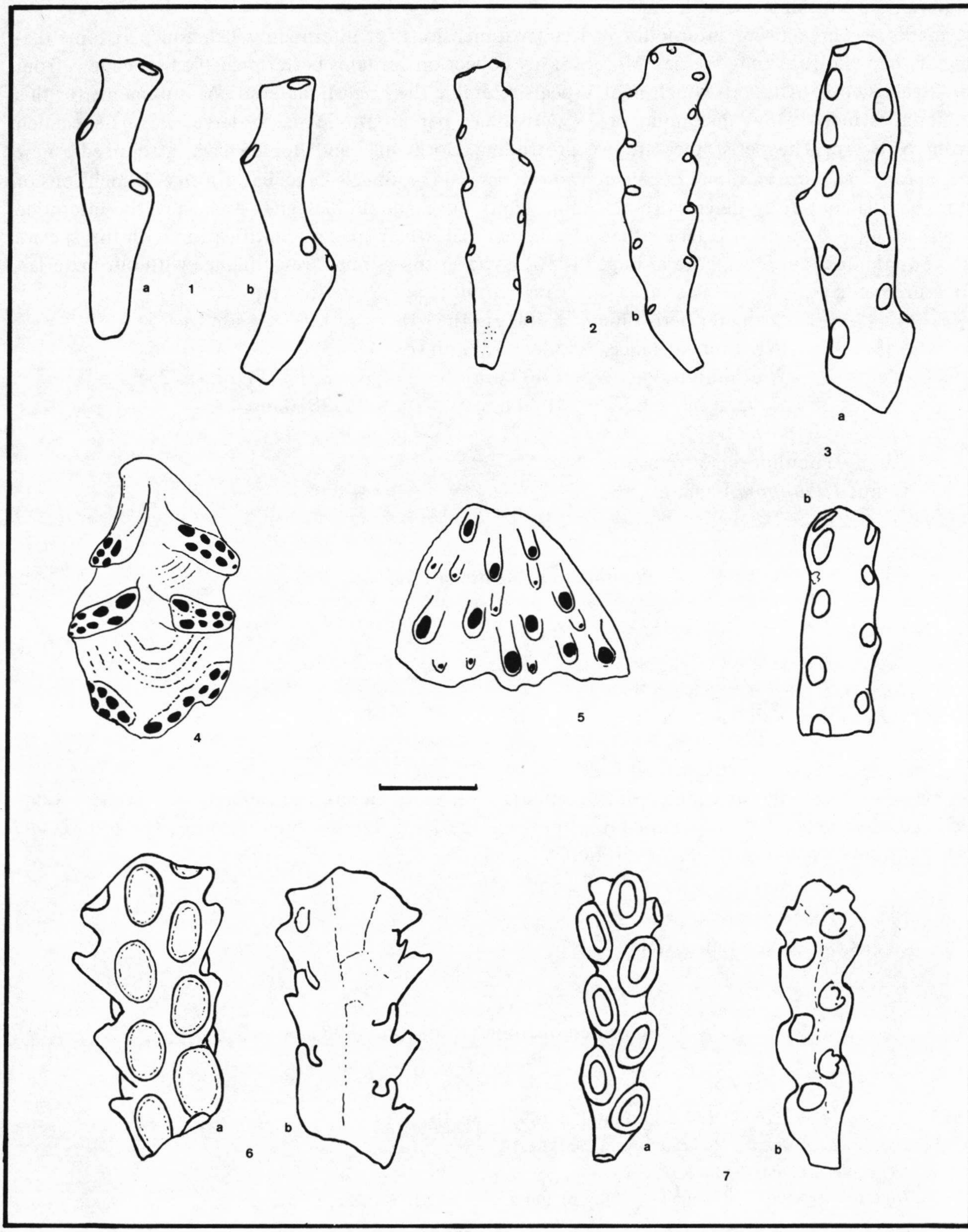
Crisia eburnea (Linnaeus, 1758)
Pl. 1, fig. 1 a-b

1934 *Crisia eburnea* – Canu & Lecointre, p. 137, pl. 26, fig. 14-15
1958 *Crisia eburnea* – Bobies, p. 151, pl. 13, fig. 2-3

Material – 10 specimens, Crag Farm.
Remarks – Internodes with only up to three peristomes. Width of internodes somewhat less than in *C. eburnea*. Peristome distance larger than in *C. eburnea*. The specimen from the Scaldisian of Breda, The Netherlands, depicted by Lagaaij (1952, pl. 17, fig. 7, second specimen from left) probably also belongs to this species and not to *C. denticulata*.
Measurements – The material is too fragmentary to allow very reliable measurements to be made. Peristome distance is ± 0.6 mm; width of the internodes 0.28 mm, the longest internode measures 1.6 mm.

Crisia aff. strangulata Buge, 1957
Pl. 1, fig. 3 a-b

1933 *Crisia edwardsi* – Canu & Lecointre, p. 135, pl. 26, fig. 4-5 (non Reuss, 1847)
1956 *Crisia strangulata* Buge, p. 7, pl. 1, fig. 1-2
1957 *Crisia strangulata* – Buge, p. 42
1958 *Crisia lecointrei* Bobies, p. 157, pl. 13, fig. 8; pl. 15, fig. 24-25.



Pl. 1. Bryozoa of the Coralline Crag. Fig. 1a-b. *Crisia eburnea* (L.), frontal side; 2a-b. *Crisia denticulata* (Lam.), frontal side; 3a-b. *Crisia* aff. *strangulata* Buge, frontal side; 4. *Tubulipora subdisticha* Buge, frontal side; 5. *Diplosolen obelium* (Johnston), frontal side; 6a-b. *Scrupocellaria elliptica* (Reuss); a: frontal; b: dorsal side; 7a-b. *Scrupocellaria* sp.; a: frontal; b: dorsal side. Bar length indicates 1 mm for fig. 4 and 0.5 mm for all other figures.

Material – 3 specimens, Crag Farm.
Remarks – Three *Crisia* internodes had larger dimensions for internode width and peristome diameter than the foregoing species. Moreover my collection contains better preserved specimens from the Scaldisien of Antwerp which in all aspects resemble the English material, measurements for this material is included. A maximum of 19 peristomes per internode was observed in one specimen from Antwerp. The peristomes are not protruding. Both Buge and Bobies have introduced a new name for *C. edwardsi* Canu & Lecointre (non Reuss, 1847), Buge's name has priority. Dimensions of our material not fully agree with the dimensions Buge and Bobies give, especially the internode width (0.44 - 0.49 mm) is larger than in our material, which makes identification with this species somewhat uncertain. The figure in Buge (1956) however shows much resemblance with our material.

Measurements –	Crag Farm	Antwerp
Diameter peristome	± 100 μm (n=14)	120 ± 36 μm (n=25)
Peristome distance	325 ± 137 μm (n=14)	328 ± 64 μm (n=25)
Width internode	± 400 μm	371 ± 34 μm (n=25)
Longest internode	1800 μm	2810 μm

Family Tubuliporidae Johnston, 1838
Genus *Tubulipora* Lamarck, 1816

Tubulipora subdisticha Buge, 1950
Pl. 1, fig. 4

1933 *Tubulipora disticha* – Canu & Lecointre, p. 169, pl. 34, fig. 14 (non Michelin, 1847)
1950 *Tubulipora subdisticha* Buge, p. 464
1957 *Tubulipora subdisticha* – Buge, p. 91

Material – One specimen, Ramsholt Cliff.
Remarks – The only specimen found compares well with description and figures given by Canu & Lecointre. Buge (1950) demonstrated that this species differs by orientation of the zooecia and smaller dimensions from *T. disticha* (Michelin, 1847).

Family Diaperoeciidae Canu, 1918
Genus *Diplosolen* Canu, 1918

Diplosolen obelium (Johnston, 1838)
Pl. 1, fig. 5

1933 *Diplosolen obelium* – Canu & Lecointre, p. 159, pl. 30, fig. 1
1949 *Diplosolen obelium* – Vigneaux, p. 112, pl. 11, fig. 7
1957 *Diplosolen obelium* – Buge, p. 73
1967 *Diplosolen obelium* – Harmelin, p. 145, pl. 9, fig. 5-7, pl. 22, fig. 4-8, pl. 23, fig. 1-3

Material – One specimen, Ramsholt Cliff.
Remarks – This species is easily recognized by the presence of about equal numbers of small kenozooecia interspersed between the autozooecia. This species was already known from the Neogene

deposits of France, Italy and Central Europa. It has a wide Recent distribution in the waters of the northern hemisphere.

Order Cheilostomata Busk, 1852
Suborder Anasca Levinsen, 1909
Family Calloporidae Norman, 1903
Genus *Rhamphonotus* Norman, 1894

Rhamphonotus spelaeus Lagaaij, 1952
Pl. 2, fig. 4

1952 *Rhamphonotus spelaeus* - Lagaaij, p. 29, pl. 1, fig. 9, Text-fig. 3

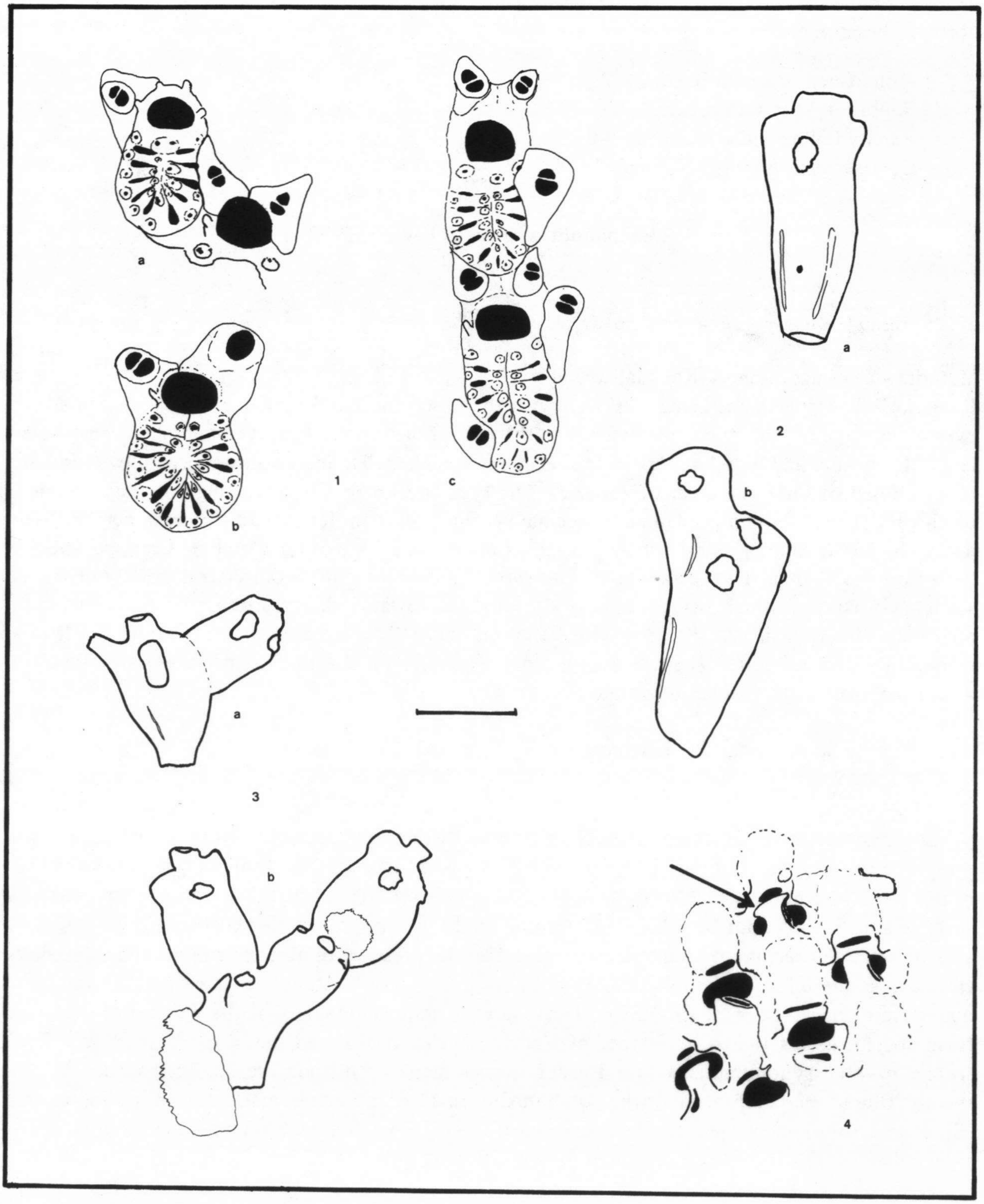
Material — Seven specimens, Rockhall Wood.
Remarks — Our specimens agree very well with the description and figures given by Lagaaij. Moreover we compared with the type-material in the collections of the Rijks Geologische Dienst, Haarlem. Of the Rockhall Wood material five specimens are bilamellar and two were probably encrusting (they consist of only one layer of zooecia). The type specimens are encrusting but the collections of the RGD also contain a bilamellar specimen from Scaldisian deposits of a boring near Roosendaal (The Netherlands), identified by Lagaaij as *R. spelaeus*. One of the Coralline Crag specimens is better preserved than the type material. This showes nicely the mushroom-shaped distally produced single avicularium, which bridges almost the distance towards the opposite ovicell, farther than mentioned by Lagaaij (Pl. 2, fig. 4). Like the scutum in *Scrupocellaria* it will protect the frontal membrane. Larwood (1969) gives many other examples of scutum-like structures developed in Anasca to protect the frontal membrane.

Family Scrupocellaridae Levinsen, 1909
Genus *Scrupocellaria* van Beneden, 1845

Some of the most important characters used to distinguish species in this genus are usually not preserved in the fossil material. The scutum, which overarches the frontal membrane is not retained in the loose internodes which form the material the paleontologist has to work with. Its presence or absence and form cannot be taken into account, only in very well-preserved material he might be able to see the attachment base of the scutum. Also the presence or absence and number of axillary vibracula at the bifurcations of the internodes can usually not be studied as these parts of the internodes are damaged in most specimens. This makes it understandable that the number of described fossil species is less than the number of Recent species known and that a name given to a fossil species may be synonymous with a Recent species name or include even more than one Recent species. Due to recristallization of the Coralline Crag material moreover, many details are obliterated, which gives another problem in identification of the material. Some 30 fragments of *Scrupocellaria* were collected which could be separated in two different forms.

Scrupocellaria elliptica (Reuss, 1847)
Pl. 1, fig. 6 a-b

1847 *Bactridium ellipticum* Reuss, p. 56, pl. 9, fig. 7-8
? 1859 *Scrupocellaria scruposa* ? — Busk, p. 19, pl. 1, fig. 6



Pl. 2. Bryozoa of the Coralline Crag. Fig. 1a-c. *Membraniporella gigas* n. sp., different zooecia of holotype; 2a-b. *Vittaticella elegans zangheri* Neviani, frontal side; 3a-b. *Vittaticella cipollai* Neviani, frontal side; 4. *Ramphonotus spelaeus* Lagaaij, frontal side. Arrow indicates complete mushroom-shaped distally produced avicularium. Bar length indicates 0.5 mm for all figures.

1874 *Scrupocellaria elliptica* – Reuss, p. 148, pl. 11, fig. 1-9
1927 *Scrupocellaria elliptica* – Canu & Lecointre, p. 27, pl. 2, fig. 10-15
1949 *Scrupocellaria elliptica* – Vigneaux, p. 33 pl. 1, fig. 13-16
1957 *Scrupocellaria elliptica* – Buge, p. 200

Material – 18 specimens Crag Farm; 2 specimens, Rockhall Wood.
Remarks – Lateral avicularia well-developed, constituting triangular prominences. Basal vibracula large. Internodes relatively broad: observed range in the only five entire specimens 0.46 - 0.80 mm. Most specimens are broken along the long axis. The fragmentary specimen studied by Busk (1859) has the same triangular prominences and is therefore probably identical. I agree with Canu & Lecointre (1927) that it is better to preserve this name for the fossil material and not to try to refer to one of the Recent species as long as no well-preserved and abundant fossil material is available.

Scrupocellaria sp.
Pl. 1, fig. 7 a-b

? 1927 *Scrupocellaria scruposa* – Canu & Lecointre, p. 26, pl. 2, fig. 16

Material – Seven specimens, Crag Farm.
Remarks – Lateral avicularia much less developed than in *S. elliptica*, no triangular prominences. Basal vibracula smaller. Internodes less broad: observed range in four specimens 0.34 - 0.42 mm. This is probably the same species identified by Canu & Lecointre as *S. scruposa* L. However, the Recent *S. scruposa* has better developed lateral avicularia on triangular prominences (see e.g. Ryland & Hayward, 1977: fig. 67). These are not visible in the figure given by Canu & Lecointre. This species might be identical with the Recent *S. reptans* (L.), which has small lateral avicularia (Ryland & Hayward, 1977: 134) and comparable dimensions of internode width (0.42 ± 0.04 mm, n=25 in Recent West-European material, own collection). However, the furcated scutum typical for this Recent species is not preserved and due to bad preservation I cannot discern an attachment base for the scutum.

Family Cribrilinidae Hincks, 1880
Genus *Membraniporella* Smitt, 1873

Membraniporella gigas n. sp.
Pl. 2, fig. 1 a-c, Pl. 3

Material – Holotype: plate 2, figs. 1 a-c, deposited in the bryozoan collections of the Rijksmuseum van Geologie en Mineralogie, Leiden, registration number RGM 339 999.

Stratum typicum – Coralline Crag, Pliocene.
Locus typicus – Ramsholt Cliff, East Anglia, England.
Derivatio nominis – The name *gigas* refers to its large size.
Description – Zoarium bilamellar. Zooecia large, broad elliptical to ovate, distinctly separated exteriorly. Aperture large subcircular with four oral spines on lateral and distal peristome, these may become invisible by overgrowth of avicularia. Frontal shield made up of 11-15 costae (including apertural bar), separated by undivided, slitlike lacunae. Costae dumb-bell shaped, provided near

both ends with papillae with opening. They fuse along the median line, in the longer zooecia the papillae lie close to this median line (Pl. 2, fig. 1c), in the broader zooecia the papillae occur at some distance from the median line leaving a central depression in the frontal shield around the median line (Pl. 2, fig. 1b). Apertural bar wide and thickened. Gymnocyst narrow, steep. Avicularia latero-distal to the orifice usually 2, sometimes only one; adventitious avicularia occur irregularly along the edge of the frontal shield. Avicularia with a cross-bar, which in many cases is broken. No ovicells observed.

Measurements –	Length of zooecium	(Lz)	1.03 ± 0.06	mm (n=20)
	Width of zooecium	(lz)	0.51 ± 0.05	mm (n=20)
	Length of aperture	(la)	0.25 ± 0.02	mm (n=10)
	Width of aperture	(ha)	0.19 ± 0.015	mm (n=10)

Remarks – This species differs from *Membraniporella robusta* Lagaaij, 1952 by its larger size (measurements for *M. robusta* Lz=0.7, lz=0.5-0.55, la=0.18, ha=16 mm according to Lagaaij, 1952), by the presence of avicularia, the papillae with opening on the costae, the presence of four instead of five oral spines and by the fact that the costae do not fuse in a callous junction along the median line as in *M. robusta*. *M. gigas* is close to *M. bioculata* Canu & Bassler, (1920, p. 287, pl. 41, fig. 11-13) from the Middle Jacksonian (Late Eocene) of South Carolina, which has comparable oral avicularia and papillae with opening (lumen pores) on the costae. However, the dimensions of *M. bioculata* are much smaller (Lz =0.60, lz=0.35, la=0.15, ha=0.10 mm), it is encrusting instead of bilamellar. The Miocene *M. bicornis* Canu & Lecointre (1927, p. 25, pl. 7, fig. 1) is also smaller (Lz=0,52, lz=0.30, ha=0.08, la=0.10 mm) and differs by the presence of two protruding lateral oral spines, whereas avicularia were not found in this species.

Suborder Ascophora Levinsen, 1909
Family Catenicellidae Busk, 1852
Genus *Vittaticella* Maple, 1900

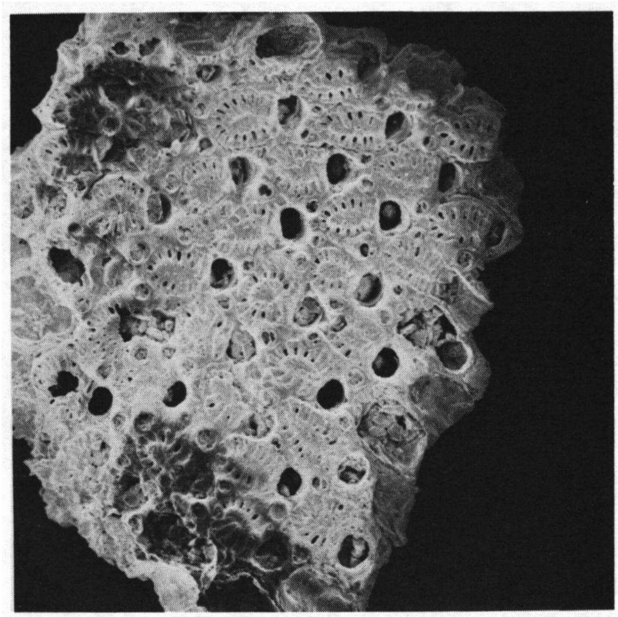
Some 70 mostly ill-preserved *Vittaticella* specimens were collected in the sample from Crag Farm. Due to recristallization most of the structures necessary for identification are obliterated. Nevertheless two different forms can be discerned differing in size and shape. They are most probably conspecific with two of the three species described by Neviani (1928) from the Late Pliocene of Capocolle (Italy). His material was restudied by Annoscia in 1966. *Vittaticella* was not observed previously in British Coralline Crag deposits. Lagaaij (1968) observed the first *Vittaticella* in Pliocene deposits from the North Sea Basin (in my paper of 1973 I overlooked this observation).

Vittaticella elegans zangheri Neviani, 1928
Pl. 2, fig. 2 a-b

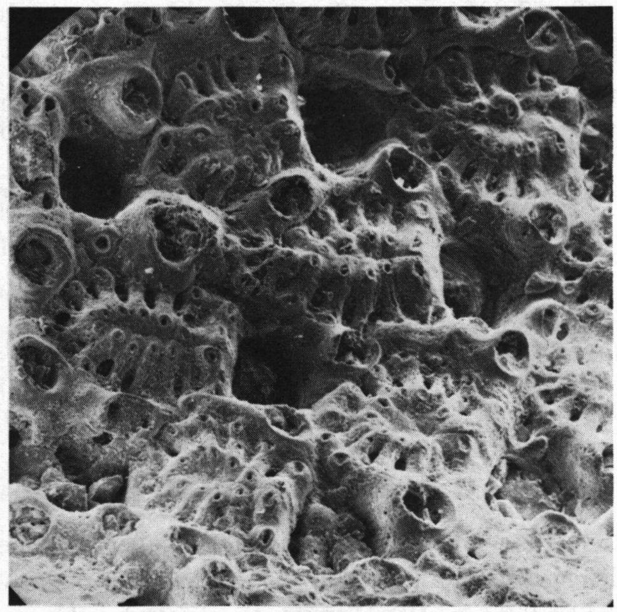
1928 *Vittaticella Zangherii* Neviani, p. 218, fig. 1
1966 *Vittaticella elegans zangheri* – Annoscia, p. 161, pl. 4, figs. 3, 10-12

Material – 20 specimens, Crag Farm.

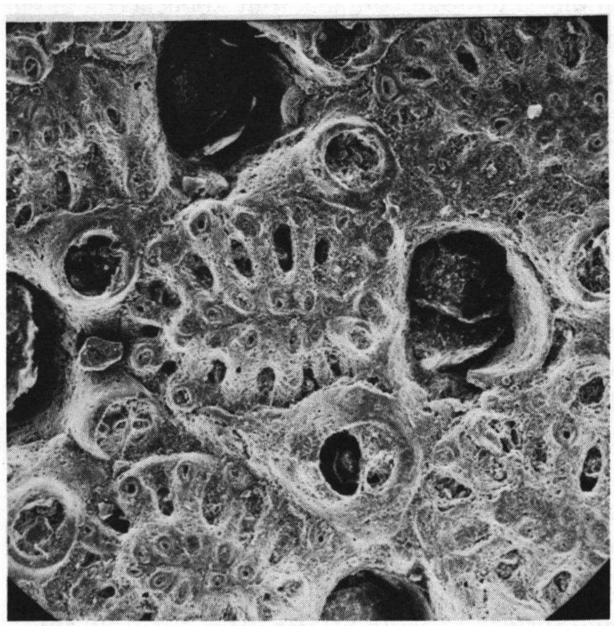
Remarks – The relatively large, straight-sided specimens agree very well with this form. For the mother-cell Neviani gives a length of 0.62 mm, Annoscia 0.5-0.65 mm and our material measures



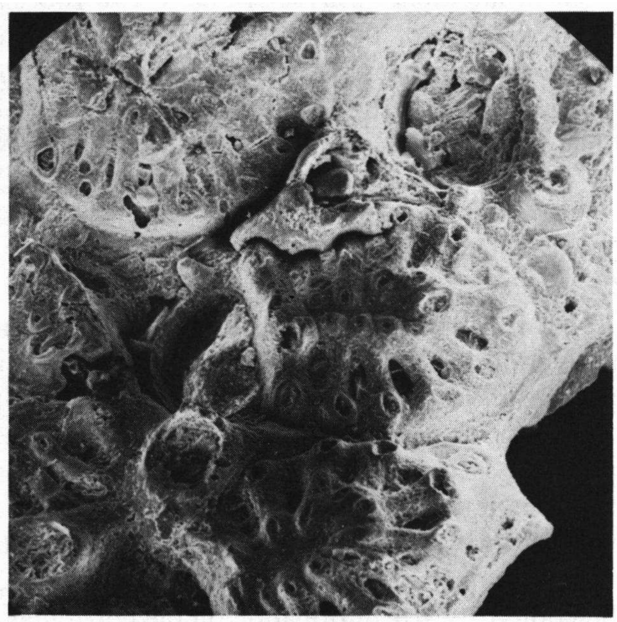
1



2



3



4

Pl. 3. *Membraniporella gigas* n. sp., Ramsholt Cliff, Coralline Crag, Pliocene, England. Holotype, RGM 339 999.

Fig. 1 Entire fragment.

Fig. 2 Part of holotype showing papillae with openings on costae, and variation in form of the central area where costae fuse, X 80.

Fig. 3 Zooecium with arrangement of oral- and advantitious avicularia, X 120.

Fig. 4 Oral spines, X 120.

0.68 ± 0.025 mm (n=9). The basal angle in the Italian material is ± 26° according to Neviani and 25-30° according to Annoscia, which agrees with the 25 ± 3.50° (n=17) we found.

The two specimens figured by Lagaaij (1966) might belong also to this species, their basal angle (as measured from the photograph) is 26° and 28°, their length is more than 0.4 mm.

Vittaticella cipollai Neviani, 1928
Pl. 2, fig. 3 a-b

1928 *Vittaticella Cippolae* Neviani p. 219, fig. 2-5
1966 *Vittaticella cipollai* – Annoscia, p. 165, pl. 3, figs. 4-5, pl. 4, figs. 4-7
1973 *Vittaticella elegans* – Cadée, p. 4, fig. 1 (non Busk, 1852)

Material – 50 specimens, Crag Farm.

Remarks – The more abundant smaller specimens of *Vittaticella* show much resemblance with *C. cipollai*. The length of the mother-cell is 0.43-0.55 mm (Neviani), 0.35-0.50 mm (Annoscia) and 0.43 ± 0.03 (n=19) in our material. The basal angle is larger than in the foregoing *C. elegans zhangeri*: 35-47° (Neviani), 35-50° (Annoscia) and 43 ± 7° (n=22) in our material. The third species described by Neviani is smaller than the other two species (0.32-0.36 mm).

Most internodes consist of one or two zooecia, one internode contains four zooecia (Pl. 2, fig. 3b). A restudy of the material I collected in the Scaldisian deposits of Antwerp (Cadée, 1973) reveals that this material also belongs to *C. cipollai*, the basal angle and length of the mother-cell (respectively 45 ± 6.5° and 0.38 ± 0.04 mm, n=10) agree best with this species. Neviani's and Annoscia's paper were unknown to me by then.

DISCUSSION

Bryozoa always have been a somewhat neglected group in paleontology, probably based on the assumption that identification is difficult. Those who have some experience with Bryozoa and can compare them with more popular groups like Mollusca and Foraminifera will agree that identification problems in such groups may be comparable. Moreover, for paleoecological purposes, identification to species level is not always necessary in Bryozoa: a distinction in growth-forms may give sufficient information. In a stimulating paper Stach (1935) showed that a definite relation exists between the various growth-forms of the Cheilostomata and their habitat. Therefore a study of the relative numbers of growth-forms in a deposit and their relative changes in horizontal and vertical directions may give information on the horizontal and vertical variations of the paleoenvironment.

Some new growth-forms were added later by Lagaaij & Gautier (1965) and Schopf (1969) tried to specify better quantitatively current strength and sedimentation rate in relation to growth-types of Bryozoa. Brood (1972) enumerated a number of growth-forms for the Cyclostomata and their relation to the environment. A number of writers used Stach's method with succes (*e.g.* Labracherie & Prud'homme, 1967; Lagaaij & Gautier, 1965; Cheetham, 1963, 1971). Balson (1981) was the first to apply growth-form analysis to the Coralline Crag Bryozoa.

New for the British Coralline Crag is our observation that catenicelliform and fragile cellariform Bryozoa are locally by no means rare. A small sample from Crag Farm near Sudbourne contained numerous internodes of *Crisia, Vittaticella* and *Scrupocellaria*. They belong to the crisiid, catenicellid and cellariid growth-forms respectively. These articulated growth-forms with internodes connected by flexible chitinous joints, are typical for the littoral and shallow sublittoral zone where wave action is strongly felt. The substratum is mainly algae, but stones, shells and other firm substrates may be used for attachment of the rootlets by which the colonies attach themselves. The difference between the catenicellid and cellarid growth-form is small: the number of zooecia per internode is smaller in the catenicellid growth-form. The crisiid growth-form created by Brood (1972) for articulate Cyclostomata is comparable to the cellarid growth-form created by Stach for the Cheilostomata.

Balson (1981) in his study of bryozoan growth-forms in relation to facies in the British Coralline Crag, only studied material larger than 2 mm. The reasons are obvious (identification is more easy in larger fragments and there are less problems with material that may be transported into the environment). This implies that an important part of the bryofauna is not considered. That small (fragments of) Bryozoa may be transported over considerable distances was demonstrated by Lagaaij (1968) who observed Eocene and Pliocene Bryozoa in Holocene sediments along the Dutch coast 100 km and more from the nearest outcrop of these strata. In our case however, I believe that the articulate Bryozoa lived mainly near the place where I found them: the internodes showed highest frequencies at the Crag Farm locality as compared with the other localities visited and signs of wear were not obvious. Moreover, the ecological information which may be derived from their presence — a high energy environment with influence of waves and currents — is in accordance with the sedimentology: well-sorted, coarse bioclastic sands with large scale cross-stratification (Balson, 1981). Balson found cellariform fragments in the fraction larger than 2 mm to make up about 35% of the bryofauna by weight at this locality. They belonged to the larger *Cellaria* species, not to the species mentioned above. He also assumed that these *Cellaria* lived there and were able to colonize the mobile coarse substrate of the sandbank.

REFERENCES

Annosicia, E., 1966. I briozi del Pliocene Superiore di Capocolle (collezione Zangheri). - Mem. Mus. Civ. Stor. Nat. Verona, 14: 105-175, 1 fig., 4 pl.

Balson, P.S., 1981. Facies-related distribution of bryozoans of the Coralline Crag (Pliocene) of Eastern England. In: G.P. Larwood & C. Nielsen, Recent and fossil Bryozoa. Fredensborg, Olsen & Olsen: 1-6, 3 fig.

Balson, P.S. & P.D. Taylor, 1982. Palaeobiology and systematics of large cyclostome bryozoans from the Pliocene Coralline Crag of Suffolk. - Palaeontology, 25: 529-554, 3 pl., 12 fig.

Bassler, R.S., 1953. Bryozoa. In: R.C. Moore, Treatise on invertebrate paleontology, Part G (Kansas Univ. Press), 253 pp., 153 fig.

Bobies, C.A., 1958. Bryozoenstudien III/1. Die Crisiidae (Bryozoa) des Tortons im Wiener Becken. - Jahrb. Bundesanst. Wien, 101: 147-165, 3 pl.

Brood, C., 1972. Cyclostomatous Bryozoa from the Upper Cretaceous and Danian in Scandinavia. - Acta Univ. Stockh., Stockh. Contrib. Geol., 26: 1-464, 78 pl., 147 fig.

Buge, E., 1950. Note sur la synonymie de trois anciennes espèces de bryozoaires: Diastopora latomarginata d'Orbigny 1852, Eschara andegavensis Michelin 1847 et Obelia disticha Michelin 1847. - Bull. Soc. géol. Fr., (5) 20: 459-465, 2 fig.

Buge, E., 1956. Les bryozoaires du Pliocène du Cap Bon (Tunisie). - Annal. Mines Géologie, 17: 1-97, 14 fig., 12 pl.

Buge, E., 1957. Les bryozoaires du Néogène de l'ouest de la France et leur signification stratigraphique et paléobiologique. - Mém. Mus. nat. Hist. Nat., N.S. (C) 6: 1-435, 11 pl., 52 fig.

Busk, G., 1859. A monograph of the fossil Polyzoa of the Crag. - Palaeontogr. Soc. London, IX + 136 pp., 22 pl.

Cadée, G.C., 1973. Vittaticella elegans (Busk), a bryozoan hitherto unknown from the North Sea basin. - Meded. Werkgr. Tert. Kwart. Geol., 10 (1): 3-8, 2 fig.

Cadée, G.C., 1981. Notes on Bryozoa, 1. Cupuladria canariensis from the British Pliocene Coralline Crag. - Meded. Werkgr. Tert. Kwart. Geol., 18 (1): 3-9, 6 fig.

Canu, F. & R.A. Bassler, 1920. North American early tertiary Bryozoa. - U.S. Nat. Mus. Bull., 106: 1-879, 162 pl., 279 fig.

Canu, F. & G. Lecointre, 1925-1930. Les bryozoaires cheilostomes des faluns de Touraine et d'Anjou. - Mém. Soc. géol. France, (N.S.) 4: 1-127, 25 pl.

Canu, F. & Lecointre, 1933-1934. Les bryozoaires cyclostomes des faluns de Tourains et d'Anjou. - Mém. Soc. géol. France, (N.S.) 4: 131-215, 19 pl.

Cheetham, A.H., 1963. Late Eocene zoogeography of the Eastern Gulf Coast region. - Mem. Geol. Soc. Am., 91: 1-113, 3 pl., 34 fig.

Cheetham, A.H., 1971. Functional morphology and biofacies distribution of cheilostome Bryozoa in the Danian stage (Paleocene) of Southern Scandinavia. - Smithson. Contrib. Paleobiol., 6: 1-87, 17 pl., 29 fig.

Curry, D., et al., 1978. A correlation of tertiary rocks in the British Isles. - Geol. Soc. Lond., Spec. Rep., 12: 1-72.

Harmelin, J.G., 1976. Le sous-ordre des Tubuliporina (bryozoaires cyclostomes) en Méditerranée. Ecologie et systématique. - Mém. Inst. Océanogr. Monaco, 10: 1-326, 38 pl., 50 fig.

Labracherie, M. & J. Prud'homme, 1966. Essai d'interpretation de paléomilieux grâce à la méthode des formes zoariales chez les bryozoaires. - Bull. Soc. géol. Fr., (7) 8: 102-106, 1 fig.

Lagaaij, R., 1952. The Pliocene Bryozoa of the Low Countries. - Meded. Geol. Sticht., (C-V) 5: 1-233, 26 pl., 29 fig.

Lagaaij, R., 1968. Fossil Bryozoa reveal long-distance sand transport along the Dutch coast. - Proceed. Kon. Ned. Akad. Wetensch., (B) 71: 31-50, 1 pl., 6 fig.

Lagaaij, R. & Y.V. Gautier, 1965. Bryozoan assemblages from marine sediments of the Rhône delta. - Micropaleont., 11: 39-58, 34 fig.

Larwood, G.P., 1969. Frontal calcification and its function in some Cretaceous and Recent cribrimorph and other cheilostomatous Bryozoa. - Bull. Br. Mus. Nat. Hist. (Zool.), 18: 171-182, 10 fig.

Neviani, A., 1928. Vittaticelle plioceniche italiane. - Atti Pont. Acad. Sc. Nuovi Lincei, 81 (4): 212-221, 8 fig.

Reuss, A.E., 1847. Die fossilen Polyparien des Wiener Tertiärbeckens. - Haidinger's naturwiss. Abh., 2: 1-109, 11 pl.

Reuss, A.E., 1874. Die fossilen Bryozoen des österreichisch-ungarischen Miocäns. - Denkschr. K. Akad. Wiss., Math.-Naturw. Cl., Wien, 33: 141-190, 12 pl.

Ryland, J.S. & P.J. Hayward, 1977. British anascan bryozoans. - Synopses British Fauna, (N.S.) 10: 188 pp., 85 fig.

Schopf, T.J.M., 1969. Paleocology of ectoprocts (bryozoans). - J. Paleont., 43: 234-244, 5 fig.

Stach, L.W., 1936. Correlation of zoarial form with habitat. - J. Geol., 16: 60-65, 1 fig.

Taylor, P.D., G.P. Larwood & P.S. Balson, 1980. Field guide. - Post-conference geological field meeting 5th International Conference on Bryozoa (Durham), 60 pp., 38 fig. (not published).

Taylor, P.D., G.P. Larwood & P.S. Balson, 1981. Some British field localities with fossil Bryozoa. In: G.P. Larwood & C. Nielsen, Recent and fossil Bryozoa. Fredensborg, Olsen & Olsen: 249-262.

Taylor, R.C., 1830. Illustrations of antediluvian zoology and botany. - Ann. Mag. Nat. Hist., 3: 262-287, 29 fig.

Vigneaux, M., 1949. Révision des bryozoaires néogènes du Bassin d'Aquitaine et essai de classification. - Mém. Soc. géol. Fr., (N.S.) 28: 1-155, 11 pl., 44 fig.

Wood, S.V., 1844. Descriptive catalogue of the zoophytes from the Crag. - Ann. Mag. Nat. Hist., 13: 10-21, 1 fig.