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NOTES ON BRYOZOA, 1. *CUPULADRIA CANARIENSIS* FROM THE BRITISH PLIOCENE CORALLINE CRAG

by

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British Coralline Crag *Cupuladria* specimens referred to *C. biporosa* Canu & Bassler, 1923 are similar to European Continental Mio-Pliocene *Cupuladria* specimens described as *C. canariensis cavernosa* 1979. This Mio-Pliocene *Cupuladria* is in many aspects an intermediate form between *C. biporosa* and *C. canariensis*. The application of a name is therefore somewhat arbitrary. Measurements of the area enclosed within the frontal outline of a zooecium give hardly more consistent data for description of this *Cupuladria* material than conventional length and width measurements.

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INTRODUCTION

Many papers are devoted to the free-living, cupshaped, so-called lunulitiform Bryozoa (for references see Cook, 1965a, 1965b; Cadée, 1975). *Cupuladria canariensis* seems to be the best known of the lunulitiforms since Lagaaij (1963) wrote his 'portrait' of this species. However, taxonomically some confusion still exists. The original description of Busk (1859a) included two species (Cook, 1965b) which are now separated: *C. canariensis* (Busk) and *C. biporosa* Canu & Bassler. Also Lagaaij's portrait includes these two species (Cadée, 1979).

Although Recent *C. canariensis* is clearly different from *C. biporosa*, Mio-Pliocene *C. canariensis* from Europe is very close to *C. biporosa* which occurs in deposits of similar age on the other side of the Atlantic and in the Recent fauna on both sides of the Atlantic. It is therefore more or less arbitrary which name should be applied to these Mio-Pliocene European *C. canariensis*. In my 1979 paper I preserved the name *C. canariensis*, used by Busk (1859b) and by many later authors for Mio-Pliocene European specimens, but described them as a new subspecies. However, Cook (1965b, p. 205) identified Busk's Coralline Crag material, on base of his nice illustrations, as *C. biporosa* and also more recently Taylor, Larwood & Balson (1980) mentioned only *C. biporosa* from the British Coralline Crag. In order to find out whether there are real differences between British and Continental specimens, as implied by Cook (1965b, p. 205) or whether different names have been applied to the same species, I studied material present in the British Museum (Natural History), Department of Palaeontology and collected and got some additional material. As this material had to be measured, I also took the opportunity to test for this material the conclusion of Cheetham & Lorenz (1976, p. 46) that 'size of autozooids, as measured by the area enclosed within the frontal outline is consistent within colonies to a higher degree than previous studies on "standard" linear dimensions (e.g., length, width) have indicated'.

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METHODS

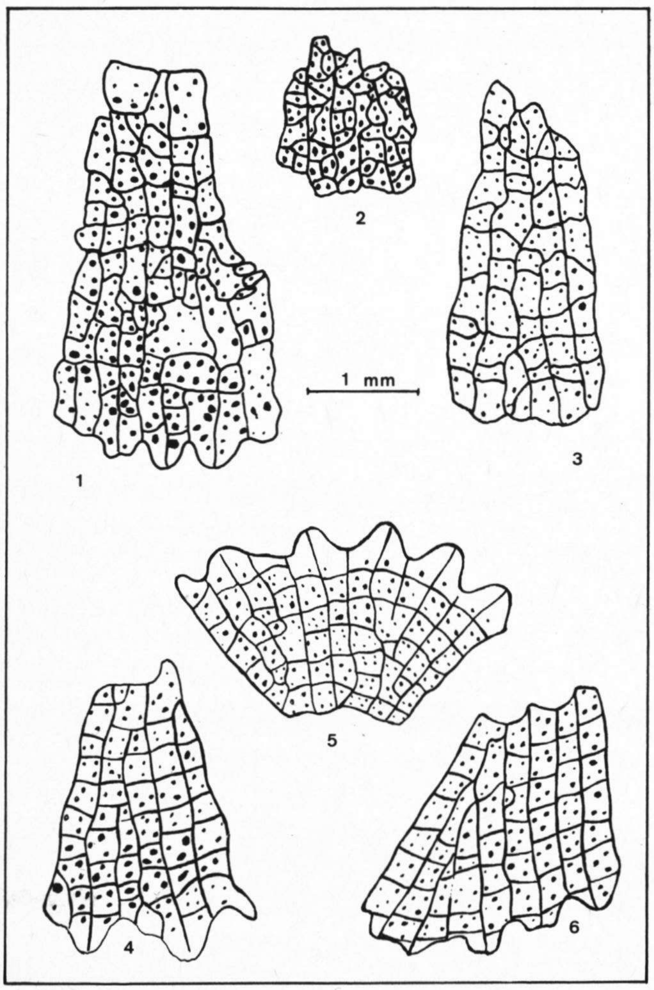
Length (Lz) and width (lz) of the zooecia were measured following Cook (1965a, p. 153) where Lz includes the distal vibraculum. The measurements were made on camera lucida drawings prepared with a Wild M5 stereomicroscope (enlargement 59 times). All measurements were made in the zone of astogenetic repetition, outside the zone of astogenetic change around the ancestrula. The area contained within the zooidal outline (further called area) was measured from the same drawings using a planimeter (G. Ott). Following Cheetham & Lorenz (1976), this area estimate was converted into a linear metric, the radius (Ra) of a semicircle with the same area, in order to preserve dimensional consistency with Lz and lz measurements. Cheetham & Lorenz (1976) estimated area from vector measurements. This gives the opportunity to define also some shape characteristics not possible with the planimeter method. However, I supposed the latter method less time consuming and sufficient to test the use of area measurements of *Cupuladria* for taxonomical purposes.

For all measurements average, standard deviation (SD) and coefficient of variation (CV), i.e. SD as percentage of average, are given.

SYSTEMATICAL PART

Cupuladria canariensis cavernosa Cadée, 1979
Text-figs 1-3

1859b *Cupularia canariensis* Busk, p. 87, pl. 13, fig. 2a-e.
1979 *Cupuladria canariensis cavernosa* Cadée, p. 451, fig. 1e-g, 2d-f, 4a-b (further synonymy see Cadée, 1979).



Text-figs 1-6. Camera lucida drawings of basal side of *Cupuladria* colonies, comparing irregular sectors in *C. canariensis cavernosa* Cadée (figs 1-3) from the Coralline Crag, with more regular sectors in *C. biporosa* Canu & Bassler (figs 4-6).
1. British Museum (Natural History), Department of Palaeontology, B1707; 2. idem D50793-802; 3. idem D6763; 4, 5. Rijksmuseum van Geologie en Mineralogie, Leiden, Niger Delta, Recent, RGM 247 071; 6. Rijksmuseum van Natuurlijke Historie, Leiden, S.E. of Madeira, Recent, Bryozoa 02623.

Material - British Museum (Natural History), Department of Palaeontology: Busk collection: Suffolk D6762 (2 colonies), D6763 (2 col.), D6764 (1 col.), D6765 (4 col.), D6766 (1 col.), D6768 (2 col.); S. V. Wood collection: Sutton B1707 (17 col.); Burrows collection: Sutton (unsorted) D50793-50802 (6 col.), Broom Hill (unsorted) 51272-51277 (3 col.); F. W. Harmer collection: Walton on the Naze, D34975 (1 col.). Cadée (Texel, The Netherlands): Ramsholt Cliff, Suffolk, International Bryozoologists Association fieldtrip September 1980 loc. 19 (20 fragments); Rockhall Wood, Suffolk, IBA fieldtrip September 1980 loc. 20 (10 fragments); The Cliff, Gedgrave, donation P. S. Balson (Leeds) (25 fragments).

Description - Zoarium free, cupshaped. Zooecia rhombic, radially arranged, an asymmetrical vibraculum distal to each zooecium. Opesia approximately rectangular, surrounded by a gently descending cryptocyst. Several layers of basal kenozooecia present. Basal surface of colony divided in sectors by irregular radial and tangential grooves. Number of pores per sector on an average 3.6, but with large within and between colony variation (Table 1). Lz 0.573 ± 0.041 mm, lz 0.362 ± 0.056 mm (see also Table 3). Vicarious vibracula not observed.

Table 1

nr	n	mean	SD	CV
1	20	5.85	2.01	34.4
2	25	3.60	1.63	45.3
3	20	6.05	2.27	37.5
4	40	3.20	1.42	44.4
5	35	3.71	1.32	35.6
6	40	3.43	1.52	44.3
7	35	3.43	1.56	45.5
8	45	3.42	1.32	38.6
1-8	260	3.85	2.01	52.2
9	214	3.59	1.88	52.4
10	295	3.46	1.60	46.2

Table 1. Number of pores per basal sector in *Cupuladria canariensis* from the British Coralline Crag, numbers of sectors used (n), mean, standard deviation and coefficient of variation indicated. Nrs 1 to 8: individual colonies from the British Museum (Natural History), Department of Palaeontology; 1 - 3 = B1707, 4 = D6762, 5 = D6763, 6 = D6766, 7 = D6768, 8 = 51272, 1-8 gives the average for these 8 colonies, 9 gives data for 13 small colony fragments from Ramsholt Cliff, Cadée collection, 10 for 8 fragments from 'The Cliff', Gedgrave, leg. P. S. Balson, Leeds, Cadée collection.

Remarks - Lagaaij (1952) did not study British Coralline Crag material of this species, although in most other species treated in his paper he studied material present in the collections of the British Museum (Natural History), Department of Palaeontology. The Coralline Crag *C. canariensis* illustrated by Busk (1859b) have not yet been located in the BM collections, although many of his illustrated specimens of other species were found. However, the material studied, partly from Busk's collection, indicates that his drawings illustrate correctly Coralline Crag material. The British material studied compares very well with the Continental Mio-Pliocene *C. canariensis cavernosa* studied earlier (Cadée, 1979), only the number of pores per basal sector is relatively low (Table 1) and not significantly different from that found in some *C. biporosa* samples (Table 2). This makes it under-

Table 2

Cupuladria biporosa nr	Locality	Mean ± SD	CV	*Cupuladria canariensis cavernosa* nr	Locality	Mean ± SD	CV
1	Madeira R	3.22 ± 0.63	19.5	10	Fécamp P	8.07 ± 4.99	61.8
2	Niger shelf R	2.45 ± 0.74	30.4	11	Palluau P	7.59 ± 3.22	42.4
3	Guyana shelf R	3.63 ± 0.73	20.1	12	Antwerp P	4.61 ± 2.03	43.9
4	Tortugas R	3.55 ± 0.61	17.2	13	Antwerp P	5.61 ± 3.60	64.3
5	Socorro Isl. R	3.42 ± 0.70	20.5	14	Coralline Crag P	3.85 ± 2.01	52.2
6	Bowden, Jamaica M	3.82 ± 1.10	28.8	15	Ramsholt P	3.59 ± 1.88	52.4
7	Manzanilla, Trinidad M	2.09 ± 0.31	14.7	16	Gedgrave P	3.46 ± 1.60	46.2
8	Port Limon, Costa Rica M	3.41 ± 0.59	17.2	17	Dingden M	6.12 ± 3.52	57.5
9	Santo Domingo M	3.51 ± 0.79	22.3	18	Gram M	6.00 ± 3.07	51.2
				19	Sylt M	5.22 ± 2.39	45.8
				20	Borgerhout M	4.54 ± 2.20	48.5

Table 2. Pores per basal sector in *Cupuladria biporosa* and *Cupuladria canariensis cavernosa*. Data from Cadée (1979) with some additions: 1. Madeira, Rijksmuseum van Natuurlijke Historie, Leiden, Bryozoa nr 02623; 2. Niger shelf, Rijksmuseum van Geologie en Mineralogie, Leiden, RGM 247 071; 5. Socorro Island, Mexico, Gulf of California, coll. Allan Hancock Foundation, Los Angeles; and 14. to 16. from Table 1. Mean, standard deviation and coefficient of variation are given. M = Miocene, P = Pliocene, R = Recent.

standable that Cook (1965b) and Taylor, Larwood & Balson (1980) identified British Coralline Crag specimens as *C. biporosa*. Also the rectangular form of the opesia is a character they have in common with *C. biporosa*. From this latter species, however, they differ by the more irregular basal sectors, which are nearly square and arranged into concentric circles (Text-figs 4-6). The number of pores per sector shows a higher variation than in *C. biporosa* (Table 2), but this is partly due to the omission in counting of irregular sectors occurring at the base of bifurcating radial series of sectors in *C. biporosa* (see Cadée, 1979). In *C. canariensis cavernosa* the basal sector pattern is usually too irregular to omit comparable sectors in pore counting. Vicarious vibracula are absent whereas in *C. biporosa* some of these occur frequently in the centre of the colony.

These differences make separation of Mio-Pliocene *C. canariensis cavernosa* and *C. biporosa* possible and in my opinion warrant the use of a subspecific name. In 1979 I described this material as a subspecies of *C. canariensis*, although it differs from Recent *C. canariensis* by the presence of more than one layer basal kenozooecia (Cadée, 1979). Such an intermediate form could as well have been described as a subspecies of *C. biporosa*. Up to now it has never been found together with *C. biporosa* (s.s.) and by definition subspecies of one species are geographically separated (Mayr et al., 1953). We have to keep in mind that *C. biporosa* as it is now understood by most authors and redescribed by Cook (1965b) as having one to six pores, usually four per basal sector, differs from the original description of Canu & Bassler (1923, p. 29, pl. 47, fig. 1-2) where clearly only specimens with two pores per basal sector were referred to *C. biporosa*. In the same paper Canu & Bassler (1923, pl. 1, fig. 7-9) give a picture of *C. canariensis*, which very much resembles the European Mio-Pliocene material, also with irregular basal sectors with four or more pores and rectangular opesia. They apparently excluded such forms from *C. biporosa*.

Table 3

nr	Length (Lz) ± SD (CV)	Width (lz) ± SD (CV)	Ra ± SD (CV)	n
1	561.0 ± 13.6 (2.42)	355.9 ± 31.7 (8.91)	297.6 ± 8.6 (2.92)	5
2	533.4 ± 16.9 (3.07)	329.7 ± 46.8 (14.19)	277.3 ± 13.7 (4.94)	10
3	571.0 ± 30.0 (5.24)	419.5 ± 46.4 (11.07)	315.8 ± 14.2 (4.51)	8
4	595.8 ± 33.1 (5.55)	366.9 ± 57.3 (15.63)	291.4 ± 13.1 (4.50)	10
5	614.9 ± 24.4 (3.96)	360.2 ± 48.0 (13.34)	309.5 ± 13.1 (4.24)	16
6	573.4 ± 40.2 (7.01)	385.3 ± 52.2 (13.55)	304.4 ± 12.5 (4.10)	15
7	566.1 ± 37.3 (6.59)	346.6 ± 59.0 (17.03)	273.2 ± 9.2 (3.36)	10
8	538.1 ± 38.1 (7.13)	341.9 ± 50.5 (14.76)	272.0 ± 12.9 (4.72)	15
1-8	572.9 ± 41.2 (7.20)	362.2 ± 56.2 (15.54)	292.6 ± 20.5 (7.02)	89

Table 3. Average values with standard deviation (SD) and coefficient of variation (CV) for zooecium length, width and Ra for eight colonies of *Cupuladria canariensis cavernosa* from the British Coralline Crag. Measurements in μm, n denotes number of zooecia measured. All specimens from British Museum (Natural History), Department of Palaeontology: 1-4 = B1707; 5 = D6766; 6 = D6762; 7 = 60282; 8 = D50793-802.

AREA VERSUS LENGTH AND WIDTH MEASUREMENTS

In Table 3 all data for 89 zooecia of 8 different colonies of *Cupuladria canariensis cavernosa* from the British Coralline Crag are given. From this table it is apparent that Ra, a measure for the area contained within the zooidal outline, is less variable than width in all colonies. In five out of eight colonies Ra is also less variable than length. Taking all data together Ra is less variable than width and slightly less variable than length. This corroborates the conclusion of Cheetham & Lorenz (1976) that size of autozooids, as measured by the area enclosed within the frontal outline, is consistent within colonies to a higher degree than previous studies on standard linear dimensions (e.g. length and width) indicated. However, the amount of work necessary for measuring Ra is (in the case of *Cupuladria canariensis cavernosa*) not rewarded by significantly more consistent data for description of the sample.

However, the vector method used by Cheetham & Lorenz (1976) gives an opportunity to define also some shape characteristics (elongation, asymmetry and distal inflation) not possible with the planimeter method. Therefore I will not use my results for a plea against measuring outlines. I agree with Scott (1980) that instrumentation (scales, callipers) and operational convenience account for a preference for gross dimensions, but that outlines of objects usually have a higher information content. An automated coordinate recorder connected with a stereomicroscope for outline processing was described by Scott in 1975.

REFERENCES

Busk, G., 1859a. On some Madeiran Polyzoa collected by J. Yates Johnston, Esq. Zoophytology. - Quart. J. micr. Sci., 7: 65-68.

Busk, G., 1859b. A monograph of the fossil Polyzoa of the Crag. - Palaeontogr. Soc. Monogr., XIII + 136 pp.

Cadée, G. C., 1975. Lunulitiform Bryozoa from the Gyuana shelf. - Neth. J. Sea Res. 9: 320-343.

Cadée, G. C., 1979. The Cupuladria canariensis complex. - In: G. P. Larwood & M. B. Abbott, Advances in Bryozoology (Syst. Assoc. Spec. Vol. 13), pp. 443-460. London (Academic Press).

Canu, F. & R. S. Bassler, 1923. North American Later Tertiary and Quaternary Bryozoa. - U.S. Nat. Mus. Bull., 125: 1-302.

Cheetham, A. H. & D. M. Lorenz, 1976. A vector approach to size and shape comparison among zooids in cheilostome bryozoans. - Smiths. Contr. Paleobiol., 29: 1-55.

Cook, P. L., 1965a. Notes on the Cupuladriidae (Polyzoa, Anasca). - Bull. Br. Mus. Nat. Hist. Zool., 13: 151-187.

Cook, P. L., 1965b. Polyzoa from West Africa. The Cupuladriidae (Cheilostomata, Anasca). - Bull. Br. Mus. Nat. Hist. Zool., 13: 191-227.

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

Lagaaij, R., 1963. Cupuladria canariensis (Busk) - portrait of a bryozoan. - Palaeontology, 6: 172-217.

Mayr, E., E. G. Linsley & R. L. Usinger, 1953. Methods and principles of systematic zoology. New York (McGraw-Hill), VII + 336 pp.

Scott, G. H., 1975. An automated coordinate recorder for biometry. - Lethaia, 8: 49-51.

Scott, G. H., 1980. The value of outline processing in the biometry and systematics of fossils. - Palaeontology, 23: 757-768.

Taylor, P. D., G. P. Larwood & P. S. Balson, 1980. Pliocene of Suffolk. Fieldguide Intern. Bryozool. Assoc., post conference geological fieldmeeting: 51-60.