Crinoidea collected by the *Meteor* and *Discovery* in the NE Atlantic

A. M. Clark

Department of Zoology, British Museum (Natural History), Cromwell Rd., London SW7 5BD

Introduction

The paper includes new records for mostly little-known Crinoidea collected by the *Meteor* and *Discovery* in the Atlantic from off NW Spain to the vicinity of the Canary Islands and from the Great Meteor Bank, S from the Azores, the source of a new genus and species, *Meteorometra monticola*. Tables of numerical data for some of the less well-known species are provided. The ranges of several species are extended and affinities of some discussed. A distribution map is included.

Systematic descriptions

Family **COMASTERIDAE**

Neocomatella europaea A. H. Clark

Actinometra pulchella (part) P. H. Carpenter, 1888: 304–306, pl. 4, pl. 52, fig. 1; Koehler & Vaney, 1910: 32. [Non *A. pulchella* Pourtalès, 1878.]

Neocomatella europaea A. H. Clark, 1913*a* : 4; 1931 : 150–153; Cherbonnier, 1970*a* : 343, 345, 346, 347; 1970*b* : 1266, 1268, 1269, 1270, 1271; Sibuet, 1974 : 791.

MATERIAL. *Meteor* cruise 9c, st. 101b AT 33, 36°36·3′N, 14°14′W (Josephine Bank, W of Portugal); 170–300 metres; 5 specimens.

Discovery st. 8966, 31°21–22′N, 10°40·5–39·2′W (off Morocco); 686–742 metres; 1 specimen.

Discovery st. 9015, 28°46·8–46·0′N, 12°47·4–46·8′W (off S Morocco); 610–637 metres; arms only.

The description of this species given by A. H. Clark is limited mainly to the form of the cirri. Unfortunately all the present specimens are badly broken but some descriptive remarks can be made from them.

All probably had c. 20 arms, not exceeding 40–50 mm in length. One of the larger *Meteor* specimens and the *Discovery* one both have the arm breadth at the first syzygy (which is usually 1 + 2) 1·1 mm. The strong, incurled cirri are one or two deep around the discoidal centrodorsal, numbering only XVIII plus ii immature ones in one specimen but XXXIII in another. There are up to 15 cirrals, laterally compressed, the distal ones broadened dorso-ventrally. The longest segment, the fourth or fifth, measures up to 1·3 mm, with length : median breadth 3·2–3·5 : 1; the total cirrus length being up to 12 mm. There are small dorsal spines on the distal segments.

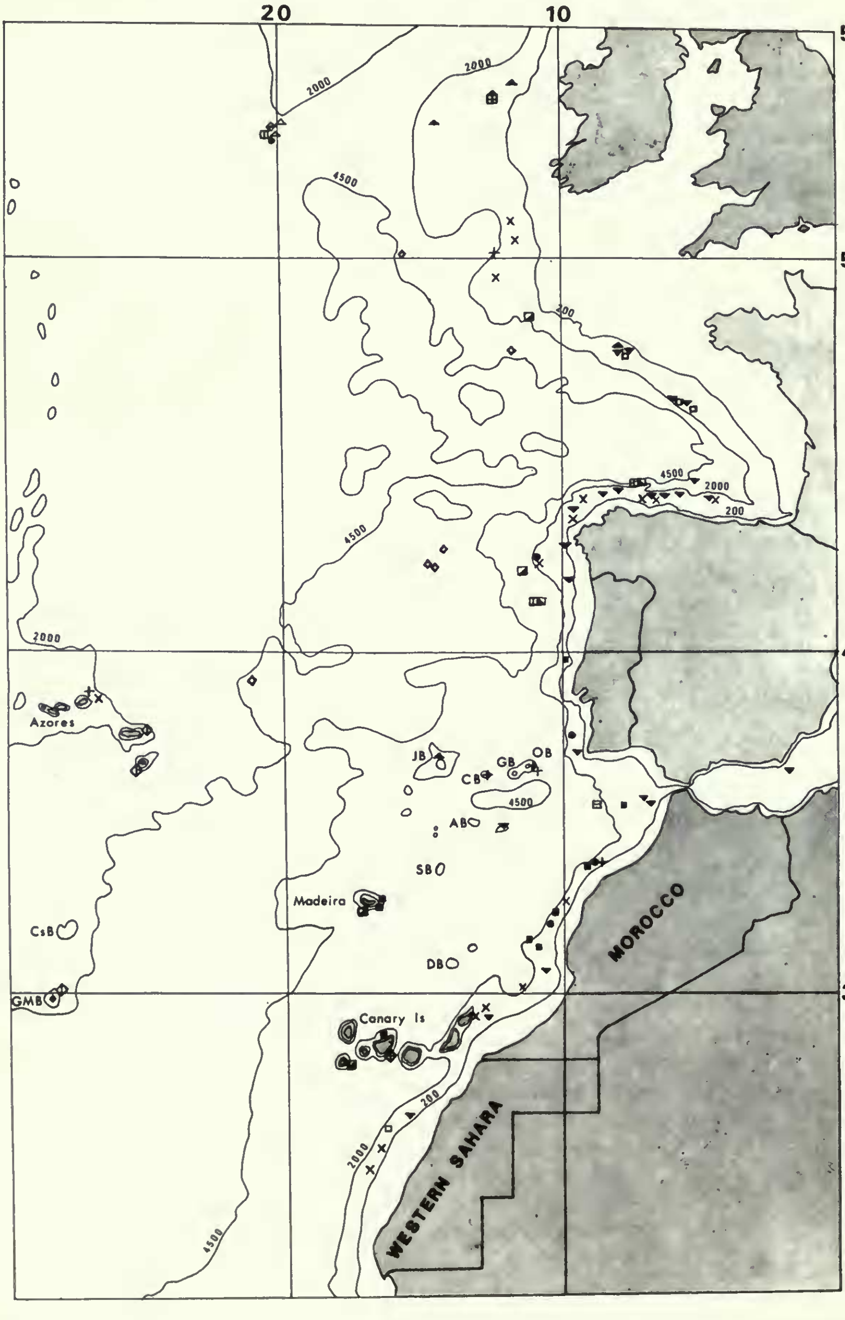
The division series are rounded laterally. The ossicles are not at all flared at the joints but are ornamented along their distal edges by a series of very fine rugosities. All the IIBr series are of two ossicles. On the brachials the ornamentation becomes stronger, the outer part is fluted, each small ridge leading to a distally-directed spine, though the ossicle is slightly

Bull. Br. Mus. nat. Hist. (Zool.). **38** (4): 187–210 Issued 25 September 1980

flared and the profile is irregular. Combs are present on the first three pinnules, which on one specimen have c. 30, c. 25 and c. 24 segments respectively, P_1 measures 7·0 mm.

DISTRIBUTION. Northern Bay of Biscay to Western Sahara, NW Africa; 337–1700 metres.

AFFINITIES. Messing (MSc thesis, 1975) has studied a large collection of *Neocomatella pulchella* (Pourtalès) from the West Indian area, ranging to St. Paul's Rocks, NE from Brazil. He noted that a relatively small specimen with arm length only c. 50 mm (compared with the usual 100+ length of most examples of this species collected) has XVI cirri, with 14–17 segments, measuring 10 mm in length, not markedly different from the specimens of *N.*



europaea mentioned above. However, already at this size, the longest cirrals in the West Indian specimen have length : median breadth only 2.1 : 1 and the cirri must be much stouter, otherwise it might be thought that the eastern Atlantic *Neocomatella* is only a stunted paedomorphic form of the West Indian species.

Family THALASSOMETRIDAE

Koehlermetra porrecta (P. H. Carpenter)

Antedon porrecta P. H. Carpenter, 1888 : 250–252, pl. 52, figs 3–5; Koehler & Vaney, 1910 : 32; Hartlaub, 1912 : 285.
Antedon flava Koehler, 1895: 475; Koehler & Vaney, 1910 : 31.
Crotalometra porrecta: A. H. Clark, 1913*b* : 46; Mortensen, 1927 : 25.
Koehlermetra porrecta: A. H. Clark, 1950 : 101–105.
Koehlermetra flava: A. H. Clark, 1950 : 105–107.

MATERIAL. *Meteor* cruise 36, st. 98 AT 149, 25°31·5′N, 16°02·2′W (off Western Sahara); 658–888 metres; 12 specimens.
Discovery st. 7984, 25°27′N, 16°10′W; 811–890 metres; 2 adult specimens and 1 pentacrinoid.

All the specimens are somewhat broken, often from the first syzygy, which is at 2 + 3 on arms following IIBr series of four ossicles – the usual number, or at 3 + 4 on arms based on IIBr series of two, occasionally at 1 + 2 or even not until 10 + 11. Where more than one IIBr series occur, these are usually adjacent and posterior.

The centrodorsal is domed in one specimen, otherwise more or less broadly truncated, even to the extent of being discoidal. Measurements are given in table 1. The cirri are arranged one or two deep around the sides. The sixth or seventh cirral is usually a transition segment and is the longest; it has a triangular raised patch dorsally.

The division series are quite smooth except sometimes for a few small knobs at the sides. They have a flattened shoulder-like flange each side continuing distally into the base of the first pinnule (P_D) on the $IIBr_2$.

The larger specimens have c. 20 arms. The arm length in one of them (the third in table 1, taken by the *Discovery*) was probably 120–130 mm. This specimen has c. 12 segments in

Fig. 1 Map of part of the NE Atlantic, with contours for 200, 2000 and 4500 metres, showing records of the following 18 species of bathyal and abyssal Crinoidea:

- ▼ *Neocomatella europaea* A. H. Clark
- ■ *Thalassometra lusitanica* (P.H.C.)
- ◆ *Meteorometra monticola* n.sp.
- ● *Trichometra cubensis* (Pourtalès)
- × *Pentametrocrinus atlanticus* (Perrier)
- ◇ *Bathycrinus gracilis* Wyville Thomson
- ⊟ *Rhizocrinus magnus* Gislén
- ◫ *Zeuctocrinus gisleni* A. M. Clark
- ◪ *Gephyrocrinus grimaldii* Koehler & Bather
- □ *Koehlermetra porrecta* (P. H. Carpenter)
- ✢ *T. omissa* (Koehler)
- ▲ *Orthometra hibernica* (A.H.C.)
- ⊞ *Atelecrinus balanoides* P.H.C.
- △ *Thaumatocrinus jungerseni* A.H.C.
- + *Democrinus parfaiti* Perrier
- ◩ *Porphyrocrinus thalassae* Roux
- ⬖ *Anachalypsicrinus nefertiti* A.M.C.
- ◈ *Cyathidium foresti* Cherbonnier & Guille

(*Note:* A few of the older records, e.g. from *Porcupine* and *Travailleur* have been slightly modified to conform with the depth contours.) An additional seven stalked species have been recorded from the area, namely: *Annacrinus wyvillethomsoni* (Jeffreys *in* W. Thomson) (from the Bay of Biscay to the Canary Is in 1330–2000 metres); *Porphyrocrinus incrassatus* Gislén (Bay of Biscay, also St. Helena, 2400–2780 metres); *Conocrinus cabiochi* Roux (Bay of Biscay, 1975–2070 metres); *C. cherbonnieri* Roux (Bay of Biscay, 330–510 metres); *Monachocrinus perrieri* (Koehler & Vaney) (off Morocco and the Azores, also South Africa, 1620–4600 metres); *M. recuperatus* (Perrier) (off Morocco and Azores, 2300–4260 metres); also ?*Democrinus conifer* (A. H. Clark) but the Josephine Bank and Portuguese records of A. H. Clark (1923) at least are probably conspecific with *D. parfaiti*, as already noted (A. M. Clark, 1977 : 177). The abbreviations for the sea mounts are as follows: AB – Ampere Bank; CB Cromer Bank; CsB Cruiser Bank; DB Dacia Bank; GB Gettysburg Bank; GMB Great Meteor Bank; JB Josephine Bank; OB Ormonde Bank; SB Seine Bank. (Gettysburg and Ormonde Banks together make up the Gorringe Ridge).

Table 1 *Koehlermetra porrecta* (P. H. Carpenter). Numerical data from 11 *Meteor* and 2 *Discovery* specimens. The length to the first brachial syzygy at Br2 + 3 includes a IIBr4 series; the relative length of the transition segment of the cirri uses the median width; immature cirri are counted in small roman numbers.

Arms		Centrodorsal		Cirri									
Width at 2 + 3	Length to Br2 + 3	Diam.	Height	No.	Segs.	L.	Trans. seg. No.	Trans. seg. L/W	P_D Segs.	P_D L.	P_1 Segs.	P_1 L.
2·7	10·2	7·5	2·3	XXII + iv	33–35	38	7	1·7	—	—	—	—
2·4	9·7	7·2	2·6	XXIV	39	45	8	1·9	—	—	—	—
2·5	10·0	7·0	2·5	XX + vi	39	40	7	1·4	20	c. 12·5	16–18	12
2·6	10·5	6·2	2·5	XXI + iv	—	—	—	—	21	13·4	17+	c. 12
2·5	9·5	6·7	3·0	XXIV	—	—	—	—	21+	c. 13·5	—	—
2·7	9·3	6·7	2·5	XIV + vi	—	—	—	—	—	—	19	9·3
2·2	c. 9·5	6·0	2·1	XVIII	32, 36	29	7	1·9	17, 19	10·0	15	c. 9·5
2·2	9·0	5·9	2·0	XXI	37	39	7	1·5	17	10·5	—	—
2·0	8·5	5·6	2·0	XXII	34	29	6	1·6	—	—	—	—
2·0	9·2	4·6	2·2	XVIII	28	23	6	1·9	18	c. 9·2	17	c. 9·0
2·0	8·5	4·7	1·9	XXIII	31–34	26	6	2·0	15	7·9	14	7·3
		2·8	1·75	XIX	27, 29	17·5	6	1·6	—	—	—	—
				XV + v	25	c. 17	5		14	5·2	11	3·7

P_2, which measures c. 7·5 mm; there are 18 segments in P_3, total length 12 mm; P_4 is similar to P_3. The smaller *Discovery* specimen has only 11 arms, c. 40 mm long. On the only pair of arms following the single IIBr series, its P_2 has 8 segments and is 2·6 mm long.

The pentacrinoid has 10 arms c. 15 mm long. The longer cirri have 15, in one case 16, segments, the fourth of which is a transition segment. The dorsal projections have sharper points than in the larger specimens. The division series are already flanged laterally but the edges of the flanges are not as straight as in the larger specimens. About 10 segments of the stalk remain, the distalmost much shorter than the proximal ones. There is a small P_1 of c. 6 segments, then a gap until P_5.

SYNONYMY. A. H. Clark (1950) distinguished two species of his new genus *Koehlermetra,* the type-species, *Antedon porrecta,* type locality near Ascension Island, S Atlantic, but subsequently recorded from the Bay of Biscay, and *A. flava* Koehler, type locality in the Bay of Biscay. In his key he separated them on the number of the cirrus segments, cited as 40–50 in *K. porrecta* (cirrus length c. 55 mm) and c. 30 in *K. flava* (cirrus length not given but noted by Hartlaub (1912) as 35–38 mm). No estimate of arm length was given for the holotype of *K. flava,* but that of *K. porrecta* was put at c. 150 mm.

The three syntypes of *K. porrecta* are in the British Museum collections. The largest has the centrodorsal diameter as much as 8 mm and the length from IBr_1 to Br_{2+3} (including a IIBr series of four ossicles) is 11·7 mm. However, the arm breadth at 2 + 3 is 2·6 mm, as in the largest *Meteor* specimens. It has only two peripheral cirri left intact; both have 49 segments and measure 51 or 52 mm. Another syntype has centrodorsal diameter 6·0 mm; all the arms are broken at the first syzygy (i.e. $IIBr_3$ or Br_3); its only intact cirrus is an immature one and has 42 segments. The third and smallest syntype with centrodorsal diameter 3·9 mm has peripheral cirri with 31 and 32 cirrals and measures c. 23 mm in length. The same measurements and counts for a comparable *Meteor* specimen are 4·6 mm, 28 cirrals and cirrus length 23 mm. The *Meteor* and *Discovery* specimens are clearly intermediate between the descriptions of *K. porrecta* and *K. flava* and show enough variation to support Hartlaub's suggestion (1912) that the two are conspecific. It is rather extraordinary that Koehler & Vaney (1910) recorded both *Antedon porrecta* from the Bay of Biscay and *A. flava* from the vicinity of the Canary Islands, without comment.

Thalassometra lusitanica (P. H. Carpenter) new comb.

Antedon lusitanica P. H. Carpenter, 1884*a* : 368; 1888 : 109–110, pl. 39, figs 1–3; 1891 : 65–67.
Antedon (Crotalometra) lusitanica: Koehler & Vaney, 1910 : 31.
Thalassometra lusitanica: A. H. Clark, 1911*a* : 37.
Stiremetra lusitanica: A. H. Clark, 1923 : 40; Mortensen, 1927 : 25; A. H. Clark, 1950 : 121–126.
? Thalassometrid. Gislén, 1955: 84.

MATERIAL. *Meteor* cruise 8, st. 19 AT 9, 33°34·2′N, 09°19·3′W (off Morocco); 1300 metres; 1 specimen.

Meteor cruise 23, st. 174 AT, 35°30·6′N, 08°07·3′W–35°37·5′N, 08°03·2′W; 1716–1912 metres; 5 specimens.

Discovery st. 8967, 31°25·9′N, 10°53·7′W–31°26·3′N, 10°50·8′W (off Morocco); 1140–1222 metres; 28 specimens.

Discovery st. 9028, 31°26·1–28·1′N, 10°52·8–50·3′W (off Morocco); 1229–1166 metres; 17 specimens.

Some numerical details of ten of the specimens from *Discovery* station 8967 are given in table 2.

The maximum arm number in the *Discovery* specimens is 16, possibly 17, but 12–14 is more usual. Only one of the six *Meteor* specimens definitely has more than ten arms, the single IIBr series being of four ossicles. Some *Discovery* specimens have IIBr2 series but more often IIBr4, as on three adjacent radii of the one with a total of 16. Breakage of the division series and arms is frequent, rarely more than half the likely arm length remaining; the maximum was probably c. 60 mm.

Table 2 *Thalassometra lusitanica* (P. H. Carpenter). Numerical data from 10 specimens from *Discovery* st. 8967. The arm width is taken at the first syzygy after the first axillary, which is therefore either Br3 + 4 or IIBr3 + 4; length is to this same joint; the cirri often obscure the diameter of the centrodorsal; immature cirri are counted in roman numbers.

	Arms				Cirri									
	Width	Length	Centrodorsal					Trans.	P_1		P_2		P_3	
No.	at 3 + 4	to 3 + 4	Diam.	Height	No.	Segs	L	seg.	Segs	L	Segs	L	Segs	L
11(?13)	1·6	4·2	—	2·7	XV	58	40	5	14	4·2	—	—	—	—
14(?15)	1·5	4·2	—	2·5	XIV	56, 57	39	5–7	14	4·6	—	—	12	3·7
13(?15)	1·6	3·9	3·0	2·0	XVI + ii	—	—	—	16	5·0	—	—	—	—
16(?17)	1·6	3·8	—	2·3	XVII + ii	—	—	—	—	—	—	—	—	—
12(?14)	1·5	3·9	—	2·5	XIV	52, 53	35	5	17	5·0	11	3·0	11	3·3
10	1·4	4·0	2·75	2·25	XV	—	—	—	14	4·6	—	—	11	3·25
10?+	1·3	4·0	—	2·25	XV	54	37	5	15	4·6	12	3·2	—	—
13	1·3	3·9	2·9	2·1	XVII	54, 59	35	5	—	—	—	—	—	—
10?+	1·3	3·8	—	2·25	XVI	50	30	4, 5	16, 17	5·0	11	2·7	9	2·3
11(?12)	1·25	3·5	—	—	XVIII	50, 54	35	5(4)	—	—	—	—	—	—

The centrodorsals are rounded conical or hemispherical, always broader than high, diameter/height 1·2–1·5/1; the apical area is very papillose. There are X–XX cirri arranged in ten columns but the adapical ones are often reduced (obsolete in A. H. Clark's terminology) so that the functional number is nearer X. The columns are separated by a vertical ridge in each interradius and there may be a short radial ridge between the peripheral sockets only. The largest *Discovery* specimen (arm length ?c. 60 mm) has up to 59 cirrus segments; another with 50–54 cirrals in the peripheral cirri has 31 in an apical cirrus with a length of 15 mm as opposed to c. 35 mm. The maximum segment number in the *Meteor* specimens is 47. The fifth cirral is usually the transition segment, sometimes the fourth, or in apical cirri the third, rarely in large cirri the sixth or even seventh. Length/median width of the transition segment in larger specimens is 2·3–2·7/1.

The short, flared proximal cirrals, the straight-sided division series, the brachials and pinnules are all finely rugose or even spinose, more so in larger specimens. The more distal brachials remaining have a flared spinose distal median area but are rounded in section, not carinate.

The straight side of the division series continues as far as P_1, which is massive basally in contrast with P_2. The S-shaped curvature of P_1 makes estimate of its length difficult. All the pinnules are very prismatic.

The disc and ambulacra of the arms are coarsely and irregularly plated.

Generic position. Contrary to the diagnosis of *Stiremetra lusitanica* given in A. H. Clark's monograph (1950) the cirri are not 'roughly in 15 columns' but in 10. Although one of the three syntypes in the British Museum collections has three cirri in each radius only two are peripheral, the third being in a column with one of them. Also many specimens, including one of the syntypes, and most of the *Meteor* and *Discovery* specimens have at least the proximal and distal edges of the division series and brachials distinctly rugose and sometimes there are also very fine spines on their surfaces, especially laterally. Accordingly these do not run down to *Stiremetra* in the 1950 key but to *Thalassometra*, of which there are two Atlantic species, *T. setosa* (A. H. Clark) from off Tristan da Cunha and *T. omissa* (Koehler) from the Canary Islands. The species of *Stiremetra* otherwise are all from outside the Atlantic and are said to have cirri in fifteen columns. Since young specimens are likely to go through a transitional stage with only ten columns and A. H. Clark has included in *Thalassometra* species with both ten and fifteen, this character does not seem to be of generic weight, though could be used specifically in comparisons of adult specimens.

AFFINITIES. Both *Thalassometra setosa* and *T. omissa* are known only from single specimens. The holotype of *T. setosa* was re-examined. The arms are all badly broken; the width at Br3 + 4 is 1·1 mm and the length to this syzygy (including a IIBr series of 4) is 3·7 mm, only a little less than in the smaller specimens of *T. lusitanica* in table 2, from which it differs in having as many as XXX cirri in 15 columns but with up to only 35 cirrals; the division series are finely 'setose' all over and show no sign of the large synarthrial tubercle developed in *T. lusitanica*.

Judging from Koehler's description (1909), *T. omissa* has the cirri in only ten columns, contrary to A. H. Clark's interpretation, but the cirral number is given as only 21. The arms were all broken by 30 mm and if the total length was appreciably less than 50 mm and the cirrus counted was not a peripheral one the holotype might prove to be conspecific with *T. lusitanica*. The edges of the proximal brachials are described as finely spinose.

For further remarks on *Thalassometra omissa* see p. 197.

Gislén (1955) has recorded two arm fragments of a thalassometrid from off Las Palmas, Canary Islands at 670–1100 metres, with erect spinose ends to the ossicles (brachials and pinnulars). He thought them to be probably of *T. omissa* but the present observations on rugose ossicles in *T. lusitanica* make that a likely candidate.

Family **ANTEDONIDAE**

Antedon bifida (Pennant)

Asterias bifida Pennant, 1777 : 55.
Antedon bifida: Clark & Clark, 1967 : 179–226, fig. 13b, g, h; A. M. Clark, 1970: 28–30, figs 7, 8.

MATERIAL. *Meteor* cruise 9c, st. 90a AT 23; 37°22·8′N 09°00·7′W (off Portugal); 150–170 metres; 2 specimens.

Meteor cruise 9c, st. 90d AT 26; 37°21·5′N, 09°12·5′W; 320–385 metres; 1 specimen.

Meteor cruise 36, st. 122 KD 173, 33°17·2′N, 08°34·5′W (off Morocco); 65 metres; 1 specimen [? *A. bifida*].

In the Portuguese specimens the cirri are markedly deeper distally than proximally, as in *A. bifida moroccana,* which I think now should be ranked as no more than a form of *A. bifida*. This distal enlargement is much less marked in the Moroccan specimen, which is only provisionally referred to *A. bifida.*

Antedon sp. ? ***A. hupferi*** Hartlaub

[*Antedon hupferi* Hartlaub, 1890 : 171; Clark & Clark, 1967 : 153–157, fig. 13d.
Antedon dübeni (part): Gislén, 1955 : 86–87, pl. 1, fig. 4, pl. 2, fig. 8.]

MATERIAL. *Meteor* cruise 9c, st. AT 19, 31°35′N, 10°10·5′W (off Morocco); 150–160 metres; 1 specimen.

As noted in 1967, I disagree with Gislén (1955) that the *Antedon* with slender cirri from West Africa is conspecific with *A. duebeni* from the tropical west Atlantic. In this specimen all the peripheral cirri are broken; the most nearly complete one has 17½ segments with probably 1½ missing. The elongated shape of the segments and the fact that there are more than 17 (the maximum number given for *A. duebeni* by Gislén) agree better with *A. hupferi* in which up to 18 cirrals are recorded. If this identification is correct, the range of *A. hupferi* is extended northwards from Sierra Leone to Morocco.

Leptometra celtica (M'Andrew & Barrett)
Fig. 2

Comatula celtica M'Andrew & Barrett, 1857 : 44.
Antedon phalangium (part): Carpenter, 1888 : 158–165 [non-Mediterranean specimens.]; 1891 : 67.
Leptometra celtica: A. H. Clark, 1913*a* : 2; Gislén, 1947 : 3–4; Clark & Clark, 1967 : 564–572, fig. 32c–g; A. M. Clark, 1970 : 36–39, fig. 12; Sibuet, 1974 : 790–791.

MATERIAL. *Meteor* cruise 9c, st. 80a AT 17, 31°01′N, 10°16′W (off Morocco); 360–375 metres; 4 specimens.

Meteor cruise 9c, st. 82a KT 18, 31°35′N, 10°10·5′W: 180–145 metres; 38 specimens.

Meteor cruise 9c, st. 82b AT 19, 31°35′N, 10°10·5′W; 150–160 metres; 55 specimens.

Meteor cruise 9c, st. 90a AT 23, 37°22·8′N, 09°00·7′W (off Portugal); 170–150 metres; 18 specimens.

Meteor cruise 9c, st. 95 AT 29, 36°29·9′N, 11°33′W (Gettysburg Bank); 150–430 metres; 17 specimens.

Meteor cruise 9c, st. 120 KD 40, 36°40·7′N, 14°15·5′W (Josephine Bank); 211–218 metres; 51 specimens.

Meteor cruise 9c, st. 40/41, same coordinates; 198–293 metres; 19 specimens.

Meteor cruise 9c, st. 41, same coordinates; 234–241 metres; 13 specimens.

Meteor cruise 9c, st. 121a AT 42, 36°42′N, 14°14′W; 210–305 metres; 26 specimens.

Meteor cruise 9c, st. 123a AT 43, 36°42·3′N, 14°15·2′W; 231–210 metres; 26 specimens.

Meteor cruise 9c, st. 130 AT 48, 36°41·4′N, 14°14·8′W; 225–216 metres; 41 specimens.

Meteor cruise 9c, st. 130 BSN 13, same coordinates; 224–246 metres; fragments.

Meteor cruise 9c, st. 132 AT 50, 36°40·2′N, 14°17·5′W; 235–240 metres; 2 specimens.

Meteor cruise 19, st. 210 AT 128, 36°41′N, 14°16′W; 223–237 metres; 5 specimens.

Meteor cruise 36, st. 94 FD 141 or 96 FD 145, 24°58·3′N, 15°32·6′W; 25°25·7′N, 15°56·8′W (Western Sahara); 50 or 217–212 metres; 4 specimens.

Meteor cruise 36, st. 96 KT 144, 25°23·2′N, 15°58·7′W; 227–252 metres; 2 specimens.

Meteor cruise 36, st. 96 KG 512, 25°24·9′N, 15°59·2′W; 247 metres; 1 specimen.

Meteor cruise 36, st. 97 KT 146, 25°25′N, 16°00·9′W; 365–337 metres; 27 specimens.

Meteor cruise 36, st. 105 FD 157, 21°19·5′N, 17°29·2′W (Cap Blanc); 206 metres; 1 specimen.

Meteor cruise 36, st. 105 KT 158, 21°20·8′N, 17°29·5′W; 247–186 metres; 3 specimens.

Discovery st. 7977, 26°15′N, 14°43′W (between Canary Is and Western Sahara); 137–143 metres; several hundred specimens.

Apart from the specimens from Gettysburg Bank, most, if not all, of the specimens from any one station are immediately recognizable as having cirri of one of two forms. In the first (fig. 2a) the dorsal side of all but the proximal segments is more or less flared at the distal end so that the profile is slightly serrated, the penultimate segment having a distinct opposing spine. In the second (fig. 2b) the cirri are more slender and tapering, almost smooth in profile and no opposing spine is developed. The first corresponds to the key description of *L. celtica* by A. H. Clark (*in* Clark & Clark, 1967 : 553) and is particularly characteristic of the specimens from the Josephine Bank. The second approximates more to the description of *L. phalangium* (J. Müller) from the Mediterranean and is shown by the specimens from NW Africa and most of those from the Portuguese shelf; however, some of these Portuguese shelf specimens are intermediate, like those from the nearby Gettysburg Bank.

Similar observations of cirral form in Atlantic specimens of *Leptometra* have been made by Carpenter (1886), who noted that specimens from the Minch, between Scotland and the outer Hebrides, adjacent to the type-locality – the 'Sound of Skye' – are of the short, flared-segmented form in contrast to those from off Cape Sagres and Mondego, Portugal, whereas others from the Seine Bank (ENE from Madeira) Carpenter found show a wide range of form in the cirri. A. H. Clark confirmed Carpenter's observations on the same material. However, whereas Carpenter concluded that *L. celtica* should be treated as a dwarfed variety of *L. phalangium,* A. H. Clark considered that there is enough difference to maintain two species.

Gislén (1947) named as *L. celtica* specimens from the vicinity of Tangier in 130 metres depth with somewhat serrated cirri. However, he suggested that *L. phalangium* might occur outside the Mediterranean off the NW African coast at depths greater than this, being transported over the sill at the Gibralter Strait in the deeper westbound current from the Mediterranean.

Certainly the specimens now studied from Atlantic Morocco to Cap Blanc might well be

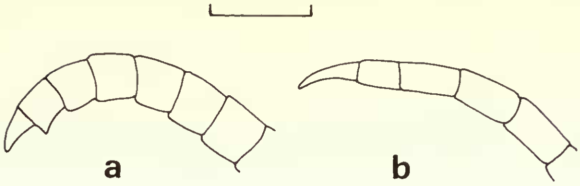


Fig. 2 *Leptometra celtica* (M'Andrew & Barrett). Tips of two extreme forms of cirri, a. *celtica*-form from Josephine Bank, b. *phalangium*-like-form from Morocco. The scale equals 2 mm.

identified as *L. phalangium* but the same is true of some but not all of those from Portugal. This fact and the presence of *celtica*-like specimens in the Gibraltar Strait and western Mediterranean deters me from adopting this course. Sibuet (1974) named as *L. celtica* specimens from the Alboran Sea, east of the Strait in the Mediterranean in 337–538 metres, though without comment on the form of their cirri.

Solution of this taxonomic problem might be assisted by study of material from SW Spain; also by detailed comparison of the particle size of the substrates with cirrus form. The specimens with longer straighter cirri would be expected on finer substrates.

Most specimens of this fragile species are more of less broken but one from the Josephine Bank (*celtica*-form) has almost complete arms just over 80 mm long. Its peripheral cirri are relatively short, up to only 22 mm or c. 25% of the arm length; they have 33–35 segments. P_1 and P_2 are very long and attenuated, c. 10 mm long and with 20–25 segments. This compares with cirrus and arm lengths of c. 35 and 50–60 mm in a *Discovery* specimen from NW Africa (*phalangium*-form), giving a value of c. 60%. It is notable that most of the specimens from off Western Sahara have a relatively high but rounded truncated centrodorsal, rather than the usual conical shape.

Trichometra cubensis (Pourtalès)

Antedon cubensis Pourtalès, 1869 : 214.

Trichometra delicata A. H. Clark, 1911*b* : 258; Clark & Clark, 1967 : 676–678.[?Non *T. delicata:* A. H. Clark, 1913*a* : 3, A. M. Clark, 1970 : 48, fig. 13.]

Trichometra cubensis: Clark & Clark, 1967 : 671–676; Meyer, Messing & Macurda, 1978 : 423. [?Non *T. cubensis:* A. H. Clark, 1923 : 11–12; A. M. Clark, 1970 : 46–48, fig. 17.]

MATERIAL. *Meteor* cruise 8, st. 8a AT 6; 37°39′N, 09°32′W (off Portugal); 1370–1430 metres; 8 specimens.

Meteor cruise 8, st. 19 AT 9, 33°34·4′N, 09°19·3′W (off Morocco); 1300 metres; 2 specimens.

Discovery st. 7711/66, 53°11·2′N, 20°05·1′W (far W from Ireland); 2432–2380 metres; 14 specimens.

Discovery st. 9029, 32°14·3–14·1′N, 11°2·8–2·5′W (off Morocco); 1886–1835 metres; 1 specimen.

Discovery st. 9042, 42°15·0–17·8′N, 11°22·0–19·7′W (off NW Spain); 1662–1541 metres; 14 specimens.

The largest specimens probably had arm length c. 55 mm, at which the arm width at the first syzygy is 1·5 mm.

The centrodorsal is blunt conical with a papillose dorsal pole. In one specimen the height just exceeds the diameter but the ratio of diameter/height ranges up to 1·7/1 with a mean of 1·3/1. The cirrus sockets usually number XLV–LXV and many specimens show complete regularity in their arrangement in columns, most often three in each radius. There is a more marked disparity in the size of the apical and peripheral cirri than is usual in most antedonids and the relative length of the segments decreases considerably with size. The small *Meteor* specimen with arm width at 3+4 only 0·8 mm has the longest cirral of peripheral cirri (the fifth) with length/median width 4·2/1 whereas in larger specimens with

Table 3 *Trichometra cubensis* (Pourtalès). Numerical data from one specimen from *Meteor* st. 8a (no. 19) and specimens from *Discovery* stations 7711 (nos 12–16) and 9042.

	Arms		Centrodorsal		Cirri			P_1		P_2		P_3	
No.	Width at 3+4	Length to 3+4	Diam.	Diam./Height	No.	Segs.	Length	Segs.	Length	Segs.	Length	Segs.	Length
1	1·5	4·5	3·5	1·5/1	LV	—	—	19	7·7	—	—	—	—
2	1·5	4·4	3·3	1·2	LX	—	—	—	—	13	5·0	—	—
3	1·5	4·2	3·1	1·3	LXV	—	—	18	6·2	—	—	—	—
4	1·5	4·2	3·2	1·3	LV	—	—	17	6·2	—	—	12	5·2
5	1·5	4·0	3·0	1·25	LV	—	—	—	—	—	—	—	—
6	1·4	4·6	—	—	XLVIII	42	18·5	15	6·2	14	6·6	11	5·8
7	1·4	3·8	2·7	1·4	L	—	—	—	—	—	—	—	—
8	1·25	3·3	—	—	LXV	38	16·2	12	4·2	13	4·4	12	5·0
9	1·2	3·8	2·4	1·1	XLVI	—	—	14	4·7	—	—	—	—
10	1·2	3·6	2·7	1·0	LVI	—	—	—	—	—	—	—	—
11	1·2	3·3	2·5	1·3	—	—	—	12	4·4	—	—	12	4·6
12	1·3	3·2	2·7	—	—	41	17·5	13	3·5	10	3·3	—	—
13	1·3	3·0	2·75	1·2	LXVI	—	—	16	5·0	11	3·7	10	3·5
14	1·25	3·2	—	—	—	40	19·5	15	4·9	12	3·6	10	3·6
15	1·2	2·9	—	—	—	37	—	12	3·3	—	—	10	3·2
16	1·2	2·75	2·25	1·3	LXIV	—	—	14	4·0	11	2·9	10	2·9
17	1·0	3·3	2·8	1·2	L	—	—	—	—	—	—	—	—
18	0·9	3·5	2·3	1·2	XLV	—	—	12	4·3	12	—	12	3·7
19	0·8	2·8	1·9	1·5	XLV	—	—	—	—	—	—	—	—
20	0·8	2·6	1·5	1·2	XLVI	—	—	11	3·3	8	2·2	8	2·5
21	0·7	2·5	1·25	1·25	—	25	8·0	10	2·7	—	—	—	—

arm width 1·2–1·5 mm the ratio is 1·6–2·7/1, on the few specimens where it can be measured, the cirri are so frequently all lost.

Larger specimens have the division series and arm bases approximating and distinctly flattened laterally, as described for West Indian specimens of *Trichometra cubensis* by A. H. Clark (*in* Clark & Clark, 1967), whereas *T. delicata* A. H. Clark from the Bay of Biscay and Portugal, in which the arm length is not known to exceed 40 mm, is similar to smaller specimens in having these ossicles rounded laterally. The division series, brachials and pinnulars mostly have flared and spinose distal edges. The distal intersyzygial interval is usually two muscular joints.

Most of the pinnules are broken; the longest intact P_1 found measures 7·7 mm and has 19 segments, whereas P_2 and P_3 in all but the smallest specimens have 10–14 and 10–12 segments respectively.

Affinities. The related species *Orthometra hibernica,* also small and with spinose distal ends to the brachials and pinnulars and recorded from W of Ireland to the Josephine Bank, W of Portugal, differs in having a much more flattened centrodorsal, without papillae, and appreciably shorter cirrals, even the longest less than half again as long as their median width.

Owing to the delicacy of this species and damage to the specimens collected, the fact that West Indian specimens have been recorded as having up to only 35 rather than 42 cirrals but as many as 25 rather than 19 pinnulars in P_1 is probably not significant. Nevertheless a direct comparison between specimens from the two sides of the ocean is desirable. The minimum depth recorded from the western tropical Atlantic is only 210 metres (Meyer, Messing & Macurda, 1978), compared with 1300 metres in the NE Atlantic, though SW of Iceland one *Ingolf* station was only 311 metres. A. H. Clark (*in* Clark & Clark, 1967) recorded as *T. cubensis* specimens from the area S of Newfoundland, W of Greenland and off Iceland, as well as in the West Indies. Meyer et al. have suggested that there may be two species-group taxa, a northern and a southern. Zoogeographically this idea has considerable justification and accordingly the references to the *Ingolf* specimens (either as *T. cubensis* or *T. delicata*) in the synonymy of *T. cubensis* given above are queried. The reference to the Helga specimen from west of Ireland as *T. delicata* by A. H. Clark (1913*a*) is additionally queried, having been referred to *Orthometra hibernica* by A. H. Clark (*in* Clark & Clark, 1967). However, since the cirri were described as having only 15–20 segments, the longest as much as three times as long as wide, I think this very unlikely and the specimen could after all have been a *Trichometra.*

One specimen from *Discovery* st. 7711 had its cirri clasped around the stalk of the hyocrinid *Anachalypsicrinus nefertiti.*

Antedonid sp. cf. *'Antedon' omissa* Koehler
Fig. 3

?*Antedon omissa* Koehler, 1909 : 268–269, pl. 32, fig. 10.
?*Thalassometra omissa:* A. H. Clark, 1950 : 184–185.

Material. *Discovery* st. 7984, 25°27′N, 16°10′W (off Western Sahara); 810–890 metres; 2 specimens.

Description. The larger specimen has ten arms 45 + ? c. 10 mm long, arm width at the first syzygy (Br3 + 4) 1·5 mm, length from the proximal edge of the IBr_1 to this syzygy 3·5 mm and to the second syzygy at 9 + 10 8·4 mm.

The centrodorsal is hemispherical, 3·0 mm in diameter and 1·8 mm high, a ratio of 1·7/1. The cirrus sockets number XXXVII and are spaced and irregularly arranged with long pointed papillae among them as well as on the apical area. The single remaining peripheral cirrus has 29 segments and is 15 mm long. The fifth and longest segment has length/median width 2·75/1; most of the cirrals are constricted medially and flared distally but the shorter distal ones have a dorsal crest, highest medially.

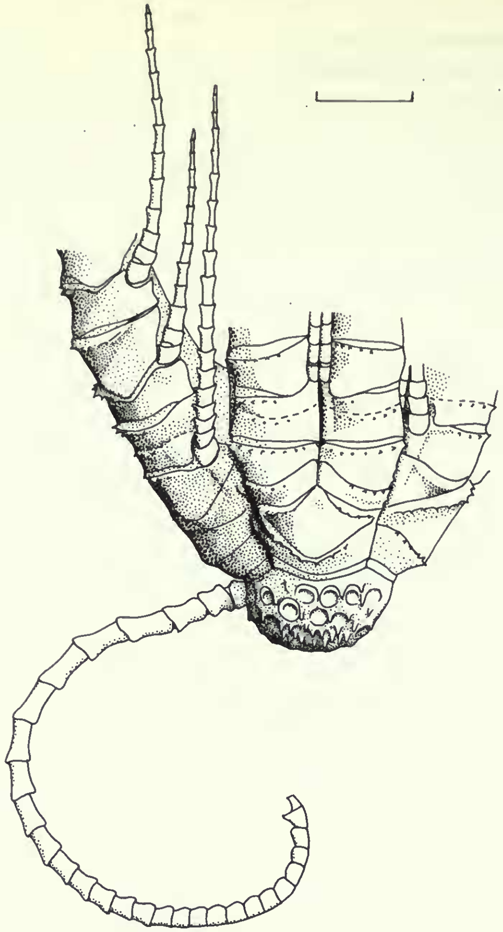


Fig. 3 Antedonid sp. cf. *'A.' omissa* Koehler. *Discovery* st. 7984. [The tip of the terminal claw is broken.] The scale equals 2 mm.

The ossicles of the division series have a small lateral flange each side; this and the arm bases are very sharply flattened laterally and the distal edges of the ossicles, even at the syzygies, bear fine pointed spines. The more distal brachials have spinose frills along their distal edges.

The second syzygy is at 9 + 10 in all but two cases, where it is at 7 + 8 or 12 + 13; the third syzygy is usually at 14 + 15 or 15 + 16; the distal intersyzygial interval is usually two muscular joints.

P_1, P_2 and P_3 have 19, 13 and 13 segments and measure 7·6, 5·8 and 6·0 mm. The first two pinnulars are short, the rest progressively more elongated. If breakage occurs it is usually after the second pinnular. P_4, sometimes P_3, is the first genital pinnule. The dorsal end of the distal edge of each pinnular is flared and bears a cluster of relatively elongated spines. The side plates in the pinnule ambulacra are partially rod-like with one or two proximal branches and a distal expansion into an irregular lattice. The covering plates are also inconspicuous and form an irregular lattice.

The smaller specimen is similar, though less spinose; it has lost all the cirri.

AFFINITIES. These two specimens were taken at the same station with some much larger specimens of *Koehlermetra porrecta* from which they were distinguished by having only ten arms, a hemispherical rather than truncated centrodorsal with numerous pointed papillae, no transition segment in the single remaining cirrus, distinctly spinose division series as well as brachials and pinnulars and inconspicuous side and covering plates in the pinnules. At first they were thought to be *Trichometra cubensis,* collected from as close as Morocco (32°14′N), though the minimum depth for that species in the NE Atlantic appears to be 1300 metres, from the present records. *T. cubensis* too has ten arms, division series and arm bases somewhat flattened laterally in larger specimens (arm width at the first syzygy $>1{\cdot}2$ mm) and P_1 much the longest pinnule. However, all the specimens in the present collection referred to *T. cubensis* have blunt conical centrodorsals with papillae only on the apical area, XLV or more cirri (with at least 35 segments in the longest ones at arm width $>1{\cdot}2$ mm) arranged in fairly regular vertical lines, relatively longer division series and brachials (length to 3 + 4 from the proximal edge of IBr_1 4·0–4·5 mm at width 1·5 mm, rather than only 3·5 mm), and only very fine bent rods in the pinnule ambulacra.

There is a possibility of identity with *Antedon omissa* Koehler, 1909, collected nearby SE of Tenerife, Canary Is in 1330–1340 metres, although Koehler referred this species to the Basicurva-group – the Thalassometrida – prompting A. H. Clark (1950) to include the species in *Thalassometra* itself. The single, poorly preserved specimen had the centrodorsal hemispherical, the division series slightly flattened laterally, the brachials flared and after about the seventh with spinose distal edges and P_1 much larger than P_2 (from the figure). However, nothing is said about papillae on the centrodorsal and the cirri are given as including only ten principal ones with others arranged above them, the number of cirrals being up to only 21; also P_1 and P_2 have only 12 and 6 segments and the distal intersyzygial interval is given as three to five muscular joints. The ambulacral plates are not described so affinity with the Thalassometrida cannot be certain. The only clue as to the size of the holotype of *A. omissa* is a disc diameter of 4 mm. The centrodorsal diameter would presumably be appreciably smaller than this, perhaps 2–3 mm.

In spite of the irregular position of the second syzygy occasionally, the two *Discovery* specimens appear to be referable to the Antedonidae and run down to the vicinity of *Trichometra* in the key to the subfamily Bathymetrinae by A. H. Clark (in Clark & Clark, 1967). This key is unfortunately far from satisfactory since it depends strongly on the relative cirral length and pinnular numbers, which vary to some extent with size. Hopefully more material will be forthcoming from the further collecting going on off NW Africa which should help towards a better assessment of the taxonomic position of these specimens.

METEOROMETRA gen. nov.

DIAGNOSIS. A genus of Antedonidae, subfamily Bathymetrinae* having a low hemispherical centrodorsal on which the cirri are more or less irregularly arranged and the dorsal pole is papillose; peripheral cirri with 17–25 segments, the longest ones flared distally and about twice as long as their median widths, the distal ones about as wide as long; the ossicles of the division series and arm bases are more or less constricted medially and flared and finely spinose distally; the pinnules all consist of attenuated segments after the first two short ones of each, the distal ends of the pinnulars being markedly flared and spinose; P_1 is markedly and consistently shorter and more slender than P_2 and the following pinnules.

TYPE SPECIES. *Meteorometra monticola* sp. nov.†

AFFINITIES. The hemispherical centrodorsal with cirrus sockets not regularly arranged, peripheral cirri mostly with more than 20 dorsally-flared segments and P_1 with usually 15–20 elongated segments ally *Meteorometra* with the genera included in the Bathymetrinae, of which *Orthometra, Hathrometra, Phrixometra* and *Trichometra* are recorded from certain parts of the Atlantic.

* Since the taxa which have been included in the Bathymetrinae and Zenometrinae include all intermediate arrangements of the cirrus sockets and shapes of the centrodorsal from completely irregular on a low hemispherical ossicle in *Bathymetra* to well-marked vertical columns on a conical or columnar centrodorsal in *Zenometra*, I consider that these two subfamilies should be merged.

† *Monticola* – dweller on a mountain.

Orthometra with *O. hibernica* recorded below (p. 203) is easily distinguished by the low, flattened centrodorsal, lacking apical papillae, and the relatively numerous and short cirrals (25–32 in peripheral ones, the longest with length/median width less than 1·5/1).

Hathrometra with two species, *H. tenella* (Retzius) from NE America and *H. sarsi* (Düben & Koren) from Norway to Greenland (but not W or S of the British Isles), is a much more delicate genus with very attenuated cirri and P_1 much longer than P_2.

Phrixometra – predominantly a Southern Ocean genus though the type-species, *P. longipinna* (P. H. Carpenter), ranges N to the River Plate (c. 37°S, 54°W) – also has P_1 usually the longer pinnule, or at least it is similar in proportions to P_2, unlike that of *Meteorometra*; it is remarkable in being viviparous, females having brood pouches alongside the gonads. Also the division series and arm bases in *Phrixometra* are constricted and spaced laterally, not closely aligned.

Trichometra with a Hawaiian species as well as *T. cubensis* above, (p. 195), is probably the closest to *Meteorometra*, also having the centrodorsal papillose apically and most of the ossicles flared and spinose or rugose but again it differs in having P_1 stouter and more elongated than P_2, while the cirri and cirrals are more numerous (XL or more, the longest rarely with less than 30 segments).

The other bathymetrin genera with cirrals of comparable proportions include *Boleometra* (from Japan), *Nepiometra* (from the Philippines) and *Tonrometra* (from the East Indies and Southern Ocean). All these have P_1 larger than P_2 and indeed the reversal of proportions of these two pinnules in *Meteorometra* appears to provide a very basic distinction.

Meteorometra monticola sp. nov.

Fig. 4

MATERIAL. *Meteor* cruise 9a, st.-AT 88, 29°55′N, 28°20′W (Great Meteor Bank); 300 metres; 2 specimens.

Cruise 9c, st. 148a AT 55, 30°06·7′N, 28°27′W; 323–314 metres; 19 specimens.
Cruise 9c, st. 159a AT 60, 29°50·2′N, 28°29·8′W; 308–310 metres; 14 specimens.
Cruise 9c, st. 172 BSN 24, 29°47·9′N, 28°23·3′W; 300–310 metres; 1 specimen.
Cruise 9c, st. 180a AT 77, 30°01·1′N, 28°24′W; 315–320 metres; 6 specimens.
Cruise 9c, st. 186 KT 82, 29°55·9′N, 28°35′W; 308–330 metres; 1 specimen.
Cruise 9c, st. 189 KT 84, 30°05·1′N, 28°38·4′W; 340–305 metres; 2 specimens.
Cruise 19, st. 126 DD 90/91, 30°09·5′N, 28°29·5′W; 342–357 metres; 1 specimen.
Cruise 19, st. 129 AT 96, 30°01·5′N, 28°30′W; 292 metres; 5 specimens.
Cruise 19, st. 131 AT 97, 30°08′N, 28°38·5′W; 330–473 metres; 8 specimens.
Cruise 19, st. 133 DD 100, 29°49·5′N, 28°19·5′W; 315–326 metres; 1 specimen.
Cruise 19, st. 133 AT 101, 29°48·5′N, 28°22·5′W; 306–308 metres; 3 specimens.
Cruise 19, st. 134 AT 104, 29°46′N, 28°29′W: 320–620 metres; 3 specimens.
Cruise 19, st. 136 KT 106, 29°59·5′N, 28°23′W: 307–337 metres; 2 specimens.
Cruise 19, st. 137 KT 107, 30°03′N, 28°23′W; 307–337 metres; 2 specimens.
Cruise 19, st. 140 AT 109, 30°03′N, 28°33·5′W; 295–310 metres; 2 specimens.
Cruise 19, st. 157 KT 115, 29°55·5′N, 28°30′W; 292–297 metres; 5 specimens.
Cruise 19, st. 157 KT 116, 29°58′N, 28°20′W; 322–422 metres; 4 specimens.
Cruise 19, st. 163 KT 123, 30°09·5′N, 28°32·2′W; 307–337 metres; 1 specimen.
Cruise 19, st. 164 KT 124, 30°06′N, 28°28·4′W; 307–317 metres; 2 specimens.

TYPE MATERIAL. All the specimens are small and more or less broken. The holotype is the best specimen from cruise 19, st. 157 KT 115; the paratypes are the others from this sample and the specimens from cruise 9c, sts 148a, 180a and 189, most of which are included in table 4.

DESCRIPTION. The holotype is specimen 7 in table 4. The arms are all broken by 27 mm and may not have measured more than 40 mm when complete.

The centrodorsal is hemispherical, diameter/height 1·9/1·1 mm = 1·7/1; the cirri are

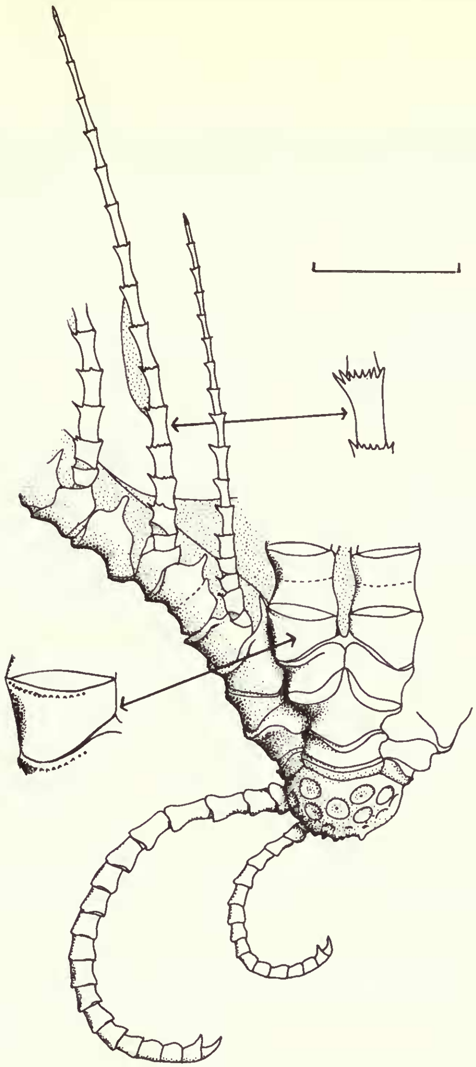


Fig. 4 *Meteorometra monticola* gen. & sp. nov. Centrodorsal from specimen 13 in table 4, *Meteor* st. 148a, otherwise from the holotype, st. 157, with enlargements of a brachial and a pinnular to show the ornamentation. The scale for the main figure equals 2 mm.

irregularly arranged around the sides and the apical area is papillose. There appear to be only c. XXV cirri, the minimum observed in the type series. The peripheral ones have 19–23 segments of which the fourth and longest has length/median width up to 2·0/1.

The ossicles of the division series and arm bases are markedly constricted medially and flared distally, where they are armed with very fine close serrations. Beyond the arm bases these serrations become coarser, fewer and more spaced, elongating into spines. The second syzygy is usually at Br9 + 10 and the distal intersyzygial interval is two, occasionally three, muscular joints.

The first pinnule is markedly more slender and somewhat shorter than P_2 and the following pinnules; P_2 is the first genital pinnule. After the first two short segments, the remaining pinnulars become progressively more attenuated; the distal ends of all but the terminal one are markedly flared and spinose. The frequent breaking point for the distal pinnules is after the second pinnular. There appear to be no rudiments of side or covering

Table 4 *Meteorometra monticola* gen. & sp. nov. Numerical data from 20 specimens from *Meteor* cruise 9c, sts 148a, 180a and 189 and cruise 19, st. 157 (the holotype, no. 7).

No.	Arms Width at 3 + 4	Arms Length to 9 + 10	Centrodorsal Diam.	Centrodorsal Diam/Ht	Cirri No.	Cirri Max. Segs	Cirri Length	P_1 Segs	P_1 Length	P_2 Segs	P_2 Length	P_3 Segs	P_3 Length	Length P_2/P_1
1	0·95	6·5	2·0	1·8/1	XXXIII	23	9·0	17++	c. 6	23	10·0	19+2, 3	c. 9·5	1·7/1
2	0·90	6·5	2·2	1·9	XXXIII	25	10·0	21	6·2	19+1, 2	c. 9·5	20	9·3	1·5
3	0·90	7·1	2·0	1·8	XXIX	21	8·0	18	6·0	—	—	13	5·2	—
4	0·90	6·4	2·0	2·0	XXX	24	9·6	—	—	17+2, 3	c. 8	16	6·2	—
5	0·90	6·4	2·0	1·8	XXXV	—	—	—	—	—	—	19	8·1	—
6	0·85	6·7	2·2	1·7	XXX	—	—	—	—	—	—	—	—	—
7	0·85	6·8	1·9	1·7	c. XXV	23	8·3	18 + 1?	c. 6	18	7·7	12	5·7	1·3
8	0·85	6·7	1·7	1·9	XXVIII	23	7·7	—	—	—	—	—	—	—
9	0·85	6·0	1·7	1·9	XXIX	—	—	—	—	16	7·2	13	6·0	—
10	0·80	6·2	1·8	2·0	XXXIII	—	—	15 + 1, 2	c. 5	20	8·7	14	6·7	1·7
11	0·75	6·2	—	—	—	23	7·5	16++	c. 5	16 + 1, 2	c. 8	12	5·2	1·6
12	0·75	6·1	1·9	1·6	c. XXX	—	—	17	5·7	24 + 1, 2	c. 11	15	7·1	1·9
13	0·75	6·2	1·8	2·1	XXX	24	9·2	20	6·0	17 + 1, 2	c. 8	16 + 2, 3	c. 7·5	1·3
14	0·75	5·8	1·8	2·3	XXVII	23	8·7	—	—	—	—	14	5·8	—
15	0·75	5·7	1·7	—	—	22	8·0	—	—	19	8·7	17	6·7	—
16	0·75	5·7	—	—	—	23	—	—	—	19	7·5	—	—	—
17	0·75	5·8	1·5	1·4	—	18	—	15	4·6	15 + 2, 3	c. 7	13	4·3	1·5
18	0·70	5·8	—	—	—	21	6·7	16	4·3	17	6·4	12	4·7	1·5
19	0·60	4·6	1·3	—	—	19	5·8	13	3·3	13	4·7	10	3·9	1·4
20	0·60	4·7	1·1	1·6	c. XXV	17	—	—	—	13	4·5	12	4·0	—
Ranges	0·60–0·95	4·6–7·1	1·1–2·2	1·4–2·3	XXV–XXXV	17–25	5·8–10·0	13–21	3·3–6·2	13–25	4·5–11·0	10–20	3·9–9·5	1·3–1·9

plates in the pinnule ambulacra, but on the disc the ambulacra are bordered by opaque plates.

PARATYPES. The maximum arm length was probably c. 50 or perhaps 55 mm.

The mean diameter/height of the centrodorsal in 15 specimens is 1·8/1. In the largest specimens the longest cirrals are relatively slightly shorter than in the holotype, with length/median width c. 1·8/1. Some of the cirrus sockets in most specimens are arranged in vertical lines but this is much less regular than in the specimens referred to *Trichometra cubensis*. P_1 is always markedly smaller than P_2, the mean inverse length ratio in ten specimens being 1·5/1. The two largest specimens (1 and 2 in the table) give an idea that P_3 increases allometrically with respect to P_2 since the lengths of these two pinnules are almost the same, where the smaller specimens tend to have a P_2/P_3 length ratio of 1·2–1·5/1.

Several samples included also material of the hydroid *Polyplumaria flabellata* G. O. Sars, which range from the Congo (Zaire) N to Iceland in 30–800 metres. I am indebted to Dr. P. F. S. Cornelius for this information. Some specimens have their cirri clasping branches of a gorgonian.

DISTRIBUTION. On present evidence *Meteorometra monticola* appears to be endemic to the Meteor Sea-mount but it is also likely to occur on the nearby Cruiser Sea-mount (c. 32°N, 28°W) and, like *Cyathidium foresti* (see p. 209), found on the slopes of the Meteor Bank, may even be found around the islands of the Azores at a similar depth of c. 300 metres, though the greater part of the Azores Plateau exceeds 1500 metres.

Orthometra hibernica (A. H. Clark)

Trichometra hibernica A. H. Clark, 1913*a* : 2–3.
Orthometra hibernica: Clark & Clark, 1967 : 680–682; A. M. Clark, 1970 : 34–36, fig. 11. [Non *O. hibernica:* A. H. Clark, 1923 : 57 = *Heliometra glacialis*].

MATERIAL. *Meteor* cruise 9c, st. 111 KD 39; 36°53·3′N, 14°24·7′W (Josephine Bank, W of Portugal); 960–980 metres; 1 specimen.

Although the arms are all detached from the first syzygy, some of the proximal pinnules remain intact and allow a description of these appendages for the first time. The arm width at 3 + 4 is 0·75 mm and the length to 9 + 10 5·75 mm. The total arm length probably did not exceed c. 20 mm.

The centrodorsal is very low, as in the paratype figured in 1970. The longer cirri have c. 30 short segments, most with a rounded transverse dorsal 'ridge' which is approximately median on the very short distal segments.

The division series and proximal brachials have finely serrated distal edges; on the remaining brachials the fine spines become fewer but longer.

Some proximal pinnules are as follows:
P_1 with 13 segments is 3·2 mm long
P_2 with 12 segments is 2·7 mm long; another with 11 segments is 2·5 mm
P_3 with 10 segments is 2·7 mm and is slightly thicker, likewise
P_4 with 10 segments 2·5 mm.
The first two pinnulars are short but the following ones become attenuated and are flared and spinose at their distal ends. The more distal pinnules are probably relatively longer with more expanded joints.

DISTRIBUTION. This record provides an extension of range to the south from the Bay of Biscay NW from Brittany and confirms a maximum depth of more than 750 metres; it is otherwise known only from W of Ireland (53–54°N, 11½°W, 698–749, ?914, metres).

Family PENTAMETROCRINIDAE

Pentametrocrinus atlanticus (Perrier)

Eudiocrinus atlanticus Perrier, 1883*b* : 725; Koehler, 1909 : 271–274, pl. 32, figs

Eudiocrinus (Pentametrocrinus) atlanticus: Koehler & Vaney, 1910 : 31.
Pentametrocrinus atlanticus: A. H. Clark, 1913*a* : 4; 1923 : 44; Mortensen, 1927 : 24, fig. 11; Clark & Clark, 1967 : 790–794; Messing, 1978: 700–708, figs 1–5, 8–11, 13–16; Meyer, Messing & Macurda, 1978 : 423.
Pentometacrinus atlanticus: Cherbonnier, 1970*a* : 343, 348.
Pentametacrinus atlanticus: Cherbonnier, 1970*b* : 1266, 1268.

MATERIAL. *Discovery* st. 7967, 29°20′N, 12°15′W (NE of Lanzarote, Canary Is); 1576–1539 metres; 1 specimen.

Discovery st. 8519/7, 24°02′N, 16°59′W (off Western Sahara); 1037–994 metres; 15 specimens.

Discovery st. 8931; 24°58·8′–25°05·4′N, 16°31·1–32·2′W; 955–1012 metres; 1 specimen.

Discovery st. 9042, 42°15·0–17·8′N, 11°22·0–19·7′W (off NW Spain); 1662–1541 metres; 3 specimens.

As usual all the specimens collected of this distinctive five-armed species are more or less badly broken. One of the largest (from st. 9042) has the centrodorsal diameter 4·0 mm and height 2·0 mm, the shape being low hemispherical. All the LXVIII cirri are broken. In contrast, a specimen from st. 7967 with centrodorsal diameter/height 3·2/1·3 mm and almost discoidal in shape, has only XIX cirrus sockets in one irregular peripheral ring. Messing gives a range of the diameter/height ratio from 1·4–3·6/1 and a maximum cirrus number of c. XC so clearly there is a great range in the centrodorsal shape and cirrus number.

A detached cirrus 20 mm long from st. 8519 has 18+ segments, the distalmost one broken so at least one more when intact; length/width of the fourth and longest segment is 2·3/0·4 mm or nearly 6/1. There is also a more slender complete detached cirrus 21·5 mm long with 19 segments. A. H. Clark (*in* Clark & Clark, 1967) gave the maximum cirral number as 17 and maximum length as 35 mm but Messing (1978) queried the length as an error of interpretation.

Three specimens from st. 8519 are unusual in having the first pinnule sometimes *before* the first syzygy (brachials 4 + 5); two of them have a P_1 on the right side of Br_2 and a P_a on the left of Br_3 on one arm only, while the third has a P_a on the left of Br_3 on two arms. The centrodorsal diameter in these three is 3·1, 2·75 and 2·6 mm and their arm widths at 4 + 5 are 1·75, 1·5 and 1·5 mm respectively. Otherwise the first pinnule is P_2 on Br_5, as usual in *P. atlanticus.* Only *P. varians* (P. H. Carpenter) from the Maldive area to Japan regularly has P_1 and P_a present.

These localities are within the known range of the species which extends in the NE Atlantic from SW of Ireland to NW of Africa and in the W Atlantic from off Martinique (Lesser Antilles) to the Blake Plateau N of the Bahamas.

Thaumatocrinus jungerseni A. H. Clark

Thaumatocrinus jungerseni A. H. Clark, 1915 : 149, 150; 1923 : 13–17, figs 2–4; Clark & Clark, 1967 : 782–785.

MATERIAL. *Discovery* st. 7711/57, 52°53·3′N, 19°52′W (far W from southern Ireland); 2742–2734 metres; 6 specimens.

Discovery st. 7711/62, 52°50·0′N, 20°02·8′W; 2727–2720 metres; 18 specimens.

Discovery st. 7711/85, 53°05·8′N, 19°55·7′W; 2652–2626 metres; 2 specimens.

The specimens collected of this distinctive species with its ten unbranched arms arising from ten radials are more or less badly broken, particularly with regard to the cirri. However, some of the *Discovery* specimens exceed in size the type-material from the *Ingolf* collections from W of Iceland for which the maximum arm length was estimated by A. H. Clark (1923) as 110 mm and the centrodorsal diameter 3·0 mm. A specimen from *Discovery* st. 7711/85 has several arms almost intact, measuring c. 130 + ?c. 5 mm; since this has the centrodorsal diameter 3·0 mm and the arm width at the first syzygy (4 + 5) 1·4 mm, a larger broken specimen with these measurements 4·4 and 1·7 mm may have had arms as much as 200 mm long.

Table 5 *Thaumatocrinus jungerseni* A. H. Clark. Numerical data from ten specimens from *Discovery* st. 7711/62 and one (no. 7) from st. 7711/85.

Arms Width at 4 + 5	Length to 4 + 5	Centrodorsal diameter	Cirrus number	No.
1·7	4·2	4·4	XVII	1
1·3	4·25	3·0–3·3	XIII	2
1·5	3·8	3·3–3·6	XVI	3
1·3	4·2	3·1	IX	4
1·6	3·75	3·1	XIII	5
1·4	3·9	2·9–3·3	XIV	6
1·4	3·8	3·0	XVIII	7
1·2	3·75	3·7	XIV	8
1·25	3·75	3·2	XIV	9
1·2	3·75	2·5–2·9	X	10
1·0	3·3	2·25–2·4	XI	11

The size of the peripheral cirri is very variable and some of the sockets are markedly projecting so that the outline of the centrodorsal is often rather irregular, resulting in a range of diameter according to the aspect, as given for some specimens in table 5. All the cirri are broken at or before the fifth cirral. The larger cirri of larger specimens have length/median width of the first three cirrals less than 1/1. In the tenth specimen in table 5 this ratio in a stout cirrus is 1·0/1, while the smallest (last) specimen in the table has even its stoutest cirrus with a third cirral ratio of 1·5/1 and a slender one with as much as 3·2/1. As I noted in 1967 (*in* Clark & Clark), the relative length of the proximal cirrals, as well as the number of cirri, vary too much for a practicable distinction between *T. jungerseni* and *T. renovatus* P. H. Carpenter from the Southern Ocean (near the Crozet Is, S of Australia and off the Antarctic continent). However, the position of the first genital pinnule will probably serve to distinguish betwen them. In *T. renovatus* this pinnule is P_a, P_2 or P_b, whereas in the *Discovery* specimens of *T. jungerseni* it is usually P_3 or P_c, sometimes P_4 and only rarely P_b.

A few specimens have the proximal pinnules intact; the largest in table 5 has the segment number and length of P_1, P_2 and P_3 : 34, 10·0 mm; 22, 9·1 mm and 32, 12·1 mm, P_3 being the first genital pinnule. A specimen with width at the first syzygy 1·4 mm gives counts of 22, 7·1 mm, 24, 7·9 mm and 23, 8·3 mm.

It should be noted that the position of the first arm syzygy is rather variable in this material. In c. 50% of cases it is at Br4 + 5 but may also be at 3 + 4 or 5 + 6. One specimen was seen to lack P_1 on seven of the ten arms.

DISTRIBUTION. These new records provide an extension of range somewhat to the southward in the North Atlantic, the type material being from the Denmark Strait and from SW of Iceland (c. 62°N, 30°W); the depth range is slightly extended beyond 2075 metres to 2734 metres.

Family BATHYCRINIDAE

Democrinus parfaiti Perrier

Democrinus parfaiti Perrier, 1883*a* : 450–451; Gislén, 1938 : 28–29; 1947 : 7–9, fig. 3; Roux, 1977 : 39–40, figs 4, 9, 10, 11, 16, pl. 2, figs 6–8, pl. 5, figs 1–6; A. M. Clark, 1977 : 172–177, fig. 3.

MATERIAL. *Meteor* cruise 36, st. 127 FD 181; 33°40′N, 08°55′W (off Morocco); 988 metres; 1 specimen lacking arms beyond the first brachial.

Table 6 *Bathycrinus gracilis* Wyville Thomson. Numerical data from the 7 *Meteor* specimens for comparison with table 1 of A. M. Clark (1977); no. 5 is from st. 24, no. 2 from st. 30 and the rest from st. 38. The height of the radials cited is the mid-radial side view (i.e. slightly foreshortened).

CALYX:	1	2	3	4	5	6	7
Height (basals and radials)	—	1·7	2·0	—	—	—	—
Basals height	—	0·50	0·58	—	—	—	—
Basals lower width	—	0·70	0·75	—	—	—	—
Radials height	1·08	1·10	1·46	1·50	1·75	1·90	2·42
Radials lower width (A)	0·75	0·83	0·92	1·42	1·67	1·42	1·50
Radials upper width (B)	1·83	1·90	2·25	3·25	3·33	3·25	3·83
A as % B	41	44	41	44	50	44	39
POST-RADIAL SERIES:							
Crown length (incl. radials)	c. 18	18+	20+	—	20++	c. 40	c. 65
IBr_1 and $_2$ length	2·42	2·60	3·00	3·42	3·58	3·75	4·33
IBr_{1-2} width	1·33	1·42	1·50	—	2·58	2·33	2·92
IBr_1–Br_4 length	5·08	5·58	6·20	7·10	7·70	7·70	8·60
Br_{4+5} width	0·58	0·67	0·71	0·92	1·17	0·87	1·21

Bathycrinus gracilis Wyville Thomson
Fig. 5

Bathycrinus gracilis Wyville Thomson, 1872 : 772–773; P. H. Carpenter, 1884*b* : 243–245, fig. 16, pl. 8a, figs 1–3; Koehler, 1909 : 254; A. M. Clark, 1977 : 164–167, fig. 1a–f.

MATERIAL. *Meteor* cruise 3, st. 24, 42°17·2′N, 14°46·3′W (W of Cape Finisterre); 5270 metres; 1 crown.

St. 30 AT 3, 42°55·4′N, 14°07·9′W; 5260 metres; 1 specimen, missing most of the stalk.

St. 38 AT 5, 42°10·7′N, 14°20·8′W; 5275 metres; 4 crowns and one specimen missing most of the stalk.

This collection has at last yielded well-developed specimens (unfortunately only two) of *Bathycrinus gracilis* in which the basal ring is still attached to the radials and the crown is not in process of regeneration. Sadly no more than 11 proximal columnals remain, all of them discoidal.

In both these specimens the junction between radial and basal rings tends to form an angle of c. 150°, the basal ring itself tapering downwards slightly but to a much less marked degree than the radials. The degree of splay of the radial ring can be expressed by the angle off the vertical derived from the vertical height and top and bottom diameters of the ring. It ranges from 24–31° in the seven specimens from the *Meteor* compared with 30 and 31° in the two *Chain* specimens included in table 1 of A.M.C. (1977) and 30–37° in the three specimens of *B. aldrichianus* in the same table. Angles of 26½°–32° are obtained for the three specimens of *B. aldrichianus* for which Macurda & Meyer (1976) cite measurements of the top diameters of both basal and radial rings, although the degree of splay appears to be greater in the crown shown in their fig. 1A. (Unfortunately they only cite measurements of the lower widths of individual radials of their detached crowns, some of which were of larger size – maximum radial ring diameter 2·41 mm compared with 1·56 mm for the largest one with basal ring attached.)

Macurda & Meyer note that the basal ring in *B. aldrichianus* is only partially fused, sutures being distinguishable in the lower part. The same is true in the specimen of *B. gracilis* from *Meteor* st. 30. Absence of fusion of the basal ring in the adult has been supposed by Gislén (1938) to be characteristic of *Monachocrinus* A. H. Clark, 1917, which is also supposed to differ from *Bathycrinus* in having a curved rather than angular junction between radial and basal rings, as well as in having non-muscular and muscular joints regularly alternating throughout the arms. These characters are discussed and doubt thrown on their generic weight in a paper on stalked crinoids now in the press (A. M. Clark, Rec. Aust. Mus.).

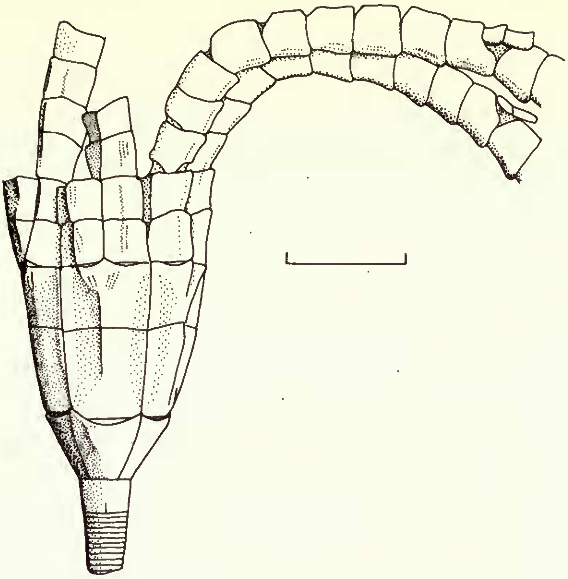


Fig. 5 *Bathycrinus gracilis* Wyville Thomson. *Meteor* st. 30. The scale equals 2 mm.

The *Meteor* specimens agree closely with the two crowns taken SW from Ireland by the *Chain* and described in 1977 (A. M. Clark), having low but sharp keels and lateral flanges on the division series and first brachials, giving way to fluting on the following ossicles, which are flared at their distal ends, making a slightly serrated profile to the arm (fig. 5).

Though indistinct, the non-muscular joints are usually at 1 + 2, 4 + 5, 7 + 8, 10 + 11 and then alternate regularly with muscular joints but one arm of the third specimen in table 6 appears to have 1 + 2, 6 + 7 + 8, 9 + 10 + 11. Because of variations in the positions of these joints, the first pinnule may be on brachial 10 or 12, though it is usually on Br11. Out of 38 arms intact to the first pinnule, in 24 it is at Br11, in 9 at Br12 and in 5 at Br10. Since Macurda & Meyer record their specimens of *B. aldrichianus* as having the first pinnule from Br8 to Br11, the mean position of this pinnule may justify maintaining distinction of these two taxa at the specific level. No other differences in the calyx or crown are evident but it is possible that material of *B. gracilis* with intact stalks will reveal differential characters.

Distribution. Apart from the record from off the U.S.A. of *Bathycrinus serratus* A. H. Clark, 1908, reduced to a synonym of *B. aldrichianus* by A. H. Clark (1949), all the records of crowns or intact specimens which can confidently be referred to *B. aldrichianus* are from the equatorial or South Atlantic in 3300–5600 metres. *B. gracilis* is recorded from SW of Ireland (c. 50°N), between the Azores and Portugal (c. 39°N, 21°W) and now from W of northern Spain, in 4430–5275 metres, which appears to show a distribution limited to the West European Basin. However, the absence of intermediate records may be an artefact of collection, considering the great depths involved.

Family **PHRYNOCRINIDAE**

Zeuctocrinus gisleni A. M. Clark

Zeuctocrinus gisleni A. M. Clark, 1973 : 277–281, fig. 5, pl. 2; Roux, 1977 : 34, figs 6, 7, pl. 1, figs 6–8, pl. 3, figs 1–7.

Material. *Discovery* st. 8511/2, 41°49′N, 11°06′W (off NW Spain); 2574–2584 metres; 1 specimen.

Distribution. This record provides a small extension of range SW from Roux's *Thalassa* sample in the southern Bay of Biscay (c. 44°N, 8°W) and takes the depth range beyond the 2380–2432 metres of the type (and only other known) locality, W of Ireland (c. 53°N, 20°W).

Porphyrocrinus thalassae Roux

Porphyrocrinus thalassae Roux, 1977 : 34–38, figs 1B, 2, 3, 5, 11A, 12, 13, 14, 16B, pl. 1, figs 1–5, pl. 7, figs 1–6, pl. 8, figs 1–6, pl. 9, figs 1–6; A. M. Clark, (in press).

MATERIAL. *Discovery* st. 8511/2, 41°49′N, 11°06′W (off NW Spain); 2574–2584 metres; 1 specimen.

The contemporaneous discovery by the *Thalassa* and *Discovery* of this species with its secondary arm branching comparable with that of *Phrynocrinus nudus* A. H. Clark from Japan, helps to justify the synonymizing with Phrynocrinidae by Roux (1977) of the nominal family Porphyrocrinidae, which I split off from the Bathycrinidae in 1973 to accommodate *Porphyrocrinus* Gislén and *Naumachocrinus* A. H. Clark on the basis of their fused plate rather than dendritic stalk attachment. In 1977 (p. 168) I noted that this character alone is not of sufficient weight to justify a family distinction, prompted by new observations on stalk attachments in the Bathycrinidae. Partly on the basis of the fine structure of joints, Roux also cast doubt on my grouping of *Zeuctocrinus*, in which the second post-radial ossicle is a primary axillary, with *Phrynocrinus*, where any axillaries are secondary, irregular and asymmetrical, rather than with *Bathycrinus*. This may well be important but at the same time the absence of discoidal proximal columnals in fully grown specimens of *Zeuctocrinus* forms a strong resemblance to *Phrynocrinus*. Possibly even Phrynocrinidae should be merged with Bathycrinidae, as Roux (1977) implied, though in his summary classification of the order Millericrinida (1978) he listed Phrynocrinidae including the four genera mentioned in this discussion. Clearly further study is needed on the affinities of these taxa to settle the best disposition.

Further remarks on *Porphyrocrinus thalassae* will be published in the proceedings of the 1978 Conference on Echinoderms in Sydney (A. M. Clark, Rec. Aust. Mus. [in press]).

DISTRIBUTION. This record extends the range slightly SW from the type-locality in the Bay of Biscay (c. 44°N, 07°W).

Family **HYOCRINIDAE**

Gephyrocrinus grimaldii Koehler & Bather

Gephyrocrinus grimaldii Koehler & Bather, 1902 : 68–79; Koehler, 1909 : 256–264, pl. 1, fig. 12, pl. 32, figs 1–9; Roux, 1977 : 31.

MATERIAL. *Discovery* st. 9042, 42°15·0–17·8′N, 11°22·0–19·7′W (off NW Spain); 1541–1662 metres; 3 specimens.

A transparency by Dr P. J. Herring verifies Koehler's observation of the colour (1909) as bright yellow in life.

DISTRIBUTION. This locality is intermediate between those of the type material, near the Canaries and Madeira and the *Thalassa* record from the Bay of Biscay (c. 49°N, 11°W) and is also within the known depth range of 1470 (?1420) – 1970 metres.

Appendix

For the sake of complete coverage of the *Meteor* crinoid collections, the following record of a species of the relict genus *Cyathidium* from the Great Meteor Bank, admirably described by Fechter (1973), should be mentioned. Sadly the going to press of this paper overlapped with that of a prior description of the same species by Cherbonnier & Guille (1972) based on material from the Azores in 380–900 metres.

Family **HOLOPODIDAE**

Cyathidium foresti Cherbonnier & Guille

Cyathidium foresti Cherbonnier & Guille, 1972 : 2193–2196, pl. 1.
Cyathidium meteorensis Fechter, 1973 : 162–169, figs 1, 2.

MATERIAL. *Meteor,* 1967, st. 173, 29°42·2′N, 28°20·5′W (Great Meteor Bank); 850–580 metres.

St. 178, 29°57·9′N, 28°15·7′W; 690–610 metres. A total of 20 specimens.

Acknowledgements

I am indebted to Dr H. Fechter of the Zoologische Sammlung des Bayerischen Staates, Münich and Dr A. L. Rice of the Institute of Oceanographic Sciences, Wormley, for access to the material.

References

Carpenter, P. H. 1884*a*. On the Crinoidea of the North Atlantic between Gibraltar and the Färoe Islands. *Proc. R. Soc. Edinb.* **1883–84** : 353–378.

—— 1884*b*. Crinoidea. 1. The stalked crinoids. *Rep. scient. Results Voy. Challenger.* Zool. **11** (32) : 1–440, 62 pls.

—— 1886. On the variations in the form of the cirri in certain Comatulae. *Trans. Linn. Soc. Lond.* **2** : 475–480, 1 pl.

—— 1888. Crinoidea. 2. Comatulae. *Rep. scient. Results Voy. Challenger.* Zool. **26** (60) : 1–399, 70 pls.

—— 1891. Notes on some crinoids from the neighbourhood of Madeira. *J. Linn. Soc.* Zool. **24** : 64–69.

Cherbonnier, G. 1970*a*. Echinodermes récoltés par la *Thalassa* au large des côtes ouest de Bretagne et du Golfe de Gascogne (3–12 Août, 1967). *Bull. Mus. natn. Hist. nat. Paris* **41** [1969] : 343–361, 6 figs.

—— 1970*b*. Echinodermes récoltés par la *Thalassa* au large des côtes d'Espagne et du Golfe de Gascogne (18–25 Octobre, 1968). *Bull. Mus. natn. Hist. nat. Paris* **41** : 1266–1277, 2 figs.

—— **& Guille, A.** 1972. Sur une espèce actuelle de crinoide crétacique de la famille Holopodidae: *Cyathidium foresti* nov. sp. *C. r. hebd. Séanc. Acad. Sci., Paris* (Sér. D) **274** (15) : 2193–2196, 1 pl.

Clark, A. H. 1911*a*. The recent crinoids of the coasts of Africa. *Proc. U.S. natn. Mus.* **40** (1808) : 1–51.

—— 1911*b*. Note sur les crinoides actuels du Muséum d'Histoire naturelle de Paris. *Bull. Mus. natn. Hist. nat. Paris* **17** : 243–260, 2 figs.

—— 1913*a*. On a collection of recent crinoids from the waters about Ireland. *Scient. Invest. Fish Brch Ire.* **1912** (4) : 1–5.

—— 1913*b*. Notes on the recent crinoids in the British Museum. *Smithson. misc. Collns* **61** (15) : 1–89.

—— 1915. Die Crinoiden der Antarktis. *Dt. SüdpolExped.* **16,** Zool. **8** (2) : 101–209, 9 pls.

—— 1923. The Danish Ingolf-Expedition. 5. Crinoidea. *Dan. Ingolf-Exped.* **4** (5) : 1–58, 58 figs.

—— 1931. A monograph of the existing crinoids. 1. The comatulids. 3. Superfamily Comasterida. *Bull. U.S. natn. Mus.* **82** (1)3 : 1–816, 82 pls.

—— 1949. Echinoderms from the mid-Atlantic dredged by the *Atlantis* in the summer of 1948. *J. Wash. Acad. Sci.* **39** : 371–377.

—— 1950. A monograph of the existing crinoids. 1. The comatulids. 4c. Superfamily Tropiometrida. *Bull. U.S. natn. Mus.* **82** (1)4c : 1–383, 32 pls.

—— **& Clark, A. M.** 1967. A monograph of the existing crinoids. 1. The comatulids. 5. Suborders Oligophreata (concluded) and Macrophreata. *Bull. U.S. natn. Mus.* **82** (1)5 : 1–860, 53 figs.

Clark, A. M. 1970. Echinodermata: Crinoidea. *Marine Invertebrates of Scandinavia.* No. 3. 55 pp., 19 figs. Oslo.

—— 1973. Some new taxa of recent stalked Crinoidea. *Bull. Br. Mus. nat. Hist.* (Zool.) **25** : 267–288, 6 figs, 2 pls.

—— 1977. Notes on deep-water Atlantic Crinoidea. *Bull. Br. Mus. nat. Hist.* (Zool.) **31** : 157–186, 5 figs.

—— [In press] Inter-relationships of recent stalked non-Isocrinid Crinoidea. *Rec. Aust. Mus.*

Fechter, H. 1973. *Cyathidium meteorensis* spec. nov., ein neuer Crinoide aus der Familie Holopodidae. *Helgoländer wiss. Meeresunters.* **25** (1) : 162–169, 2 pls.

Gislén, T. 1938. A revision of the recent Bathycrinidae with a study of their phylogeny and geographical distribution. *Acta Univ. lund.* N.F. **34** (10) : 1–30, 18 figs.

—— 1947. The echinoderms collected by the *Skagerak* Expedition in the eastern Atlantic, 1946. 2. Crinoidea. *Göteborgs K. Vetensk.-o. vitterhSamh. Handl.* **B5** (10) : 1–9, 3 figs.

—— 1955. West african crinoids. *Atlantide Rep.* **3** : 83–92, 3 pls.

Hartlaub, C. 1890. Beitrag zur Kenntniss der Comatuliden-Fauna des Indischen Archipels. *Nachr. Ges. Wiss. Gottingen.* **1890** : 168–187.

—— 1912. Die Comatuliden. Reports on the results of dredging, . . . , by the U.S. coast survey steamer *Blake. Mem. Mus. comp. Zool. Harv.* **27** : 277–491, 18 pls.

Koehler, R. 1895. Dragages profonds exécutés à bord du *Caudan* dans le Golfe de Gascogne. *Revue biol. N. Fr.* **7** : 439–496.

—— 1909. Echinodermes provenant des campagnes du yacht *Princesse-Alice. Result. Camp. scient. Prince Albert* **34** : 1–317, 32 pls.

—— **& Bather, F. A.** 1902. *Gephyrocrinus grimaldii* crinoide nouveau provenant des campagnes de la *Princesse-Alice. Mém. Soc. zool. Fr.* **1902** : 68–79, 4 figs.

—— **& Vaney, C.** 1910. Note préliminaire sur les crinoides du *Travailleur* et du *Talisman. Bull. Mus. natn. Hist. nat. Paris* **1910** : 23–32, 3 figs.

M'Andrew, R. & Barrett, L. 1857. List of the Echinodermata dredged between Drontheim and the North Cape. *Ann. Mag. nat. Hist.* (2) **20** : 43–46.

Macurda, D. B. & Meyer, D. L. 1976. The morphology and life habits of the abyssal crinoid *Bathycrinus aldrichianus* Wyville Thomson and its paleontological implications. *J. Paleont.* **50** : 647–667, 5 figs, 5 pls.

Messing, C. G. 1978. *Pentametrocrinus atlanticus* (Perrier) (Crinoidea: Echinodermata): a review. *J. nat. Hist.* **12** : 699–708, 18 figs.

Meyer, D. L., Messing, C. G. & Macurda, D. B. 1978. Zoogeography of tropical western Atlantic Crinoidea (Echinodermata). *Bull. mar. Sci.* **28** : 412–441, 12 figs.

Mortensen, T. 1927. *Handbook of the echinoderms of the British Isles.* ix + 471, 269 figs. London.

Pennant, T. 1777. *British Zoology.* Ed. 4. **4** : 1–136, 93 pls. London.

Perrier, E. 1883*a*. Sur un nouveau crinoide fixé, le *Democrinus parfaiti,* provenant des dragages du *Travailleur. C. r. hebd. Seanc. Acad. Sci., Paris* **96** : 450–452.

—— 1883*b*. Sur des *Eudiocrinus* de l'Atlantique, et su la nature de la faune des grandes profondeurs. *C. r. hebd. Seanc. Acad. Sci., Paris* **96** : 725–728.

Pourtalès, L. F. de. 1869. List of the crinoids obtained on the coasts of Florida and Cuba, by the U.S. Coast Survey Gulf Stream Expedition in 1867, 1868, 1869. *Bull. Mus. comp. Zool. Harv.* **1** : 355–358.

Roux, M. 1977. Les Bourgueticrinina (Crinoidea) recueillis par la *Thalassa* dans le golfe de Gascogne: anatomie comparée des pédoncules et systématique. *Bull. Mus. natn. Hist. nat. Paris.* Zool. **296** : 25–83, 17 figs, 10 pls.

—— 1978. Ontogenèse, variabilité et évolution morphofonctionnelle du pédoncule et du calice chez les Millericrinida (Échinodermes, Crinoides). *Géobios* No. 11(2) : 213–241, 15 figs, 2 pls.

Sibuet, M. 1974. Echinodermes de la mer d'Alboran. *Bull. Mus. natn. Hist. nat. Paris.* Zool. **155** : 789–798.

Thomson, C. Wyville, 1872. On the crinoids of the *Porcupine* Deep Sea Dredging Expedition. *Proc. R. Soc. Edinb.* **7** : 764–773.

Manuscript accepted for publication 28 November 1979