

Associated occurrence of *Cyclocoeloma tuberculata* Miers, 1880 (Decapoda: Majidae) and species of Discosomatidae (Anthozoa: Corallimorpharia)

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Several cases are reported of associated occurrence of the crab *Cyclocoeloma tuberculata* Miers, 1880 (Majidae) and species of Discosomatidae (Anthozoa: Corallimorpharia) carried on the crab's carapace, and colonies of Xenidiidae (Alcyonacea) carried on the ambulatory legs. This is the first record of an association of a crab and a corallimorpharian.

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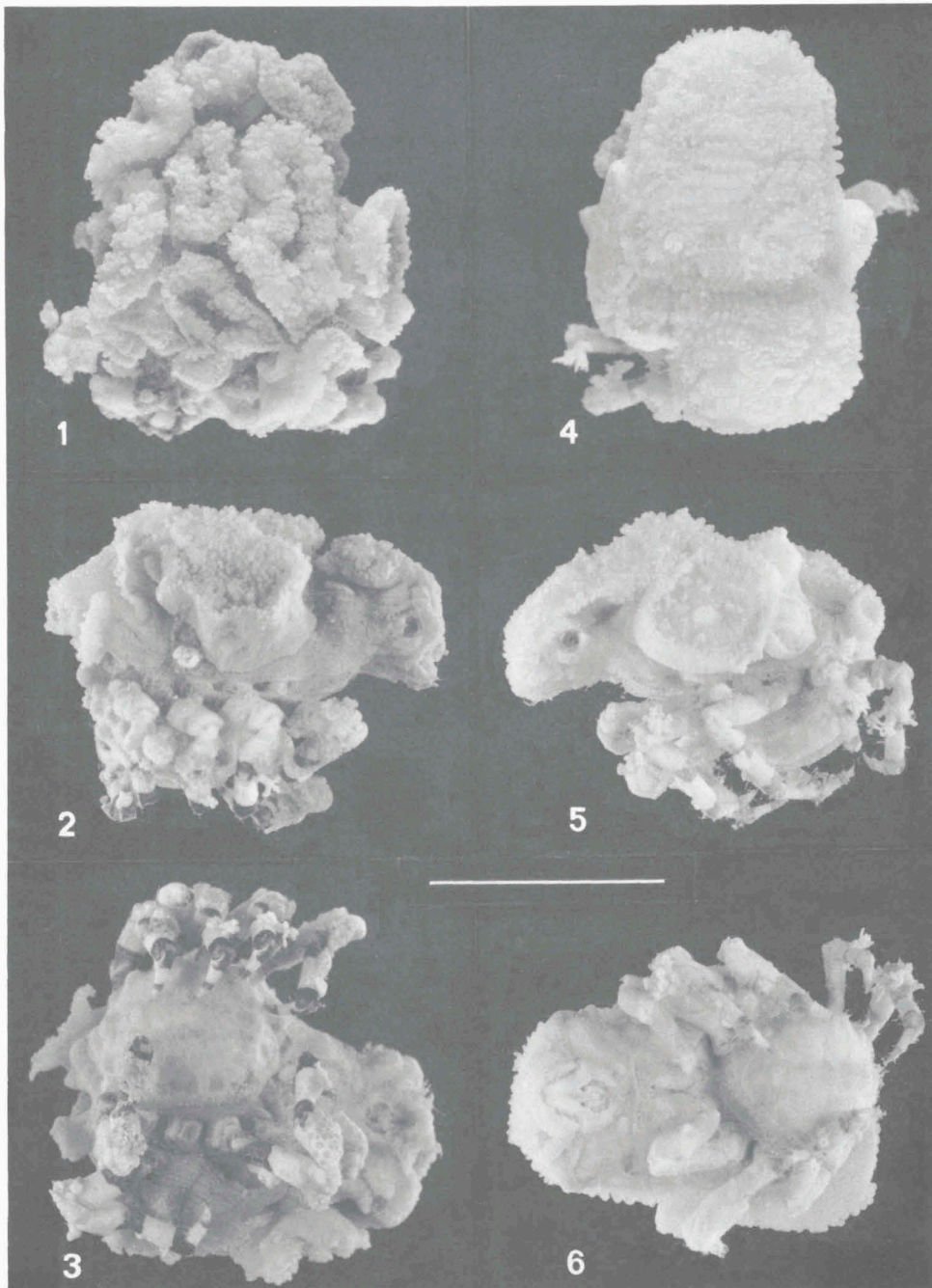
Introduction

Decapoda Brachyura form an ecologically very diverse group of Crustacea, rich in species, and showing a wide variation in morphology and life style. Associated occurrence with Anthozoa is common and was reported for members of most orders of this class of Coelenterata, but not so far for the order Corallimorpharia. On that account it is worth mentioning that during the Dutch-Indonesian Snellius II expedition of 1984 in Indonesian waters were collected two individuals of the majid crab *Cyclocoeloma tuberculata* Miers, 1880 (identification: C.H.J.M. Fransen), of which the carapace was almost entirely covered with *Discosoma*-polyps (Corallimorpharia: Discosomatidae); in addition the ambulatory legs were set with solitary polyps and small colonies (of up to 20 polyps) of at least two species of Xenidiidae (Alcyonacea).

Collecting data

Sample 1: Snellius II, cruise 1, Sta. 4.096 (leg 5). Komodo, NE cape, 8° 29' S, 119° 34'1" E, snorkeling, inner zone of narrow coastal reef, 0.5-1 m, 20.ix.1984, 1 ovigerous ♀ of *Cyclocoeloma tuberculata*, carapace 45 × 30 mm (RMNH Crust. D 37893) covered with nine polyps of *Discosoma* spec. and walking legs set with some 35 small colonies and single polyps of at least two species of a xeniid alcyonacean, chelipeds clean; coll. J.C. den Hartog (figs. 1-3).

Sample 2: Snellius II, cruise 1, Sta. 4.133 (leg 7). NE Taka Bona Rate (Tiger Islands), east coast of Tarupa Kecil, 6° 29' S 121° 8' E, snorkeling, shallow water with coral patches and sea grass, 26.ix.1984, 1 ovigerous ♀ of *Cyclocoeloma tuberculata*, carapace 43.5 × 27 mm (RMMH Crust. D37894) covered with seven *Discosoma*-polyps belonging to two species, walking legs with some 10 small colonies and single polyps of xeniid Alcyonacea, chelipeds clean; coll. J.C. den Hartog (figs. 4-6).



Figs. 1-6. *Cyclocoeloma tuberculata*; two specimens with the carapace well camouflaged with *Discosoma*-polyps and the ambulatory legs set with single polyps and minute colonies of Xeniidae (Alcyonacea); figs. 1-3. RMNH Crust. D37893, dorsal, lateral and ventral view; figs. 4-6. RMNH Crust. D37894, idem. Scale line = 3 cm.

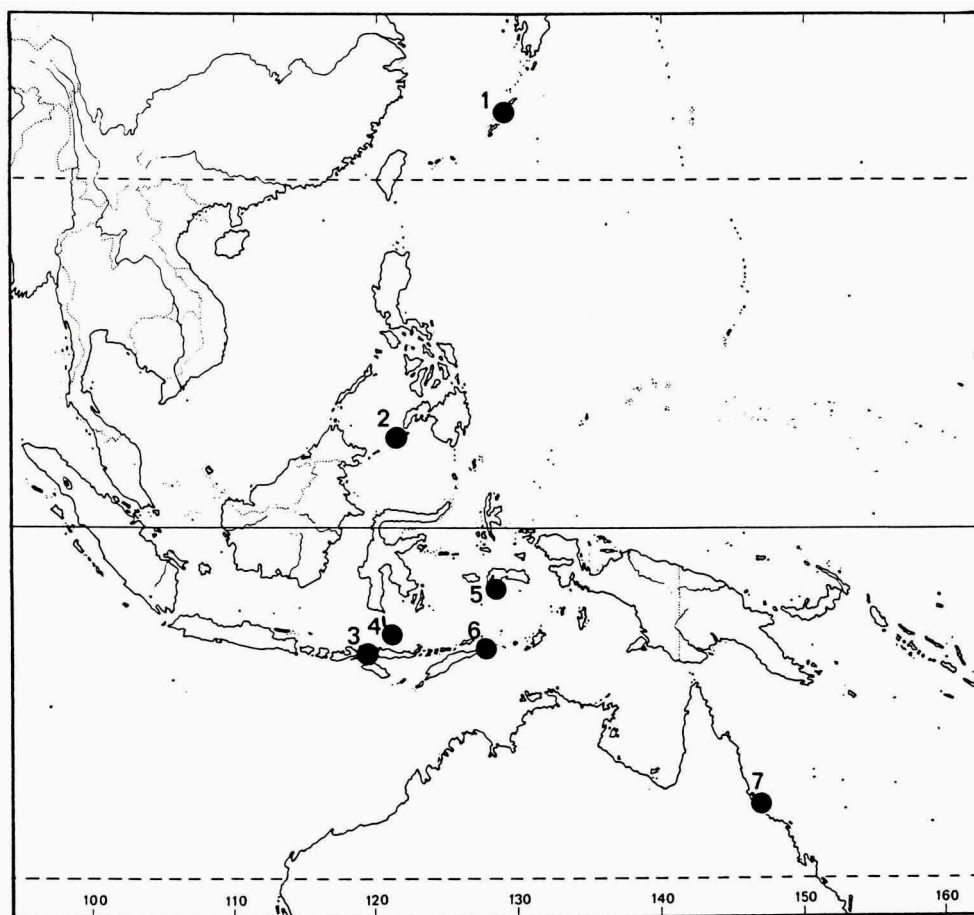


Fig. 7. Known distribution of *Cyclocoeloma tuberculata*: 1. Yoron, Amami Islands, 2. Siasi Island, Sulu Archipel, 3. Komodo, 4. Tarupa Kecil, Taka Bona Rate, 5. Amboina, 6. Kisar, 7. Wheeler reef, Townsville, Queensland.

Additional data from the literature

The fact that associated occurrence of *Cyclocoeloma tuberculata* and species of Discosomatidae (and Xeniidae) was established for two crabs from different localities suggested that this association was not just coincidental, and therefore worthy of further attention.

Cyclocoeloma tuberculata appears a little known crab. There are only a few previous records, all from the Central Indo-West-Pacific (fig. 7): Miers (1880: 229-230; Amboina, one σ , the holotype; BMNH), Buitendijk (1939: 236; Kisar, north east of Timor, 1 ovigerous f ; RMNH D 3172), Sakai (1967: 76-77, frontispiece fig. 2; Yoron, Amami Islands, 4 σ , 1 f , photograph of additional female), and Griffin & Tranter (1986: 265, fig. 102g, h; Siasi Island, Sulu Archipel, 1 f , WAM; Wheeler Reef, Townsville, Queensland, 1 σ , AMS).

It is interesting to note that Sakai (1967: l.c. ; 1976: 192, pl. 67: fig. 2) mentioned

that the crab specimens examined by him carried "several Zoanthids" on the carapace and the ambulatory legs, and that he even considered this an additional diagnostic character of the species. Sakai's observations may be perfectly correct, but taking into account the condition of the Snellius II-specimens and the data presented below, one wonders whether Sakai did use the term zoanthids in its restricted sense, or for sea-anemones or even Anthozoa in general, so that these zoanthids may in fact also have been Discosomatidae and, as far as the ambulatory legs are concerned, xeniid polyps. Unfortunately, this could not be verified as I did not succeed in obtaining Sakai's material for examination.

Griffin & Tranter (1986: 265) explicitly mentioned that one of their two specimens (from Queensland: AMS P. 23824) was camouflaged with anemones, more or less implicating that the other specimen (from the Sulu Archipel; WAM) was not. Efforts to obtain the latter specimen to check this failed. Examination of the Queensland specimen showed the anemones to be two small individuals of a *Discosoma* species, about 7 mm in diameter.

Buitendijk (1939: 236) did not mention the presence of any associated organisms on her specimen from Kisar, but examination of this specimen revealed the right half of its carapace to bear three *Discosoma*-polyps, whilst the bare left half bears traces indicating that additional polyps have been removed, presumably to study the structure of the carapace. In addition, a few small colonies of a xeniid alcyonacean are present on some of the ambulatory legs.

Miers (1880: 229) also failed to mention any organisms associated with the holotype of *Cyclocoeloma tuberculata*. Re-examination of this specimen showed it to be quite clean and fresh-looking; only the first left ambulatory leg bears a small colony of some ten polyps of a xeniid alcyonacean and one solitary polyp of a second species.

Concluding Remarks

The habit to camouflage themselves with foreign materials such as algae, sponges, etc., is widely spread among majid crabs and presumably helps them in hiding from view of potential predators, thus contributing to their survival, especially in the day-time. A variety of species tend to associate with actinarian sea anemones, seeking cover and protection under the potentially dangerous tentacle crown of these hosts, usually with the abdomen turned towards the host's column and the hind legs anchored around it. This behaviour is not otherwise restricted to majid crabs; in subtropical and temperate European waters, e.g., a striking variety of majid and non-majid crab species may be found (non-obligatory) associated with the sea anemone *Anemonia sulcata* (Pennant, 1777) sensu lato (personal observations). It is noticeable that this type of association seems bound to limit the diurnal activity range of the crabs involved; a restriction that has been overcome by species that – in conformity with many hermit crabs – carry their protective anthozoan associates along, actively transferred to the carapace, as e.g. in the Caribbean "decorator crab" *Stenocionops furcata* (Olivier, 1791) (cf., e.g., Cutress et al., 1969).

The available evidence shows that *Cyclocoeloma tuberculata* ranges among the last-named category of crabs, tending to associate with Anthozoa, more specifically with

species of Discosomatidae, attached to the surface of the carapace (as established in four out of five crabs examined) and small colonies of xeniid Alcyonacea attached to the ambulatory legs (as established in all five crabs). It seems probable that the highly sessile corallimorpharians, practically incapable of any movement over the substrate, are actively detached by the crab partner from their substrate and transferred to the carapace, where they may increase in size and propagate by asexual reproduction. The records by Sakai from Japan suggest that the associated Anthozoa may also belong to other orders but this remains uncertain until the identity of Sakai's "Zoanthids" is verified, or until new, irrefutable records become available.

Camouflage with discosomatid and alcyonacean polyps, both zooxanthellate, shows that *Cyclocoeloma tuberculata* haunts the light-shed parts of coral reefs, etc., and does not hide away in the day-time. This, however, does not necessarily implicate that the species is diurnally active.

Presuming a protective character of the anthozoan partners one would infer a greater vulnerability to predators of clean non-associated crab individuals. To what extent the clean uncamouflaged condition, or almost so, of some of the specimens examined is temporarily, possibly related to recent ecdysis, must at present remain an unanswered question.

Notes on the Corallimorpharian associates

The taxonomy of Corallimorpharia, notably of the family Discosomatidae, is in a most unsatisfactory state. A revision of the family is most desirable, but it is doubtful whether this is possible on the basis of morphological and anatomical characters alone. On the one hand there is a great general uniformity within the family, also as concerns the composition of the cnidom (nematocyst signature), whereas, on the other hand, the morphological variation (at least in part phenotypical) within single species may be considerable, and therefore confusing. The number of species definitely is considerably larger than hitherto described and there is no doubt that there are several genera. However, the characters used so far to separate these genera, such as the presence (in e.g. *Rhodactis* Milne-Edwards & Haime, 1851) or absence (in e.g. *Discosoma* Rüppell & Leuckart, 1828, and *Paradiscosoma* Carlgren, 1900) of a distinct naked zone between discal and marginal tentacles, are inconsistent and hence unreliable. For this reason I have provisionally lumped the whole group into a single genus *Discosoma* sensu lato (den Hartog, 1980: 37-40), although I am quite aware that a division of the family on the basis of other or additional characters may prove possible in due course.

The specific identity of the Indonesian Discosomatidae found associated with *Cyclocoeloma tuberculata* could not be determined with the existing literature, but they definitely belong to two distinct species (A and B). Notes on their morphology and cnidom are presented below and in table 1.

Sample 1. Komodo. Morphological notes.— Nine densely arranged polyps, presumably a clone, of a rather thin-walled, flexibel species (A). Polyps with concave oral disc, up to ca 25 mm across, with irregularly undulating margin. Column up to ca 12 mm high. Marginal tentacles arranged in a more or less double crown, very

short, acute to obtuse or clavate, but in places reduced giving rise to crenulate marginal patches. Oral disc, excepting the central part and a narrow marginal region, rather densely covered with stalked, compound, bunchy tentacles with up to ca 15 digitiformous to subglobular branches, arranged in radial rows of ca 5-10 tentacles each. Central part of the oral disc, including the hypostome, with fewer, less compound to simple tentacles, extending up to the edge of the mouth. There is also a narrow, more or less naked marginal zone, but several rows of discal tentacles cross this zone to merge in the marginal tentacles.

Colour of the polyps predominantly dirty brownish- to greyish-green; a grey hue occurs on the column, especially near the limbus. Marginal tentacles often with distinctly white tips.

Cnidom.— A survey of the cnidom is presented in table 1.

Sample 2. Taka Bona Rate. Morphological notes.— Seven densely arranged polyps belonging to two species. Two small individuals of species A, and five individuals of a second, rather rigid species (B), with a heavily developed discal mesogloea, but with a narrow, flexible sparsely and minutely tentaculate marginal zone. In this latter species the oral disc is slightly to distinctly convex with cushion-like elevations bearing concentrations of short, digitiformous to slightly compound tentacles (unless these bunches are to be considered as branches of large compound tentacles embedded in the mesogloea). Between these cushions tentacles are absent to sparse. An arrangement of the discal tentacles in radial rows is absent or otherwise completely obscured by the structure of the oral disc. In the smallest polyp, of some 8 mm across, the disc does not (yet) bear tentacles, but irregular, compound, star-shaped branching structures are visible through the semi-opaque mesogloea (cf. Carlgren, 1943: 13, fig. 4), the arms of which presumably would seem to have emerged eventually as tentacles. In the larger polyps a crown of some 10-15 distinct, simple tentacles marks the edge of the mouth. The marginal tentacles are short and clavate, and on the average more robust than the discal tentacles; they are arranged in a more or less double crown.

Colour of the polyps in life greenish to greyish, semi-opaque; discal tentacles yellowish- to greenish-brown, except for a few creamy ones, notably around the edge of the mouth. Marginal tentacles also predominantly creamy- or white-tipped.

Cnidom.— A survey of the cnidom is presented in table 1. A comparison of the cnidom of the two species, as presented in this table, confirms the high degree of similarity of the cnidom of species of *Discosoma* (and Discosomatidae) in general (cf. den Hartog, 1980: 48-51, table 5). Differences between species, as far as present, bear upon details. The difference in morphology of the two species is supported by a slight but significant difference in the cnidom of the discal tentacles, viz. by a conspicuous disparity in the dimensions of the penicilli D(3b). The significance of this disparity is obvious from the fact that it was not only present between polyps of the two species from different crabs (and different localities), but also between polyps of the two species coexisting on the carapace of the crab specimen from Taka Bona Rate (sample 2). In addition it was found that large penicilli E (3c2) were invariably present in squash preparations of the discal tentacles of species A (though in small numbers), whereas – in spite of intensive search – only very few of these nematocysts were found in the discals of species B. It is difficult to establish to what extent this last-named quantitative difference is reliable, and even if it is, its practical diagnostic

value is bound to be most limited. Whether the two species differ in respect of the size of the penicilli E of the column (1c) could not be established with certainty on account of their mostly collapsed condition in smears of species B.

Table 1. Survey of the cnidom of two unidentified Indonesian species of *Discosoma* (sensu lato) found associated with two individuals of the crab *Cyclocoeloma tuberculata* Miers from Komodo (A; RMNH D 37893) and Taka Bona Rate (B; RMNH D 37894), respectively. Terminology according to den Hartog, 1980: 7-9, pls. 5-6. Symbols used to indicate frequency: + = rather common; ++ = common, +++ = very common, - = uncommon, -- = rare, --- = sporadic.

Organ Nematocyst type	Species	Average and range of length and width of nematocyst capsules in μm	N	Frequency
1. Column:				
a. Spirulae	A	19.7 (16.2-23.4) \times 6.1 (5.4-7.2)	20	++
	B	19.9 (18.0-22.5) \times 6.5 (5.9-7.2)	20	+
b. Penicilli D	A	20.5 (18.9-24.3) \times 7.0 (6.3-8.1)	20	+
	B	23.9 (21.6-27.0) \times 9.0 (8.1-10.8)	20	+
c. Penicilli E	A	28.7 (25.2-31.5) \times 9.1 (8.1-10.4)	20	-
	B	ca. 30 \times 11 (ca 45 \times 15?); mostly collapsed	-	?
2. Marginal tentacles:				
a. Homotrichs	A	43.8 (22.5-57.6) \times 6.9 (3.6-10.8)	35	+++
	B	41.3 (30.6-49.5) \times 7.0 (5.0-8.1)	20	+++
b. Spirulae	A	18.8 (16.2-21.6) \times 5.7 (4.5-6.3)	20	-
	B	18.9 (18.0-20.7) \times 5.6 (5.0-6.3)	4	---
c. Penicilli D	A	21.0 (19.8-22.5) \times 7.4 (6.8-8.6)	3	---
	B	23.5 (18.0-27.0) \times 6.7 (6.3-8.1)	10	--
d. Penicilli E	A, 1	32.4 (30.6-34.2) \times 14.0 (13.5-14.4)	7	---
	2	81.3 (76.5-108.0) \times 34.9 (28.8-41.4)	10	-
	B, 1	34.2 (30.6-36.9) \times 13.9 (13.5-15.8)	20	--
	2	93.4 (85.5-99.0) \times 32.9 (31.5-35.1)	4	---
3. Discal tentacles:				
a. Spirulae	A	not observed		
	B	not observed		
b. Penicilli D	A	20.1 (16.2-23.4) \times 7.1 (6.3-7.7)	20	-
	B	31.2 (25.2-34.2) \times 8.3 (7.2-9.0)	30	-
c. Penicilli E	A, 1	33.7 (31.5-40.5) \times 14.9 (13.5-17.1)	35	-
	2	84.0 (67.5-99.0) \times 35.3 (28.8-44.1)	20	--
	B, 1	35.5 (31.5-38.7) \times 14.2 (12.6-16.2)	20	--
	2	one or two observed, collapsed	-	---
4. Stomodaeum:				
a. Penicilli E	A	52.8 (47.7- 61.2) \times 18.7 (15.3-22.5)	40	+
	B	54.6 (45.0- 61.2) \times 16.4 (13.5-18.9)	25	+
5. Filaments:				
a. Penicilli D	A, 1	19.8 (18.0-22.5) \times 5.5 (5.4- 5.9)	10	-
	2	31.3 (27.0-37.8) \times 8.6 (8.1- 9.5)	20	+
	B, 1	19.3 (18.0-22.5) \times 5.1 (4.1- 6.8)	13	--
	2	36.1 (28.8-41.4) \times 9.6 (9.0-10.8)	25	+
b. Penicilli E	A, 1	32.1 (29.7-34.2) \times 15.7 (13.5-18.0)	7	---
	2	151.6 (126.0-165.6) \times 61.3 (54.0-69.3)	30	++
	B, 1	37.6 (33.3-43.2) \times 14.0 (13.5-14.4)	4	---
	2	166.7 (139.5-198.0) \times 61.9 (49.5-68.4)	20	+

Acknowledgements and abbreviations

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