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A case study of variation in two nominal species of *Sinularia* (Coelenterata: Octocorallia), *S. brassica* May, 1898, and *S. dura* (Pratt, 1903), with a proposal for their synonymy

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Key words: Coelenterata; Anthozoa; Octocorallia; *Sinularia brassica*; *S. dura*; synonymy.
Two nominal species of *Sinularia* (Coelenterata: Octocorallia), *S. brassica* May, 1898 and *S. dura* (Pratt, 1903), are redescribed and figured. Their synonymy is proposed. Additional material from a number of diverse Indo-Pacific geographic locations is presented.

Introduction

In 1898, May described *Sinularia brassica* on the basis of a single colony, and in the following year, 1899, he depicted the colony and two of its sclerites. Unfortunately, the only sclerites he illustrated were a large coenenchymal spindle, the sort which is more or less common to all *Sinularia* species, and a surface layer club of a form which is not characteristic of *S. brassica*. In 1906, Kükenthal re-examined the holotype, and similarly illustrated a coenenchymal spindle and a surface club, the drawing of the club being hardly more characteristic of the species. In the same year, Thomson & Henderson referred two Zanzibar specimens to the species, providing only minimal description as also did several later authors (Lüttschwager, 1914; Kolonko, 1926; Tixier-Durivault, 1945; 1951)

In 1903, Pratt described *Sinularia dura* (under the name of *Sclerophytum durum*) as a species with two types of capitula, viz. cup-shaped and lobate, unaware, somewhat understandably, that her material possessed a similar form of sclerites to those found in *S. brassica*. In 1905, the same author commented further on the variability of the colonial form when she assigned four specimens from Ceylon to *S. dura*. Brief references to the species were given later by Lüttschwager (1914) and Kolonko (1926), and in 1910 Thomson & Mackinnon recorded the species as occuring in the Seychelles, the Amirante Isles, and on the Saya de Malha Bank (all Mascarene ridge, Indian Ocean). In 1931, Thomson & Dean referred a number of lobed and cup-shaped specimens collected by the *Siboga* expedition to this species, commenting that "This is one of the most striking instances in the Collection of the unimportance of modes of growth". This was followed by Macfadyen identifying a lobed specimen with the species in 1936, and by Tixier-Durivault's brief description of a specimen from Djibouti, shaped like a "corne d'abondance" [horn of plenty], in 1945. In 1951, Tixier-Durivault pub-

lished a "Revision" of the genus *Sinularia* but did not consult type material extra to the MNHN collection. As a consequence she did not become aware of the sclerite similarity between the two species. Her description of *S. brassica* was based on the accounts of previous authors, and that of *S. dura* was a fuller account of the specimen from Djibouti. After stating that it was not known from which of Pratt's two colonial forms that author's sclerite illustrations were derived, and without examining that author's specimens, Tixier-Durivault formed the opinion that the lobed form of *S. dura* should be referred to *S. variabilis* Tixier-Durivault, 1945.

In 1960, Verseveldt re-examined the specimens collected by the *Siboga* expedition which Thomson and Dean identified as *S. dura*. He clearly showed that Tixier-Durivault's proposal that Pratt's lobed specimen of that species was actually *S. variabilis* was not tenable, and he also concluded that the two colonial forms of *S. dura* should remain as representing a single species. In 1966 and 1970, Tixier-Durivault assigned material from Madagascar and New Caledonia, respectively, to *S. dura*, apparently now conceding in the latter publication that the species could include lobed colonies. In 1974, Verseveldt maintained his conclusion that the species was one of variable morphology when he referred some specimens from New Caledonia to *S. dura*, and also re-examined and illustrated three of Pratt's syntypes. However, in his 1980 revision of the genus *Sinularia*, he had cause to examine the holotype of *S. brassica*, and so became the first author to notice the similarity between the sclerites of that species and *S. dura*. As a result of this finding, Verseveldt reversed his previously held opinion and concluded that lobate forms with this style of sclerites should be referred to *S. brassica* and cup-shaped forms to *S. dura*.

The present authors, while examining various collections of soft corals, have often encountered difficulties with the identification of colonies resembling *S. dura* and *S. brassica*, as defined by Verseveldt (1980). This problem lead us to re-examine the type material of these two species along with numerous other colonies in order to establish whether they are two distinct species or a single polymorphic one.

Abbreviations

BMNH = British Museum of Natural History, London, United Kingdom.
MNHN = Muséum National d'Histoire Naturelle, Paris, France.
NTM = Museum and Art Gallery of the Northern Territory, Darwin, Australia.
RMNH = National Museum of Natural History, Leiden, The Netherlands.
ZMH = Zoologisches Museum, Hamburg, Germany.
ZMTAU = Zoological Museum, Tel Aviv University, Israel.

Systematics

Family Alcyoniidae Lamouroux, 1812
Genus *Sinularia* May, 1898

Sinularia brassica May, 1898
(figs 1-4, 25a)

Type material examined.— Holotype: ZMH C 2511, coll. Stuhlmann, Tumbatu.

Description of the holotype

Colony morphology

The holotype is a stalked colony with a convoluted capitulum consisting of closely appressed marginal folds (fig. 1). The position of the polyps is indicated by small pits.

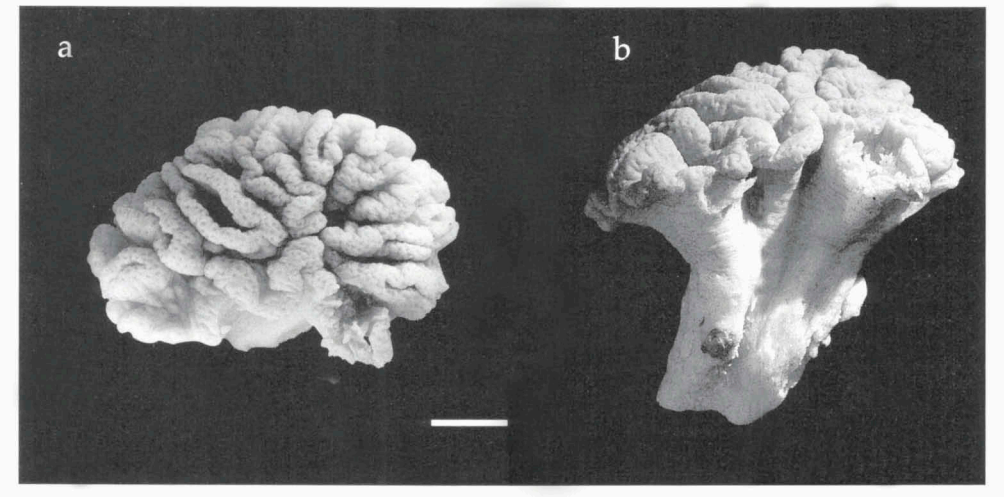

Fig. 1. *Sinularia brassica* May, 1898; holotype ZMH C 2511; a, view from above; b, side view. Scale 1 cm.

Sclerites

Polyps.— With small rods and scales, 0.05-0.10 mm long and 0.01-0.04 mm wide (fig. 25a). Furthermore, some club-like sclerites are present, 0.10-0.18 mm long and 0.02-0.04 mm wide (fig. 25a)

Surface layer of the capitulum.— Clubs with heads consisting of two or three diverging, wide, toothed prominences. The clubs are 0.07-0.27 mm long and 0.04-0.15 mm wide (figs 2a, 3a). Furthermore, small spindles are present, more tuberculated towards their ends (fig. 3b). They are 0.11-0.27 mm long and 0.03-0.07 mm wide.

Interior of the capitulum.— Spindles with complex tubercles, 0.30-2.75 mm long and 0.10-0.65 mm wide. A few of the smallest spindles have simple tubercles.

Surface layer of the stalk.— Clubs similar to those of the capitulum but somewhat shorter (fig. 4). They are 0.10-0.20 mm long and 0.06-0.11 mm wide. In addition, a few small spindles and some double heads are present. The spindles are about 0.20 mm long and 0.06-0.08 mm wide, the double heads are about 0.10 mm long and 0.05 mm wide.

Interior of the stalk.— Spindles with complex tubercles, 0.30-3.75 mm long and 0.10-0.80 mm wide (figs 2b, 3c). A few of the smallest spindles have simple tubercles.

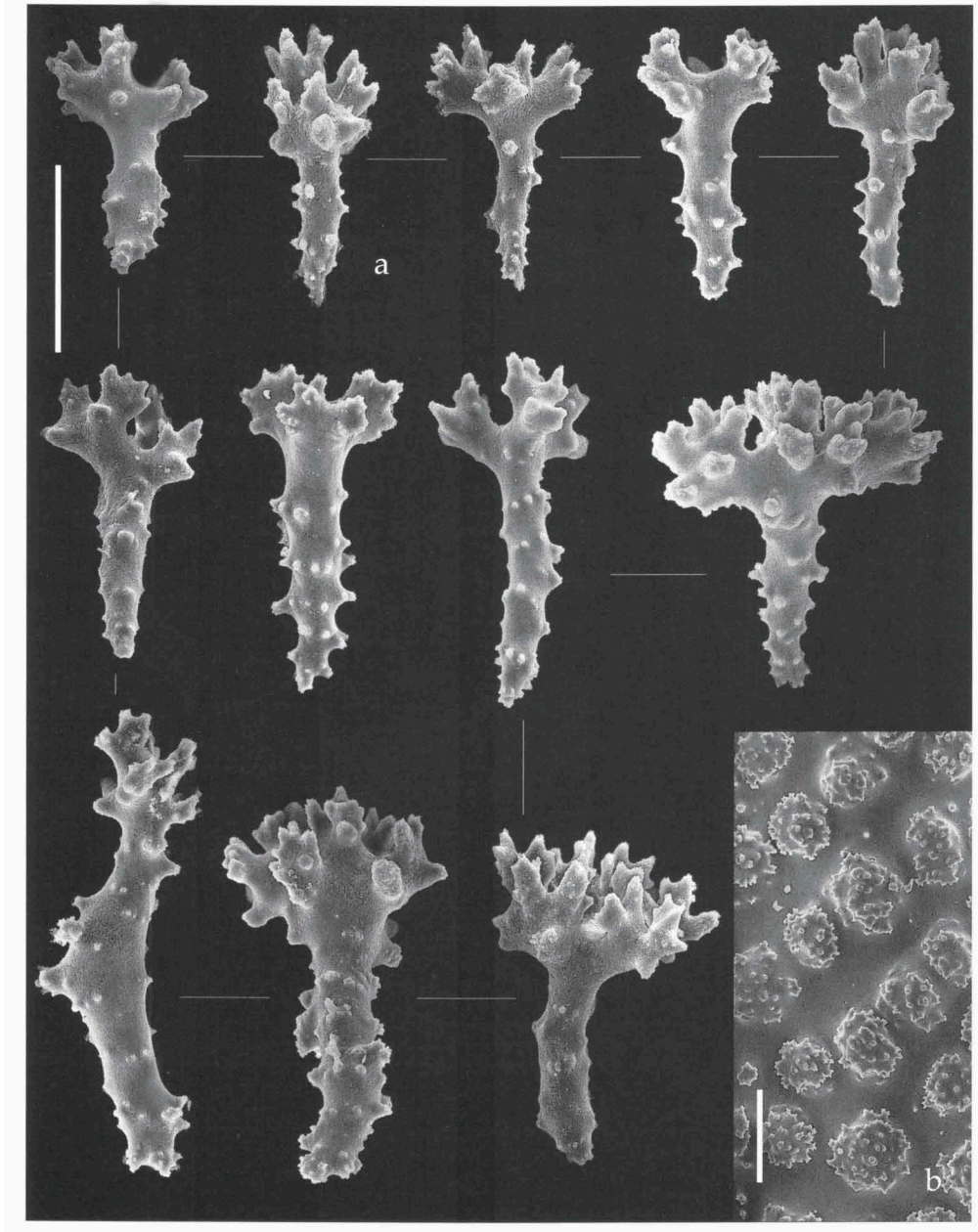

Fig. 2. *Sinularia brassica* May, 1898; holotype ZMH C 2511; a, clubs of surface layer of capitulum; b, detail of spindle of interior of stalk. Scales 0.10 mm.

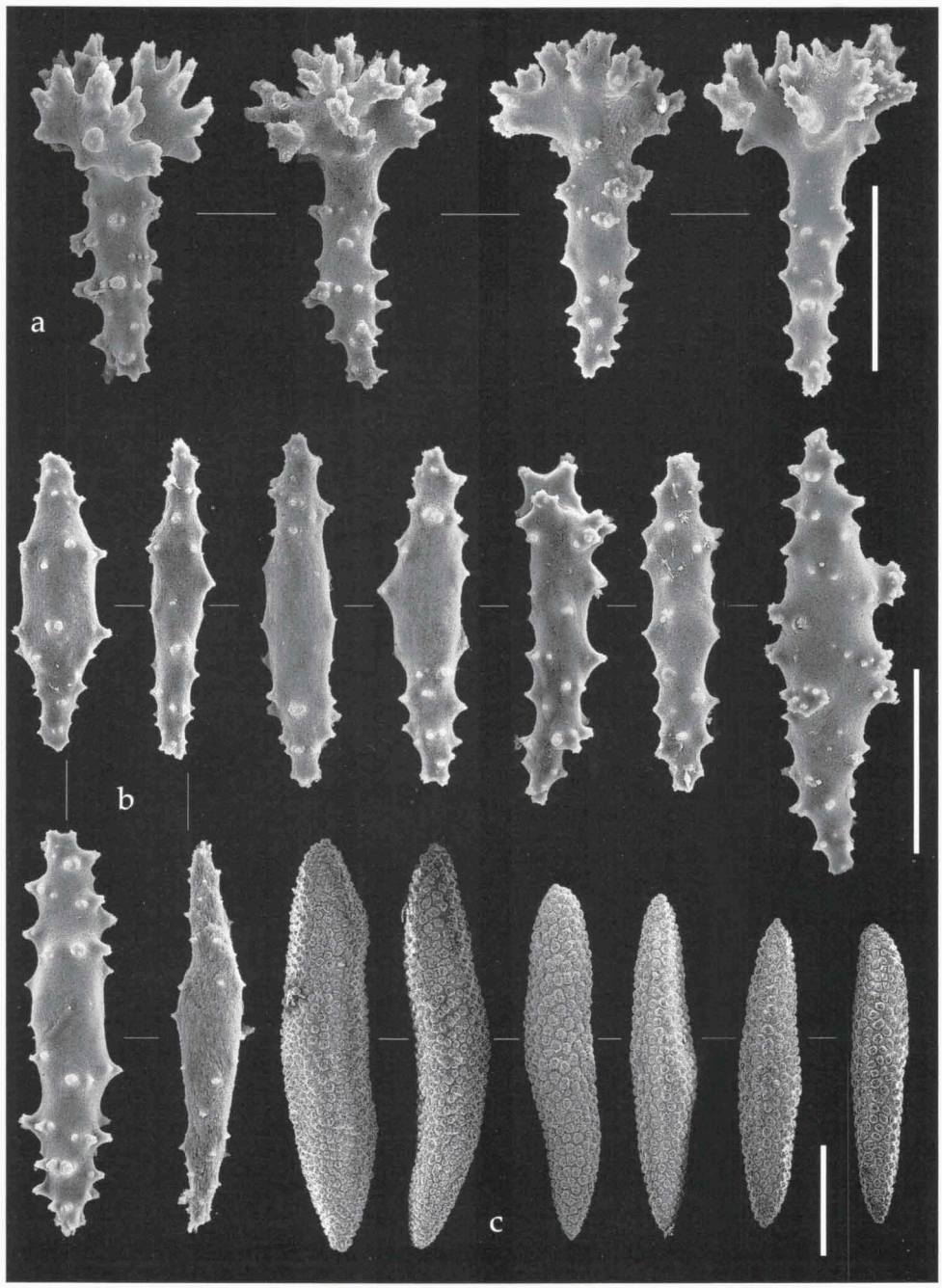

Fig. 3. *Sinularia brassica* May, 1898; holotype ZMH C 2511; a, clubs of surface layer of capitulum; b, spindles of surface layer of capitulum; c, spindles of interior of stalk. Scale for 3a-b = 0.10 mm, scale for 3c = 1 mm.

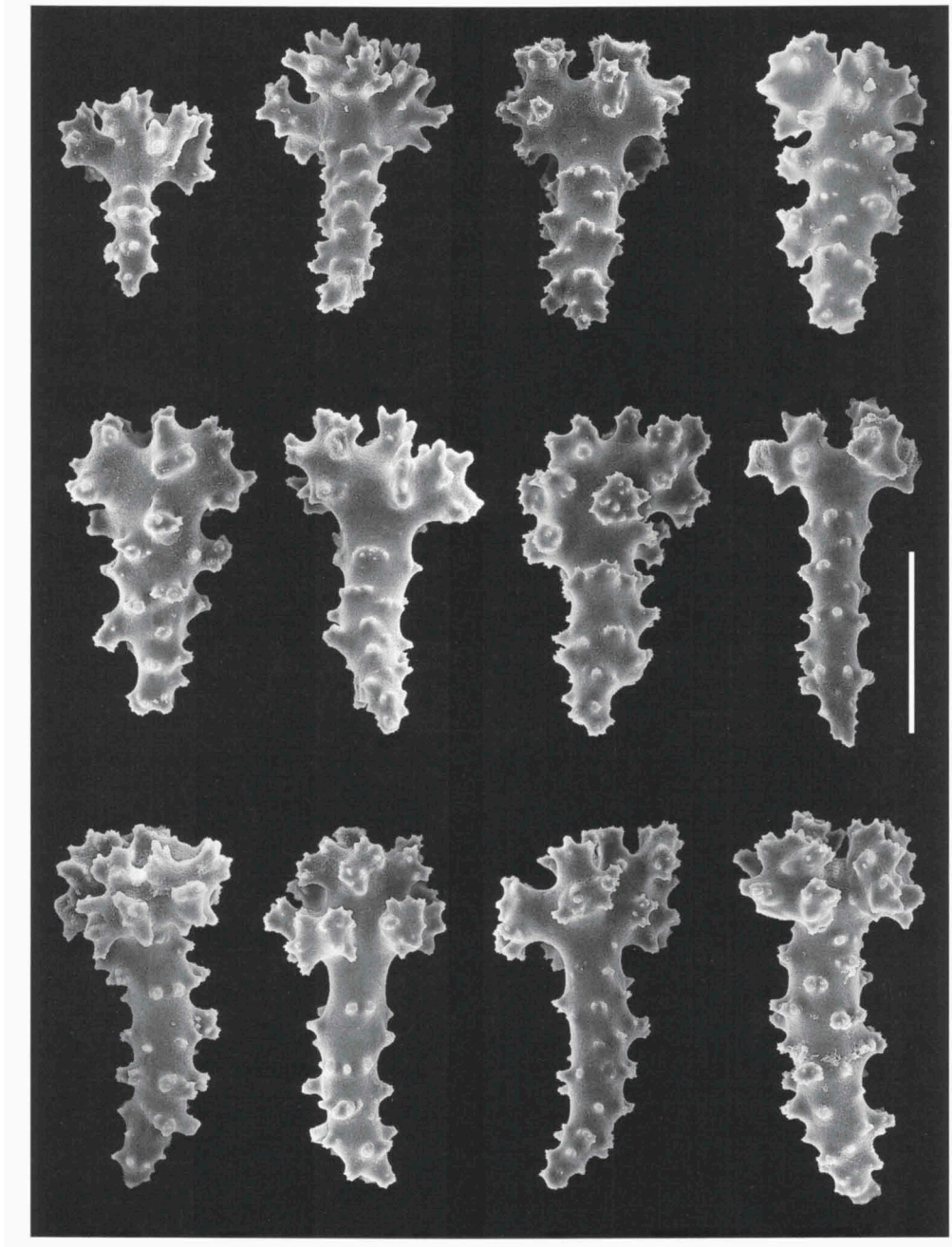

Fig. 4. *Sinularia brassica* May, 1898; holotype ZMH C 2511; clubs of surface layer of stalk. Scale 0.10 mm.

Sinularia dura (Pratt, 1903)
(figs 5-8, 25b)

Type material examined.— Lectotype: (here designated) BMNH 1962.7.20.100A, Addu Atoll, Maldive Islands, shallow water; Paralectotypes: BMNH 1962.7.20.100B, BMNH 1962.7.20.100C, Mahlos Atoll, Maldive Islands, shallow water.

Pratt referred to four specimens in her original description of the species, (the whereabouts of only three of which are known), but neglected to designate a holotype. In her plate 31 she figured two of the syntypes (fig. 29, a lobed colony; and fig. 30, a cup-like colony). Therefore it is appropriate to designate one of these illustrated specimens as a lectotype (Article 74 of the ICZN). There is, however, some uncertainty as to the identity of the cup-like colony depicted in Pratt's fig. 30. By a process of elimination, and considering the size of the specimens given by Pratt, and the magnification of the poor drawings, it would appear that syntype BMNH 1962.7.20.100C (fig. 6d-e) should fit the illustration. However, there is no stolonic outgrowth on this specimen, nor any apparent site of any previous attachment, and one would have to assume that the artist purposely neglected to draw the rock which is attached to this specimen. Accordingly we choose to designate the lobed specimen BMNH 1962.7.20. 100A as lectotype, which we are satisfied is depicted in Pratt's fig. 29. Such a choice not only conforms to Verseveldt's (1974) opinion that the sclerites figured by Pratt (1903: fig. 31a, d) came from this specimen, but also serves the purpose of leaving the species name *Sinularia dura* still available for relevant lobate specimens should later researchers show our proposed synonymy unjustified.

Description of the Lectotype

Colony morphology

The lectotype is a stalked colony with a capitulum consisting of short lobes, up to 10 mm long (fig. 5). Sometimes the lobes are slightly flattened.

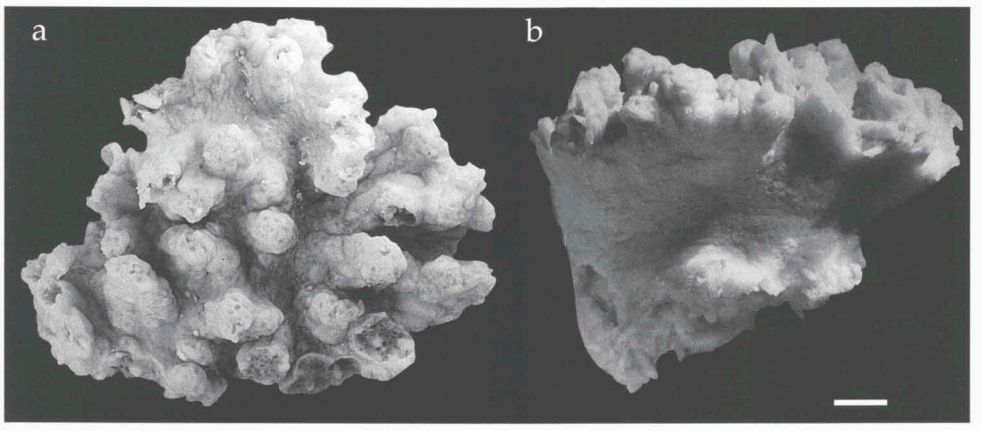

Fig. 5. *Sinularia dura* (Pratt, 1903); lectotype BMNH 1962.7.20.100A; a, view from above; b, side view. Scale 1 cm.

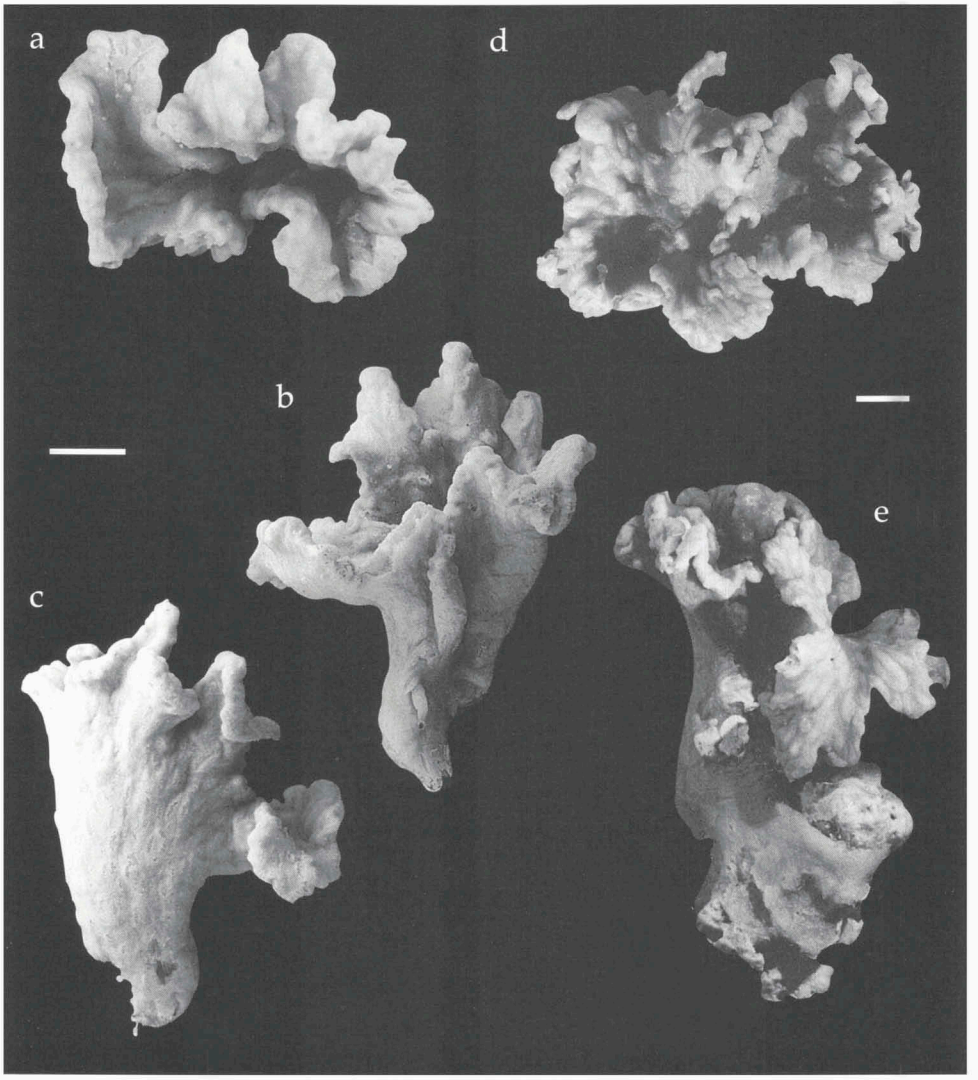

Fig. 6. *Sinularia dura* (Pratt, 1903); paralectotypes; a-c, BMNH 1962.7.20.100B; a, view from above; b-c, side views; d-e, BMNH 1962.7.20.100C; d, view from above; e, side view. Scales 1 cm.

Sclerites

Polyps.— Small rods, 0.05-0.10 mm long and 0.02-0.03 mm wide (fig. 25b). Furthermore, some club-like sclerites are present, 0.12-0.19 mm long and 0.02-0.04 mm wide (fig. 25b).

Surface layer of the capitulum.— Clubs with heads consisting of two or three diverging, wide, toothed prominences. The clubs are 0.10-0.19 mm long and 0.05-0.12 mm wide (fig. 7a). There are also small spindles which are more tuberculated towards their ends (fig. 7b). They are 0.12-0.20 mm long and 0.03-0.05 mm wide.

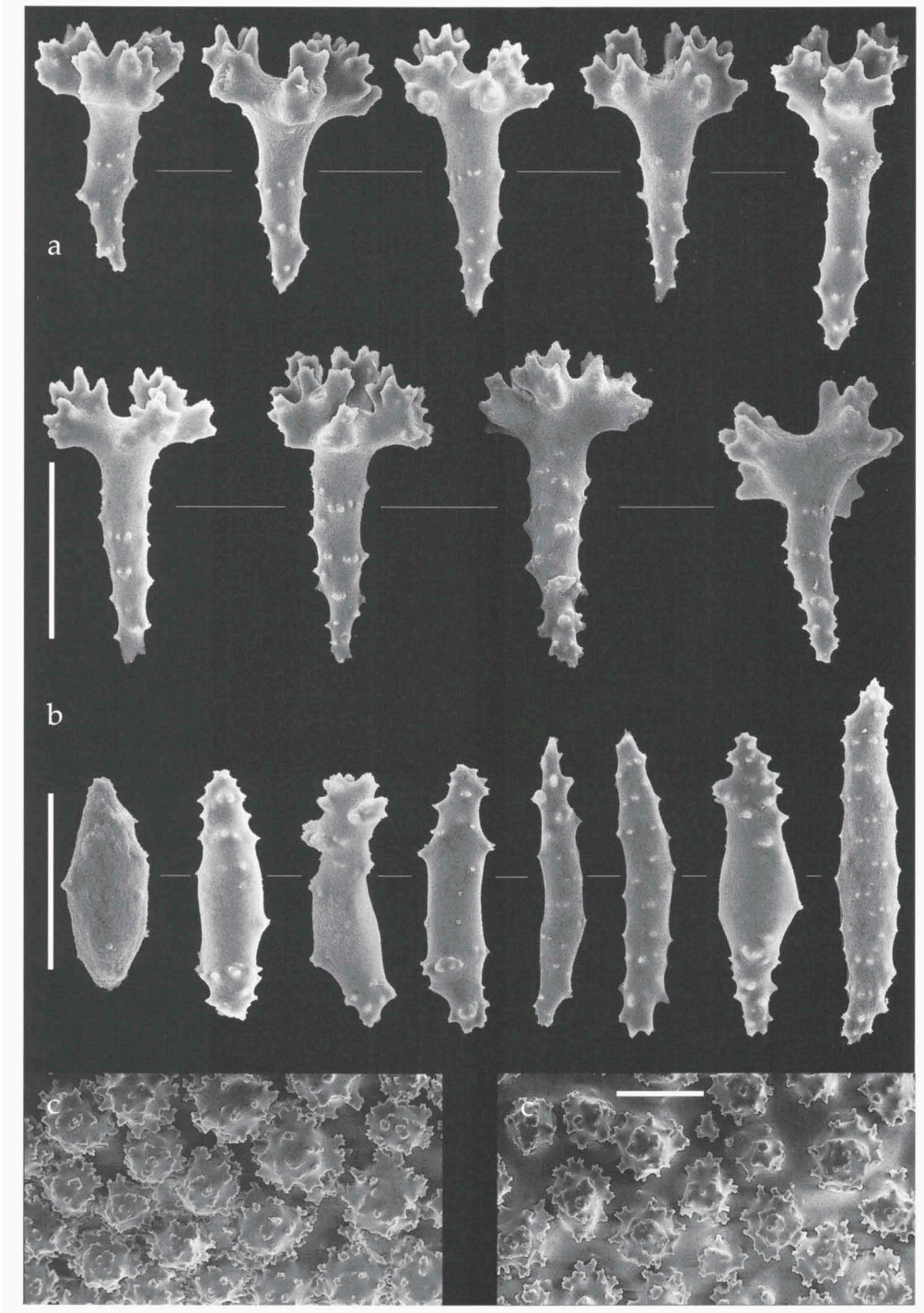

Fig. 7. *Sinularia dura* (Pratt, 1903); lectotype BMNH 1962.7.20.100A; a, clubs of surface layer of capitulum; b, spindles of surface layer of capitulum; c, detail of spindle of interior of stalk. Scales 0.10 mm.

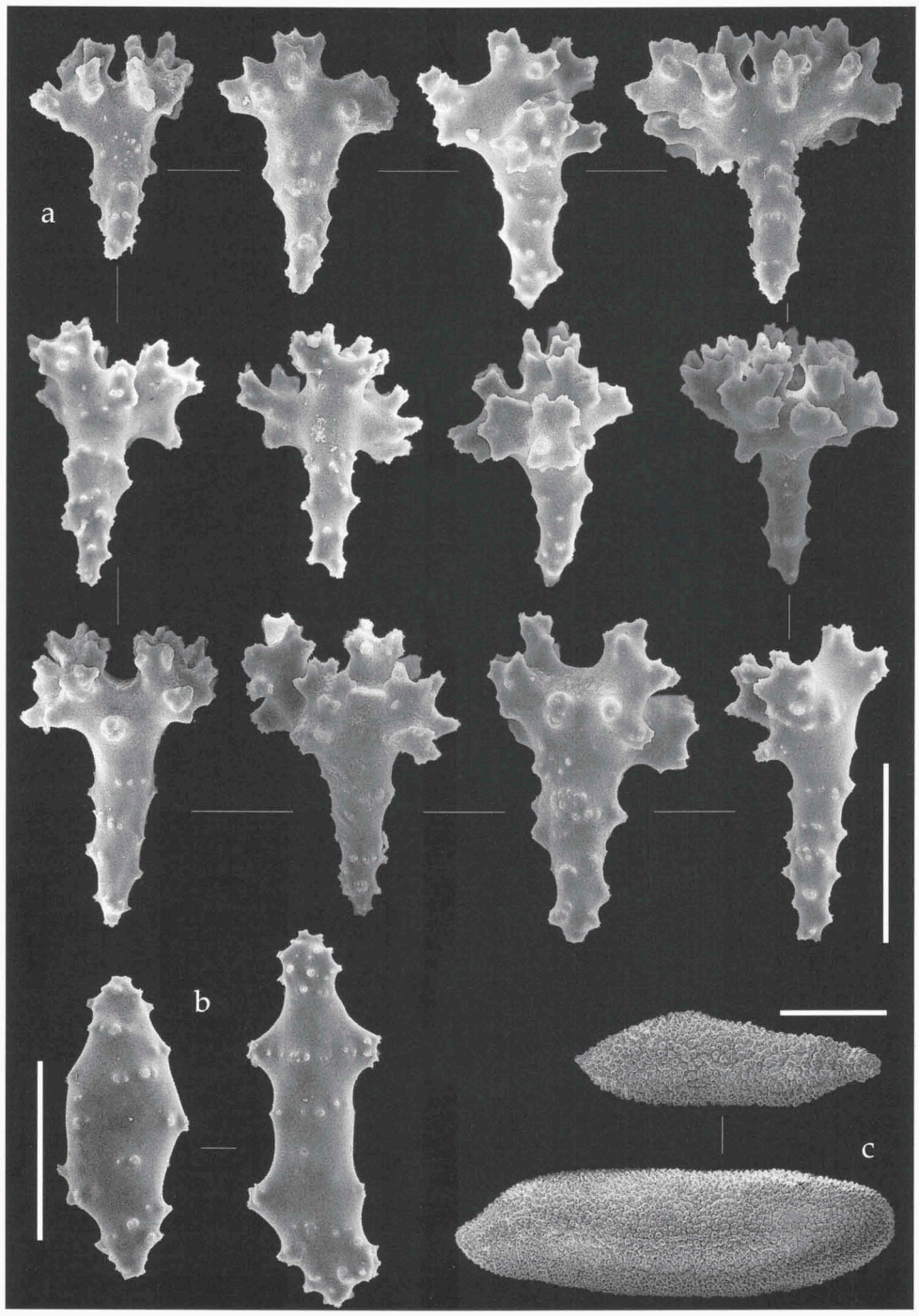

Fig. 8. *Sinularia dura* (Pratt, 1903); lectotype BMNH 1962.7.20.100A; a, clubs of surface layer of stalk; b, spindles of surface layer of stalk; c, spindles of interior of stalk. Scale for 8a-b = 0.10 mm, scale for 8c = 1 mm.

Interior of the capitulum.— Spindles with complex tubercles, 0.45-8.10 mm long and 0.10-1.70 mm wide. A few of the smallest spindles have simple tubercles.

Surface layer of the stalk.— Clubs similar to those of the capitulum, 0.08-0.19 mm long and 0.05-0.13 mm wide.(fig. 8a). In addition there are small spindles, 0.11-0.20 mm long and 0.05-0.08 mm wide (fig.8b).

Interior of the stalk.— Spindles with complex tubercles, 0.30-7.00 mm long and 0.10-2.20 mmm wide (figs 7c, 8c). A few of the smallest spindles have simple tubercles.

Variation

BMNH 1962.7.20.100B is a stalked colony having a funnel-shaped capitulum with lobes along the margin (fig. 6a-c).

BMNH 1962.7.20.100C is a stalked colony with a capitulum consisting of two cup-shaped parts, one with lobes around the margin, the other spread out (fig. 6d-e).

The sclerites of the paralectotypes resemble those of the lectotype but the spindles of the interior are smaller, up to about 5.50 mm long.

Additional material

In addition to the type material we have been fortunate to have at our disposal a large suite of specimens recently collected from a number of diverse geographic locations from the Red Sea to Australia.

Red Sea.— ZMTAU NS 8349, Ras el Kanissa, Gulf of Suez, 10 m, 28.x.1971, coll. N. Gunderman (see Verseveldt & Benayahu, 1983; listed as *S. dura*); RMNH Coel. 23951, Maaya Tila, 3 km SO Maaya Fushi, 25.iii. 1994, 20-25 m, coll. A. Svoboda; ZMTAU Co 26085, Jubal Island, Gulf of Suez, Bluf point, 25 m, 23.ix.1989, coll. Y. Benayahu; ZMTAU Co 29201, Shag Rock, Gulf of Suez, 7.x.1988, coll. Y. Benayahu.

S-Africa.— ZMTAU Co 27807 (2 fragments), Sodwana Bay, Two-mile Reef, 20.vii.1991; ZMTAU Co 27830, Sodwana Bay, Two-mile Reef, 21.vii.1991; ZMTAU Co 27832, Sodwana Bay, Two-mile Reef, 21.vii.1991, 17 m; ZMTAU Co 27844, Sodwana Bay, Two-mile Reef, 21.vii.1991; ZMTAU Co 27881, Sodwana Bay, Nine-mile Reef, 24.vii.1991; ZMTAU Co 27894, Sodwana Bay; ZMTAU 28612, Sodwana Bay, Sponge Reef, 25.vii.1992, 28-30 m; ZMTAU 28614 (2 fragments), Sodwana Bay, Nine-mile Reef, vii.1992 (with exception of ZMTAU 28612 & ZMTAU 28614 see Benayahu, 1993; all listed as *S. brassica*); ZMTAU Co 27803, Sodwana Bay, Two-mile Reef, 20.vii.1991; ZMTAU Co 27827, Sodwana Bay, Two-mile Reef, 21.vii.1991; ZMTAU Co 27834, Sodwana Bay, Two-mile Reef, 21.vii.1991; ZMTAU Co 27835, Sodwana Bay, Two-mile Reef, 21.vii.1991, 17 m; ZMTAU Co 27856, Sodwana Bay, Nine-mile Reef, 22.vii.1991; ZMTAU Co 27880, Sodwana Bay, Nine-mile Reef, 24.vii.1991; ZMTAU Co 27884, Sodwana Bay, Two-mile Reef, 25.vii.1991; ZMTAU Co 27885, Sodwana Bay, Two-mile Reef, 25.vii.1991 (see Benayahu, 1993; all listed as *S. dura*).

Mozambique.— ZMTAU Co 28727, 21°31'30"S 35°29'35"E, Inner Lighthouse Reef, 4.vii.1993, coll. M. Schleyer; ZMTAU Co 28729, 21°42'13"S 35°29'54"E, Ponta Chilola, 7.vii.1993, coll. M. Schleyer; ZMTAU Co 28737, 21°31'30"S 35°29'35"E, Inner Lighthouse Reef, 4.vii.1993, coll. M. Schleyer; ZMTAU Co 28753, 21°31'15"S 35°29'50"E, Marta Reef, 10-15 m, 6.vii.1993, coll. M. Schleyer; ZMTAU Co 28776, 21°21'18"S 35°30'12"E, Twelve-mile Reef, 8.vii.1993, coll. M. Schleyer; ZMTAU Co 28778, 21°31'30"S 35°29'35"E, Inner Lighthouse Reef, 4.vii.1993, coll. M. Schleyer; ZMTAU Co 28783, 21°31'30"S 35°29'35"E, Inner Lighthouse Reef, 4.vii.1993, coll. M. Schleyer (see Benayahu & Schleyer, 1996; all listed as *S. brassica*); ZMTAU Co 28734, 21°21'18"S 35°30'12"E, Twelve-mile Reef, 16-19 m, 8.vii.1993, coll. M. Schleyer (see Benayahu & Schleyer, 1996; listed as *S. dura*).

Comores.— ZMTAU Co 30076, Mayotte, shallow reef, iv.1997, coll. M. Aknin.
Seychelles.— RMNH Coel. 23952, NIOP-E, "Tyro" Seychelles Expedition 1992/93, sta. 716, N of Aride Island, 4°11'S 55°40'E, calcareous nodules, 40 m, rectangular dredge, 19.xii.1992.
Chagos Archipelago.— RMNH Coel. 23953 (9 specimens), 7°0'S 72°30'E, Salomons, Lagoon Bommie, 9.iii.1996, coll. G.B. Reinicke, ex. no. 134; RMNH Coel. 23954 (8 specimens), same data, but ex. no. 133; RMNH Coel. 23955 (9 specimens), 7°0'S 72°30'E, Peros banhos, Ile de Coin, lagoon, 4.iii.1996, coll. G.B. Reinicke, ex. no. 66; RMNH Coel. 23956 (3 specimens), 7°0'S 72°30'E, Great Chagos Bank, off Nelson I., N slope, 12.iii.1996, coll. G.B. Reinicke, ex. no. 211.
Maldives.— RMNH Coel. 23957 (4 specimens), Galhu Falhu NW Reef, 10 m, 13.x.1993, coll. H. Schumacher.
Japan.— ZMTAU Co 28478, 24°19'N 123°57'E, Ryukyu Archipelago, Kohama Is, Yonara, 2 m, 15.xi. 1992, coll. & det. Y. Benayahu.
Micronesia.— ZMTAU Co 29320, 13°25'N 144°48'E, Guam, Iates, 24 m, 4.x.1994, coll. & det. Y. Benayahu (Benayahu, 1997); NTM C12051-12502, patch reef between Pata and Polle Islands, Chuuk, 7°21.5'N 151°35'E, 9 m, 9.viii.1993, coll. Charles Birkeland (no. 14; murky water); OCDN-4388F, Coral Reef Research Foundation, Palau, 3 m, 2.xii.1996, fringing reef; ZMTAU Co 28615 (5 specimens), Palau, Blue Corner, 12 m, vii.1992, coll. Y. Benayahu; Y14, Marine Biotechnology Institute Co., Palau, Yap Island, 9°31'N 138°6'E, 12-15 m.
Indonesia.— NTM C12008-12011, Merak Island, West Java, 5°56'S 105°59.37'E, 5 m, 3.v.1991, coll. A. Manuputty, bottom type: sand; RMNH Coel. 23958 (11 specimens), Buginesia Prog. UNHAS-NNM, coll. B.W. Hoeksema, SW Sulawesi, Spermonde Archipelago, NW of Barang Lompo (= 13 km NW of Ujung Pandang), 5°03'S 119°20'E, coral reef, SCUBA, 19.v.1994; RMNH Coel. 23959 (6 specimens), Buginesia Prog. UNHAS-NNM, coll. B.W. Hoeksema, SW Sulawesi, Spermonde Archipelago, S of Barang Caddi (= 11 km NW of Ujung Pandang), 5°05'S 119°19'E, coral reef, SCUBA, 23.v.1994; RMNH Coel. 23967 (4 specimens), Buginesia Prog. UNHAS-NNM, coll. B.W. Hoeksema, SW Sulawesi, Spermonde Archipelago, W of Badi Isl. (= 20 km NNW of Ujung Pandang), 4°57'S 119°17'E, coral reef, SCUBA, 2.vi.1994; RMNH Coel. 23968 (7 specimens), Buginesia Prog. UNHAS-NNM, coll. B.W. Hoeksema, SW Sulawesi, Spermonde Archipelago, W of Barang Lompo (= 13 km NW of Ujung Pandang), 5°03'S 119°20'E, coral reef, SCUBA, 4.vii.1994; RMNH Coel. 23969 (3 specimens), SUL 04, Selat Lembeh, bay S of Pulau Putus, 01°31'N 125°16'E, rocky shore and small sandy beach, coral cover from shore to more than 20 m, seagrass on N-side, diving, 27.x.1994; RMNH Coel. 23970 (2 specimens), SUL 07, N Sulawesi, Selat Lembeh, bay N of Tanjung Batuangus, 01°31'N 125°15'E, rather steep slope of vulcanic rock, stony & soft corals on boulders, SCUBA, 8-10 m, 16.x.1994, coll. M. Slierings; RMNH Coel. 23971 (3 specimens), SUL 07, same data but -25 m, 25.x.1994, coll. L.P. van Ofwegen/M. Slierings; RMNH Coel. 23972, SUL 15, N Sulawesi, Selat Lembeh, N of Pulau Burung, 01°29'N 125°15'E, sandy beach merging to the north in stony boulders beach, stony & soft corals, SCUBA, 22.x.1994, 5-25 m, coll. L.P. van Ofwegen; RMNH Coel. 23973 (3 specimens), SUL 20, N Sulawesi, Selat Lembeh, S of Tanjung Batu Angus, 01°30'N 125°15'E, slope of 150 years old lava outflow, mostly densely covered with corals, some reef formation near the shore, diving, 29.x.1994, 10-20 m, coll. M. Slierings.
Australia.— NTM C12083, off Ludmilla Creek, Darwin, NT, Australia, 12°23.3'S 130°49.7'E, 3 m, 10.vii.1993, coll. N. Coleman (Photograph); NTM C17, Palm islands, North Queensland, Australia, 18°40'S 146°33'E, coll. T. Done; NTM C2014, Bills reef, Swain reefs, Queensland, 9.xi.1980, coll. P. Alderslade (purplish-grey in colour).

Review of additional material

The type material of the two nominal species described above essentially shows a lobate colonial form and a cup- or funnel-like form with little example of anything in between. In the additional material, however, there are representatives of what would appear to be a more or less complete range of forms. With reference to the architecture of the capitulum and the presence or absence of a stalk, comments on selected specimens are given below.

RMNH Coel. 23958: short stalk and spreading capitulum (fig. 9).

RMNH Coel. 23958): short stalk and capitulum divided into several flat leaves, that partly overlap each other (fig. 10).

RMNH Coel. 23968: short stalk and divided capitulum but the margins curve inwards (fig. 11).

RMNH Coel. 23955: long stalk and cup-shaped capitulum with flattened lobes around the margin (fig. 12).

RMNH Coel. 23971: very long stalk and with a capitulum consisting of folds originating from the margin and directed inwards (fig. 14).

RMNH Coel. 23953: three small colonies with long stalk and lobes up to 15 mm long, mostly situated around the margin (fig. 13).

The above mentioned specimens show a range from flat to strongly infolded capitulum. Their stalk shows longitudinal furrows, which may indicate various progressive degrees of colony fission.

ZMTAU Co. 27856: without a stalk, and possessing a cup-shaped capitulum provided with small elevations and a slightly infolded margin (fig. 15).

ZMTAU Co. 27884: part of a colony without a stalk, and possessing an almost flat capitulum provided with small elevations and a margin with low ridges directed inwards (fig. 16).

ZMTAU Co. 27803: part of a colony without a stalk, and possessing a flat capitulum with small lobes (fig. 17).

ZMTAU Co. 27827: part of a colony without a stalk, and possessing a cup-shaped capitulum with small lobes of about a few mm high and a slightly infolded margin (fig. 19).

ZMTAU Co. 27832: part of a colony with flat capitulum with distinct lobes of up to about 10 mm long. The margin shows ridges directed inwards (see arrow) (fig. 18).

ZMTAU Co. 27834: without a stalk, and possessing a cup-shaped capitulum with the margin folded inwards (fig. 20).

These specimens are all encrusting. Some have a cup-like capitulum, and some are lobate. From observations in the field we know that some colonies of this growth form may reach a diameter of more than 1 m.

ZMTAU Co. 27807: part of a colony with short stalk, and lobes up to 15 mm long, margin only partly folded inwards (fig. 21).

ZMTAU Co. 27844: short stalk, and lobes up to 15 mm long, some of which are divided (fig. 22).

RMNH Coel. 23956: short stalk, lobes up to 10 mm long, and margin folded inwards (fig. 23).

RMNH Coel. 23972: part of a colony with a short stalk, and lobes up to 25 mm long, of which several have a few short lobules (fig. 24).

These last four specimens have a stalk and lobes.

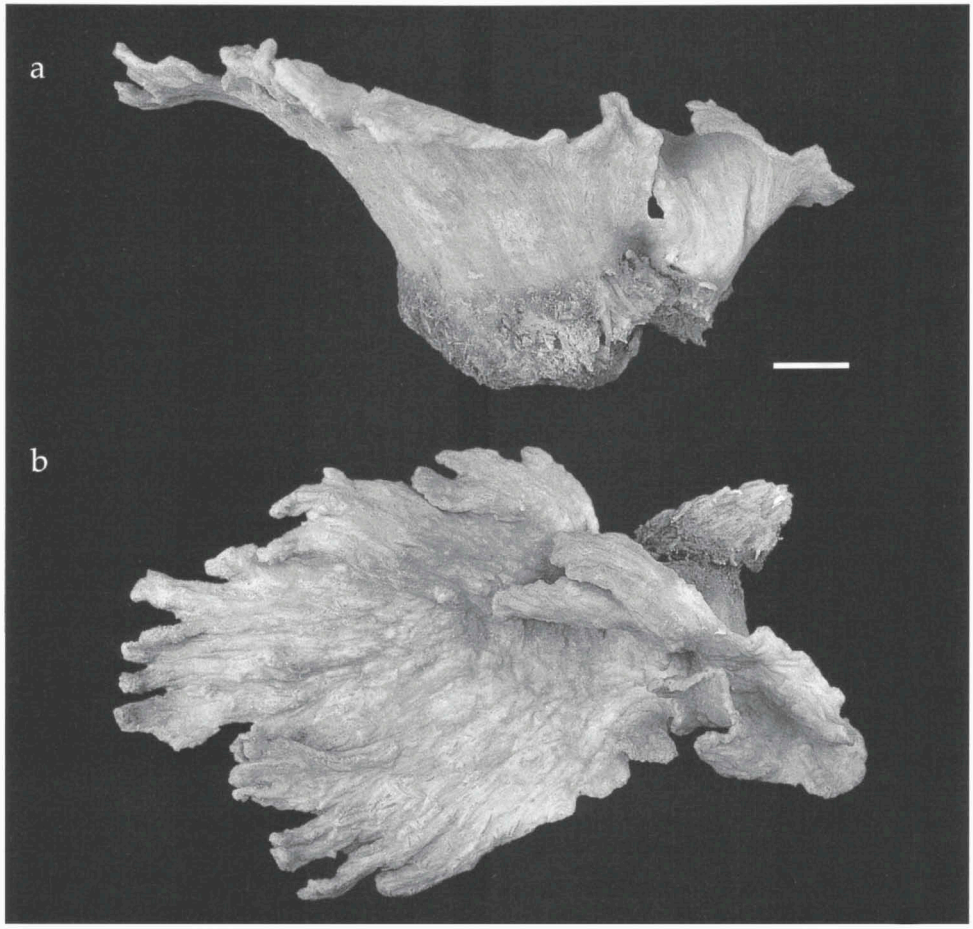

Fig. 9. *Sinularia brassica* May, 1898; RMNH Coel. 23958; a, side view; b, view from above. Scale 1 cm.

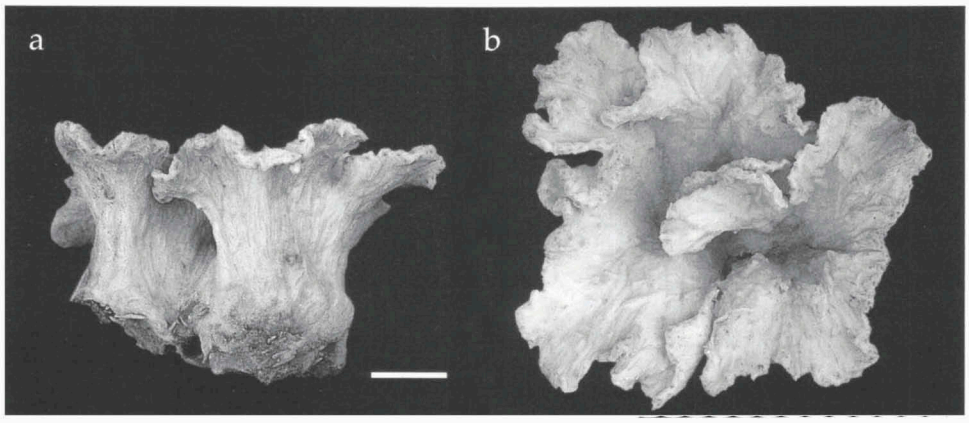

Fig. 10. *Sinularia brassica* May, 1898; RMNH Coel. 23958; a, side view; b, view from above. Scale 1 cm.

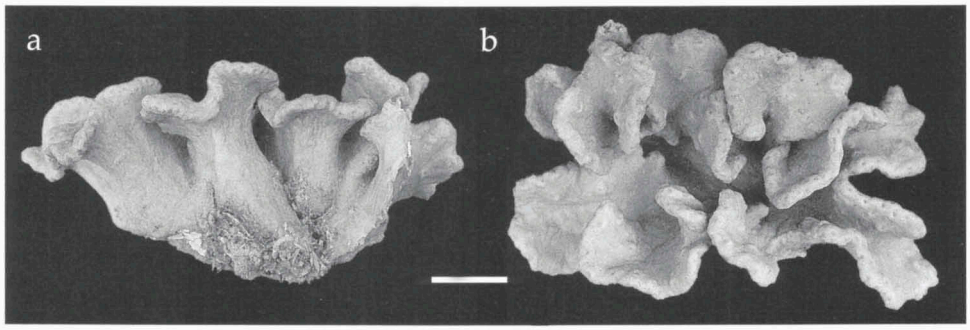

Fig. 11. *Sinularia brassica* May, 1898; RMNH Coel. 23968; a, side view; b, view from above. Scale 1 cm.

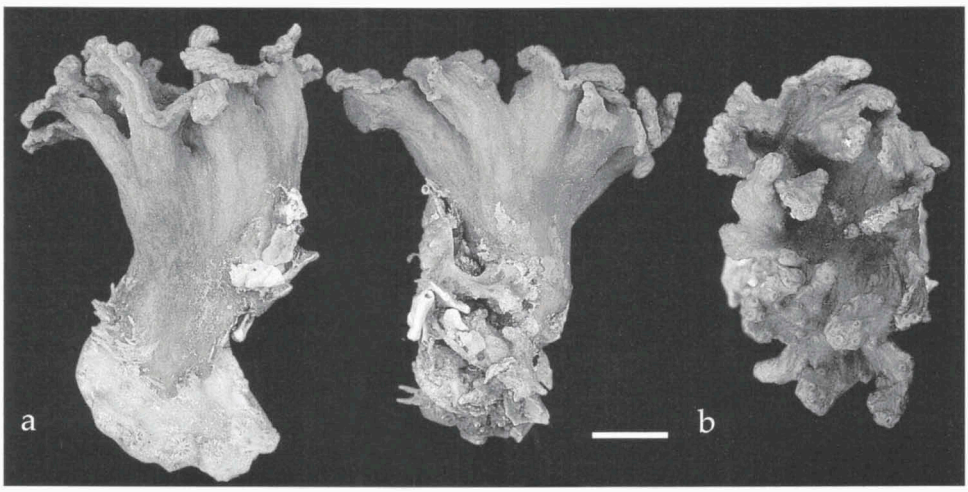

Fig. 12. *Sinularia brassica* May, 1898; RMNH Coel. 23955; a, side views; b, view from above. Scale 1 cm.

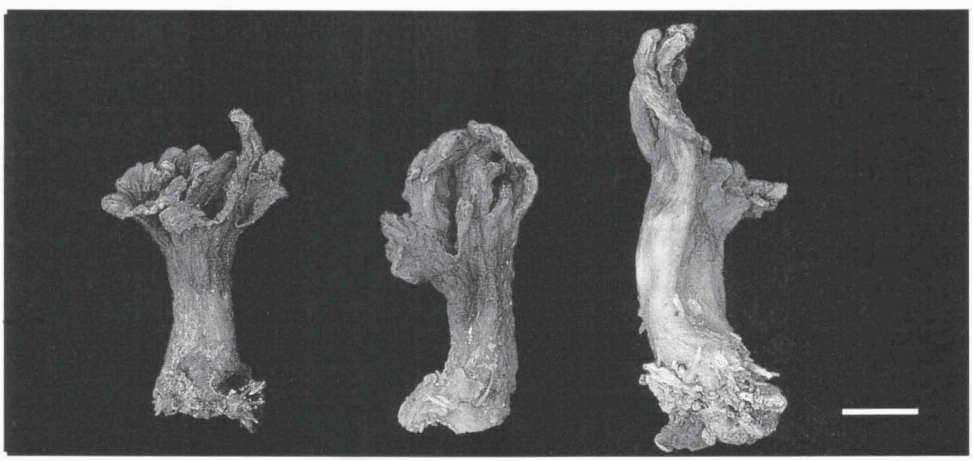

Fig. 13. *Sinularia brassica* May, 1898; RMNH Coel. 23953; side views. Scale 1 cm.

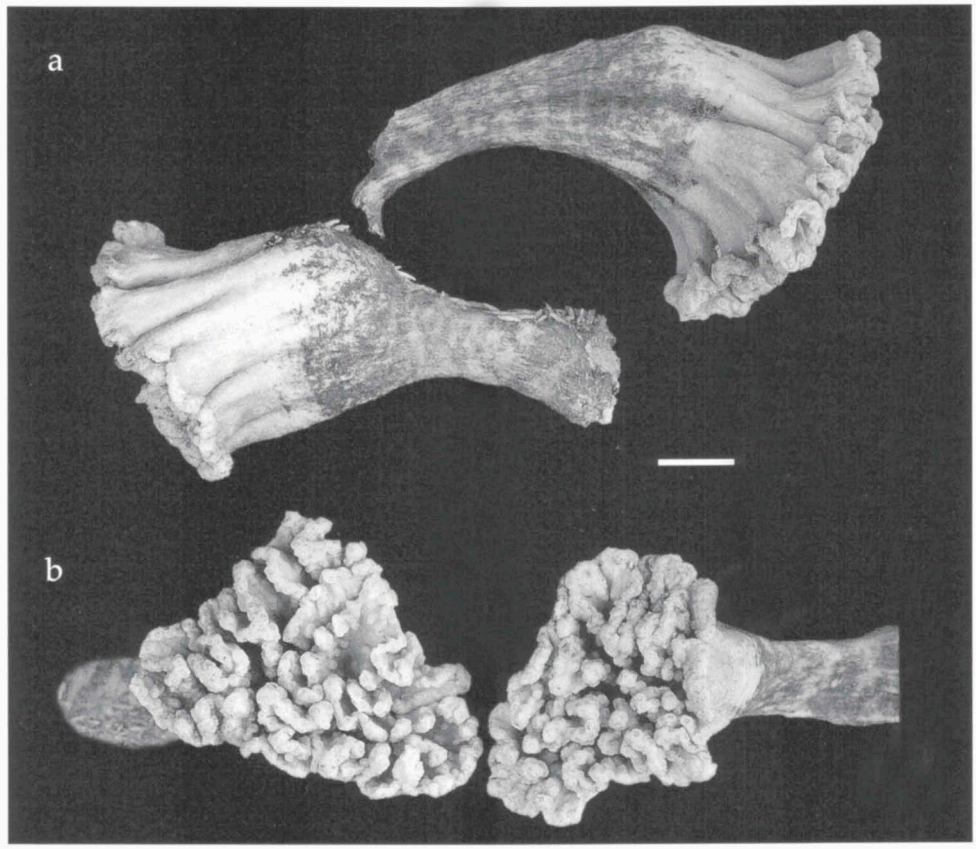

Fig. 14. *Sinularia brassica* May, 1898; RMNH Coel. 23971; a, side views; b, views from above. Scale 1 cm.

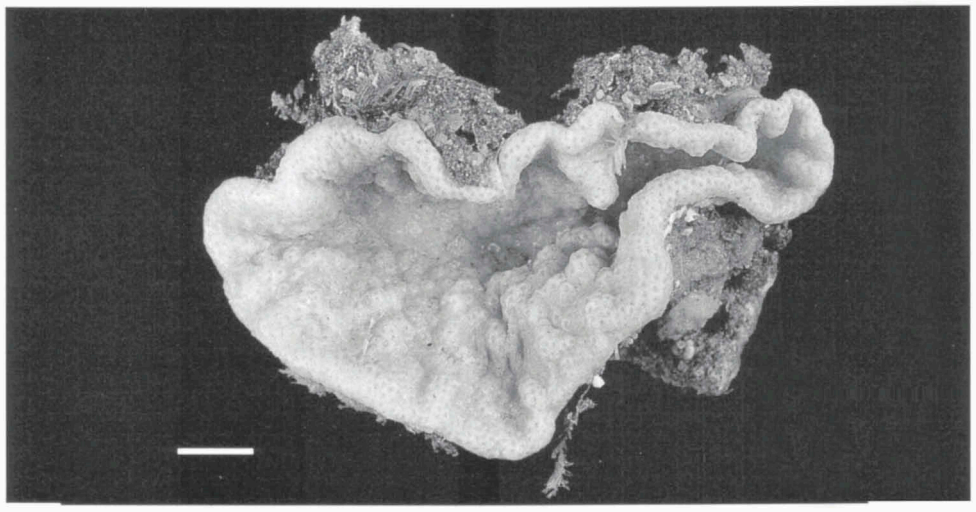

Fig. 15. *Sinularia brassica* May, 1898; ZMTAU 27856; view from above. Scale 1 cm.

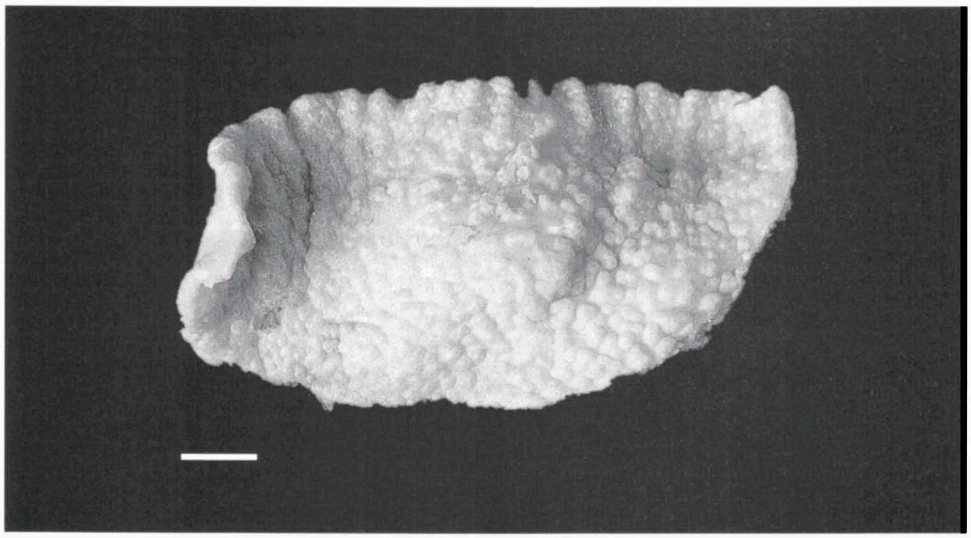

Fig. 16. *Sinularia brassica* May, 1898; ZMTAU 27884; view from above. Scale 1 cm.

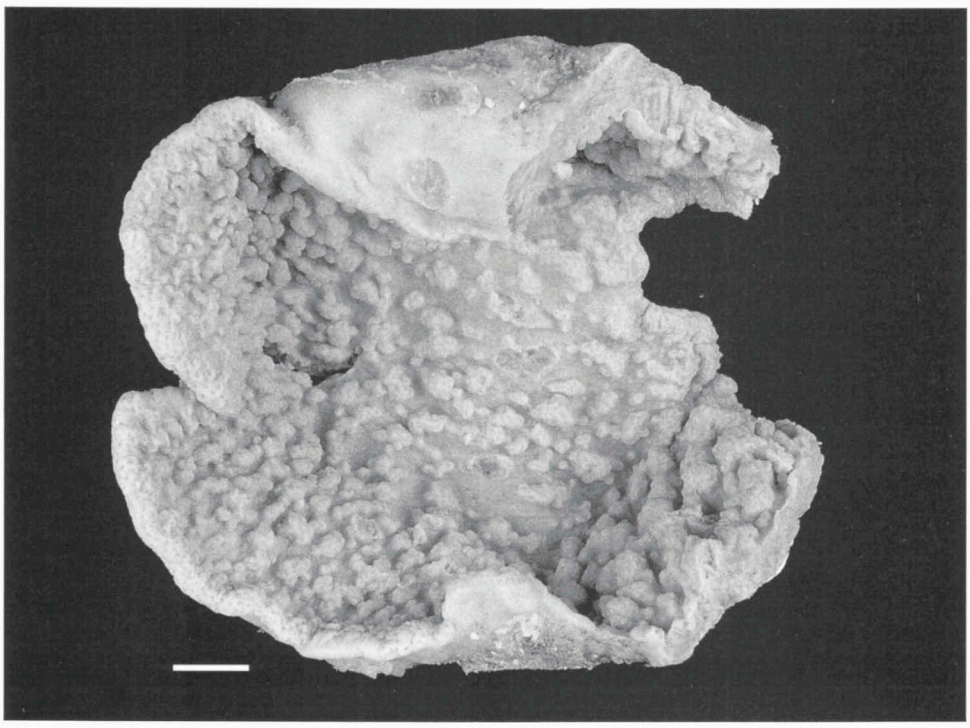

Fig. 17. *Sinularia brassica* May, 1898; ZMTAU 27803; view from above. Scale 1 cm.

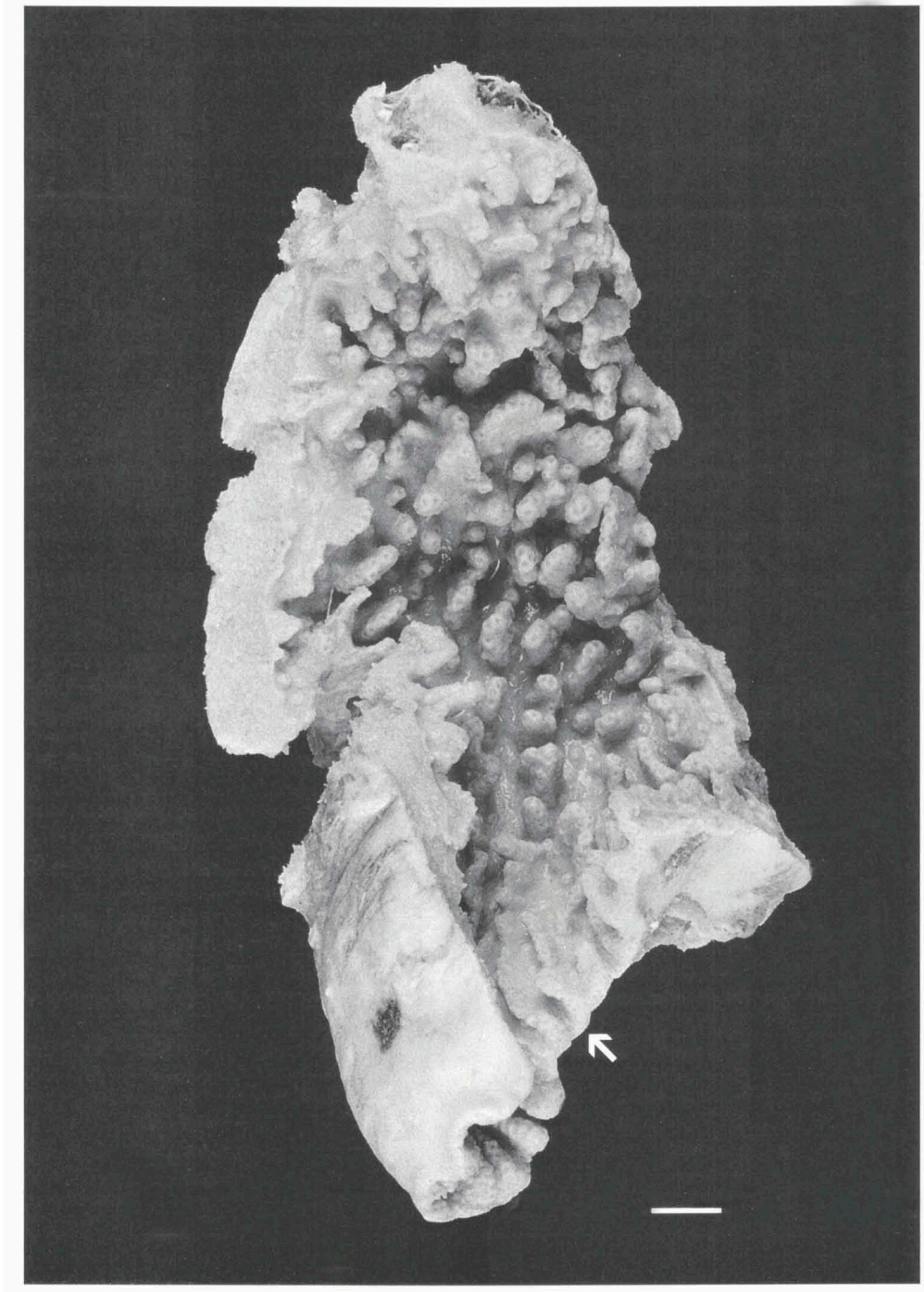

Fig. 18. *Sinularia brassica* May, 1898; ZMTAU 27832; view from above; arrow indicates ridges directed inwards. Scale 1 cm.

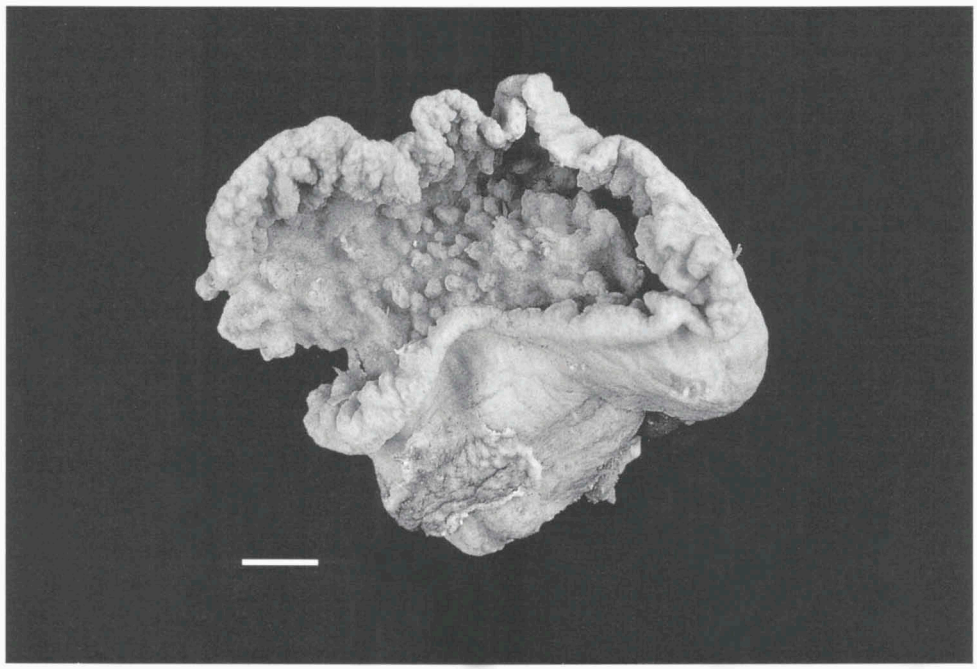

Fig. 19. *Sinularia brassica* May, 1898; ZMTAU 27827; view from above. Scale 1 cm.

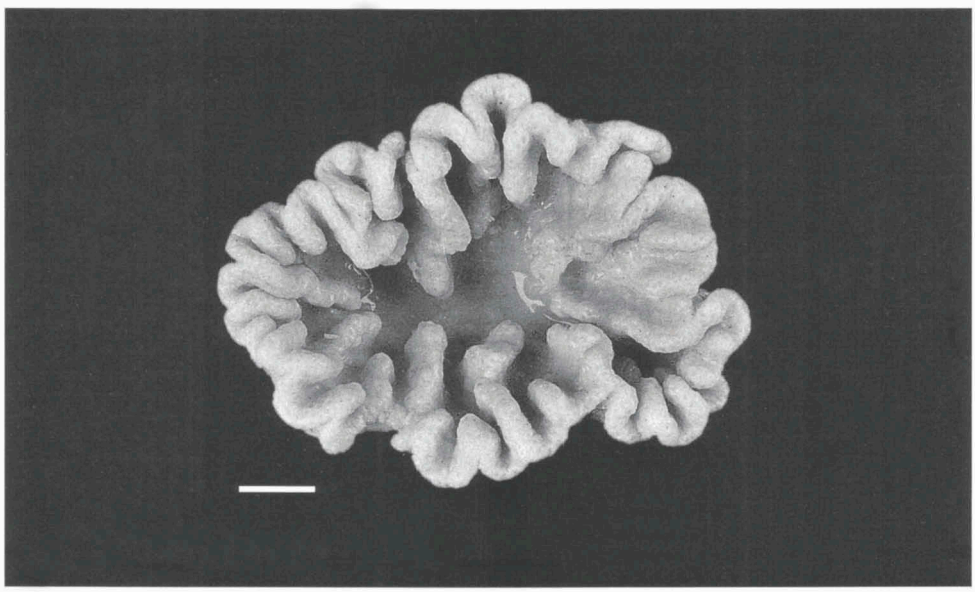

Fig. 20. *Sinularia brassica* May, 1898; ZMTAU 27834; view from above. Scale 1 cm.

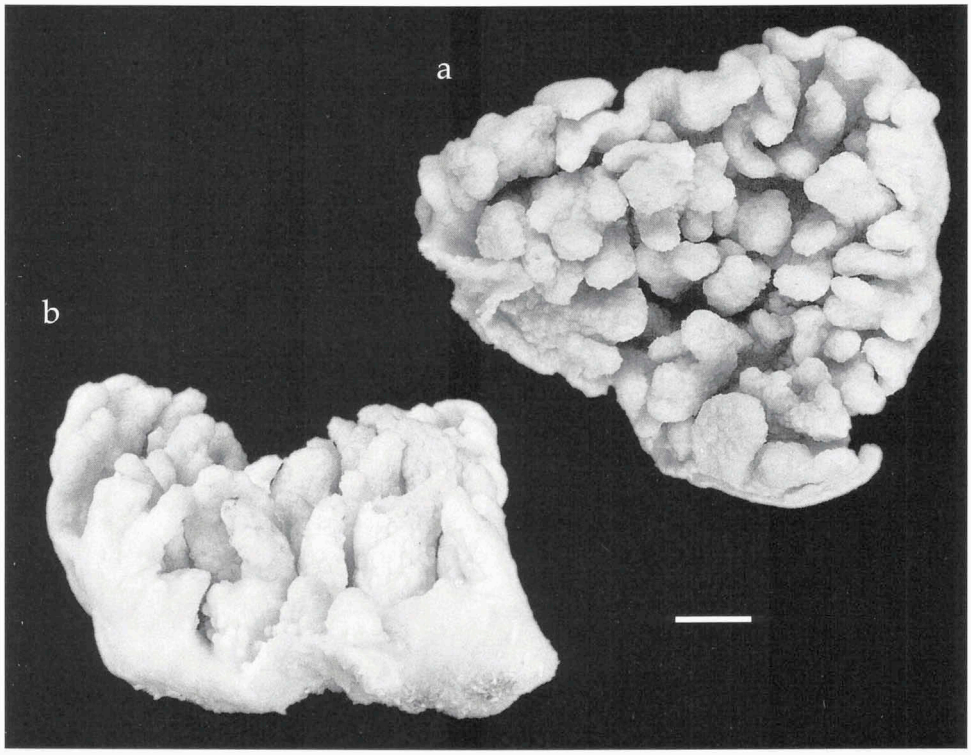

Fig. 21. *Sinularia brassica* May, 1898; ZMTAU 27807; a, view from above; b, side view. Scale 1 cm.

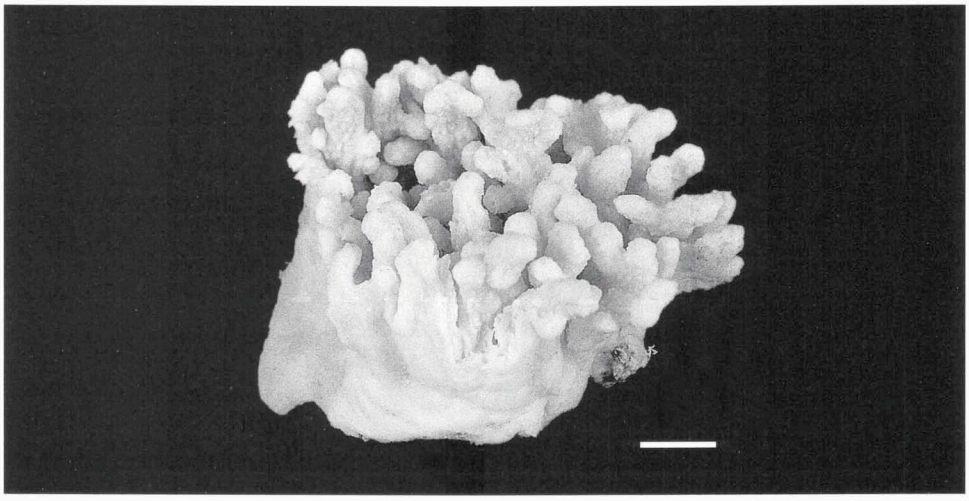

Fig. 22. *Sinularia brassica* May, 1898; ZMTAU 27844; side view. Scale 1 cm.

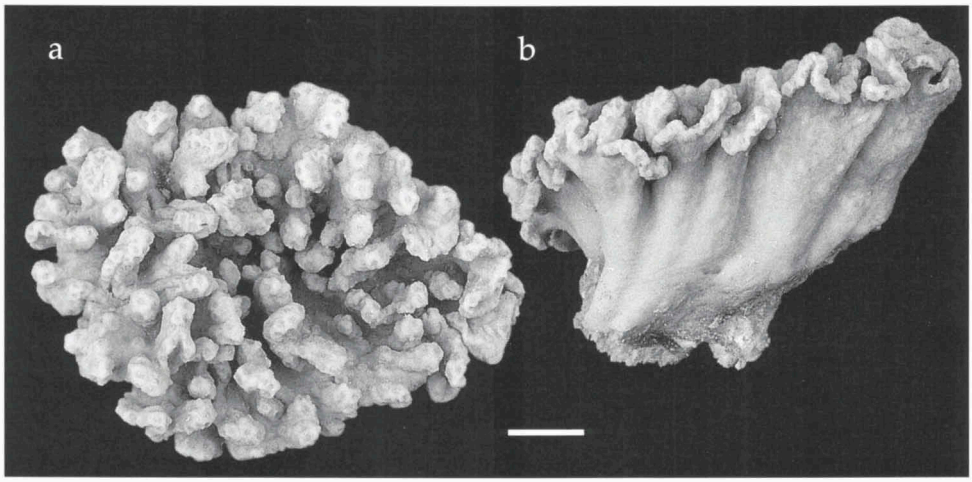

Fig. 23. *Sinularia brassica* May, 1898; RMNH Coel. 23956; a, view from above; b, side view. Scale 1 cm.

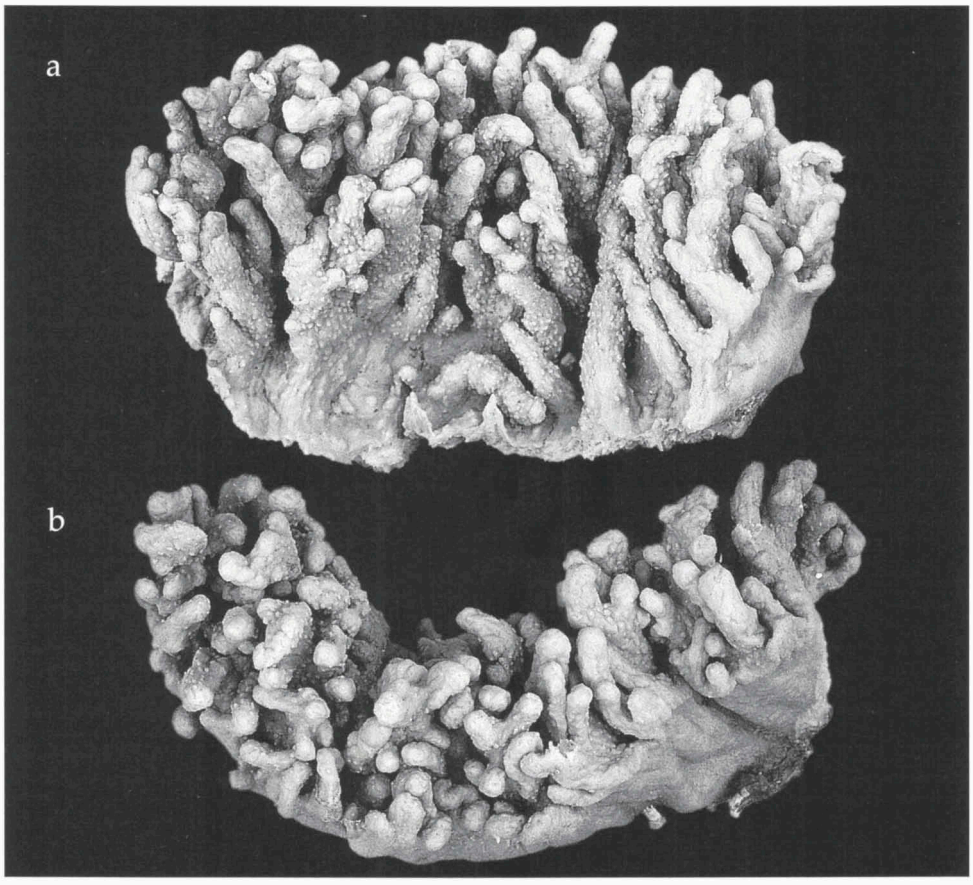

Fig. 24. *Sinularia brassica* May, 1898; RMNH Coel. 23972; a, view from above; b, side view. Scale 1 cm.

Sclerites

Examinaton of the sclerites of the additional material showed that most variation is present in the polyp rods and the clubs of the surface layer of the capitulum. Therefore, only these two types of sclerites are compared and depicted.

RMNH Coel. 23958 (fig. 9): polyps with rods, 0.03-0.11 mm long, 0.01-0.03 mm wide (fig. 26a); clubs of surface layer of disc 0.08-0.16 mm long, 0.04-0.10 mm wide (fig. 25c). Compared with the above described type material the clubs are rather small, but the heads are well developed.

RMNH Coel. 23958 (fig. 10); RMNH Coel. 23968: have somewhat similar sclerites, although the heads of the clubs are slightly more developed.

RMNH Coel. 23955: the polyps show rods as well as scales (fig. 26b). The clubs are up to 0.20 mm long and up to 0.12 mm wide. The heads of the clubs are more developed than in the preceeding specimens (fig. 26c).

RMNH Coel. 23971: polyps with rods only (fig. 27b). Clubs with extremely well developed heads, up to 0.20 mm long and up to 0.15 mm wide (figs 26d, 27a).

RMNH Coel. 23953: polyps with almost smooth scales (fig. 27c). Clubs up to 0.20 mm long, up to 0.09 mm wide. The heads of many clubs are compressed (fig. 27d).

ZMTAU Co. 27856; ZMTAU Co. 27884; ZMTAU Co. 27803; ZMTAU Co. 27827; ZMTAU Co. 27832; ZMTAU Co. 27834: all show little variaton in polyp sclerites and clubs of the surface layer (fig. 28a-b, d).

ZMTAU Co. 27807; ZMTAU 27844: sclerites similar to the above mentioned group (fig. 28c, e).

RMNH Coel. 23956: shows sclerites similar to those of RMNH Coel. 23971.

RMNH Coel. 23972 shows the same almost smooth rods as RMNH Coel. 23953 (fig. 29a), the clubs look like RMNH Coel. 23958.

In all other specimens examined the sclerites fall entirely in the range mentioned above, except for specimen Y14 of the Marine Biotechnology Institute Co., Japan. This specimen with a short stalk and a flat cup shaped capitulum, with slightly infolded margins, shows clubs with extremely rudimentary heads (fig. 29b).

Discussion

Almost all species of zooxanthellate scleractinian corals display a wide range of morphological variation (Veron, 1995). In our experience a similar magnitude of variation exists in many octocorals in general, and in various *Sinularia* species in particular. This explains the confusion in the taxonomic literature dealing with the two species (see Introduction).

It seems clear that, before Verseveldt's examination of the holotype of *S. brassica* in 1980, its similarity to *S. dura* was unrecognised. Prior to this, Verseveldt and other researchers seemed to accept the assigning of colonies with two extreme morphologies to *S. dura*, except for Tixier-Durivault (1951) who, with very little evidence, pro-

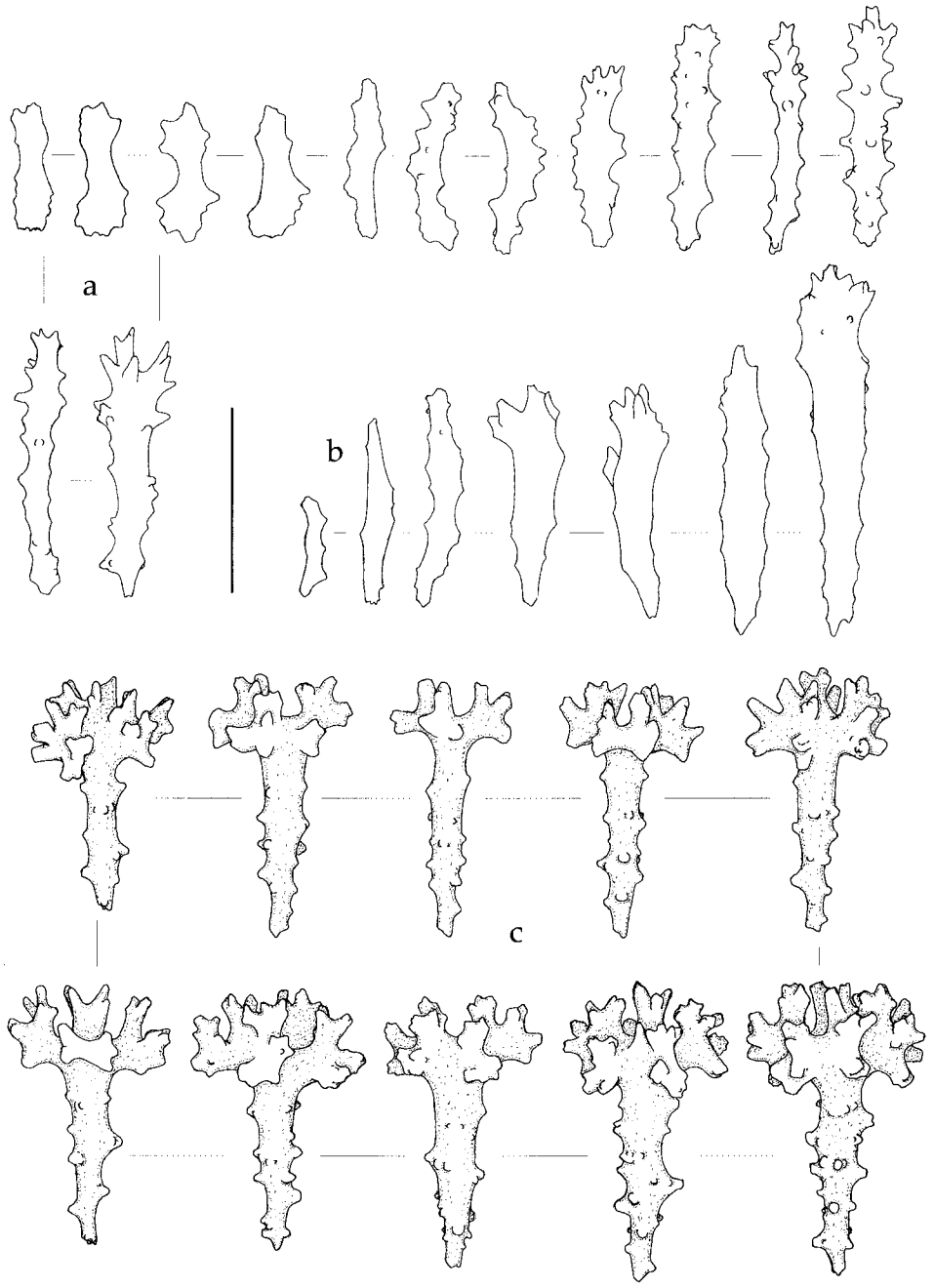

Fig. 25. *Sinularia brassica*, May, 1898; a, anthocodial sclerites of the holotype of *S. brassica* (ZMH C 2511); b, anthocodial sclerites of the lectotype of *S. dura* (BMNH 1962.7.20.100A); c, clubs of surface layer of capitulum of RMNH Coel. 23958. Scale 0.10 mm.

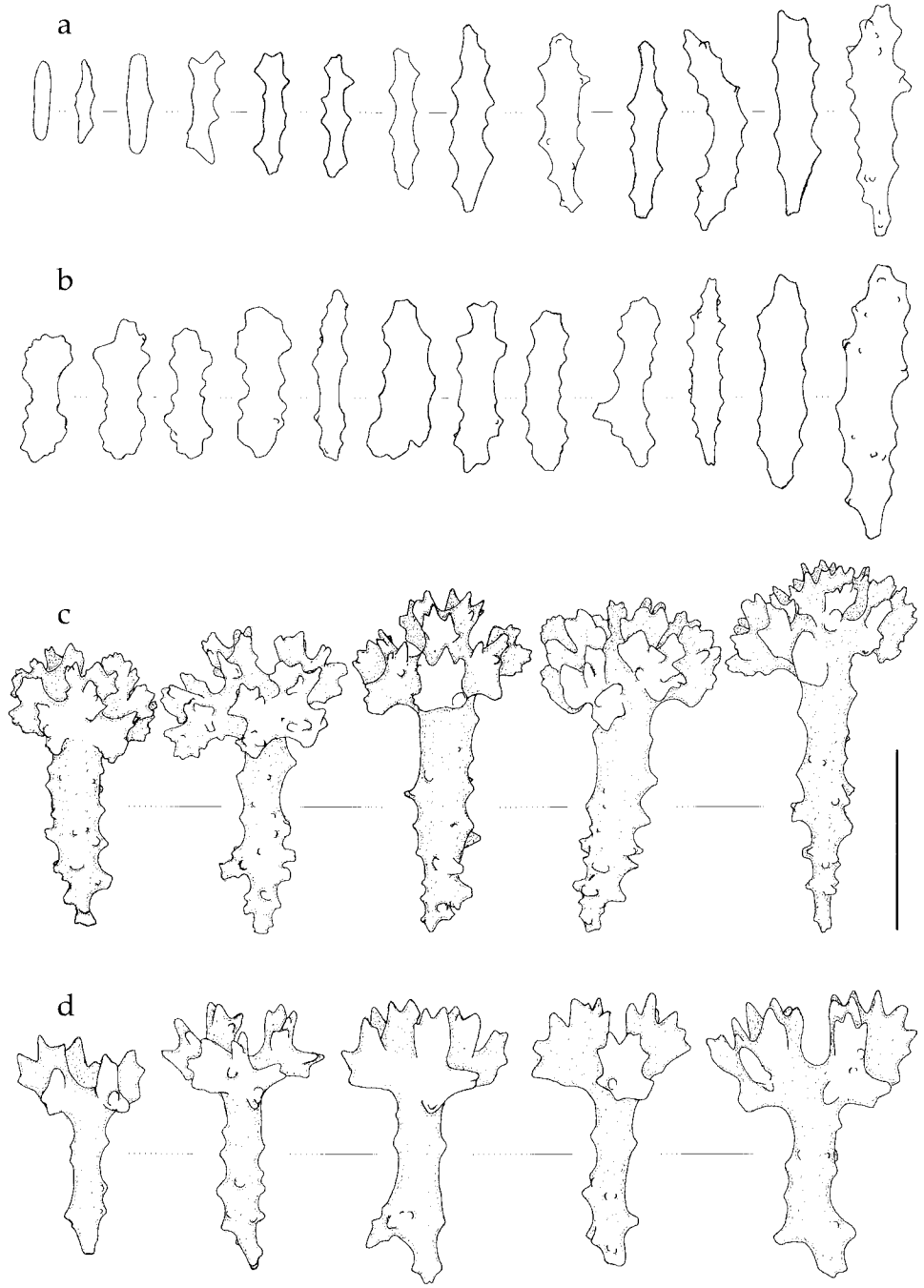

Fig. 26. *Sinularia brassica*, May, 1898; a, anthocodial sclerites of RMNH Coel. 23958; b, anthocodial sclerites of RMNH Coel. 23955; c, clubs of surface layer of capitulum of RMNH Coel. 23955; d, clubs of surface layer of capitulum of RMNH Coel. 23971. Scale 0.10 mm.

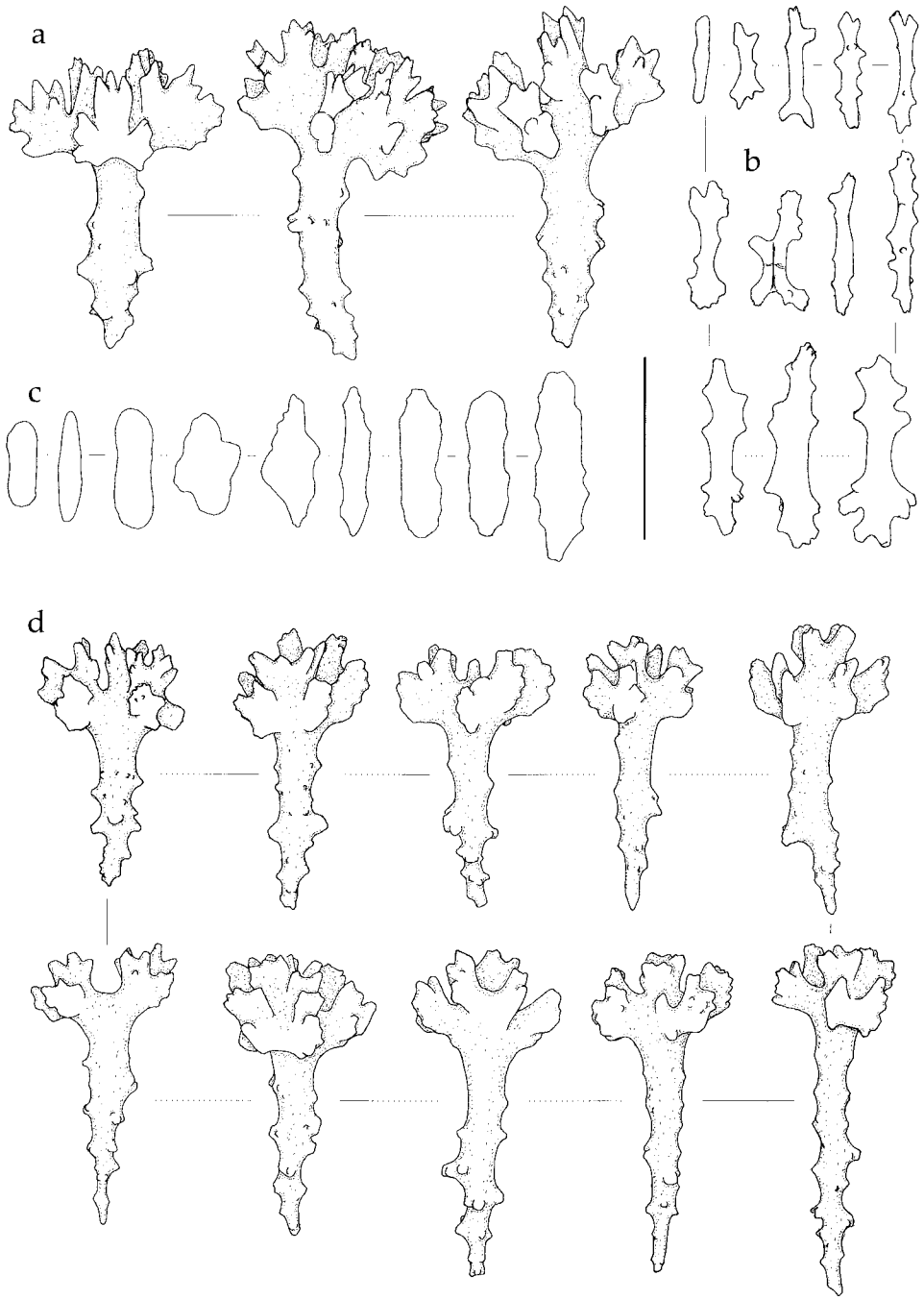

Fig. 27. *Sinularia brassica*, May, 1898; a, clubs of surface layer of capitulum of RMNH Coel. 23971; b, anthocodial sclerites of RMNH Coel. 23971; c, anthocodial sclerites of RMNH Coel. 23953; d, clubs of surface layer of capitulum of RMNH Coel. 23953. Scale 0.10 mm.

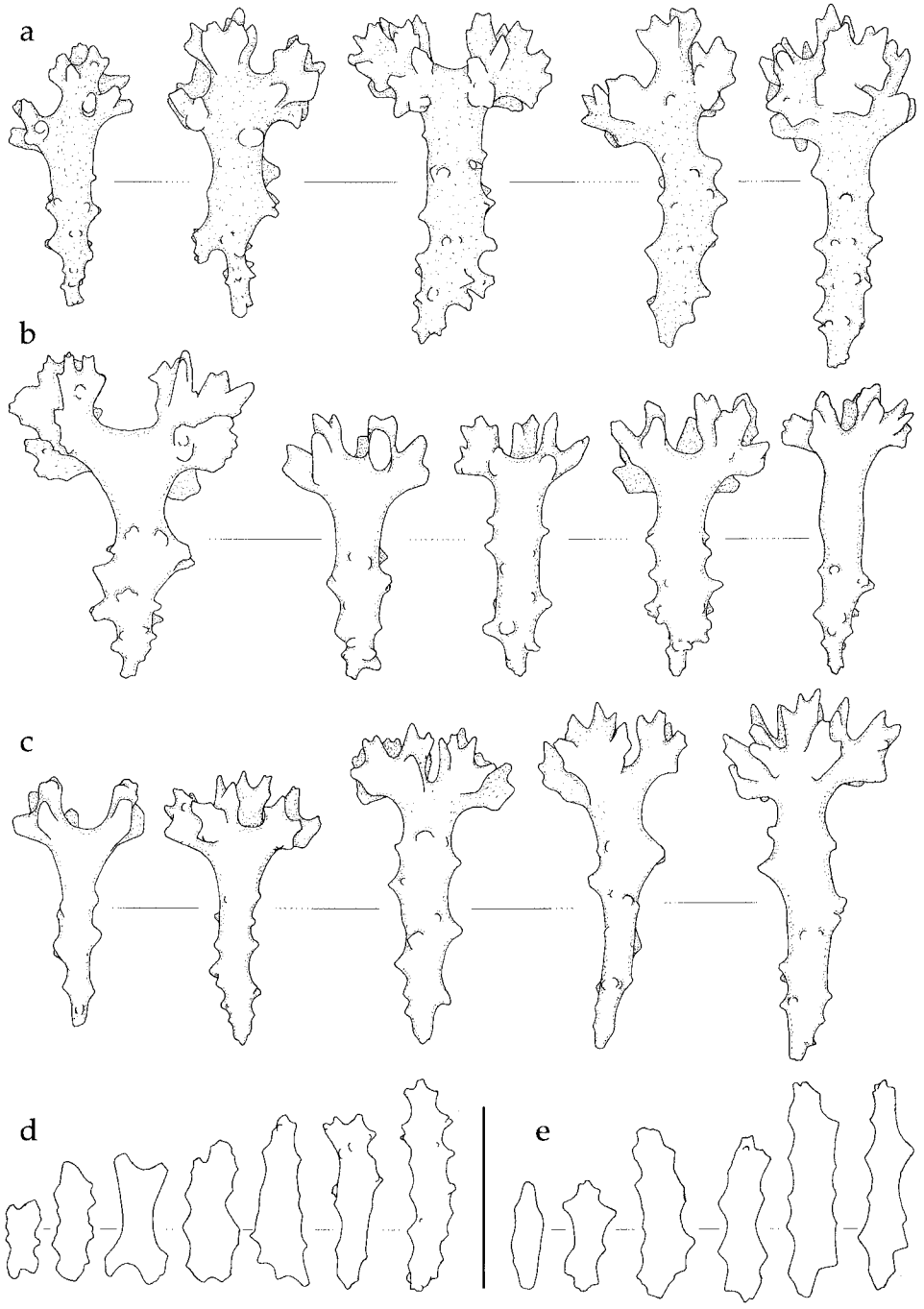

Fig. 28. *Sinularia brassica*, May, 1898; a, clubs of surface layer of capitulum of ZMTAU 27803; b, clubs of surface layer of capitulum of ZMTAU 27827; c, clubs of surface layer of capitulum of ZMTAU 27807; d, anthocodial sclerites of ZMTAU 27827; e, anthocodial sclerites of ZMTAU 27807. Scale 0.10 mm.

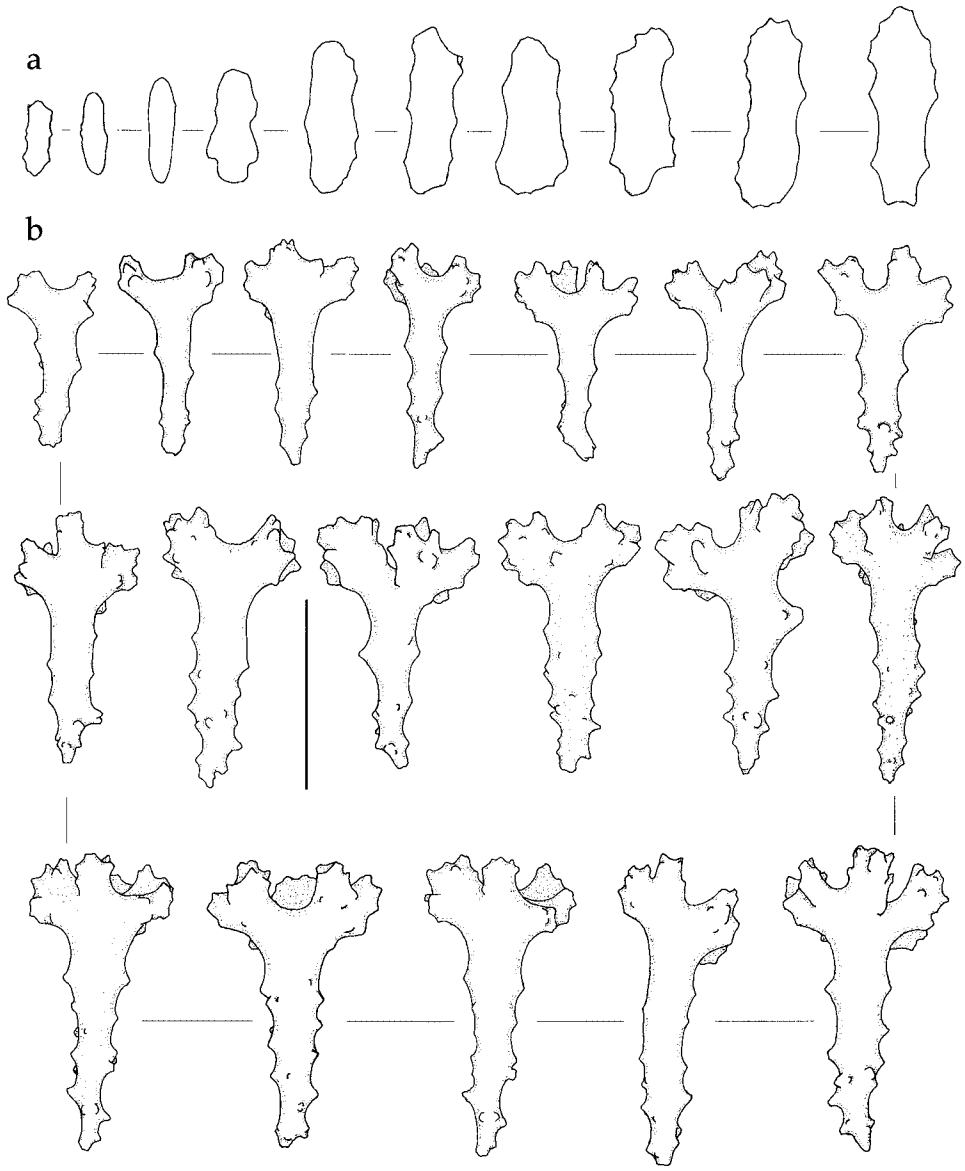

Fig. 29. *Sinularia brassica*, May, 1898; a, anthocodial sclerites of RMNH Coel. 23972 27807; b, clubs of surface layer of capitulum of specimen Y14 of the Marine Biotechnology Institute Co., Japan. Scale 0.10 mm.

posed that they represented different species; neither of which was *S. brassica*.

Verseveldt reversed his opinion on the subject in 1980, but his treatment of the problem was inconsistent. When he borrowed three of Pratt's syntypes from the BMNH in 1974, he did not designate a lectotype. However, the only specimen that he described in detail, including sclerite illustrations, was the lobate specimen (BMNH 1962.7.20.100A). It was also to this specimen that he attributed Pratt's sclerite figures. Yet, in 1980, upon discovering that *S dura* had the same sort of sclerites as *S. brassica*, he chose to label *S. dura* as a cup-shaped, not a lobate, species. At the same time he erroneously diagnosed the convoluted funnel-like holotype of *S. brassica* as being lobate, despite May's description of the capitulum ("Die Scheibe ist im allgemeinen von elliptischer Form, flach und bis in die Mitte vielfach gefalted"). Curiously, in his discussion about the similarities between these two species, Verseveldt stated that "the spiculation [of *S. brassica*] completely agrees with that of *S. dura* .... and the most plausible inference would be to call May's specimen *S. dura*. But this is impossible since May's specific name *brassica* is the earlier name and thus has priority!". Surely, the most plausible inference would have been to call Pratt's specimens *S. brassica*. Nevertheless, stating that "so many distinct lobate and cup-shaped specimens have been found", Verseveldt decided to assign each form to a separate species rather than merging them.

Obviously Verseveldt was of the opinion that the specimens to which he was referring fell into two distinct morphological categories. The problem of identity arises when colonies are encountered with morphologies that fall between these two categories. Fortunately we have been able to examine a considerable number of specimens covering a large variety of growth forms ranging through capitula which are encrusting and flat, stalked and flat, encrusting and cup-shaped, stalked and cup-shaped, encrusting and lobate, and stalked and lobate. Several of the examined colonies show various degrees of marginal folding (figs 14-16, 18-20). Such folded margins appear in both encrusting and stalked colonies which show various degrees of lobulation. We found a range from small surface elevations to distinct lobes (figs 15-18), and the latter (lobes of about 10 mm long and more) appear in both encrusting and stalked colonies (figs 18, 21-24). Because a range of forms from absence of lobes through small surface elevations to distinct lobes was observed, we see no possible way to separate 'lobate' colonies from the rest.

Another variable feature is that some colonies show very prominent, calicular-like mounds surrounding the polyp opening. There are no specialised sclerites in these elevations which are just coenenchymal swellings, and their occurrence does not correlate with any distinct growth form.

The composition and architecture of the sclerites of the two primary types are essentially the same. There are, however some minor differences. The few double heads present in the surface of the stalk of *S. brassica* are missing in *S. dura*, and in the surface layer of the capitulum of *S. dura* the clubs and spindles are smaller: up to 0.19 mm versus up to 0.27 mm long for the clubs; up to 0.20 mm versus up to 0.27 mm long for the spindles. Furthermore, *S. dura* has much larger internal spindles in the stalk; up to 8.10 mm versus up to 3.75 mm long. However, Verseveldt (1974) already mentioned that the spindles in the interior of the two other syntypes of *S. dura* were of intermediate size; up to 5.40 mm and up to 5.60 mm long. Finally, the polyps of the

holotype of *S. brassica* contain scales as well as rods (fig. 25a) while the *S. dura* lectotype has only rods (fig. 25b). Our examination of the sclerites of the additional material, however, indicates that sclerite architecture and composition is somewhat variable, and does not correlate with colonial morphology.

We found most variation in the rods of the polyps and the clubs of the surface layer of the capitulum of the colonies. This variation is related with the collection site. For instance all S-African material showed little variation (fig. 28). RMNH Coel. 23958 (fig. 9), RMNH Coel. 23958 (fig. 10), RMNH Coel. 23968, all from S-Sulawesi, also showed little variation (figs 25c, 26). But the differences between the S-African and the Sulawesi material are considerable. However, this is not a general rule as RMNH Coel. 23971, from Sulawesi, had similar sclerites as RMNH Coel. 23956, from the Chagos Archipelago.

There are a few puzzling observations related to colonial form that should be mentioned in the context of this study. In our experience colonies with a cup-like capitulum, which can be more or less flat when alive, seem to remain rather small (few cm in diameter), and tend to grow on vertical surfaces or under small overhangs, or in the open when in deep water. Also, they often grow closely grouped together. Although it is extremely risky to identify species from underwater pictures, we feel relatively confident that such groups appear in the following published photographs: Tomascik et al. (1997: colour plate 8.2); Schumacher & Hinterkircher (1996: 51); Colin & Arneson (1995: 83, fig 308; identified as *S. frondosa*); and Erhardt & Moosleitner (1995: 226).

Lobate colonies, on the other hand, seem to grow in relatively shallow, open, flat reef habitats, and become much larger than the colonies with a cup-like capitulum (see Sprung & Delbeek, 1997: 213, centre). Oddly, it seems that small lobate colonies are seldom observed; our fig. 30e shows a possible juvenile colony of this form, and two others are shown by Sprung & Delbeek (1997: 213) and Erhardt & Moosleitner (1995: 228; as *Sinularia* spec.). It is unlikely that the small flat colonies represent juvenile forms of the large lobate ones. First, aggregated small, flat colonies are unlikely to be able to grow large and develop lobes because of space limitation. Second, we have never observed small flat juvenile colonies in the neighbourhood of the large lobate colonies. The situation of juveniles aggregated together with adult colonies is often observed in other species of *Sinularia*.

A further point of interest is that in living colonies with a flat growth form, it is virtually always possible to see the large coenenchymal sclerites through the surface of the capitulum (fig. 30f), but, in the large, lobate colonies such an occurrence is rare. It does happen, however, as noted by us under water, and also shown by Sprung & Delbeek (1997: 213, centre) and fig. 30e.

A possible explanation for the variation in colony morphology of the studied specimens could be that colonies adopt lobe production and a faster growth rate in response to an increase of available light. Some evidence from aquarium observations supports this idea. We have examined samples and seen photographs of healthy specimens kept in aquaria by Julian Sprung that exhibit growth of lobes in colony portions that extend into areas of increased illumination. We should mention, however, that Sprung & Delbeek (1997) considered that there are possibly two different species involved here with over-lapping growth forms; one that responded to an

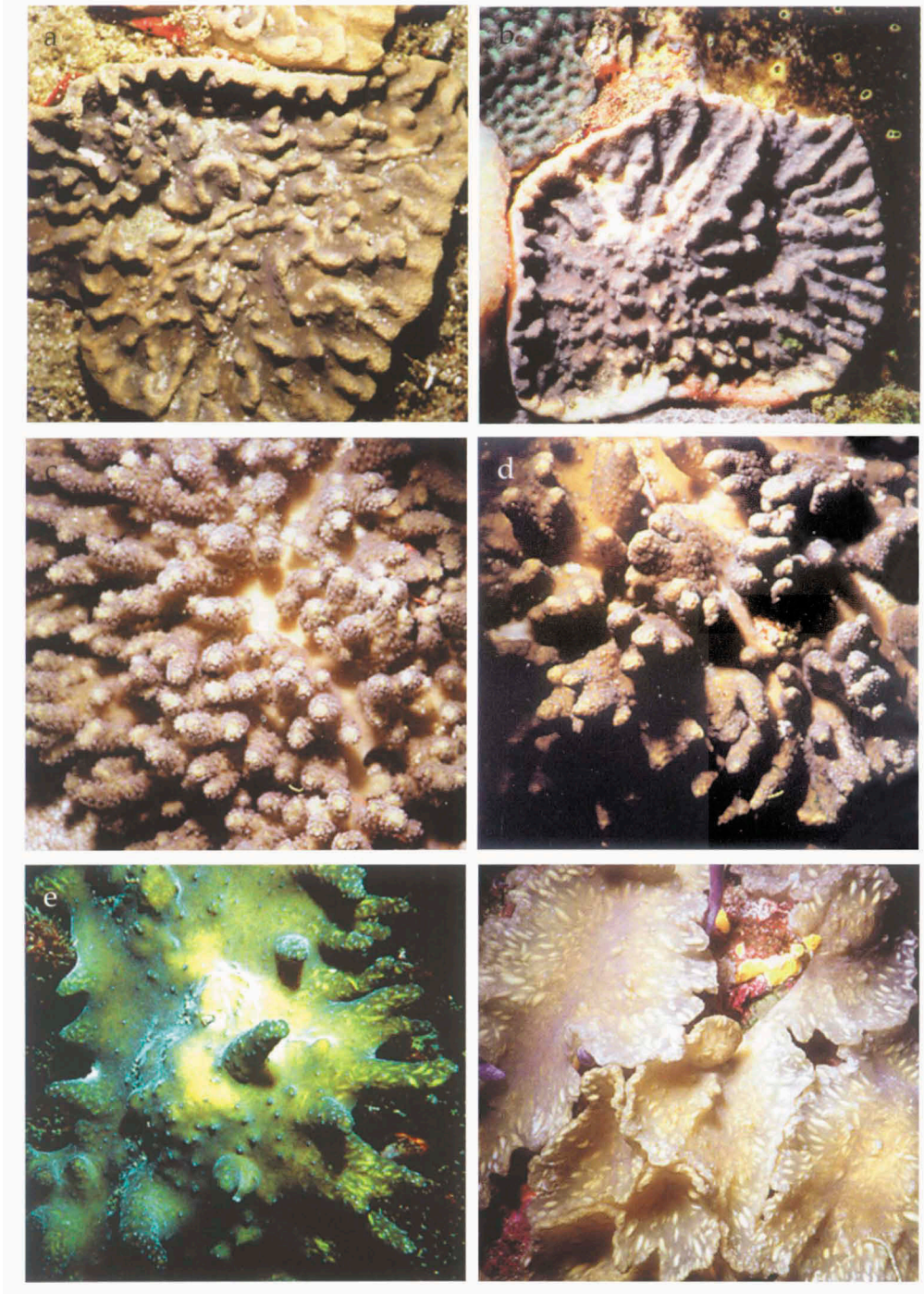

Fig. 30. *Sinularia brassica*; photographs of living specimens; a-d, from Sodwana Bay, South Africa; e, OCDN-4388F, Coral Reef Research Foundation, Palau; f, from Palau.

increase in illumination by producing lobes over most of the upper surface, and one that responds by producing lobes mostly at the periphery. Therefore, it is indeed possible that environment-correlated variation in growth in *Sinularia* has led to ecomorphs (see Veron, 1995: 269) which are linked by a continuum of growth forms similar to what has been suggested for some scleractinian corals. In addition, but not less intriguing is the possibility that part of this variation is the result of cross-fertilization within sibling species (Szmant et al., 1997; Willis et al., 1997). Awareness of such a variation requires examination of series of specimens from the entire distributional range of a given taxon. No doubt that the issue of species separation in a situation as described in the present study awaits future work, that will reveal other possible boundaries than based on morphological taxonomic characters.

Other photographs of living specimens we believe to be relevant to this study are: Fossa & Nilsen (1995: 174, *S. dura*; 176, *S. brassica*); Gosliner et al. (1996: 37); and Sprung & Delbeek (1997: 212).

Conclusion

Without any way of distinguishing distinct morphological boundaries within the material at hand, the most practical solution proposed here is to regard *Sinularia dura* (Pratt, 1903) a junior subjective synonym of *Sinularia brassica* May, 1898. Clearly, more work is needed to verify possible ecological or genetic isolation among the range of colony morphologies described in this study. Such data may either indicate that we are dealing with a highly variable species or perhaps a similar situation to that encountered in *Platygyra* on the Great Barrier Reef (Miller & Babcock, 1997; Miller & Benzie, 1997) where genetic comparisons showed no differentiation between a group of morphospecies which interbreed.

At present, such a wide variation in colonial form among soft corals is best recognized in the genus *Sinularia*; perhaps it is indicative of further species-concept problems to be encountered in this group. Unfortunately, similar cases may be more difficult to perceive, as few species have such distinctive spiculation as the two nominal taxa considered here.

Acknowledgements

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