STUDIES ON THE FAUNA OF CURAÇAO AND OTHER CARIBBEAN ISLANDS: No. 210

CARIBBEAN BRYOZOA: ANASCA AND ASCOPHORA IMPERFECTA OF THE INNER BAYS OF CURAÇAO AND BONAIRE

by

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SYSTEMATICS

ANASCA

ASCOPHORA IMPERFECTA

ABSTRACT

The present paper deals with the Anasca and Ascophora Imperfecta of the inland bays of Curaçao and Bonaire. Collections were made by P. WAGENAAR HUMMELINCK (1930, 1936/37, 1948/49, 1955, 1963/64, 1968, 1970, and 1973) and by the author (1982), and stored in the collections of the Rijksmuseum van Natuurlijke Historie, Leiden. A total of 25 species – almost all occurring in inland bays – are described here and fully illustrated. Six new species are established: *Crassimarginatella harmeri, Scrupocellaria curacaoensis, Scrupocellaria carmabi, Scrupocellaria piscaderaensis, Scrupocellaria hildae* and *Bugula hummelincki.* Attention is given to the ecology of the species. The bays have been compared as to species composition in relation to substrate and conditions during collecting.

INTRODUCTION

The Bryozoans of West Atlantic tropical waters have in the past 100 years been studied by many authors (SMITT 1872/1873; OSBURN 1914, 1927, 1940; CANU & BASSLER 1928; LAGAAIJ 1963; SHIER 1964; MATURO 1968; LONG & RUCKER 1970; POWELL 1971; WINSTON 1982). Most of these studies were on material dredged from deep waters, and little is known about shallow coastal waters and reefs. In particular, shallow inland bays, with their typical mangrove vegetations have been poorly investigated. OSBURN (1927) described 23 species of bryozoans collected by Dr. C. J. VAN DER HORST in 1920, from Caracas Baai and Spaanse Water on Curaçao, remarking: "The collection is quite limited in the number of species, as might have been expected on account of the inconspicuous nature of most of them. Only the specialist in the group, accustomed to collect these minute animals and familiar with their habits and growth, occurrence and appearance, need ever expect to take a very complete series of them. Most of the species in the collection appear to be there incidentally, attached to shells, corals etc. and were later found on close inspection. A considerable number of the species are represented by only one or two specimens and the examination of debris under the binocular microscope yielded several species in the form of minute portions of colonies. No doubt the Bryozoan fauna of the waters about Curaçao includes several times as many species as appear in this report." WINSTON (1982) made a study of the complete Bryozoan fauna of the Indian River area, which is a shallow water environment in Florida, within the Caribbean fauna province (BRIGGS 1974), and she included many ecological data. WINSTON (1984) also described the environments of 36 shallow-water species, including lagoon and mangrove habitats, of Carrie Bow Cay, Belize.

The ecological data included in the present, mainly systematic, study of the Bryozoan fauna of the inland bays of Curaçao and Bonaire (Fig. 1) concern temperature, turbidity, salinity tolerance and substratum preference.

Comparison of the species composition in certain areas of one bay, as well as a comparison between the bays, gives information about the differences between zonal areas both within and between bays. Changes due to human activities could be studied because material over a long period was available. The samples examined were collected by P. WAGENAAR HUMME-

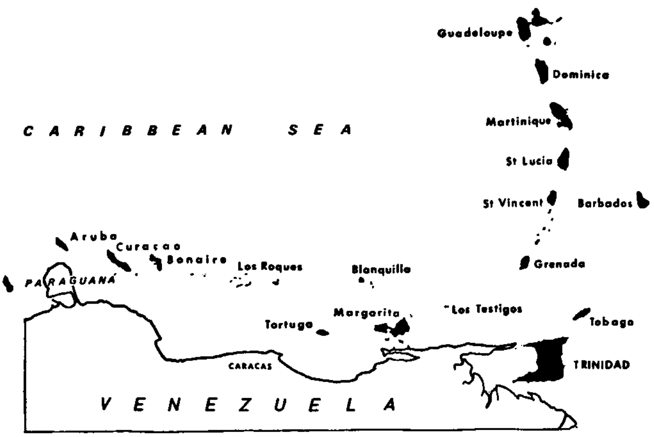

Fig. 1. West Indies: location of Curaçao and Bonaire.

LINCK during visits to the Netherlands Antilles in 1930, 1936/37, 1948/49, 1955, 1963/64, 1967, 1968, 1970 and 1973 (WAGENAAR HUMMELINCK 1977), and by the author in 1982 (see Appendix I). Piscadera Bay samples of 1963/64 were investigated by J. G. SENNEF in 1970 (unpublished).

Material of the Bonaire stations is almost absent in the present paper. More Bonaire localities, as well as reef stations of both Curaçao and Bonaire will be studied in future.

ACKNOWLEDGEMENTS

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THE MANGROVE COMMUNITY

The main mangrove species is *Rhizophora mangle* (red mangrove) which is also the most aquatic species, growing in water up to 1 meter depth, and

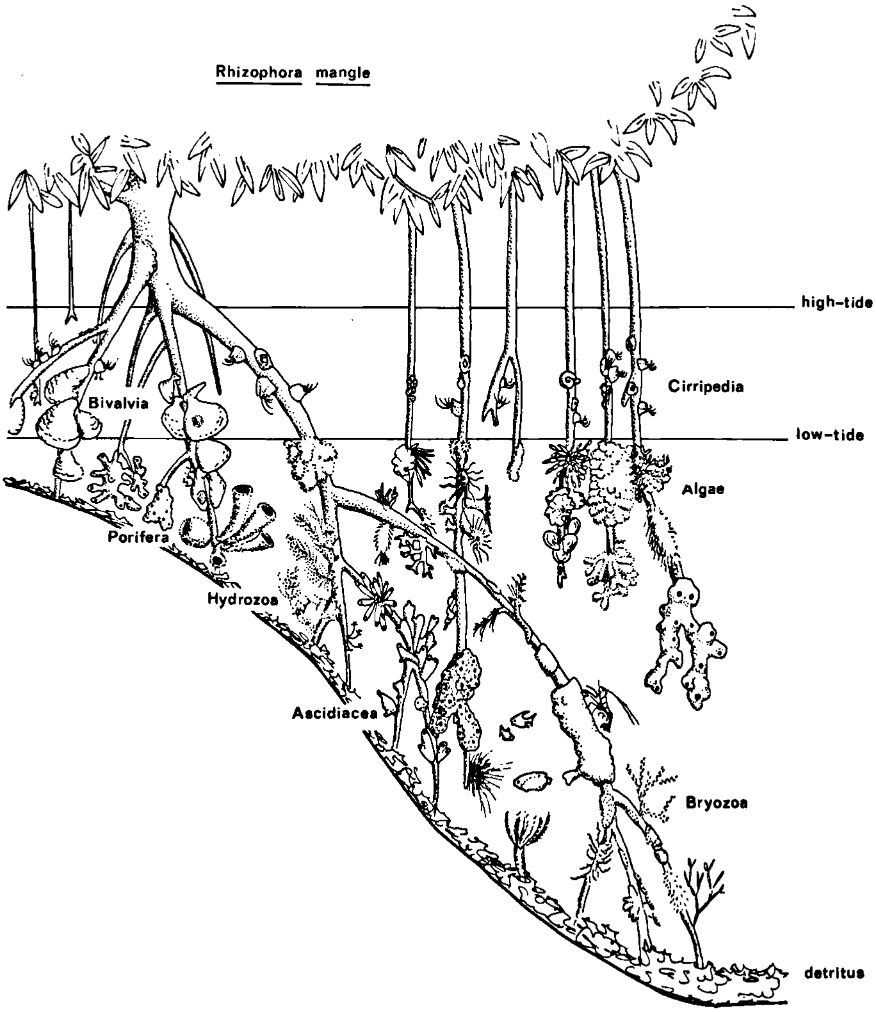


Fig. 2. Mangrove community at station 46 (Piscadera Inner Bay).

reaching the bottom with its long bifurcating roots. *Rhizophora mangle* prefers low salinities (about 30‰ NaCl/l), environments of high salinities (60‰) causing its death (WAGENAAR HUMMELINCK & ROOS 1969). Exposure to wave action also damages the species. This explains the presents of *Rhizophora* on eastern shores mainly and sheltered places in the bays. Landwards we find *Avicennia nitida* [= *germinans*] (black mangrove) with its pneumatophores, tolerating higher salinities (50‰). *Laguncularia racemosa* (white mangrove) and *Conocarpus erecta* (grey mangrove) may occur, but are never in direct contact with bay water.

The underwater community of the mangroves is limited in number of species, compared with the reef community. This is the result of the extreme and unstable conditions in the mangroves. Absence of many reef-organisms give those species tolerating the extreme environment the opportunity of explosive growth.

In Piscaderabaai (cf. stat. 46, Fig. 2) the roots of *Rhizophora* are the only solid substratum suitable for settlement of most filter feeders. On these roots a certain zonation occurs. This zonation is vertical as well as horizontal. The eulittoral zone is often occupied by animals with closeable shells, like oysters (*Crassostrea rhizophorae* and *Isognomom alata*), barnacles (*Balanus, Chthamalus*) and serpulids. The sublittoral zone on the roots is occupied by all sorts of filter feeders (sponges, serpulids, bryozoans and ascidians), algae and sessile predators (actinians and hydroids). A zonation exists depending on the amount of light. Some species prefer dark places: at 1 m depth and under a dense roof of leaves; other species need light (algae) or tolerate light, and grow in the peripheral zone of the mangroves. When a root enters the water competition for space begins. The microenvironment of the root at the moment of being colonized is of great importance for the success of the species concerned. In general a root surface is dominated by one or a few species, two roots near each other can be dominated by different organisms. When the root grows towards the bottom, there is a change in epifaunal species to one of those preferring a darker environment. Other sessile animals are adapted to grow on primary encrusting organisms.

Further investigations are needed for a better understanding of the complex mangrove community.

LOCALITIES STUDIED

Two types of bays are recognized by their form and origin: 1) Hand-shaped bays, extending inland, which are the result of post-glacial inundation of Pleistocene valley-systems. During rainfall water runs off, transporting sediment towards the bays. 2) Oval lagoons, parallel to the coastline which are formed by barriers of coral debris.

In contrast to the open sea environment, the bays have a relatively small volume of water and little depth and are therefore subject to changes of environmental factors, causing an unstable habitat. De Kock & de Wilde (1964) studied the fertility of some bays on Curaçao and measured several kinds of parameters; some general conclusions of their report are summarized here.

The inland bays have a high salinity reaching the highest values in sheltered places. Open sea values measure 36 g NaCl/l. Temperature fluctuates between 26–29°C, and instability increases towards the peripheral, shallow parts of the bays. In the open sea temperatures measure between 27.3–27.6°C (Jan–June). At high tide, particularly, the water in the entrances of the bays on the south coast shows a distinct temperature stratification. The colder sea water overflows the warmer water of the bay which has a relatively high salinity. Oxygen content is always near saturation point, as a result of small productivity and turbulence caused by a constant trade wind. The trade wind also causes an east-west surface current. Transparency is generally low, in some bays algae cannot grow beneath 2–4 m depth (van den Hoek 1972: 6). Turbidity is mainly caused by inorganic matter (low B.O.D. amounts, de Kock & de Wilde 1964). Generally turbidity increases towards the bottom and decreases towards the entrance of the bays. The pH is about the same in all bays (7.66–8.04).

In his "Index of marine and saltpond habitats" Hummelinck's stations are roughly arranged according to characteristics such as water movement, substrate and salinity. Though stressing the fact that coastal and inland waters cannot be properly classified, he attempts to give the following classification of the "Land-locked bays or almost enclosed lagoons" in which collections were made on Curaçao and Bonaire.

MORE OR LESS HANDSHAPED BAYS OR LAGOONS: drowned valleys completely intersecting a coastal range of neogene limestone

entrance relatively wide	
clear water	Spaanse Water, in part.
turbid, slightly polluted	Lagoen of Bon.; Spaanse Water, in part, St. Jorisbaai, Playa Grandi, Boca Bartool on Cur.
turbid, polluted	Schottegat.
entrance relatively narrow	
turbid, rather polluted	Piscaderabaai.

MORE OR LESS OVAL BAYS OR LAGOONS: land-locked and almost completely surrounded by limestone or coral debris

entrance relatively wide	
clear water	Lac; Awa di Oostpunt, Fuikbaai W. part, Lagoen St. Jan.
turbid, slightly polluted	Fuibaai, E part.
entrance relatively narrow	
clear water	Awa Blanco, Lagoen Blanco, Lagoen di Venni of Spaanse Water, Sta Marta lagoons.
turbid, slightly polluted	Rifwater.

A study of the algal vegetation-types by VAN DEN HOEK e.a. (1972) resulted in a further classification of the bays.

Type 1. BAYS WITH RELATIVELY WIDE AND DEEP ENTRANCES: Bartolbaai, Playa Grandi, St. Jorisbaai, Spaanse Water, Schottegat and E part of Fuikbaai.

The first two bays are filled with refuse and will not be discussed. Schottegat is polluted by oil and drainage, causing abiotic zones, and has not been investigated.

The relatively wide entrances ensure a relatively great exchange of seawater with baywater. One would expect a higher "oceanity" in this type of bay compared with bays with narrow entrances. However, neither salinity nor temperature differ significantly (36–39 salinity, 26°–29°C temperature). More oceanity is found in the relative high transparency values, when compared with those of Piscadera Bay and Sta. Marta Bay. Vegetation consists of *Rhizophora mangle* on the shore, *Thalassia testudinum* until down to 2–4 m (depending on transparency), and mud at greater depths. In some places in St. Joris Bay, Spaanse Water and Fuikbaai, coral growth is possible in places with high transparency, but only a few species are present (about 8). Filter feeders are the dominant species in these bays.

Type 2. BAYS WITH RELATIVELY NARROW AND SHALLOW ENTRANCES: Santa Marta Bay and Piscadera Bay.

Santa Marta Bay lacks the *Rhizophora* vegetation as well as the *Thalassia* zone. Since 1962 a channel has been made (30 m wide, 5 m deep). The hypersaline character has disappeared, and flora and fauna with lower salinity tolerances now colonize the bay. It is expected that *Rhizophora* will soon appear.

Probably due to human influences, phosphate and pigment amounts are higher than in bays of Type 1. Filter feeders are even more dominant and abundant than in bays of Type 1. Turbidity is generally high.

Piscaderabaai is bordered by *Rhizophora*; zones of *Thalassia* and *Syringodium* are also present. Some algal species, and 3 species of coral are present (southern part and near Marie Pompoen). Filter feeders are most prominent in this bay. Mangrove roots are covered by *Crassostrea*, balanids, ascidians, bryozoans, sponges, hydrozoans and tubeworms. As a result of drainage (1000 m^3/day (WAGENAAR HUMMELINCK 1977: 4)) at Klein Hoffie since 1960, the bay is much more eutrophicated, and inflow of fresh water prevents the bay from becoming hypersaline (for further description of Piscadera Bay see HOFKER 1971: 1–5, and GOODBODY 1984: 24–26).

Type 3. THE OCEANIC LAGOON: Awa di Oostpunt, west part of Fuikbaai, both on Curaçao and Lac on Bonaire. Awa Blancu and Lagoon Blanco show some characteristics of an oceanic lagoon, but water exchange with the open sea is limited.

Exchange with open seawater gives these bays a high oceanity. Turbidity is low, also because of the absence of seasonal run-off of fresh water from dry river beds ("rooien"), which in other areas transport water and sediment during heavy rainfall. The number of species is high, compared with types 1 and 2, and the number of filter feeders relatively low. Corals are present, and echinoids are sometimes present in high numbers (Fuikbaai). *Cassiopea*, a scyphomedusa with symbiontic zooxantellae (WAGENAAR HUMMELINCK 1968), is found in the west part of Fuibaai, Lac and Awa Blancu.

Type 4. HYPERSALINE BAYS SEPARATED FROM THE OPEN SEA: Lagun Jan Thiel, Salina St. Michiel, Salina Santa Marta, San Juan Bay and Santa Cruz Bay.

High salinity and temperature stratification often occur in these habitats. For example, in the lagoon of Jan Thiel, relatively cold rainwater may cover water of high salinity at about 50°C (stat. 25). Recently a channel has been cut in Santa Cruz Bay making some water exchange possible with the Salina.

Type 5. POLLUTED LAGOONS: Zakito and Rifwater.

These areas are polluted by surrounding settlements, dumping of refuse on the shores, discharge of ferric chloride by the desalination plant, and oil pollution. The lagoons have a dead appearance, and only *Rhizophora* and some algae seem to survive. When HUMMELINCK took his samples from the northern shore of the Rifwater in Feb. 1970 *Cassiopea* was still present among some *Halodule*.

Type 6. SMALL HYPERSALINE LAGOONS: Several places along the shore.

These are unstable habitats with fluctuations in temperature and salinity. Characteristic algae are *Batophora oerstedi* and *Acetabularia crenulata*. *Cassiopea* is often present, and filter feeders are rare.

MATERIAL AND METHODS

Collecting was done snorkling or with SCUBA equipment. At the stations different microenvironments were carefully examined for bryozoans. All possible types of substrata were collected, such as *Rhizophora* roots, shells, rocks, algae and organisms growing on these substrata (sponges, ascidians, hydroids etc). Notes were made on amount of light and direction, turbidity, salinity and pollution. Substrata with bryozoans were taken to the field laboratory, where behavior and morphology of living bryozoans were studied under a dissecting microscope and a microscope. Examination of the substratum led to the discovery of inconspicuous species, especially those with non-calcified zooids.

Measurements of number and dimensions of tentacles were made when possible. Behaviour of the different types of heterozooids (avicularia, vibracularia, onychocellaria) and everted tentacle sheaths was observed. Colours of living species were also noted. Black and white photographs of everted tentacle sheaths were made. Specimens were preserved in 75% alcohol.

Collections made by Hummelinck are the result of sorting out of random collections of whole ecosystems. For descriptions of his marine localities reference may be made to Wagenaar Hummelinck, 1977.

In the museum both collections were thoroughly studied as to their morphological structures. Slides for microscopic examination were made. Specimens were gradually transferred to alcohol 96% and terpiniol, then mounted in malinol. In special cases calcite was dissolved by HCL for a better view of the internal structures. Measurements of morphological structures were made. Species are illustrated by drawings (slides used were given a catalogue number).

Abreviations

D ov : Diameter ovicell
L av : Length avicularium
L av m : Length avicularium mandible
Ldp : Length distal part
Lf : Length frontal membrane
L int : Length internode
L k+av : Length kenozooecium + avicularium
L oper : Length operculum
L opes : Length opesia
L ov : Length ovicell
L sp 1 : Length spicula type 1
L stalk : Length stalk
BMNH : British Museum (Natural History)

Lz : Length zooecium
Wz : Width zooecium
W av m : Width avicularium mandible
Wf : Width frontal membrane
W k+av : Width kenozooecium + avicularium
W oper : Width operculum
W opes : Width opesia
W ov : Width ovicell
Ws : Width stem
W stalk : Width stalk
Wz : Width zooecium
RMNH : Rijksmuseum van Natuurlijke Historie, Leiden.

SYSTEMATICS

The classification follows Cook 1968a and Ryland & Hayward 1977. The characteristics of the families and genera are generally described. Descriptions of species investigated include the range measured and a mean of dimensions and the number of tentacles. Interesting behaviour is noted, and nomenclatorial problems and differences from other descriptions are discussed. Localities of the material investigated are enumerated and summarized (for a list of stations and maps (Figs 33–41), see Appendix I), and the geographical distribution of each species is generally reconstructed from literature but will be far from complete. The collection is stored in the Rijksmuseum van Natuurlijke Historie, Leiden. Type specimens were given a catalogue number.

Class GYMNOLAEMATA Allman, 1856

Order CHEILOSTOMATA Busk, 1852

Suborder ANASCA Levinsen, 1909

Superfamily INOVICELLATA Jullien, 1888

Family **AETEIDAE** Smitt, 1867

Only genus **Aetea** Lamouroux, 1818

Aetea, Prenant & Bobin 1966: 78; Cook 1968b: 135; Ryland & Hayward 1977: 44.

Colonies consisting of zooids divided in creeping stolonate proximal, and erect, tubular distal parts. The proximal parts, widening distally, occur in uniserial rows. Bifurcations by multiporous septulae in the broad proximal part of the zooid. The slightly calcified colonies are mostly white in colour. Erect part of the zooid forming a terminal area, covered by the frontal membrane, 2–4 times longer than wide, facing proximally. The frontal membrane typically develops an ellipsoid distal operculum with a thickened rim, closed by laterally attached occlusor muscles. Avicularia never present.

The polypide bears about 12 tentacles and can be retracted into the proximal part of the zooid. The tentacle sheet is surrounded by small denticles (probably a homologue of the "colar" of the Ctenostomata

(Ryland & Hayward 1977: 44)). The zooid wall is minutely punctate. Embryos are brooded in ovisacs developing on the outside of the terminal distal part (Cook 1977). No ovicells.

1. **Aetea ligulata** Busk, 1852

Figs 3a–d

Aetea ligulata Busk, 1852: 31, pl. 42 fig. 2; Hincks 1882b: 460; Marcus 1937: 30, 31, pl. 4 fig- 10; Osburn 1940: 347, pl. 1 figs 9–11; 1950: 13, pl. 1 fig. 4; Soule 1959: 4; Cook 1968b: 137; Aristegui Ruiz 1984: 101, 102, figs 18d,e.
Aetea fuegensis Jullien, 1888: 125, pl. 7 fig. 7.
Aetea crosslandi Waters, 1910: 253, pl. 24 fig. 8.

Curaçao: Piscadera Outer Bay, 1, 2; Piscadera Inner Bay, entrance 57, 58, southern part 34, 34a, 34b, 35, 43, 48, 48a, 49, central part 36, 42, northern part 7; Spaanse Water, entrance 27, 77, 81, inner bay 51, 78; Fuikbaai 32, 61, 67; St. Joris Bay, inner bay 89, 93, 94; St. Marta Bay entrance 44.
On *Rhizophora mangle* roots, stones, dead coral, rubber, glass, shells, sponges, algae, erect and encrusting Bryozoa; in clear and turbid water; at 0–6 m depth.

Description

Colonies encrusting, seldom erect, white in colour.

Erect portion straight, coarsely wrinkled or corrugated like in some hydroid stems, variable in length, constant in thickness; distal part wider, bearing the frontal membrane. Number of wrinklings varies between 3–50, depending on the length of the stem.

Polypide with 11–13 tentacles; when everted a small part of the introvert visible; tentacles forming a straight funnel. Zooid wall minutely punctate, not annulated like the stem of *A. anguina*. Proximal part of the zooecia irregularly formed.

No ovisacs observed.

Sometimes the distal region is constricted, probably due to polypide regeneration as described by Osburn (1940: 347).

Measurements (see Fig. 30a): Ldp 0.43–*0.79*–1.91 mm. Ws 0.054–*0.064*–0.072 mm. Lf 0.25–*0.35*–0.41 mm. Wf 0.078–*0.095*–0.117 mm.

Discussion

Aetea ligulata very much resembles *Aetea truncata* (Landsborough 1852) and *Aetea curta* Jullien, 1888, as already mentioned by Hastings in

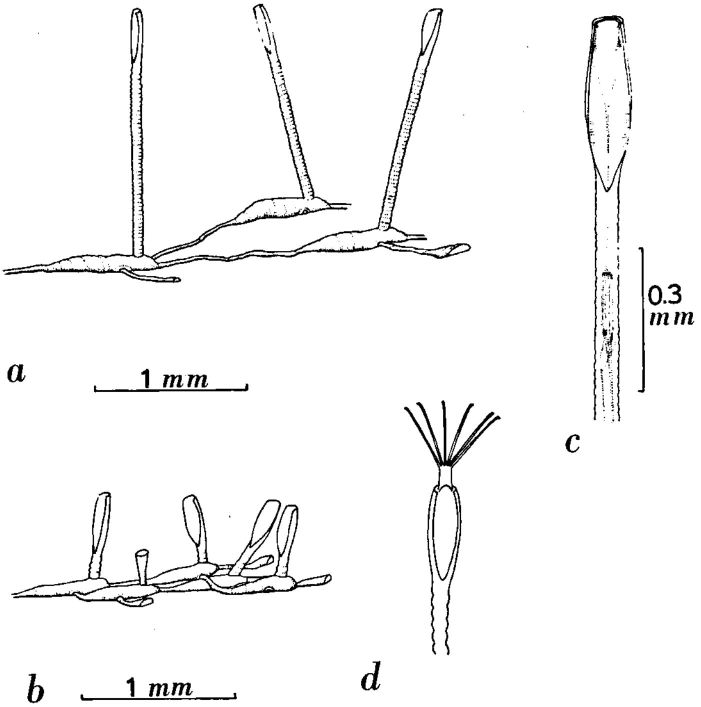


Fig. 3. *Aetea ligulata* Busk, 1852. *a*. Zooids with long stems. *b*. Zooids with short stems. *c*. Distal erect portion of the zooid; polypide retracted. *d*. Zooid with expanded tentacles. (RMNH 02967, figs 3a, c, stat. 34b; RMNH 02968, figs 3b, d, stat. 51)

1943: 475. The specimens of *A. ligulata* present in the collection investigated are very variable, and many descriptions of *A. truncata* and *A. curta* could fall into that of *A. lingulata,* as given above. *A. lingulata* and *A. truncata* both occur on the Canary Islands, where they are clearly different. The three species should be studied throughout their geographical range to solve the problem of identity.

The holotype of *A. lingulata* Busk, from Tierra del Fuego (BMNH 54.11.15.63) is dried out. Nothing is visible on the slide that resembles the species as figured by Busk 1852: pl. 42 fig. 2. On the basal side of the slide is writen: "This was mounted in fluid which dried up, nothing could be seen. All has been remounted".

Widely distributed, in shallow water to 73 m depth.

CARIBBEAN: Curaçao. – Guánica Harbor (P.R.) at 33–37 m, on sponge and calcareous algae (OSBURN 1940). ATLANTIC COAST OF SOUTH AMERICA: Santos, at 17 m depth, on *Conus*, *Cardium* and encrusting Bryozoa (MARCUS 1937a). ATLANTIC COAST OF AFRICA: Coast of Ghana, on the foraminifer *Jullienella foetida* (COOK 1968b). Canary Islands, 0–50 m, on all kinds of substrates (ARISTEGUI RUIZ 1984). INDO-WEST-PACIFIC: Khor Donogab (Red Sea) (WATERS 1910, as *A. crosslandi*). PACIFIC COAST OF AMERICA: Socorro Island (California), Albemarle, Chatham, Bartholomew (Galápagos), Gorgona (Col.), Gulf of Panamá, i.a. on pearl oysters (OSBURN 1950). Gulf of California, at 13–73 m (SOULE 1959). Queen Charlotte Islands (Brit. Columbia) (HINCKS 1882). Bay of Orange (Terra del Fuego) (JULLIEN 1888, as *A. fuegensis*). Patagonia and Straits of Magellan (BUSK 1852).

Superfamily MALACOSTEGA Levinsen, 1909

Family **ELECTRIDAE** Stach, 1937

Electridae, RYLAND & HAYWARD 1977: 64.

Colonies normally encrusting, sometimes erect. Well-developed gymnocyst, porous or imperforate. Cryptocyst present but generally reduced. Spines present or absent. No avicularia or ovicells.

Genus **Electra** Lamouroux, 1816

Electra, OSBURN 1940: 354, 355; RYLAND & HAYWARD 1977: 64.

Proximal portion of zooid covered by a gymnocyst, distally leaving a large oval or elliptical opesia. Generally there is a proximal median spine on the gymncyst. No pore-chambers.

2. **Electra bellula** (Hincks, 1881)?

Figs 4a–c

Membranipora bellula HINCKS, 1881a: pl. 149 fig. 4.
Electra bellula, MARCUS 1937: 37, pl. 6 figs 14a–f (non fig. 14c = var. *bicornis* Hincks); OSBURN 1940: 355; MARCUS 1953: 280; LAGAAIJ 1963: 170, 171; SHIER 1964: 611; COOK 1968b: 141, pl. 9 fig. a; WINSTON 1982: 121, 122, fig. 33.

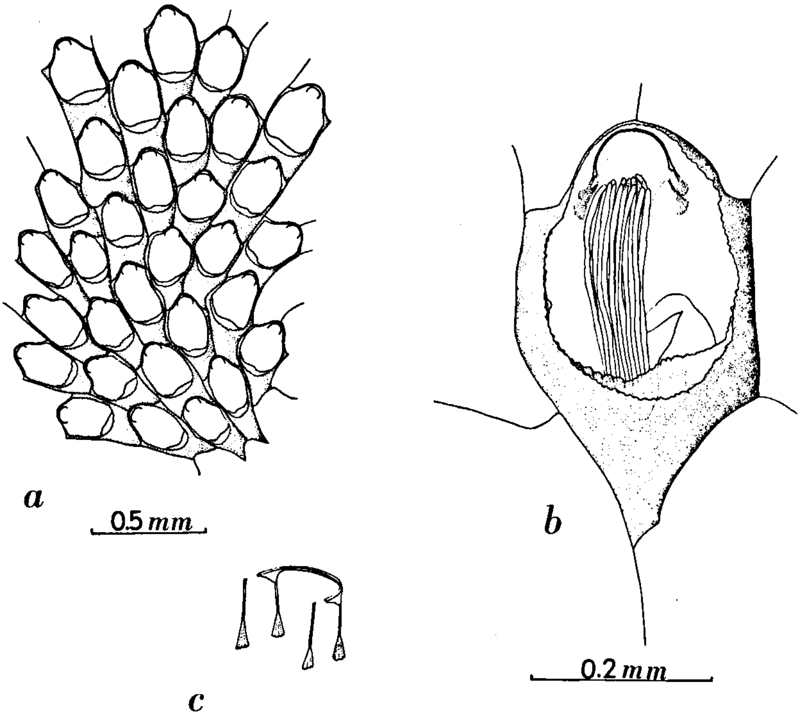


Fig. 4. *Electra bellula* (Hincks, 1881)? *a*. Portion of a colony. *b*. Detail of a zooid. *c*. Diagram of the operculum, occlusor muscles, and parietal adductor muscles. (RMNH 02069, stat. 1643)

Curaçao: Spaanse Water, inner bay 1627; St. Joris Bay 1643, 1688A; Rifwater 1669A. On *Thalassia*; in clear water; at 0.25–2 m depth.

Description

Colonies encrusting, one layer thick, observed to form rounded encrustations of up to 2 cm diameter. Colour transparently white.

Zooecia nearly rectangular, distally a little broader, slightly calcified, separated by shallow grooves. The thin, proximally imperforate gymnocyst covers 1/3–1/2 of the front, leaving the oval opesia proximally surrounded by a cryptocyst. Both gymnocyst and cryptocyst have denticulate edges. No spines present.

The semi-circular, slightly thickened operculum is closed by occlusor muscles attached to triangular lateral sclerites of the operculum. Polypide with about 10 tentacles.

No avicularia or ovicells.

Measurements (see Fig. 30b): Lz 0.35–*0.41*–0.47 mm. Wz 0.24–*0.25*–0.28 mm. L opes 0.25–*0.29*–0.33 mm. W opes 0.20–*0.23*–0.33 mm. W opes 0.20–*0.23*–0.27 mm. W oper 0.038–*0.040*–0.041 mm.

Discussion

The few encrusting colonies I observed do not show any spines, but they fit the descriptions of the spineless variety of *E. bellula* given by the following authors. HASTINGS (930: 706) observed a great variation in form and number of spines in *E. bellula.* She also observed zooids without spines. MARCUS (1937: 37, 38) described this variety, fig. 14A of his paper shows 2 spineless zooids. OSBURN (1940: 355) gave the spineless variety a name and called it *Electra bellula* var. *ramosa.* OSBURN observed reduction and absence of spines when the species contacts the substratum. I am still uncertain about the identity of the Curaçao specimens, because I never observed spines, which would have characterized the specimens as belonging to *E. bellula.*

Widely distributed in shallow water, mostly on algae.

CARIBBEAN: Curaçao. – Outside Guánica Harbor (P.R.), at 5–11 m, on piles of wharves (OSBURN 1940). Florida, on weed (LAGAAIJ 1963). Indian river area (Florida), in shallow water, on seagrass and brown algae (WINSTON 1982). ATLANTIC COAST OF SOUTH AMERICA: Bahia de Santos (Brasil), at 0–20 m, on algae and shells (MARCUS 1937). Espirito Santo, Ilha do Francês (Brasil), on algae (MARCUS 1953). ATLANTIC COAST OF AFRICA: Coast of Ghana, encrusting algae (COOK 1968b). St. Vincent (Cape Verde Islands), on algae (HINCKS 1881). INDO-WEST-PACIFIC: Madagascar, on algae (HINCKS 1881). Australia, on algae (HINCKS 1881). PACIFIC COAST OF AMERICA: Keyton beach to Panamá City (gulf of Panamá), on marine grass (SHIER 1964).

Family **HINCKSINIDAE** Canu & Bassler, 1927

Hincksinidae Canu & Bassler, 1927: 3; Osburn 1950: 40; Bassler 1953: G159.

Membraniporids of simple structure, similar to the *Membraniporidae* but with endozooecial ovicells.

Genus **Cranosina** Canu & Bassler, 1933

Cranosina Canu & Bassler, 1933: 16; Osburn 1940: 363; 1950: 48.

Ovicell endozooecial. Setiform, transverse avicularium distally of the zooecium. Pore-chambers extremely conspicuous.

3. **Cranosina coronata** (Hincks, 1881)

Figs 5a–e

Membranipora coronata Hincks, 1881a: 147, pl. 10 fig. 1.
Setosellina coronata, Harmer 1926: 265, 266, pl. 16 figs 2–4.
Cranosina coronata, Osburn 1940: 363, 364; Hastings 1945: 88, 89, fig. 4.

Curaçao: Piscadera Outer Bay 2; Piscadera Inner Bay, northern part 7.
On stones, dead coral, and glass; in both clear and turbid water; at 0.5–10 m.
BMNH 99.5.1.556, Singapore or Philippines (*Membranipora coronata,* holotype); BMNH 1966.9.2.8, Aden (*Setosellina coronata*); BMNH 28.3.6.78, N. of N. end of New Guinea, Malay Archipelago, stat. 164.32 Siboga Exp. (*Setosellina coronata*).

Description

Colonies consisting of heavily calcified zooecia forming small, one-layered encrustrations, white in colour.

Zooecia variable in form and size, proximally broad, rounded distally. All opesia surrounded by a granulated cryptocyst which is more extensive in older zooecia.

Operculum provided with submarginal sclerite, semi-circular, with laterally placed, strongly projecting sclerites to which the occlusor muscles are attached, fitting in a smooth "rostrum".

Distal transverse setiform avicularium often asymmetrical. Opesia con-

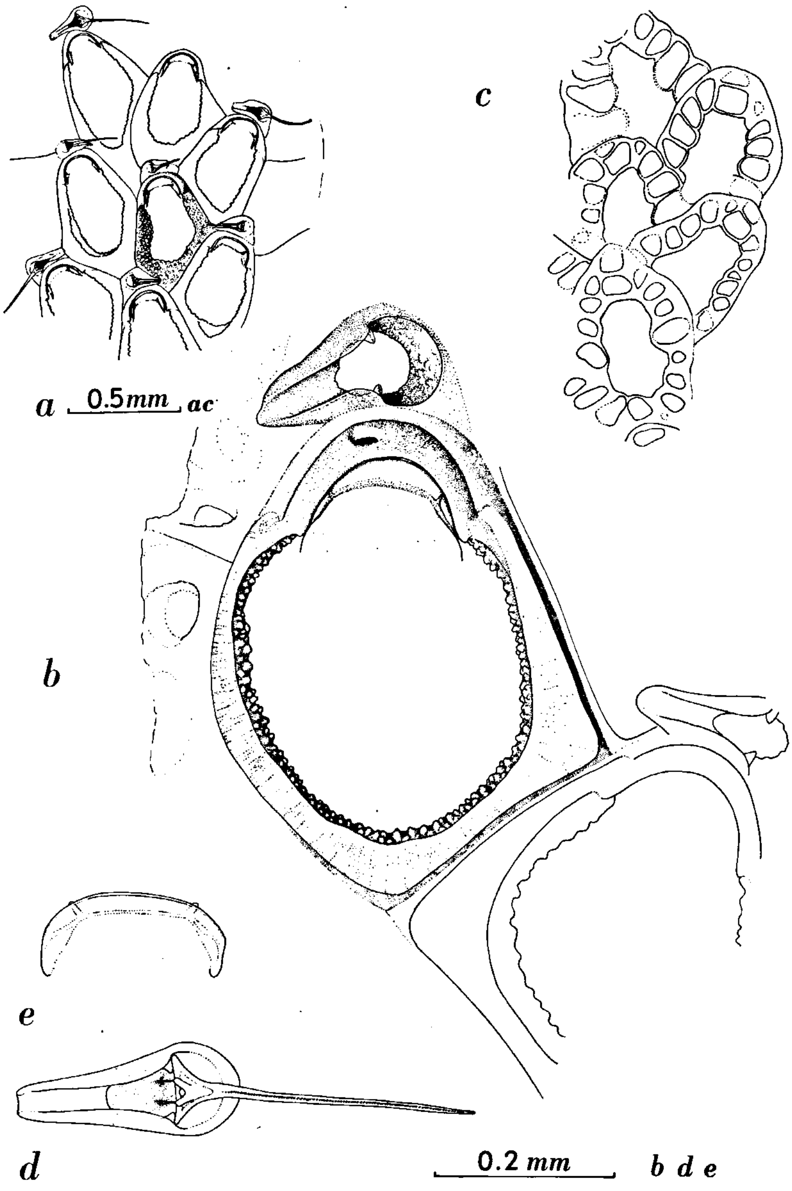


Fig. 5. *Cranosina coronata* (Hincks, 1881). *a*. Portion of a colony. *b*. Detail of regenerated zooid with ovicell. *c*. Basal side of the colony showing pore chambers and avicularia chambers. *d*. Detail of an avicularium with setiform mandible. *e*. Frontal view of the operculum, showing marginal, sub-marginal sclerites, and notches for attachment of occlusor muscles. (RMNH 02970, stat. 2)

stricted by strong condyles, proximally surrounded by a granulated cryptocyst, distally by an obliquely placed, smooth and oblong rostrum. Gymnocyst absent.

Mandible distally curved, proximally triangular, denticulated on the proximal side. Mandibular occlusor muscles, like the opercular occlusor muscles, attached to projecting sclerites.

Four (3–5) very conspicuous pore-chambers in the distal, lateral walls, 2 distal chambers of which one originates the avicularium.

Polypides with 16–18 tentacles.

Ovicells endozooecial, inconspicuous.

Figure 3b shows a young zooid in an old zooecium, building its own walls, probably due to regeneration of the polypide. Sometimes 2 opercula are seen, one above the other, the upper one old and thick, the lower one younger and slightly thickened.

Measurements (see Figs 30c, d): Lz 0.50–*0.56*–0.63 mm. Wz 0.31–*0.45*–0.55 mm. L opes 0.36–*0.40*–0.50 mm. W opes 0.20–*0.27*–0.37 mm. W oper 0.15–*0.16*–0.17 mm. L av m 0.28–*0.34*–0.42 mm.

Discussion

Well-known species from the Indo-Pacific region; first and only record from the Caribbean by OSBURN (1940). Caribbean and Indo-Pacific specimens differ in length of the avicularian mandible. In the Caribbean specimens, the avicularium mandibles are shorter, in the Indo-Pacific specimens little longer than the zooecia.

Known from the shallow waters of the Caribbean and the Indo-Pacific.

CARIBBEAN: Curaçao. – Off Pt. Brea, near mouth of Guánica Harbor (P.R.), at 15 m (OSBURN 1940). INDO-WEST-PACIFIC: Aden (BMNH 1966.9.2.8). Singapore or the Phillipines, on coral (HINCKS 1881). Indonesian archipelago, at 18, 32 and 66 m, on coral (HARMER 1926).

Genus **Antropora** Norman, 1903

Antropora NORMAN, 1903: 87, 88; HARMER 1926: 232; MARCUS 1937: 50; OSBURN 1950: 51; COOK 1968a: 137.

Pore-chambers present. Well-developed cryptocyst; gymnocyst reduced or vestigial. Ovicells endozooecial. Interzooecial avicularia present.

4. **Antropora minus** (Hincks, 1880)

Fig. 6

Membranipora trifolium S. Wood var. *minor* HINCKS, 1880: 87, pl. 11 fig. 6.
Membrendoecium compressum OSBURN, 1927: 124, 125, text-figs 1, 2.

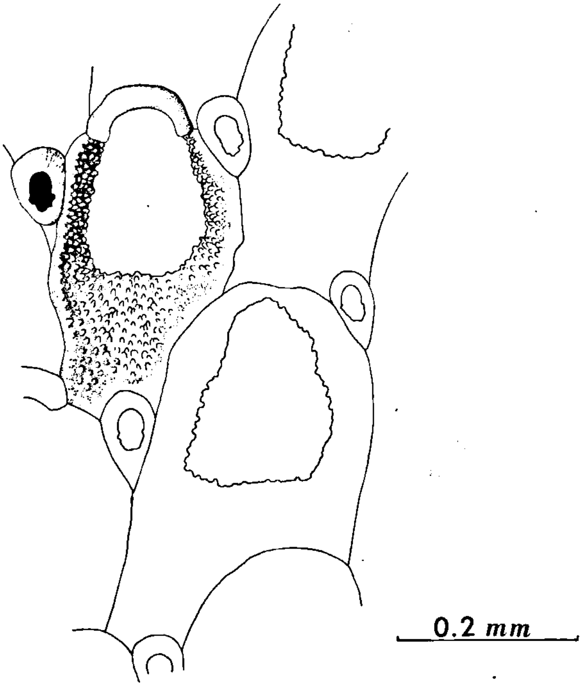


Fig. 6. *Antropora minus* (Hincks, 1880). Zooecium of fertile zooid, surrounded by interzooecial avicularia. (RMNH 02971, stat. 52)

Membrendoecium minus, MARCUS 1937: 50, 51, pl. 9 figs 22a, b.
Canua compressa, OSBURN 1940: 358; 1947: 10, 11.
Antropora compressa, OSBURN 1950: 51.
Antropora minus, COOK 1968a: 139, 140, text-fig. 10.

CURAÇAO: Spaanse Water, inner bay 52.
On stones and dead coral; in clear water; at 0.5 m depth.
BMNH 99.5.1.654 Hincks coll., Bahia dos Tigres, Angola (*Membranipora trifolium* S. Wood var. *minor* Hincks, holotype).

Description (based on a skeleton of a colony)

Colony encrusting, one layer thick. Colour light brown.

Zooecia in longitudinal series, often indistinct, heavily calcified, varying in form, rounded distally, narrowing proximally. Gymnocyst vestigial; cryptocyst proximally well-developed, granulated, surrounding the more or less triangular opesia.

Avicularia interzooecial, small, little raised, situated between 3 bordering zooids.

Ovicells endozooecial and vestigial, forming a smooth distal lip.

Pore-chambers present, one in the distal wall, 3–4 in the disto-lateral walls.

Measurements (see Fig. 30e): Lz 0.32–*0.39*–0.46 mm. Wz 0.21–*0.25*–0.31 mm. L opes 0.17–*0.19*–0.20 mm. W opes 0.12–*0.13*–0.14 mm.

Discussion

I place *Antropora compressa* (Osburn 1927) in the synonymy of *Antropora minus* (Hincks 1880), agreeing with MARCUS, 1937. The description of OSBURN (1927) does not differ significantly from *Antropora minus* (HINCKS, 1880), as described by COOK (1968), and MARCUS (1937), *Membrendoecium minus*).

In the warmer waters of the Atlantic Ocean, at 0–40 m depth. Common in the West Indian region.

CARIBBEAN: Curaçao. – Spaanse Water and Caracas Bay, in shallow water, on coral and gastropod shells (OSBURN 1927). Caledonia Bay (Panamá), Cabo la Vela (Colombia), Cubagua, Coche, Margarita and Aruba, shore to 42 m (OSBURN 1947). Between Caya Caribe and Caya Parguera (Puerto Rico), at 9–15 m, on shells (OSBURN 1940). ATLANTIC COAST OF SOUTH AMERICA: Bahia de Santos (Brasil), at 10 m, on shells (MARCUS 1937). ATLANTIC COAST OF AFRICA: Bahia dos Tigris (Angola) (HINCKS 1880). Isl. Tortuga, face

N.W., N.E. Annobon, at 14–40 m, on echinoderm spine, and Hospital reef (Atim), on the foraminifer *Jullienella foetida*, shells and stones (Cook 1968a).

5. Antropora tincta (Hastings, 1930)

Figs 7a–e

Crassimarginatella tincta Hastings, 1930: 708, 709, pl. 5 figs 16–19, pl. 17 fig. 120.
Antropora tincta, Osburn 1950: 54, pl. 4 fig. 7, pl. 29 figs 7, 8; Cook 1968a: 140, 141, text-fig. 11; 1968b: 150.

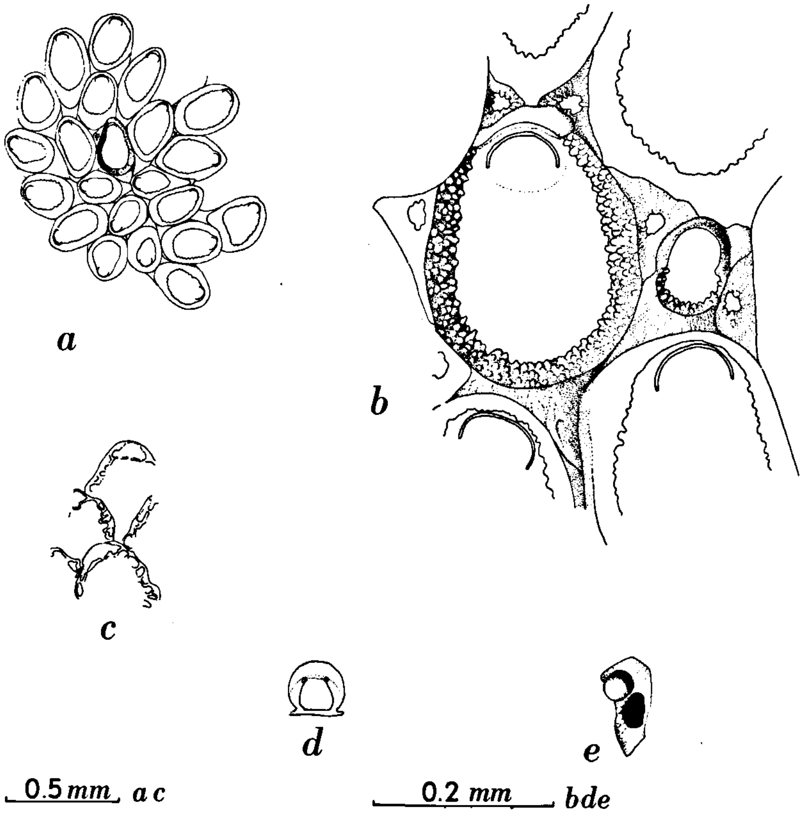


Fig. 7. *Antropora tincta* (Hastings, 1930). *a*. Part of a colony around the ancestrula. *b*. Detail of a zooecium with ovicell, kenozooecia and vicarious avicularium. *c*. Basal side showing pore chambers. *d*. Frontal view of avicularium mandible. *e*. Kenozooecium with tubercle. (RMNH 02972, stat. 52)

Curaçao: Piscadera Inner Bay, southern part 34b, northern part 7.
On stones and glass; in turbid water; at 0.3–2 m depth.
BMNH 1975.9.10.8 Seymour Isl. (Galápagos) (Hastings); BMNH 29.4.26.68 Balboa (Panamá) (Hastings 1930: holotype).

Description

Colonies encrusting, uni- or plurilaminar; few colonies on stones. Ancestrula in center of colony. Colour white to brown, not pink as described by Hastings (1930).

Zooecia increasing in size towards the periphery of the colony, situated in longitudinal series, often indistinct, when old heavily calcified. Small vicarious avicularia present in small numbers; kenozooecia with central openings, seldom bearing a tubercle, increasing in number towards the periphery of the colony. Autozooids irregular in form and size. Gymnocyst vestigial and smooth. Cryptocyst granulated, sloping downward, proximally broad, surrounding the more or less oval opesia.

Operculum a semi-circular, thickened sclerite; occlusor muscles attached laterally to triangular sclerites.

Vicarious avicularia small, ca. 1/3 of the length of an autozooid. Rostrum semi-circular, smooth. Cryptocyst granulated; small condyles present. Mandible broadly thickened, semi-circular or rounded triangular, with a proximal cross-sclerite, articulating on the condyles. Tendons of occlusor muscles separate, laterally attached to the mandible.

Ovicells endozooecial, closed by the operculum, inconspicuous, recognized by the presence of a smooth calcified band distally of the operculum, and a scleritinous bar situated between this band and the operculum. Embryo beneath the operculum in an inner vesicle.

Pore-chambers present, irregular in form and number.

Measurements (see Fig. 30f): Lz 0.25–*0.34*–0.39 mm. Wz 0.17–*0.22*–0.25 mm. Lf 0.20–*0.27*–0.31 mm. Wf 0.17–*0.21*–0.24 mm.

Discussion

Cook (1968a) and Winston (1982) described the resemblance between *A. tincta* (Hastings, 1930) and *A. leucocypha* (Marcus, 1937) only differing in frequencies of kenozooecia, size of avicularia and shape of their mandibles. In *A. tincta* these characters are variable, depending on the place in the colony. Further studies are needed to clarify the relation between *A. tincta* and *A. leucocypha*.

If *A. tincta* and *A. leucocypha* are no synonyms then is this the first record of *A. tincta* in the Caribbean.

Known from tropical water of the Atlantic and eastern Pacific.

CARIBBEAN: Curaçao. – ATLANTIC COAST OF AFRICA: Sierra Leone to Ghana, at 32–79 m, on stones, shells, corals and spines of *Eucidaris tribuloides* (COOK 1968a, 1968b). PACIFIC COAST OF AMERICA: Coiba Isl., Jicaron Isl. (Panamá), Gorgona (Col.), Galápagos, at 6–55 m, and Balboa (Pan.) and Galápagos at the shore (HASTINGS 1930). From Point Conception (Calif.) to Perú and Galápagos, at 4–143 m, on shells (OSBURN 1950).

Family ALDERINIDAE Canu & Bassler, 1927

Alderinidae CANU & BASSLER, 1927: 3, 4; 1928: 27.

Membraniporids with hyperstomial ovicells.

Genus **Crassimarginatella** Canu, 1900

Crassimarginatella, HASTINGS 1945: 69–73; COOK 1968a: 149; HARMELIN 1973: 471–492.

Zooecia with septulae, pore-chambers absent. Avicularium-chambers reaching the basal lamina between the zooecia. Ovicells endozooecial, prominent, ectooecium mostly leaving a frontal fenestra.

6. **Crassimarginatella harmeri** sp. n.

Figs 8a–e

not *Membranipora granulifera* HINCKS, 1980: 72.
not *Antropora granulifera* NORMAN, 1903: 87, pl. 8 fig. 4.
Antropora granulifera HARMER, 1926 (part.): 232, 233, pl. 14 figs 11–14.

Holotype: RMNH 02973.

CURAÇAO: Piscadera Outer Bay 2.
On stones and coral debris; in clear water; at 2–5 m depth.

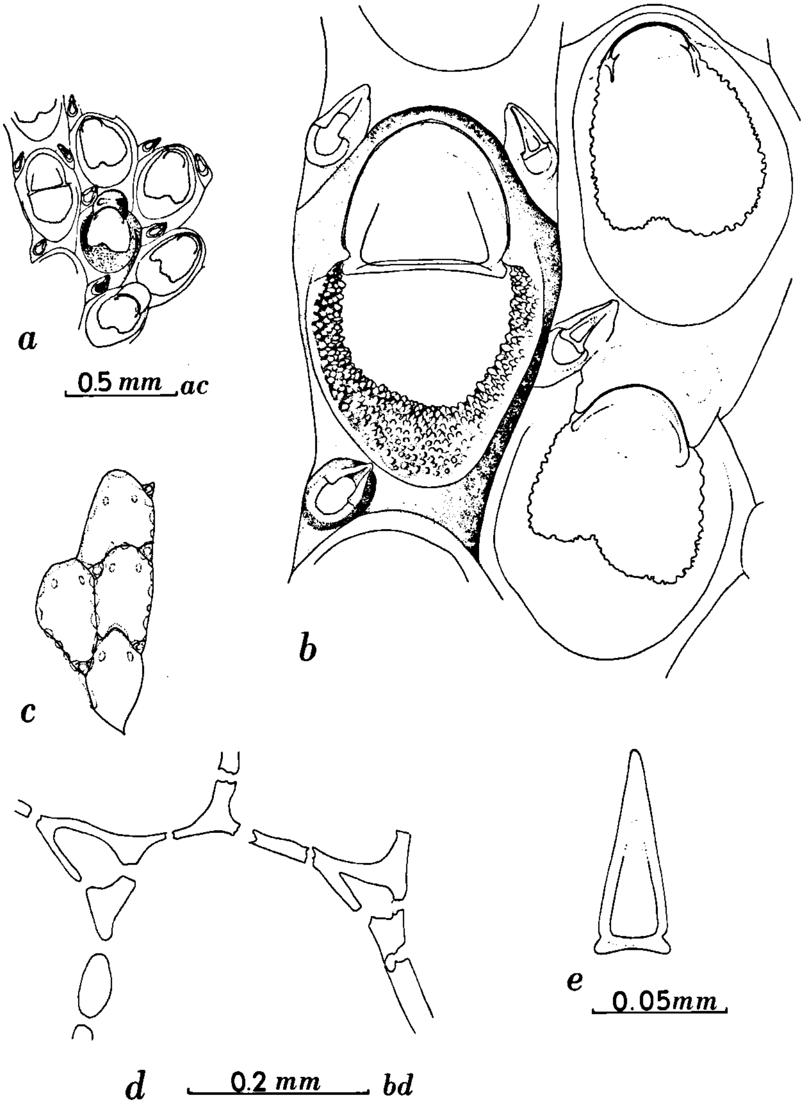


Fig. 8. *Crassimarginatella harmeri* n. sp. *a*. Part of a colony with vicarious and interzooecial avicularia and zooecia bearing ovicells. *b*. Detail vicarious avicularium, fertile zooid and autozooid. *c*. Basal side with uniporous septulae, lacunae in the basal wall and avicularium chambers reaching the basal lamina. *d*. Detail uniporous septulae. *e*. Frontal view of the mandible of an interzooecial avicularium. (RMNH 02973, stat. 2)

BMNH 34.10.8.9 Mauritius (*Antropora granulifera* Hincks); BMNH 28.9.13.17 Tosa Skikoku Isl., Japan (*Antropora granulifera* Hincks); BMNH 28.3.6.49 Sumbawa E., Malay archipelago, stat. 310 Siboga Exp., 73 m. (*Antropora granulifera* Hincks).

Description

Colonies encrusting, one layer thick, zooecia in longitudinal series, varying in form, increasing in size towards the periphery of the colony. Heavily calcified zooecia separated by shallow grooves. Small interzooecial avicularia present between three bordering zooids. Large vicarious avicularia present in small numbers. Colour white to light brown.

Gymnocyst reduced and smooth; cryptocyst well-developed proximally, surrounding, often proximally projecting into, the asymmetrically formed opesia. Frontal membrane bearing a semicircular scleritinous operculum provided with two sclerites facing the center of the operculum. Occlusor muscles attached to the laterally scleritinous parts. Proximally directing sclerites increase the action of the parietal muscles to open the operculum.

Vicarious avicularia as large or larger than the autozooecia. Mandible broad and rounded, formed by a distal, semi-circular bow, bearing 1–3 teeth and a proximal, cross-bar. Abductor muscles laterally attached to the bow. Mandible articulating on 2 condyles, when closed lying in a complementary formed, smooth rostrum. Cryptocyst of vicarious avicularia as in autozooids.

Small interzooecial avicularia directed latero-distally, when in the same longitudinal row often directed toward each other. Rostrum pointed and slightly elevated. Cryptocyst well-developed, not granulated. Mandible long and triangular, with a curved beak. Tendon attached medio-distally to the lucida.

Muscles leaving lacunae in the basal wall.

Ovicells endozooecial, closed by the heavily scleritinous operculum. The ectooecium leaving a transverse fenestra. Embryos observed, lying in an ooecial vesicle.

Communication between zooids by uniporous septulae, pore-chambers absent.

Measurements (see Figs 30g, h): Lz 0.34–*0.41*–0.44 mm. Wz 0.28–*0.31*–0.35 mm. Lf 0.25–*0.33*–0.36 mm. Wf 0.25–*0.26*–0.31 mm. L av m 0.057–*0.064*–0.071 mm. W av m 0.026–*0.030*–0.032 mm.

Discussion

Some of the specimens of *Antropora granulifera* (Hincks, 1880) of HARMER (1926: 233) do not show pore-chambers. these specimens (BMNH 28.9.13.17 and BMNH 28.3.6.49) do have vicarious avicularia and interzooecial avicularia, of which the chambers reach the basal lamina. The interzooecial avicularia possess rostra directed more distally than in *Antropora granulifera* (Hincks, 1880). These differences lead to the conclusion that some of HARMER's specimens were mis-identified and belong to the genus *Crassimarginatella* Canu, as indicated by COOK (1968a: 137). The present specimens show the same characters as the mis-identified specimens of HARMER. The new species is named: *Crassimarginatella harmeri* in honor of S. F HARMER.

This is the first record of the species from the Atlantic Ocean. Known from shallow water from the Caribbean and the Pacific.

CARIBBEAN: Curaçao.-INDO-WEST-PACIFIC: Mauritius, BMNH 34.10.8.9 (*Antropora granulifera* Hincks). Toza Skikoku Isl., Japan, BMNH 28.9.13.17 (*Antropora granulifera* Hincks). Sumbawa, Malay Archipelago, stat. 310 Siboga Exp., 73 m, BMNH 28.3.6.49 (*Antropora granulifera* Hincks).

Genus **Parellisina** Osburn, 1940

Parellisina OSBURN, 1940: 360, 361; 1949: 1–9, pl. 1 figs 1–11; PRENANT & BOBIN 1966: 260, 261; RYLAND & HAYWARD 1977: 102.

Colony encrusting. Zooids with small gymnocyst and reduced cryptocyst. Spines reduced or absent. Ovicell hyperstomial, prominent. Vicarious avicularia always present, associated with kenozooid.

7. **Parellisina curvirostris** (Hincks, 1862)

Figs 9a–f; 10g–k

Membranipora curvirostris HINCKS, 1862: 29, pl. 7 fig. 4; 1880a: 153, pl. 20 figs 5, 6.
Ellisina curvirostris, HARMER 1926: 228, pl. 14 fig. 7; HASTINGS 1930: 711, pl. 7 figs 28–31.
Callopora curvirostris, CANU & BASSLER 1928: 32, pl. 3 figs 9, 10, pl. 32 fig. 8; 1930: 9.
Parellisina curvirostris, OSBURN 1940: 361, pl. 4 fig. 32; 1949: 4, pl. 1 fig. 5; 1950: 75, pl. 8 fig. 8; PRENANT & BOBIN 1966: 261, 262, figs 87 I-VII; COOK 1968a: 156, text-fig. 16; 1968b: 149, 245; POWELL 1971: 769; RYLAND & HAYWARD 1977: 102, 103, fig. 43; ARISTEGUI RUIZ 1984: 139, 140, fig. 25d, pl. 3 fig. 8; WINSTON 1984: 7–9, fig. 14.

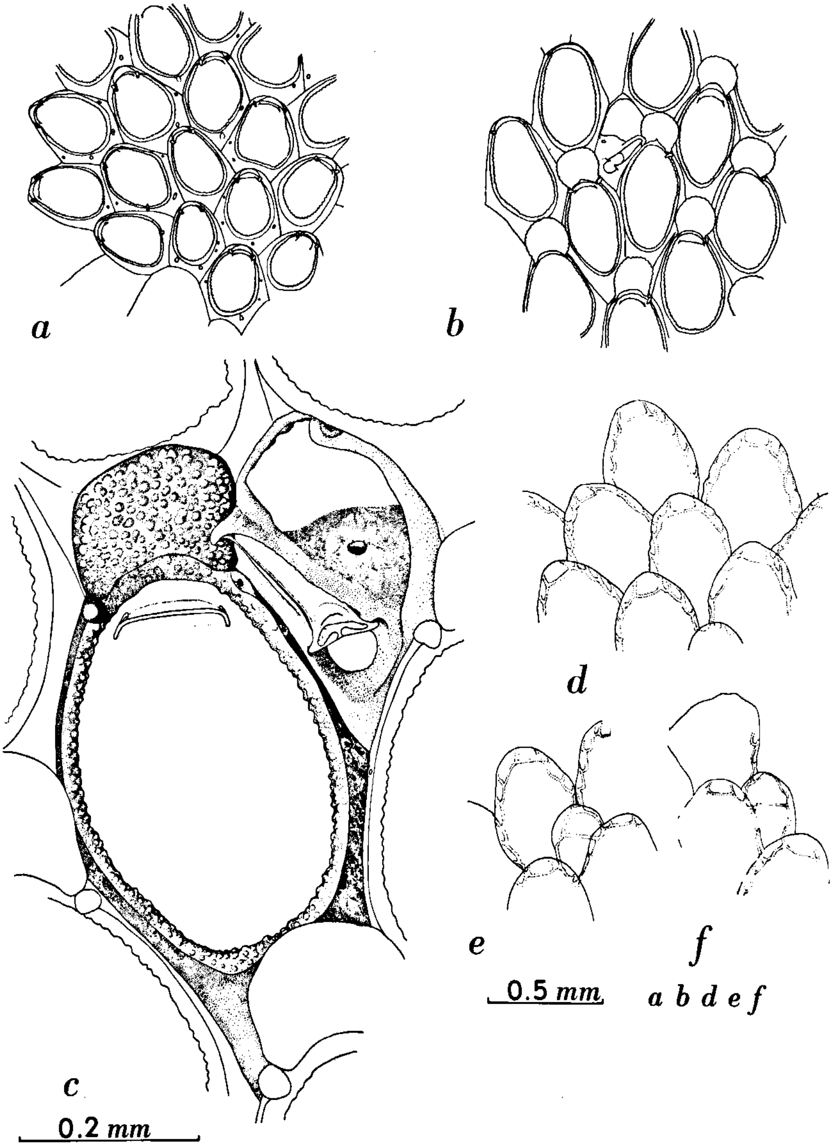


Fig. 9. *Parellisina curvirostris* (Hincks, 1862). *a*. Part of a colony near the ancestrula. *b*. Periphery of the colony. *c*. Detail of zooecium with an ovicell, and an avicularium associated with a kenozooid. *d*. Basal side showing pore chambers. *e*, *f*. Basal side showing chambers of kenozooid and avicularium. (RMNH 02984, stat. 2)

CURAÇAO: Piscadera Outer Bay 2. On underside of stones, iron, glas and plastics; in clear water, at 3–6 m depth.
BMNH 99.5.1.564 Cornwall, England (Hincks, holotype).

Description

Colonies encrusting, one layer thick, forming rounded patches that may cover several cm^2. Zooecia near the ancestrula small, larger towards the periphery of the colony. Colour white.

Zooecia more or less hexagonal, separated by shallow grooves. Basal wall slightly calcified, gymnocystial walls raised forming a mural rim. Reduced, downward sloping, granulated cryptocyst surrounds the large

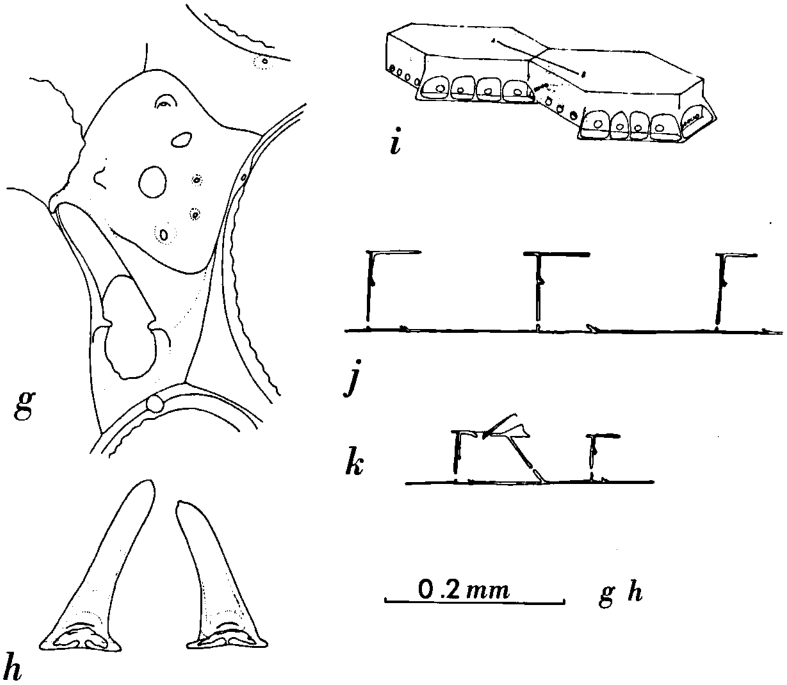


Fig. 10. *Parellisina curvirostris* (Hincks, 1862). *g*. Detail of a kenozooid with calcified frontal area, spines and opesia, associated with an avicularium. *h*. Frontal view of avicularium mandibles. *i*. Diagram of communication system. *j*. Diagram from transverse section on line A-B showing the septulum and distal pore-chamber. *k*. Diagram of a transverse section through avicularium and kenozooid. (RMNH 02984, stat. 2)

oval opesia. Short gymnocystidial spines present, two, often short, oral, and few, more reduced, spines around the opesia, often only seen as perforations of the gymnocyst (HASTINGS 1930: 711, 712). Division between gymnocyst and cryptocyst difficult to observe.

Polypide with 12 tentacles, when everted, bell shaped.

Characteristic are the vicarious avicularia with their raised, oblique rostrum, pointing towards the distal part of the neighbouring zooid. Mandible oblong, with a curved beak, articulating on large condyles. Cryptocyst of avicularia well-developed, sometimes granulated. Attachment-side of occlusor muscles to the mandible, arched, rather proximally placed. Distally to the avicularium lies a more or less triangular chamber, covered by a membrane, which could be called a kenozooid. It is in contact with the avicularium by 2 or 3 uniporous septulae perforating the slantwise downward sloping wall. Sometimes a cryptocyst has developed. No functional structures can be found in the kenozooid. In a few cases the frontal membrane was calcified as shown in Figure 10h, with a central round opesia, surrounded by reduced spines and perforations with the same origin as the spines. Both kenozooid and avicularium share the same basal wall.

Ovicells hyperstomial, placed on the gymnocyst of the successor, prominent, spherical, with a calcified, granulated ectooecium. Opening semicircular, not closed by the operculum, Embryos observed, white in colour.

Pore-chambers present, 3–*4*–5 in the latero-distal wall, one distal chamber. Chambers very open to the outside, see schematic drawing Fig. 9j.

Measurements (see Fig. 30i–k): Lz 0.33 (near ancestrula)–*0.48*–0.60 (periphery of the colony) mm. Wz 0.25 (near ancestrula)–*0.30*–0.35 (periphery of the colony) mm. L opes 0.24 (near ancestrula)–*0.37*–0.46 (periphery of colony) mm. L av m 0.14–*0.17*–0.19 mm. L k + av 0.36–*0.40*–0.46 mm. W k + av 0.16–*0.20*–0.18 mm.

Discussion

Although the genus *Parellisina* is characterized by the association of avicularia and kenozooids, the origin of these structures is unclear. OSBURN (1949) concludes that the kenozooids are aborted zooids and gives a comprehensive survey of the historical development of this hypothesis.

The 100% invariable co-occurrence of avicularium and kenozooid combined with the common basal wall makes it likely that they form one structure. Why does this structure have one basal wall when it is composed of two distinct chambers? The kenozooid rarely bears a calcified frontal with opesia and spines like a reduced or aborted zooid. The differences between normal communication in the colony and that between avicularium and kenozooid is the absence of pore-chambers. A study of this genus and closely related genera could possibly give some answers about the origin of these structures.

Widely distributed in tropical and temperate waters, up to 400 m depth.

CARIBBEAN: Curaçao. – Off the mouth of Guánica Harbor (P.R.) at 44 m (OSBURN 1940). Cuba, at 368 and 262 m, on coral (CANU & BASSLER 1928). Carrie Bow Cay, Belize, reef, 20 m (WINSTON 1984). ATLANTIC COAST OF AFRICA: Tropical West Africa, at 21–51 m, on the foraminifer *Jullienella foetida*, shells, Bryozoa (*Steganoporella magnilabris*) and sponges (COOK 1968a, 1968b). Canary Islands, on calcareous algae and *Pycnodonta cochlear*, (ARISTEGUI RUIZ 1984). ATLANTIC COAST OF EUROPE: Atlantic and Mediterranean coast of France (PRENANT & BOBIN 1966). Cornwall (HINCKS 1862). Britain (RYLAND & HAYWARD 1977). 10–12 Miles south of Polperro (Britain), at 73 m, on stones (HINCKS 1880a). INDO-WEST-PACIFIC: Singapore, at 11 m (HARMER 1926). PACIFIC COAST OF AMERICA: Galápagos, shore (HASTINGS 1930). Galápagos, on shells and Bryozoa (*Cellepora* (dead) and *Smittina foliacea*) (CANU & BASSLER 1930). Clipperton Island (México), Galápagos, Gulf of Panamá, i.a. on pearl oysters (OSBURN 1950). Panama Canal area, at 0–4 m, on stones, broken coral and wharf pilings (POWELL 1971).

Superfamily (Division) COILOSTEGA Levinsen, 1909

Family **ONYCHOCELLIDAE** Jullien, 1881

Onychocellidae JULLIEN, 1881: 276; HARMER 1926: 255; COOK 1964: 66, 67.

Well-developed cryptocyst, inconspicuous endozooecial ovicells, vicarious avicularia with mandibles with a winged rachis.

Genus **Smittipora** Jullien, 1881

Smittipora JULLIEN, 1881: 284; MARCUS 1949: 8, 9; BASSLER 1953: G169; COOK 1964: 71.
Velumella CANU & BASSLER, 1917: 26.
Rectonychocella CANU & BASSLER, 1917: 25, 26.

On both sides winged avicularian mandibles present. Distinct avicularian rostrum, or distal canal, absent.

8. **Smittipora levinseni** (Canu & Bassler, 1917)

Figs 11a–f

Vincularia abyssicola Smitt, 1872/3, Hincks 1881: 155, 156, pl. 10 fig. 4.
Onychocella spec. Levinsen, 1909: 153, pl. 22 figs 3a–c.
Smittipora abyssicola, Osburn 1914: 195, 196; Harmer 1926: 259, 260, pl. 16 figs 10–13; Osburn 1927: 125; Weisbord 1967: 82–86, pl. 8 fig. 3.
Velumella levinseni Canu & Bassler, 1917: 26.
Velumella americana Canu & Bassler, 1928: 54–56, text-figs 7a–c, pl. 6 figs. 9, 10; Osburn 1940: 371, 372; 1947: 17; 1950: 103, pl. 12 figs 7, 8; Soule 1959: 28, 29.
Smittipora levinseni, Marcus 1941a: 17–23; Bassler 1953: G169, text-figs 128, 6, 7; Marcus 1953: 282, 283, fig. 24; Cook 1964: 71, 72, text-fig. 13; 1968b: 151.
Smittipora americana, Shier 1964: 618.

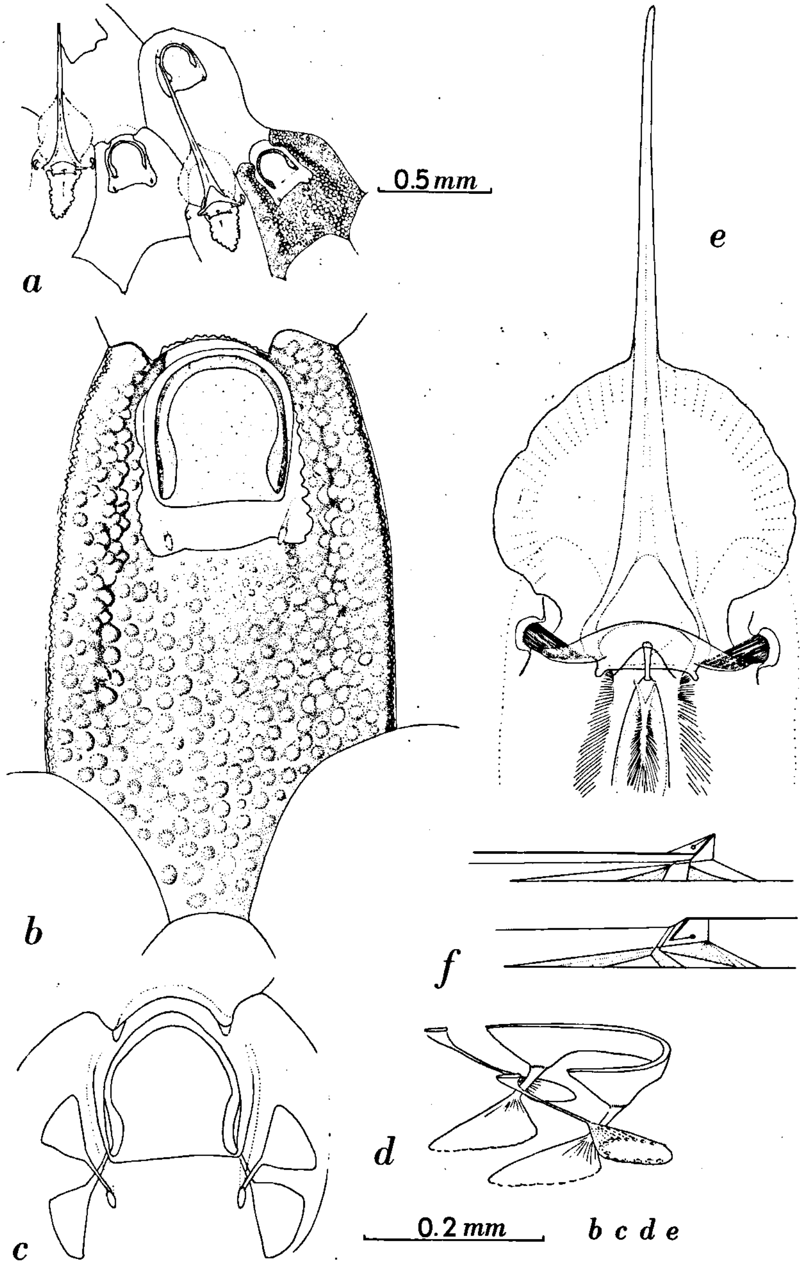
Curaçao: spaanse Water, entrance 27.
On dead coral; in clear water, with considerable influence of the open ocean; at 1.5–3.0 m depth.

Description

Colonies one layer thick, forming lobate encrustations, avicularia (onychocellaria) visible with the naked eye. Zooecia situated in longitudinal series, separated by distinct lines. Ratio avicularia and autozooids ca. 1:3. Colour of the colony yellow-brown to light pink, avicularian mandibles dark brown.

Zooecia hexa-, sometimes heptagonal, irregular in form, distally rounded. Spines and gymnocyst absent. Granulated cryptocyst, immediately sloping downward, in the center flat or somewhat convex, leaving a bell-shaped opesia with a straight proximal edge. In non-fertile zooids, a rounded calcified plate is visible through the opesia beneath the cryptocyst.

Fig. 11. *Smittipora levinseni* (Canu & Bassler, 1917). *a.* Part of a colony, frontal view. *b.* Detail of a fertile zooid. *c.* Detail of the operculum, occlusor muscles and parietal adductor muscles, frontal view. *d.* As *c*, lateral view. *e.* Detail of an avicularium (onychocellarian) mandible, frontal view. *f.* Diagram of an opened onychocellarium (upper), and of a closed onychocellarium (lower). (RMNH 02985, stat. 102)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The band-shaped strong, scleritinous, semi-circular operculum laterally bears triangular sclerites for attachment of the occlusor muscles. Around the operculum lies a thickened band of the frontal membrane extending proximally to the attachment sides of the parietal muscles which are concentrated above the opesiular notches.

Polypide bears 22–23 tentacles, when everted forming a bell, when retracted lying under the cryptocyst.

Avicularia vicarious, penta- or hexagonal, oblong, distally rounded. Cryptocyst also granulated, leaving a key-hole-shaped opesia, rounded distally and with sharp, projecting denticles proximally.

The mandible hangs between striated bands, laterally attached to scleritinous areas. The distally closing, bilaterally flattened, setiform, distally curved, and proximally triangular mandible is provided with wings on both sides, forming an oval membrane, reaching 1/2–2/3 of the rachis. Proximally the mandible is strongly scleritinous and provided with two conical elevations between which the band-shaped abductor tendon is lying. The abductor tendon is attached to the mandible forming a wide arc. Dorsally the adductor muscles are attached to the frontal membrane; one against the mandible-tendon, descending distally, attached median to the basal wall, the other lying somewhat proximally, muscles situated between the enormous abductor muscles. The tendon of the abductor muscles is first band-shaped, then splitting up in two separated tendons towards the muscles. On the bifurcation the abductor and distal adductor tendons are lying against each other, when the avicularium is closed.

All walls are double, Communication by multiporous septulae, mostly one for each wall, with 15–20 pores.

Inconspicuous ovicells are recognized by cap-shaped, scleritinous structures, distally to the operculum, which are overgrown by the following zooid. Zooids bearing an ovicell do not have a distal cryptocyst. Embryos endozooecial, lying beneath the operculum.

Measurements (see Figs 31a–d): Lz 0.61–*0.69*–0.79 mm. Wz 0.29–*0.41*–0.49 mm. Lopes 0.18–*0.20*–0.22 mm. Wopes 0.18–*0.20*–0.22 mm. Woper 0.111–*0.160*–0.183 mm. L av 0.0.61–*0.65*–0.69 mm. W av 0.31–*0.35*–0.42 mm. L av m 0.59–*0.66*–0.73 mm. W av m 0.20–*0.21*–0.24 mm.

Remarks

The position of muscles and tendons results in an effective cleaning mechanism by sweeping and beating with great force. When a living avicularium was stimulated, neighboring polypids were retracted and the avicularium started sweeping and beating. No synchronisation with other avicularia was observed.

Discussion

Problems concerning the name of this species started in 1873, when SMITT described two colonies from different places under one name: *Vincularia abyssicola.* Later there were doubts about the homogeneity and identity of the specimens of SMITT, figs 60 and 61 of his publication. JULLIEN, in 1881, described the family Onychocellidae and SMITT's fig. 60 was called *Smittipora abyssicola.* The genus *Smittipora* is characterized by wings on both sides of the rachis of the onychocellarian mandible. In 1909 LEVINSEN described a specimen as *Onychocella* spec.. CANU & BASSLER created the genera *Rectonychocella* and *Velumella* in 1917, calling LEVINSEN's *Onychocella* spec., *Velumella levinseni* and, in 1928, SMITT's fig. 60 *Velumella americana,* and his fig. 61 *Rectonychocella abyssicola.*

When MARCUS discussed the taxonomy of his *Smittipora levinseni* in 1941a and 1953 he concluded that *Rectonychocella* and *Velumella* were not separated from *Smittipora* by solid characters and should be placed in the synonymy of *Smittipora* Jullien, as indicated by HARMER in 1926.

Velumella levinseni and *Velumella americana* were found synonym. Following the law of priority both SMITT's fig. 60 and 61 should now be called *Smittipora abyssicola* (fig. 60, *Smittipora abyssicola,* Jullien 1881; fig. 61, *Rectonychocella abyssicola,* Canu & Bassler 1928), which would again lead to problems about the homogeneity and identity of SMITT's material. MARCUS avoided these problems and referred his *Smittipora levinseni* to *Velumella levinseni* Canu & Bassler, 1917. Later, authors accepted *Smittipora levinseni* as the valid name (BASSLER 1953; COOK 1964 and 1968b).

Caribbean specimens are slightly different from the east Atlantic form (COOK 1964: 71, 72). The avicularium of the Caribbean form has a narrower proximal part of the opesia, which bears sharp denticles. The east Atlantic form has a broad proximal part of the opesia, separated from the distal part by two condyles. The opesia of the autozooids is also larger and more triangular in the east Atlantic specimens than in the Caribbean form; here the opesia is small and has parallel lateral borders. The velum of the avicularian mandible in the east Atlantic form is larger, reaching 3/4 of the rachis, in the Curaçao specimens only 1/2–2/3. WINSTON (1984) found a species of *Smittipora* in Belize which she identified as *S. acutirostris* (Canu & Bassler). According to her the latter differs from *S. levinseni* in size of the zooids. The two species coexist in Jamaica.

Distributed in warmer waters around the world, at 0–850 m depth.

CARIBBEAN: Curaçao. – Spaanse Water, in shallow water on *Meandra* [= *Diploria*] *clivosa* (OSBURN 1927). Cabo Blanco (Ven.), at the beach, encrusting pelecypods (WEISBORD 1967). Gulf of Venezuela, Tortuga (Ven.), Cabo la Vela (Col.), at 38–40 m (OSBURN 1947). Tortugas (Florida) (OSBURN 1914). Off Cojima (Cuba), at 823 m, on Bryozoa (*Retepora*), Florida, at 124 m, on *Nullipora* (HINCKS 1881). Cuba, Florida, and Gulf of Mexico, at 24–262 m, on shells, serpulids and nullipores (CANU & BASSLER). Between Rotones and Caribe Island (P. R.), at 11–20 m (OSBURN 1940). Off Aligator Point (N.W. Florida), at 9 m, on shell (SHIER 1964). ATLANTIC COAST OF SOUTH AMERICA: Ilha de San Sabastião (Brasil), on shells, polychaete-tubes and calcareous algae (MARCUS 1941a). Espirito Santo de Vitoria (Brasil), at 35 m (MARCUS 1953). ATLANTIC COAST OF AFRICA: Tropical West Africa, at 25–70 m, on other Bryozoa (*Cupuladria*), the foraminifer *Jullienella foetida*, echinoderm spines (COOK 1964 and 1968b). INDO-WEST-PACIFIC: Indo-Pacific, at 0–45 m (HARMER 1926). Singapore or the Phillipines, on coral (HINCKS 1881). PACIFIC COAST OF AMERICA: Off Salina Bay and Carmen Island (Gulf of California), at 26–55 m, on gastropod shells and other Bryozoa (SOULE 1959). Galápagos and Gulf of Panamá, at 31–59 m, i.a. on pearl oysters (OSBURN 1950).

Family THALAMOPORELLIDAE Levinsen, 1902

Thalamoporellidae, LEVINSEN 1909: 175; OSBURN 1940: 377; BASSLER 1953: G173; COOK 1964: 61.

Large prominent, hyperstomial ovicells calcareous spicules free in the zooecial cavity; opesiules separated from aperture; vicarious avicularia present.

Genus **Thalamoporella** Hincks, 1887

Thalamoporella, HARMER 1926: 289–291 (synonymy and discussion); OSBURN 1940: 377; COOK 1964: 62; BASSLER 1953: G173.

Depressed porous cryptocyst; two asymmetrical, rounded opesiules which meet the basal or lateral walls. Vicarious avicularia at base of new series of zooecia.

9. **Thalamoporella distorta** Osburn, 1940

Figs 12a–f, 13g, h

Thalamoporella distorta Osburn, 1940: 380, pl. 6 figs 48, 49.

Curaçao: Piscadera Outer Bay 2.
On plastics and stones; in clear water; at 3–6 m depth.

Description

Colonies encrusting, one layer thick. Zooecia in longitudinal series, vicarious avicularia generally at the base of a new series of zooecia. Colonies white in colour.

Autozooecia oblong, hexagonal or rectangular, surrounded by 6, seldom 7, zooecia. Gymnocyst absent. Cryptocyst granulated, perforated, underlying the frontal membrane, leaving 2 opesiules and the nearly co-extensive opesia and orifice. Distal, smooth, semi-circular border of the orifice larger than the proximal, denticulated, rounded, rectangular border. Orifice variable in its dimensions. Opesiules latero-proximally of the orifice, irregular in shape. Vertical opesiular walls, reaching the lateral and basal walls of the zooecium, forming tubes which are distally open. Parietal muscles going through the tubes to the basal wall. Immediately distal to the parietal muscles, the occlusor muscles of the semi-circular operculum are attached to the basal wall, leaving their impressions. The tendons are attached to triangular sclerites on the lateral parts of the operculum. From here thin sclerites are directed inside, strengthening the frontal membrane. These kind of thickenings are also found going from the opercular area to the attachmentside of the parietal muscles, even extending proximally. Tubercles are situated on both sides of the orifice. The distal area around the operculum is smooth. The distal wall slopes downward beneath the orifice, first slightly, then steeply.

The retracted polypide lies between the opesiular tubes. When everted, 18 tentacles can be counted, forming a bell-shaped configuration.

Vicarious avicularia with a non-perforated, granular cryptocyst, have

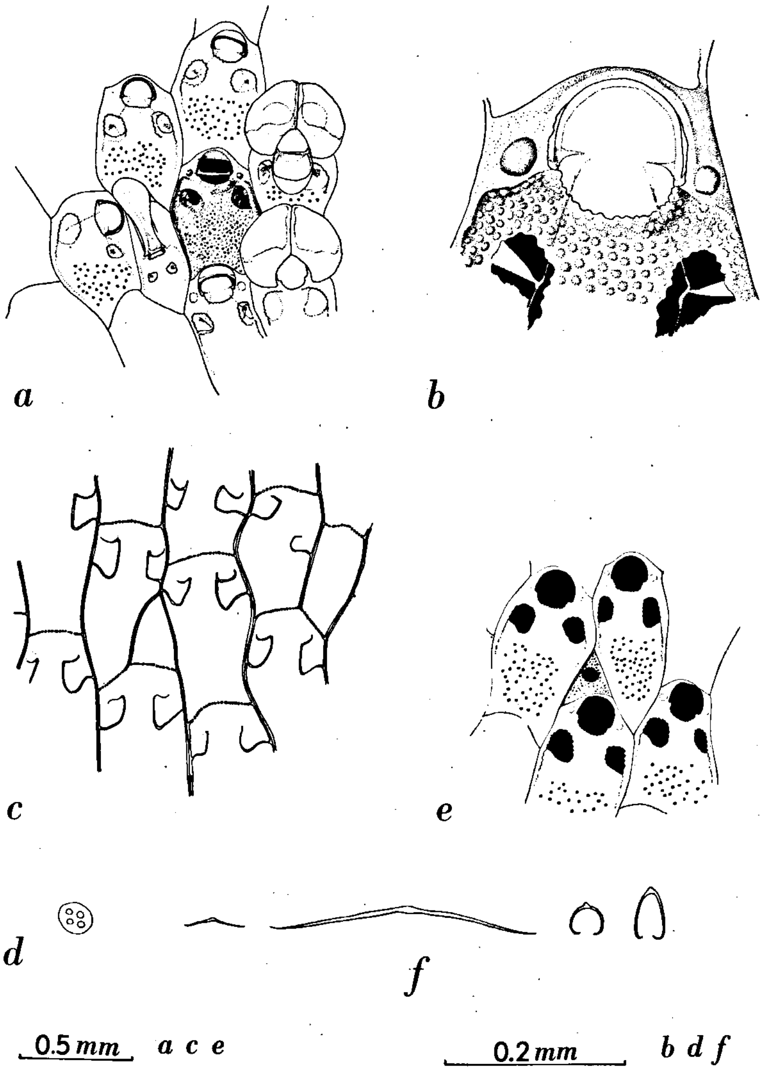


Fig. 12. *Thalamoporella distorta* Osburn, 1940. *a*. Part of a colony. *b*. Detail of the distal area of a zoóid. *c*. Basal side of a part of a colony. *d*. Multiporous septulum in the lateral wall. *e*. Triangular kenozooecium. *f*. Types of spiculae. (RMNH 02986, stat. 2)

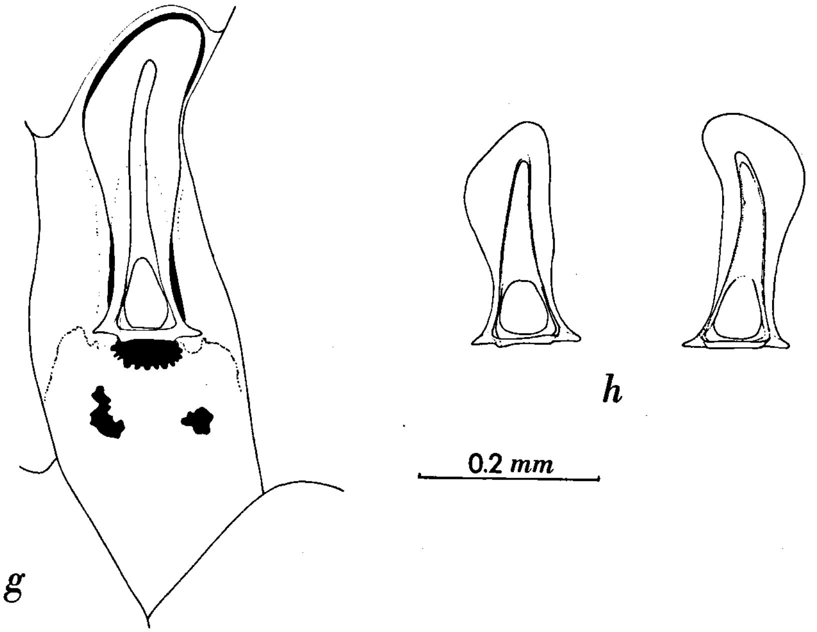


Fig. 13. *Thalamoporella distorta* Osburn, 1940. *g*. Vicarious avicularium. *h*. Detail of the mandibles. (RMNH 02986, stat. 2)

an oblong opesia, which consists of a large, smooth, distal, and a small, denticulated, proximal part. Two, irregularly formed, sometimes merged, denticulated opesiules are lying proximally to the opesia. There are no vertical, opesiular walls. Parietal muscles are laterally, strong occlusor muscles centrally, attached to the basal wall. Rostrum smooth. Mandible spatulate, asymmetrical.

Vicarious avicularia associated with neighboring autozooids, which differ from other autozooids in the orientation of the orifice. Orifice twisted 90°, directed towards the avicularium, with a small but broad proximal area. Opesiule near the avicularium small, the other large.

Kenozooecia appearing sporadic on places with little space, reducing the number of series of zooecia. Kenozooecia triangular in form, containing a granulated, non-perforated cryptocyst, with a circular opesia.

Three kinds of compass-shaped spiculae present in the zooecial cavity; long straight, short straight, and spiculae with closed legs.

Lateral walls double, with multiporous septulae with ca. 4 pores. Terminal walls single, with many uniporous septulae.

Fertile zooids differing from autozooids in having larger opesiae, with smooth proximal borders. Ovicell large, spherical, with a median suture. One to five embryos can be present in the ovicell. Operculum of fertile zooid consists of 2 scleritinous flaps, one of which closes the ovicell, the other the aperture. The operculum is provided with strong occlusor muscles. MARCUS (1941: 23–46, pl. II fig. 4, pl. III figs 5–8, pl. IV figs 7–11, pl. V figs 9, 12, 13, pl. VI figs 14–17, pl. VII figs 18–26, pl. VIII figs 15–17) describes the morphology of *Thalamoporella evelinae* Marcus, giving a representative view on the genus *Thalamoporella* especially concerning the fertile zooids.

Polypide of fertile zooids with small tentacles, 14 in number.

Embryos yellow to red.

Measurements (see Figs 31e–h): Lz 0.46–*0.52*–0.60 mm. Wz 0.27–*0.32*–0.35 mm. L opes 0.10–*0.13*–0.15 mm. W opes 0.12–*0.14*–0.15 mm. L av 0.63–*0.66*–0.68 mm. W av 0.21–*0.23*–0.28 mm. L av m 0.33–*0.35*–0.35 mm. W av m 0.07–*0.08*–0.08 mm. L sp 1 0.14–*0.20*–.26 mm. L sp 2 0.04–*0.06*–0.08 mm. L sp 3 0.02–*0.03*–0.04 mm. L ov 0.30–*0.32*–.33 mm. W ov 0.41–*0.43*–0.45 mm..

Discussion

Ovicells of a different origin than in other Cheilostomata. MARCUS (1941: 28) discusses the origin and structure of the "gonozoécios".

Function of the spiculae is unclear. HYMAN (1959: 313): "Possibly they serve as reserve supply of calcium carbonate". Another possibility is that they function as a passive defence mechanism. They could damage the digestive tract of some potential predators.

Known from Curaçao and Puerto Rico, 3–49 m deep.

CARIBBEAN: Curaçao. – Of the mouth of Guánica Harbor (P.R.), at 49 m, on dead coral (OSBURN 1940).

Superfamily (Division) CELLULARINA Smitt, 1867

Family **FARCIMINARIIDAE** Busk, 1852

Farciminariidae Busk, 1852: 32; Bassler 1953: G178.

Slender, erect, prismatic segments forming dichotomously branched tufts. Zooecia membraniporoid; sessile avicularia only, commonly paired on the gymnocyst. Ovicell endozooecial.

Genus **Nellia** Busk, 1852

Nellia Busk, 1852: 18.

Colony consists of delicate, erect, 4-sided internodes. Zooecia oblong. No spines. Pair of small, adventive avicularia on proximal gymnocyst.

10. **Nellia tenella** (Lamarck, 1816)

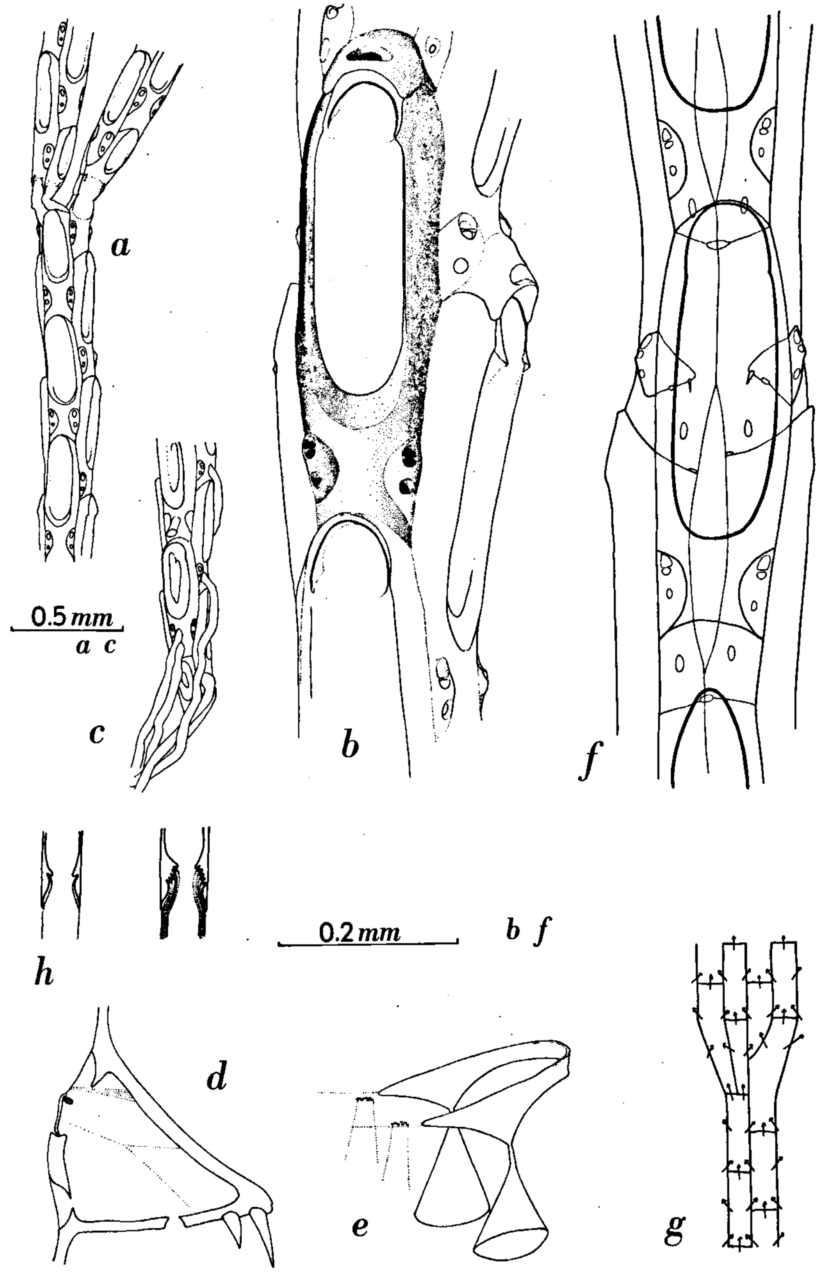
Figs 14a–h

Cellaria tenella Lamarck, 1816: 135.
Nellia oculata Busk, 1852: 18, pl. 64 fig. 6, pl. 65 fig. 4; Smitt 1873: 3, pl. 1 figs 53, 54; Busk 1884: 27; Osburn 1914: 191; Harmer 1926: 240–242, text-figs 3B, 3D, 4A, 4B, pl. 14 fig. 18; Osburn 1927: 125; Canu & Bassler 1928: 26; Marcus 1939: 131, pl. 8 figs 9A–C; Osburn 1940: 400; 1947: 25; 1950: 119, 120, pl. 13 fig. 4; Shier 1964: 622.
Nellia tenella, Levinsen 1909: 120, pl. 1 figs 13A–E; Cheetham 1966: 48–52, text-fig. 28 (synonymy); Cook 1968b: 156, 157, pl. 9 fig. 9; Rao 1975: 50, 51, figs 47, 48; d'Hondt 1983: 139, 140; Winston & Cheetham 1984: 257–265.
Farcimia oculata, Waters 1909: 167; 1913: 489, pl. 67 figs 8, 9.

Curaçao: Spaanse Water, entrance 81, inner bay 29, 51, 78, 79, 80.
On *Rhizophora mangle* roots; in clear and turbid water; at 0–1 m.

Description

Colonies erect, consisting of dichotomous, jointed systems of bifurcations, up to 20 cm in diameter, forming white tufts. Internodes consist of 2 pairs, adjacent, alternating series of calcified zooecia. Internodes with 4–5–8 zooecia in each series.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Zooecia oblong, rectangular, about 3 times longer than wide, separated by distinct grooves. Opesia oval, distally constricted, comprising the larger part of the frontal surface of the zooid, surrounded by a ban-shaped, downward sloping, smooth cryptocyst. Operculum semi-circular, band-shaped, with basally pointed sclerites for attachment of the occlusor muscles.

Polypide with 11 tentacles.

On each side of the proximal gymnocyst, a small, adventive, slightly raised avicularium is present, except on reduced zooids of the nodes. Opesia of the avicularium oval, divided in a distal (rostrum) and a proximal part by a pivotal structure, on which the slightly thickened, semicircular mandible articulates. The proximal gymnocyst of the avicularium bears a small pore the function of which is unknown. The avicularium chamber is triangular in cross-section and has one uniporous septulum in the proximal wall. One or two spines directed proximally are present on the basal point of the chamber. Harmer (1926: 244) thought they could have a function in the retraction mechanism of the polypide, serving as guides for the retractor muscles.

Bifurcation at nodes, consisting of 3 scleritinous tubes each. Tubes consist of 1–5 (perhaps more) layers. Communication system complicated at the bifurcations (fig. 14g). Uniporous septulae present, one in each wall.

Rhizoids growing out of the proximal gymnocyst of the basal, often heavily calcified, zooids. Rhizoids are attached to the substratum and are strengthening the basal part of the colony.

Ovicells endozooecial, inconspicuous, provided with a frontal, transverse fenestra in the ectoecium.

Measurements (see Fig. 31i): Lz 0.41–*0.48*–0.54 mm. Wz 0.14–*0.16*–0.17 mm. Lf 0.31–*0.34*–0.37 mm. Wf 0.10–*0.12*–0.13 mm.

Fig. 14. *Nellia tenella* (Lamarck, 1816). *a*. Portion of a colony. *b*. Detail of a zooecium with ovicell. *c*. Heavily calcified basal portion of a colony, showing rhizoids. *d*. Diagram of frontal avicularium in cross section. *e*. Diagram of operculum and occlusor muscles in lateral view. *f*. Diagram showing place of communication pores. *g*. Diagram of communication system of 2 alternating series of zooecia, forming one onternode after bifurcation. *h*. Diagram of the cuticular layers at the nodes (joints). (RMNH 02987, stat. 81, fig. 14c; RMNH 02999, stat. 51, figs 14a, b)

Discussion

Since D'HONDT (1983) found the type-material of LAMARCK it became clear that *Nellia oculata* Busk, 1852 is a synonym of *Nellia tenella* (Lamarck, 1816).

Widely distributed in warmer waters around the world, in shallow water to 250 m depth. Common in the West Indian region.

CARIBBEAN: Curaçao. – Spaanse Water, in shallow water, on *Maeandra clivosa* (OSBURN 1927). Cabo la Vela (Col.) and Tortuga (Ven.), Caledonia Bay (Panamá), Gulf of Venezuela, at 18–71 m (OSBURN 1947). Puerto Rico, at 9–18 m (OSBURN 1940). Texas and St. Thomas, W.I. (LEVINSEN 1909). Florida, at 24 and 252 m (SMITT 1873). Tortugas, at 18–33 m, on sponges and occasionally on shells (OSBURN 1914). Gulf of Mexico, at 44 and 55 m (CANU & BASSLER 1928). Dog Island (N.W. Florida), at 9 m (SHIER 1964). ATLANTIC COAST OF SOUTH AMERICA: Guiana shelf of Suriname (D'HONDT 1983). Recife, barre de Seringaem, on algae, sponges, hydroids and shells (MARCUS 1939). ATLANTIC COAST OF AFRICA: Off Freetown (Sierra Leone), at 15 m, on sponge (COOK 1968b). INDO-WEST-PACIFIC: Zanzibar, at 11–18 m (WATERS 1913). Indo-Pacific, 0–75 m (HARMER 1926). Ceylon and Siam (LEVINSEN 1909). N.E. India, in shallow water (RAO 1975). Bass Strait, Port Denison, Austr. (LEVINSEN 1909); Torres Strait, Prince of Wales Channel, at 16 m (BUSK 1852). PACIFIC COAST OF AMERICA: La Plata Island (Ecuador), at 37 m (OSBURN 1950).

Family SCRUPOCELLARIIDAE Levinsen, 1909

Scrupocellariidae LEVINSEN, 1909: 130–133; HARMER 1926: 348, 349; RYLAND & HAYWARD 1977: 128.

Colony erect, unilaminar, branching, always jointed, attached to the substratum by rhizoids. Zooid calcified apart from the frontal membrane, cryptocyst usually not well-developed. Marginal spines usually present. Modified spine (scutum) often overarching the frontal membrane. Avicularia, usually present, frontal, lateral and basal (vibracula). Ovicells hyperstomial.

Genus **Scrupocellaria** van Beneden, 1845

Scrupocellaria, HARMER 1926: 364–366; OSBURN 1950: 130, 131; RYLAND & HAYWARD 1977: 133.

Colony biserial, with scleritinous joints just distal to a bifurcation (occasionally absent). Bifurcations of type 8 (HARMER 1923). Opesia oval or elliptical, occupying 1/3–2/3 of the frontal area, covered by a modified spine (scutum) (occasionally wanting). Distal oral spines present. Frontal and lateral adventitious avicularia, and basal avicularia (vibracula) usually present. Proximal part of vibracular chamber giving rise to a rhizoid, particularly in the lower part of the colony, Ovicells prominent, hyperstomial.

11. **Scrupocellaria curacaoensis** n. sp.

Figs 15a–d

Scrupocellaria bertholletti, OSBURN 1940: 386; 1947: 20.
not *acamarchis Bertholletii* AUDOUIN, 1826: 241, pl. 11 figs 3i–v (Savigny).
not *Scrupocellaria bertholletii,* HINCKS 1886: 158, pl. 9 figs 1, 2; HASTINGS 1930: 703, pl. 1 figs 1–5; MARCUS 1938a: 24–26, pl. 5 figs 11a, 11b; POWELL 1971: 770; SCHOPF 1974: 355.
not *Scrupocellaria Bertholletii,* WATERS 1909: 133.
not *Scrupocellaria bertholetti,* OSBURN 1950: 133, pl. 15 figs 7, 8, pl. 21 fig. 8.
not *Scrupocellaria bertholleti,* SOULE 1959: 35, 36; SOULE & SOULE 1964: 11; PRENANT & BOBIN 1966: 418, text-figs 136I–VIII, 137I–V; BANTA & CARSON 1977: 389–390, fig. 3.
not *Scrupocellaria bertholettii,* RYLAND 1965: 55, text-figs 27a–c; COOK, 1968b: 168.

Holotype: RMNH 02975.

CURAÇAO: Piscadera Outer Bay 1620; Spaanse Water 1037A, 1629, entrance 81; Fuikbaai 33, 66, 66a; Schottegat 1218.
BONAIRE: Klein Bonaire 1049C.
On *Rhizophora,* rocks and other firm substrates, 0–3 m deep.

Description

Colony erect. Biserial rows of zooecia, all facing the same direction, form flabellate, bifurcated systems. Colonies small, up to 2 cm observed. Internodes not constant in length, 5–10 zooecia lying between the successive scleritinous joints. Joints are crossing the first pair of zooecia after a

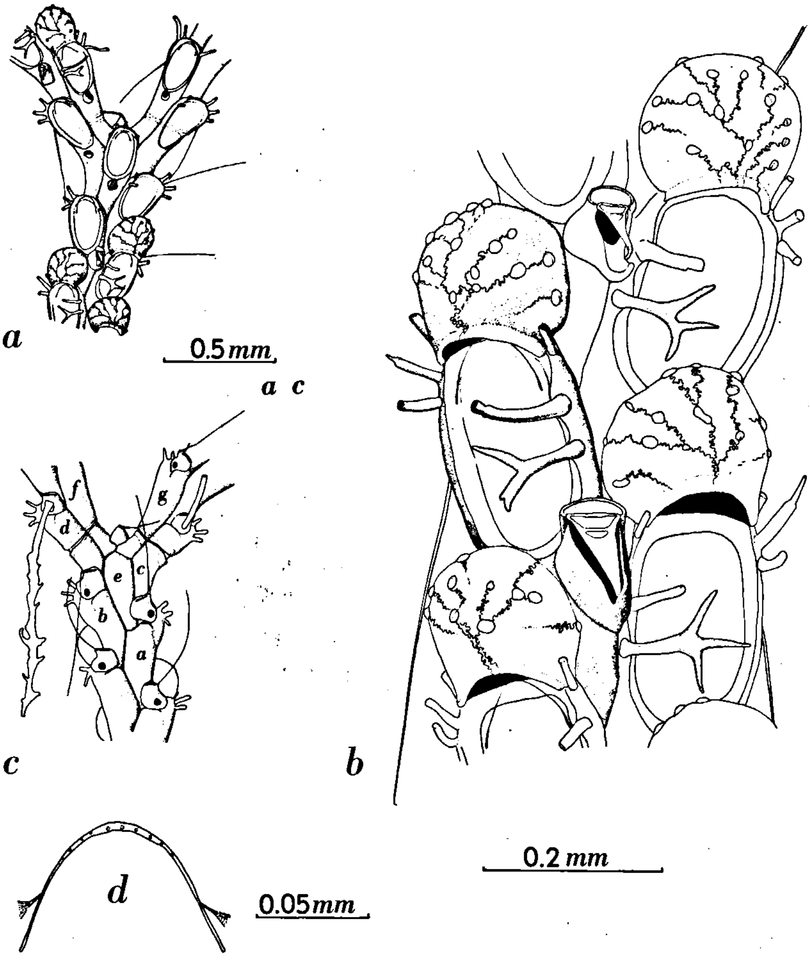


Fig. 15. *Scrupocellaria curacaoensis* n. sp. *a*. Frontal side of a part of the colony. *b*. Detail of a zooecium with an ovicell. *c*. Basal side of a part of the colony, showing the type of bifurcation. *d*. Detail of the denticulated operculum, basal side. (RMNH 02975, stat. 33)

bifurcation. They cross the base of the opesia of zooids C and D (see Fig 15c). Zooecia are hardly constricted at these joints. Colour of the colonies is white to light-brown.

Zooecia 2–3 times as long as wide, narrowing proximally. the oval opesia is large, occupying 1/2 of the frontal side. Cryptocyst very small, difficult to observe, sloping downwards. Operculum composed of a slightly scleritinous, parabolic arch, provided with about 10 denticles. Occlusor muscles laterally attached to the operculum. Scutum is an up to 3 times bifurcated spine which overarches the opesia, and is planted mediolaterally to the opesia, sometimes wanting.

Number of spines normally 5, sometimes 4, 3 outer and 2 or 1 inner spines, on the distal part of the zooecium. The inner proximal spine is situated near the scutum, and overarches the opesia. The distal outer spine is often hidden by the ovicell. None of the spines, except the scutum, are forked.

On the gymnocyst are placed, frontally, adventitious avicularia, varying in their dimensions. The rostra and mandibles are directed proximally or proximo-laterally, to the outside. Lateral avicularia absent. Mandibles of the avicularia oblong, triangular with a curved beak. Tendon of occlusor muscles has an oblong attachment side.

Basal avicularia (vibracula) present on the proximal basal wall. Vibracula chamber 1/3–1/4 of the zooecium length, groove transversely situated. Mandibles (setae) as long as one zooecium. Axillary vibraculum single.

Rhizoids growing out of the rhizoid chambers, which are situated proximally to the outside of the vibracular chamber. Rhizoids are straw-coloured, provided with retorse hooks.

Ovicells prominent, spherical, sometimes longer than wide. Opening semi-circular, directed proximally, provided with an extending lip. Surface of the ovicell ornamented with moderate pores, and radiating sutures connecting the pores, comming together near the opening. Embryos orange to white in colour.

Measurements (see Fig. 31j): Lz 0.46–*0.51*–0.59 mm. Wz 0.12–*0.14*–0.16 mm. Lf 0.18–*0.23*–0.26 mm. Wf 0.09–*0.11*–0.13 mm. L ov 0.15–*0.17*–0.19 mm. W ov 0.15–*0.17*–0.17 mm.

Discussion

The species very much resembles *S. bertholletii* (Audouin, 1826). The difference is the absence of lateral avicularia in the present material. The present species was first recorded by OSBURN (1940) in the West Indies.

His specimens of Puerto Rico also differ from most descriptions of *Scrupocellaria bertholletii* (Audouin, 1826) in the absence of the lateral avicularia. OSBURN 1940: 386: "The small lateral avicularia indicated by various authors as usually [in *S. bertholletii*] present appear to be wanting from West Indian material."

Distributed in shallow waters of the Caribbean.

CARIBBEAN: Curaçao. – Cabo la Vela (Col.) and Aruba, at 21–71 fms (OSBURN 1947). Guánica Harbor (P.R.) (OSBURN 1940).

12. **Scrupocellaria carmabi** n. sp.

Figs 16a–d

Holotype: RMNH 02977.

CURAÇAO: Piscadera Inner Bay, entrance 57, northern part 1493; Spaanse Water, entrance 77, inner bay 29, 51, 78, 1629; Fuikbaai 31, 61, 66, 1039, 1039A.
On *Rhizophora mangle* roots, stones and glass; at 0–6 m depth; in clear water.
BMNH 35.11.26.2 (coll. R. C. Osburn), TORTUGAS, Florida, 2 fms (*Scrupocellaria cornigera* (Pourtalès)); BMNH 35.12.19.6 (part) (coll. Colman & Tandy no 205A), W. side of Fort Jefferson, Moat Tortugas (*Scrupocellaria cornigera* (Pourtalès)); BMNH 85.1.26.6-7, Red Sea (*Scrupocellaria cervicornis*).

Description

Colonies erect. Biserial rows of zooecia, all facing the same direction, forming flabellate bifurcated systems. Colonies are small in size, up to 3 cm observed. Internodes not constant in length, 5–15 zooecia are lying between the succesive cuticular joints. Joints crossing the basal sides of the first pair of zooecia after a bifurcation, at the proximal half of zooecium C and D. Zooecia are hardly constricted at these joints. Colour of the colonies is white to light-brown.

Zooecia about half as wide as long, closely set, slightly narrowing proximally, forming compact branches. The oval opesia occupies about 1/2 of the frontal side. The cryptocyst is narrow, forming a ring around the opesia, slightly sloping downwards under the operculum. Operculum formed by a slightly parabolic thickening of the frontal membrane, to which the occlusor muscles are laterally attached. Scutum covering 2/3 of the frontal membrane, oval in outline, provided with retorse proximal

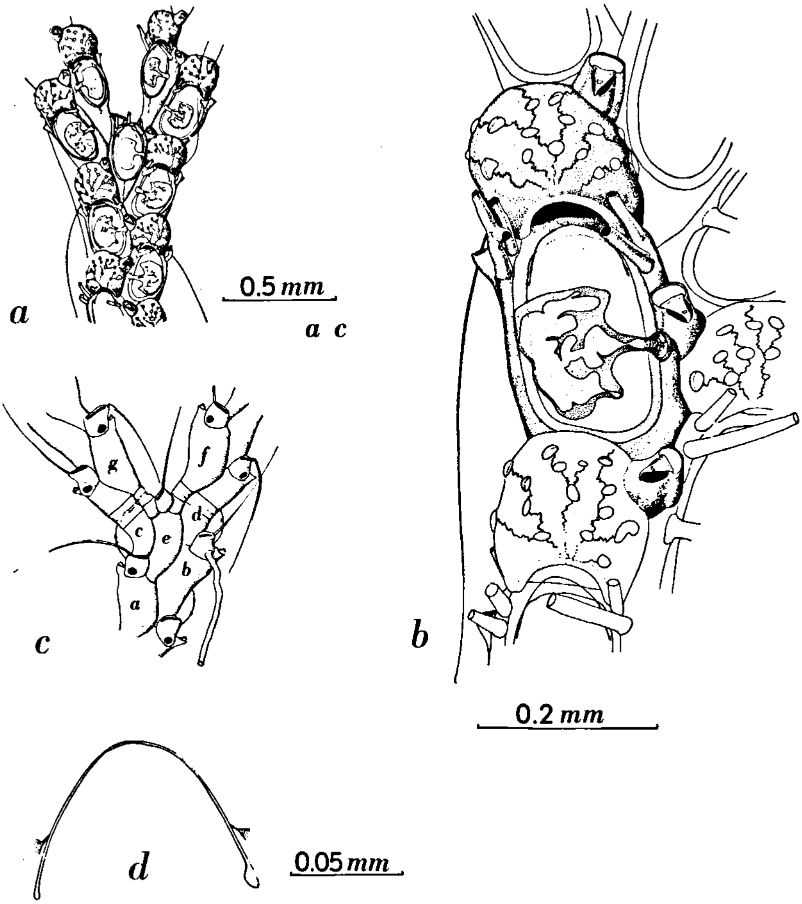


Fig. 16. *Scrupocellaria carmabi* n. sp. *a*. Frontal side of a part of a colony. *b*. Detail of a zooecium with ovicell. *c*. Basal side of a part of a colony, showing the type of bifurcation. *d*. Detail of the operculum, basal side. (RMNH 02977, stat. 51)

hooks and an alcicorn decoration of the lumen. Number of spines normally 6, spread out over the distal side of the zooecium. When the zooecium bears an ovicell, 3 spines are situated on the outer, 2 spines on the inner side, at the distal end of the opesia. The outer proximal spine is often one time bifurcated. The outer distal spine is often hidden behind the ovicell.

The frontal, adventitious avicularia, placed on the gymnocyst, are of moderate size, and are situated proximally to the opesia, against the neighbouring zooid and the ovicell (when present) of its predecessor. Triangular mandible is distally hooked, obliquely directed towards the base and the outside; rostrum with a sharp curved point. Frontal avicularia sometimes wanting, always present when predecessor bears an ovicell. Lateral avicularia usually present, situated on the disto-lateral wall. Mandible also distally hooked, rostrum with a sharp, curved point.

Basal avicularia (vibraculae) present, on the proximal basal wall; vibracula/rhizoid chambres square in outline, 1/3–1/4 of the zooecium length, groove transversely situated. Seta 1.5–2 times as long as a zooecium. Axillary vibraculum single, small in size.

Rhizoid chamber forming the proximo-lateral part of the vibracular chamber, giving issue to straw-coloured rhizoids growing towards the substratum, forming fingered terminal plates.

Ovicells prominent, spherical, perforated, radiating sutures connecting the pores, comming together near the semi-circular opening which is provided with a somewhat extended lip. Embryos orange coloured.

Measurements (see Fig. 31j): Lz 0.41–*0.47*–0.53 mm. Wz 0.14–*0.17*–0.19 mm. Lf 0.18–*0.22*–0.24 mm. Wf 0.10–*0.12*–0.13 mm. L ov 0.13–*0.15*–0.17 mm. W ov 0.14–*0.17*–0.18 mm.

Discussion

Comparing the present species with *S. regularis* Osburn, 1940, some differences are evident. a) Vibracula in *S. regularis* are large (1/2 of the zooecium length) and have the setal groove longitudinal, *Scrupocellaria carmabi* has small vibracula (1/3–1/4 of the zooecium length) and transverse setal grooves. b) In *S. regularis* the proximal inner spine can be bifurcated which does not occur in *S. carmabi.* Differences between the present species and *S. cornigera* (Pourtalès, 1867), as described by MARCUS in 1937: 55, are present in the bifurcation area. Joints are crossing far more proximally in *S. cornigera* and the zooids C and D are more narrow proximally. Specimens identified as *S. cornigera* from Tortugas, by OSBURN, present in the British Museum (N.H.), are identical to my specimens, as well as a specimen from the Red Sea, identified as *S. cervicornis* (Busk, 1852), and are definitely different from *S. cornigera* and *S. cervicornis.*

The description of *Canda cornigera* Pourtalès, 1867, is not accompanied by a figure, and so poor that numerous scrupocellarias could fall in it.

The species is named after the "Caraïbisch Marien-Biologisch Instituut" (CARMABI) on Curaçao.

Occurring in the West Indies and in tropical waters of the East.

CARIBBEAN: Tortugas (Florida) 2 fms, BMNH 35.11.26.2 and 35.12.19.6 (*Scrupocellaria cornigera* (Pourtalès)). INDO-WEST-PACIFC: Red Sea, BMNH 85.1.26.6-7 (*Scrupocellaria cervicornis* Busk).

13. **Scrupocellaria piscaderaensis** n. sp.

Figs 17a–b

Holotype: RMNH 02979.

CURAÇAO: Piscadera Inner Bay, southern part 6, 34, 34a, 35, 43, 46, 46a, 47, 48, 49, central part 36. On *Rhizophora mangle* and *Crassostrea*, rare on stones and glass; at 0–2 m, in turbid water.
BMNH 99.5.1.343 (Hincks coll.), Arabian Sea (*Scrupocellaria cervicornis* Busk); BMNH 89.8.21.117, ? , 27 fms (*Scrupocellaria cervicornis* Busk); BMNH 82.2.23.76.83, Torres Straits (*Scrupocellaria cervicornis* Busk).

Description

Colonies erect. Biserial rows of zooecia, all facing the same direction, forming flabellate bifurcated systems. Colonies are small in size, up to 2 cm observed. Internodes not constant in length, 5–15 zooecia are present between the successive cuticular joints. Joints crossing the basal side of the first pair of zooicia after a bifurcation, proximally of the opesia of zooecia C and D, or crossing the opesia proximally. Zooecia slightly constricted at these joints. Colour white to light-brown.

Zooecia are about 2/5 as wide as long, narrowing proximally. The oval opesia occupies about 1/2 of the front. The cryptocyst is narrow, forming a ring around the opesia, slightly sloping downwards under the operculum. The operculum formed by a parabolic thickening of the frontal membrane, to which the occlusor muscles are laterally attached. Scutum overarching the opesia, covering ca. 2/3 of the opesia, oval in outline, with an alcicorn decoration of the lumen, scutum curled upwards above the

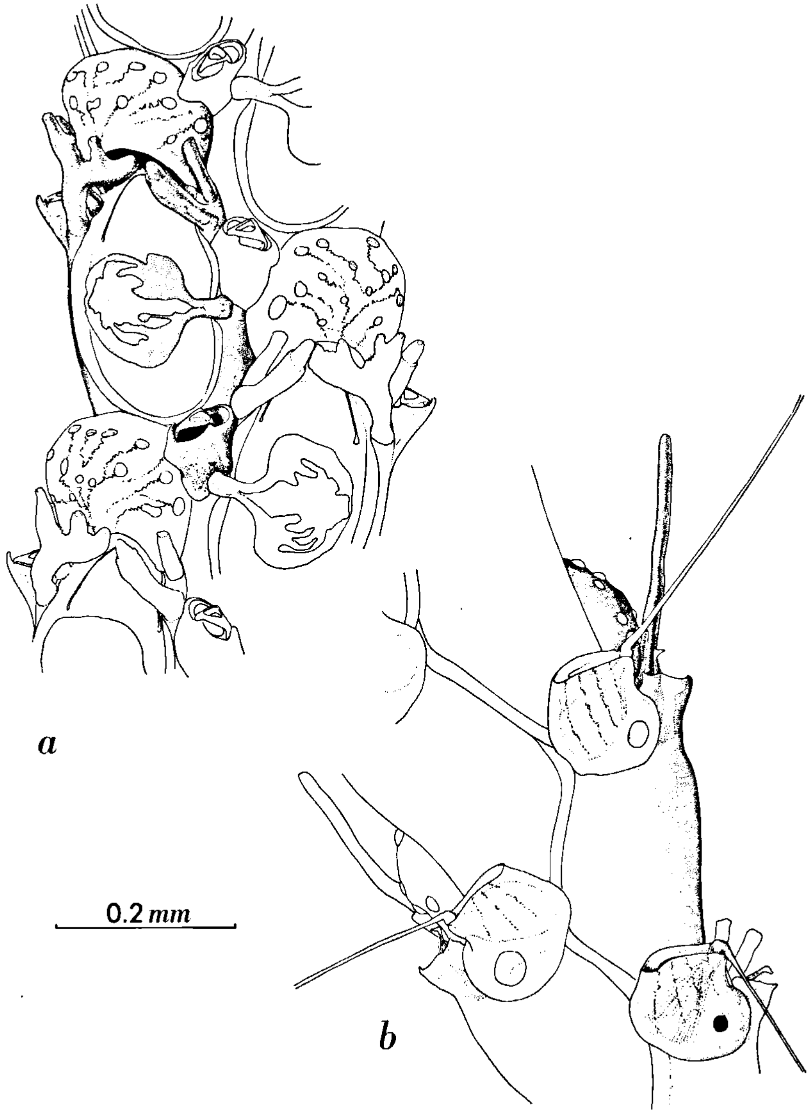


Fig. 17. *Scrupocellaria piscaderaensis* n. sp. *a*. Detail of a zooecium with ovicell. *b*. Detail of basal side of a zooecium. (RMNH 02979, stat. 43)

operculum. Number of spines normally 6, spread out over the distal side of the opesia. When the zooecium bears an ovicell, 3 spines are situated on the outer, 2 spines on the inner side at the distal end of the opesia. The outer proximal spine is generally bifurcated 2 of 3 times. The outer distal spine is often hidden behind the ovicell. Spines thicker compared with *Scrupocellaria carmabi.*

Frontal, adventitious avicularia are placed on the gymnocyst and are seldom absent; they are of moderate size, and are situated proximally to the opesia, against the neighbouring zooid and the ovicell (when present) of its predecessor. Mandible triangular, distally hooked, obliquely directed to the base and the outside; rostrum with a sharp, curved point. Small, lateral avicularia usually present, situated on the disto-lateral wall; mandible distally hooked; rostrum with a sharp, curved point.

Basal avicularia (vibracula) present, situated on the proximal basal wall; vibracula/rhizoid chamber more or less square in outline, 1/3 of the zooecium length; groove transversely orientated. Mandibles (setae) 1.5–2 times as long as the zooecium. Axillary vibraculum single, small in size. Rhizoid chamber forming the proximo-lateral part of the vibracula/rhizoid chamber, giving rise to straw-coloured rhizoids attached to the substratum, forming fingered terminal attachment plates.

Ovicells prominent, spherical, perforated, pores connected by radiating sutures, comming together near the semi-circular opening which is provided with a somewhat extended lip. Embryos orange coloured.

Measurements (see Fig. 31j): Lz 0.43–*0.46*–0.49 mm. Wz 0.17–*0.18*–0.20 mm. Lf 0.24–*0.25*–0.26 mm. Wf 0.14–*0.15*–0.17 mm. L ov 0.12–*0.12*–0.13 mm. W ov 0.14–*0.15*–0.16 mm..

Discussion

The present species resembles *S. carmabi.* It differs in the following characters: a) Scuta of *S. piscaderaensis* do not possess the retorse hooks. b) Spines are thicker and more often bifurcated. c) Joints crossing more proximally on the basal wall of zooids C and D. d) Branches are not as compact as in *S. carmabi.*

Comparison with the type specimen of *S. frondis* (Kirckpatrick, 1890) (BMNH 88.4.16.20A) showed a general resemblance with *S. piscaderaensis.* The main difference is the presence of lateral avicularia which are unexceptionally absent in *S. frondis*. This differences seems important enough to keep *S. piscaderaensis* separated from *S. frondis*.

This species is named after Piscadera Bay on Curaçao, where it was first found.

Known from Antillean and Arabian waters.

CARIBBEAN: Curaçao. – INDO-WEST-PACIFIC: Arabian Sea, BMNH 99.5.1.343 (Hincks coll.) (*Scrupocellaria cervicornis* Busk); BMNH 89.8.21.47, loc.?, 27 fms (*Scrupocellaria cervicornis*); Persean Gulf, Burkire, BMNH 99.6.15,2 (*Scrupocellaria cervicornis*).

14. **Scrupocellaria hildae** n. sp.

Figs 18a–d

Holotype: RMNH 02980.

CURAÇAO: Piscadera Outer Bay 2; Spaanse Water, entrance 27, 77; Fuikbaai 33, 1039; Santa Marta Bay, entrance 44; St. Michiels Outer Bay 24.
BONAIRE: Lac 1068a.
On hard substrata only, like stones, glass, metal, plastics, dead coral, and red calcareous algae; at 0–6 m depth; in clear water with great influence of the open ocean.

Description

Colonies erect. Biserial rows of zooecia, all facing the same direction, forming flabellate bifurcated systems. Colonies small, up to 2 cm observed. Internodes not constant in length, 5–15 zooecia are present between the successive cuticular joints. Joints situated at the first pair of zooecia after a bifurcation, crossing the base of the opesia of zooids C and D. Zooids hardly constricted at these joints. Colour of the colony white or light-brown.

Zooecia 2–3 times longer than wide, slightly narrowing proximally. The oval opesia occupies 2/5–1/3 of the frontal side. Cryptocyst broad, particularly on the outside, sloping downwards under the operculum. Operculum formed by a parabolic thickening of the frontal membrane, to which the occlusor muscles are laterally attached. Scutum situated medially, on the inner side, overarching the opesia, covering it half, oval in outline, with a simple, or without, alcicorn decoration of the lumen. Number of spines normally 6, when an ovicell is present 5, 3 outer and 2 inner spines.

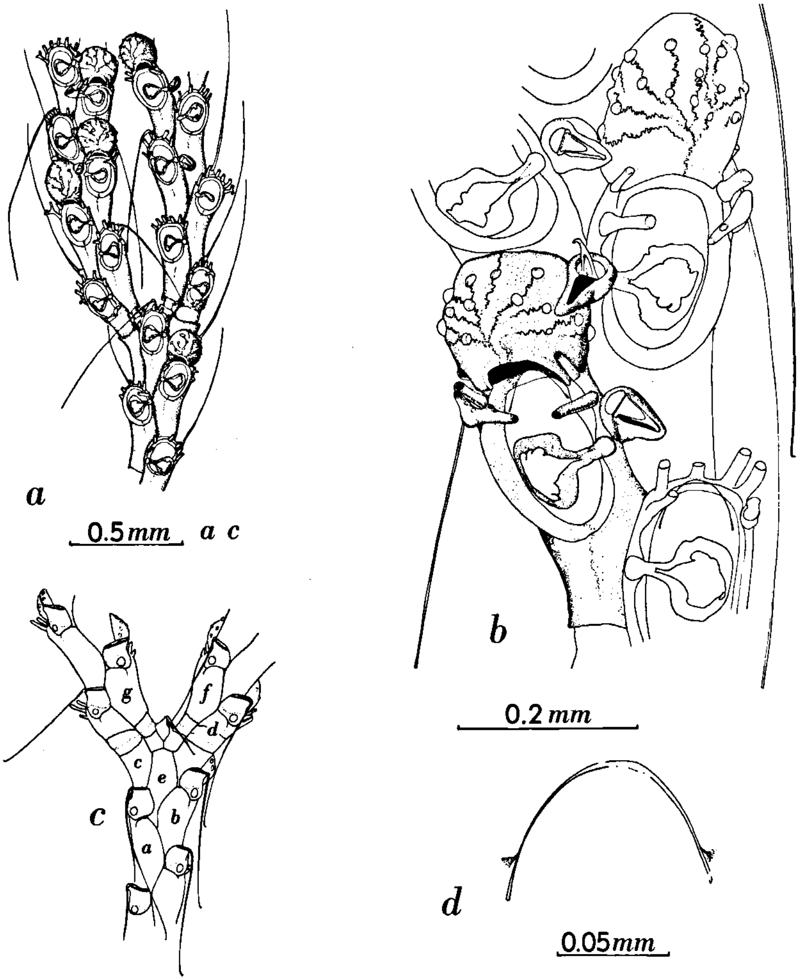


Fig. 18. *Scrupocellaria hildae* n. sp. *a.* Frontal side of a part of a colony. *b.* Detail of a zooecium with ovicell. *c.* Basal side of a part of a colony, showing the type of bifurcation. *d.* Detail of the operculum, basal side. (RMNH 02980, stat. 44)

Proximal outer spine usually bifurcated. Proximal inner spine more or less overarching the opesia. Distal outer spine often hidden by the ovicell.

Frontal, small, adventitious avicularia are placed on the gymnocyst; rostrum elevated and with a curved point. Mandibles triangular with a curved beak, directed proximo-laterally to the outside, occasionally wanting. Lateral avicularia absent.

Vibracula/rhizoid chambers 1/3 of the zooecium length. Only the top of the vibracula chamber visible from the front. Setal groove transversely orientated. Mandible (seta) 1–2 times the zooecium length.

Rhizoid chamber proximally of vibracula chamber, giving issue to straw-coloured, broad rhizoids, growing towards the substratum, provided with terminal, fingered attachment plates.

The prominent ovicells are spherical, and perforated; radiating sutures connect the pores, coming together near the semi-circular opening, provided with a somewhat extended lip. Embryos white to orange in colour.

Measurements (see Fig. 31j): Lz 0.37–*0.43*–0.47 mm. Wz 0.13–*0.15*–0.16 mm. Lf 15–*0.17*–0.19 mm. Wf 0.09–*0.10*–0.11 mm. L ov 0.12–*0.13*–0.17 mm. W ov 0.14–*0.16*–0.17 mm.

Discussion

Although lateral avicularia are absent, it is clear that the present species belongs to the genus *Scrupocellaria*.

This species is named after the authors fiancée, Hilde van der Linden.

GENERAL REMARKS CONCERNING THE SPECIES OF *Scrupocellaria*

Four species that could not be possitively identified have been described as new after a thourough investigation of the literature about the Atlantic species of *Scrupocellaria* and the general studies of the Pacific area (Harmer 1926, Osburn 1950, Busk 1884). The genus *Scrupocellaria* is large and consists of many closely related, or at least morphologically resembling forms. The question is if these forms are varieties, subspecies, or different species in relation to each other. It seems that Scrupocellarias are often misidentified. These errors could give wrong impressions concerning the distributions of certain "species". For a better understanding of the genus, the geographic distributions of the species should be thouroughly investigated.

Scrupocellaria carmabi and *S. piscaderaensis* show an allopatric distribution on Curaçao, in relation with the different habitats they occur in. The question arises if these forms are subspecies or different ecotypes of the same species or different species. No real isolation seems to occur, because the different habitats are in contact with each other, so it is not likely they are subspecies. Intermediate forms do not occur at the borders of the 2 populations, which makes it unlikely (though not impossible) that these forms are ecotypes. The forms are therefore more or less arbitrarily given the status of different species. Little is known about the effect of the environment on the phenotypical developement of Bryozoa.

Family **EPISTOMIIDAE** Gregory, 1893

Epistomiidae, OSBURN 1940: 402.

Colonies branched, rising from a delicate stolon. Zooecia in pairs, back to back, each pair beginning in short tubular processes. Adventitious and pedunculate avicularia present. Gonozooecia slightly enlarged.

Genus **Synnotum** Pieper, 1881

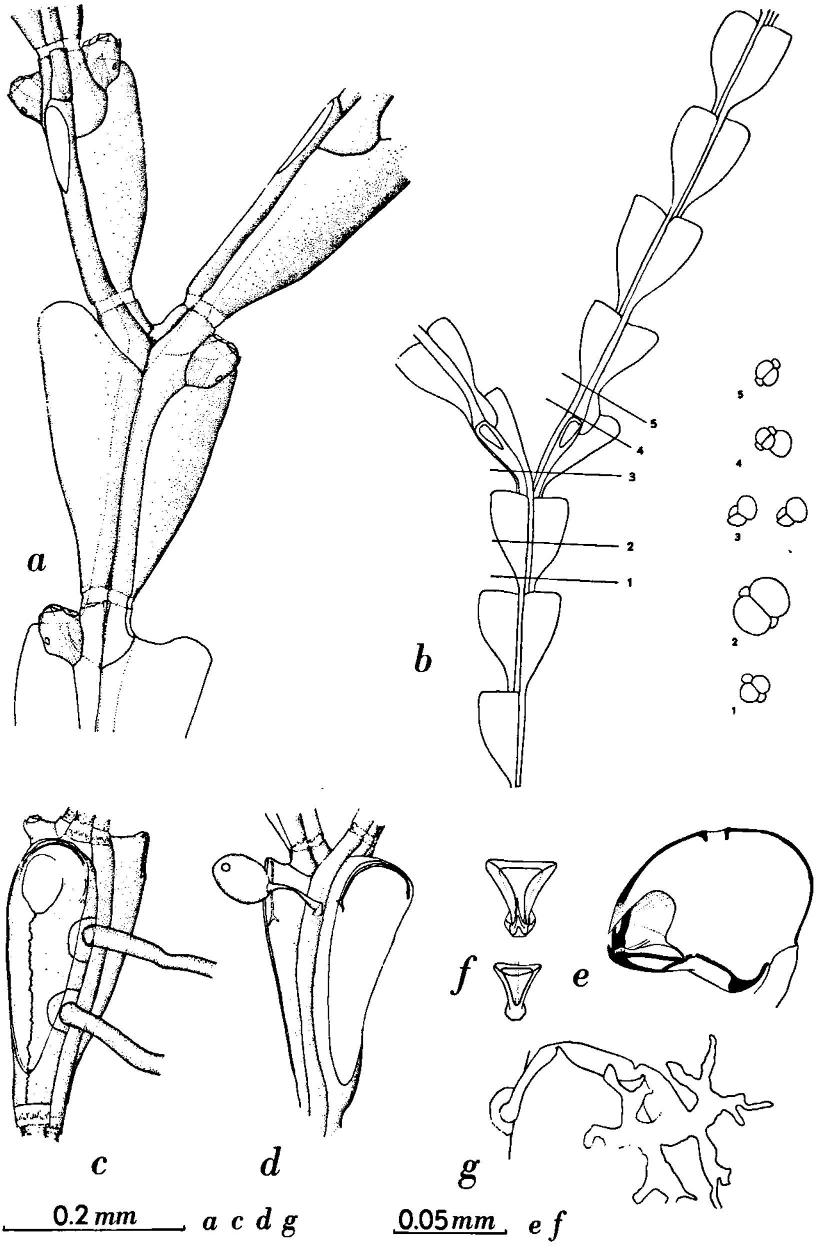
Synnotum, OSBURN 1950: 150.

Sessile lateral avicularia at distal ends and frequently a stalked avicularium between the two distal zooecial parts, at or near the distal end.

15. **Synnotum aegyptiacum** (Audouin, 1826)

Figs 19a–g

Loricaria aegyptica AUDOUIN, 1826: 143, pl. 13 figs 4i–v in Savigny, 1826.
Gemellaria(?) *avicularis* PIEPER, 1881: 13, 47, pl. 2 figs 5–7.


a
b
1
2
3
4
5
c
d
e
f
g
0.2 mm a c d g
0.05mm e f

Synnotum aegyptiacum, HARMER 1926: 398, pl. 27 figs 3, 4; OSBURN 1927: 126; HASTINGS 1930: 702; MARCUS 1937: 58, 59, pl. 12 figs 28A, B; 1938a: 26, pl. 5 fig. 12; 1939: 181, 191, 193, 194, 198, 201, 203–205, pl. 18 figs. 45A, B; OSBURN 1940: 402; MARCUS 1941b: 227–234; OSBURN 1947: 25; 1950: 151, pl. 13 fig. 5; MARCUS 1953: 290, 291; MATURO 1957: 42, fig. 36; SOULE, J.D. 1959: 38; SHIER 1964: 623; WINSTON 1982: 127, fig. 53.

CURAÇAO: Piscadera Outer Bay 1, 2; Piscadera Inner Bay, entrance 57, 58, southern part 3, 4a, 34, 34a, 34b, 49, 50, 62; Spaanse Water, entrance 27, 77, 81, inner Bay 29, 51, 78, 1629; Fuikbaai 33, 61, 66; St. Joris Bay, inner bay 89, 91, 92, 93.
BONAIRE: Lac 1067, 1653; Lagoen 1070A, 1555.
On stones, glass, metal, plastics, hydroids, *Rhizophora mangle* roots and other bryozoans; in clear and turbid water; at 0–6 m depth.

Description

Colonies erect or creeping, lying as loose threads on the substratum, frequently bifurcating. Colonies white or straw-coloured, inconspicuous and easily overlooked.

Branches consist of ca. 5 internodes. Joints divide the zooids in 3 parts. One internode consists of parts of 6 different zooids; 2 distal, 2 median and 2 basal parts. The 2 distal parts are lying back to back and are somewhat turned to one side, so the internode has a dorsal and a frontal side. The internodes, connected by cuticular joints form a branch which also has a dorsal and frontal side, although the zooecia are alternating. Zooecia are slightly calcified and scleritinous.

On the bifurcations smaller zooecia are present, divided in 2 parts by a joint.

The distal part of the zooecium is scoop-shaped and leaves an oval opesia, occupying most of the frontal side. The operculum is semi-circular, obliquely orientated, in relation to the main axis of the branch. A sessile, box-shaped, disto-laterally situated avicularium is present on one, seldom two, distal zooecial parts of the internode. The mandible of the bow-

Fig. 19. *Synnotum aegyptiacum* (Audouin, 1826). *a.* Detail of a part of the colony at the bifurcation, viewed from the basal side. *b.* Diagram of the situation on a bifurcation with cross-sections. *c.* Basal zooecium with calcified frontal membrane. *d.* Frontal side of an internode with pedunculate avicularium. *e.* Lateral diagram of the pedunculate avicularium. *f.* Avicularium mandibles, viewed from the inside (upper), and from the outside (lower). *g.* Budding place of rhizoid, rhizoid and terminal attachment plate. (RMNH 02988, stat. 1653)

shaped avicularium is hooked. The avicularium chamber has a lateral opening.

The median part of the zooecium is shaped as an oblong tube, and frequently bears a pedunculate avicularium on its distal part, especially at the bifurcations, The pedunculate avicularium is pear-shaped. The mandible is very scleritinous, hooked, armed with several (3) sharp points. The rostrum is also distally sharp, and has lateral excavations. An opening in the avicularium chamber is present as in the sessile avicularia.

The basal zooecial part is short and tubular.

Polypide with 10, short tentacles. Tentacle sheath little everted when feeding, introvert not reaching further than the operculum.

The common lateral walls are perforated by 1, seldom 2, septulae, probably uniporous, although this is difficult to observe. Terminal parts are communicating by 1, probably uniporous, septulum. Each zooid bears at least 6 septulae.

Proximal zooids of the colony may have calcified frontal membranes, leaving a circular distal opening. These zooids do not contain polypides, but are filled with lumps of proteins or lipids. WINSTON (1982): 127) saw this "starchy-looking granular material" in proximal zooids, after a cold spel. The same zooids often form 1 or 2 rhizoids, originating from the distal part of the zooid. A septulum is formed against the median part of another zooid and gives issue to a rhizoid. The rhizoids are tubular and provided with fingered terminal attachment plates. Rhizoids develop in the basal area of the colony. Only in basal parts of the colony, bifurcation sometimes takes place at pore-plates, which are normally formed to give off rhizoids. On these bifurcations a small zooid is formed, divided in 2 parts by one joint; then distally 2 zooids are formed, one divided in 2 and one divided in 3 parts; the succesive joint crosses 3 zooecia, the 4th joint crosses 4 zooecia.

Gonozooids not observed.

Measurements (see Fig. 31k): L int 0.29–*0.32*–0.36 mm. L opes 0.21–*0.24*–0.25 mm. W opes 0.071–*0.076*–0.079 mm.

Discussion

Although the material observed must be *S. aegyptiacum*, none of the authors mentioned have described the opening in the avicularium chamber.

Widely distributed in warmer, shallow waters.

CARIBBEAN: Curaçao. Bonaire. – Spaanse Water (Cur.), in shallow water, on other Bryozoa (*Holoporella albirostris*) (OSBURN 1927). Cabo la Vela (Col.), at 38–40 m (OSBURN 1947). Tortugas, at 14–18 m, on shells and sponges (OSBURN 1914). Off Parguera and Guánica Harbor (P.R.), at 13–24 m (OSBURN 1940). Dog Island (NW Fla.), at 9 m, on algae (SHIER 1964). Indian River area (Fla.), in shallow water, on hydroid stems (*Thyroscyphus, Eudendrium*), shells and stones (WINSTON 1982). ATLANTIC COAST OF SOUTH AMERICA: Bay of Santos, at 20 m (MARCUS 1937). Espirito Santo (Brasil), at 35 m (MARCUS 1953). ATLANTIC COAST OF NORTH AMERICA: Cape Lookout (N. C.) (MATURO 1957). INDO-WEST-PACIFIC: Red Sea (AUDOUIN 1826). Indonesian Archipelago, at 0–82 m (HARMER 1926). PACIFIC COAST OF AMERICA: Vicinity of Panama Canal, at 27 m (HASTINGS 1930). Tropical and subtrop. waters of E. Pacific, at 0–82 m (OSBURN 1950). San Marcos Isl. (Gulf of Calif.), at 18–20 m (SOULE 1959).

Family **BICELLARIELLIDAE** Levinsen, 1909

Bicellariidae LEVINSEN, 1909: 93–100.
Bicellariellidae LEVINSEN, 1909: 431; HARMER 1926: 409, 410; RYLAND & HAYWARD 1977: 146.

Colony erect, branched, unilaminar, attached by rhizoids. Marginal spines usually present; frontal membrane restricted to the distal part of the zooid. Walls slightly calcified. Pedunculate avicularia often present. Ovicells independent, hyperstomial; ectooecium membranous.

The genus name *Bicellaria* was found to be preoccupied. LEVINSEN therefore changed it in *Bicellariella* and the family name Bicellariidae in Bicellariellidae. HARMER (1926) and RYLAND & HAYWARD (1977) narrowed the limits of LEVINSEN's family, this is adopted here.

Genus **Bicellariella** Levinsen, 1909

Bicellaria LEVINSEN, 1909: 99, 110.
Bicellariella LEVINSEN, 1909: 431; HARMER 1926: 421; OSBURN 1950: 152; RYLAND & HAYWARD 1977: 146.

Zooids horn-shaped, divided in 3 parts by 2 constrictions. Proximal part of zooid, forked, short; middle part cylindrical; distal part funnel-shaped. Operculum present. Bifurcation of type 4 (HARMER, 1923). Avicularia birdhead-shaped, pedunculate, situated proximally of the frontal membrane. Ovicells globular, pedunculate, situated on the inner distal corner of the zooid; ectooecium membranous.

16. **Bicellariella chuakensis** (Waters, 1913)

Figs 20a–d

Bicellaria chuakensis WATERS, 1913: 467, 468, pl. 68 figs 7, 8.

CURAÇAO: Piscadera Inner Bay, entrance 57.
On red algae; in a bottle (dark), at 3 m depth.

Description (based on one colony of 5 mm hight)

Colony erect, fan-shaped. First 3 zooids formed, arranged uniserial, other alternating zooids forming biserial rows. Bifurcation of type 4 (HARMER, 1923), closely arranged. Slightly calcified zooids all facing the same direction, growing from an upright ancestrula. Ancestrula gives issue to many rhizoids, situated basally on the ancestrula, and creeping over the substratum. Colony white in colour.

Zooids oblong, horn- or funnel-shaped, divided in 3 parts by wrinkled constrictions. Distal part of the zooecium bears an opesia which widens distally and occupies about 2/3 of the distal part of the zooecium. An oblique, distinct constriction on basal and frontal walls, separates the tubular, median part of the zooecium from the distal part. Another constriction separates the short, forked, proximal part from the median part. An inconspicuous, semi-circular, slightly scleritinous operculum is present in the distal part of the fontal membrane. Spines present, situated at the distal corners of the zooecium, often very long, curved towards the long axis of the branch, always jointed at the base. Spines placed at the inner corner can reach 3 or 4 times the zooecium length, spines at the outer corner are mostly short, no more than one zooecium length. Differentiation in number of spines between central and lateral branches was observed. Central branches consist of zooids with spine formula 1:1, lateral branches with spine formula 2:1 or 3:1 (RYLAND 1960).

Avicularia are pedunculate, situated on the distal part of the zooecium, proximo-laterally of the opesia on the outside of the zooecium, directed basally. They are slightly calcified with a curved rostrum which has crenated edges; cryptocyst moderately developed.

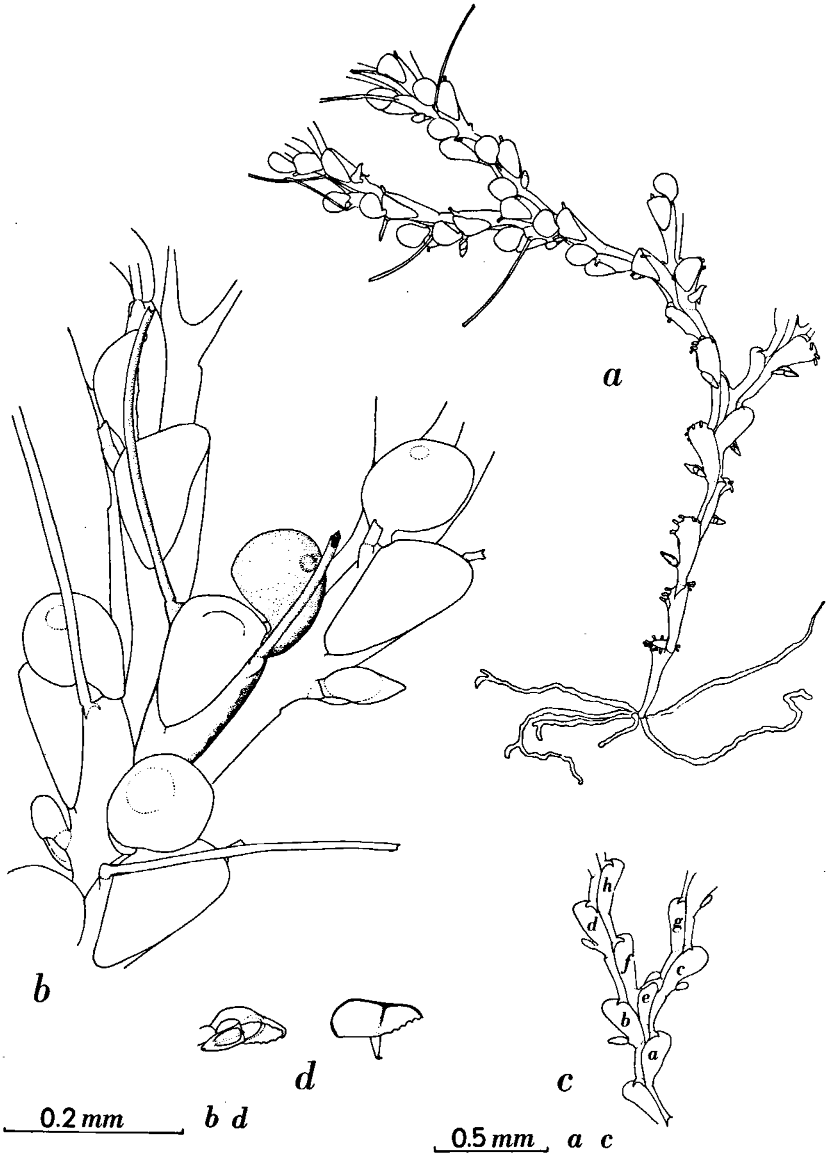


Fig. 20. *Bicellariella chuakensis* (Waters, 1913). *a*. Part of a colony with rhizoids and ancestrula. *b*. Detail of a zooecium with ovicell. *c*. Basal side of a part of a zoarium showing the type of bifurcation. *d*. Avicularia, habitus (left), diagram (right). (RMNH 02989, stat. 57)

Communication between zooids by uniporous septulae; 2 in each lateral wall, not visible in the terminal walls.

Rhizoids bifurcating.

Ovicells pedunculate, globular, situated at the inner distal corner of the zooid, opening towards the opercula of the zooids to which they belong. Ectooecium membranous; endooecium calcified, often ornamented with cristal-like structures. Embryos white.

Ancestrula has a different morphology. More distally situated zooids gradually change in character towards the zooids described above. The ancestrula is trumpet-shaped and has a distal round opesia surrounded by 10 short jointed spines. Constrictions are absent.

Measurements (see Figs 32a, e): Lz 0.35–*0.39*–0.47 mm. Wz 0.10–*0.11*–0.12 mm. Lav 0.075–*0.087*–0.093 mm. Wav 0.039–*0.046*–0.053 mm.

Discussion

Shape of ancestrula; zooids divided in 3 parts; horn-shaped zooids; jointed spines; these are all typical characters of *Bicellariella.* WATERS mentioned that the first 18 zooids were without avicularia which differs from the present colony in which the 3th zooid bears an avicularium. It is assumed that this is not a character on which the present material should be separated from WATER's specimens. All the other characters are identical.

Occurring in shallow East-African waters and in the Caribbean. – First record of the species in the Atlantic area.

CARIBBEAN: Curaçao. – INDO-WEST-PACIFIC: Chuaka Bay (Zanzibar), Wasin (Brit. E. Africa), at 10 fms, Chuaka at 2–3 fms (WATERS 1913).

Genus **Bugula** Oken, 1815.

Bugula, BASSLER 1953: G181; RYLAND 1960: 66–73; MATURO 1966: 558; RYLAND & HAYWARD 1977: 151–153.

Bushy colonies with unilaminar, biserial to multiserial rows of zooecia. Zooids facing the same direction, usually truncate distally and narrowed proximally, with a forked proximal portion. Operculum indistinct or absent. Spines may be present especially at the distal angles of the zooids. Pedunculate avicularia usually present. Ovicells hyperstomial, globular, sometimes reduced, usually attached to the zooid by a short stalk; endooecium calcified, ectooecium membranous.

Disposition of spines expressed in a formula, 2:1, indicating three spines, two on the outer distal angel and one on the inner distal angle of the zooid.

Bifurcation types described by HARMER in 1923. Zooids involved coded by letters. The first zooid from which 2 zooids are budding is referred to as A, the next in the other series as B. Outer zooids above A and B are C and D respectively, inner zooids E and F. HARMER's types 3, 4 and 5 are most important in the present material.

Discussion

Following Opinion 417 of the International Commission on Zoological Nomenclature, the genus name *Bugula* is invalid as a result of the rejection for nomenclatorial purposes of volume 3 (Zoologie) of the work by LORENZ OKEN entitled *Okens Lehrbuch der Naturgeschichte* published in 1815–1816.

Opinion 417. Ruling: – "(1) It is hereby ruled that in Volume 3 (Zoologie) of the work entitled 'Okens Lehrbuch der Naturgeschichte' published in 1815–1816 Lorenz Oken dit not apply the principles of binominal nomenclature as required by Proviso (b) to article 25 of the 'Règles', as amended by the Thirteenth International Congress of Zoology, Paris, 1948, and therefore that no name published in the foregoing volume of the above work acquired the status of availability by reason of having been so published."

Rejection of the genus name *Bugula* would, in the opinion of the author, lead to instability and confusion in the nomenclature concerning this group. A request for the validation of the genus name *Bugula* will be submitted to the Plenary Powers of the International Commission on Zoological Nomenclature.

17. Bugula neritina (Linnaeus, 1758)

Figs 21a–d

Sertularia neritina Linnaeus, 1758: 815.
Bugula neritina, Busk 1852: 44, pl. 43 figs 1–6; 1884: 42; Waters 1909: 135, 136, pl. 11 figs 1–3; Osburn 1914: 186; 1927: 126; Hastings 1930: 704; Marcus 1937: 66, pl. 13 fig. 34; Osburn 1940: 389; Marcus 1941c: 20, fig. 13j; Osburn 1950: 154, 155, pl. 23 fig. 3, pl. 24 fig. 3; Maturo 1957: 42, 43, fig. 37; Soule 1959: 39; Ryland 1960: 74, 75, figs 1C, 3A, 3B, pl. 2C; Shier 1964: 624; Ryland 1965: 45, figs 23A, 23B; Maturo 1966: 560, 561, text-fig. 4; Prenant & Bobin 1966: 492–495, fig. 162; Cook 1968b: 157; Powell 1971: 769; Rao 1975: 52, 53, figs 47, 48; Ryland & Hayward 1977: 162, fig. 78; Winston 1982, fig. 52; Aristegui Ruiz 1984: 202–203, fig. 43.

Curaçao: Piscadera Inner Bay, southern part 4, 5, 34, 35, 49, 1466, 1671, central part 22, 36, 41, 42, 63, 1477, northern part 8, 18a, 37, 60, 64, 74, 75, 1482, 1484, 1487, 1488, 1488a, 1493b; Spaanse Water, inner bay 78, 79, 80; Fuikbaai 67, 83; St. Joris Bay, inner bay 89, 91, 92, 94; St. Marta Bay, inner bay, 45.
Abundant on oyster shells, *Rhizophora mangle* roots and *Thalassia testudinum*; in clear and turbid water; at 0.1 m depth.

Description

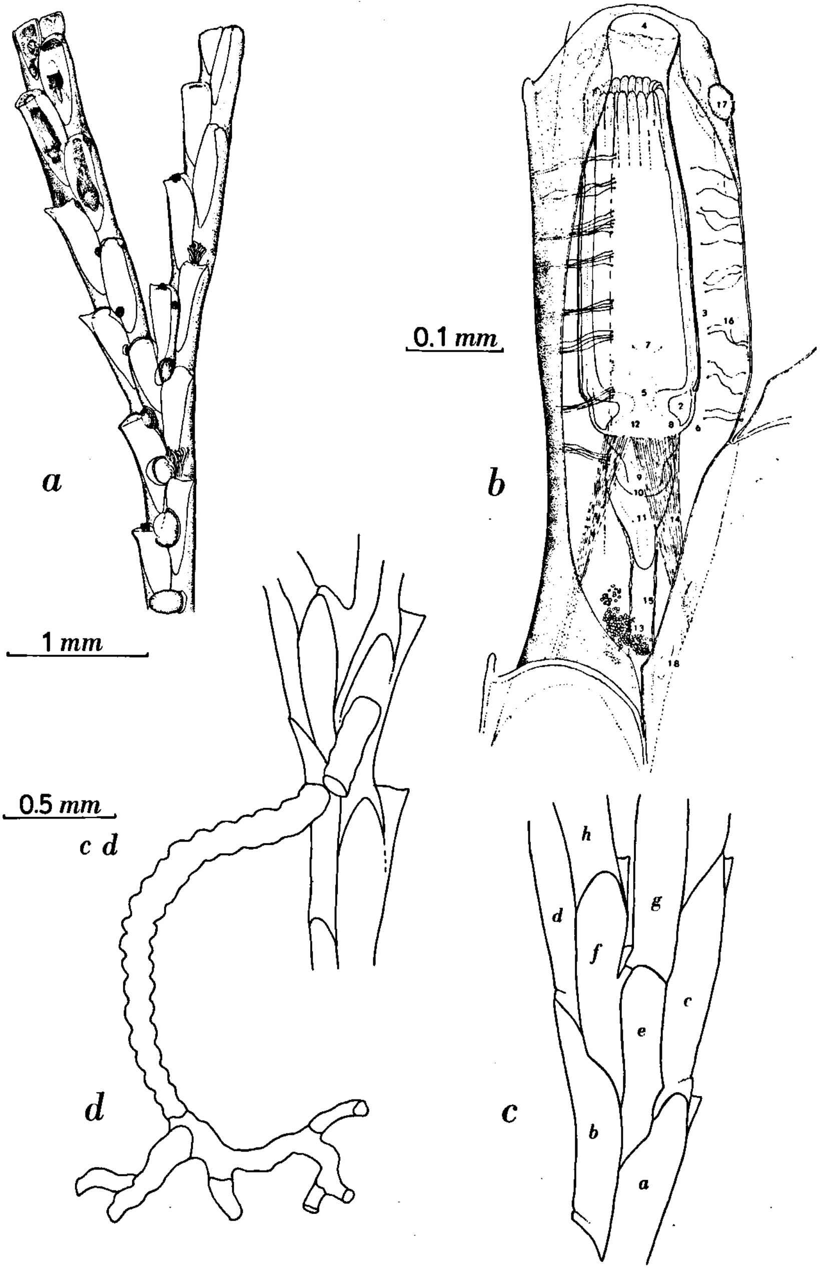
Colonies erect, bushy, up to 10 cm, growing from an upright ancestrula; attached to the substratum by rhizoids. Slightly calcified zooids forming biserial bifurcation systems of type 4 or 5 (Harmer 1923). Tips of branches show slight spiral growth. Zooecia alternating, all facing one direction.

Zooecium oblong, proximally narrowed, forked, attached to the distobasal side of its predecessor. Opesia occupying the whole of the frontal surface, Oblique wrinklings in the basal walls. No operculum, instead a sphincter is present. No spines, although the outer distal corner may form a slight projection. No avicularia present.

Polypide with 23 tentacles. Brown bodies often present.

Communication by uniporous septulae, 2 in each lateral wall, 7–10 in the terminal walls.

Fig. 21. *Bugula neritina* (Linnaeus, 1758). *a*. Tip of a branch. *b*. Detail of a zooid showing inner structures; 1. tentacle, 2. ring cavity, 3. tentacle sheath (retracted), 4. orifice, 5. mouth, 6. coelom, 7. anus, 8. pharynx, 9. esophagus, 10. cardia, 11. caecum, 12. pylorus, 13. testis, 14. Retractor muscles of the lophophore, 15. funiculus, 16 parietal muscles. 17. developing ovicell, 18. septulum. *c*. Basal side of a branch, showing bifurcation type. *d*. Detail of a bifurcating rhizoid. (RMNH 02990, stat. 1466)


a
1 mm
b
0.1 mm
4
17
3
16
7
5
2
12
8
6
9
10
11
14
15
13
18
0.5 mm
c d
d
c
h
d
g
f
c
e
b
a

Broad rhizoids corrugated, growing from the basal wall of the basal zooids towards the substratum, often bifurcating.

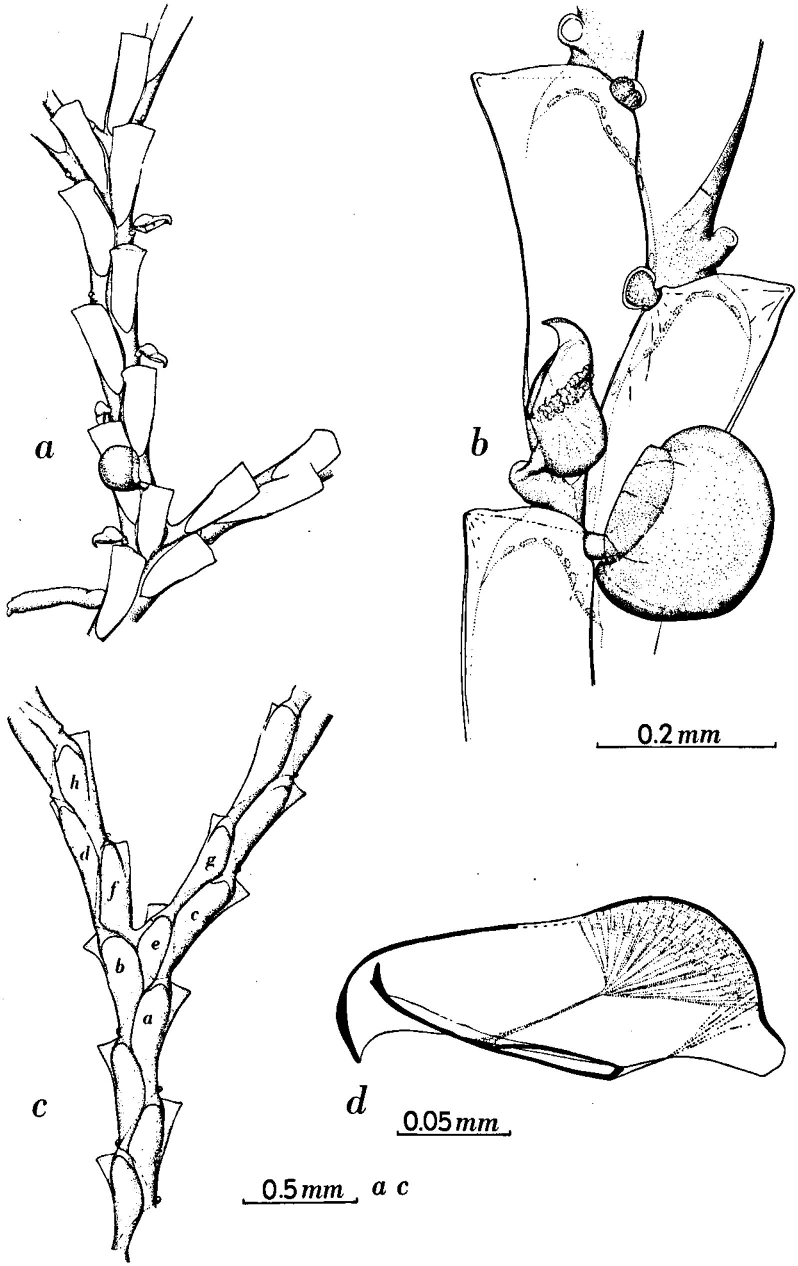
Ovicells globular, situated on the inner distal corner; opening provided with a lip, directed laterally towards the zooid to which it belongs. Ectooecium membranous; endooecium often heavily calcified, giving it a white pearl-like appearance. Embryos purple, red or brown.

Measurements (see Fig. 32b): Lz 0.59–*0.74*–0.89 mm. Wz 0.16–*0.22*–0.25 mm.

Widely distributed in warmer, shallow waters around the world.

Caribbean: Curaçao. – Spaanse Water, in shallow water (Osburn 1927). N.W. Florida, in shallow water and on beach drift, on shells, ascidans, hydroid stems, seagrass, other Bryozoa (Shier 1964). Tortugas, in shallow water, fouling (Osburn 1914). Cubagua and Margarito, at shore to 40 m depth (Osburn 1947). Off Guánica, Parguera and at Guayanilla (P.R.), in shallow water down to 11 m, on mangrove roots, piles of docks (Osburn 1940). Indian River area (Fla.), in shallow water, on seagrass, oysters, docks and canal walls, floats, rotting wood, and algae (Winston 1982). Lemon Bay (Panamá), fouling (Powell 1971). Atlantic Coast of South America: Santos, at 17 m, Itahae, Ilha de S. Sebastião and Bertioga, on floating substrate (Marcus 1937. E of Paraná, Cayoba, São Paulo Ithanhaen, Santos, Bertioga, Ilha de São Sebastião, and Rio de Janeiro, on floating objects (Marcus 1941c). Atlantic Coast of North America: Southeast coast of U.S.A. (Maturo 1966). Beaufort and vicinity (N.C.) (Maturo 1957). Bermudas, on coral at 55 m (Busk 1884). Atlantic Coast of Africa: Senegal and the Azores (Cook 1968b). Canary Islands, shallow water, hard substrates and fouling (Aristegui Ruiz 1984). Atlantic Coast of Europe: Scarborough (Britain) not sure (Busk 1852). Swansea, in artificially warmed water (Ryland 1960). Indo-West-Pacific: Sudanese Red Sea (Waters 1909). N.E. India, in shallow water (Rao 1975). Pacific Coast of America: Balboa Harbour, Panamá Bay, fouling (Powell 1971). Galápagos, at 2–22 m, on docks and buoy (Hastings 1930). From Channel Islands all down the Mexican coast and on to the Angel de la Guardia Island, at 0–78 m (Osburn 1950). Gulf of California, at 0–73 m (Soule 1959). Fouling: On ships (Ryland 1971).

Fig. 22. ***Bugula minima*** Waters, 1909. *a*. Frontal side of a part of the colony. *b*. Detail of a zooecium with ovicell and avicularium. *c*. Basal side of a branch showing the type of bifurcation. *d*. Diagram of an avicularium. (RMNH 02991, stat. 1053)


a
b
0.2 mm
h
d
f
g
c
e
b
a
c
d
0.05 mm
0.5 mm a c

18. **Bugula minima** Waters, 1909

Figs 22a–d

Bugula neritina var. *minima* Waters, 1909: 136, 137, pl. 11 figs 4–7; Waters 1913: 471; Osburn 1914: 187; Marcus 1921: 1, pl. 1 figs 1A, 1B; Hastings 1930: 704, 705, pl. 2 fig. 6.

Bugula minima, Osburn 1940: 390; 1950: 155, pl. 22 fig. 8, pl. 23 fig. 5; Soule 1959: 40; Winston 1982: 130, fig. 47; Aristegui Ruiz 1984: 200–202, fig. 42.

Curaçao: Awa blanco 62.
Bonaire: Kralendijk roadstead, buoys, 1053.
On buoys and plastic plates in reef areas; in clear water at 0–8 m depth.

Description

Colonies erect, bushy, small (up to 2 cm), consisting of bifurcating, alternating, slightly calcified, biserial rows of zooecia, all facing one direction. The colony grows from an upright ancestrula, and is attached to the substatum by rhizoids. Bifurcation of type 4 (Harmer 1923). Colour of the colony red to purple.

Zooecium oblong, narrowed and forked proximally, attached to the disto-basal side of its predecessor. Opesia occupying the whole of the frontal surface. Distinct, oblique wrinklings on the basal walls of the zooecia. No spines present, although the outer distal corner often forms a sharp angle. No operculum, instead a sphincter is present.

Avicularia present, large, oblong, pedunculate, situated on the proximo-lateral outer walls of the zooids. Rostrum forming a curved reddish beak; cryptocyst not well-developed; outer calcified wall flaky at the distal cryptocystial area. Communication between zooids by uniporous septulae; 2 in each lateral wall; about 8 in the terminal walls.

Broad rhizoids growing from the median basal wall of basal zooids towards the substratum, often bifurcating.

Ovicells globular, situated on the inner distal corner of the zooid; opening surrounded by a broad lip, directed laterally to the zooid to which it belongs. Embryos orange to red.

Measurements (see Figs 32b, e): Lz 0.47–*0.60*–0.79 mm. Wz 0.13–*0.14*–0.15 mm. L av 0.158–*0.221*–0.319 mm. W av 0.075–*0.078*–0.079 mm.

Widely distributed in warmer, shallow waters around the world.

CARIBBEAN: Curaçao, Bonaire. – Guánica Harbor (P.R.), on piles and docks (OSBURN 1940). Tortugas, at 15 m (OSBURN 1914). Indian River area, Fla., in shallow water, on algae, hydroids (*Thyroscyphus*), sponges, other bryozoans (*Amathia distans*) (WINSTON 1982). ATLANTIC COAST OF AFRICA: Canary Islands, shallow water, mainly on *Sargassum* and other algae (ARISTEGUI RUIZ 1984). INDO-WEST-PACIFIC: N.S. Wales (Austr.), Red Sea, Cargados Reef, Providence Island (Brit. E. Africa), at 91–143 m, Prison Island, at 18–37 m, Chuaka (Zanzibar) (WATERS 1913). Gaspar Strasse (Indonesia), at 33 m (MARCUS 1921). PACIFIC COAST OF AMERICA: Gorgona (Col.), at 27 m, Galápagos, shore (HASTINGS 1930). Off Tiburón Island (Gulf of California), at 91 m (SOULE 1959). Off Nuez Island, Cocos Islands, at 55–91 m, Isla Santelma (Gulf of Panamá), on pearl oysters (OSBURN 1950).

19. **Bugula hummelincki** n. sp.

Figs 23a–d

Holotype: RMNH 02982.

BONAIRE: West coast of Klein Bonaire 1049C. On underside of coral debris and corals, 1–3 m deep.

Description

Colonies erect, up to 1 cm observed, budding from an upright ancestrula, consisting of biserial rows of zooecia, forming a fan-shaped bifurcation system, of type 3 (HARMER 1923). Slightly calcified zooids alternating, all facing the same direction. Zooecia immediately distal of a bifurcation (zooids C, D, E, and F), sometimes have thickened cuticular walls, resembling joints. These "joints" are more prominent towards the base of the colony. Colony white or very light brown in colour.

Zooecium oblong, slightly narrowed proximally. Opesia occupies 3/4–5/6 of the frontal side, is proximally rounded and bears a little slit. No operculum, instead a sphincter is present. No spines.

Polypide with about 12 tentacles.

Avicularium of medium size, pedunculate, situated at 2/3 of the opesia, on the outer lateral wall, directed outwards. Rostrum forming a curved beak; distal and proximal cryptocyst well-developed.

Communication between zooids by uniporous septulae; 2 in each lateral wall; about 7 in the terminal walls.

Rhizoids attached to the baso-proximal part of basal zooids, especially the ancestrula. Budding-place of rhizoids oval. Rhizoids growing towards the substratum along basal zooids, straw-coloured.

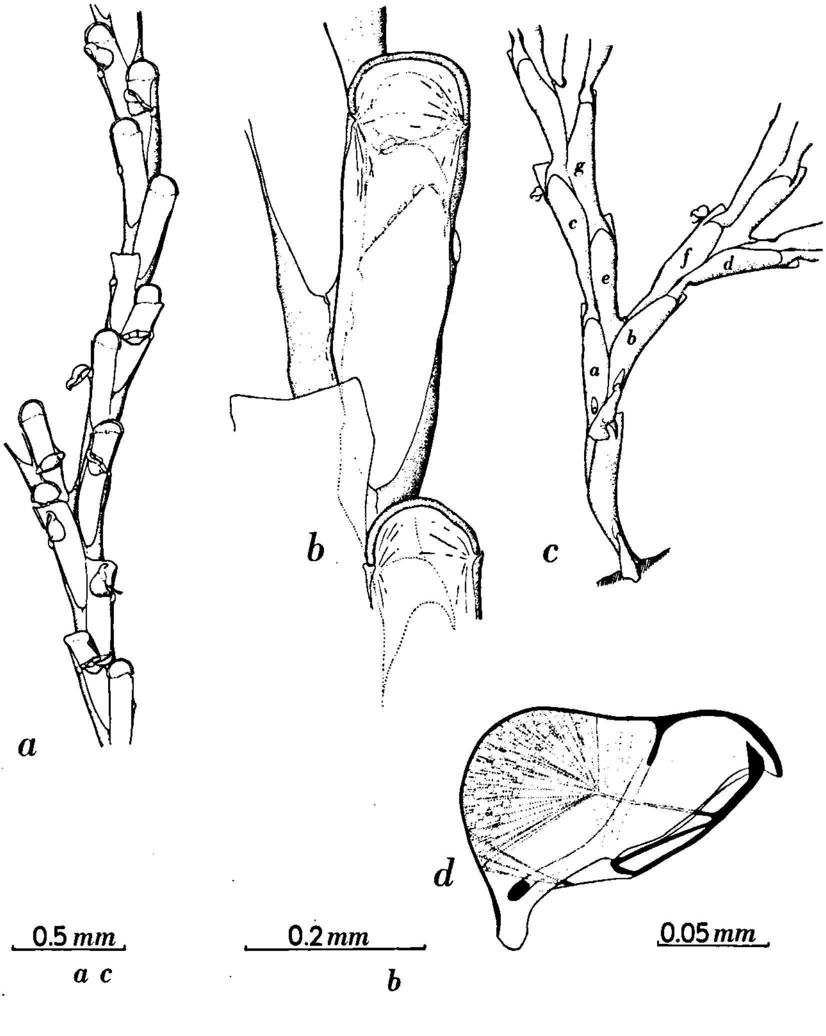


Fig. 23. *Bugula hummelincki* n. sp. *a*. Frontal side of a part of the colony. *b*. Detail of a zooecium with ovicell. *c*. Basal side of the basal part of a colony, showing the type of bifurcation, ancestrula, and rhizoids. *d*. Diagram of an avicularium. (RMNH 02982, stat. 1049C)

Ovicells cap-shaped, pedunculate, attached to the middle of the distal wall; endooecium partly calcified. Embryos yellowish.

Measurements (see Figs 32b, e): Lz 0.48–*0.63*–0.77 mm. Wz 0.13–*0.14*–0.15 mm. L av 0.130–*0.137*–0.142 mm. W av 0.077–*0.078*–0.079 mm.

Discussion

The present species very much resembles *Bugula carvalhoi* MARCUS (1949: 17, 18, figs 20, 21), differing in the absence of the distal spines. No further resembling species found in the bryozoan literature of the Atlantic area and in general works (HARMER 1926, OSBURN 1950, BUSK 1884).

The species is named after P. WAGENAAR HUMMELINCK.

20. **Bugula aff. uniserialis** Hincks, 1884

Figs 24a–e

Bugula uniserialis HINCKS, 1884: 367, pl. 8 fig. 8; HASTINGS 1930: 705, pl. 2 fig. 7; MARCUS 1937: 72, 73, pl. 15 fig. 38; OSBURN 1950: 159; WINSTON 1982: 130, 131.
Bugula pedunculata O'DONOGHUE, 1925: 17, 18, pl. 2 figs 3, 4.
Kinetoskias spec. GANAPATI, RAO & RAO, 1969: 387, 388, fig. 1.
Kinetoskias klugei RAO & GANAPATI, 1972: 212–219, fig 1–5.

CURAÇAO: Awa Blanco 62.
BONAIRE: Punt Vierkant 1059B; Klein Bonaire 1049C.
On living and dead coral; in reef areas (clear water); at 1–3 m depth.
BMNH 99.5.1.413, Australia (Hincks, Holotype).

Description

Colonies erect, consisting of biserial rows of zooecia, forming a bifurcation system of type 3 (HARMER 1923). Zooecia alternating, those of the 2 series are slightly turned outwards instead of toward each other as in most members of the genus. Branches geniculate because the distal parts of the zooecia are hanging to the outside. Colour of the colonies is white or very light brown.

Zooecia oblong, slightly calcified, divided in 3 parts by 2 wringkly constrictions. Distal frontal part occupied by the opesia. Operculum pre-

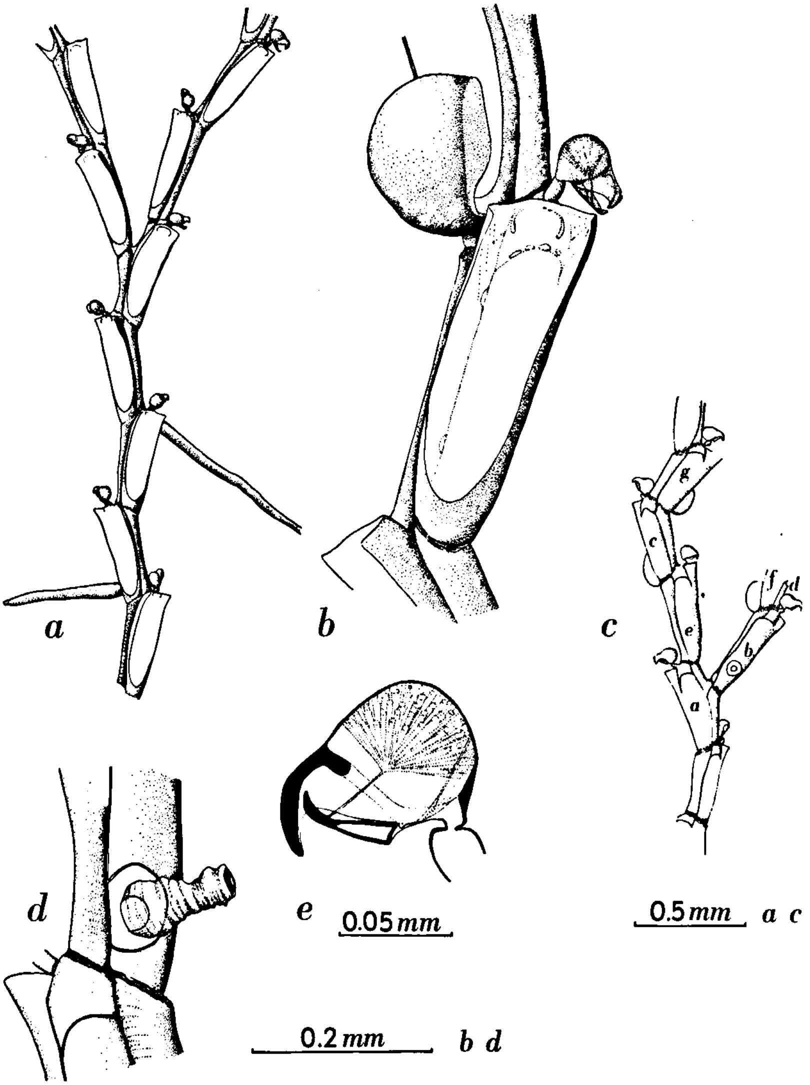


Fig. 24. *Bugula* aff. *uniserialis* Hincks, 1884. *a*. Part of the colony, frontal side. *b*. Detail of a few zooecia, frontal side, showing an ovicell, an avicularium on the proximal part of a zooecium, and the communication pores in the distal part of a zooecium. *c*. Part of the colony, basal side, showing the bifurcation type. *d*. Detail of a few zooecia on the basal side, showing the budding place of the rhizoid. *e*. Diagram of an avicularium. (RMNH 02993, stat. 1059B)

sent, a broad, elliptical, slightly thickened arch. Median part of zooid, oblong, tubular. Proximal part short, forked, bearing the avicularium on a rather long peduncle. Spines absent.

Polypide with 16–17 tentacles.

Avicularium small: mandible very scleritinous; rostrum hooked; cryptocyst developed.

Communication between zooids by uniporous septulae, 2 in each lateral wall, 2–4 in the terminal walls.

Rhizoids attached to the distal part of the zooecium, near the wrinkled zone, on the basal side.

Ovicells globular, pedunculate, slightly calcified, attached to the distal inner corner of the zooecium, provided with a broad lip around the large opening which is directed towards the zooid to which the ovicell belongs. Embryos orange.

Measurements (see Figs 32c, f, g): Lz (=Lz1+Lz2) 0.61–*0.73*–0.84 mm. Wz 0.10–*0.12*–0.13 mm. L av 0.087–*0.102*–0.112 mm. W av 0.059–*0.064*–0.073 mm. D ov 0.154–*0.170*–0.187 mm.

Discussion

The present species resembles *Bugula uniserialis* as described by Hincks in 1884, from Australia (type BMNH 99.5.1.413). The holotype is dry and shrivelled which gave some difficulties when comparing. The zooids of the holotype are smaller and the colony is more "zig-zag" shaped. The present form resembles that described by Marcus (1937) as *B. uniserialis*. Specimens from the Netherlands Antilles and Brazil (Marcus 1937) differ significantly from the description given by Hastings (1930: 705). In her specimens the inner distal corner is rounded and the opesia is half the length of the expanded distal part. There is reason to doubt the identity of the West Atlantic and East Pacific forms in relation to the holotype of *B. uniserialis* from Australia. Very little is known about the distribution of these forms and their variability. Because of this uncertainty no definite status is given to the present form.

Figures given by Rao & Ganapati (1972: figs 1–5) show specimens which very much resemble *B. uniserialis* Hincks, 1884. The pedunculate avicularium is placed on the proximal part of the zooid, not on the disto-basal wall. The specimens found by Rao & Ganapati could be identified with *B. uniserialis* Hicks 1884. In that case, *Kinetoskias klugei* Rao & Ganapati, 1972 is synonymous with *B. uniserialis*.

B. uniserialis from Australia and the forms from the West Atlantic are not characteristic for the genus *Bugula*. Zooids divided in 3 parts by constrictions is a character mostly seen in *Bicellariella* and in *Caulibugula*, which indicates a certain affinity with these genera. For the systematic place of the species, a study of the Bicellariellidae is needed.

A circumtropical shallow-water species.

Distribution (with reservations, see Discussion):
CARIBBEAN: Curaçao, Bonaire. – Indian River area (Fla.), in shallow water, on red algae (*Laurencia*) (WINSTON 1982). ATLANTIC COAST OF SOUTH AMERICA: Bahia de Santos, in shallow water, on algae (MARCUS 1937). INDO-WEST-PACIFIC: Off Port Phillips Heads, Victoria, on weed (HINCKS 1884). Visakhapatnam coast (Bengal), shallow water (RAO & GANAPATI 1969; GANAPATI & RAO 1972). PACIFIC COAST OF AMERICA: Galápagos, on shore and 18–22 m (HASTINGS 1930). La Jolla (Calif.), on stone (O'DONOGHUE 1925). – Often occurring on algae.

Genus **Caulibugula** Verrill, 1900

Caulibugula, HARMER 1926: 456–459; MARCUS 1941a: 57 (key to species); OSBURN 1950: 160; BASSLER 1953: G181; MATURO 1966: 574.

Colony biserial, with "jointed" stalks of long, narrow, kenozooids. Zooids narrowing towards their base, sometimes divided in 3 areas by constrictions. Proximal zooid of a fan ancestrula-like. Avicularia, when present, pedunculate, "bird head"-shaped.

HARMER discussed the genus and noted the graduation in characters between *Bicellariella*-like, and *Bugula*-like species. *Caulibugula* is separated from *Bugula* and *Bicellariella* because of the presence of stalks in *Caulibugula*.

21. **Caulibugula dendrograpta** (Waters, 1913)

Figs 25a–f

Stirparia dendrograpta WATERS, 1913: 470, pl. 66 figs 4–9.
Bugula armata, OSBURN 1914: 188, 189, figs 4, 5.

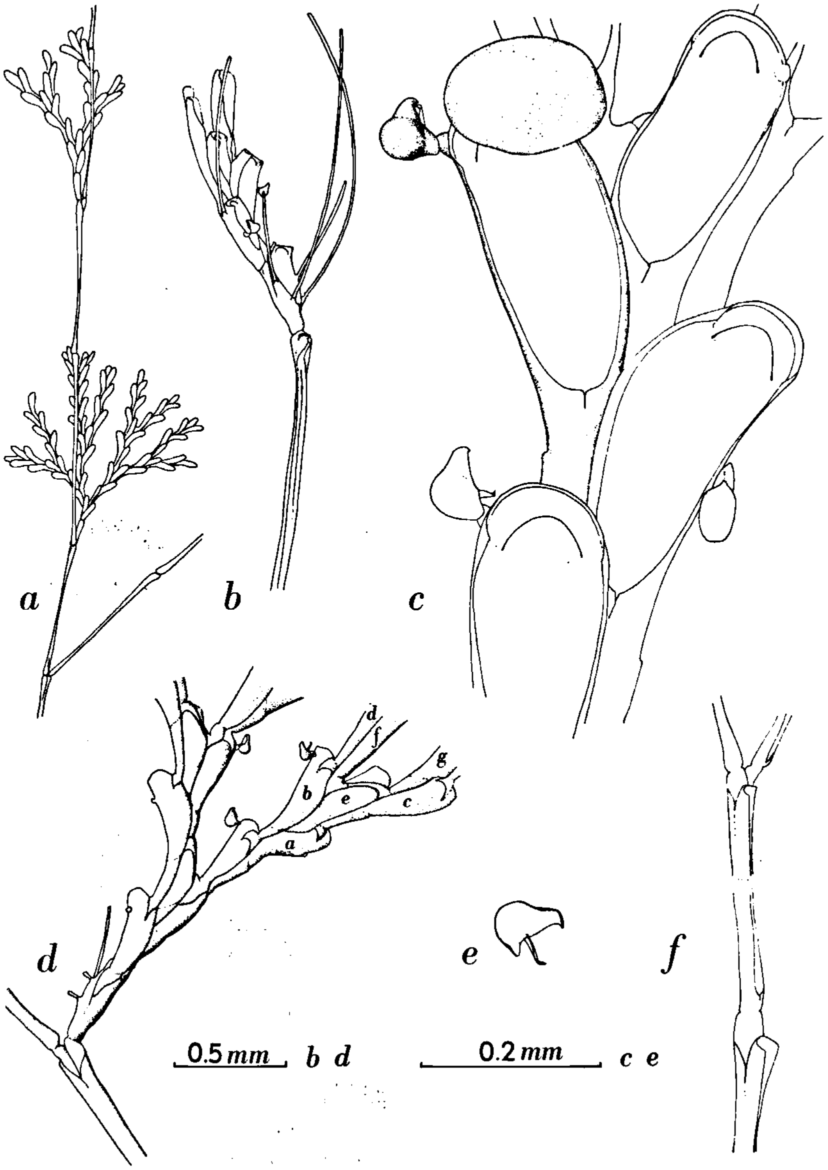


Fig. 25. *Caulibugula dendrograpta* (Waters, 1913). *a*. Part of a colony. *b*. Proximal part of a fan, with ancestrula-like zooid (lateral view). *c*. Detail of the frontal side, distal part of a fan. *d*. Basal part of a fan showing constrictions and bifurcations. *e*. Diagram of an avicularium. *f*. Diagram of stalk-kenozooids. (RMNH 02994, stat. 60)

Caulibugula dendrograpta, HARMER 1926: 458, 459, pl. 33 figs 1–4; MATURO 1966: 574, fig. 14; COOK 1968b: 162.
Caulibugula armata, MARCUS 1938a: 29, pl. 7 figs 14A, B, pl. 6 fig. 15; OSBURN 1940: 393.
not *Bugula* (*Caulibugula*) *armata* VERRILL, 1900: 593 (see MATURO 1966: 575 to distinguish *C. armata* (Verrill) from *C. dendrograpta* (Waters)).

CURAÇAO: Piscadera Inner Bay, northern part 60; Spaanse Water, inner bay 51.
Attached to sponges and ascidians on *Rhizophora mangle* roots; in very turbid and clear water; at 0–1 m depth. The species occurred on 1 or 2 roots at the 2 localities and was absent in the surrounding environment.
BMNH 99.7.1.257 Busk coll. (*Bicellaria glabra*); BMNH 28.3.6.304 Bornea Bank, Straits of Makassar, Malay Archipelago, Siboga exp. stat. 77, 59 m depth.

Description

Colonies erect, consisting of fan-shaped, biserial, bifurcation systems of type 4 (HARMER 1923), situated on stalks of kenozooids. Alternating, slightly calcified zooecia, all turned towards the stalk. Succesive bifurcations, in the fan, closely set; zooid D can be zooid A of the next bifurcation.

Zooids oblong, proximally narrowing, divided in 3 parts by 2 basal constrictions. The proximal ancestrula-like zooid has one constriction. forked basal part separated from the tubular median part by a straight constriction. Median and distal parts separated by an oblique constriction. Opesia occupies the distal part of the front, is proximally rounded and bears a little slit. Inconspicuous operculum formed by a semi-circular thickening of the frontal membrane, situated between the distal pointed processes at the distal corners of the zooecium.

Proximal ancestrula like zooecium of a fan bears 4–6–8 long (up to 4 times the zooecium length), curved, at the base jointed, spines around the opesia. The opesia has a deep slit. Distal zooecia bear 0–4, jointed spines. Zooecia at the periphery of the fan bear 3 (seldom 4) long spines, zooecia in the center of the fan bear 1 or 2 (seldom 0) short spines (as long as the zooecium).

Polypide with 12 tentacles.

Proximal zooids form calcified thickenings in their lateral walls, like the kenozooids of the stalks.

Slightly calcified pedunculate avicularia, situated on the lateral, outer wall of the zooecia, directed basally. Proximal ancestrula-like zooid without avicularium. Towards the tips of the branches, the avicularia are more distally situated on the zooids. Rostrum hooked; cryptocyst not developed; mandible with hooked point.

Bifurcating stalks consist of oblong kenozooids with heavily calcified lateral walls and oblong, frontal opesiae of which the distally pointed corners are recognizable. Kenozooids with forked proximal part on distal basal part of their predecessors, immediately followed by 1 or 2 constrictions (joints).

Stalk kenozooids give rise to thin stolon-like rhizoids.

Communication by uniporous septulae, 2 in the common lateral walls, 2–4 in the terminal walls.

Spherical, pedunculate, slightly calcified ovicells situated at the inner distal corners of the zooecia. Embryos orange.

Measurements (see Figs 32a, d, e): Lz 0.46–*0.47*–0.68 mm. Wz 0.12–*0.13*–0.15 mm. L opes 0.32–*0.36*–0.39 mm. W opes 0.12–*0.13*–0.15 mm. L av 0.065–*0.070*–0.075 mm. W av 0.045–*0.046*–0.049 mm. L stalk 2.24–*2.52*–3.00 mm. W stalk 0.054–*0.077*–0.097 mm.

Discussion

The species has some characters of *Bicellariella*: proximal, ancestrula-like zooids have long jointed spines surrounding the opesiae, and 2 constrictions divide the zooecia in 3 parts. Differentiation in number of spines related to the position of the zooid in the fan is similar to that in *Bicellariella chuakensis* Waters, 1913. The presence of "stalk-kenozooids" leads to *Caulibugula.*

MATURO (1966) revised the nomenclature of the species. MARCUS (1926) described the morphology of the stalks of *Caulibugula.*

Widely distributed in warmer, shallow waters, often occurring on sponges.

CARIBBEAN: Curaçao. – Tortugas, at 18–33 m, on sponges and crab legs (OSBURN 1914). Puerto Rico, to 37 m, on mangrove roots, sponges and corallines (OSBURN 1940). ATLANTIC COAST OF SOUTH AMERICA: Bahia de Santos, at 20 m, on sponges (MARCUS 1938a). ATLANTIC COAST OF AFRICA: Off Freetown (Sierra Leone), at 15 m, Bay of Biafra, Cape Verde Islands (COOK 1968b). INDO-WEST-PACIFIC: Chuaka (Zanzibar), at 4 m (WATERS 1913). Sumbawa, at 69 m, Borneo Bank, Strait of Makassar, at 59 m, Off Loslos Island (N. end of New Guinea), at 18 m (HARMER 1926).

Family BEANIIDAE Canu & Bassler, 1927

Beaniidae, BASSLER 1953: G181; RYLAND & HAYWARD 1977: 150.

Zooecia recumbent, more or less separated, except for linking tubular extensions from the proximal region. Colonies attached to the substratum by rhizoids. Zooecia little calcified, forming uni- or multi-serial rows. No gymnocyst present. Opesia occupies all of the front. Avicularia commonly pedunculate. Ovicells often absent.

Genus **Beania** Johnston, 1840

Beania JOHNSTON, 1840: 272; HARMER 1926: 410–412; OSBURN 1950: 169, 170; BASSLER 1953: G182; MATURO 1966: 578; RYLAND & HAYWARD 1977: 150.

Colony unilaminar, ramifying or reticulate; zooids quincuncially or irregularly spaced; multiporous septulae present at proximal end of tubes. Rhizoids for attachment issuing from basal surface.

22. **Beania cupulariensis** Osburn, 1914

Figs 26a–d

Beania cupulariensis OSBURN, 1914: 190, 191, figs 6, 7; HARMER 1926: 419, pl. 28 figs 13, 14; OSBURN 1940: 399; MARCUS 1944: 1–3, figs 1–4; 1953: 291, figs 41–43; COOK 1968b: 164.

CURAÇAO: Piscadera Outer Bay 2; Fuikbaai 61.
On dead coral and glass; in clear water; at 3–6 m depth.

Description

Colonies ramifying, covering large parts of the substratum (up to 8 cm in diameter), consisting of bifurcating uniserial rows of slightly calcified, white zooecia, attached to the substratum by rhizoids.

Zooecium large, boat-shaped, proximal part short, tubular, attached to the basal wall of its predecessor. Frontal membrane covering the opesia, occupying the frontal side, surrounded by 4–6–7 pairs of lateral and one pair of distal spines, which are often overarching the fontal membrane.

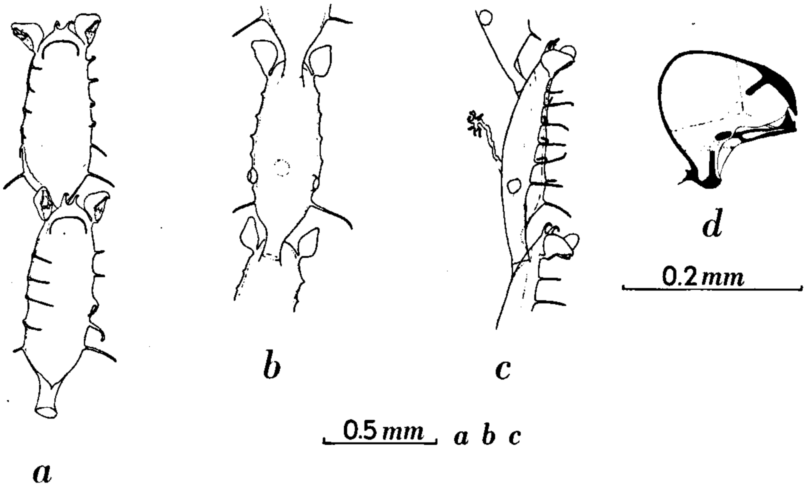


Fig. 26. ***Beania cupulariensis*** Osburn, 1914. *a*. Frontal side of a zooecium. *b*. Basal side of a zooecium. *c*. Lateral view of a zooecium. *d*. Diagram of an avicularium. (RMNH 02998, stat. 2)

Scleritinous thickened operculum almost semi-circular, broad, surrounded by a wrinkling in the frontal membrane. Occlusor muscles attached to lateral triangular sclerites.

Avicularia pedunculate, calcified, normally present, situated on both sides of the zooecium, near the operculum. Avicularian cryptocyst well-developed; rostrum hooked; mandible with a hooked point and 3 (2 lateral, 1 distal) smaller teeth. Tendons of occlusor muscles separate.

Communication by multiporous septulae, one distally on the basal wall, 2 latero-proximally when bifurcation occurs.

Median on the basal wall, rhizoids are growing to the substratum. These rhizoids are tubular, very strong, provided with calcified, fingered, terminal attachment plates.

Ovicells absent, embryos develop endozooecial.

Measurements (see Figs 32h, i): Lz 0.84–*0.94*–1.01 mm. Wz 0.24–*0.31*–0.37 mm. L av 0.156–*0.160*–0.169 mm.

Widely distributed in warmer, shallow waters.

CARIBBEAN: Curaçao. – Tortugas, at 18–40 m, on *Cupuladria* (OSBURN 1914). Parguera (P.R.), at 18 m, on *Cupuladria* (OSBURN 1940). ATLANTIC COAST OF SOUTH AMERICA: Ilha de San Sebastião, 100 km off Santos, on algae (MARCUS 1953). ATLANTIC COAST OF AFRICA: Bay of Praia (Cape Verde Islands), at 47 m, on calcareous accretions (COOK 1968b). INDO-WEST-PACIFIC: Sulu Archipelago, at 16–23 m, Aru Isl., at 13 m (HARMER 1926).

23. **Beania klugei** Cook, 1968

Figs 27a–c

Beania intermedia, WATERS 1909 (part): 137, specimen from the Red Sea; OSBURN 1914: 189; HASTINGS 1930: 705; MARCUS 1938b: 210, text-fig. 15; OSBURN 1940: 398; 1947: 25; SHIER 1964: 624; MATURO 1966: 579, text-fig. 18.
not *Diachoris intermedia* HINCKS, 1881: 133, pl. 5 fig. 8.
Beania klugei COOK, 1968b: 164–167, fig. 2A, 2B; RAO 1975: 60, 61, fig. 68; WINSTON 1982: 131, fig. 46.

CURAÇAO: Piscadera Outer Bay 2; Piscadera Inner Bay, entrance 57, northern part 1493b; Spaanse Water, entrance 27; Fuikbaai 61, 82; Santa Marta Bay, inner bay 45.
BONAIRE: Lac 1067.
On stones, shells, hydroids, Bryozoa (usually on erect species like *Bugula neritima, Savignyella lafontii, Vittaticella elegans* and *Bowerbankia* spec.), not observed directly growing on *Rhizophora*-roots; generally in clear water; at 0–6 m depth.
BMNH 1974.1.18.1 West Africa (Cook, holotype).

Description

Colony uniserial, consisting of creeping or semi-erect white zooecia, attached to the substratum by rhizoids. Easily overlooked in spite of the large zooecia, because of the small and loose colonies, often adventitious on bushy Bryozoa.

Zooecia boat-shaped, slightly calcified, proximally narrowing and forming a short tubular extension. Zooids without spines but with 2 minute distal prominences immediately followed by 2 lacunae in the basal wall. Laterally, sharp lines divide the zooecium walls in basal and lateral parts. Operculum a broad, almost semicircular thickening of the frontal membrane, on which the occlusor muscles are laterally attached to triangular sclerites.

Polypide with 26 long tentacles, when everted forming a bowl configuration. Introvert very long, about 1 mm when fully everted.

Oblong avicularia pedunculate, placed distally on both sides of the zooecium. Rostrum and cryptocyst of the avicularium well-developed;

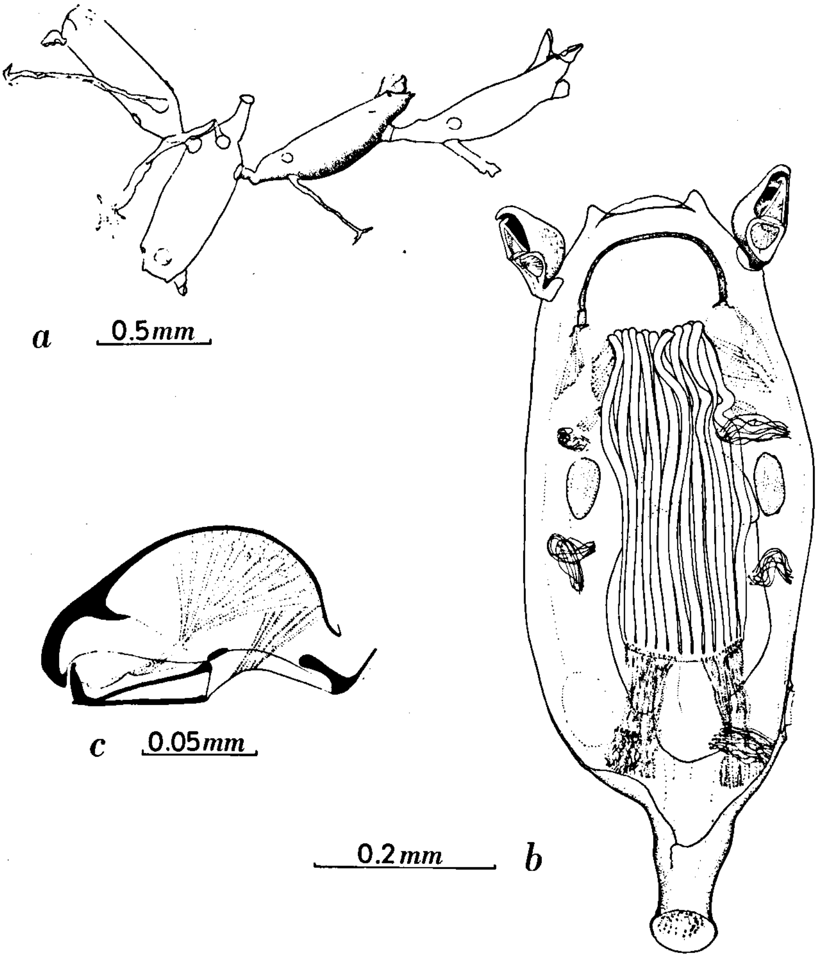


Fig. 27. ***Beania klugei*** Cook, 1968. *a*. Part of a colony. *b*. Detail of a zooid. *c*. Diagram of an avicularium. (RMNH 02995, stat. 1493b)

calcified walls flaky. Mandibles with a hooked point. Two separate tendons lead to the occlusor muscles. When an avicularium is absent, a little prominence is present instead.

Budding at 4 places on the basal wall. Medio-distally, a short tubular extension is present to which the successor is attached. Proximo-laterally there are 2 places for bifurcation. Between these 3 places a rhizoid is growing towards the substratum. Rhizoids can be very long and are provided with heavily calcified, fingered, terminal attachment plates. All communications between zooids by multiporous septulae.

Ovicells not present. Embryos endozooecial.

Measurements (see Figs 32h, i): Lz 0.95–*0.98*–1.03 mm. Wz 0.24–*0.29*–0.32 mm. L av 0.106–*0.127*–0.158 mm.

Discussion

Cook (1968b) separated 2 distinct species in the material previously referred to *Beania intermedia*: "The first form, originally described by Hincks, from Tasmania, has smaller zooids, distinct distal and lateral spines, the larger, but shorter, domed avicularia and lateral tubules at the level of the middle of the zooid. The second form, which occurs in the Indian Ocean and Red Sea, and from both sides of the Atlantic Ocean, has consistently different characters, and is here considered to be a distinct species, *Beania klugei.*"

Menon & Nair (1969) describe *Bugulella clavata* Hincks, 1887, which they rediscovered. Hincks wrote about *Bugulella clavata,* that he lost the only specimens he had, so there is no holotype. The figure and description of Hincks are very poor and it is not advisible to choose his figure as a lectotype. The specimens of Menon & Nair should be compared with *Beania klugei,* which is common in the Atlantic ocean, to consider its synonymy with *Beania klugei.*

Unknown structures on both sides of the polypide could be glands. Hagemen & Lutaud (1982) mention the occurrence of glands in Anascan Bryozoa.

Widely distributed in warmer, shallow waters.

Caribbean: Curaçao, Bonaire. – Guánica Harbor (P.R.), at 11–64 m (Osburn 1940). Tortugas, at 9, 19, and 27 m, on hydroids, other Bryozoa and shells (Osburn 1914). Cubagua, shore (Osburn 1947). Indian River area (Fla.), in shallow water, on hydroid stems (*Thyroscyphus*), algae and seagrass (Winston 1982). Atlantic Coast of North America: East of Cape Lookout (N.C.), on shells (Maturo 1966). Atlantic Coast of Africa: Off Sugarloaf (St. Helena), at 36–69 m (Marcus 1938b). Bay of Praia (Cape Verde Isl.), off Freetown (Sierra Leone), at 8–22 m, on calcareous accretions, and hydroids (Cook 1968b). Indo-West-Pacific: Red Sea (Waters 1909). Pacific Coast of America: Coiba Isl. (Panamá), shore (Hastings 1930). St. Andrews State Park (Panamá City), shore, on seagrass (Shier 1964).

24. **Beania mirabilis** Johnston, 1840

Figs 28a–c

Beania mirabilis JOHNSTON, 1840: 272–274, figs 1, 2; BUSK 1852: 32, pl. 24 figs 4, 5; HINCKS 1880: 96, pl. 4 figs 8–10; OSBURN 1914: 189; HARMER 1926: 419, pl. 18 fig. 15; CANU & BASSLER 1929: 233, figs 96A–C; HASTINGS 1930: 705; MARCUS 1937: 60, pl. 12 fig. 29; 1938b: 209; OSBURN 1940: 398; 1947: 24; 1950: 170, fig. 8; PRENANT & BOBIN 1966: 552–555, figs 191I–VIII; COOK 1968b: 163; RYLAND & HAYWARD 1977: 150, fig. 73; WINSTON 1982: 133, fig. 45.

CURAÇAO: Piscadera Outer Bay 2.
On stones; in clear water; at 3–6 m depth.
BMNH 47.10.11.43 & 47.9.18.91, Scarborough, England (Johnston, holotypes, see discussion).

Description

Colonies consist of uniserial rows of creeping, distally erect, white, zooecia, attached to the substratum by rhizoids. Very inconspicuous species because of the loose colonies.

Zooecia slightly calcified, distally boat-shaped, proximally long, tubular. Distal and proximal parts at angles of 120°–130°. The opesia is surrounded by 9–*12*–14 lateral and 2 distal spines, all overarching the frontal membrane. A lateral line divides the wall in lateral and basal parts. Operculum broad, almost semi-circular, at an obtuse angle (120°–123°) with the frontal membrane, with triangular sclerites for attachment of the occlusor muscles.

Polypide with 20 tentacles and a long introvert.

No avicularia present.

Budding at 4 places, closely spaced, at the proximo-basal wall of the distal part. The most distal bud becomes the successor, 2 lateral buds are for bifurcations and the one in the middel of these 3 becomes a rhizoid.

All communications by multiporous septulae. Rhizoids with fingered, heavily calcified, terminal attachment plates.

Ovicells absent, embryos endozooecial.

Measurements (see Figs 32j, k): L1z 0.48–*0.70*–0.93 mm. L2z 0.50–*0.59*–0.63 mm. Wz 0.15–*0.17*–0.18 mm.

Discussion

JOHNSTON (1840) designated two different colonies as holotypes

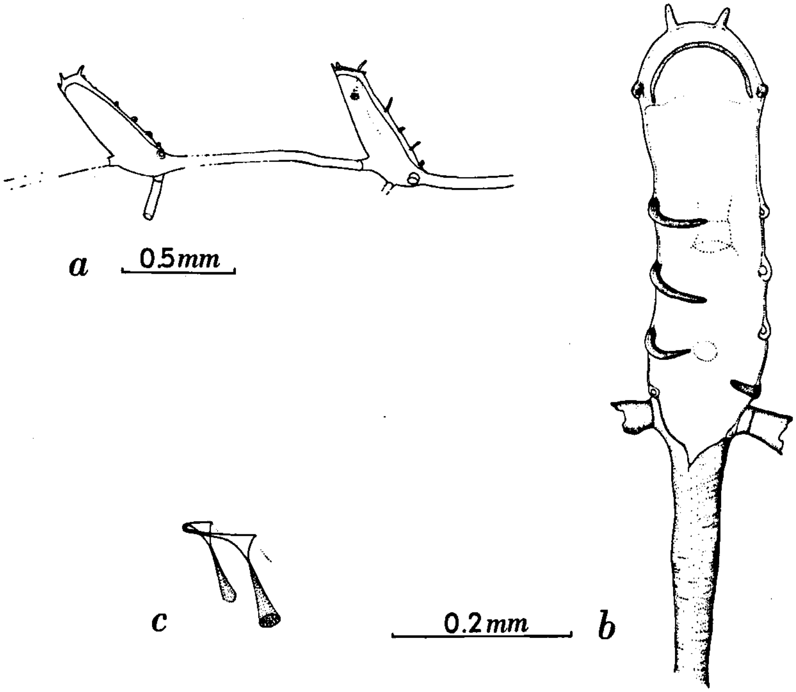


Fig. 28. *Beania mirabilis* Johnston, 1840. *a*. Part of a colony. *b*. detail of a zooecium. c. Diagram of the operculum with occlusor muscles. (RMNH 02996, stat. 2)

(BMNH 47.10.11.43 and BMNH 47.9.18.91). One of the type specimens should become lectotype, the other a syntype.

Cosmopolitan, litoral-130 m.

Caribbean: Curaçao. – Guánica Harbor (P.R.), at 9–36 m (Osburn 1940). Tortugas, at 33 m, on crab legs (Osburn 1914). Indian River area (Fla.), at 0–10 m, on hydroid roots and shells (Winston 1982). Cabo La Vela (Col.), at 38–40 m, on algae, hydroids, crustaceans, other Bryozoa, tunicates etc. (Marcus 1937). Atlantic Coast of Africa: St. Helena, at 27 and 50 m (Marcus 1938b). Cape Verde Isl., at 8–50 m, on other bryozoans, calcareous accretions, hydroids, the foraminifer *Jullienella foetida* (Cook 1968b). Atlantic Coast of Europe: Scarborough (Britain), on shell (Johnston 1840). Britain, on shell (Busk 1852). Britain, on weed (*Laminaria*), hydroids, bryozoans (*Bugula avicularia, Bugula turbinata*), stones, shells (*Pecten maximus, Pectunculus*), crabs (Hincks 1880). Britain at 0–130 m, on *Laminaria* holdfasts, bryozoans (*Cellaria, Flustra, Pentapora*), dead shells (Ryland & Hayward 1977). Indo-West-Pacific: Sulu Archipelago, Torres Straits, at 16–23 m (Harmer 1926). Pacific Coast of America: Panamá Canal, at 27 m (Hastings 1930).

Order ASCOPHORA IMPERFECTA Harmer 1957

Family EXECHONELLIDAE Harmer 1957

Exechonellidae HARMER, 1957: 651, 652.

Frontal membrane continous with the operculum, separated from the calcareous frontal shield.

Genus **Exechonella** Canu & Bassler, 1927

Exechonella CANU & BASSLER, 1927: 4; HARMER 1957: 652; COOK 1967: 337.

Colonies encrusting; zooids large. Frontal shield with numerous foramina covering the ectocyst.

25. **Exechonella antillea** (Osburn, 1927)

Figs 29a–g

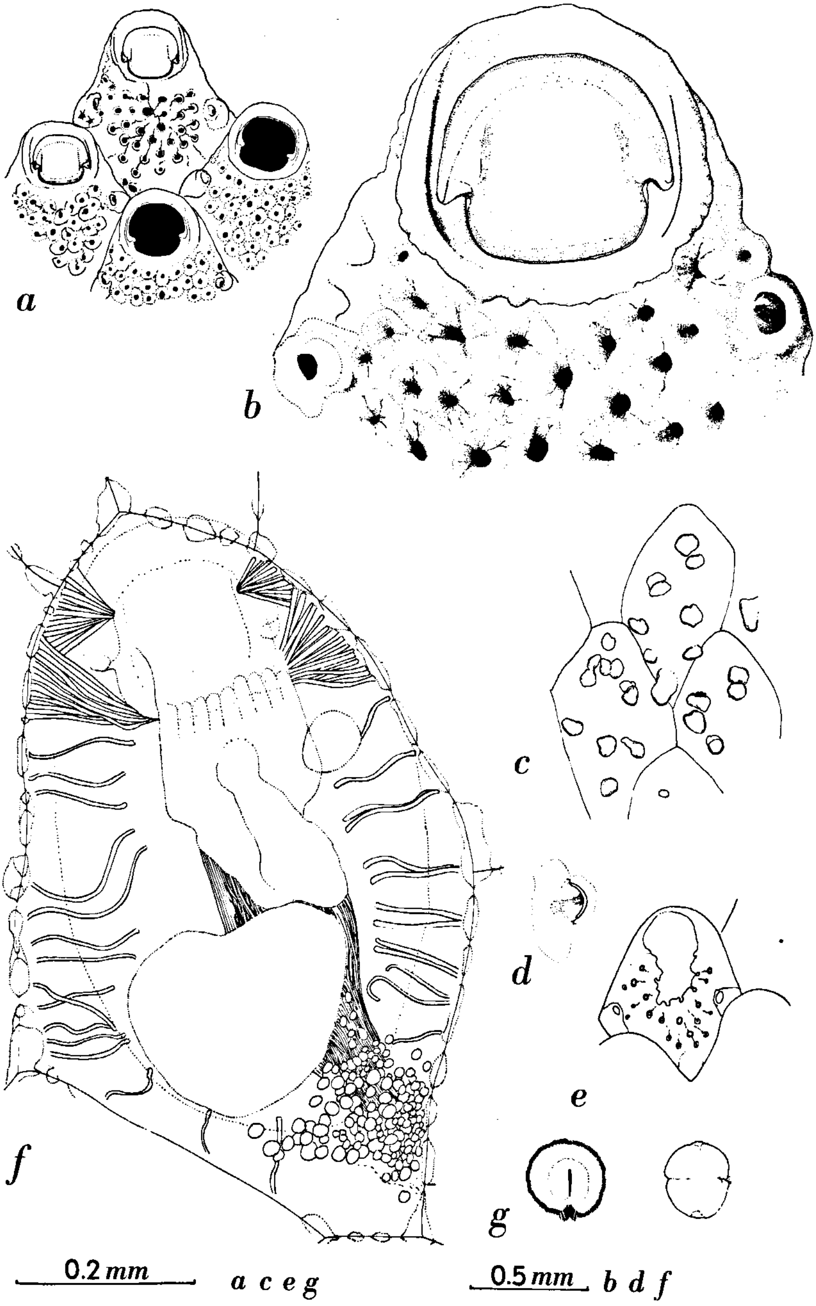
Lepralia antillea OSBURN, 1927: 128, text-figs 6, 7.
Exechonella pumicosa CANU & BASSLER, 1928: 70, 71, pl. 14 fig. 1, text-fig. 11a.
Exechonella antillea, OSBURN 1940: 366; 1950: 95, 96, pl. 10, figs 9, 10; SHIER 1964: 616; WINSTON 1982: 136, fig. 60.
not *Exechonella antillea*, COOK 1967: 337, 338, pl. 1 fig. E; 1968b: 173.

CURAÇAO: Spaanse Water 1630 (topotypic); St. Joris Bay, inner bay 93.
On *Rhizophora mangle* and *Crassostrea*; in turbid water; at 0–1 and 5 m.

Description

Colonies encrusting, one layer thick; attached to the substratum by dorsal attachment organs. Colonies varying in form and dimensions; white, sometimes red in colour.

Zooecia hexagonal, distally rounded, separated by deep grooves. Convex calcareous frontal shield covers the frontal membrane (ectocyst), provided with 40–*61*–86 foramina. Foramina surrounded by calcareous collars, which are more heavily calcified in older zooids. Small marginal pores present, not surrounded by calcareous collars. Orifice surrounded


a
b
c
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by a peristome. Orifice formed by 2 arches, the distal arch wider than the proximal arch. The distal arch is formed by 2 calcareous layers of which the inner-lower layer forms the cardellae on which the operculum articulates. Operculum with marginal sclerites and longitudinal sclerites to which the tendons of the occlusor muscles are attached. The ectocyst is attached to the proximal border of the operculum.

Small avicularia, when present, laterally situated, budding from pores, forming tubular chambers of which the opesia are directed towards the long axis of the zooecia; mandible, when present, semi-circular, with a marginal sclerite; occlusor muscle attached median, behind the marginal sclerite of the mandible.

Communications by numerous uniporous septulae in all walls.

Basal wall forming tubular attachment organs varying in form and number, up to 10 tubular processes on one basal wall observed.

Embryos brooded endozooecially; polypide degenerate when embryos become larger and occupy the inner part of the zooid.

Measurements (see Figs 32L): Lz 0.81–*0.88*–0.97 mm. Wz 0.61–*0.69*–0.78 mm. L opes 0.197–*0.224*–0.240 mm. W opes 0.223–*0.238*–0.252 mm.

Discussion

There is a large range in variation in most of the characters of this species. The number of frontal foraminae (40–86) for example, is related to the size of the zooecium and differs enormously between zooecia of the same colony. The zooids around the ancestrula are generally smaller and bear less foraminae than the peripherical zooids. Cook (1967, 1968b) compared the specimens found by the author with the specimens in the British Museum, which were found in the East Atlantic. The East Atlantic material differed significant from the West Indian material (type-locality Spaanse Water, Curaçao), and probably belongs to an other species (Cook, pers. comm.).

Fig. 29. *Exechonella antillea* (Osburn, 1927). *a*. Part of the periphery of a colony. *b*. Detail of the distal part of a zooid. *c*. Basal side of a part of the colony, showing the tubular attachment organs. *d*. Avicularium mandible. *e*. Peripherical zooid, showing development of the frontal shield. *f*. Inner structures of the zooid, visible after dissolving the calcareous parts. *g*. Embryos. (RMNH 02997, stat. 93)

When the calcareous parts of the zooid are dissolved, the inner structures become visible. Parietal muscles lead from the frontal membrane or ectocyst to the lateral walls and reach their highest density near the proximal border of the operculum. Occlusor muscles of the operculum are also attached to the lateral walls. Uniporous septulae are scattered in the lateral and terminal walls as described by OSBURN in 1927 and shown in his figure 7.

The developing frontal shield was observed in marginal zooids. Irregular processes are growing from the lateral walls towards the center of the zooid, leaving pores which then start forming calcareous collars.

Common in the West Atlantic shallow waters.

CARIBBEAN: Curaçao. – Spaanse Water, in shallow water, on oysters and pottery (OSBURN 1927). Puerto Rico, at 9–36 m, on shells and corals (OSBURN 1940). Northwest Florida, at 9–27 m, on shells and stones (SHIER 1964). Indian River area (Fla.), in shallow water, on hydroid (*Thyroscyphus*) (WINSTON 1982). Fowey Light, 15 miles south of Miami, at 73 m (CANU & BASSLER 1928). PACIFIC COAST OF AMERICA: Gulf of California (OSBURN 1950).

ECOLOGICAL REMARKS

Bays of Type 4, 5 and 6 as far as investigated were almost devoid of Anascan bryozoans. Only *Electra bellula*? was found in Rifwater (stat. 1669), a less polluted bay at that time (1970).

Bays of TYPE 2 were poor in species of Anascan Bryozoa. The species present in these bays develop large and numerous colonies when suitable substrate is present. The absence of hard substrate like stones and dead coral can be the reason for the limited development of *Cranosina coronata* and *Antropora tincta* in this type of bay (both on stones at stat. 7, *Antropora tincta* also on glass at stat. 34b). Species using *Rhizophora mangle* and its epifauna for substrate, grow luxuriantly. This group consists of: *Aetea ligulata* (mostly on erect hydroids and bryozoans), *Bugula neritina* (on *Rhizophora, Thalassia* and *Crassostrea*), *Scrupocellaria piscaderaensis* (on *Rhizophora*), *Synnotum aegyptiacum* (forming tufts with other erect bryozoans and hydroids). *Beania klugei* was found in both Piscadera Inner Bay (stat. 1493b in 1973) and St. Marta Bay (stat. 45 in 1982). This species is inconspicuous and does not seem to produce large and numerous colonies. *Scrupocellaria carmabi* was present in Piscadera Inner Bay in 1963 (stat. 1493) but not found in 1982. The distribution of *Caulibugula dendrograpta* is very peculiar. It was found at one station in the most northern and eutrophicated place of Piscadera Inner Bay, but there it was present in large numbers. It grows on sponges and ascidians which are both common in Piscadera Inner Bay. This makes it difficult to understand the restricted presence (on 3 or 4 *Rhizophora* roots with epifauna). This is probably not a normal distribution pattern for *Caulibugula dendrograpta* considering OSBURN's (1940: 393) observation on the species: "Porto Rican Survey at numerous stations, at low tide on mangrove roots and piles of wharves, down to 20 fathoms on sponges, corallines etc., one of the most generally distributed species of the region." Although St. Marta Bay is of Type 2, the absence of mangroves reduces the possibilities for bryozoans, the bottom is of mud, only some stones are suitable for substratum and bear bryozoan species that also stand a high sedimentation rate of fine mud. As a result of factors mentioned above, the number of species and colonies is very low compared with Piscadera Inner Bay.

In the bays of TYPE 1 only few species of Anascan bryozoans occur. Species occurring develop numerous and large colonies when a suitable substratum is present. *Antropora minus* was only found at one station (stat. 52, on stones and coral debris), probably due to the absence of a suitable substratum. *Electra bellula*? was present in 1968 and 1970 (stat. 1627, 1643 and 1668A) on *Thalassia* in both Spaanse Water and St. Joris Bay. In spite of examining *Thalassia* at several stations, this inconspicuous species was not found in 1982. The following species are abundant: *Aetea ligulata, Bugula neritina, Synnotum aegyptiacum, Scrupocellaria carmabi* and *Nellia tenella*. The last species was only found in Spaanse Water, but at several stations and in large quantities. *Beania klugei, Caulibugula dendrograpta* and *Exechonella antillea* were rare in Type 1 bays. *Caulibugula dendrograpta* appeared at one station in Piscadera Inner Bay. Although the type locality of *Exechonella antillea* is Spaanse Water (OSBURN 1927: 128) it also appears in St. Joris Bay. *Scrupocellaria curacaoensis* was found in Spaanse Water in 1968 (stat. 1629) on *Rhizophora* but not in Spaanse Water in 1982. In Fuikbaai it is abundant in the eastern part, which is of Type 1 (stat. 33, 66, 66a).

In TYPE 3 bays, both the number of Anascan bryozoan species and number of colonies are lower than in bays of Type 1 and 2. Species occurring: *Aetea ligulata, Beania cupulariensis, Beania klugei, Bugula neritina, Scrupocellaria carmabi, Scr. hildae, Synnotum aegyptiacum.*

Reef, outer bay and entrance stations have the highest amounts of species. However, the species never occur in large numbers of colonies. Colony size is generally smaller here than at inner bay stations. Species only occurring in these environments: *Crassimarginatella harmeri, Parellisina curvirostris, Smittipora levinseni, Beania mirabilis, Bugula minima, Bugula* aff. *uniserialis, Bugula hummelincki, Thalamoporella distorta* and *Bicellariella chuakensis*. Species also occurring in inner bays: *Aetea ligulata, Cranosina coronata, Nellia tenella, Beania cupulariensis, Beania klugei, Scrupocellaria curacaoensis, Scr. carmabi, Scr. hildae, Synnotum aegyptiacum.*

SUBSTRATUM

The substratum on which a bryozoan grows has always been regarded as one of the most important environmental factors. Some species are restricted to certain substrata as a result of selection by their larvae (RYLAND 1959), and specific associations between bryozoans and certain substrata are often found (GAUTIER 1962).

One must be very careful when drawing conclusions concerning substratum preference. Only when the substratum alone is variable and all other conditions remain constant, more definite conclusions can be drawn. The problem is that various substrata are correlated with certain environments. Examples are: the preference of *Rhizophora mangle* for the eastern shores of muddy bays, bivalves like *Crassostrea* and *Isognomon* mostly occur on *Rhizophora* when growing in a certain environment, limited distribution of *Thalassia,* algae, hydroids and other bryozoans. Hard substrata are rare in inner bays and common in outer bays, entrances of bays and reefs. The correlation between species occurring on hard substrata and in reef-, entrance- and outer bay areas is striking as well as the resemblance between the composition of species on soft substrata and in inner bays.

Some species seem to occur on all kinds of substrata: *Aetea ligulata,* *Synnotum aegyptiacum*, *Bugula neritina* (not found on stones) and *Beania klugei* (not found directly attached to *Rhizophora mangle*). The absence of encrusting species is interesting; they are probably more dependent on the properties of the substratum for their colony development.

Antropora minus, *Antropora tincta*, *Beania mirabilis*, *Beania cupulariensis*, *Bugula minima*, *Bugula hummelincki*, *Bugula* aff. *uniserialis*, *Cranosina coronata*, *Crassimarginatella harmeri*, *Parellisina curvirostris*, *Smittipora levinseni* and *Thalamoporella distorta* only occur on hard, inflexible substrata. *Electra bellula*? is completely limited to *Thalassia testudinum*.

A comparison of the occurrence of Anascan bryozoans on various substrata observed during the investigations on Curaçao and Bonaire, with data obtained from the literature, did not show significant differences.

The occurrence of *Electra bellula*? on especially seagrass and algae on Curaçao and Bonaire is an argument more to suggest its identity to be the same as *Electra bellula* of various authors (HINCKS 1881, MARCUS 1937, LAGAAIJ 1963, SHIER 1964, COOK 1968a, WINSTON 1982) who observed *Electra bellula* encrusting seagrass and algae.

SUBSTRATA AND ASSOCIATED BRYOZOANS

Rhizophora mangle roots: *Aetea ligulata*, *Nellia tenella*, *Bugula neritina*, *Scrupocellaria curacaoensis*, *Scr. carmabi*, *Scr. piscaderaensis*, *Caulibugula dendrograpta*, *Synnotum aegyptiacum*, *Exechonella antillea*.

Bivalves (*Crassostrea*, *Isognomon*): *Aetea ligulata*, *Bugula neritina*, *Beania klugei*, *Caulibugula dendrograpta*, *Scrupocellaria piscaderaensis*, *Exechonella antillea*.

Algae: *Aetea ligulata*, *Synnotum aegyptiacum*, *Bicellariella chuakensis*, *Beania klugei*, *Scrupocellaria piscaderaensis*.

Thalassia testudinum: *Bugula neritina*, *Electra bellula*?.

Sponges: *Aetea ligulata*, *Synnotum aegyptiacum*, *Caulibugula dendrograpta*.

Ascidians: *Caulibugula dendrograpta*.

Hydroids: *Aetea ligulata*, *Synnotum aegyptiacum*, *Beania klugei*.

Other Bryozoans (*N. tenella*, *Savignyella lafontii*, *Zoobotryon verticilliatum*, *Vittaticella* spec., *Bugula neritina*): *Aetea ligulata*, *Synnotum aegyptiacum*, *Beania klugei*.

Stones and dead coral: *Aetea ligulata, Cranosina coronata, Antropora minus, Antropora tincta, Crassimarginatella harmeri, Parellisina curvirostris, Smittipora levinseni, Thalamoporella distorta, Scrupocellaria curacaoensis, Scr. carmabi, Scr. piscaderaensis, Scr. hildae, Synnotum aegyptiacum, Bugula minima, Bugula hummelincki, Bugula* aff. *uniserialis, Beania cupulariensis, Beania mirabilis.*

Rubber: *Aetea ligulata.*

Glass: *Aetea ligulata, Cranosina coronata, Antropora tincta, Parellisina curvirostris, Scrupocellaria carmabi, Scr. piscaderaensis, Scr. hildae, Synnotum aegyptiacum, Beania cupulariensis, Beania klugei.*

Shells: *Aetea ligulata.*

Iron: *Parellisina curvirostris, Scrupocellaria curacaoensis, Scr. hildae, Synnotum aegyptiacum.*

Plastics: *Parellisina curvirostris, Thalamoporella distorta, Scrupocellaria hildae, Synnotum aegyptiacum, Bugula minima.*

DISCUSSION

Two factors could have affected the results:

- Even in this tropical area, the species are influenced by seasonal variations. Collections have been made over a long period, but not always in the same part of the year. Conclusions concerning quantities in which the species occur, and comparison of species composition in different seasons between different years of collecting should be drawn with care.
- The methods of collecting are not consistent. Collections made by WAGENAAR HUMMELINCK are more or less random samples. Collections made by the author concern specifically Bryozoa. Both methods may have excluded certain species.

There are differences in species-composition between the bays. The classification of the bays after VAN DEN HOEK is not optimal when considering the composition of Anascan Bryozoa species. Bays of one type may have different species compositions. Which environmental factors cause these differences, and to what degree, is not so easy to assess. Correlations between some environmental conditions (salinity, temperature, turbidity, substratum, etc.) and species composition can be made, but one cannot conclude that there is a direct causal link. The ecosystems are very complex and a lot of environmental factors are unknown. Predators, for example, will also be restricted in their occurrence as substratum- and food-competitors are. An integrated study of all life in the bays and the relationships between the different groups of animals, algae and vascular plants could give some answers to questions concerning occurrence of certain species. The present study must be seen as a contribution to the inventarisation of the ecosystem.

Changes due to human activity can be seen, and correlations between human influence and species compositions are demonstrated. How the changes effect the occurrence of the species is generally unknown.

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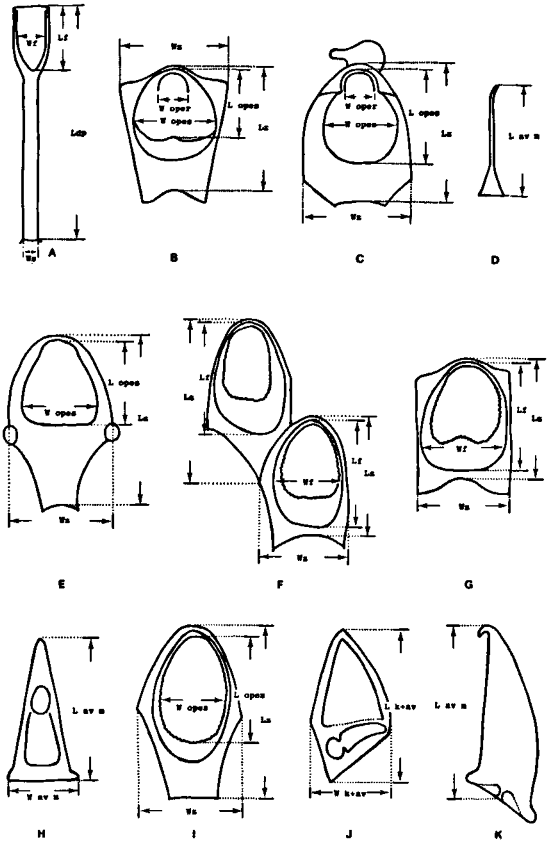

Fig. 30. Measurements: a. *Aetea ligulata*; b. *Electra bellula*?; c, d. *Cranosina coronata*; e. *Antropora minus*; f. *Antropora tincta*; g, h. *Crassimarginatella harmeri* n. sp.; i, j, k. *Parellisina curvirostris.*

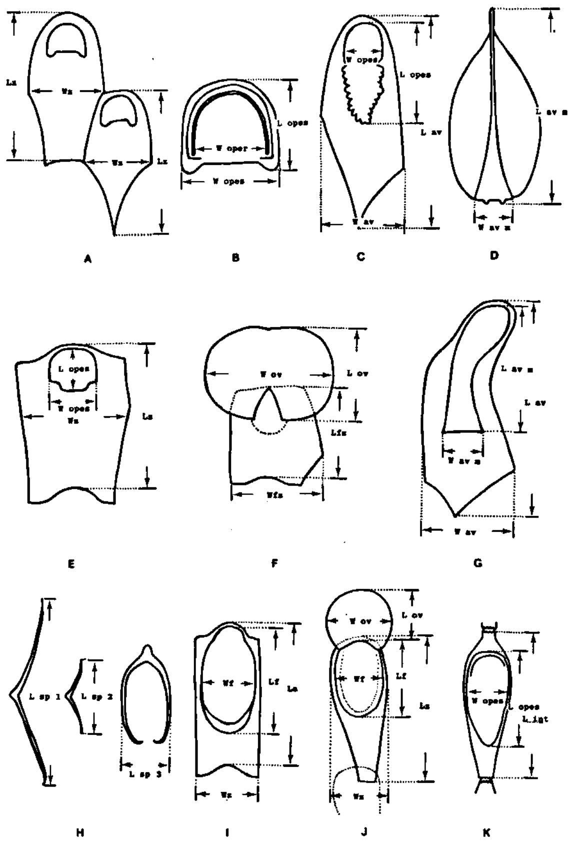

Fig. 31. Measurements: a, b, c, d. *Smittipora levinseni*; e, f, g, h. *Thalamoporella distorta*; i. *Nellia tenella*; j. *Scrupocellaria*; k. *Synnotum aegyptiacum*.

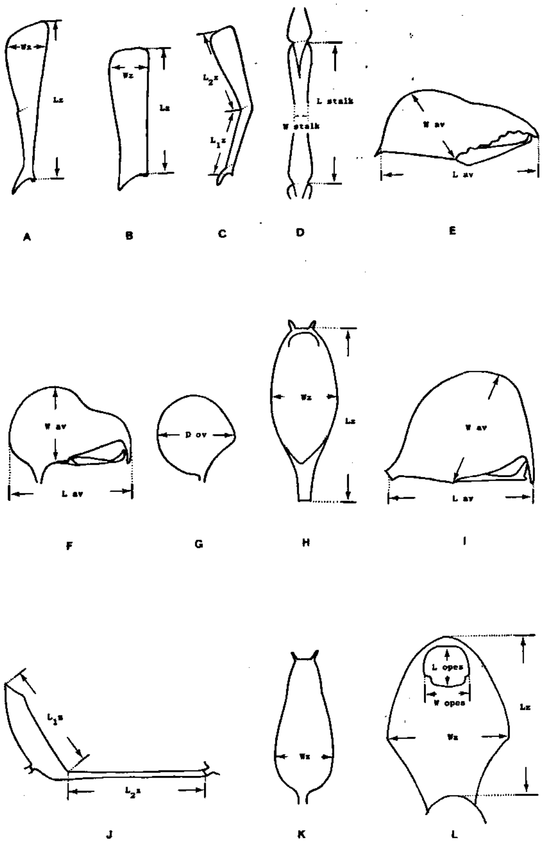

Fig. 32. Measurements: a. *Bicellariella chuakensis, Caulibugula dendrograpta*; b. *Bugula neritina, Bugula minima, Bugula hummelincki*; c. *Bugula* aff. *uniserialis*; d. *Caulibugula dendrograpta*; e. *Bicellariella chuakensis, Bugula minima, Bugula hummelincki, Caulibugula dendrograpta*; f, g. *Bugula* aff. *uniserialis*; h, i. *Beania cupulariensis* and *B. klugei*; j, k. *Beania mirabilis*; l. *Exechonella antillea*.

APPENDIX I

STATIONS OF AUTHOR ON CURAÇAO AND BONAIRE

August, September and October 1982

Station number – Locality; date; habitat; substrate; depth (remarks).

CURAÇAO

1 *Piscadera Outer Bay,* near Punta Mahok; 4.VIII; coral formations on coarse sand; dead coral, bottles and cans; 5 m.

2 — under the Hilton pier; 4.VIII, 5.IX, 11.IX; rubbish on coarse sand; glass, plastics, metal and stones; 3–6 m.

3 *Piscadera Inner Bay,* southern part, near Piedra Kreef; 3.VIII; coral fragments (dead), covered by very fine mud; 0.5–2 m (many tube-worms).

4 — southern part, between Piedra Kreef and Punta Kibracos; 4.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.7 m.

4a — southern part, between Piedra Kreef and Punta Kibracos; 4.VIII; stones on mud; 1.5–2 m.

5 — southern part, near Marie Pampoen; 4.VIII; fine sand and mud, with *Thalassia* and hydroids; *Thalassia*; 0.5–1 m.

6 — southern part, north of Marie Pampoen; 4.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m.

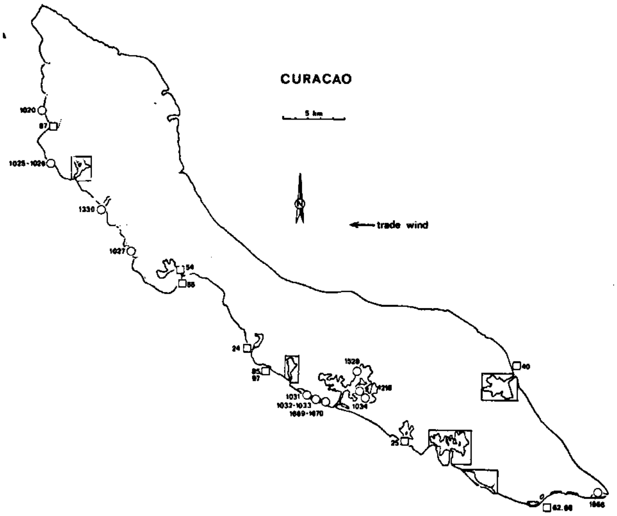

Fig. 33. Curaçao, with station numbers (○: stations P. WAGENAAR HUMMELINCK, □: stations C. FRANSEN).

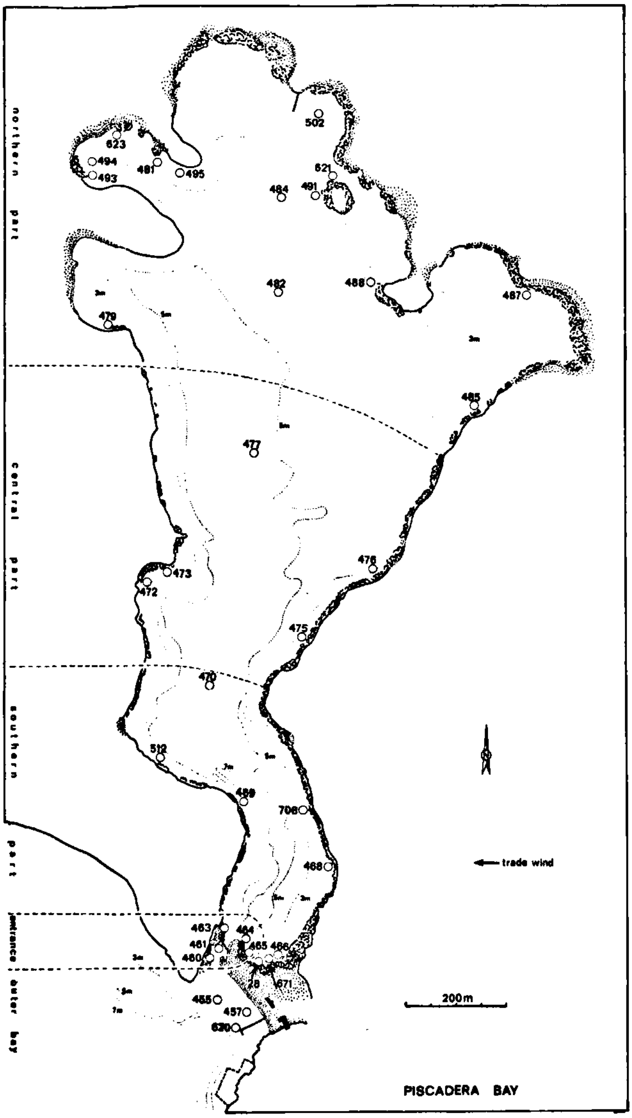

Fig. 34. Curaçao, Piscadera Bay, before 1972 with stations of WAGENAAR HUMMELINCK.

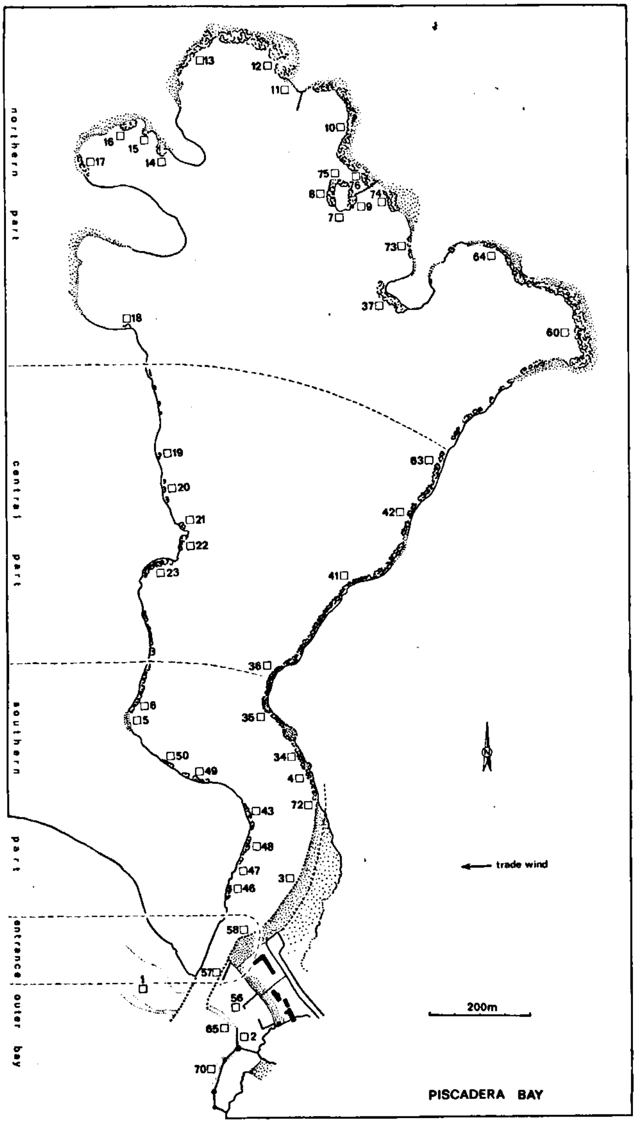

Fig. 35. Curaçao, Piscadera Bay, 1982 with stations of the author.

7 — northern part, near Isla Rafael; 5.VIII; stones on mud, with *Thalassia*, algae and hydroids; stones and shells; 0.3–0.5 m.

8 — northern part, near Isla Rafael; 5.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (*Zoobotryon verticilliatum* dominating).

9 — northern part, Isla Rafael, eastern shore; 5.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.3 m (*Zoobotryon verticilliatum* and *Schizoporella errata* dominating).

10 — northern part, east of Klein Hoffie; 5.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (H_2S formed in the mud, very turbid water).

11 — northern part, Klein Hoffie; 5.VIII; wooden piles of pipeline; ----; 0–1 m (no invertebrates seen, H_2S, drainage of eutrophicated water).

12 — northern part, west of Klein Hoffie; 5.VIII; mangroves; *Rhizophora*-roots with epifauna (only balanids); 0–0.5 m.;

13 — northern part, near Klein Piscadera; 5.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m.

14 — northern part, near Klein Piscadera; 5.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1.5 m (*Zoobotryon verticilliatum* and *Watersipora* spec. dominating).

15 — northern part, near Klein Piscadera; 5.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1.5 m (*Zoobotryon verticilliatum*, *Bugula neritina*, *Schizoporella errata* and *Watersipora* spec. dominating).

16 — northern part, near Klein Piscadera; 5.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (*Zoobotryon verticilliatum* dominating).

17 — northern part, near Klein Piscadera; 5.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m.

18 — northern part, Martin Stredu; 5.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.2 m.

18a — northern part, Martin Stredu; 5.VIII; *Thalassia* on mud; *Thalassia*; 0–0.4 m (*Bugula neritina* dominating).

19 — central part, between Martin Stredu and Punta Chumbu; 7.VIII; mangroves; *Rhizophora*-roots with epifauna; 0.5–1 m (*Zoobotryon verticilliatum*, *Schizoporella errata* and *Watersipora* spec. dominating).

20 — central part, north of Punta Chumbu; 7.VIII; mangroves; *Rhizophora*-roots with epifauna; 0.5–1 m (*Schizoporella errata* and *Watersipora* spec. dominating).

21 — central part, Punta Chumbu; 7.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.7 m (*Schizoporella errata* dominating).

22 — central part, Punta Chumbu; 7.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.7 m.

23 — central part, Punta Chumbu; 7.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (*Schizoporella errata* dominating).

24 *St. Michiel* Outer Bay; 7.VIII; coral formations, dead corals, algae, on coarse sand; red algae; 2 m.

25 *Lagun Jan Thiel*; 9.VIII; temperature stratification (Bryozoa absent).

26 *Spaanse Water, entrance*, near Punta Cabajero; 9.VIII; mangroves, *Rhizophora*-roots with epifauna; 0–1 m (no Bryozoa found).

27 — near Punta Cabajero; 9.VIII; living and dead coral formations on coarse sand, dead coral blocks; 1.5–3 m.

28 *Spaanse Water, Inner Bay*, Kabrietenbaai; 9.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.8 m (no Bryozoa found).

28a — Kabrietenbaai; 9.VIII; sandy mud with *Thalassia*; *Thalassia*; 0.5–1 m.

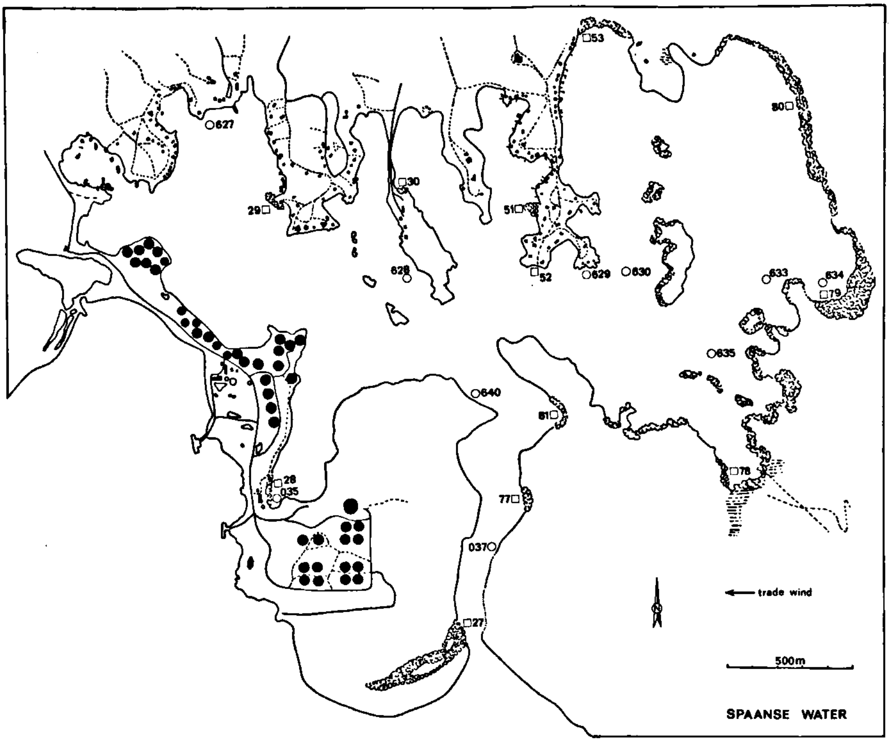

Fig. 36. Curaçao, Spaanse Water, with station numbers (○: HUMMELINCK, □: author).

29 — Brakke Put; 9.VIII; mangroves, *Rhizophora*-roots with epifauna; 0–1 m (roots luxuriantly overgrown by sponges, ascidians and bryozoans (*Nellia tenella* and *Schizoporella errata*)).

29a — near Brakke Put; 9.VIII; sandy mud with *Thalassia*; *Thalassia*; 1–1.5 m (no Bryozoa found).

30 — near Brakke Put; 9.VIII; mangroves; *Rhizophora*-roots luxuriantly overgrown; 0–0.8 m.

30a — near Brakke Put; 9.VIII; sand with *Thalassia*; *Thalassia*; 0–0.8 m (no Bryozoa found).

31 *Fuikbaai, eastern part*; 9.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (*Schizoporella errata, Scrupocellaria* spec. and *Savignyella lafontii* dominating).

32 — 9.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1.2 m (*Schizoporella errata* dominating).

33 — 9.VIII; living and dead coral, rubbish on sandy mud; dead coral and rubbish; 1.5–3 m.

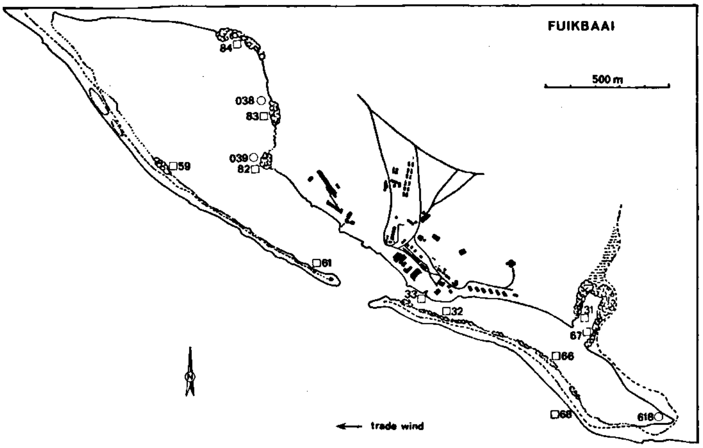

Fig. 37. Curaçao, Fuikbaai, with station numbers (○: HUMMELINCK, □: author).

34 *Piscadera Inner Bay,* southern part, near Punta Kibracos; 11.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m.

34a — southern part, near Punta Kibracos; 11.VIII; living and dead coral, stones, algae and tubeworms on sand; stones; 0.8–2 m.

34b — southern part, near Punta Kibracos; 1.XI; living and dead coral, stones, glass and tubeworms; glass; 0.8–2 m.

35 — southern part, near Punta Kibracos; 11.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.8 m.

36 — central part, Punta Kibracos; 12.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m.

37 — northern part, punta Rafael; 12.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (roots scantily overgrown).

38 *St. Joris Bay, inner bay,* near Punta Blanco; 13.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m (roots mainly covered by algae).

38a — near Punta Blanco; 13.VIII; *Thalassia* and *Halimeda* on mud and stones; stones collected; 0–0.3 m.

39 *St. Joris Bay, entrance*; 13.VIII; stones and dead and living corals on coarse sand; stones; 2–3 m.

40 *North coast,* near St. Joris Bay; 13.VIII; reef fragments, stones on sand; ----; 2–3 m (no Bryozoa found).

41 *Piscadera Inner Bay,* central part, Abao di Seroe Vers; 14.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m.

42 — central part, Abao di Seroe Vers; 14.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m (*Bugula neritina, Schizoporella errata, Zoobotryon verticilliatum* and *Savignyella lafontii* dominating).

43 — southern part, Candelchi; 14.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m.

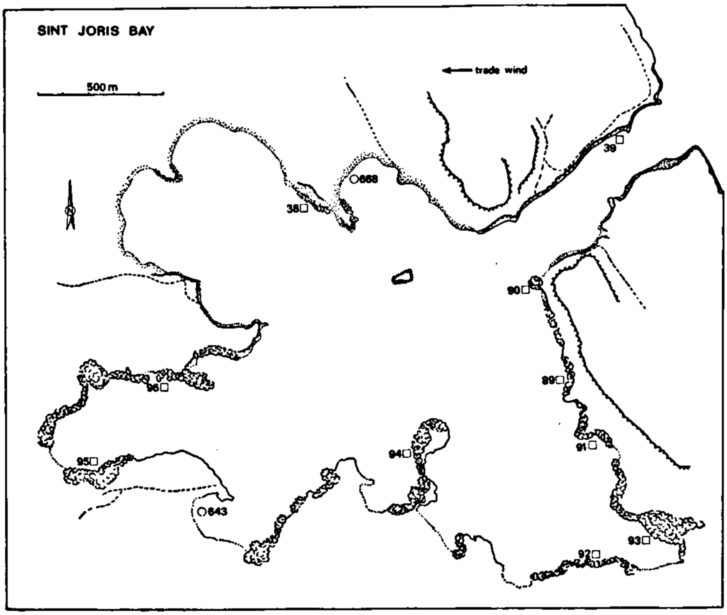

Fig. 38. Curaçao, St. Joris Bay, with station numbers (○: Hummelinck, □: author).

44 *St. Marta Bay,* entrance; 16.VIII; wall of stones and dead coral; stones and dead coral; 0.3–2 m.

45 — Inner Bay, eastern shore; 16.VIII; stones on mud; stones; 0.3–1 m (*Holoporella* spec. and *Nolella stipata* dominating).

46 *Piscadera Inner Bay,* southern part, near Candelchi; 17.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m.

46a — southern part, near Candelchi; 17.VIII; bottles and rubbish on coarse sand; bottles; 0.4–0.8 m.

47 — southern part, near Candelchi; 17.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (roots scantily overgrown).

48 — southern part, neat Candelchi; 17.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (*Aetea ligulata, Scrupocellaria* spec., *Savignyella lafontii* and *Schizoporella errata* dominating).

48a — southern part, near Candelchi; 7.IX; coral debris on sand; coral debris; 1–2 m.

49 — southern part, western shore; 18.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–0.8 m.

50 — southern part, western shore; 18.VIII; *Halimeda* and other algae on dead coral and sand; dead coral; 0.8–1 m.

51 *Spaanse Water, Inner Bay,* near Jan Sofat; 19.VIII; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (*Nellia tenella* dominating).

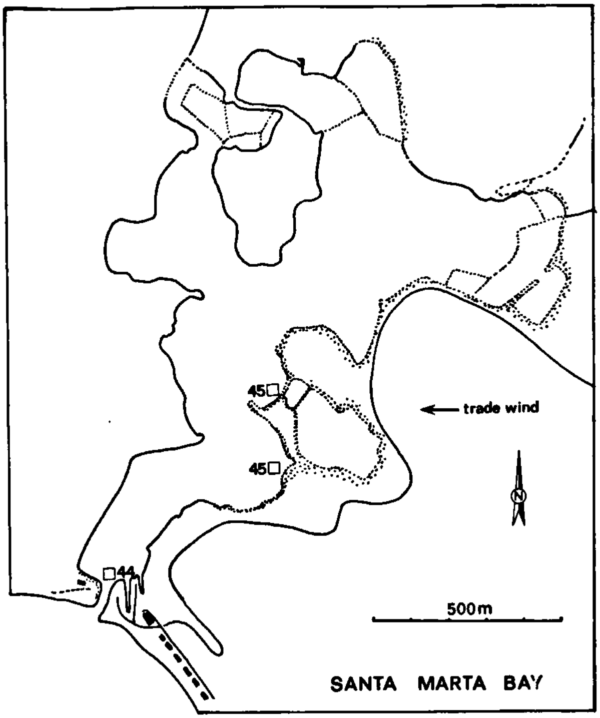

Fig. 39. Curaçao, Santa Marta Bay, with station numbers of author.

52 — near Jan Sofat; 19.VIII; stones, living and dead coral, *Thalassia*, *Lobophora*, sponges and rubbish on sand; stones and plastics; 0.4–0.5 m.

53 — northen part, near Jan Sofat; 19.VIII; mangroves; *Rhizophora*-roots with poor epifauna; 0–0.5 m (*Holoporella* spec. dominating).

54 *Saliña St. Marie*, entrance (artificial) and eastern shore; 2.IX; stones and dead coral; ----; 0–1 m (no Bryozoa found).

55 *Boca St. Marie*; 2.IX; reef with *Acropora palmata* and *Millepora* dominating; dead fragments of both corals collected; 2–7 m.

56 *Piscadera Outer Bay*, Frommer Beach; 3.IX; bottles and dead coral on sand; bottles and dead coral; 3–5 m.

57 *Piscadera Inner Bay*, entrance, on slope of canal (recenty dug); 5.IX; coral fragments (dead and living), bottles and other rubbish; dead coral, bottles and rubbish; 2–6 m.

58 — entrance, eastern shore; 6.IX; stones, tires, glass on muddy bottom; bottles; 1–2 m.

59 *Fuikbaai, western part*; 8.IX; mangroves; *Rhizophora*-roots, *Thalassia*, bottles and stones, coral (*Porites porites*); 0–1 m.

60 *Piscadera Inner Bay,* northern part, Baai Vers; 8.IX; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m (*Bugula neritina* and *Schizoporella errata,* dominating).

61 *Fuikbaai, western part*; 8.IX; living and dead coral, stones, bottles, on sand; stones and bottles; 3–6 m.

62 *Awa Blanco*; 8.IX; panels for settling experiments, plastic panels with cubby-holes of 1.5 cm diameter, vertically placed; panels; 8 m (mostly erect species of Bryozoa; *Scrupocellaria* and *Bugula*).

63 *Piscadera Inner Bay,* central part, Abao di Seroe Vers; 9.IX; mangroves; *Rhizophora*-roots with epifauna; 0–1 m.

64 — northern part, Dam di Rafael; 9.IX; mangroves; *Rhizophora*-roots with epifauna; 0–0.7 m.

65 *Piscadera Outer Bay,* 9.IX; reef slope; bottles; 10 m.

66 *Fuikbaai, eastern part*; 10.IX; mangroves; *Rhizophora*-roots with epifauna; 0–1 m.

66a — 10.IX; stones on mud; stones; 1–3 m.

67 *Fuikbaai, western part*; 10.IX; mangroves; *Rhizophora*-roots with epifauna; 0–1 m.

68 *South coast,* near Fuikbaai; 10.IX; reef, *Acropora palmata* and *A. cervicornis* zone; dead *Millepora*; 3–4 m (undersides of corals up to 50% covered with Bryozoa).

69 *Piscadera Outer Bay,* under Hilton pier; 12.IX; reef slope with bottles, plastics and dead coral; bottles, plastics, and dead coral; 30 m.

70 — near Hilton pier; 13.IX; reef sloop; plastics, bottles and dead coral; 20 m.

71 *Slangenbaai*; 14.IX; buoy; 0–0.1 m (no bryozoans).

72 *Piscadera Inner Bay,* southern part, east shore; 15.IX; boat on stones and mud; from boat; 1 m.

73 — southern part, Palidatu; 16.IX; mangroves; *Rhizophora*-roots with poor epifauna; 0–1 m (*Schizoporella errata* and *Zoobotryon verticilliatum* dominating).

74 — northern part, near Palidatu; 16.IX; mangroves; *Rhizophora*-roots with poor epifauna; 0–1 m.

75 — northern part, northside of Isla Rafael; 16.IX; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m (*Zoobotryon verticilliatum* dominating).

76 — northern part, north of Isla Rafael; 16.IX; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m (*Nolella stipata* and *Schizoporella errata* dominating).

77 *Spaanse Water, entrance,* east shore of Spaanse Lagoen; 17.IX; mangroves; *Rhizophora*-roots with epifauna; 0–1 m.

78 *Spaanse Water, Inner Bay,* near New Haven; 17.IX; mangroves; *Rhizophora*-roots; 0–1 m.

79 — eastern part; 17.IX; mangroves; *Rhizophora*-roots with epifauna; 0–0.8 m.

80 — eastern part; 17.IX; mangroves; *Rhizophora*-roots mainly covered by bryozoans; 0–0.5 m (*Schizoporella errata* dominating).

81 *Spaanse Water, entrance,* Spaanse Lagoen; 17.IX; mangroves; *Rhizophora*-roots with epifauna; 0–0.8 m.

81a — Spaanse Lagoen; 17.IX; stones on sand with *Thalassia*; stones; 1.3 m.

82 *Fuikbaai, western part*; 22.IX; mangroves; *Rhizophora*-roots with epifauna; 0–0.3 m.

83 — 22.IX; mangroves; *Rhizophora*-roots with epifauna; 0–1 m.

84 — 22.IX; mangroves; *Rhizophora*-roots with mainly algae; 0–1 m (bottom with *Thalassia* and the jellyfish *Cassiopea*).

85 *Buoy* 0, near Piscadera Outer Bay; 28.IX; reef environment; dead coral; 6 m.

86 *Awa Blanco,* Carmabi Buoy; 29.IX; reef slope, undamaged reef; dead coral and dead gorgones; 6–8 m.

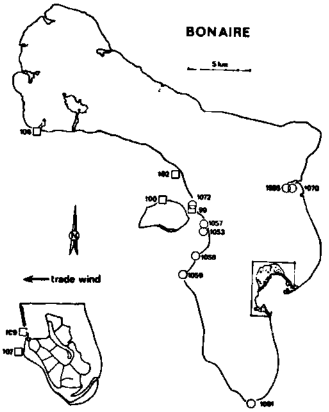

Fig. 40. Bonaire, with station numbers (○: HUMMELINCK, □: author).

87 *Boca Sta. Cruz*, just passed the entrance; 1.X; mangroves; *Rhizophora*-roots with epifauna; 0.3–0.4 m (roots covered by algae and *Amathia distans*).
88 *Piscadera Outer Bay*, between canal and buoy 0; 1.X; reef slope; *Agaricia*; 12 m.
89 *St. Joris Bay, inner bay*, eastern part; 4.X; mangroves; *Rhizophora*-roots with epifauna; 0–0.8 m (*Zoobotryon verticilliatum* and *Schizoporella errata* dominating).
90 — near entrance; 4.X; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m (*Schizoporella errata* dominating).
91 — eastern part; 4.X; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (*Zoobotryon verticilliatum, Schizoporella errata* dominating).
92 — eastern part; 4.X; mangroves; *Rhizophora*-roots with epifauna; 0–1 m (*Schizoporella errata* dominating).
93 — eastern part; 4.X; mangroves; *Rhizophora*-roots with epifauna; 0–1 m.
94 — Isla Bechi; 4.X; mangroves; *Rhizophora*-roots with epifauna; 0–1 m.
95 — western part; 4.X; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m (*Nolella stipata* dominating).
96 — western part; 4.X; mangroves; *Rhizophora*-roots with epifauna; 0–0.5 m.
97 *Buoy* 0, Piscadera Outer Bay near Carmabi; 4.X; reef slope; dead coral; 18 m.
98 KLEIN CURAÇAO, western part, near landing; 16.X; reef flat; dead coral; 6 m.

BONAIRE

99 *Playa Lechi*; 24.VIII; reef slope; dead coral; 3 m (small sample).
100 KLEIN BONAIRE, northern coast, diving place; 25.VIII; intact reef near drop-off; dead coral; 3–5 m (extremely clear water, small sample).
101 *Lac*, entrance at Cai; 25.VIII; mangroves and *Halimeda*; *Rhizophora*-roots with epifauna; 1 m (mainly Ctenostomata).
102 *Hotel "Habitat"*, north of Kralendijk; 26.VIII; *Acropora palmata* on sand with dead coral; dead *Acropora* and *Millepora*; 3–6 m (many encrusting bryozoans).

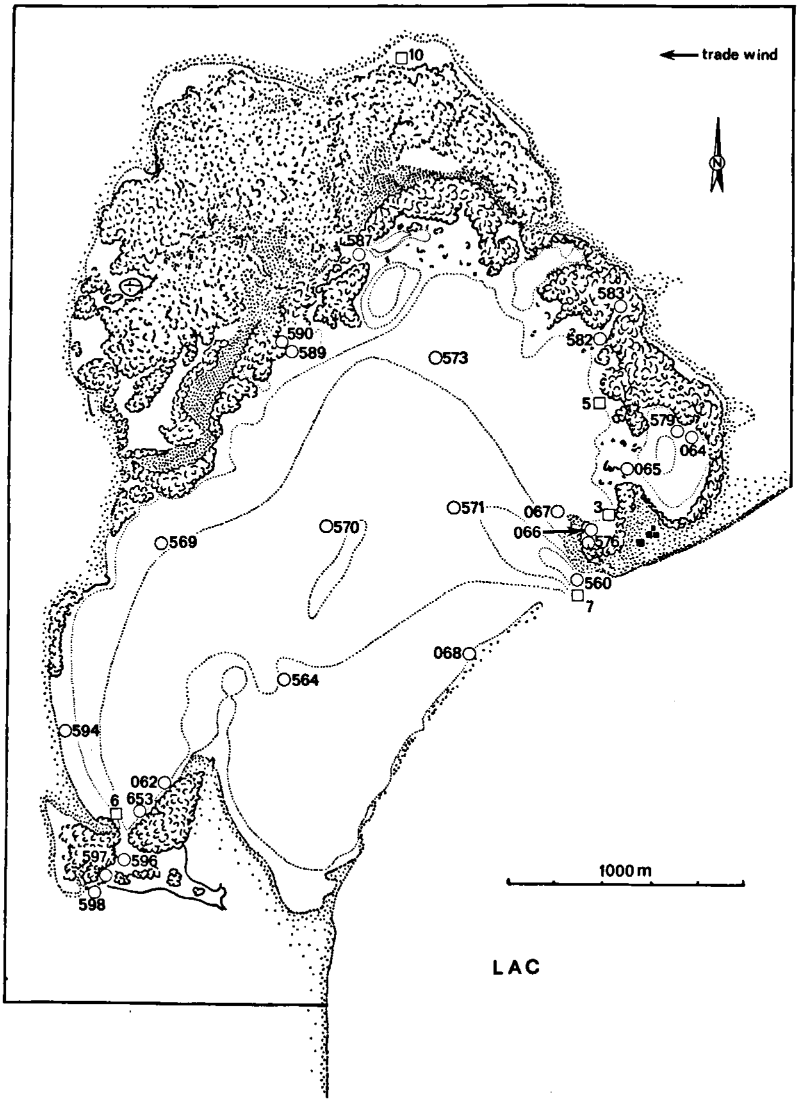

Fig. 41. Bonaire, Lac, with station numbers (○: Hummelinck, □: author).

103 *Lac*, Cai; 26.VIII; mangroves; *Rhizophora*-roots with epifauna; 1 m (few bryozoans).
104 — near Sorobon; 28.VIII; mangroves; *Rhizophora*-roots with epifauna and flora (mainly sponges, ascidians and algae); 0–2 m (some Ctenostomata present).
105 — entrance at Cai; 28.VIII; walls of dead coral fragments; dead gorgone; 8 m (gorgone probably from another location).
106 *Near Salinja Tam*; 29.VIII; reef dominated by *Acropora palmata*; dead coral; 3 m.
107 *Southwest coast*, 500 m S of salttransporter; 29.VIII; *Acropora palmata* and *Acr. cervicornis* patches on sand; dead coral; 4–6 m (many species).
108 *Lac*, western part; 30.VIII; decaying mangroves; *Rhizophora*-roots; 0.5 m (no bryozoans).
109 *Southwest coast*, 500 m N of salttransporter; 31.VIII; *Acropora palmata* and *Acr. cervicornis* patches on sand; dead *Millepora*; 5–7 m (many species of Bryozoa).

APPENDIX II

SPECIES OF ANASCA AND ASCOPHORA IMPERFECTA FROM STATIONS SAMPLED BY THE AUTHOR ON CURAÇAO AND BONAIRE

Station

1 *Aetea ligulata, Synnotum aegyptiacum.*

2 *Aetea ligulata, Crassimarginatella harmeri, Parellisina curvirostris, Cranosina coronata, Thalamoporella distorta, Synnotum aegyptiacum, Beania cupulariensis, Beania klugei, Beania mirabilis, Scrupocellaria hildae.*

3 *Synnotum aegyptiacum.*

4 *Bugula neritina.*

4a *Synnotum aegyptiacum.*

5 *Bugula neritina.*

6 *Scrupocellaria piscaderaensis.*

7 *Aetea ligulata, Antropora tincta, Cranosina coronata.*

8 *Bugula neritina.*

18a *Bugula neritina.*

22 *Bugula neritina.*

24 *Scrupocellaria hildae.*

27 *Aetea ligulata, Smittipora levinseni, Synnotum aegyptiacum, Beania klugei, Scrupocellaria hildae.*

29 *Synnotum aegyptiacum, Nellia tenella, Scrupocellaria hildae.*

31 *Scrupocellaria carmabi.*

32 *Aetea ligulata.*

33 *Synnotum aegyptiacum, Scrupocellaria curacaoensis, Scr. hildae.*

34 *Aetea ligulata, Synnotum aegyptiacum, Bugula neritina, Scrupocellaria piscaderaensis.*

34a *Aetea ligulata, Synnotum aegyptiacum, Scrupocellaria piscaderaensis.*

34b *Aetea ligulata, Antropora tincta, Synnotum aegyptiacum.*

35 *Aetea ligulata, Bugula neritina, Scrupocellaria piscaderaensis.*

36 *Aetea ligulata, Bugula neritina, Scrupocellaria piscaderaensis.*

37 *Bugula neritina.*

41 *Bugula neritina.*

42 *Aetea ligulata, Bugula neritina.*

43 *Aetea ligulata, Scrupocellaria piscaderaensis.*

44 *Aetea ligulata, Scrupocellaria hildae.*

45 *Beania klugei, Bugula neritina.*

46 *Scrupocellaria piscaderaensis.*

46a *Scrupocellaria piscaderaensis.*

47 *Scrupocellaria piscaderaensis.*

48 *Aetea ligulata, Scrupocellaria piscaderaensis.*

48a *Aetea ligulata.*

49 *Aetea ligulata, Synnotum aegyptiacum, Bugula neritina, Scrupocellaria piscaderaensis.*

50 *Synnotum aegyptiacum.*

51 *Aetea ligulata, Synnotum aegyptiacum, Nellia tenella, Caulibugula dendrograpta, Scrupocellaria carmabi.*

52 *Antropora minus.*

57 *Aetea ligulata, Synnotum aegyptiacum, Beania klugei, Bicellariella chuakensis, Scrupocellaria carmabi.*

58 *Aetea ligulata, Synnotum aegyptiacum.*

59 No Anasca.

60 *Bugula neritina, Caulibugula dendrograpta.*

61 *Aetea ligulata, Synnotum aegyptiacum, Beania cupulariensis, Scrupocellaria carmabi.*

62 *Bugula minima* (Partly investigated).

63 *Bugula neritina.*

64 *Bugula neritina.*

65 Not yet investigated.

66 *Synnotum aegyptiacum, Scrupocellaria curacaoensis, Scr. carmabi.*

66a *Scrupocellaria curacaoensis.*

67 *Aetea ligulata, Bugula neritina.*

72 *Synnotum aegyptiacum.*

74 *Bugula neritina.*

75 *bugula neritina.*

76 No Anasca.

77 *Aetea ligulata, Synnotum aegyptiacum, Scrupocellaria carmabi, Scr. hildae.*

78 *Aetea ligulata, Synnotum aegyptiacum, Nellia tenella, Bugula neritina, Scrupocellaria carmabi.*

79 *Nellia tenella, Bugula neritina.*

80 *Nellia tenella, Bugula neritina.*

81 *Aetea ligulata, Synnotum aegyptiacum, Nellia tenella, Scrupocellaria curacaoensis.*

81a No Anasca.

82 *Beania klugei.*

83 *Bugula neritina.*

89 *Aetea ligulata, Synnotum aegyptiacum, Bugula neritina.*

90 No Anasca.

91 *Synnotum aegyptiacum, Bugula neritina.*

92 *Synnotum aegyptiacum, Bugula neritina.*

93 *Aetea ligulata, Synnotum aegyptiacum, Exechonella antillea.*

94 *Aetea ligulata.*

Sta. 9, 10, 13–21, 23, 30, 38, 38a, 53, 59, 73, 76, 81a, 84, 87, 90, 95, 96, 101, 103, 104: No Anasca.

Sta. 11, 12, 25, 26, 28, 28a, 29a, 30a, 39, 40, 54, 71, 108: No Bryozoa.

Sta. 55, 56, 65, 68–70, 85, 86, 88, 97–100, 102, 105–107, 109: Not yet or partly investigated.

APPENDIX III

List of Stations of Wagenaar Hummelinck
with reference to his "Marine localities" (1977)

Curaçao Stations

Piscadera Baai
1466 — *Rhizophora* in soft mud with *Crassostrea* and *Didemnum*, 17.XII.1963 (spec. 17).
1477 — 3. Buoy, crowded with ascidians, 31.X.1963 (spec. 17).
1482 — 2. Buoy, crowded with ascidians and oysters, 31.X.1963 (spec. 17).
1484 — 1. Buoy, with dense ascidians, oysters and algae, 2.XI.1963 (spec. 17).
1487 — Muddy debris with some *Rhiz.*, *Crass.* and ascidians, 25.XI.196 (spec. 17).
1488 — *Rhiz.* with *Crass.*, 27.VII.1962 (spec. 17).
1493b — *Rhiz.* in muddy sand, many oysters, 25.XI.1963 (spec. 12).
1493b — *Rhiz.* in muddy sand, 26.VII.1973 (spec. 17 & 23).
1588a — ? indien 1488a: Muddy debris with *Rhiz.* and *Crass.* (spec. 17).
1620 — Poles from jetty in Outer Bay, *Spirobranchus* (spec. 11).
1671 — *Rhiz.* in mud and sand, 30.III.1970 (spec. 17).

Rifwater
1669 — *Rhiz.* and *Avicennia* in sand and mud, 24.II.1970 (spec. 2).

Schottegat
1218 — On Venezuelan destroyer, 3.III.1955 (spec. 11).

Spaanse Water
1037A — Sandy beach with *Rhiz.* and *Isognomon*, 21.V.1949 (spec. 11).
1627 — Muddy area with *Thalassia*, 2 m deep, 1.XI.1968 (spec. 2)
1629 — Muddy rook debris with *Rhiz.*, 17.XI.1968 (spec. 11, 12, 15).
1630 — Muddy sand, 5 m deep, 1.XI.1968 (spec. 25).

Fuik Baai
1039 — Rooky shore with muddy sand, some *Thal.*, 20.XI.1948 (spec. 12, 14).
1039A — Sandy mud with rock debris, few *Thal.*, *Sargassum*, 20.XI.1948 (spec. 12).

St. Joris Baai
1643 — Wood decay in soft mud, some *Thal.*, 23.X.1968 (spec. 2).
1688A — Muddy debris with *Thal.* and *Halodule*, 25.II.1970 (spec. 2).
— Muddy area (spec. 25).

Bonaire stations

Lac
1067 — Sandflat with *Thal.*, 1½–2 m deep, 17.IX.1948 (spec. 15, 23).
1068a — Sandy reef flat, 1–2 m deep, 1.X.1948 (spec. 14).
1653 — Sandy mud near *Rhiz.*, 10.III.1970 (spec. 15).

Lagoon
1070A — Muddy rock with *Rhiz.*, 28.X.1930 (spec. 15).
1555 — Soft mud in *Avicennia* grove, 19.IX.1967 (spec. 15).

Kralendijk roadstead
1053 — Buoy in part covered with algae, 21.IX.1948 (spec. 18).

Punt Vierkant
1059B — Sandy reef, 1–2 m deep, 9.IX.1948 (spec. 20).

Klein Bonaire
1049C — Sandy reef, 1–3 m deep, 13.IX.1948 (spec. 19, 20).