

Anthoathecatae and Leptothecatae hydroids from Costa Rica (Cnidaria: Hydrozoa)

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Abstract: This paper is the first taxonomic account of the hydroid orders Anthoathecatae and Leptothecatae from the Caribbean and Pacific coast of Costa Rica. All specimens are currently stored at the reference collection of the Museo de Zoología, Escuela de Biología, Universidad de Costa Rica. Sixteen hydroid species are recorded: *Eudendrium carneum*, *Pennaria disticha*, *Acryptolaria longithecata*, *Plumularia floridana*, *Halopteris polymorpha*, *Aglaophenia dubia*, *Aglaophenia latecarinata*, *Lytocarpia tridentata*, *Macrorhynchia philippina*, *Macrorhynchia* sp., *Clytia gracilis*, *Cnidoscypus marginatus*, *Thyroscypus ramosus*, *Dynamena disticha*, *Sertularella diaphana*, and *Tridentata distans*. An extensive synonymy has been given for each species. A simplified taxonomic key is included, and illustrations and descriptions are provided for each species.

Key words: Anthoathecatae, Leptothecatae, hydroids, taxonomy, Costa Rica.

The hydroid fauna of Costa Rica is little studied and therefore poorly known. Studies on species from the Pacific coast of the country include those of Fraser (1938, 1948) and Hertlein (1963), but no study exists recording the hydroids from the Caribbean coast. The most recent report on the biodiversity of cnidarians from Costa Rica (Cortés 1997) is a list of species previously reported.

The scarcity of reliable taxonomic characters in various hydroid taxa, together with a scarcity of data on the biology of these animals, including the life cycles (Calder 1988, Kelmo and Santa-Isabel 1998), hampers hydrozoan taxonomy. This discourages research into the group, and therefore impedes the advancement of knowledge.

The purpose of this report is to provide the first taxonomic account of the Anthoathecatae and Leptothecatae hydroids currently stored at the reference collection of the Museo de

Zoología, Escuela de Biología, Universidad de Costa Rica (UCR), San Pedro, San José, Costa Rica. Here we present a detailed synonymy, a simplified identification key, descriptions and illustrations for each studied species covering both Pacific and Atlantic coasts.

MATERIALS AND METHODS

Colonies were examined using stereoscopic and light microscopy, and the taxonomic identifications were based on the specific literature noted in the text of this paper. All descriptions provided herein are from the examined material, with accompanying illustrations constructed using brightfield microscopy.

The listed synonymy essentially follows that of Calder (1988, 1991, 1997a), Marques (1992), Migotto (1993), and Kelmo and

Santa-Isabel (1998), and virtually all of these lists have been verified by examination of the original references. In most of cases, only one significant record has been cited to document occurrences worldwide. Hydroid classification has been extensively modified by Petersen (1979, 1990), Werner (1984), Bouillon (1985), and Calder (1988, 1991, 1997a). However, in the interests of simplicity, the classification adopted here is that followed by Calder (1988, 1991, 1997a, 1997b).

Nematocysts were examined by compressing pieces of tissue, or entire individuals, between slide and coverslip (Calder 1991). The specimens were treated with 10% solution of sodium hypochlorite for 5-10 seconds, and

rinsed twice in distilled water prior to slide preparation (Kelmo and Santa-Isabel 1998). Nematocyst categories were identified according to the classification of Weill (1934). At least 10 nematocysts of each type were measured from each species in order to determine size ranges.

RESULTS

A total of 243 colonies were analyzed, consisting of nine families and sixteen species of anthoathecate and leptothecate hydroids from both the Pacific and Caribbean coast of Costa Rica (Table 1).

TABLE 1

Systematic list of the Antoathecatae and Leptothecatae hydroids from Costa Rica recorded from the collection of the Museo de Zoología, Escuela de Biología, UCR.

- Order Antoathecatae Cornelius, 1992
 - Superfamily Eudendrioideae L.Agassiz, 1862
 - Family Eudendriidae L.Agassiz, 1862
 - Genus *Eudendrium* Ehrenberg, 1834
 - Eudendrium carneum* Clarke, 1882
 - Family Halocordylidae Stechow, 1921
 - Genus *Pennaria* Goldfuss, 1820
 - Pennaria disticha* Goldfuss, 1820
 - Order Leptothecatae Cornelius, 1992
 - Superfamily Lafoeoidae A.Agassiz, 1865
 - Family Lafoeidae A.Agassiz, 1865
 - Subfamily Lafoeinae A.Agassiz, 1865
 - Genus *Acryptolaria* Norman, 1875
 - Acryptolaria longithecata* (Allman, 1877)
 - Suborder Plumulariida Bouillon, 1985
 - Family Thyroscyphidae Stechow, 1920
 - Genus *Cnidoscypus* Spletstösser, 1929
 - Cnidoscypus marginatus* (Allman, 1877)
 - Genus *Thyroscyphus* Allman, 1877
 - Thyroscyphus ramosus* (Allman, 1877)
 - Superfamily Sertularioidea Lamouroux, 1812
 - Family Sertulariidae Lamouroux, 1812
 - Genus *Dynamena* Lamouroux, 1812
 - Dynamena disticha* (Bosc, 1802)
 - Genus *Sertularella* Gray, 1848
 - Sertularella diaphana* (Allman, 1885)
 - Genus *Tridentata* Stechow, 1920
 - Tridentata distans* (Lamouroux, 1816)
 - Superfamily Plumularioidea McCrady, 1859
 - Family Plumulariidae McCrady, 1859
 - Genus *Plumularia* Lamarck, 1816
 - Plumularia floridana* Nutting, 1900

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TABLE 1 (continuación...)

Systematic list of the Anthoathecatae and Leptothecatae hydroids from Costa Rica recorded from the collection of the Museo de Zoología, Escuela de Biología, UCR.

- Family Halopterididae Millard, 1962
 - Genus *Halopteris* Allman, 1877
 - Halopteris polymorpha* (Billard, 1913)
- Family Aglaopheniidae Marktanner & Turnretscher, 1890
 - Subfamily Aglaopheniinae Marktanner & Turnretscher, 1890
 - Genus *Aglaophenia* Lamouroux, 1812
 - Aglaophenia dubia* Nutting, 1900
 - Aglaophenia latecarinata* Allman, 1877
 - Genus *Macrorhynchia* Kirchenpauer, 1872
 - Macrorhynchia phillipina* Kirchenpauer, 1872
 - Macrorhynchia* sp.
 - Genus *Lytocarpia* Kirchenpauer, 1872
 - Lytocarpia tridentata* (Verluyts, 1899)
- Suborder Campanulariida Bouillon, 1985
 - Superfamily Campanularioidea Johnston, 1837
 - Family Campanulariidae Johnston, 1837
 - Subfamily Clitiinae Cockrell, 1911
 - Genus *Clytia* Lamouroux, 1812
 - Clytia gracilis* (M.Sars, 1850)

Simplified identification key

- I. Anthoathecatae
 - 1. Hydranths urn-shaped; hypostome flared to knob-shaped, 28-32 tentacles in one whorl *Eudendrium carneum*
 - 2. Hydranths clavate to pear-shaped; hypostome dome-shaped *Pennaria disticha*
- II. Leptothecatae
 - 1a. Hydrocaulus monosiphonic 2
 - 1b. Hydrocaulus polysiphonic 3
 - 2a. Branched colonies 4
 - 2b. Unbranched colonies 5
 - 3a. Nematothecae present 6
 - 3b. Nematothecae absent *Acryptolaria longitheca*
 - 4a. Cauline nematothecae bitalamic; hydrothecal margin entire *Plumularia floridana*
 - 4b. Cauline nematothecae absent; hydrothecal margin with four cusps of moderate prominence; operculum with four conspicuous valves *Thyroscyphus ramosus*
 - 5a. Hydrocaulus unbranched in small colonies, but occasionally with 1 to 4 branches 7
 - 5b. Hydrocaulus always branched 8
 - 5c. Hydrocaulus lacking hydrocladia *Halopteris polymorpha*
 - 6a. Hydrothecae 300-350 mm deep from tips *Macrorhynchia* sp.
 - 6b. Hydrothecae slipper-shaped, 250-270 mm deep from adcauline wall *Macrorhynchia phillipina*
 - 7a. Operculum consisting of a large abcauline valve; hydranth with an abcauline diverticulum *Tridentata distans*
 - 7b. Hydrothecal margin with 9 acute cusps separated by U-shaped incisions *Aglaophenia dubia*

- 8a. Operculum present9
 8b. Operculum absent10
- 9a. Operculum shed*Cnidoscypus marginatus*
 9b. Operculum with two or four valves11
- 10a. Hydrothecae with internal septa; pseudonematothecae present *Lyotocarpia tridentata*
 10b. Hydrothecae without internal septa; pseudonematothecae absent12
- 11a. Operculum consisting of a large abcauline and a smaller tent-shaped adcauline valve ... *Dynamena disticha*
 11b. Operculum with 4 valves*Sertularella diaphana*
- 12a. Hydrothecal margin with nine cusps all rounded and prominent,
 one median and 4 lateral pairs*Aglaophenia latecarinata*
 12b. Hydrothecal margin with 12-17 deeply cut, blunt, triangular cusps separated
 by U-shaped incisions*Clytia gracilis*

Systematic Account

Order Antoathecatae Cornelius, 1992
 Super Family Eudendrioidea L. Agassiz, 1862
 Family Eudendriidae L. Agassiz, 1862

Eudendrium carneum Clarke, 1882
 (Fig. 1)

Eudendrium ramosum McCrady, 1859;
 A. Agassiz, 1865; Congdon, 1906; Fraser,
 1912; Bennett, 1922 [Not *Eudendrium ramo-*
sum (Linnaeus, 1758)]. *Eudendrium carneum*
 Clarke, 1882; Calder, 1988; Marques, 1992;
 Kelmo and Santa-Isabel, 1998. *Eudendrium*
cunninghami Kirkpatrick, 1910.

Material examined: eleven colonies,
 with male and female gonophores, Puerto
 Limón, Limón, Caribbean coast, 9°59'40" N,
 83°01'30" W, 12 November 1993 (UCR-845).

Description: branched and bushy
 colonies, up to 12 cm, arising from creeping
 hydrorhizal stolons. Hydrocaulus upright,
 polysiphonic, more or less alternately
 branched; primary branches also polysiphonic
 and irregularly branched; secondary branches
 polysiphonic basally and irregularly or alter-
 nately branched. Perisarc thick, annulated or
 wrinkled at bases of branches and hydranth
 pedicels, with occasional annulations else-
 where. Hydranths urn-shaped, about 0.82 mm
 long from proximal end to base of hypostome,

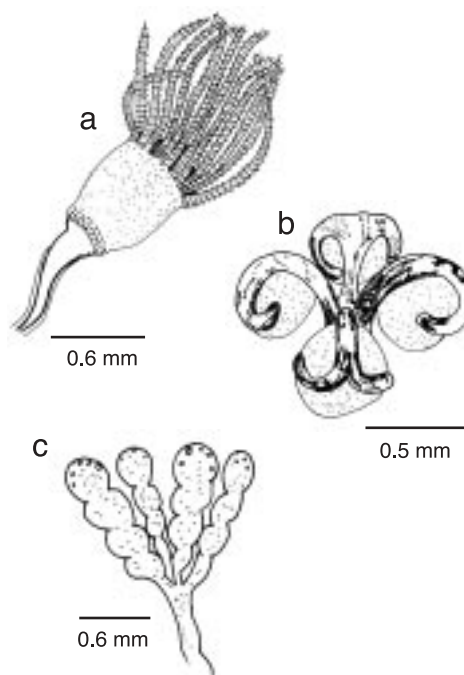


Fig. 1. *Eudendrium carneum*. a: hydranth; b: female gonophores; c: male gonophores.

0.63 mm wide, with a shallow perisarc groove;
 hypostome very large, flared to knob-shaped.
 Tentacles solid, filiform, 28-32 in number,
 disposed in one whorl. Gonophores fixed
 sporosacs, developing on hydranth distal to
 perisarc groove. Female gonophores on reduced
 hydranths with partially atrophied tentacles;
 spadix bifid, curving over egg. Male
 gonophores with up to five chambers each,

borne on atrophied hydranths. Cnidome comprising heterotrichous anisorhizas $20.2\text{--}22.8\ \mu\text{m}$ x $9.3\text{--}11.4\ \mu\text{m}$, and by heterotrichous microbasal euryteles $8.2\text{--}9.4\ \mu\text{m}$ x $3.5\text{--}4.0\ \mu\text{m}$.

Known range: Bermuda (Congdon 1906, 1907; Bennett 1922; Summers 1972; Calder 1986, 1988); western Atlantic (Fraser 1944); eastern Atlantic (Kirkpatrick 1910); Indian Ocean (Millard 1975); eastern Pacific, Gulf of California, north of Clarion Island (Fraser 1948); Brazil (Marques 1992, Kelmo and Santa-Isabel 1998).

Family Halocordylidae Stechow, 1921

Pennaria disticha (Goldfuss, 1820)
(Fig. 2)

Pennaria disticha Goldfuss, 1820; *Plumularia pennaria* Blainville, 1830; *Pennaria cavolini* Ehrenberg, 1834; Chiaje, 1841 in Calder, 1988. *Anisocalyx pinnarium* Costa, 1842. *Globiceps tiarella* Ayres, 1854. *Eucoryne elegans* Leidy, 1855. *Pennaria tiarella* McCrady, 1859. *Pennaria gibbosa* L. Agassiz, 1860. *Halocordyle tiarella* Allman,

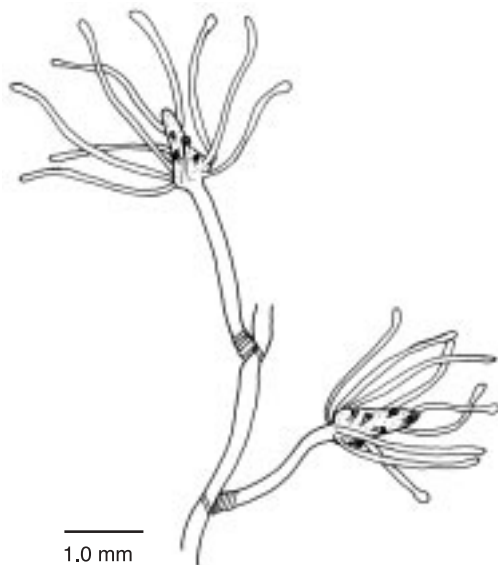


Fig. 2. Hydrocaulus and hydranth of *Pennaria disticha*.

1872. *Pennaria symmetrica* Clarke, 1879. *Globiceps globator* Haeckel, 1879. *Pennaria inornata* Brooks, 1883. *Pennaria australis* Bale, 1884. *Pennaria adamsia* van Lendenfeld, 1885b. *Pennaria pennaria* Marktanner-Turneretscher, 1890. *Halocordyle australis* Bale, 1894. *Halocordyle cooperi* Warren, 1906. *Pennaria pacifica* Clarke, 1907. *Pennaria australis* var. *cooperi* Warren, 1908. *Pennaria australis* Warren, 1908. *Pennaria disticha* var. *australis* Ritchie, 1910. *Pennaria wilsoni* Bale, 1913. *Halocordyle disticha* Stechow, 1923a. *Halocordyle wilsoni* Stechow 1923a. *Corydendrium splendidum* Boone, 1938. *Halocordyle disticha* var. *australis* Vervoort, 1941. *Halocordyle fragilis* Vannuci, 1951. *Halocordyle pennaria* var. *australis* Mammem, 1963. *Pennaria americana* García-Corrales and Aguirre, 1985 [Nomem Nudum according to Calder (1988)]. *Pennaria* (*Halocordyle*) *tiarella* García-Corrales and Aguirre, 1985. *Pennaria europea* García-Corrales and Aguirre, 1985 [Nomem Nudum according to Calder (1988)]; *Pennaria* (*Halocordyle*) *disticha* García-Corrales and Aguirre, 1985. *Pennaria symmetrica* García-Corrales and Aguirre, 1985; *Halocordyle disticha* Calder, 1988; Kelmo and Santa-Isabel, 1998; *Pennaria disticha* Silveira and Migotto, 1992.

Material examined: four colonies without gonophores or medusae buds, artificial reef, Bahía Huevos, Guanacaste, Pacific coast, $10^{\circ}38'40''$ N, $85^{\circ}41'30''$ W, 28 March 1984 (UCR-895). Eight colonies without gonophores or medusae buds, Manzanillo, Limón, $9^{\circ}38'10''$ N, $82^{\circ}38'10''$ W, Caribbean coast, 19 September 1992 (UCR-690).

Description: erect colonies, arising from a creeping and branched hydrorhiza; growth monopodial with terminal hydranths. Hydrocaulus monosiphonic, reaching about 0.4 mm wide, zigzag to nearly straight, annulated basally, divided at more or less regular intervals by one or more well-developed annulations; internodes 0.62–4.0 mm long, each typically supporting a branch distally. Perisarc thick, black or dark-brown. Branches up to

28 mm long, annulated basally, given off alternately from opposite sides of hydrocaulus, curved outwards, divided into internodes. Internodes 1.6-4.2 mm long, marked by distinct to rather faint annulations proximally and distally; each internode giving rise to a ramulus from both its upper surface and its distal end. Ramuli unbranched, annulated basally or throughout entire length, each terminating in a hydranth. Hydranths clavate to pear-shaped, up to 1.8 mm long, 0.35 mm wide; with a whorl of about 10 to 18 long, filiform or faintly knobbed tentacles aborally; a varied number of short, capitate tentacles in one or more regular or irregular verticils medially; and a whorl of about five capitate tentacles orally. Hypostome dome shaped. Cnidome comprising desmonemes $4.4\text{-}5.3\ \mu\text{m} \times 3.2\text{-}3.8\ \mu\text{m}$; basitrichous haplonemes $5.6\text{-}9.5\ \mu\text{m} \times 2.5\text{-}3.7\ \mu\text{m}$; heterotrichous microbasic euryteles $10.6\text{-}13.5\ \mu\text{m} \times 6.0\text{-}6.9\ \mu\text{m}$, and four sizes of stenoteles: (i) very small, $5.5\text{-}6.5\ \mu\text{m} \times 4.2\text{-}4.6\ \mu\text{m}$; (ii) small, $7.3\text{-}7.8\ \mu\text{m} \times 5.4\text{-}5.8\ \mu\text{m}$; (iii) medium, $14.1\text{-}17.5\ \mu\text{m} \times 10.0\text{-}12.2\ \mu\text{m}$, and (iv) large, $28.0\text{-}40.0\ \mu\text{m} \times 16.4\text{-}20.5\ \mu\text{m}$.

Known range: Bermuda (Verrill 1900, Congdon 1907, Bennett 1922, Weill 1937, Cowden 1964, 1965a, b; Summers and Haynes 1969; Summers 1970, 1972; Lesh-Laurie 1976, Calder 1986, 1988); western Atlantic (Fraser 1944); eastern Atlantic (Brinckmann-Voss 1970); Indian Ocean (Millard 1975); western Pacific (Yamada 1959); eastern Pacific, from San Pedro, California; San Francisco Bay, east of Panamá City; off La Libertad, Ecuador (Fraser 1948); Brazil (Migotto 1993, Kelmo and Santa-Isabel 1998).

Order Leptothecatae Cornelius, 1992
 Superfamily Lafoeioidea A. Agassiz, 1865
 Family Lafoeidae A. Agassiz, 1865
 Subfamily Lafoeinae A. Agassiz, 1862

Acryptolaria longitheca (Allman, 1877)
 (Fig. 3)

Cryptolaria longitheca Allman, 1877;
 Clarke, 1879; Fewkes, 1881; Bedot, 1912;

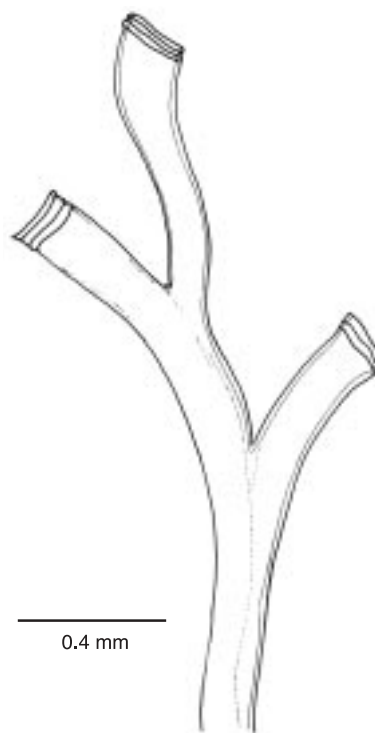


Fig. 3. Hydrocaulus and hydrotheca of *Acryptolaria longitheca*.

Bedot, 1916; Bedot, 1918; Bedot, 1925; *Cryptolaria crassicaulis* Driesch, 1889; Ritchie, 1911; Leloup, 1932; Stranks, 1993. *Lafoea (Cryptolaria) longitheca* Bonnevie, 1899; Billard, 1906. *Cryptoaria crassicaulis* Pictet and Bedot, 1900; Browne, 1907; Jaderholm, 1907; Stechow, 1913a, b; Jaderholm, 1919. *Cryptolaria crassicaulis* var. *dimorpha* Ritchie, 1911; Jarvis, 1922. *Oswaldaria crassicaulis* Stechow, 1921; Stechow, 1923b; Leloup, 1940. *Oswaldaria longitheca* Stechow, 1923b; *Acryptolaria longitheca* Fraser, 1943, 1944; Deevey, 1954; Vervoort, 1968; Vervoort, 1972; Cairns *et al.*, 1991; Calder, 1996; Calder and Vervoort, 1998. *Acryptolaria crassicaulis* Yamada, 1959; Rees and White, 1966; Millard, 1967; Leloup, 1974; Gravier-Bonnet, 1979; Vervoort, 1985; Ramil and Vervoort, 1992; Altuna Prados, 1994; Blanco, 1994a,b; Altuna Prados, 1995; Bouillon *et al.*, 1995; Mendel and López Gonzalez, 1996. *Acryptolaria*

crassicaulis var *dimorpha* Smaldon *et al.*, 1976; Gravier-Bonnet, 1979.

Material examined: one colony without gonothecae, northwestern Isla del Caño, Puntarenas, Pacific coast, 8°46'08" N, 84°17'04" W, 990 m, 25 January 1994 (UCR-899).

Description: colony erect and flabellate, 1.2 cm high, arising from a creeping hydrorhiza. Hydrocaulus geniculate, polysiphonic; nodes indistinct; branches in one plane, resembling hydrocaulus, and not secondarily branched. Perisarc fairly thick. Hydrothecae very long, slender, total length excluding renovations is about 1793 μm , occurring on hydrocaulus and branches, given off alternately in one plane, each adnate to axial tube for most of its length, curving outwards and slightly frontwards, becoming free distally; narrowest at the base, gradually widening distally, free part nearly cylindrical. Hydrothecal walls smooth; perisarc of abcauline wall thicker basally than distally. Margin entire, slightly flaring, usually with 3 or 4 renovations; orifice round, diameter about 296 μm . Operculum, diaphragm, desmocytes and nematothecae absent. Cnidome represented by very small microbasal mastigophores, 3.5–4.2 μm x 1.1–1.4 μm .

Known range: western Atlantic, mid-Atlantic Ridge, Australia (Allman 1877, 1888 as *Cryptolaria crassicaulis*); Clarke 1879, Vervoort 1972, Calder 1996, Calder 1997b, Calder and Vervoort 1998.

Family Thyrosocyphidae Stechow, 1920

Thyrosocyphus marginatus (Allman, 1877)
(Fig. 4)

Obelia marginata Allman, 1877;
Campanularia insignis Allman, 1888 [not
Campanularia insignis Fewkes, 1881 =
Campanularia macroscypha Allman, 1877];
Obelia (Lytoscyphus) marginata Ritchie, 1909;
Lytoscyphus insignis Ritchie, 1909;
Lytoscyphus marginata Ritchie, 1909;

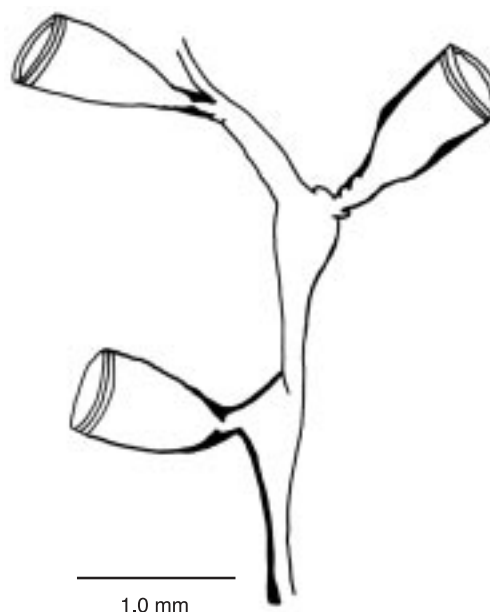


Fig. 4. Portion of hydrocaulus of *Thyrosocyphus marginatus*.

Lytoscyphus marginatus Billard, 1910;
Campanularia marginata Nutting, 1915;
Leptocysphus marginatus Jaderholm, 1920;
Cnidoscyphus marginatus Splettsosser, 1929;
Thyrosocyphus marginatus Calder, 1983, 1990.

Material examined: twelve colonies without gonophores, Manzanillo, Limón, Caribbean coast, 9°37'55" N, 82°39'10" W, 19 September 1992 (UCR-688). Nineteen colonies without gonophores, Punta Piuta, Limón, Caribbean coast, 10°00'35" N, 83°02'15" W, subtidal zone, 1-2 m, 13 November 1983 (UCR-847).

Description: colonies erect, up to 20 cm high, arising from a creeping hydrorhiza. Hydrocaulus monosiphonic, up to 1 mm wide, straight basally, becoming slender and distinctively geniculate distally, divided into internodes at regular intervals by slightly, distinct or indistinct, oblique nodes. Perisarc thick basally and thinner distally. Internodes with prominent apophysis distally; apophyses alternating from side to side, each supporting a hydrotheca. Hydrocladia typically alternate, unbranched or alternately branched; hydrocladia divided by oblique nodes into internodes

resembling, but more slender than, internodes of hydrocaulus, and with basal internode somewhat longer than others. Hydrothecae pedicellate, cone-shaped, 1018-1090 μm long from apophysis to margin; adcauline wall convex, abcauline wall nearly straight; diaphragm a ring of perisarc, often somewhat thicker on adcauline than abcauline wall; margin entire, occasionally renovated, with a ring like thickening; hydrothecal operture round, 486-680 μm wide; operculum shed. Hydranth attached to hydrothecal wall by an annular fold distal to diaphragm. Abcauline diverticulum not observed. Gonophores not observed. Cnidome comprising microbasic mastigophores of three distinct sizes: (i) very large, 31-34 x 12.4-16 μm ; (ii) large, 27-29 x 9.8-10.6 μm ; and (iii) small, 3.5-3.9 x 1.1-1.8 μm .

Known range: Bermudas (Allman 1888, Congdon 1907, Ritchie 1909, as *Campanularia insignis*), (Jaderholm 1920 as *Leptoscyphus marginatus*), (Bennit 1922, Fraser 1944 as *Campanularia marginata*), Calder 1986, 1990; western Atlantic Calder 1983; eastern Atlantic Vervoort 1959.

Thyrosocyphus ramosus (Allman, 1877)
(Fig. 5)

Thyrosocyphus ramosus (Allman, 1877); (Spletstösser, 1929); (Vervoort, 1959); (van Germerden-Hoovegeen, 1965).

Material examined: thirteen colonies, without gonophores, Punta Moín, Limón, Caribbean coast, 10°00'05" N, 83°05' W, 9 m, 12 November 1983 (UCR-842). Nine colonies without gonophores, north-east coast of Isla Uvita, Limón, Caribbean coast, 9°59'40" N, 83°00'50" W, 11 November 1993 (UCR-844). Eight colonies without gonophores, Refugio Nacional de Vida Silvestre Gandoca-Manzanillo, Limón, Caribbean coast, 9°37'55" N, 82°39'10" W. 20 m, 4 August 1995 (UCR-849).

Description: colonies erect, up to 25 cm high, arising from a creeping hydrorhiza. Hydrocaulus monosiphonic, up to 1.2 mm wide, divided into internodes, by oblique nodes. Internodes of 1180-2968 μm long and

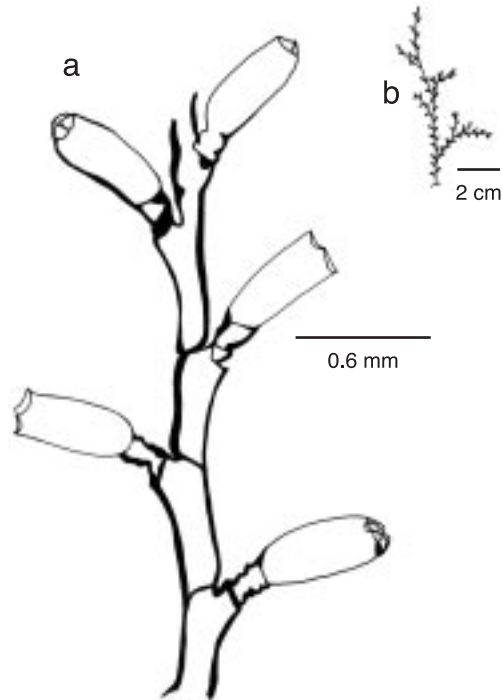


Fig. 5. *Thyrosocyphus ramosus*. a: Part of hydrocaulus and hydrotheca; b: aspect of a colony.

250-772 μm in diameter, inclined alternately in opposite directions. Nodes vary from 300 to 1043 μm in diameter. Irregularly branched. Perisarc of moderate thickness. Internodes with an apophysis distally placed, supporting a pedicellate hydrotheca. Pedicel short, with 2 to 5 annulations. Hydrothecae alternately placed; abcauline wall slightly convex. Apophysis margin of hydrothecae about 1198 to 1802 μm long, and diaphragm margin vary from 800 to 1343 μm long. Diaphragm oblique, virtually thicker on adcauline wall. Margin with four teeth of moderate prominence. Operculum with four conspicuous valves. Gonothecae not observed. Cnidome comprising microbasic mastigophores of two distinct sizes: (i) very large, 22.6-25.2 x 10.3-11.8 μm and (ii) small, 8.1-9.6 x 3.0-4.1 μm .

Known range: Caribbean Sea (Van Germerden-Hoovegeen 1965); western Atlantic (Vervoort 1959); southern Atlantic (Allman 1888, Migotto 1993).

Family Sertulariidae Lamouroux, 1812

Dynamena disticha (Bosc, 1802)
(Fig. 6)

Sertularia pumila Cavolini, 1785; *Sertularia disticha* Bosc, 1802; *Dynamena disticha* Lamouroux, 1812; *Dynamena cornicina* McCrady, 1859; *Sertularia cornicina* Verrill, 1874; *Sertularia exigua* Allman, 1877; *Sertularia complexa* Clarke, 1879; *Sertularia mayeri* Nutting, 1904; *Sertularia pourtalesii* Nutting, 1904; *Sertularia densa* Stechow, 1919; *Dynamena densa* Stechow, 1920; *Tridentata complexa* Stechow, 1922; *Tridentata cornicina* Stechow, 1922; *Tridentata disticha* Stechow, 1922; *Tridentata exigua* Stechow, 1922; *Tridentata pourtalesii* Stechow, 1922; *Dynamena mayeri* Stechow, 1925; *Dynamena disticha* form *dense* Picard, 1951a; *Dynamena disticha* form *souriei* Picard, 1951b; *Dynamena cavolini* Riedl, 1959 [Justified emendation]; *Dynamena disticha* Calder, 1990; Migotto, 1993; Souza, 1997.

Examined material: thirty six colonies with gonothecae, northeast part of Isla Uvita, Limón, Caribbean coast, 9°59'40" N, 83°00'50" W, 11 November 1993 (UCR-844).

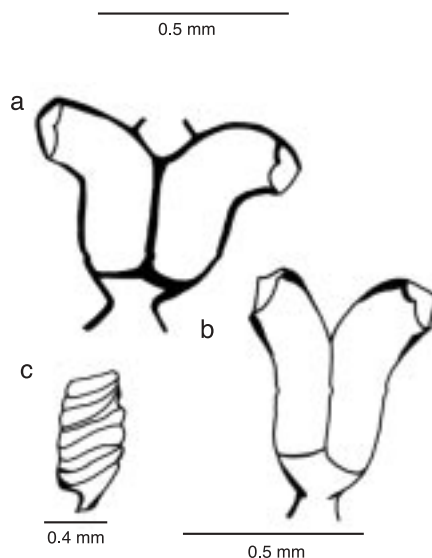


Fig. 6. *Dynamena disticha*. a: Basal hydrotheca; b: distal hydrotheca; c: gonothecae.

Description: colonies erect, up to 1.2 cm high, arising from a creeping hydrorhiza. Hydrocaulus monosiphonic, straight, unbranched, divided into internodes by usually distinct oblique nodes, or by distinct hinge-joints; basal part of hydrocaulus with one or more athecate internodes 1.6 to 2.1mm long, each with one pair of frontally placed hydrothecae. Hydrothecal pairs contiguous for a varying distance in front of internode; distal half parallel with axis of internode; distal half curving outwards with orifice facing nearly perpendicular to internodal axis. Abcauline wall concave, 267-474 μm long; contiguous portion of adcauline wall straight, 129-360 μm long; free part of adcauline wall convex, 202-350 μm long. Hydrothecal base about 112 μm wide, with triangular perisarcular projections extending proximally; hydrothecal orifice oval, 98-136 μm wide from adcauline to abcauline wall; margin with two large pointed lateral teeth and a smaller marginal adcauline tooth. Operculum consisting of a large abcauline valve and a smaller tent-shaped adcauline valve. Hydrothecae usually with internal teeth. Gonophores fixed sporosacs. Gonothecae oval-shaped laterally, round-shaped in cross section, usually with six, rounded, transverse ridges. Gonothecae about 1mm long from base to orifice, 0.62 mm wide, placed by short pedicels into hydrorhiza. Submarginal teeth present. Cnidome comprising microbasic mastigophores of two distinct sizes: (i) large, 21.0-26.2 x 8.9-10.02 μm , and (ii) small, 6.8-8.1 x 2.0-2.8 μm .

Known range: Bermudas (Bennett 1922 as *Sertularia cornicina*; Calder 1986, 1990), western Atlantic (García *et al* 1980), Indian Ocean (Mammen 1965), western Pacific (Park and Rho 1986 as *Dynamena cornicina*), eastern Pacific (Fraser 1937), Brazil (Migotto 1993, Souza 1997).

Sertularella diaphana (Allman, 1885)
(Fig. 7)

Thuiaria distans Allman, 1877; *Thuiaria pinnata* Allman, 1877; *Thuiaria diaphana*



Fig. 7. Portion of hydrocladium with hydrotheca of *Sertularella diaphana*.

Allman, 1885; *Thuiaria hyalina* Allman, 1888; *Sertularella distans* Hartlaub, 1901; *Sertularella pinnata* Hartlaub, 1901; *Thujaria pinnata* Hartlaub, 1901b; *Sertularella pinigera* Hartlaub, 1901b; *Sertularella lata* Nutting, 1904; *Sertularella lata* Billard, 1907, Jarvis, 1922. *Sertularella torreyi* Nutting, 1905; *Sertularella speciosa* Congdon, 1907; *Sertularella tridentata* Stechow, 1913a; *Sertularella diaphana* Bale, 1919; *Sertularella delicata* Billard, 1919; *Sertularella sargassi* Stechow, 1920; *Sertularella diaphana madagascariensis* Billard, 1921; *Sertularella diaphana orthogona* Billard, 1921; *Thuiaria quadrilateralis* Hargitt, 1924; *Sertularella diaphana* var *gigantea* Billard, 1925a; *Sertularella diaphana* var *delicata* Billard, 1925. *Sertularella diaphana* Calder, 1990, Souza, 1997.

Examined material: five colonies without gonothecae, Refugio Nacional de Vida

Silvestre Gandoca-Manzanillo, northern Punta Mona, Limón, Caribbean coast, 9°37'45" N, 82°37'07" W, 9 m, 4 August 1995 (UCR-846).

Description: colonies erect, up to 16 mm high, arising from a creeping hydrotheca. Hydrocaulus usually polysiphonic, rarely monosiphonic, slightly geniculate, divided into internodes at regular intervals by oblique nodes sloping alternately left and right. Perisarc thick. Internodes with pairs of alternate hydrothecae; apophyses short, given off alternately from opposite sides of hydrocaulus; each apophysis separated from hydrocladium by a distinct transverse node. Hydrocladia straight to slightly geniculate, up to 9.3 mm long, divided into internodes of varied length by oblique nodes. Hydrothecae alternate, on opposite sides of hydrocladia, almost entirely adnate, each with axis oblique to that of internode; adcauline wall convex, 310-349 μm long; abcauline wall slightly concave, occasionally with a faint bulge basally; basal diameter 105-151 μm . Hydrothecal orifice nearly circular, 201-220 μm wide from adcauline to abcauline tooth; margin with four small teeth. Operculum with four valves. Hydranths with an abcauline diverticulum. Gonophores not observed. Cnidome comprising microbasic mastigophores of two distinct categories: (i) large, 23.2-27.4 x 9.3-11.2 μm , and (ii) small, 6.6-8.4 x 2.6-3.1 μm .

Known range: Bermudas (Congdon 1907 as *Sertularella speciosa*, Calder 1990), western Atlantic (Vervoort 1968 as *Sertularella speciosa*), Indian Ocean (Millard 1975), western Pacific (Billard 1925a), Brazil (Souza 1997).

Tridentata distans (Lamouroux, 1816)
(Fig. 8)

Dynamena distans Lamouroux, 1816; *Sertularia lamourousii* Deshayes and Milne-Edwards, 1836; *Sertularia gracilis* Hassall, 1848; *Sertularia (Dynamena) distans* Busk, 1852; *Dynamena gracilis* Marktanner-Turneretscher, 1890; *Sertularia stookeyi* Nutting, 1904; Stechow, 1922. *Sertularia*

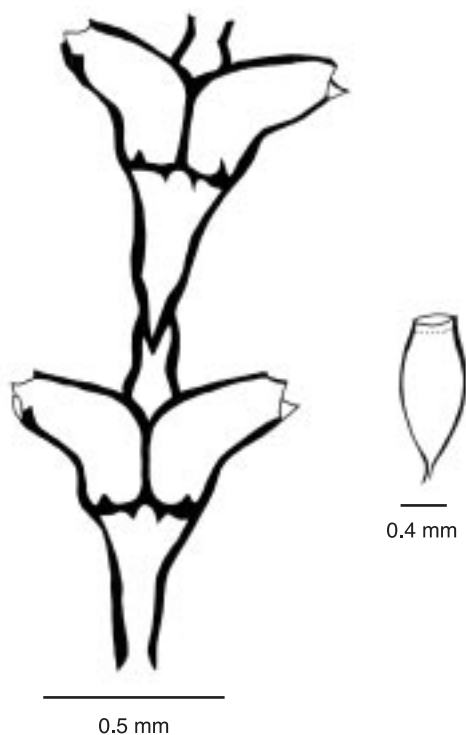


Fig. 8. *Tridentata distans*. a: Portion of hydrocaulus with hydrothecal pairs; b: gonothecae.

distans Billard, 1906; *Sertularia distans gracilis* Billard, 1912; *Tridentata gracilis* Stechow, 1920; *Tridentata (Sertularia) gracilis* Stechow, 1920; *Tridentata heterodonta* Stechow, 1922. *Tridentata distans* Hiroito, 1969; Calder, 1990; Souza, 1997. *Sertularia distans* Migotto, 1993.

Examined material: twenty five colonies with gonophores, south of lighthouse, Isla del Caño, Puntarenas, Pacific coast, 8°43' N, 83°52' W, 19 April 1984 (UCR-892).

Description: colonies erect, up to 12 mm high, arising from a creeping hydrorhiza having internal septa. Perisarc thick. Hydrocaulus monosiphonic, straight, usually with a long stolon distally, unbranched but occasionally with one to four branches; each branch arising from renovation of an old hydrotheca, divided into internodes. Basal part of hydrocaulus with one to six short athecatae internodes separated by oblique hinge-joints. Upper thecate intern-

odes 286-432 μm long, separated by distinct or indistinct oblique to occasionally almost transverse nodes; each internode with a distal pair of frontally placed hydrothecae. Sometimes two athecata internodes separated by a short athecata internode marked by an oblique node at proximal end and oblique hinge-joint at distal end. Hydrothecal pairs opposite; pairs virtually contiguous; rarely separated frontally. Hydrothecae horn-shaped, facing outwards to obliquely upwards, each with an axis oblique to that of internode; abcauline wall 180-232 μm long, concave medially, nearly straight distally, often with a basal bulge proximally; contiguous part of adcauline wall straight, 5-160 μm long, becoming nearly straight distally; diameter at base 55-118 μm . Perisarc of hydrothecae thickened near margin; adcauline and abcauline walls each either lacking intrathecal teeth or having one or two such teeth just below margin; hydrothecal base near adcauline wall with a small triangular perisarc projection extending proximally into internode, and usually with a perisarc projection protruding from base near hydropore into hydrothecal cavity. Hydrothecal orifice irregularly oval, 60-90 μm wide from adcauline to abcauline wall; margin with two lateral teeth and a smaller median adcauline tooth. Operculum consisting of a large abcauline valve. Hydranth with an abcauline diverticulum. Gonophores fixed sporosacs. Gonothecae arising from short pedicels on hydrocaulus at bases of hydrothecae, normally numbering two per hydrocaulus, elongated and oval in lateral view, irregularly oval to nearly round in cross section, with about four faint, rounded ridges. Gonothecae vary from 923 to 1024 μm long from base to orifice; diameter vary from 398 to 414 μm . Orifice nearly round, about 220 μm in diameter. Operculum and submarginal teeth present. Cnidome comprising microbasic mastigophores of two distinct sizes: (i) large, 14.0-15.2 x 3.6-4.5 μm and (ii) small, 5.2-5.9 x 2.0-2.7 μm .

Known range: Bermuda (Bennit 1922 as *Sertularia stookey*, Calder 1991), western Atlantic (van Gemerden-Hoogeven 1965 as

Sertularia distans var *gracilis*), eastern Atlantic (Cornelius 1979 as *Sertularia distans*), Indian Ocean (Millard 1975 as *Sertularia distans*), western Pacific (Hirohito 1969), eastern Pacific (Fraser 1948 as *Sertularia stookey*).

Superfamily Plumularioidea McCrady, 1859
Family Plumulariidae McCrady, 1859

Plumularia floridana Nutting, 1900
(Fig. 9)

Plumularia floridana Nutting, 1900; *Plumularia alicia* Torrey, 1902; *Plumularia florida* Wallace, 1909; *Plumularia alicia* var. *minuta* Billard, 1927; *Plumularia sinuosa* Fraser, 1938; *Plumularia floridana* Pennycuik, 1959; *Plumularia* sp. Pennycuik, 1959; ?*Plumularia indica* Mammen, 1965; *Plumularia pennycuikae* Millard and Bouillon, 1973; *Plumularia pennycuikai* Rho and Park, 1986.

Material examined: one colony with several hydrocauli, gonophores not observed, Punta Pitahaya, Guanacaste, Pacific coast,

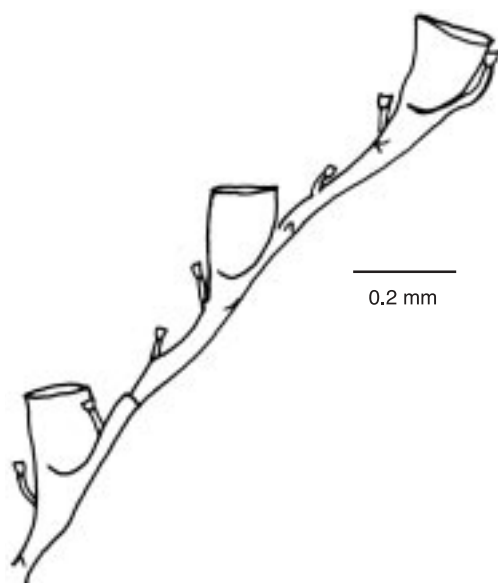


Fig. 9. Part of hydrocladium in lateral view of *Plumularia floridana*.

10°03'55" N, 85°45'57" W, 15 June 1991 (UCR-898).

Description: colony 12 mm high, with a creeping hydrorhiza. Hydrocaulus monosiphonic, branched, more or less straight basally, geniculate elsewhere, divided at regular intervals beyond basal region internodes by distinct transverse nodes; internodes 290-600 μm long, 40-90 μm wide at nodes, with conspicuous septa adjacent to nodes. Each internode with a distal apophysis and typically with two or more nematothecae, one or two axillary and one along internode on side opposite apophysis; cauline nematothecae bithalamic, movable, cone shaped to scoop shaped. Apophysis short, alternate, each bearing a mamelon on dorsal side near node and supporting a hydrocladium. One or two branches, irregularly arranged, inserted at an angle of about 45° to the hydrocaulus, each replacing a hydrocladium and arising from an apophysis. Hydrocladia unbranched, up to 3.4 mm long, directed outward at an angle of about 60° from axis of hydrocaulus, divided into alternating athecate and thecate internodes each with two variably developed internal septa, one at each end; most proximal internode 90-330 μm long, with a straight node proximally and an oblique node distally, lacking hydrothecae and nematotheca; thecate internodes 238-409 μm long, each with an oblique node proximally, a straight node distally, a medium inferior nematotheca; athecate internodes beyond the most proximal one 192-590 μm long, with a straight node proximally, an oblique node distally, and one intermediate nematotheca. Nematotheca of hydrocladia bithalamic, movable, cone-shaped to scoop-shaped; median nematotheca 43-55 μm long, typically ending proximal to or just reaching the base of hydrotheca; lateral nematotheca 55-65 μm long, not reaching to margin of hydrotheca. Hydrotheca 148-178 μm deep, cup-shaped, distal third or more of adcauline wall free from internode, axis oblique to that of internode; abcauline wall slightly convex basally, concave distally; margin entire, perpendicular or nearly so to axis of hydrothecae, aperture oval, in outline, diameter

115-144 μm ; without intratecal septum. Cnidome comprising microbasic mastigophores 4.4-5.1 x 1.9-2.0 μm , pseudostenoteles 8.4-10.2 x 3.9-4.4 μm ; and isorhizas 7.8-8.9 x 1.9-2.5 μm .

Known range: Bermuda (Calder 1983, 1993, 1997a); western Atlantic (Calder 1983); eastern Atlantic (Billard 1927); Indian Ocean (Millard 1975); western Pacific (Hirohito 1974); eastern Pacific, Point Vicente, California (Fraser 1948).

Family Halopterididae Millard, 1962

Halopteris polymorpha (Billard, 1913)
(Fig. 10)

Plumularia polymorpha Billard, 1913; *Halopteris polymorpha* Vervoort, 1966; Millard and Bouillon, 1973; Millard, 1975; Hirohito, 1983; Migotto, 1993; Schuchert, 1997.

Material examined: fourteen colonies (gonothecae not observed), Manzanillo, Limón, Caribbean coast, 9°37'55" N, 82°39'10" W, 19 September 1992 (UCR-691).

Description: colonies up to 32 mm, arising from a creeping hydrorhiza. Hydrocaulus monosiphonic, unbranched, base not segment-

ed, lacking hydrocladia, with a variable number of nematothecae, separated by an oblique articulation; hydrocaulus divided at regular intervals by distinct transverse nodes; each caulinar internode with one hydrothecae, one apophysis laterally disposed and five to seven nematothecae (one mesial, two lateral, and two to four superior). Hydrocladia alternate, composed of one or two basal joints, followed by two athecate internodes with one nematotheca and alternately athecate. Atecate internode usually continued with the thecate one, with an inconspicuous node, or lacking a node. Hydrothecal internode with one hydrotheca and three or five nematothecae (one mesial and two laterally disposed), and with one or two reduced sessile nematothecae between hydrothecae and hydrocaulus. Hydrothecal margin 180-200 μm , and 60-128 μm deep; lateral nematothecae 76-128 μm long, placed on the apophysis. Cnidome comprising pseudostenoteles 18-22 x 7.6-9.2 μm and microbasic mastigophores 6.0-7.1 x 1.8-2.1 μm .

Known range: Indian Ocean, Pacific (Billard 1913, Vervoort 1966, Millard and Bouillon 1973, Millard 1975, Hirohito 1983); Brazil (Migotto 1993).

Family Aglaopheniidae Marktanner
and Turmetscher, 1890

Aglaophaenia dubia Nutting, 1900
(Fig. 11)

Aglaophaenia gracilis Allman, 1877 [Not *Aglaophaenia gracilis* Lamouroux, 1816]; *Aglaophaenia dubia* Nutting, 1900; *Aglaophaenia flowersi* Nutting, 1900; *Aglaophaenia lophocarpa* Bennet, 1922 [Not *Aglaophaenia lophocarpa* Allman, 1877]; *Aglaophaenia allmani* Leloup, 1935 [Not *Macrorhynchia allmani* (Nutting, 1900)]; *Aglaophaenia elongata* Leloup, 1937; Deevey, 1954; van Gemerden-Hoogeven, 1965; Vervoort, 1968; Defenbaugh, 1974 [Not *A.elongata* Meneghini, 1845]; ?*Aglaophaenia dubia* Fraser, 1938; *Aglaophaenia acacia*

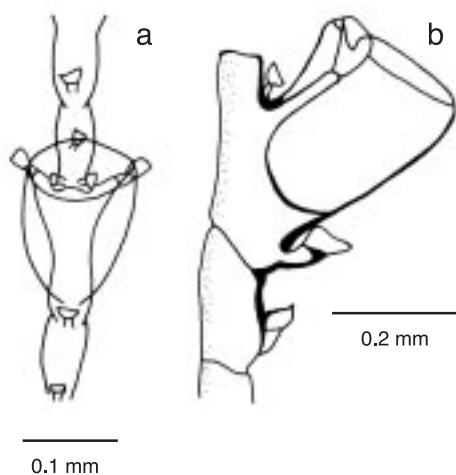


Fig. 10. Hydrocaulus with hydrothecae of *Halopteris polymorpha*. a: frontal view; b: lateral view.

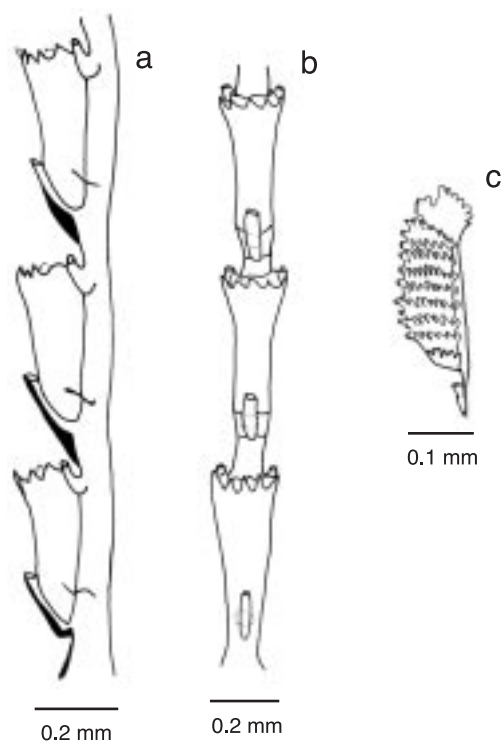


Fig. 11. Fragment of hydrocladium of *Aglaophenia dubia*. a: lateral view; b: front view; c: corbulae.

Svoboda, 1979; Svoboda and Cornelius, 1991 [Not *A. acacia* Allman, 1883]; *Aglaophenia apocarpa* Calder, 1993 [Not *Aglaophenia apocarpa* Allman, 1877]; *Aglaophenia* sp. Calder, 1993; *Aglaophenia dubia* Calder, 1997a.

Material examined: eight colonies, Punta Pitahaya, Guanacaste, Pacific coast, 10°03'55" N, 85°45'57" W, 15 June 1991 (UCR-577).

Description: colonies up to 18 cm high, with a creeping hydrohiza. Hydrocaulus monosiphonic, wiry and slender, reaching 0.6 mm wide basally; straight and unbranched in small colonies, gradually curved and branched in larger ones; basis of hydrocaulus devoid of apophysis, hydrocladia, nematophores, and regular nodes, merging imperceptibly and without an oblique hinge-joint with hydrocladium and nematophore-bearing part above; perisarc thick; nodes obliterated; cauline internodes marked by distinct to indistinct transverse nodes; each internode with a fronto-

laterally situated hydrocladial apophysis, a pair of axillary nematothecae, and one or two inferior nematothecae. Apophysis short, given off alternately from two sides of hydrocaulus; each apophysis with a cone-shaped mamelon and supporting a hydrocladium. Cauline nematothecae scoop to sac-shaped; aperture single, keyhole-shaped. Branches originating from front of hydrocaulus, typically given off singly, unbranched or rebranched; anterior surfaces of branches generally facing hydrocaulus or branch from which they originate. Hydrocladia unbranched, about 18 mm long, directed outward at an angle of about 50° from axis of hydrocaulus; each hydrocladium arising directly from an apophysis and divided by nearly transverse nodes into internodes; nodes sometimes indistinct. Hydrocladial internodes 335-490 µm long, 72-126 µm wide at nodes, each one with one hydrotheca placed frontally, one median inferior nematotheca and one pair laterally placed nematothecae. Two internodal septa, one placed laterally at the basis of intrathecal septum and other at basis of lateral nematothecae. Hydrothecae deeply cone-shaped, axis slightly oblique to that of internode; adcauline wall slightly convex, adnate to hydrocladial internode; abcauline wall basally convex, slightly concave distally from median to inferior nematothecal margin; intrathecal septum short; perisarc quite thin; abcauline wall lacking carina. Hydrothecal aperture 125-208 µm in diameter, outline nearly round. Hydrothecal margin with nine acute cusps separated by U-shaped incisions. Lateral nematotheca duct-shaped, distal and bent forward and somewhat outward, terminal orifice scoop-shaped, reaching to or just beyond hydrothecal margin; base of each lateral nematotheca with an aperture into internode. Gonophores fixed sporosacs. Female corbula closed, up to 4 mm long, 1 mm wide, born on peduncles with from one to three cormidia; rachis straight to slightly curved, bearing alternate nematocladia indistinctly separated from metabasal cladia; either side of the rachis with six to twelve fused nematocladia, each with a row of hoof-shaped nematothecae. Cnidome

comprising microbasic mastigophores of three sizes: (i) small, 4.5-5.4 x 1.6-2.0 μm ; (ii) medium, 7.9-9.2 x 2.5-2.8 μm , and (iii) large, 26.4-35.6 x 3.2-5.1 μm .

Known range: Bermuda (Bennett 1922, Calder 1993, 1997a); western Atlantic (Rees and Thursfield 1965); eastern Pacific (Fraser, 1938).

Aglaophenia latecarinata Allman, 1877
(Fig.12)

Sertularia pluma Bosc, 1802 [Not *Aglaophenia pluma* (Linnaeus, 1758)].
?Aglaophenia pelagica Lamouroux, 1816 [Nomem dubium].
?Plumularia simplex d'Orbigny, 1846 [Nomem dubium].
?Aglaophenia simplex Kirchenpauer, 1872 [Not *Aglaophenia perforata* Kirchenpauer, 1876 (Nomem nudum)] [= *Macrohynchia philippina* Kirchenpauer, 1872].
Aglaophenia perpupila Allman, 1877; *Aglaophenia latecarinata* Allman, 1877 [Incorrect original spelling]; *Aglaophenia latecarinata* Tizard *et al.* 1885 [Justified emendation]; Migotto,

1993; Calder, 1997a. *Aglaophenia minuta* Fewkes, 1881; *Agalophenia perforata* Allman, 1885; *Aglaophenia mammilata* Nutting, 1900; *Aglaophenia minima* Nutting, 1900; *Anisocalyx (Aglaophenia) pelagica* Bedot, 1905; *Aglaophenia latecarinata madagascariensis* Billard, 1907; *Aglaophenoides mamillata* Morris and Mogelberg, 1973; Not *Aglaophenia latecarinata* García *et al.*, 1978; *Aglaophenoides mamillatus* Cairns *et al.*, 1991 [Justified emendation].

Examined material: six colonies, with corbulae, Ocotol, Guanacaste, Pacific coast, 10°32'54" N, 85°43'30" W, 23 March 1984 (UCR-896).

Description: colonies up to 28 mm high, with a creeping, wrinkled hydrorhiza. Hydrocaulus monosiphonic, slender, unbranched, 0.1-0.2 mm wide basally, slightly convex frontally; perisarc thick basally, thinning progressively towards distal end. Basis of hydrocaulus with several irregular annulations just above the juncture with hydrorhiza. One or two large cauline nematothecae present; separated from hydrocladium-bearing part above by one short internode having a single nematothecae and oblique hinge-joints proximally and distally. Distal part of hydrocaulus divided into internodes by distinct to indistinct transverse nodes; each internode of hydrocaulus typically with a large, cone-shaped, inferior nematothecae, a fronto-laterally situated hydrocladial apophysis, and a pair of small, sac-shaped, axillary nematothecae; apophysis short, given off alternately from each side of hydrocaulus, adjacent pair on a given side about 0.60-1.0 mm apart; each apophysis with a cone shaped mamelon basally and supporting a hydrocladium distally; mamelon prominent, with a round to oval orifice. Hydrocladia reaching about 4 mm long, unbranched, directed outward at an angle of about 60° or more from the axis of hydrocaulus; frontal sides convex; top sides nearly straight; each hydrocladium arising directly from an apophysis and divided into short internodes by nearly transverse nodes. Hydrocladial internodes 215-420 μm long, 50-60 μm wide at nodes, each

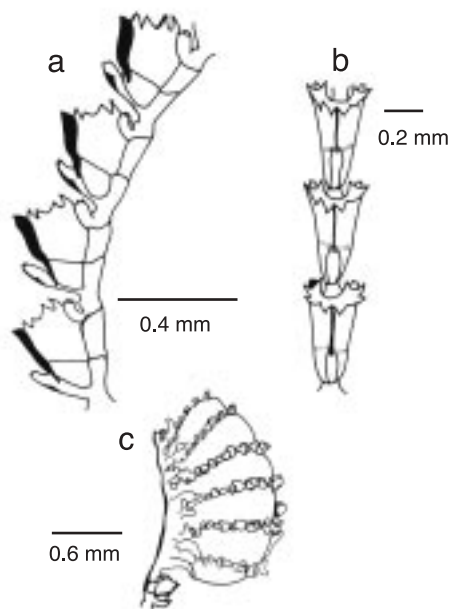


Fig. 12. Fragment of hydrocladium of *Aglaophenia latecarinata*. a: lateral view; b: front view; c: corbulae.

one with one frontally placed hydrotheca, one median inferior nematotheca, and one pair of lateral nematothecae; internodal septa typically two, with one at base of intrathecal septum and another at the basis of lateral nematothecae, both well developed and reaching across internode, occasionally with an additional weakly developed septum between these two. Hydrothecae close together, 241-318 μm deep from tip of median abcauline cusps to base, cone shaped, axis oblique to that of internode, adcauline wall convex, occasionally with a slight concavity at the proximal end, notched at the intrathecal septum, adnate to hydrocladial internode except for small free part at the distalmost end; abcauline wall convex basally, nearly straight to slightly concave from juncture of intrathecal septum to margin; prominent septum, slightly oblique, extending from adcauline to abcauline wall of hydrothecae; appearing in lateral view to divide cavity into two sections; abcauline wall with a carina of varying thickness, from thin and almost imperceptible to thick and keel-shaped, extending forward to median abcauline cusp, distal end of carina prow-shaped. Perisarc elsewhere of moderate thickness. Hydrothecal aperture 140-168 μm in diameter from adcauline wall to base of median abcauline cusp, irregularly oval in outline, plane of orifice nearly perpendicular to long axis of the hydrothecae; margin with nine cusps all rounded and prominent, one median and four lateral pairs, separated by U-shaped incisions; cusps usually more or less equal in size. Median inferior nematothecae anvil-shaped, adnate to abcauline wall of hydrothecae basally, small part free distally; apex reaching from one third to one half distance along abcauline wall of hydrothecae; distal aperture scoop-shaped, or oval with an additional oval aperture at the juncture with abcauline wall of the hydrothecae; nematothecae directed outward, with terminal orifice scoop-shaped, reaching to or just beyond hydrothecal margin; base of each lateral nematothecae with an internodal aperture. Gonophores fixed sporosacs. Mature cobulae kidney-shaped up to 1.7 mm long, 1.1 mm

wide, borne on peduncle having a single cormidium; rachis wrinkled, slightly curved, bearing alternate nematocladia arising from metabasal cladia; either side of the rachis with five to seven partially fused nematocladia each with one conspicuous anterior spur, small oval gaps laterally and distally on the corbulae between adjacent nematothecae. Cnidome comprising two sizes of microbasic mastigophores: (i) small, 4.9-5.6 \times 1.8-2.2 μm , and (ii) large, 27-38 \times 3.7-5.1 μm .

Known range: Bermuda (Congdon 1907, Smallwood 1910, Bennitt 1922, Morris and Mogelberg 1973, Butler *et al.* 1983, Calder 1986, 1993, 1995, 1997); western Atlantic (Vervoort 1968); eastern Atlantic (Vervoort 1968); Indian Ocean (Millard 1975); western Pacific (Hirohito 1983).

Macrorhynchia philippina

Kirchenpauer, 1872

(Fig. 13)

Macrorhynchia philippina Kirchenpauer, 1872; Rees and Vervoort, 1987; Calder, 1986; Migotto, 1993; Calder, 1997. *Aglaophenia philippina* Kirchenpauer, 1872; *Aglaophenia*

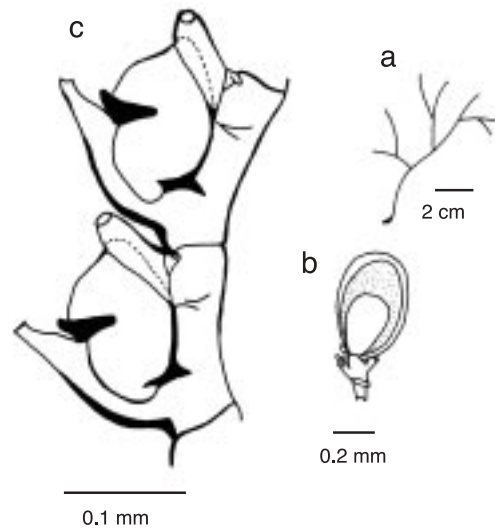


Fig. 13. *Macrorhynchia philippina*. a: aspect of the entire colony; b: filatocarp; c: lateral view of hydrothecae.

urens Kirchenpauer, 1876 [Nomem Nudum]; *Lytocarpus urens* Bale, 1888; *Aglaophenia (Lytocarpus) philippina* Bale, 1888 not *Lytocarpus philippinus* Congdon, 1907 [= *Macrorhynchia allmani* Nutting, 1900, according to Calder (1997a)]; *Lytocarpus crosslandi* Ritchie, 1908; *Lytocarpus philippinus atlanticus* Billard, 1913; *Aglaophenia (Macrorhynchia) philippina* Stechow, 1919; *Macrorhynchia crosslandi* Stechow, 1923a; *Macrorhynchia urens* Stechow, 1923a; *Lytocarpus (Macrorhynchia) philippinus* Boero and Bouillon, 1987.

Examined material: twenty-two colonies with gonophores and phylactocarps, Conchal, Guanacaste, Pacific coast, 10°23'55" N, 85°48'45" W, 31 September 1976 (UCR- 614).

Description: colonies up to 9 cm high. Hydrocaulus arising from stolons. Hydrocaulus pinnately or twice pinnately branched, reaching up 1.3 mm in width basally. Hydrocaulus and branches polysiphonic except at distal ends, curved gradually backward; nodes inconspicuous. Cauline internodes each with one hydrocladial apophysis and two nematothecae, one distal axillary and one proximal; nematothecae sac-shaped, tapering to a slender cone distally, orifice small, spherical to oval. Hydrocladial apophysis short, each bearing a cone shaped mamelon on anterior surface; given off alternately from frontal surface of axial tubes of hydrocaulus and branches, quite closely spaced, directed outward at an angle of about 45° from axis of adjacent hydrocaulus or branch. Hydrocladia up to 5mm long, unbranched; top and frontal sides convex; each hydrocladium arising directly from apophysis and separated from it by an oblique node; divided into short internodes by nearly straight nodes. Hydrocladial internodes 240-305 µm long, 75-110 µm wide at nodes, each with one frontally placed hydrotheca, one median inferior nematotheca, one pair of lateral nematotheca, and two internodal septa; adjacent hydrothecae close to one another. Hydrothecae slipper-shaped, 250-271 µm deep from adcauline wall at margin to base, curving abruptly outward distally;

adcauline wall convex except for pronounced concavity just below margin; abcauline intrathecal septum conspicuous, cusp-shaped, curved away from hydrocaulus, extending about halfway across intrathecal cavity; hydrothecal aperture 130-156 µm in diameter from adcauline to abcauline wall, irregularly oval; plane of aperture oblique to axis of internodes and to that of hydrothecae; margin with an acute median abcauline cusp, a pair of low and rounded lateral cusps, and low and unobscured median adcauline cusp, and a flange on either side where rim meets lateral nematothecae; aperture distinctly flaring in top view. Median inferior nematothecae long, anvil-shaped, reaching beyond margin of hydrothecae distally, slightly curved, adnate to abcauline wall of hydrothecae as far as intrathecal septum, distal third free, cone-shaped, length free 118-139 mm; lateral nematothecae tubular, largely adnate to hydrothecal wall, distal end tapered and curved forward, extending a varying distance beyond margin of hydrothecae; terminal aperture small and spherical. Phylactocarps single, oval-shaped, slightly curved, up to 4.2 mm, unbranched; each with a basal thecate internode, followed by an internode with a gonotheca. Gonothecae as fixed small sporosac, oval-shaped and flattened laterally. Cnidome comprising microbasic mastigophores of three sizes: (i) small, 4.9-6.5 x 1.8-2.2 µm; (ii) medium, 20.0-30.0 x 3.9-5.4 µm, and (iii) large, 95.0-100.0 x 7.1-7.9 µm.

Known range: Bermudas (Bennitt 1922, Calder 1983, 1986, 1993, 1997); western Atlantic (Vervoort 1968); eastern Atlantic (Ritchie 1908); Indian Ocean (Millard 1975); western Pacific (Hirohito 1983); eastern Pacific (Fraser 1948); Brazil (Migotto 1993).

Macrorhynchia sp.

(Fig. 14)

Macrorhynchia Kirchenpauer, 1872, Calder, 1997a. *Nematophorus* Clarke, 1879. *Pleurocarpa* Fewkes, 1881.

Examined material: nine damaged colonies, Punta Cabuja, Guanacaste, Pacific

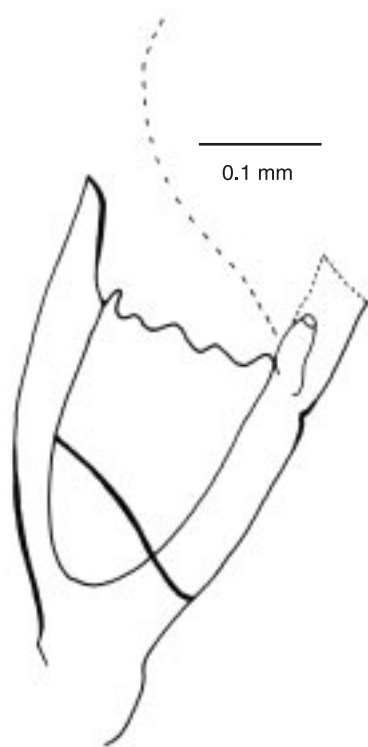


Fig. 14. Lateral view of the hydrothecae of *Macrorhynchia* sp.

coast, 10°22'20" N, 85°51'25" W, 16 November 1991 (UCR-894).

Description: colony erect, up to 10 cm high; hydrocaulus branched, polysiphonic arising from anchoring filaments; cauline internodes with triangular nematothecae. Hydrocladia unbranched, arranged pinnately, arising alternately from apophyses on axial tube of hydrocaulus and branches. Hydrothecae 300-350 μ m deep from tips of the seven marginal cusps to base, and usually cone-shaped; perisarc of moderate thickness; hydrothecal aperture 140-190 μ m in diameter from adcauline to abcauline wall, irregularly oval. Each hydrotheca with a pair of lateral horn-shaped nematothecae and one partially adnate median inferior nematothecae. Gonophores not observed. Cnidome comprising microbasic mastigophores of three distinct sizes: (i) small, 4.6 x 1.4-2.0 μ m, (ii) medium, 16.0-28.0 x 3.5-5.0 μ m, and (iii) large, 90.0-95.0 x 6.5-7.5 μ m.

Lytocarpia tridentata (Verluys, 1899)
(Fig. 15)

Aglaophenia tridentata Verluys, 1899, Stechow, 1923b. *Aglaophenia contorta* Nutting, 1900; Bedot, 1921; Vannucci-Mendes, 1946; Vannucci, 1951. *Thecocarpus contorta* Totton, 1926, *Aglaophenia tridentata* Picard, 1951a; Vervoort, 1968; Forneris, 1969. *Lytocarpia tridentata* Migotto, 1993.

Examined material: nine colonies without gonophores, northern part of Isla Pájaros, Limón, Caribbean coast, 10°01'10" N, 83°04'45" W, 27 September 1996 (UCR-891).

Description: colonies up to 16 cm high, with a creeping hydrorhiza. Hydrocaulus monosiphonic and unbranched. Basal part of the colony usually without hydrocladia and nematothecae. Distal part divided into internodes by distinct transverse nodes. Internodes with one hydrocladial apophysis and four nematothecae: two axillary disposed, one inferior, and one frontal pseudonematothecae. Hydrocladia with distinct internodes, separated by oblique nodes. Each internode with one hydrotheca and three nematothecae: two laterally and one mesial. Hydrothecae with short

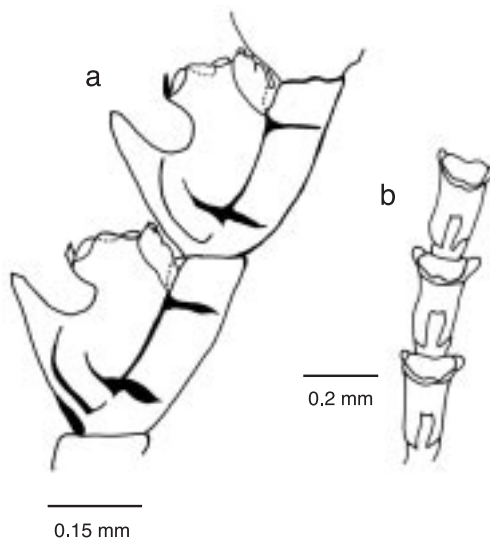


Fig. 15. *Lytocarpia tridentata*. a: lateral view of two hydrothecae; b: part of hydrocaulus.

internal septa, two almost imperceptible lateral teeth, and one conspicuous median tooth. Nine or eleven tentacles. Margin of hydrotheca about 166 μm in diameter and 280-336 μm deep. Mesial nematotheca up to 288 μm long; lateral nematothecae about 125 μm long. Perisarc of moderate thickness. Gonophores not observed. Cnidome comprising microbasic mastigophores of two categories: (i) small, 4.9-5.2 x 1.8-2.5 μm , and (ii) large, 28.0-36.0 x 4.1-5.2 μm .

Known range: western Atlantic (Vervoort 1968 as *Aglaophenia tridentata*); Brazil (Totton 1926, Vannucci-Mendes 1946, Vannucci 1951, Migotto 1993).

Superfamily Campanularioidea Johnston, 1837

Family Campanulariidae Johnston, 1837

Subfamily Clytiinae Cockrell, 1911

Clytia gracilis (Sars, 1850)

(Fig. 16)

Laomedea gracilis M. Sars, 1850; *Laomedea* (*Campanularia*) *gracilis* M. Sars, 1857; *Clytia* (*Platypyxis*) *cilindrica* L. Agassiz, 1862; *Clytia cilindrica* L. Agassiz, 1862; *Platypyxis cylindrica* L. Agassiz, 1862; *Gonothyrea gracilis* Allman, 1864; *Campanularia gracilis* Van Beneden, 1867; *Clytia laevis* Weismann, 1883; *Campanularia serrulata* Bale, 1888; *Clytia serrulata* Pictet, 1893; *Laomedea* (*Gonothyraea*) *gracilis* Levinsen, 1893; *Campanularia attenuata* Calkins, 1899; *Obelia serrulata* Thornely, 1900; *Campanularia pelagica* van Breemen, 1905; *Clytia coronata* Fraser, 1912; *Clytia elsae-oswaldae* Stechow, 1914; *Clytia pelagica* Billard, 1917; *Clytia gracilis* Stechow, 1923a; Calder, 1990. *Laomedea* (*Phialidium*) *pelagica* Hummelinck, 1930; *Laomedea* (*Phialidium*) *gracilis* Hummelinck, 1930; *Laomedea pelagica* Hummelinck, 1930; *Laomedea* (*Clytia*) *gracilis* Broch, 1933; *Laomedea gracilis* form *pelagica* Leloup, 1933; *Clytia* (*campanularia*) *pelagica* Kunne, 1937; *Laomedea cylindrica* Leloup, 1937; *Clytia hemisphaerica* Millard, 1966;

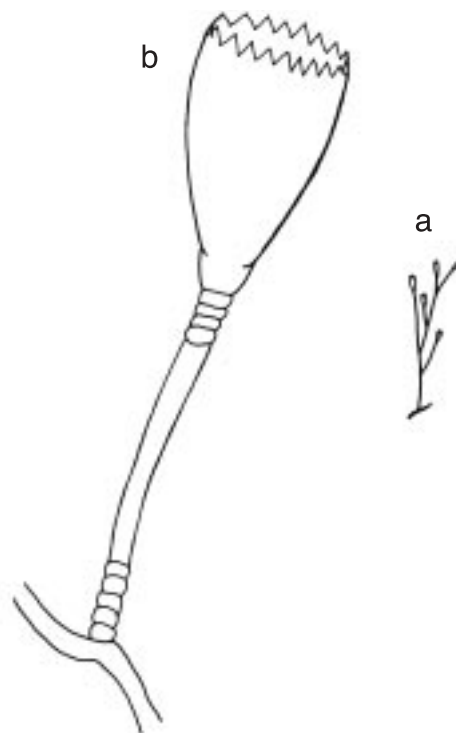


Fig. 16. *Clytia gracilis*. a: aspect of a branched colony; b: hydrotheca - unbranched colony.

Cornelius, 1982. *Clytia elsaeoswaldae* Vervoort, 1968; *Campanularia* (*Clytia*) *cylindrica* Vervoort, 1968; *Laomedea* (*Clytia*) *pelagica* Vervoort, 1972; *Clytia sarsi* Cornelius, 1982.

Material examined: twenty three colonies with gonothecae, Isla del Coco, Pacific coast, 5°29'81" N, 87°03'09" W, 17 June 1994 (UCR-832).

Description: colonies erect, fragile, sparingly and irregularly branched, up to 10 mm high, always arising from a creeping hydrorhiza. Hydrocaulus monosiphonic; each branch arising from a slightly curved aphophysis given off below hydrothecae of pedicel from which it arises; branches resembling primary pedicels and directed abruptly upwards, 6-10 annulations proximally and 2-6 distally placed. Pedicels about 0.5-0.4 mm high, 101-142 μm in diameter, annulated basally and distally, with annuli or wrinkles elsewhere.

Perisarc firm. Hydrothecae more or less cone-shaped, about 730-930 μm long, 390 μm wide at margin, 165-244 μm wide at diaphragm, with thin perisarc. Walls convex above diaphragm, nearly straight elsewhere; margin with about 12 to 17 deeply cut, blunt, triangular tooth cylindrical by U-shaped incisions; hydrothecal walls weakly scalloped in cross section at margin. Diaphragm thin, straight; the basal chamber varied in depth but usually deep and cup-shaped. Tentacles small, 18-21 in number, but usually 20. Gonothecae urn-shaped, about 968-1000 μm long, and 404-432 mm in diameter; orifice diameter about 305-342 μm wide, constricted just below aperture to about 320 μm wide, arising from hydrorhiza on short pedicels; walls smooth, constricted below aperture. Cnidome comprising isorhizas about 5.8-6.5 x 1.6-1.9 μm and microbasic mastigophores of three distinct sizes; (i) small, 6.5-7.8 x 1.8-2.6 μm ; (ii) medium, 8.4-9.2 x 2.8-3.1 μm ; and (iii) large, 13-16.3 x 3.1-3.9 μm .

Known range: Bermudas (Bennett 1922 and Calder 1986 as *Clytia Cylindrical*, Calder 1990); western Atlantic (Vervoort 1968 as *Laomedea (Phialidium) pelagica*); eastern

Atlantic (Vervoort 1946 as *Laomedea pelagica*); Indian Ocean (Mammen 1965); western Pacific (Yamada 1959); eastern Pacific (Fraser 1948 as *Gonothyrea gracilis*); Brazil (Migotto 1993).

DISCUSSION

The most recent report on the fauna of hydroids from Costa Rica (Cortés 1997), provided a list of 69 species of hydrozoans, including seven orders: Siphonophora, Stylasterina, Anthoathecatae, Leptothecatae, Leptomedusae, Narcomedusae and Trachymedusae. In this study, we introduce 16 new records to the list (Table 1), increasing the total number of species of the class Hydrozoa from Costa Rica to 75.

The list presented by Cortés (1997) includes 20 species of both Anthoathecatae and Leptothecatae orders. However, the reviewed synonym reduced this number to 19 (Table 2). With the additional contribution from this study, the actual number of Anthoathecatae and Leptothecatae species appears to be 35, of which only 16 are stored at the Museum of Zoology, University of Costa Rica.

TABLE 2
Anthoathecatae and Leptothecatae hydroids previously recorded from Costa Rica according to Fraser (1938, 1948), Hertlein (1963) and Cortés (1997).

Cytaeis tetrastyla Eschscholtz, 1829
Bimeria gracilis Clark, 1876
Halitholus intermedius (Browne, 1902)
Calycopsis papillata H.B. Bigelow, 1913
Solandaria gracilis Duchassaing & Michelin, 1846
Polyorchis penicellata (Eschscholtz, 1829)
Sarsia coccometra Bigelow, 1909
Dipleurosoma pacificum Agassiz & Meyer, 1902
Halecium washingtoni Nutting, 1901
Clytia gracilis (Sars, 1850) [as *Clytia cylindrica* A. Agassiz, 1862 and as *Gonothyraea gracilis* (Sars, 1851)]
Clytia linearis (Thornely, 1900) [as *Gonothyraea serialis* Fraser, 1938]
Clytia fascicularis Fraser, 1938
Clytia universitatis Torrey, 1904
Obelia longissima (Pallas, 1766) [as *Obelia commissurallos* McCrady, 1859]
Filellum serratum (Clarke, 1879) [as *Filellum serpens* (Hassall, 1852)]
Sertularella pedrensis Torrey, 1904
Dynamena crisioides Lamouroux, 1824 [as *Thuiaria crisioides* (Lamouroux, 1824)]
Aglaophenia rigida Allman, 1877
Plumularia micronema Fraser, 1938

The species *Halopteris polymorpha* (Billard 1913) previously reported in the Indian and Pacific Oceans (Billard 1913, Vervoort 1966, Millard and Bouillon 1973, Millard 1975, Hirohito 1983) and Brazil (Migotto 1993), is reported for first time from Caribbean Sea.

Another two species are new additions to the eastern Pacific fauna: *Acryptolaria longithecica* (Allman 1877), previously known from western Atlantic and Australia (Allman 1877, 1888, Clark 1879, Vervoort 1972, Calder 1996, Calder and Vervoort 1998), and *Aglaophenia latecarinata* Allman, 1877, from Bermuda (Congdon 1907, Smallwood 1910, Benitt 1922, Moris and Mogelberg 1973, Butler *et al.* 1983, Calder 1986, 1993, 1995, 1997a), western and eastern Atlantic (Vervoort 1968), Indian Ocean (Millard 1975), western Pacific (Hirohito 1983). Finally, the southerly range of *Plumularia floridana* Nutting, 1900, is now extended from Vicente Point, California to Punta Pitahaya, Guanacaste.

The Anthoathecatae and Leptothecatae hydroids are a diverse and conspicuous group of marine invertebrates. Most of the species have an apparent cosmopolitan distribution, with records from almost all oceans. However, the number of species reported from Costa Rica is still comparatively low, and unfortunately, the degree of preservation of the voucher material restricted the observation of any morphological variation. Additionally, although the hydroids are able to produce phenotypic responses to environmental changes (Kelmo and Attrill, in press), the absence of quantitative ecological data impedes the formulation of any robust conclusion about the distribution or ecology of the group. Therefore, there is a requirement for further baseline research on this group for both Pacific and Caribbean coasts of Costa Rica.

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RESUMEN

Este estudio proporciona el primer informe taxonómico de los hidroides de los Ordenes Anthoathecatae y Leptothecatae presentes en las colecciones del Museo de Zoología de la Escuela de Biología de la Universidad de Costa Rica. Se informan 16 especies de hidroides: *Eudendrium carneum*, *Pennaria disticha*, *Acryptolaria longithecica*, *Plumularia floridana*, *Halopteris polymorpha*, *Aglaophenia dubia*, *Aglaophenia latecarinata*, *Lytocarpia tridentata*, *Macrorhynchia phillipina*, *Macrorhynchia* sp., *Clytia gracilis*, *Cnidoscypus marginatus*, *Thyrosocypus ramosus*, *Dynamena disticha*, *Sertularella diaphana* y *Tridentata distans*. Se presenta una exhaustiva revisión de la sinonimia y una clave taxonómica simple e ilustraciones y descripciones para cada una de las especies.

REFERENCES

- Agassiz, A. 1865. North American Acalephae. Illustrated Catalogue of the Museum of Comparative Zoology. Harvard College, Cambridge No II, 234 p.
- Agassiz, L. 1860. Contributions to the natural history of the United States of America. Vol III. Little Brown & Company, Boston. 301 p.
- Agassiz, L. 1862. Contributions to the natural history of the United States of America. Vol. IV. Little Brown & Company, Boston. 380 p.
- Allman, G.J. 1864. On the construction and limitation of genera among the Hydroida. Ann. Mag. Nat. Hist. 13: 345-380.

- Allman, G.J. 1872. A monograph of the gymnoblastic or tubularian hydroids. Conclusion of the part I and part II. Roy. Society, London. pp. 155-450
- Allman, G.J. 1877. Report on the Hydroida collected during the exploration of the Gulf Stream by L. F. de Portualès, assistant United States Coast Survey. Mem. Mus. Comp. Zool. Harvard Coll. 5: 1-66.
- Allman, G.J. 1883. Report on the Hydroida dredged by H.M.S. Challenger during the years 1873-76. Part I. Plumularidae. Report on the Scientific Results of the Voyage of H.M.S. Challenger during the years 1873-76. Zoology 7: 1-54.
- Allman, G.J. 1885. Description of Australian, Cape, and other hydroida, mostly new, from the collection of Miss H.Gatty. J. Linn. Soc. Zool. 19: 132-160.
- Allman, G.J. 1888. Report on the Hydroida dredged by H. M. S. Challenger during the years 1873-76. Part II: The Tubularinae, Corymorphinae, Campanularinae, Sertularinae, and Thalamophora. Report on the Scientific Results of the Voyage H. M. S. Challenger during the years 1873-76. Zoology 23: 1-90.
- Altuna Prados, A. 1994. Estudio faunístico, ecológico y biogeográfico de los cnidarios bentónicos de la Costa Vasca. Ph.D. Dissertation. Universidad de Navarra. Pamplona, España. 769 p.
- Altuna Prados, A. 1995. Observaciones geográficas sobre los cnidarios bentónicos de la Costa Vasca. Kobie 22: 41-57.
- Ayres, W.O. 1854. Description of new species Polyps: *Globiceps tiarella*. Proc. Boston Soc. Nat. Hist. 4: 193-195.
- Bale, W.M. 1884. Catalogue of Australian hydroid zoophytes. Australian Mus. 8: 1-198.
- Bale, W.M. 1888. On some new and rare Hydroida in the Australian Museum Collection. Proc. Linn. Soc. New South Wales 2: 745-799.
- Bale, W.M. 1894. Further notes on Australian hydroids, with descriptions of some new species. Proc. Roy. Soc. Victoria 16: 93-117.
- Bale, W.M. 1913. Further notes on Australian hydroids II. Proc. Roy. Soc. Victoria 26: 114-147.
- Bale, W.M. 1919. Further notes on Australian hydroids IV. Proc. Roy. Soc. Victoria 31: 327-361.
- Bedot, M. 1905. Matériaux pour servir a l'histoire des hydroïdes. 2ème période (1821 à 1850). Rev. Suis. Zool. 13: 1-183.
- Bedot, M. 1912. Matériaux pour servir a l'histoire des hydroïdes. 4ème période (1872 à 1880). Rev. Suis. Zool. 20: 213-469.
- Bedot, M. 1916. Matériaux pour servir a l'histoire des hydroïdes. 5ème période (1881 à 1890). Rev. Suis. Zool. 24: 1-349.
- Bedot, M. 1918. Matériaux pour servir a l'histoire des hydroïdes. 6e période (1891 à 1900). Rev. Suis. Zool. 24: 1-376.
- Bedot, M. 1921. Hydroïdes provenant des campagnes des yachts Hironnelle et Princesse-Alice (1887 à 1912). I. Plumularidae. Résultats des Campagnes Scientifiques Accomplies sur son Yacht par Albert Iér, Prince Souverain de Monaco 60: 1-70.
- Bedot, M. 1925. Matériaux pour servir a l'histoire des hydroïdes. 7ème période (1901 à 1910). Rev. Suis. Zool. 32 (Suppl.): 1-657.
- Bennitt, R. 1922. Additions to the hydroid fauna of the Bermuda. Contributions from the Bermuda Biological Station for Research No 136. Proc. Amer. Acad. Arts Sci. 57: 241-259.
- Billard, A. 1906. Note sur les hydroïdes du Travailler et du Talisman. Bull. Mus. Hist. Nat. Paris 12: 329-334.
- Billard, A. 1907. Hydroïdes de Madagascar et du sud-est de l'Afrique. Arch. Zool. Exp. Gén. 7: 335-396.
- Billard, A. 1910. Revision d'une partie de la collection des hydroïdes du British Museum. Ann. Sci. Nat. Zool. 11: 1-67.
- Billard, A. 1912. Hydroïdes de Roscoff. Arch. Zool. Exp. Gén. 51: 459-478.
- Billard, A. 1913. Les hydroïdes de l'expédition du Siboga. I. Plumulariidae. Siboga-Expeditie, Monographie 7a: 1-115.
- Billard, A. 1917. Note sur quelques espèces d'hydroïdes libres. Bull. Mus. Nat. Hist. Nat. Paris 23: 539-546.
- Billard, A. 1919. Notes sur quelques espèces nouvelles de *Sertularella* de l'Expédition du "Siboga". Arch. Zool. Exp. Gén. 58: 18-23.
- Billard, A. 1921. Note sur une variété de *Sertularella* (*Sertularella diaphana madagascariensis*). Bull. Mus. Nat. Hist. Nat. Paris 27: 184-186.
- Billard, A. 1925. Les hydroïdes de l'expédition du Siboga II. Syntheciidae et Sertulariidae. Siboga-Expeditie. Monographie 7b: 115-232.

- Billard, A. 1927. Les hydroïdes de la côte atlantique de France. *Compt Rend. Congr. Soc. Savantes Paris, Séc. Sci* 1926: 326-346.
- Blainville, H.M.D. 1830. Zoophytes, Zoophyta. *In* F.G. Levrault (ed.), *Dictionnaire des sciences naturelles*. Tome 60. Le Normant, Paris. 548 p.
- Blanco, O.M. 1994a. Claves de familias y géneros para facilitar el reconocimiento de los hydroids (Leptolina) Athecata, Thecata y Limnomedusae Argentinos (generación polipoide exclusivamente). *Rev. Mus. Plata (Zool)* 14(160): 147-179.
- Blanco, O.M. 1994b. Enumeración sistemática y distribución geográfica preliminar de los hydroïda de la República Argentina, Suborden Athecata (Gymnoblastera, Anthomedusae), Thecata (Calyptriblastera, Leptomedusae) y Limnomedusae. *Rev. Mus. Plata (Zool)* 14(161): 181-216.
- Boero, F. & J. Bouillon. 1987. Inconsistent evolution and paedomorphosis among the hydroids and medusae of the Athecatae/Anthomedusae and the Thecatae/Leptomedusae (Cnidaria, Hydrozoa) p. 229-250. *In* J. Bouillon, F. Boero, F. Cicogna & P. F. S. Cornelius (eds.). *Modern trends in the systematics, ecology, and evolution of hydroids and hydromedusae*. Clarendon, Oxford.
- Bonnevie, K. 1899. Hydroïda. *Den Norske Nordhavs-expedition 1876-1878, Zoologi*, 7. Christiania, GrAndahal and SAn. 103 p.
- Boone, L. 1938. Scientific results of the world cruises of the yachts "Ava", in 1928-1929, and "Alva", 1931-1932, "Alva" Mediterranean cruise, 1933, and "Alva" South America cruise, 1935, William K. Vanderbilt, Commanding. Part II: Coelenterata. *Bulletin of the Vanderbilt Mar. Mus.* 7: 29-76.
- Bosc, L.A.G. 1802. *Histoire naturelle des vers, contenant leur description et leurs moeurs; avec figures dessinées d'après nature*. Tome 3. Guilleminet, Paris. 270 p.
- Bouillon, J. 1985. Essai de classification des hydropolypes-hydroméduses (Hydrozoa-Cnidaria). *Indo-Malayan Zool.* 1: 29-243.
- Bouillon, J., C. Massin & R. Krešević. 1995. Hydromedusae de l'Institut Royal des Sciences Naturelles de Belgique. *Doc. Trav. I.R.Sc.N.B.* 78: 3-106.
- Brinckmann-Voss, A. 1970. Anthomedusae/Athecata (Hydrozoa, Cnidaria) of the Mediterranean, part I. *Capitata. Fauna e Flora del Golfo di Napoli* 39: 1-96.
- Broch, H. 1933. Zur Kenntnis des Adriatischen Hydroïdenfauna von Split. Arten und variationem. *Skrifter Utgitt av det Norske Videnskaps-Akademi i Oslo I. Mat.-Natur. Kl.* 1933: 1-115.
- Brooks, W.K. 1883. Notes on the medusae of Beaufort, N.C. Part II. *Stud. Biol. Lab. Johns Hopkins Univ.* 2: 465-475.
- Browne, E.T. 1907. The hydroids collected by the Huxley from the north side of the Bay of Biscay in August 1906. *J. Mar. Biol. Asso. U. K.* 8: 15-36.
- Busk, G. 1852. An account of the Polyzoa, and sertularian zoophytes, collected in the voyage of the "Rattlesnake", on the coasts of Australia and the Louisiade Archipelago. p. 343-402. *In* J. MacGillivray (ed.). *Narrative of the voyage of H.M.S. Rattlesnake, commanded by the late Captain Owen Stanley, R.N., F.R.S., during the years 1846-1850*. Vol.1, Append. 4. T. & W. Boone, London.
- Butler, J.N., B.F. Morris, J. Cadwallader & A.W. Stoner. 1983. Studies of *Sargassum* and the *Sargassum* community. *Bermuda Biol. Sta. (Spec. Publ.)* 22: 1-306.
- Cairns, S.D.; D.R. Calder; A. Brinckmann-Voss; C.B. Castro; P.R. Pugh; C.E. Cutress; W.C. Jaap; D.G. Fautin; R.J. Larson; G.R. Harbison; M.N. Arai & D.M. Opresko. 1991. Common and scientific names of aquatic invertebrates from the United States and Canada: Cnidaria and Ctenophora. *Amer. Fish. Soc. (Spec. Publ.)* 22: 1-75.
- Calder, D.R. 1983. Hydroïda from estuaries of South Carolina, USA: families Sertulariidae and Plumulariidae. *Proc. Biol. Soc. Wash.* 96: 7-28.
- Calder, D.R. 1986. Class Hydrozoa. p. 127-155. *In* W. Sterrer (ed.). *Marine fauna and flora of Bermuda: a systematic guide to the identification of marine organisms*. Wiley-Interscience, New York.
- Calder, D.R. 1988. Shallow water hydroids of Bermuda: the Athecatae. *Roy. Ontario Mus., Life Sci. Contrib.* 148: 1-107.
- Calder, D.R. 1990. Seasonal cycles of activity and inactivity in some hydroids from Virginia and South Carolina, USA. *Can. J. Zool.* 68: 442-450.
- Calder, D.R. 1991. Shallow water hydroids from Bermuda: the Thecatae, exclusive of Plumularioidea. *Roy. Ontario Mus., Life Sci. Contrib.* 154. 140 p.
- Calder, D.R. 1993. Local distribution and biogeography of the hydroids (Cnidaria) of Bermuda. *Carib. J. Sci.* 29: 61-74.

- Calder, D.R. 1996. Hydroids (Cnidaria: Hydrozoa) recorded from depths exceeding 3000 m in the western North Atlantic. *Can. J. Zool.* 74: 1721-1726
- Calder, D.R. 1997a. Shallow water hydroids of Bermuda: superfamily Plumularioidea. *Roy. Ontario Mus., Life Sci. Contrib.* 161: 1-85.
- Calder, D.R. 1997b. Synopsis of hydroids from 1000 m and deeper in the western North Atlantic. p. 85-90. *In* J.C. Denhartog *et al.* (eds.). *Proc. 6th Int. Conf. Coelenterate Biol.* Leiden. The Netherlands.
- Calder, D.R. & W. Vervoort. 1998. Some hydroids (Cnidaria: Hydrozoa) from the Mid-Atlantic Ridge, in the North Atlantic Ocean. *Zool. Verhandl.* 319: 1-65.
- Calkins, G.N. 1899. Some hydroids from Puget Sound. *Proc. Boston Soc. Nat. Hist.* 28: 333-368.
- Cavolini, F. 1785. *Memorie per servire alla storia de' polipi marini.* Napoli. 279 p.
- Clarke, S.F. 1879. Report on the hydroids collected during the exploration of the Gulf Stream and Gulf of Mexico by Alexander Agassiz, 1877-78. *Bull. Mus. Comp. Zool. Harvard Coll.* 5: 239-252.
- Clarke, S.F. 1882. New and interesting hydroids from Chesapeake Bay. *Mem. Boston Soc. Nat. Hist.* 3: 135-142.
- Clarke, S.F. 1907. Reports on the scientific results of the expedition to eastern tropical Pacific, in charge of Alexander Agassiz, by the U.S. Fish Commission steamer "Albatross", from October, 1904, to March, 1905. Lieut.-Commander L.M. Garret, U.S.N., commanding. VIII. The hydroids. *Mem. Mus. Comp. Zool. Harvard Coll.* 35: 1-18.
- Cockrell, T.D.A. 1911. The nomenclature of the hydromedusae. *Proc. Biol. Soc. Wash.* 24: 77-86.
- Congdon, E.D. 1906. Notes on the morphology and development of two species of *Eudendrium*. *Biol. Bull.* 11: 27-46.
- Congdon, E.D. 1907. The hydroids of Bermuda. *Proc. Amer. Acad. Arts Sci.* 42: 463-485.
- Cornelius, P.F.S. 1979. A revision of the species of Sertulariidae (Coelenterata: Hydroida) recorded from Britain and nearby seas. *Bull. Brit. Mus. Nat. Hist. Zool.* 34: 243-321.
- Cornelius, P.F.S. 1982. Hydroids and medusae of the family Campanularidae recorded from the eastern North Atlantic, with a world synopsis of genera. *Bull. Brit. Mus. Nat. Hist. Zool.* 42: 37-148.
- Cornelius, P.F.S. 1992. The Azores hydroid fauna and its origin, with discussion of rafting and medusa suppression. *Arquipélago* 10: 75-99.
- Cortés, J. 1997. Biodiversidad marina de Costa Rica: Filo Cnidaria. *Rev. Biol. Trop.* 44(3)/45(1): 323-334.
- Costa, O.G. 1842. Fauna del regno di Napoli. Zoofiti. Genere Anisocalice; *Anysocalix*, Don. Napoli, Azzolino e Compagno. 24 p.
- Cowden, R.R. 1964. A cytochemical study of gonophore and oocyte development in *Pennaria tiarella*. *Acta Embryol. Morphol. Exp.* 7: 167-179.
- Cowden, R.R. 1965a. A cytological and cytochemical study of hydranths of the hydroid coelenterate, *Pennaria tiarella*. *Zeitsch. Zellforsch. Mikroskop. Anat.* 65: 869-883.
- Cowden, R.R. 1965b. Cytochemical studies of embryonic development to metamorphosis in the gymnoblastic hydroid, *Pennaria tiarella*. *Acta Embryol. Morphol. Exp.* 8: 221-231.
- Deevey, E.S. 1954. Hydroids of the Gulf of Mexico. *Fish. Bull.* 55: 267-272.
- Defenbaugh, R. 1974. Hydroids. 94-112. *In* T.J. Bright & L.H. Pequegnat (eds.). *Biota of the West Flower Garden Bank.* Gulf Publ. Co., Houston.
- Deshayes, G.P. & H. Milne-Edwards. 1836. *Histoire naturelle des animaux sans vertèbres par J.B.P.A. de Lamarck.* 2 éd. Tome 2. Baillière, Paris. 683 p.
- Driesch, H. 1889. Tektonische Studien au Hydropolypen. *Jena. Z. Naturw.* 24(1): 189-226.
- Ehrenberg, C.G. 1834. Beiträge zur physiologischen Kenntniss der Corallenthiere im allgemeinen, und besonders des Rothen Meers, nebst einem Versuche zur physiologischen Systematik derselben. *Abhandl. Königlich. Akad. Wiss.* 1: 225-380.
- Fewkes, J.W. 1881. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Caribbean Sea, in 1878, 1879, and along the Atlantic coast of the United States, during the summer of 1880, by the US Coast Survey Steamer "Blake", Commander J.R. Bartlett, USN, commanding. XI. Report on the Acalephae. *Bull. Mus. Comp. Zool. Harvard Coll.* 8: 127-140.
- Forneris, L. 1969. Fauna bentônica da baía do Flamengo, Ubatuba. Tese de Livre Docência (Thesis), Faculdade de Filosofia, Ciências e Letras, Universidade de São Paulo. São Paulo. 215 p.

- Fraser, C.M. 1912. Some hydroids of Beaufort, North Carolina. *Bull. U. S. Bur. Fish.* 30: 339-387.
- Fraser, C.M. 1937. Hydroids of the Pacific coast of Canada and the United States. University of Toronto, Toronto. 207 p.
- Fraser, C.M. 1938. Hydroids of the 1932-38 Allan Hancock Pacific Expedition. *Allan Hancock Pac. Exped.* 4: 1-153.
- Fraser, C.M. 1943. Distribution records of some hydroids in the collection of the Museum of Comparative Zoology at Harvard College, with description of new genera and new species. *Proc. New Engl. Zool. Club* 22: 75-98.
- Fraser, C.M. 1944. Hydroids of the Atlantic coast of North America. University of Toronto, Toronto. 451 p.
- Fraser, C.M. 1948. Hydroids of the Allan Hancock Pacific Expeditions since March, 1938. *Allan Hancock Pac. Exped.* 4: 179-335.
- García, P., A. Aguirre & D. Gonzalez. 1978. Contribución al conocimiento de los hidrozoos de las costas Españolas. Parte I: Halecidos, campanularidos y plumularidos. *Bol. Inst. Españ. Oceanogr.* 4: 3-73.
- García, P., A. Aguirre & D. Gonzalez. 1980. Contribución al conocimiento de los hidrozoos de las costas Españolas. Parte III. "Serulariidae" *Bol. Inst. Españ. Oceanogr.* 6: 5-67.
- García-Corrales, P. & A. Aguirre. 1985. La especie *Halocordyle disticha* (Goldfuss, 1820), y sus sinonimias. *Bol. Inst. Españ. Oceanogr.* 2: 85-96.
- Goldfuss, G.A. 1820. *Handbuch der Zoologie I. Abtheilung.* Nürnberg, Johan Leonhard Schrag. 696 p.
- Gravier-Bonnet, N. 1979. Hydraires semi-profonds de Madagascar (Coelenterata Hydrozoa), étude systématique et écologique. *Zool. Verhandl.* 169: 1-76.
- Haeckel, E. 1879. *Das System der Medusen. Erster Theil einer Monographie der medusen.* Denkschriften der Medizinisch-Naturwissenschaftlichen Gesellschaft zu Jena, 1. 360 p.
- Hargitt, C.W. 1924. Hydroids of the Philippine Islands. *Philippine J. Sci.* 24: 467-507.
- Hartlaub, C. 1901. Revision der *Sertularella*-Arten. *Abhandl. Geb. Natur.* 16: 1-143.
- Hassall, A.H. 1848. Definitions of three new British zoophytes. *The Zoologist* 6: 2223.
- Hertlein, L.G. 1963. Contribution to the biogeography of Cocos Island, including a bibliography. *Proc. Calif. Acad. Sci.* 32: 219-289.
- Hirohito. 1969. Some hydroids of the Amakusa Islands. Biological Laboratory, Imperial Household, Tokyo. 32 p.
- Hirohito. 1974. Some hydrozoans of the Bonin Islands. Biological Laboratory, Imperial Household, Tokyo. 55 p.
- Hirohito. 1983. Hydroids from Izu Ōshima and Niijima. Biological Laboratory, Imperial Household, Tokyo. 83 p.
- Hummelink, P.W. 1930. Beiträge zur Kenntnis Holländischer Hydroiden I. Bemerkungen über einige Camapnuliden und Camanulariden vom Vagdam und Nieuwediep. *Tijdschr. Ned. Dierkund.* Ver. 2: 28-42.
- Jäderholm, E. 1907. Über einige nordische Hydroiden. *Zool. Anz.* 32: 371-376.
- Jäderholm, E. 1919. Zur Kenntnis der Hydroidenfauna Japans. *Arkh. Zool.* 12: 1-34.
- Jäderholm, E. 1920. On some exotic hydroids in the Swedish Zoological State Museum. *Arkh. Zool.* 13: 1-11.
- Jarvis, F.E. 1922. The hydroids from the Chagos, Seychelles and other islands and from coasts of British East Africa and Zanzibar. *Trans. Linn. Soc. London Zool.* 18: 331-360.
- Johnston, G. 1837. A catalogue of the zoophytes of Berwickshire. *History of Berwickshire Naturalists' Club* 1: 107-108.
- Kelmo, F. & L.M. Santa-Isabel. 1998. Athecatae hydroids (Cnidaria-Hydrozoa) from Northern Bahia, Brazil. *Proc. 28th Meet. Asso. Mar. Lab. Caribbean. Rev. Biol. Trop.* 46(Suppl. 5): 61-72.
- Kelmo F. & M. Attrill. (in press). Cnidaria community structure of coastal reefs from northern Bahia, Brazil. *Bull. Mar. Sci.*
- Kirchenpauer, G.H. 1872. Ueber die Hydroidenfamilie Plumularidae, einzelne Gruppen derselben und ihre Fruchthälter. I. *Aglaophenia* Lx. *Abhandl. Geb. Natur. Herausg. Naturwiss. Ver. Hamburg-Altona* 5: 1-52.
- Kirchenpauer, G.H. 1876. Ueber die Hydroidenfamilie Plumularidae, einzelne Gruppen derselben und ihre

- Fruchtbehälter. II. Abhandl. Geb. Natur. Herausg. Naturwiss. Ver. Hamburg-Altona 6: 1-59.
- Kirkpatrick, R. 1910. Hydrozoa and Porifera. Proc. Zool. Soc. London 1910: 86-131.
- Künne, C. 1937. Über die Verbreitung der leitformen des Grossplanktons in der südlichen Nordsee in winter. Ver. Deut. Wiss. Komm. Meer. 8: 131-164.
- Lamouroux, J.V.F. 1812. Extrait d'un memoire sur la classification des polypieres coralligènes non entièrement pierreux. Nouv. Bull. Sci. Soc. Philom. Paris 3: 181-188.
- Lamouroux, J.V.F. 1816. Histoire des polypieres coraligènes flexibles, vulgairement nommés zoophytes. F. Poisson, Caen. 559 p.
- Leidy, J. 1855. Contributions towards a knowledge of the marine invertebrate fauna, of the coasts of Rhode Island and New Jersey. J. Acad. Nat. Sci. Philadelphia, 2nd series, 3: 135-152.
- Leloup, E. 1932. L'homologie des parties constituantes du gonosome chez *Thecocarpus* et *Aglaophenia* et la classification des Aglaopheniidae. Bull. Mus. Roy. Hist. Nat. Belg. 8: 1-26.
- Leloup, E. 1933. Contribution à la connaissance des hydropolypes de la côte des Pays-Bas. Bull. Mus. Roy. Hist. Nat. Belg. 9 (45): 1-30.
- Leloup, E. 1935. Hydriaires calyptoblastiques des indes Ovidentales. Mém. Mus. Roy. Hist. Nat. Belg. 2: 1-73.
- Leloup, E. 1937. Résultats scientifiques des croisières du navire-école belge "Mercator". VI. Hydroidea, Siphonophora, Ceriantharia. Mém. Mus. Roy. Hist. Nat. Belg. 9: 91-121.
- Leloup, E. 1940. Hydropolypes provenant des croisières du Prince Albert I de Monaco. Résultats des Campagnes Scientifiques Accomplies sur son Yacht par Albert I, Prince Souverain de Monaco, Fasc. 104. 39 p.
- Leloup, E. 1974. Hydropolypes calyptoblastiques du Chili. Report n° 48 of the Lund University Chile Expedition 1948-1949. Sarsia 55: 1-61.
- Lesh-Laurie, G.E. 1976. Stolon vs hydranth determination in *Pennaria tiarella* planulae: a role for DNA synthesis. p. 365-375. In G.O. Mackie (ed.). Coelenterata Ecology Behavior. Plenum Press, New York.
- Levisen, G.M.R. 1893. Annulata, Hydroidae, Anthozoa, Porifera. Det Videnskabelige udbytte af Kanonbaaden "Hauchs" Togter i de Danske have indenfor Skagen i aarene 1883-86. Kjøbenhavn, Andr. Fred. Høst & Søns. pp. 317-427.
- Linnaeus, C. 1758. Systema naturae per regna tria naturae, secundum classes, ordines, genera, species cum characteribus, differentiis, synonymis, locis. 10 ed. reformata. Holmiae, Laurentii Salvi. 823 p.
- Mammen, T.A. 1963. On a collection of hydroids from south India I. Suborder Athecata. J. Mar. Biol. Ass. India 5: 27-61.
- Mammen, T.A. 1965. On a collection of hydroids from south India. III. Family Plumulariidae. J. Mar. Biol. Ass. India 7: 291-324.
- Marktanner-Turneretscher, G. 1890. Die Hydroiden des K. K. Naturhistorischen Hofmuseums. Ann. K. K. Naturhist. Hofmus. 5: 195-286.
- Marques, A.C. 1992. Sistemática dos Eudendriidae L. Agassiz, 1862 (Cnidaria, Hydrozoa) do Litoral Paulista. M. Sc. Thesis, Universidade de São Paulo. São Paulo. Brasil. 125 p.
- McCrary, J. 1859. Gymnophthalmata of Charleston Harbor. Proc. Elliott Soc. Nat. Hist. 1: 103-221.
- Mendel, M.D. & P.J. Lopez-Gonzalez. 1996. Updated catalogue of hydrozoans of the Iberian Peninsula and Balearic Islands, with remarks on zoogeography and affinities. In S. Piraino, F. Boero, J. Bouillon, P.F.S. Conelius & J.M. Gili (eds.). Advances in Hydrozoan Biology. Sci. Mar. 60: 183-209.
- Meneghini, G. 1845. Osservazioni sull'ordine delle sertularie della classe de'polipi. Mem. Imp. Reale Inst. Veneto Sci., Lettere ed Arti 2: 183-199.
- Migotto, A.E. 1993. Hidróides (Hydrozoa, Cnidaria) marinhos bentônicos da região costeira do canal de São Sebastião, SP. Ph. D. Dissertation, Universidade de São Paulo. Brasil. 258 p.
- Millard, N.H.A. 1962. The Hydrozoan of south and west coasts of South Africa. Part I. The Plumulariidae. Ann. South Afr. Mus. 46: 261-319.
- Millard, N.H.A. 1966. The Hydrozoa of south and west coasts of South Africa. Part III. The Gymnoblastera and small families of Calyptoblastea. Ann. South Afr. Mus. 48: 427-487.
- Millard, N.H.A. 1967. Hydroids from the south-west Indian Ocean. Ann. South Afr. Mus. 50: 168-194.
- Millard, N.H.A. 1975. Monograph on the Hydroidea of southern Africa. Ann. South Afr. Mus. 68: 1-513.

- Millard, N.H.A. & J. Bouillon. 1973. Hydroids from the Seychelles (Coelenterata). Ann. Mus. Roy. Afr. Cent., sér. In-8°, Sci. Zool. 206: 1-106.
- Morris, B.F. & D.D. Mogelberg. 1973. Identification manual to the pelagic *Sargassum* fauna. Bermuda Biol. Sta. Res. 11: 1-63.
- Nutting, C.C. 1900. American hydroids. Part I. The Plumulariidae. Smithsonian Institution, U. S. Nat. Mus., Spec. Bull. 4: 1-285.
- Nutting, C.C. 1904. American hydroids. Part II. The Sertulariidae. Smithsonian Institution, U. S. Nat. Mus., Spec. Bull. 4: 1-325.
- Nutting, C.C. 1905. Hydroids of the Hawaiian Islands collected by the steamer Albatross in 1902. Bull. U. S. Fish Comm. 1903: 931-959.
- Nutting, C.C. 1915. American Hydroids. Section III. The Campanulariidae and Bonneviellidae. Smithsonian Institution, U. S. Nat. Mus. Spec. Bull. 4: 1-126.
- Orbigny, A. 1846. Voyage dans l'Amerique Méridionale (le Brésil, la République orientale de l'Uruguay, la République Argentine, la Patagonie, la République du Chili, la République de Bolivie, la République du Pérou), exécuté pendant les années 1826, 1827, 1828, 1829, 183, 1831, 1832 et 1833. Tome 5. 4e. Partie: Zoophytes. Levrault, Paris. 28 p.
- Park, J.H. & B.J. Rho. 1986. A systematic study on marine hydroids of Korea. 9. The family Sertulariidae. Korean J. Syst. Zool. (Special Issue) 1: 1-52.
- Pennycuik, P.R. 1959. Faunistic records from Queensland. Part V. Marine and brackish water hydroids. Papers Dep. Zool. Univ. Queensland 1: 141-210.
- Petersen, K.W. 1979. Development of coloniality in Hydrozoa. p. 105-139. In G. Larwood & B. Rosen (eds.). Biology and Systematics of colonial organisms. The Systematic Association, Academic, New York.
- Petersen, K.W. 1990. Evolution and taxonomy in capitate hydroids and medusae. Zool. J. Linn. Soc. 100: 101-231
- Picard, J. 1951a. Note sur le hydraire littoraux de Banyuls-sur-Mer. Vie et Milieu. Banyuls-sur-mer 2: 338-349.
- Picard, J. 1951b. Hydraires littoraux du Sénégal récoltés par H. Sourie aux environs de Dakar. Bull. Inst. Fondam. Afr. Noire 13: 109-115.
- Pictet, C. 1893. Étude sur les hydraires de la Baie d'Amboine. Rev. Suis. Zool. 1: 1-64.
- Pictet, C. & M. Bedot. 1900. Hydraires provenant des campagnes de l'Hirondelle (1886-1888). Résultats des Campagnes Scientifiques Accomplies sur son Yacht par Albert I, Prince Souverain de Monaco 18: 1-59.
- Ramil, F. & W. Vervoort. 1992. Report on the Hydroids collected by the "BALGIM" expedition in and around the Strait of Gibraltar. Zool. Verhandl. 277: 3-262.
- Rees, W.J. & S. Thursfield. 1965. The hydroid collections of James Ritchie. Proc. Roy. Soc. Edinburgh Biol. 69: 34-220.
- Rees, W.J. & W. Vervoort. 1987. Hydroids from the John Murray Expedition to the Indian Ocean, with revisory notes on *Hydrodendron*, *Abientinella*, *Cryptolaria* and *Zygophylax* (Cnidaria:Hydrozoa). Zool. Verhandl. 237: 1-209.
- Rees, W.J. & E. White. 1966. New records and fauna list of hydroids from the Azores. Ann. Mag. Nat. Hist. 9: 271-284.
- Rho, B.J. & J.H. Park. 1986. A systematic study on the marine hydroids in Korea. 10. The family Plumulariidae. J. Korean Res. Inst. Better Living, Ewha Womans Univ. 37: 87-112.
- Riedl, R. 1959. Die Hydroiden des Golfes von Naepel und ihr Anteil an der Fauna unterseeischer Höhlen. Pub. Sta. Zool. Napoli 30(Suppl.): 591-755.
- Ritchie, J. 1908. On collections of the Cape Verde Islands marine fauna, made by Cyril Crossland, M.A. (Cantab.), B.Sc. (London), F.S.Z., of St. Andrews University, July to September, 1904. The hydroids. Proc. Zool. Soc. London 1907: 488-514.
- Ritchie, J. 1909. Supplementary report on the hydroids of the Scottish National Antarctic Expedition. Trans. Nat. Roy. Soc. Edinburgh 47: 65-101.
- Ritchie, J. 1910. The marine fauna of the Mergui Archipelago, Lower Burma, collected by Jas. J. Simpson, M.A., B.Sc., and R.N. Rudmose-Brown, D. Sc., University of Aberdeen, February to May 1907. The hydroids. Proc. Zool. Soc. London 1910: 799-825.
- Ritchie, J. 1911. Hydrozoa (hydroid zoophytes and Stylasterina) of the "Thetis" Expedition. Australian Mus. 4: 805-869.
- Sars, M. 1850. Beretning om en i Lofoten og Finmarken. Nyt. Mag. Naturvidensk. 6: 121-211.

- Sars, M. 1857. Bidrag til kundskaben om Middelhavets Littoral-Fauna, Reisebemaerlinger fra Italien. *Nyt Mag. Naturvidensk.* 9: 110-164.
- Schuchert, P. 1997. Review of the Family Halopteridae (Hydrozoa, Cnidaria). *Zool. Verh. Leiden* 309: 1-162.
- Silveira, F.L. & Migotto, A.E. 1991. The variation of *Halocordyle disticha* (Cnidaria, Athecata) from the Brazilian Coast: an environmental indicator species? *Hydrobiologia* 216/217: 437-442.
- Smaldon, G.D., D. Heppell & K.R. Watt. 1976. Type specimens of invertebrates (excluding insects) held at the Royal Scottish Museum, Edinburgh. *Inf. Ser. R. Scot. Mus (Nat. Hist.)* 4: i-iv, 1-118.
- Smallwood, W.M. 1910. Notes on hydroids and nudibranchs of Bermuda. *Proc. Zool. Soc. London* 1910: 137-145.
- Souza, A.F. 1997. Sertularídeos (Hydrozoa, Thecatae) das construções recifais do litoral norte do estado da Bahia. B. Sc. Thesis. Instituto de Biologia, Universidade Federal da Bahia, Brasil. 84 p.
- Spletstösser, W. 1929. Beiträge zur Kenntnis der Sertulariden. *Thyrosocyphus* Allm., *Cnydosocyphus* nov. gen., *Parascyphus* Ritchie. *Zool. Jahrb. Abt. Syst. Ökol. Geogr. Tiere* 58: 1-134.
- Stechow, E. 1913a. Hydropolypen der japanischen Ostküste II. Teil: Campanulariidae, Halecidae, Lafoedidae, Campanulidae und Sertularidae, nebst Ergänzungen zu den Mathematisch-Physikalischen Klasse der Königlichen Bayerischen Akademie der Wissenschaften (Suppl.-Band 2) 3: 1-162.
- Stechow, E. 1913b. Neue Genera thecater Hydroiden aus der Familie der Lafoeiden und neue Species von Thecaten aus Japan. *Zool. Anz.* 43: 137-144.
- Stechow, E. 1914. Zur Kenntnis neuer oder seltener Hydroidpolypen, meist Campanulariden, aus Amerika und Norwegen. *Zool. Anz.* 45: 120-136.
- Stechow, E. 1919. Zur Kenntnis der Hydroidenfauna des Mittelmeeres, Amerikas und anderer Gebiete, nebst Angaben über einige Kirchenpauer'sche Typen von Plumulariidae. *Zool. Jahrb. Abt. Syst. Geogr. Biol. Tiere* 42: 1-172.
- Stechow, E. 1920. Neue Ergebnisse auf dem Gebiete der Hydroidenforschung. *Sitzungsb. Ges. Morphol. Physiol. München* 31: 9-45.
- Stechow, E. 1921. Neue Genera und Species von Hydrozoen und anderen Evertibraten. *Arch. Naturges. Abt. A.* 3. Heft 87: 248-265.
- Stechow, E. 1922. Zur Systematik der Hydrozoen, Stromatoporen, Siphonophoren, Anthozoen und Ctenophoren. *Arch. Naturges.* 88: 141-155.
- Stechow, E. 1923a. Zur Kenntnis der Hydroidenfauna des Mittelmeeres, Amerikas und anderer Gebiete II. Teil. *Zool. Jahrb. Abt. Syst. Ökol. Geogr. Tiere* 47: 29-270.
- Stechow, E. 1923b. Neue Hydroiden der Deutschen Tiefsee-Expedition, nebst Bemerkungen über einige andre Formen. *Zool. Anz.* 56: 1-20.
- Stechow, E. 1925. Hydroiden von West und Südwestaustralien nach den Sammlungen von Prof. Dr. Michaelsen und Prof. Dr. Hartmeyer. *Zool. Jahrb. Abt. Syst. Geogr. Biol. Tiere* 50: 191-270.
- Stranks, J.N. 1993. Catalogue of recent Cnidaria type specimens in the Museum of Victoria. *Occ. Papers Mus. Victoria* 6: 1-28.
- Summers, R.G. 1970. The fine structure of the spermatozoon of *Pennaria tiarella* (Coelenterata). *J. Morph.* 131: 117-130.
- Summers, R.G. 1972. A new model for the structure of the centriolar satellite complex in spermatozoa. *J. Morph.* 137: 229-242.
- Summers, R.G. & J.F. Haynes. 1969. The ontogeny of interstitial cells in *Pennaria tiarella*. *J. Morph.* 129: 81-88.
- Svoboda, A. 1979. Beitrag zur Ökologie, Biometrie und Systematik der mediterranen *Aglaophenia* Arten (Hydroidea). *Zool. Verhandl.* 167: 1-114.
- Svoboda, A. & P.F.S. Cornelius. 1991. The European and Mediterranean species of *Agalophenia* (Cnidaria: Hydrozoa). *Zool. Verhandl.* 274: 1-72.
- Thornely, L.R. 1900. The hydroid zoophytes collected by Dr. Willey in the southern seas. p. 451-457. *In* A. Willey (ed.). *Zoological results based on material from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1895, 1896 and 1897. Part IV.* Cambridge University, Cambridge.
- Tizard, T.H., H.N. Moseley, J.Y. Buchanan & J. Murray. 1885. Narrative of the cruise of H. M. S. Challenger with a general account of the Scientific Results of the Voyage of H. M. S. Challenger during the Years 1873-76. *Narrative* 1: 1-509.
- Torrey, H.B. 1902. The Hydroidea of the Pacific coast of North America, with especial reference to the species in the collection of the University of California. *Univ. Calif. Publ. Zool.* 1: 1-104.

- Totton, A.K. 1926. Note on rare Atlantic hydroid. *Ann. Mag. Nat. Hist.* 27: 210-212.
- Van Beneden, P.J. 1867. Recherches sur la faune littorale de Belgique (polyptes). *Mém. Acad. Roy. Sci. Let. Beaux-Arts Belg.* 36: 1-207.
- Van Breemen, P.J. 1905. Plankton van Noord - en Zuiderzee. *Tijdschr. Ned. Dierk. Vereenig.*(2). 9: 145-324.
- Van Germerden-Hoogeveen, G.C.H. 1965. Hydroids of the Caribbean: Sertulariidae, Plumulariidae and Aglaopheniidae. *Stud. Fauna Curaçao* 22: 1-87.
- Vannucci, M. 1951. Hydrozoa e Scyphozoa existentes no Instituto Paulista de Oceanografia. *Bol. Inst. Paulista Oceanogr.* 2: 69-100.
- Vannucci-Mendes, M. 1946. Hydroida Thecaphora do Brasil. *Arq. Zool. São Paulo* 4: 535-597.
- Verrill, A.E. 1874. Report upon the invertebrate animals of Vineyard Sound and the adjacent waters, with an account of the physical features of the region. *Rep. Comm. Fish.* 1871-1872: 295-747.
- Verrill, A.E. 1900. Additions to the Anthozoa and Hydrozoa of Bermuda. *Trans. Connect. Acad. Arts Sci.* 10: 551-572.
- Versluys, J. 1899. Hydriaires calyptoblastiques recueillis dans le Mer des Antilles, pendant l'une des croisières accomplies par le comte R. de Dalmas sur son yacht CHAZALIE. *Mém. Soc. Zool. France* 12: 29-58.
- Vervoort, W. 1941. Biological results of the Snellius Expedition. XI. The Hydroida of the Snellius expedition (Milleporidae and Stylasteridae excluded). *Temminckia* 6: 186-240.
- Vervoort, W. 1959. The Hydroida of the tropical west coast of Africa. *Atlantide Rep.* 5: 211-325.
- Vervoort, W. 1966. Bathyal and abyssal hydroids. *Galathea Rep.* 8: 97-174.
- Vervoort, W. 1968. Report on a collection of Hydroida from the Caribbean region, including an annotated checklist of Caribbean hydroids. *Zool. Verhandl.* 92: 1-124.
- Vervoort, W. 1972. Hydroids from the Theta, Vema and Yelcho cruises of the Lamont-Doherty Geological Observatory. *Zool. Verhandl.* 120: 1-247.
- Vervoort, W. 1985. Deep-water hydroids: 267-297. *In* L. Laubier & C. Moniot (eds.). *Peuplements profonds du golfe de Gascogne. Campagnes Biogas: 267-297.* Institut Français de Recherche pour L'Exploration de la Mer (INFREMER), Brest.
- von Lendenfeld, R. 1885. The Australian Hydromedusae. II. *Proc. Linn. Soc. New South Wales* 9: 345-363.
- Wallace, W.S. 1909. A collection of hydroids made at the Tortugas, during May, June and July, 1908. *Carnegie Inst. Wash., Year Book* 7: 136-138.
- Warren, E. 1906. On *Halocordyle cooperi* sp. Nov. a hydroid from the Natal Coast. *Ann. Natal Govern. Mus.* 1: 73-81.
- Warren, E. 1908. On a collection of hydroids, mostly from the Natal coast. *Ann. Natal Govern. Mus.* 1: 269-355.
- Weill, R. 1934. Contribution à l'étude des cnidaires et de leurs nematocystes II. Valeur taxonomique du cnidome. *Travaux de la station Zoologique de Wimereux* 11: 351-701.
- Weill, R. 1937. Existence d'un monocnidome dans le médusoïde d'un polype (*Pennaria? Tiarella* McGr) à tétracnidome. *Compt. Rend. Hebdomad. Séanc. Acad. Sci.* 204: 1479-1752.
- Weismann, A. 1883. Die Entstehung der Sexualzellen bei den Hydromedusen. Zugleich ein Beitrag zur Kenntnis des Baues und der Lebenserscheinungen dieser Gruppe. *Gustav Fisher, Jena.* 295 p.
- Werner, B. 1984. Stamm Cnidaria, Nessetiere. p. 11-305. *In* G. Hartwich, F. Killian, K. Odening. & B. Werner (eds). *Lehrbuch der Speziellen Zoologie, Band I: Wirbellose Tiere 2. teil: Cnidaria, Ctenophora, Mesozoa, Plathelminthes, Nemertini, Entoprocta, Nematelminthes, Priapulida.* Gustav Fischer, Stuttgart.
- Yamada, M. 1959. Hydroid fauna of Japanese sea and its adjacent waters. *Publ. Akkeshi Mar. Biol. Sta.* 9: 1-101.