Shallow Water Hydroids from Enewetak Atoll, Marshall Islands

WILLIAM J. COOKE

Department of Zoology, University of Hawaii, Honolulu, Hawaii 96822

Abstract

Collections from shallow water (less than 5 m depth) and intertidal sites at Enewetak Atoll in the Marshall Islands provided material representing seventeen species, twelve genera, and seven families of gymnoblastic and calyptoblastic hydroids. Most of the species recorded (10 of the 17) are cosmopolitan forms found worldwide. The possible methods of introductions of these species and the effects of fish grazing pressure on the hydroids' ecology in a coral reef ecosystem are discussed.

INTRODUCTION

As part of research conducted at the Mid-Pacific Marine Laboratory of the United States Atomic Energy Commission at Enewetak Atoll during 1974, several collections were made of the shallow water hydroids. This report results from those collections, and details the commoner hydroids likely to be found in the atoll environment of the western Pacific. It is hoped that this compilation will aid later efforts which may wish to focus on the role and importance of these species in the reef ecosystem. Determination of many of these species is complicated by the fact that this region has not been well represented in the previous taxonomic literature. The majority of the earlier monographs from the Pacific were restricted to the continental shelf islands (Billard, 1913, 1925; Nutting, 1927; Briggs and Gardiner, 1931). Some specimens taken from the oceanic islands came to the attention of European workers near the turn of the century, and some of these hydroid species were described in Marktanner-Turneretscher (1890) and Hartlaub (1901).

As will be evident from the individual descriptions, most of these reef forms are quite delicate and even cryptic (although there are some spectacular exceptions), posing some difficulty for the collector and researcher. They are easily overlooked in general collecting and for the present study close examination of the substratum underwater was necessary to reveal their presence. In addition, representative samples of the bottom material were collected and examined under a dissecting microscope to obtain the most delicate forms, especially of the smaller gymnoblastic species. As a further complication, the perisarc is often overgrown with epiphytic algae and protozoans, especially in reef flat and beach rock crevice specimens, and critical details are difficult to distinguish. The following list and des-

Micronesica 11(1): 85-108. 1975 (July).

criptions cover the specimens that could be reasonably identified. Some other unidentifiable material and some of a fragmentary nature is not included.

Suborder GYMNOBLASTEA

Family Clavidae

(?) *Rhizogeton* sp.

Family Eudendriidae

Eudendrium (*?*) *breve* Fraser, 1938

Eudendrium capillare Alder, 1856

Family Halocordylidae

Halocordyle disticha (Goldfuss, 1820)

Suborder CALYPTOBLASTEA

Family Haleciidae

Halecium beani (Johnson, 1847)

Halecium sp.

Family Campanulariidae

Clytia hemisphaerica (Linnaeus, 1767)

Family Sertulariidae

Thyroscyphus vitiensis Marktanner-Turneretscher, 1890

Dynamena cornicina McCrady, 1857

Dynamena crisioides Lamouroux, 1824

Sertularella miniscula Billard, 1925

Sertularia subtilis Fraser, 1937

Sertularia westindica Stechow, 1919

Family Plumulariidae

Halopteris diaphana (Heller, 1868)

Plumularia halecioides Alder, 1859

Plumularia setacea (Linnaeus, 1758)

Aglaophenia pluma (Linnaeus, 1758)

Key to the Genera of Hydroids at Enewetak

1	Polyp not protected by theca at all.	2
	Polyp at least partially protected by theca.	4
2	Filiform tentacles only present.	3
	Capitate and filiform tentacles present	*Halocordyle*
3	Tentacles in basal ring, hypostome trumpet shaped.	*Eudendrium*
	Tentacles scattered over body.	Family Clavidae
4	Hydrothecae short, not completely covering the polyp when retracted.	*Halecium*
	Hydrotheca able to fully cover the polyp.	5
5	Hydrotheca cup-shaped, placed on a stem, no operculum.	*Clytia*
	Hydrotheca not cup-shaped.	6
6	Hydrothecae operculate.	7
	Hydrothecae nonoperculate.	10

7	Hydrothecae operculate and borne on peduncle.	*Thyroscyphus*
	Hydrothecae nonpedunulate.	8
8	Hydrothecae opposite and paired on an internode.	*Sertularia*
	Hydrothecae not always opposite and paired, but may be.	9
9	Larger, branching forms, with more than one hydrotheca per internode.	*Dynamena*
	Smaller forms with one hydrotheca per internode	*Sertularella*
10	Stems with only nematothecae	*Plumularia*
	Stems with hydrothecae and nematothecae	11
11	Movable nematothecae on the stems and hydroclades	*Halopteris*
	Immovable nematothecae present on stems and hydroclades	*Aglaophenia*

Glossary

abcauline:	away from the stem.
adcauline:	next to the stem.
adnate:	with one side adherent to a stem or branch.
annulations:	rings on stem or pedicel perisarc which allow flexibility.
aperature:	an opening of the perisarc through which a polyp emerges (thecate hydroids only).
athecate:	without a perisarcal covering for the retracted polyp.
bell:	the main body of a medussae.
capitate tentacles:	those with an enlarged terminal ball of nematocysts.
fasicled:	having several stems bound together.
filiform tentacles:	tentacles decreasing in diameter distally, usually with an even distribution of nematocysts.
gonophore:	a reproductive polyp.
gonotheca:	the perisarcal covering of a gonophore.
hydranth:	a feeding polyp.
hydrorhiza:	the attachment stolons of a colony which spread over the substrate.
hypostome:	the upper, highly extensible portion of the hydranth bearing the mouth.
manubrium:	the hollow structure supporting the mouth of a medusa.
moniliform tentacles:	tentacles with discreet rings of nematocysts.
nematophore:	a mouthless defensive polyp heavily loaded with nematocysts.
nematotheca:	the perisarcal covering of the nematophore.
node:	a joint in the stem or branch.
ocellus:	an eyespot on a medusa.

operculum: the movable segments of perisarc covering the aperature.
perisarc: the chitonous covering secreted by the ectoderm.
sporosac: a fixed reproductive structure.
stolon: basal tubular extensions of the hydroid stem attached to the substrate.
thecate: with a modified portion of the perisarc into which a polyp may completely withdraw.

SPECIES DESCRIPTIONS

Family CLAVIDAE
(?) **Rhizogeton** sp.
Plate I, Fig. 1

MATERIAL: E II–16, a few sterile polyps, on coral rock in the inner reef flat off Lidilbut, depth, —0.5 m.

DESCRIPTION: Colonies consist of single polyps 1–2 mm high (in full extension) arising from a basal network which is usually not visible under the algal growth. Sometimes this basal network is beneath the surface of the substratum itself. The upper portion of the polyp bears 10–15 scattered filiform tentacles which are usually 0.5 mm to 1.5 mm long. The body of the polyp is often brownish red in color, and the origin of the tentacles is usually marked with a white spot. This material is identical to specimens collected from alpheid shrimp crevices in the coral *Porites* in Hawaii. In the absence of reproductive structures on the body of the polyp, the Hawaiian material was assigned to the genus *Rhizogeton* (Cooke, in press) although this is generally an uncertain procedure. The two species of *Rhizogeton*, *R. nudus* Broch, an Arctic species, and *R. fusiformis* (L. Agassiz), from the east coast of North America, have not been described in sufficient detail (particularly lacking is any information about the nematocysts) for these Enewetak specimens to be placed in either known species.

The nematocysts of the present material are of two types, desmonemes about 5–6 μ long and about 4 μ wide, and what appear to be microbasic euryteles about 7–8 μ long and about 3 μ wide. The nature of the spination on the presumed microbasic euryteles could not be determined. This cnidome, as well as the general features, is similar to that of the "clavuline indetermine" of Wiell, (1934: 381). It also bears a resemblance to the "*Clava* sp." of Millard (1966: 452).

Family EUDENDRIIDAE
Eudendrium (?) **breve** Fraser, 1938
Plate I, Fig. 2

MATERIAL: E II–10, a small sterile colony on algae, from a lagoon patch reef off Enewetak islet: depth, —3 m.

DESCRIPTION: The colony consist of a small close network of basal elements which

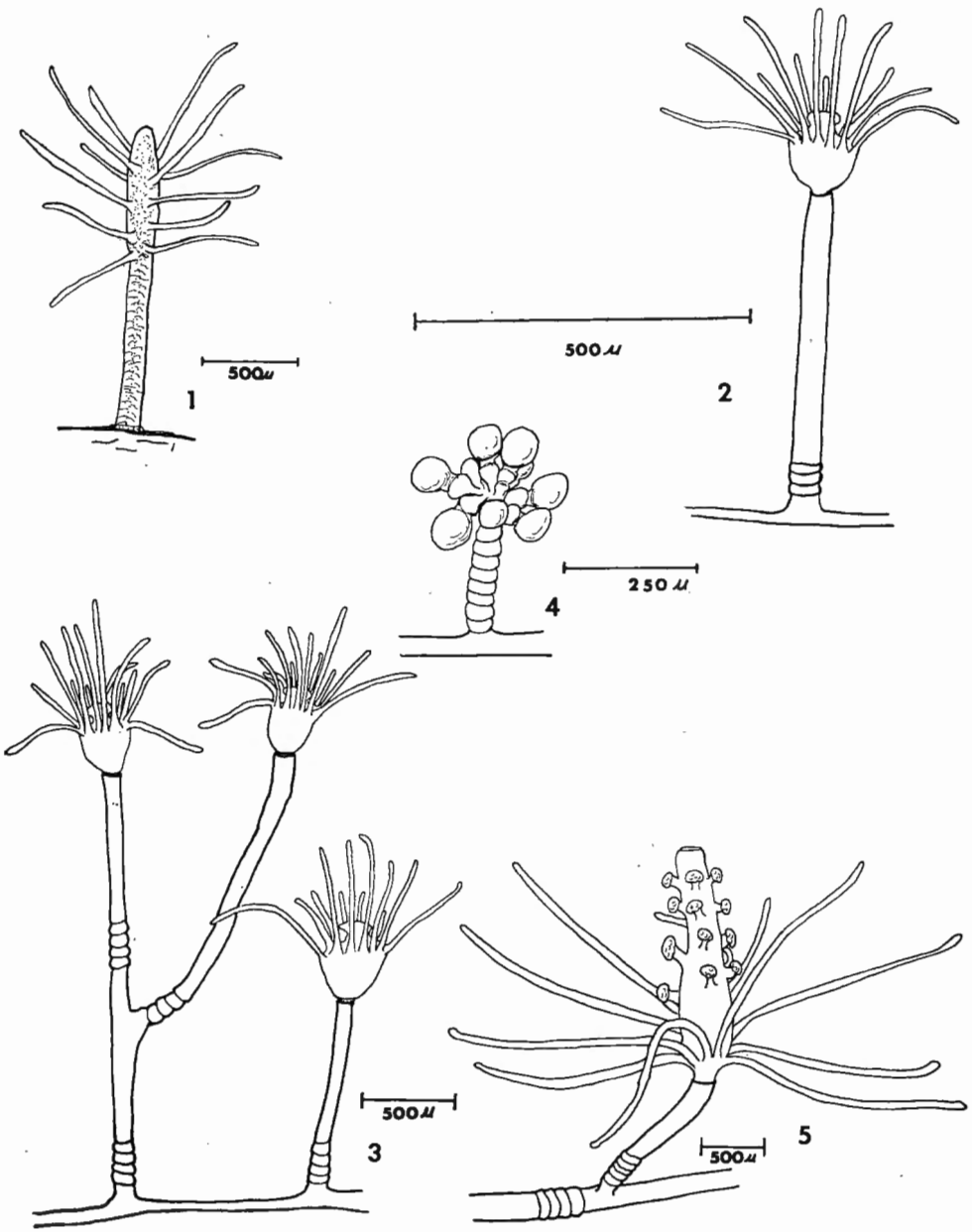


Plate I

Fig. 1. *Rhizogeton* sp., drawn from life.
Fig. 2. *Eudendrium* (?) *breve*, single polyp.
Fig. 3. *Eudendrium capillare*, group of polyps.
Fig. 4. *Eudendrium capillare*, gonophore arising from the hydrorhiza.
Fig. 5. *Halocordyle disticha*, single polyp on a branch.

give rise to individual polyps, or rarely, two polyps on a stem. The stems are 55–65 μ in diameter and 750 μ high in the largest example. The perisarc of the stems is lightly annulated at the base, and sometimes for a short distance at mid-stem, but is never completely annulated. The hydranths are small, 100 μ in diameter, and have 16–18 filiform tentacles arranged as a basal ring. This species may be distinguished from the following congener by its much smaller size and by the presence of large (20–25 $\mu \times 7$–8 μ) atrichous isorhizas in this species.

REMARKS: Fraser's (1938) description of *E. breve* from the Galapagos islands (type locality; habitat, intertidally and 50 fathoms) is very incomplete, but the Enewetak material fits this species better than that of any other described species. It is interesting that the only other location for *E. breve* given by Fraser (1938) is from 25 fathoms on the western coast of Baja California. However, it is highly likely that many of the species of *Eudendrium* reported are variants of highly plastic cosmopolitan species, but without a thorough review of the genus, it is not possible to test this hypothesis.

Eudendrium capillare Alder, 1856
Plate I, Figs. 3 & 4

MATERIAL: E I–12, an extensive fertile colony on pier pilings at the north end of Enewetak islet, depth, −2 m.

DESCRIPTION: The colony consist of a basal hydrorhiza and upright portions which may be single polyps on stems 1–2 mm tall, stems with a few branches, or short completely aborted hydranths bearing gonophores. The stems are about 100 μ in diameter, and bear one terminal polyp, or several irregularly arranged lateral branches each with a terminal polyp. The polyps are 200–300 μ in diameter and about 400 μ tall. They have between 20 and 30 filiform tentacles in a single basal ring. The perisarc of the stems may be annulated at the base, base and mid-stem, or completely on short stems.

The gonophores are borne on completely annulated pedicels 200–300 μ high arising directly from the stolon. The gonophores, all male in this material, are arranged in a dense whorl around the top of the pedicel. They are composed of two or three chambers depending on their stage of development.

The polyps are provided with small nematocyts, apparently microbasic euryteles approximately 10 $\mu \times 3$ μ. *E. capillare* is usually considered to lack the large atrichous isorhizas, although Millard (1966: 454) reports a form morphologically identical with *E. capillare* which possesses them.

REMARKS: *Eudendrium capillare* is a very cosmopolitan species being found in temperate and tropical waters of all oceans.

Family HALOCORDYLIDAE
Halocordyle disticha (Goldfuss, 1820)
Plate I, Fig. 5

Pennaria disticha Goldfuss, 1820: 89.

MATERIAL: E I–8, a fragment of a stem taken from the reef crest off Enewetak islet; E III–2 several large sterile colonies on pier pilings on the west side of Muti islet, depth, −1 m.

DESCRIPTION: The colonies consist of simple erect stems which bear alternate side branches. The individual polyps are borne on the short stalks (ramuli) on the upper surface of the side branches and one at the end of the stem. There are usually between two to five polyps per branch. The terminal polyp on a branch is usually the largest, and the next proximal, the smallest. The polyps bear a ring of 12–18 filiform tentacles in a basal ring and 8–12 tentacles scattered over the hypostome. The perisarc over the ramuli is variously annulated, ranging from just a few basal rings to complete annulation. The stem and branches are also annulated in various degrees. The color of the stem is often a deep black-brown with the branches and ramuli being lighter colored. (On fertile colonies, medusae are borne at the base of the polyps. From these medusae, gametes may be shed before or after medusae release; a point which at one time was given taxonomic significance, before the amount of variability was recognized.)

The Enewetak material has large (30–35 $\mu \times 14$–18 μ) stenoteles present in the capitate tentacles, as does the European form of *H. disticha*. Wiell (1934: 376) lists the maximum size for stenoteles of the American form, *H. tiarella* (Ayres) as 18 $\mu \times 8$ μ, and this is used by some authors as one reason for maintaining the two species, although they have at times been synonymized.

REMARKS: *Halocordyle disticha* is a very cosmopolitan species found in temperate and tropical regions of all oceans. It is often found on man-made structures, although it is also common on marine angiosperms in temperate waters.

Family HALECIIDAE

Halecium beani (Johnson, 1847)

Plate II, Fig. 1

Thoa beanii Johnson, 1847: 120.

MATERIAL: E I–9, several sterile colonies on pier pilings at the north end of Enewetak islet, depth, −2 m.; E II–8, several sterile colonies on rubble, from a patch reef off Enewetak islet, depth, −4 m.

DESCRIPTION: Colonies consist of branching stems, up to 30 mm high arising from an extensive basal hydrorhiza. The lower part of the stem is fasicled, and the polyps are given off irregularly at this level. The side branches are similarly given off irregularly, and in all planes. On the distal portion of the stem and on the side branches, the hydrothecae are borne alternately, one per internode. The nodes are just above the level of the hydrothecal aperture, usually complete, and straight or low oblique. The hydrophores are barely divergent from the stem and usually have only one hydrotheca, although reduplicated hydrothecae are occasionally present. The hydrotheca is slightly flaring and is clearly marked with a ring of distinct punctae. The polyps are white with 16–20 filiform tentacles in a basal ring and are borne on long stalks, so that the polyps reach to, or slightly beyond, the

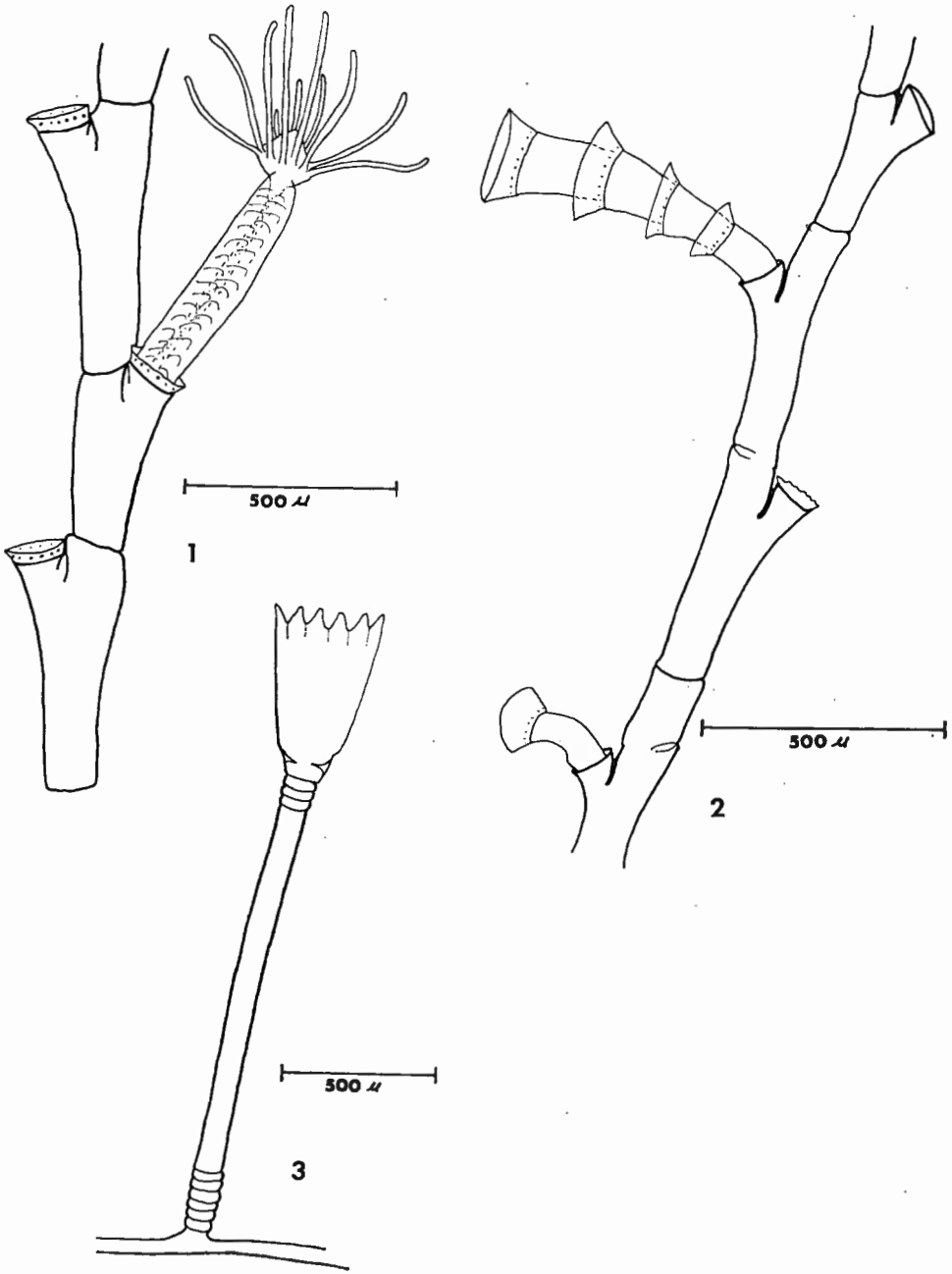


Plate II

Fig. 1. *Halecium beani*, distal portion of the stem including one polyp.
Fig. 2. *Halecium* sp., portion of the stem showing extensively reduplicated hydrothecae.
Fig. 3. *Clytia hemisphaerica*, single hydrotheca arising from the hydrorhiza.

level of the next hydrotheca.

The internodes on the unfasicled stem are 100–180 μ in diameter and 300–600 μ long. The hydrophores have a basal diameter of 90–150 μ and an inner wall length of 70–110 μ, and the hydrothecae are 20–35 μ high with a diameter of 120–160 μ.

REMARKS: *Halecium beani* is a very cosmopolitan species, and although it is more common in temperate waters, it has been recorded from the tropics before (Cooke, in press). Although the material is sterile, there is little doubt in the author's mind about the identification.

Halecium sp.
Plate II, Fig. 2

MATERIAL: E II–1, few sterile fragments from a lagoon patch reef near Chinimi islet, depth, —2 m.

DESCRIPTION: The material consists of a few short fragments, none taller than 8 mm, detached from their basal hydrorhiza. The stems are simple, without branches, and bear hydrothecae alternately. There is often an incomplete oblique node a short distance above the hydrotheca and, sometimes, a distinct complete node midway to the next hydrophore, although this may not always be present, even on the same stem. The hydrophores are rather divergent, and the adcauline wall is sometimes thickened. The hydrothecae are rather large and flaring, and the hydrophore and hydrotheca may be reduplicated up to five times. The diameter of the internode is 90–110 μ and between 550–900 μ long, from hydrophore to hydrophore. The hydrophore is 70–90 μ in diameter and 80–100 μ long, and the hydrotheca is between 100–140 μ long, with a diameter of 150–200 μ.

REMAKRS: This form is very like *H. dyssymetrum* Billard (1929) from the East Indies, but in view of the meager description provided and the fragmentary nature of the present material no more precise identification is possible.

Family CAMPANULARIIDAE
Clytia hemisphaerica (Linnaeus, 1767)
Plate II, Fig. 3

Medusa hemisphaerica Linnaeus, 1767: 1098.
Campanularia johnstoni Alder, 1856: 359.
Laomedea gracilis Sars, 1851: 138.
Campanularia raridentata Alder, 1863: 238.
(?) *Campanularia pelagica* Van Breemen, 1905: 205.

MATERIAL: E III–2, a sterile colony on *Halocordyle* stems and a sponge, Muti islet, depth, —1 m.; E II–2, a small sterile colony on coral rock from a lagoon patch reef off Chinimi islet; depth, —2 m.; E II–15, a small sterile colony on coral rock in the inner reef flat off Lidilbut islet, depth, —0.5 m.

DESCRIPTION: Colonies consist of a loosely arranged network of basal elements giving off stems at irregular intervals. The stems are usually solitary or may have one lateral offshoot. The stems are annulated four to eight times at the base, and

three to five times just below the hydrotheca and with occasional stems with annulations in the middle. The hydrothecae are tall, slightly tapering cylindrical cups, with a margin marked by about 10–14 triangular teeth. The wall of the hydrothecae are quite thin and easily distorted. The teeth, sometimes in favorable view, can be seen to extend down the wall as somewhat angular plates. The stems are anywhere from 500–3000 μ tall, with a diameter of 60–80 μ. The hydrothecae are 400–820 μ tall and a maximum diameter of from 320–450 μ.

REMARKS: *Clytia hemisphaerica* is a very cosmopolitan species found in temperate and tropical parts of all oceans. In the absence of gonothecae, the designation is not incontestable, but the agreement of this Enewetak material with the many published descriptions is quite complete. For a discussion of the extreme variability of the species, as well as proposed synonymies, the reader is referred to Ralph (1957) and Millard (1966).

Family SERTULARIIDAE

Thyroscyphus vitiensis Marktanner-Turneretscher, 1890

Plate III, Figs. 1 & 2

MATERIAL: E II–3, some sterile colonies on coral rock from a lagoon patch reef off Chinimi islet, depth, −3 m.; E II–5, some sterile colonies on coral rock from a lagoon patch reef off Enewetak islet, depth, −2 m.

DESCRIPTION: Colonies consist of simple unbranched stems up to 25 mm tall arising from a creeping hydrorhiza. The stem is divided into internodes by straight or slightly oblique septa. The hydrothecae are borne on short pedicels which are not marked by any rings or nodes. The hydrothecae are deeply cup-shaped and could easily be mistaken for those of a campanularid were it not for the operculum of four thin triangular flaps. The margin of the hydrotheca is marked by four teeth, outstanding to a greater or lesser extent on different hydrothecae. The adcauline and abcauline teeth are usually more developed than the lateral teeth. The color of the polyps in life is a deep purple. The stem is between 360–420 μ in diameter, while the hydrothecae are between 1000–1100 μ deep with a diameter of 400–420 μ.

REMARKS: *Thyroscyphus vitiensis* has been described from Fiji (the type locality), the Gilbert islands, and Madagascar and the east coast of Africa. This species is thus the only clearly delimited tropical Indo-Pacific form in the collections. Splett-stosser (1929) has a detailed discussion of the genus and the relationship of these pedunculate forms to the other sertularids.

Dynamena cornicina McCrady, 1857

Plate III, Figs. 3 & 4

MATERIAL: E I–16, 13, several sertile stems on coral rock from a lagoon patch off Enewetak islet, depths, −2 m, −3 m (normal form); E III–1, several sterile colonies on pier pilings west side of Muti islet, depth, −3 m (robust form).

DESCRIPTION: This species exists in two distinct forms, which differ from each

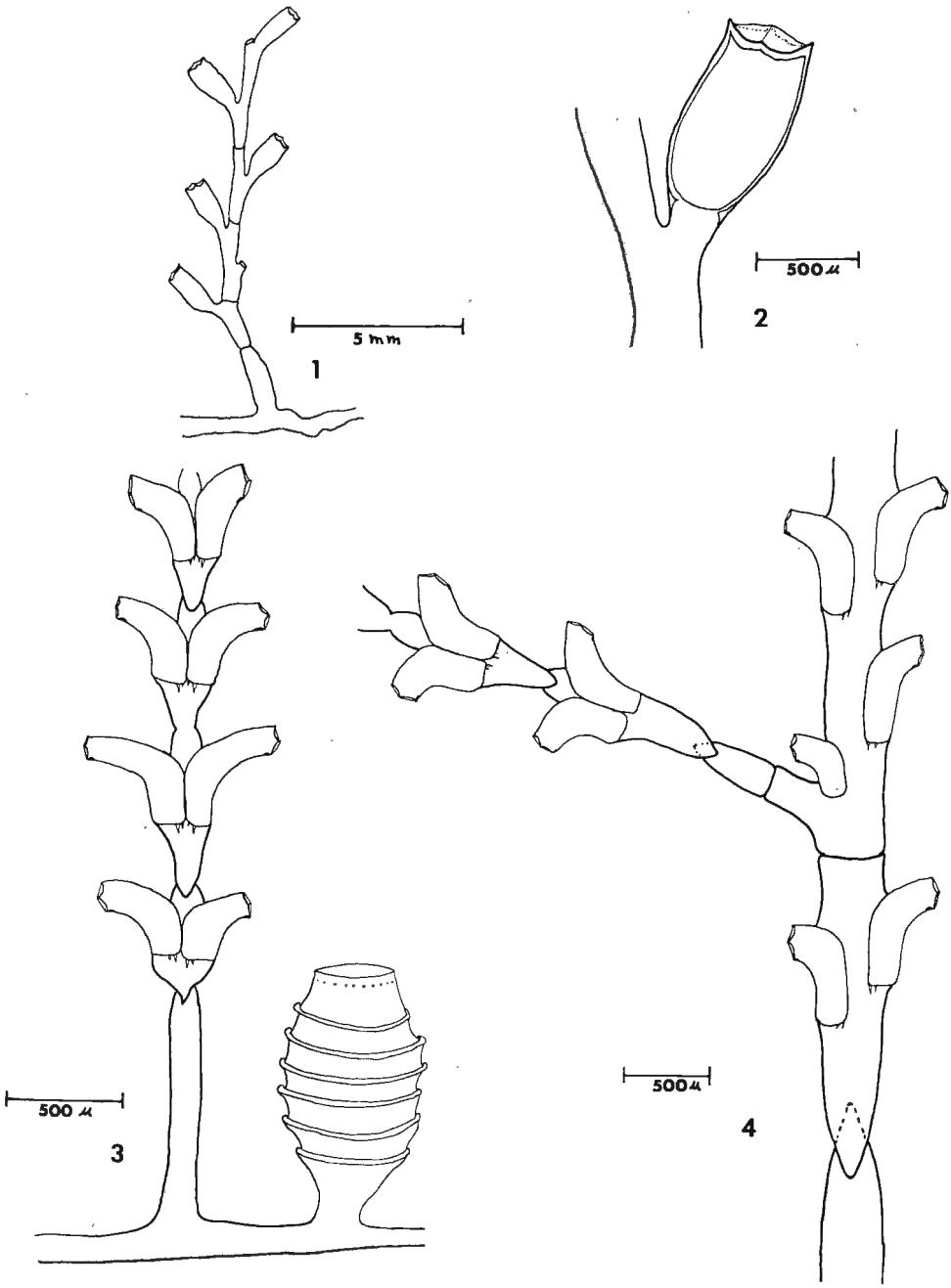


Plate III

Fig. 1. *Thyroscyphus vitiensis*, general view of a stem arising from the hydrorhiza.
Fig. 2. *Thyroscyphus vitiensis*, detail of a hydrotheca.
Fig. 3. *Dynamena cornicina*, normal stem with gonotheca.
Fig. 4. *Dynamena cornicina*, robust stem showing branching.

other in absolute size and in degree of branching. The normal form is at most 10–15 mm tall and consists of unbranched stems arising from a dense hydrorhiza. The robust form consists of stems up to 180 mm tall with irregular side branchings. The qualitative aspects of the description applies equally to both.

The basal part of the stem on the normal form is an apophysis of varying length, arising from one of the hydrorhizal fibers. An oblique hinge joint separates this apophysis from the remainder of the stem. The stem internodes are divided either by similar oblique joints, or more often, by straight septa. The stem of the robust form is always divided into internodes by straight septa. Hydrothecae are borne subopposite on the stem, and there is usually a hydrotheca in the angle of the branches. Branches arise from a short apophysis from the stem internode and are provided with a short athecate portion separated from the distal parts of the branch by an oblique hinge joint. On the stem of the normal form (or branches of the robust form) the hydrothecae are strictly opposite, frontally displaced so that the inner walls of a pair are adnate on the front face, but non-contiguous on the back. The outer part of the hydrotheca curves away from the stem abruptly and is of varying length, often quite short, but in some cases, longer than the basal part of the hydrotheca. The basal part of each hydrotheca has two internal perisarcal spines projecting into the interhydrothecal space. These mark the insertion of the hydrothecal wall onto the stem. The margin of the hydrotheca is marked by two sharp, laterally placed teeth, and one adcauline tooth. There is also often a slight thickening under the abcauline rim of the margin. The operculum is composed of two flaps, the abcauline being the larger.

The gonothecae are cylindrical to suboval structures borne on the hydrohiza or the lower stem. They are ringed with 6–13 thickenings or corrugations. The distal portion just below the margin is smoothly cylindrical and is often marked by a ring of punctae.

On the normal form, the stem diameter is 80–120 μ, and the internodes are between 400 and 620 μ long. The hydrothecae have an adnate contiguous length of 210–300 μ and a free length of 200–420 μ. The margin diameter is 110–130 μ. On the robust form, the stem diameter is 270–700 μ with internodes of about the same length as the normal form. The diameter of the branches is 200–220 μ. The hydrothecae have an adnate contiguous length of 450–560 μ and a free length of 280–320 μ. The gonothecae are 900–1200 μ tall and have a margin diameter of 300–350 μ.

REMARKS: *Dynamena cornicina* is a very cosmopolitan species found in temperate and tropical parts of all oceans. Although the robust form (see also Fraser, 1944) is quite a bit larger than the normal form, in detail, it agrees completely with the normal form and the most thorough description available (Billard, 1925).

Dynamena crisioides Lamouroux, 1824

Plate IV, Fig. 1

MATERIAL: E I–1, many sterile colonies from beach rock crevices, north end of

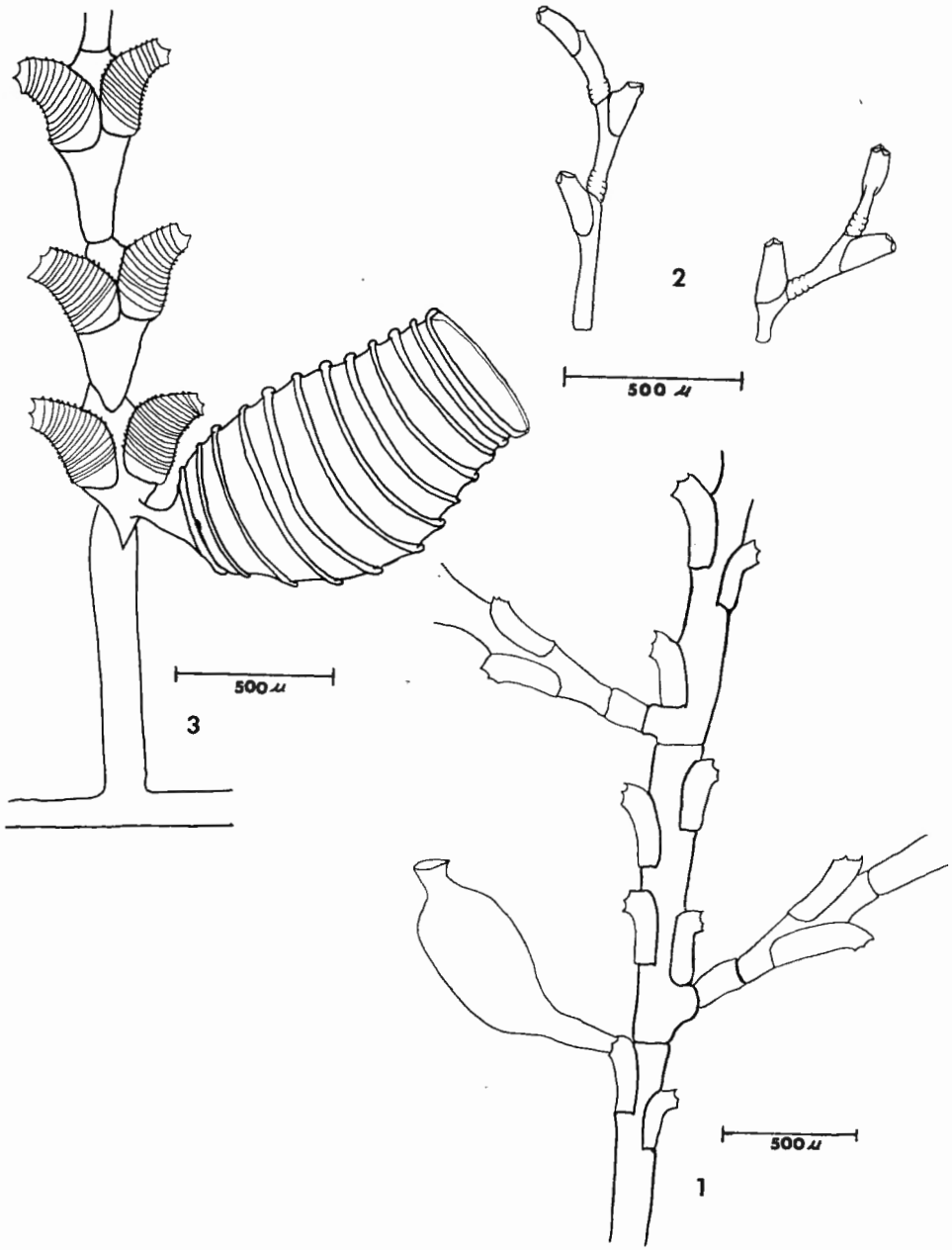


Plate IV

Fig. 1. *Dynamena crisioides*, portion of the stem showing branching and a gonotheca.
Fig. 2. *Sertularella miniscula*, two fragments of stems.
Fig. 3. *Sertularia subtilis*, proximal portion of the stem showing a gonotheca.

Enewetak islet, intertidally +0.5 m.; E I–4, several sterile colonies from beach rock crevices, north end of Muti islet, intertidally, +0.2 m.; E III–4, many sterile colonies from pier pilings, west side of Muti islet, depth, −2 m.; E III–4a, a few sterile colonies from beach rock crevices, Rojoa islet intertidally, 0.0 m, level; E III–4b, many sterile colonies from the outer reef flat at Enewetak islet, 0.0 m level.

DESCRIPTION: Colonies of this species consist of simple short, sometimes irregularly branched stems arising from a thick hydrorhiza. The usual height of the stems is between 5 and 15 cm. The basal part of the stem is a short apophysis of the hydrorhizal fiber, which is separated from the rest of the stem by a straight septa. When branched, the branches are given off from proximal apophyses of the stem internodes. The number of hydrothecae between branches on the stem internodes is variable. There is a hydrotheca in the axis of each side branch. The proximal part of the branch is a short athecate section separated by straight septa both proximally and distally. The upper part of the stem and the branches are divided by straight septa into internodes which have a variable number of pairs of hydrothecae.

The hydrothecae are variously disposed, from opposite to almost alternate. They are for most of their length immersed in the stem or branch, with a shorter portion being free, curving away sharply. The margin is marked by two large lateral teeth and a somewhat smaller adcauline tooth. The operculum is composed of three flaps (two triangular adcauline flaps and one abcauline flap).

The gonothecae are quite distinctive. They are irregularly shaped flasks each with a short stem and distally a curved neck leading to a circular aperture. They are usually borne low on the stem, often arising from within a hydrotheca.

The stem diameter is 70–140 μ and the internodes are between 700 and 1600 μ. The diameter of the side branches is 70–100 μ, while the hydrothecae are 350–420 μ long adnate to the stem, and 250–400 μ long free with a marginal diameter of 110–140 μ. The gonothecae are 1000–1300 μ tall and have an aperature diameter of about 200 μ.

REMARKS: This was the most abundant hydroid of the collections and was found in a wide variety of habitats. It is not, however, conspicuous in the field, as it is often heavily encrusted with detritus and algae. The specimens from the reef flat had been completely overlooked in close daylight inspection and were only noticed during night collecting when a low oblique light revealed them projecting above the algal turf. The presence of abundant colonies in beach rock crevices intertidally would seem to indicate a good ability to withstand desiccation. This is a tropical and subtropical, cosmopolitan species found in warm regions of all oceans.

Sertularella miniscula Billard, 1925
Plate IV, Fig. 2

MATERIAL: E III–3, a few sterile stems on coral rubble off Muti islet, depth −2 m.

DESCRIPTION: The present material consist of a few short stems, (less than 5 mm high) arising from a delicate hydrorhiza. The stems are simple and unbranced and are divided by low oblique septa into internodes each of which bear one hydrotheca.

Each stem internode is also annulated with three to five rings in its proximal portion.

The hydrothecae are located in the distal part of the internode, are adnate for about one-half of their total height, and curve sharply away from the stem distally. (In some cases, the stem is also curved at the node, so that a zig-zag appearance results.) The hydrotheca is roughly cylindrical in cross section with the basal adnate portion somewhat fuller. The margin is marked by four teeth (two lateral teeth and two lower adcauline and abcauline teeth). The walls of the hydrothecae are smooth, not being marked by any annulations or rugosities.

The diameter of the stem is 60–80 μ and the internode length, 300–500 μ. The adnate length of the hydrotheca is 120–160 μ with a free length of 110–180 μ and a margin diameter of 100–120 μ.

REMARKS: *Sertularella miniscula* has been reported from both the tropical western Pacific and western Atlantic, so it may be considered a circumtropical cosmopolitan. It is quite an attractive, delicate species, and perhaps easily overlooked. *S. exilis* Fraser (1938) from the eastern tropical Pacific seems very similar, except for lacking the stem annulations.

Sertularia subtilis Fraser, 1937
Plate IV, Fig. 3

MATERIAL: E I–5, several fertile specimens from coral rock from a lagoon patch reef off Bogen islet, —4 m.

DESCRIPTION: Colonies of this hydroid consist of simple unbranched stems up to 8 mm tall arising from a creeping hydrorhiza. The basal part of the stem is a short apophysis of a hydrorhizal fiber. The next portion is an athecate length of variable height separated proximally by a strong oblique hinge joint and distally by a straight or low oblique septa. The remainder of the stem is divided into internodes by oblique septa, each internode bearing a pair of hydrothecae.

The hydrothecae are frontolaterally placed so that a considerable portion of each pair is contiguous and adnate on the front of the stem but free on the back. The hydrothecae are swollen basally, then taper gradually distally as they curve free from the stem. They are distinctly oval with the long axis from front to back in relation to the stem in cross section. The surface of the hydrothecae is ornamented by approximately 20 corrugated ridges ringing the entire length except for a basal, adnate smooth portion. The margin is marked by four teeth (two long and sharp lateral teeth and two lower rounded adcauline and abcauline teeth). The operculum is composed on one abcauline and two triangular adcauline flaps.

The gonothecae (not previously described) are ovoid structures arising on very short pedicels from the front of the stem, just below a pair of hydrothecae. They are ringed with 10–12 thick corrugations and have a similarly thickened margin. The operculum is a broad circular plate.

The stem has a diameter of 70–130 μ and an internode length of 420–560 μ. The hydrothecae are 180–200 μ long in adnate length contiguous, and 200–270 μ

in the free portion. Their margin diameter is 90–100 μ. The height of the gonothecae is approximately 1260 μ and the greatest diameter is 700 μ and margin diameter, 560 μ.

REMARKS: The corrugated hydrothecae make *S. subtilis* unmistakably distinct from any other sertularid, but in view of Fraser's (1937b) brief description, a check was made of his type specimen (USNM cat. 43288) which confirmed that the Enewetak material is indeed conspecific. The type locality is a shallow bank north of Puerto Rico, and while it has not been reported elsewhere in the Caribbean, it has recently been found in Hawaii (Cooke, in press); a very spotty distribution. (Deevey, in WHOI, 1952: 188, reports it from buoys from an undisclosed location.)

Sertularia westindica Stechow, 1919
Plate V, Fig. 1

S. borneensis Billard, 1925

MATERIAL: E I–17, several sterile stems on rubble, from a patch reef off Bogen islet, depth, —2 m.

DESCRIPTION: Colonies consist of simple unbranched stems arising from a hydrorhiza. The basal part of the stem consists of a short apophysis of the hydrorhizal fiber separated from the thecate portion by a strong oblique hinge joint. The distal stem is divided by straight or low oblique septa into thecate internodes with a pair of oppositely placed hydrothecae on each.

The hydrothecae are slightly swollen basally, and narrow somewhat as they curve free from the stem at a distinct right angle. The surface of the hydrotheca is smooth. They are frontolaterally placed, with the proximal hydrothecae noncontiguous but with the distal pairs contiguous and adnate in front. The operculum is composed of two flaps. There are no ridges projecting into the hydrothecae although there may be slight marginal thickenings.

The stem diameter is 70–100 μ and the stem internodes are 300–450 μ long. The adnate length of the hydrothecae is 170–200 μ and the free length 140–280 μ with a margin diameter of 100–130 μ.

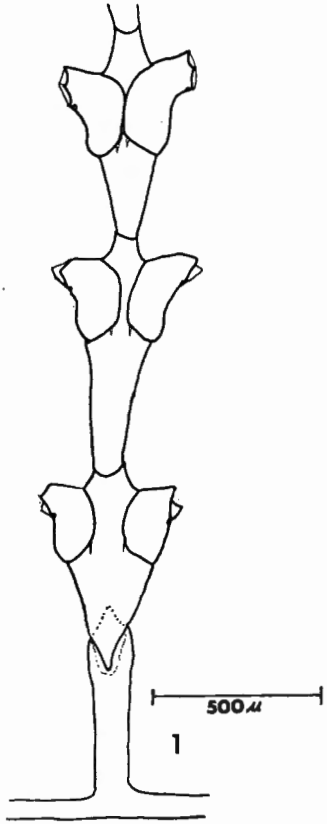
REMARKS: *Sertularia borneensis* was synonymized by Mammen (1965) with *S. westindica*, a procedure with which there can be little contest, as Billard (1925) himself recognized the close relationship between the two forms. *S. westindica* is thus a tropical cosmopolitan being found in the Atlantic, Pacific, and Indian Oceans.

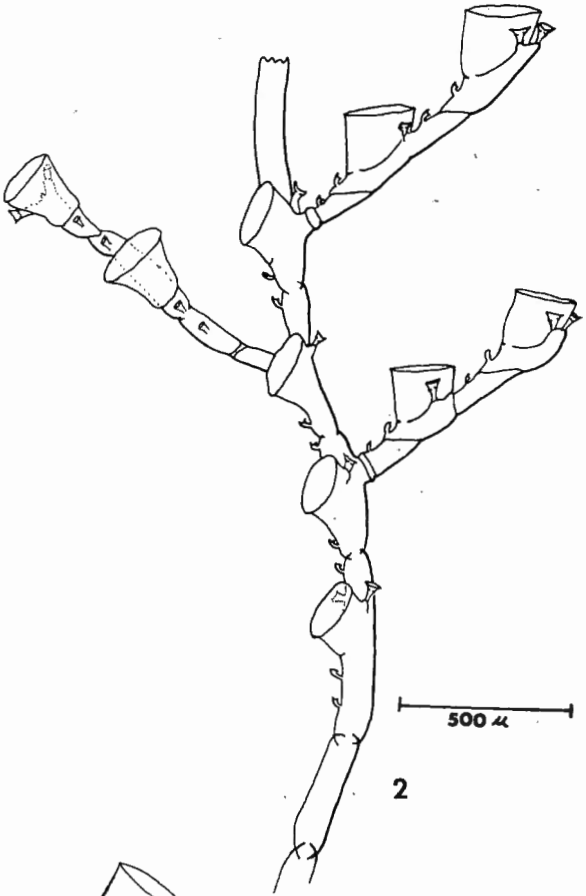
Family PLUMULARIIDAE
Halopteris diaphana (Heller, 1868)
Plate V, Figs. 2, 3, & 4

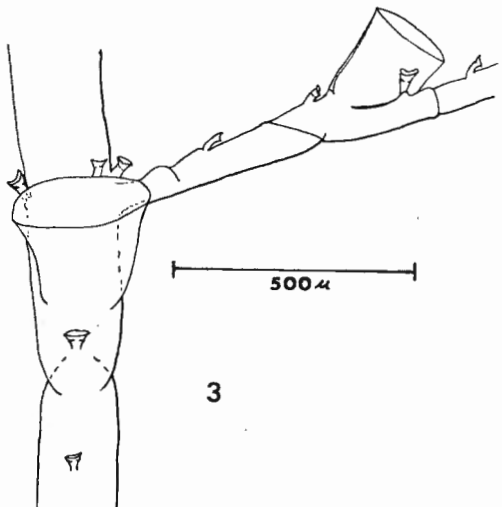
Anisocalix diaphana Heller, 1868: 42

Plumularia alternata Nutting, 1900: 62

MATERIAL: E I–14, several sterile colonies from pier pilings north end of Enewetak islet, depth, —3 m.; E II–14, a small colony from coral rock in the inner reef flat off Lidilbut, depth, —0.5 m.







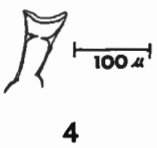


Plate V

Fig. 1. *Sertularia westindica*, proximal portion of a stem showing development of the adnate condition in the distal hydrothecae.
Fig. 2. *Halopteris diaphana*, portion of a colony.
Fig. 3. *Halopteris diaphana*, detail of the stem and proximal part of branch.
Fig. 4. *Halopteris diaphana*, detail of a pleurohydrothecal nematotheca.

DESCRIPTION: The colonies consist of upright stems up to 20 mm tall arising from a basal hydrorhiza. The stem has several basal athecate internodes which bear only nematothecae. Above, the stem is divided by oblique septa into internodes each one having a hydrotheca, four to six nematothecae, and an alternately directed distal apophysis which supports a hydroclade. The nematothecae on the stem are arranged one below the hydrotheca, two immediately beside the distal adnate portion of the hydrotheca, one in the angle of the apophysis, and one or two medially above the hydrotheca. The hydrothecae and the nematothecae are all borne on one side of the stem, this being designated the anterior side.

The hydroclades are all borne in one plane and consist of a series of thecate and athecate internodes, with one to four hydrothecae per hydroclade. The first internode is very short and bears no nematothecae, the next being longer and bearing one or two nematothecae medially on the upper surface. A long oblique septa separates this portion from the thecate internode which has one hydrotheca and three nematothecae. There is one small immovable nematotheca medially just proximal to the hydrotheca and two movable bithalamic nematothecae (the pleurohydrothecal nematothecae) near the distal base of the hydrotheca. The distal end of the internode is marked by a straight septa, quite close to the hydrotheca, and this is followed by an athecate internode similar to the preceding one.

The diameter of the stem is 70–90 μ and the internodes are 450–750 μ. The hydroclades have a diameter of 60–80 μ. The first athecate internode is 50–70 μ long, and the second is 200–300 μ, while the thecate internodes are approximately 250 μ long. The length of the abcauline wall of the hydrotheca is 150–200 μ, the length of the free part of the adcauline wall is 80–90 μ, and the margin diameter is 200–220 μ. The pleurohydrothecal nematothecae are 80–90 μ tall with a margin diameter of 50–60 μ.

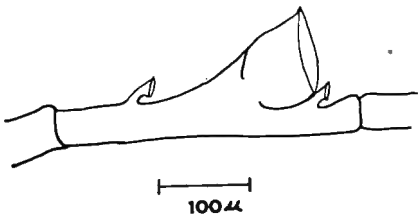
REMARKS: *Halopteris diaphana* is a tropical cosmopolitan species found in the Atlantic, Indian, and Pacific Oceans. The species has variously been placed in *Plumularis, Antenella,* and *Schizotricha.* Millard (1962) contains an excellent discussion of the generic relationships within the Halopterinae and should be consulted for further details.

Plumularia halecioides Alder, 1859
Plate VI, Figs. 1 & 2

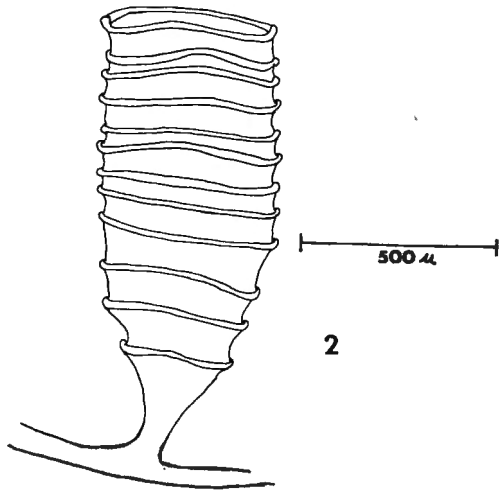
MATERIAL: E I–10, several fertile colonies on algae north end of Enewetak islet, depth, −2 m.

DESCRIPTION: The colonies consist of many upright stems arising from a closely spaced hydrorhiza. The stems are rather short, 8–10 mm at most, and are fasicled in the lower portions. They are divided by straight septa into internodes which bear alternately directed apophyses distally. Each stem internode is provided with one nematotheca in the angle of the apophysis. Rarely, there will be a short internode without an apophysis between the normal internodes.

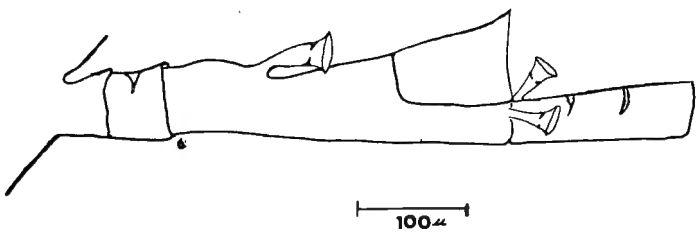
The hydroclades are all in the same plane and are divided into thecate and



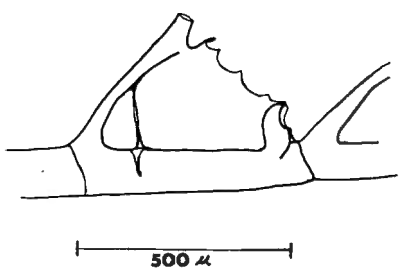
1



2



3



4

Plate VI

Fig. 1. *Plumularia halecioides*, portion of a hydroclade showing the hydrotheca and two nematotheca.
Fig. 2. *Plumularia halecioides*, gonotheca.
Fig. 3. *Plumularia setacea*, proximal portion of a hydroclade, showing a hydrotheca and several nematothecae.
Fig. 4. *Aglaophenia pluma*, detail of a hydrotheca.

athecate internodes with usually three or fewer hydrothecae per hydroclade. There is sometimes a short basal athecate internode on the hydroclade, although this may be missing. The thecate internodes have one adnate cylindrical hydrotheca, and two nematothecae (one medially proximal to the hydrotheca and one just below the lower margin of the hydrotheca). The athecate internodes between these thecate internodes do not have any nematothecae.

The gonothecae are borne on the hydrorhiza, often in groups, or on the lower part of the stem. The are generally cylindrical in outline with a short pedicel. The surface is marked with about 10–12 strong corrugations.

The diameter of the stem is 75–90 μ and the internodes 220–350 μ long. The diameter of a hydroclade is 50–60 μ and the first athecate internode is about 70 μ long, while the thecate internodes are 350–450 μ. The length of the hydrothecae is 70–80 μ, and diameter at margin is 90–110 μ. The gonothecae are 1100–1300 μ high and have a margin diameter of 410–440 μ.

REMARKS: The presence of the unique gonothecae leaves no doubt that this Enewetak material is conspecific with *P. halecioides*, a species usually reported from northern temperate areas such as the Gulf of Alaska or the northern Atlantic. The present material has the nematothecae as described for the classical form from England (Hincks, 1868), although Fraser (1937a) described a form of *P. halecioides* with two nematothecae beside the hydrotheca and nematothecae on the athecate internodes of the hydroclade. *P. setaceoides* and *P. strictocarpa* are somewhat similar species found in the tropics, but differ in regards to the nature of the stem and in the disposition of the nematothecae.

Plumularia setacea (Linnaeus, 1758)
Plate VI, Fig. 3

Sertularia setacea Linnaeus, 1758: 813

MATERIAL: E I–17, several sterile colonies, specific collection data unavailable, collected by other investigators.

DESCRIPTION: Colonies consist of simple stems up to 30 mm tall arising from a basal hydrorhiza. There are several short athecate internodes basally, and above this, the stem is separated into the internodes bearing hydroclades by straight septa. Each internode has an alternately directed apophysis distally, a nematotheca proximally on the side opposite the apophysis and a nematotheca in the angle of the apophysis.

The hydroclades are divided into thecate and athecate internodes and usually have four to six hydrothecae. The first hydrocladial internode is a short athecate section with a straight septa proximally, an internal ridge, and an oblique septa distally. Each thecate internode bears one slightly flared, adnate hydrotheca, and three nematothecae, (one medially some distance proximal to the hydrotheca and two pleurohydrothecal nematothecae beside the hydrotheca). The athecate internodes usually bear just one medial nematotheca.

The stem diameter is 80–120 μ and the internode length, 250–600 μ. The

diameter of the hydroclades is 40–60 μ, with the first athecate internode 60–75 μ, and the thecate internode 500–560 μ. A hydrotheca is about 100–110 μ in marginal diameter and 80 μ in length. The diameter of a pleurohydrothecal nematotheca is 50 μ and it is about 70 μ tall.

REMARKS: *Plumularia setacea* is a very cosmopolitan species found in temperate and tropical regions of all oceans.

Aglaophenia pluma (Linnaeus, 1758)
Plate VI, Fig. 4

Sertularia pluma Linnaeus, 1758: 811
A. dichotoma Kirchenpauer, 1872: 30
A. tubiformis Marktanner-Turneretscher, 1890: 269
A. heterodonta Jaderholm, 1903: 296
A. parvula Bale, 1882: 23

MATERIAL: E III–5, many sterile colonies on pier pilings, Muti islet, depth, —4 m.

DESCRIPTION: Colonies consist of simple unbranched stems up to 18 cm tall arising from a basal hydrorhiza. The basal portion of a stem is an unsegmented apophysis of a hydrorhizal fiber. Above this, the stem is divided by two oblique hinge joints. The majority of the stem is divided into short internodes which bear four nematothecae and an apophysis distally, the apophysis being somewhat frontally displaced. There is one nematotheca medially on the proximal part of the internode, one in the angle of the apophysis, and two on the apophysis.

All of the internodes of the hydroclade are thecate. The hydrothecal margin is toothed with the teeth being usually more sharply defined on the more distal hydrothecae. The medial hydrothecal nematotheca has its attached end just below the margin of the hydrotheca and its free opening equal to or just above the rim. There is also an opening into the interior of the hydrotheca on this nematotheca. The lateral nematothecae are large, erect, and swollen with a distinctly scooped aperture.

The stem diameter is 200–500 μ and the internodes 300–560 μ long. The hydroclade diameter is 80–100 μ and the internodes are about 350 μ long. The hydrothecae are 210–230 μ deep with a margin diameter of 200–210 μ. The lateral nematothecae have a margin diameter of 40–50 μ while it is about 30 μ for the medial ones.

REMARKS: *Aglaophenia pluma* is a very cosmopolitan species, begin found in temperate and tropical parts of all oceans. Millard (1957) discusses extensively the synonymies of this species.

DISCUSSION

As might be expected, the forms described have been for the most part, quite wide ranging. This is probably a function of several factors; the limits of the collections, the vagile nature of most hydroid species, and the recent history of

the atoll. None of the present collections were made deeper than five meters and as such, represent only the shallowest depths of the lagoon shores and reefs. No collections were made from the seaward reef slope. It is expected that further exploration of the deeper portions of the atoll will reveal more distinctive forms.

It is not certain how representative the Enewetak hydroid fauna is of the fauna of a normal, less disturbed Indo-Pacific atoll as there are several unique features about Enewetak which must be covered in any discussion of the fauna. While its location in the middle of the province might reasonably be expected to result in a fauna composed of rather widely distributed members, the large number of very cosmopolitan species, especially with temperate and tropical distributions still requires some consideration.

Hydroids are often common fouling organisms (WHOI, 1952: 185–189) and as such they can be easily dispersed by natural drift on floating objects, or similarly may be transported on vessel bottoms across normal distributional boundries. Nine of the fifteen named species found at Enewetak have been recorded as fouling organisms (WHOI, 1952: 185–189). Noting that many hundreds of ships and barges visited Enewetak Atoll in the later part of World War II and during the period of atomic bomb testing a ready method is provided for the introduction of so many cosmopolitan species.

As may be noted, many of the larger and more distinctive forms were found on artificial habitats, especially pier pilings. It has been shown (see Bakus, 1964 for review) that grazing fish herbivores can exert a great influence on the natural benthic communities, even to the extent of removing appreciable quantities of the $CaCO_3$ substrate. It is presumed that the hydroid colonies able to grow on pilings are not subjected to the same pressures as those on the natural carbonate surfaces, as the creosote treated pilings support only sparse algal growth and are less grazed by fishes. The next most favorable habitat for extensive colonies was the beach rock crevices, presumably due to physical protection.

REFERENCES CITED

Alder, J. 1856. A notice of some new genera and species of British hydroid zoophytes. Ann. Mag. Nat. Hist. (II)18: 353–362.

————. 1859. Discription of three new species of sertularian zoophytes. Ann. Mag. Nat. Hist. (III)3: 353–355.

————. 1863. Supplement to a catalogue of the zoophytes of Northumberland and Durham. Trans. Tyneside Nat. Field Club V: 224–247.

Bakus, G. J. 1964. The effects of fish grazing on invertebrate evolution in shallow tropical waters. Occ. Pap. Allan Hancock Found. 27: 1–29.

Bale, W. M. 1882. On the Hydroida of south eastern Australia, with descriptions of supposed new species, and notes on the genus *Aglaophenia*. J. Micro. Soc. Vict. 2: 15–48.

Billard, A. 1913. Les hydroides de l'Expedition du Siboga. I. Plumulariidae. Res. Explor. Zool. Bot. Siboga VIIa: 1–114.

————. 1925. Les hydroides de l'Expedition du Siboga. II. Syntheciidae et Sertulariidae. Res. Explor. Zool. Bot. Siboga VIIb: 115–232.

————. 1929. Note sur un genere nouveau et quelques especes nouvelles d'Haleciidae. Bull.

Soc. Zool. de France 54: 305–307.

Briggs, E. A. and V. E. Gardiner. 1931. Hydroida. Gt. Barrier Reef Exped. Scient. Rep. 4: 181–196.

Cooke, W. J. In Press. Shallow water hydroids of the Hawaiian Islands. In L. G. Eldredge and D. Devaney (eds.), Hawaiian Reef and Shore Fauna. B. P. Bishop Museum.

Fraser, C. M. 1937a. Hydroids of the Pacific Coast of Canada and the United States. Univ. of Toronto Press, Toronto.

———. 1937b. New species of hydroids from the Puerto Rican Region. Smithson. Misc. Coll. 91(28): 1–7.

———. 1938. Hydroids of the Allan Hancock Pacific Expeditions. Allan Hancock Pac. Expeds. 4: 1–105.

———. 1944. Hydroids of the Atlantic Coast of North America. Univ. of Toronto Press. Toronto.

Goldfuss, G. A. 1820. Handbuch der Zoologie, (I): 1–696.

Hartlaub, C. 1901. Hydroiden aus dem Stillen Ocean. Ergebnisse einer Reisenach dem Pacific, 1896–97. Zool. Jahrb. 14: 349–379.

Heller, C. 1868. Die Zoophyten un Echinoderma des Adriatishen Meeres. Ver. zool. bot. Ges. Wien. 18: 1–88.

Hincks, T. 1868. A history of the British hydroid zoophytes, Vol. I & II. John van Voort, London.

Jaderholm, E. 1903. Aussereuropaischen Hydroiden in schwedischen Reichsmuseum. Ark. Zool. 1: 259–312.

Johnson, G. 1847. A history of the British zoophytes (1): 1–488.

Kirchenpauer, G. H. 1872. Uber die Hydroiden familie Plumularidae. Abh. Naturw. Hamburg 5: 1–58.

Lamouroux, J. V. F. 1824. Descriptions des polypies flexible. In Quoy et Gaimard, Voyage autour la monde execute sur les corvettes "Uranie" et "l'Physicienne," Zoologie. Paris.

Linnaeus, C. 1758. Systema Naturae (10): 1–824.

———. 1767. Systema Naturae (12): 533–1327.

Mammen, T. A. 1965. On a collection of hydroids from South India, Thecata except Plumulariidae. J. Mar. Biol. Ass. India 7: 1–59.

Marktanner-Turneretscher, G. 1890. Die Hydroiden des K. K. naturhistorischen Hofnuseum. Ann. Naturhist. Hofmus. 5: 195–286.

McCrady, J. 1857. Gymnophtalmata of Charleston Harbor. Proc. Elliot Soc. Nat. His. 1: 103–221.

Millard, N. A. H. 1957. The Hydrozoa of False Bay, South Africa. Ann. S. Afr. Mus. 43: 173–243.

———. 1962. The Hydrozoa of the south and west coasts of South Africa, I. The Plumulariidae. Ann. S. Afr. Mus. 46: 261–319.

———. 1966. The Hydrozoa of the south and west coasts of South Africa, III. The Gymnoblastea and small families of Calyptoblastea. Ann. S. Afr. Mus. 48: 427–490.

Nutting, C. C. 1900. American Hydroids, Part I. The Plumularidae. Spec. Bull. U. S. Nat. Mus. 100: 1–285.

———. 1927. Report on the Hydroida collected by the U. S. Fisheries Steamer "Albatross" in the Philippine Region, 1907–1910. U. S. Nat. Mus. Bull. 100: 195–242.

Ralph, P. M. 1957. New Zealand thecate hydroids, Part I. Trans. Roy. Soc. N. Z. 85: 811–854.

Sars, M. 1851. Beretnig om en i Sommeren 1849 foretagen Zoologish Reise i Lofoten og Finmarken. Nytt. Mag. Naturv. 6: 121–211.

Splettstosser, M. 1929. Beitrage zur Kenntnis der Sertulariiden. Zool. Jahb. Syst. 58: 1–134.

Stechow, E. 1919. Zur Kenntnis der hydroiden fauna des Mittelmeeres, Amerikas und anderer Gebiete. Zool. Jahb. Syst. 42: 1–172.

VanBreemen, P. J. 1905. Plankton van Noord-en-Zuider Zee. Tijdschr. Ned. dierk. Ver. (2)9: 145–324.

Wiell, R. 1934. Contribution a l'etude des Cnidaires et de leurs nematocyts. Trax. Sta. Zoo. Wimereux. 10: 1–791.

Woods Hole Oceanographic Institution (WHOI). 1952. Marine Fouling and its Prevention. Bur. Ships., U. S. Navy.