Title: First records of four soft coral species from Japan, with a list of soft corals previously found from the shallow waters of the Ryukyu Archipelago, Japan, and an overview on the systematics of the genera Siphonogorgia and Chironephthya

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First records of four soft coral species from Japan, with a list of soft corals previously found from the shallow waters of the Ryukyu Archipelago, Japan, and an overview on the systematics of the genera Siphonogorgia and Chironephthya

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Abstract. So far, 121 species (including Briareum of the suborder Scleraxonia) of the shallow water soft corals had been found in the waters of the Ryukyu Archipelago. During 2011–2012, we surveyed the shallow water soft coral fauna from northern Motobu Peninsula (Okinawa, Japan), and obtained a large quantity of new material. This collection contains two genera of the suborder Stolonifera, six genera of Alcyoniidae, three genera of Nephtheidae, two genera of Nidaliidae, two genera of Xenidae, and one genus (Briareum) of Scleraxonia, and includes four species new to Japan; Klyxum molle (Thomson & Dean, 1931), Lobophytum salvati Tixier-Durivault, 1970, Chironephthya hicksoni Harrison, 1908, and Siphonogorgia cf. godeffroyi Kölliker, 1874, as well as nine possibly undescribed species. Information on the four newly recorded species from Japan is described in detail. A list of the shallow water soft corals found from the waters of the Ryukyu Archipelago, including new discoveries in this survey, is also provided. In addition, the history and problems on the systematics of the genera Siphonogorgia and Chironephthya are overviewed.

Introduction

Shallow-water soft coral fauna in the Ryukyu Archipelago has been studied by several authors (Verrill 1865; Utinomi 1976a, b, 1977a, b; Imahara 1991; Benayahu 1995, 2002, 2010; Benayahu & McFadden 2011; Iha & Yoshino 1997; Williams 1997; Ofwegen & Benayahu 2006; Miyazaki & Reimer 2014). Those studies recorded 117 soft coral species including two Briareum species (suborder Scleraxonia) in this region. In addition to these, the following four species have been discovered by the first author (Y. I.) from this region but have not published yet, i.e. Carijoa sp. (Clavulariidae), Coelogorgia sp. (Coelogorgiidae), Nephthygorgia sp. (Nidaliinae), and Heteroxenia elisabethae (Xeniidae). During a survey between 2011 and 2012, a considerable amount of new material of shallow water soft corals was collected from the northern Motobu Peninsula, Okinawa Island, Japan. These materials contained four newly recorded species from Japan; Klyxum molle (Thomson & Dean, 1931), Lobophytum salvati Tixier-Durivault, 1970 (both Alcyoniidae), Chironephthya hicksoni Harrison, 1908, and Siphonogorgia cf. godeffroyi Kölliker, 1874 (Nidaliidae), 12 species already been reported from Japan, as well as nine probably undescribed species. This paper aims to re-describe the four newly recorded species and to list the soft coral species found from this region. The newly recorded species include one species each of genera Siphonogorgia and Chironephthya, the systematics of which have been confused for a long period of time. We also overview the history and problems on the systematics of these two genera.

Material and Methods

A list of the soft coral species from the Ryukyu Archipelago was compiled by a literature survey and recently conducted field surveys. New materials were photographed in situ and then collected during the 2011–2012 SCUBA diving expeditions in shallow waters (<30 m) around northern Motobu Peninsula, from Cape Bise in Motobu-cho to Sesoko Island. Sub-samples were removed from collected material and preserved in absolute alcohol for future molecular studies. The rest of the materials were then fixed in 20% formalin overnight, rinsed for over 24 h in fresh water, and then transferred to 75% ethanol. Sclerites were obtained by dissolving the tissues in kitchen bleach (10–13% sodium hypochlorite), followed by careful and repeated rinsing in distilled water. Sclerites were mounted in two series: (1) via Eukitt (ORSAtec) for permanent microscope slides, and (2) onto scanning electron microscope (SEM) stubs coated with Pt-Pd, for examination under a scanning electron microscope (Hitachi S-4300) at 10 kV. Polyp measurements were obtained from drawings made under a stereomicroscope, whereas sclerites were measured by drawings made under a biological microscope or from SEM pictures. Observations of anthocodial formula were performed under a stereomicroscope using...
transparent polyps prepared with clove oil (see Imahara 2014). Sclerite terminology followed Bayer et al. (1983). All newly collected materials were deposited in the Okinawa Churashima Foundation Research Center (OCF), Japan. Materials used for comparative purpose were loaned from The Natural History Museum, London, UK (BM), Naturhistorisches Museum der Burgergemeinde Bern, Switzerland (NMBE), Zoologisches Museum der Universität Hamburg, Germany (ZMH), and the U. S. National Museum of Natural History, Smithsonian Institution, USA (USNM).

**Results**

The shallow water soft coral species so far found from the Ryukyu Archipelago are listed in Appendix 1. The total number of recorded species is 133, including previously recorded species (n = 117), species found by the first author (Y.I.) but unpublished (n = 4; Carjosa sp., Coelogorgia sp., Nephthigorgia sp. and Heteroxenia elisabethae), newly recorded species found during this survey (n = 4) and probably undescribed species (n = 9).

The identified material yielded four species new
to Japan: Klyxum molle (Thomson & Dean, 1931), Lobophytm salvati Tixier-Durivault, 1970, Chironephthya hicksoni, Harrison, 1908, and Siphonagorgia cf. godeffroyi Kolliker, 1874. Although these four species have been described several times in the past, the present study examined and presents SEM pictures of the sclerite for the first time.

**Descriptions of four species new to Japan**

**Class Anthozoa Ehrenberg, 1834**  
**Subclass Octocorallia Haeckel, 1866**  
**Order Alcyoniidae Lamouroux, 1812**  
**Family Alcyoniidae Lamouroux, 1812**

**Klyxum molle (Thomson & Dean, 1931)**  
[New Japanese name: Futoeda-yawatosaka]  
(Figs. 1, 2)

Alcyonium molle Thomson & Dean 1931: 43, pl. 8, fig. 3, pl. 14, fig. 4; Tixier-Durivault 1966: 31, figs. 12, 13; 1970a: 182–183; 1970b: 120; Benayahu, Weil & Kleinman 1990: 324 (list only).

Klyxum molle — Alderslade 2000: 240 (list only).

**Material examined.** OCF-Cn20110929-08 (No. 62). Off Yamakawa, Motobu, Okinawa Island, 26°40′48.5″N, 127°52′45.2″, 2 m deep, September 29, 2011.

**Description.** Colony. Flabby, 75 mm high with maximum cross section of 50 × 100 mm (Fig. 1D, E). Stalk 20–40 mm high with maximum proximal cross section of 32 × 45 mm, spreading toward polypary. Polypary with four large lobes swollen upward, 45 mm high with maximum proximal cross section 25 × 30 mm, maximum distal cross section 38 × 50 mm. Lobes covered with small knobs (Fig. 1F), 3 mm high and wide, or finger-like projections, up to 26 mm high with maximum cross section of 8 × 9 mm.

Polyps. Monomorphic, large, almost completely retractile (Fig. 1H), contracted diameter 1.4 mm, uniformly crowded over polypary except near stalk, polypary-stalk boundary indistinct (Fig. 1G). Tentacles with elongate rods, up to 0.07 mm long (Fig. 2A), arranged longitudinally on the aboral side of the rachis. These rods with a few small simple warts. Anthocodiae armed by elongated rods or spindles, up to 0.18 mm long, with a few large conical warts (Fig. 2B). Generally few sclerites, longitudinally arranged, occasionally in eight double rows (Fig. 1I). Thick spindles up to 0.24 mm long, sparsely covered with large conical warts (Fig. 2C), transversely arranged on proximate portion of anthostele.

Sclerites. Lobe surface layer with many thick spindles up to 0.26 mm long, some cross-shaped branching (Fig. 2D). Lobe interior contains thick spindles, up to 0.31 mm long, shorter spindles having blunt ends. Slender spindles up to 0.13 mm long also present, with a few conical warts, mixed (Fig. 2E). Stalk surface layer with many thick spindles, up to 0.22 mm long, often with blunt ends, rarely cross-branching (Fig. 2F). Stalk interiors contain thick spindles, up to 0.24 mm long, occasional distinct blunt ends, rarely cross-branching. Several slender rods present, up to 0.18 mm long, mixed (Fig. 2G). Thick spindles with large conical prominences in coenenchyme, several with slight indication of girdles of prominences.

**Color.** Pale yellowish with reddish brown tentacles in life. Pale yellowish brown in ethanol.

**Remarks.** Klyxum molle resembles Klyxum tuberculosa (Tixier-Durivault, 1970) in the presence of elongated rods with few conical warts in anthocodiae. However, K. tuberculosa differs from K. molle in its large sclerites of the surface layer of lobes and stalk (0.3–0.35 mm long vs. < 0.26 mm long in K. molle).

Three species of Klyxum have been recorded from the Ryukyu Archipelago, K. simplex (Thomson & Dean, 1931), K. utinomii (Verseveldt, 1971), and K. okinawanum (Utinomi, 1976). Klyxum simplex is different from K. molle in having sclerites with typically tapered ends in the coenenchyme (vs. blunt ended sclerites in K. molle). Verseveldt (1971: 8) mentioned that K. utinomii is characterized by the nearly smooth, fusiform sclerites. Klyxum utinomii is also distinguished from K. molle by having hexagonal sclerites in the interior the stalk (vs. spindles and rods in K. molle). Klyxum okinawanum is distinguished from other species by smooth surfaces of all sclerites in the coenenchyme.

**Distribution.** Okinawa Island, Indonesia, Vietnam, Australia, New Caledonia, Madagascar. 2–15 m deep. Type locality: Hainsisi, Semau Island, Indonesia (Siboga-Station 60), 3 m deep.

**Lobophytm salvati Tixier-Durivault, 1970**  
[New Japanese name: Futoyubi-unetake]  
(Figs. 3, 4)

Lobophytm salvati Tixier-Durivault 1970a: 207, 208, figs. 32–34; Verseveldt 1977: 13–15, figs. 7, 8, pl. 10, fig. 2; 1983: 86, fig. 42, pl. 28, fig. 3.
Material examined. OCF-Cn20110927-15 (No. 15). Off Cape Bise, Motobu, Okinawa Island, 26°42′51.2″N, 127°52′26.8″, 6 m deep. September 27, 2011.

Description. Colony. Massive, 42 mm high with 54×72 mm maximum cross section (Fig. 3C, D).

Fig. 3. Lobophytum salvati Tixier-Durivault, 1970, OCF-Cn20110927-15, (No. 15). A, B: colony in situ; C, D: colony in ethanol, showing waving periphery of polypary and many finger-like projections; E: enlargement of around center of polypary; F: enlargement of distal portion of lobe; G: enlargement of lobe in situ; H: arrangement of sclerites of anthocodia. au: autozooids; pr: polypary; sc: sclerites; si: siphonozooids; sl: stalk. Scales bars= 0.1 mm (H), 1 mm (E, F), 1 cm (C, D, G).

Stalk 18–22 mm high, maximum proximal cross section 32 × 33 mm. Polypary covered with about 30 thick club-shaped lobes, 4–25 mm high, maximum proximal cross section 5–14 mm, maximum distal cross section, 5–9 mm. Periphery undulating, about 15 upright lobes at margin.

Polyps. Dimorphic. Retracted autozooids clearly hollow. Siphonozooids easily distinguishable by the
Fig. 4. Sclerites of *Lobophytum salvati* Tixier-Durivault, 1970, OCF-Cn20110927-15, (No. 15). A: point; B: surface layer of lobes; C: interior of lobes; D: surface layer of stalk; E: interior of stalk. Scale bars = 0.1 mm.

図4. フトユビウネタケの骨片, 1970, OCF-Cn20110927-15, (No. 15). A: ポイント; B: 裂葉皮部; C: 裂葉内部; D: 栄部皮部; D: 栄部内部. スケールバー = 0.1 mm.
naked eye (Fig. 3G). Autozooids 1.0–1.5 mm apart at lobe distal portion, 2.5–3 mm apart at proximal portion, and 3.5–14 mm apart around polypary center. Lobe distal portion, 3–5 siphonozooids between two autozooids (Fig. 3F), proximal portion about six siphonozooids, polypary center around 8–26 siphonozooids (Fig. 3E). Anthocodiae with eight points of 5–6 small spindle pairs (Fig. 3H, 4A). No sclerites in tentacles and anthostele.

**Sclerites.** Lobe surface with clubs, 0.11–0.20 mm long, and spindles up to 0.33 mm long (Fig. 4B). Clubs with small warty head, occasionally with an indistinct central wart between head and handle, handle covered in 3–4 girdles of complex warts. Spindles with large complex warts usually arranged in 6–7 girdles. Lobe interior with cylinders and pointed spindles, 0.20–0.40 mm long, crosses rarely present (Fig. 4C). Cylinders and spindles usually with 4–8 girdles of large warts, sometimes irregularly arranged, frequently with median waist. Stalk surface layer with clubs 0.10–0.16 mm long, spindles up to 0.27 mm long, fusiform sclerites 0.17 mm long (Fig. 4D). Clubs with an indistinct central wart similar to those of lobe surface. Spindles thicker than those of lobe surface. Fusiform sclerites with cone-shaped processes. Stalk interior contains cylinders and spindles, 0.22–0.36 mm long, four distinct girdles of large warts on smaller cylinders (Fig. 4E). Additionally pointed fusiform sclerites, ca 0.2 mm long with four girdles of large warts, in stalk interior.

**Color.** Colony pale yellowish brown in life, yellowish white in ethanol.

**Remarks.** Lobophytum salvati is morphologically similar to L. pauciflorum (Ehrenberg, 1834) in their thick finger-like lobes. These two species, however, differ from each other in the number of cylinder girdles in stalk interior (four in L. salvati vs. usually two in L. pauciflorum).


**Family Nidaliidae Gray, 1869**

**Subfamily Siphonogorgiinae Kölliker, 1874**

**Chironephthya hicksoni** Harrison, 1908
[New Japanese name: Chibieda-kudayagi]
(Figs. 5–9)

*Chironephthya hicksoni* Harrison 1908: 188; 1909: 36, pl. 5, fig. 40. pl. 6, fig. 57. *Siphonogorgia hicksoni* --- Thomson & Dean 1931: 158 (reproduced from Harrison 1909)

(Not *Siphonogorgia hicksoni* Thomson & Mackinnon 1910: 189–190, pl. 11, fig. 3, pl. 14, fig. 4., see remarks and “Overview of the genera *Siphonogorgia* and *Chironephthya*”)

**Material examined.** OCF-Cn20121004-10 (No. 135). West coast of Sesoko Island, Motobu, near Okinawa Island, 26°38′39.9″N, 127°51′11.7″, 13.7 m deep. October 4, 2012. BM-1982.8.224.7 (holotype of *C. hicksoni* Harrison, 1908), Macclesfield Bank, Admiralty Islands, Papua New Guinea, unknown depth.

**Description.** Colony. Arborescent, 150 mm high, 35 × 85 mm in polypary diameter (Fig. 5B, C). Stalk missing. Lower stem maximum cross section 9 × 10 mm. Polypary comprising five upright main branches nearly all in one plane. Main branches projecting slender secondary branches in all directions (Fig. 5D), distal portion of main and secondary branches slightly flattened. Terminal branches short (2.5–11.5 mm), maximum diameter 2.1 × 2.1 mm to 2.6 × 3.0 mm.

**Polyp.** Monomorphic, crowded with groupings of 4–5 individuals at distal portion of terminal branches (Fig. 5G), scattered on secondary and lateral sides of terminal branches in spiral pattern (Fig. 5F). Several solitary polyps on stem. Anthocodiae <0.70 mm high, maximum cross section of <0.85 mm when contracted, almost completely retracted into calyces, diameter <1.2 mm. Tentacles with many thick rods, up to 0.40 mm long, with a few conical large warts (Fig. 6A), arranged longitudinally on rachis (Fig. 5J). Similar rods invade into pinnules. Anthocodiae consist of eight points, each comprising two to three sclerite pairs, and crown of six to eight transversely arranged sclerites, and one to two small sclerite pairs between each point (Fig. 5K, L). Anthocodial formula is 1P + (1–2)p + (6–8)Cr + (1/2)M. Point sclerites, up to 0.60 mm long spindles covered in complex warts, with sharp upper and blunt lower ends (Fig. 6B). Crown sclerites, up to 0.70 mm long spindles with many complex warts (Fig. 6C). Below crown (introvert), 10–12 spindles, up to 0.28 mm long, arranged horizontally (Fig. 6D). Distal calyces on terminal branches sheath-like (Fig. 5H), outer side surrounded by 2–3 teeth comprising large (up to 3.0 mm long) spindles continuing from branch cortices and covered with many complex warts (Fig. 6E1). Many small spindles (up to 1.0 mm long) of inner side arranged vertically, with many complex warts (Fig. 6E2); between spindles, elongated rods (up to 0.5 mm long) with few simple warts (Fig. 6E3).
Fig. 5. *Chironephthya hicksoni* Harrison, 1908, OCF-Cn20121004-10, (No, 135). A: colony *in situ*. B, C: colony in ethanol; D: enlargement of B; E: cross section of stalk; F: enlargement of around distal portion of terminal branch; G: arrangement of polyps on distal portion of terminal branch; H: arrangement of sclerites of calyx on distal portion of terminal branch; I: arrangement of sclerites of calyx on stem; J: arrangement of sclerites of tentacle; K, L: arrangement of sclerites of anthocodia. mb: main branch; sm: stem; tb: terminal branch. Scale bars = 0.1 mm, 1 mm (G–L), 1 cm (D–F), 5 cm (B, C).

図5. チビエダクダヤギ *Chironephthya hicksoni* Harrison, 1908, OCF-Cn20121004-10, (No, 135). A: 生態写真; B, C: エタノール標本写真; D: Bの拡大; E: 柄部横断面; F: 端末枝頂端の拡大; G: 端末枝頂端のポリブの配列; H: 端末枝頂端の莢の骨片の配列; I: 幹部の莢の骨片の配列; J: 触手の骨片の配列; K, L: 花頭の骨片の配列。Mb: 主枝; sm: 幹部; tb: 端末枝。スケールバー = 0.1 mm, 1 mm (G–L), 1 cm (D–F), 5 cm (B, C).
Fig. 6. Sclerites of *Chironephthya hicksoni* Harrison, 1908, OCF-Cn20121004-10, (No, 135). A: tentacle; B: point; C: crown; D: introvert; E: calyx of distal portion of terminal branches. Scale bars = 0.1 mm (A–D, E2–3), 1 mm (E1).

図6. チビエダクダヤギの骨片, OCF-Cn20121004-10, (No, 135). A: 触手; B: ポイント; C: クラウン; D: 頭部; E: 端末枝頂端の莢. スケールバー = 0.1 mm (A–D, E2–3), 1 mm (E1).
図7. チリエダクダヤギの骨片, OCF-Cn20121004-10, (No, 135). A: 端末枝側面の莢; B: 幹部の莢. スケールバー = 0.1 mm (A2, 3, B2, 3), 1 mm (A1, B1).

Fig. 7. Sclerites of Chironephthya hicksoni Harrison, 1908, OCF-Cn20121004-10, (No, 135). A: calyces on lateral sides of terminal branches; B: calyces on stem. Scale bars = 0.1 mm (A2, 3, B2, 3), 1 mm (A1, B1).
Shelf-like, lateral calyces on branches and stem (Fig. 5I), outer side surrounded by 2–3 vertically arranged spindles (up to 1.5 mm long) with many complex warts (Fig. 7A1, 7B1). Between spindles, many slender spindles up to 0.7 mm long with a few complex warts (Fig. 7A2, right four of 7A3, 7B2), and needles up to 0.25 mm long with a few large warts (left four of Fig. 7A3). Inner side of calyces
almost membranous with slender needles or elongated rods, up to 0.2 mm long with a few simple, vertically arranged warts (left four of Fig. 7B3). Between these sclerites, a few almost smooth...
elongated rods, ca. 0.2 mm long, (one right end of Fig. 7B3).

Sclerites. Branch surface layers covered with large spindles, up to 5.5 mm long with many complex warts (Fig. 8A1). Slender spindles between them, up to 1.0 mm long, blunt both ends, with a few complex warts (Fig. 8A2). Branch interior contains needles (as in calyces), 0.30 mm long, with a few large simple warts (one each on the left and right of Fig. 8B), and rods up to 0.20 mm long, with a few simple large warts (center one of Fig. 8B). Surface layer of middle portion of stem covered with blunt-ended spindles up to 5.0 mm long, often bent at one end, with many complex warts (Fig. 8C1). Between spindles, shorter (up to 0.7 mm) blunt-ended spindles with complex large warts (fig. 8C2), and slender spindles up to 0.15 m long, with a few complex large warts (Fig. 8C3). Interior of middle portion of stem contains blunt-ended spindles up to 2.0 mm long with many compound warts (Fig. 8D1), blunt-ended slender spindles up to 0.35 mm long with a few compound warts (Fig. 8D2), and needles up to 0.30 mm long (Fig. 8D3). Surface layer of lower position of stem covered in spindles, often bent, up to 3.0 mm long with many complex warts (Fig. 9A1), and spindles up to 0.60 mm long with a few simple warts (Fig. 9A2). Between spindles, elongate rods up to 0.25 mm long, with a few simple warts (Fig. 9A3). Lower portion of stem interior contains spindles up to 3.0 mm long with many compound warts (Fig. 9B1), sharp-ended spindles 2.0 mm long with few simple warts (right end of Fig. 9B2), and blunt-ended slender spindles 0.80 mm long with a few simple warts (two on the left side of Fig. 9B2). Between spindles, elongated rods 0.30 mm long with a few simple small warts (left five and bottom right one of Fig. 7A3), and a few needles 0.30 mm long with few simple large warts (upper right one of Fig. 9B3). Terminal branch surface layers with vertically arranged spindles; branch stem and stalks with spindles arranged vertically, horizontally, and in layers. Branches fragile, but stem hard with numerous sclerites filling interior.

Color. Lower stem white, upper stem and branches gradually turn pale orange-yellow, terminal branches dark-red distally. Polyps white, point and crown sclerites yellow, polyp-stalk sclerites red.

Remarks. Chironephthya hicksoni was only briefly described by Harrison (1908, 1909) without any photograph or figure of the colony, based on a specimen collected from Macclesfield Bank, Admiralty Islands, Papua New Guinea. The specimen examined in this study closely resembles the holotype in the branching mode, anthocodial formula, stem surface layer sclerites (blunt spindles covered with warty projections), and large coenenchyma interior spindles with numerous typical small thorny forms. The only exceptions are colony/polyp color of terminal branch (dark-red vs. dull yellow in the holotype) and the size of the branch surface layer sclerites (up to 5.5 mm and much longer in the specimen examined vs. largest size of 3.7 mm in the original description). The differences are, however, relatively minor and considered as intraspecific variations.

The present study represents the second record of C. hicksoni since the original description. This species has long been forgotten in octocoral taxonomy. Chironephthya hicksoni is therefore still not listed in World Register of Marine Species (WoRMS; Ofwegen 2017a, b). The “Species Search Result for GBIF 2017 (Global Biodiversity Information Facility)” includes C. hicksoni (as Siphonogorgia hicksoni Harrison), but it is posted as a “doubtful species”. Such situation is likely due to the species Siphonogorgia hicksoni Thomson & Mackinnon, 1910, that was described two years after the description of Chironephthya hicksoni Harrison, 1908. Siphonogorgia hicksoni was described based on a specimen collected from Providence Island, Seychelles. Siphonogorgia hicksoni is characterized by the following traits: polyps arranged only on the branches, not appearing on the stem, anthocodial formula 1P + (2–3)p + 10Cr + (1/2–1)M, and coenenchyme sclerites <1.3 mm long. Thus S. hicksoni is a totally different species from Chironephthya hicksoni. The genus Chironephthya Wright & Studer, 1889 (see ICZN Art. 12.2.5 for the genus name authorship), was often been considered as a junior synonym of Siphonogorgia Kölliker, 1874, by many authors (see “Overview of the genera Siphonogorgia Kölliker, 1874 and Chironephthya Wright & Studer, 1889” until Verseauelt & Bayer (1988) recognized them as two distinct genera. Both Chironephthya hicksoni Harrison, 1908, and Siphonogorgia hicksoni Thomson & Mackinnon, 1910, became congeneric and were secondary homonyms for long periods of time. However, no one proposed a replacement name for Siphonogorgia hicksoni Thomson & Mackinnon, 1910. Indeed Thomson & Dean (1931: 157–158) and Tixier-Durivault (1968: 18) considered Siphonogorgia and Chironephthya as synonyms but treated the two species by the same name, “Siphonogorgia hicksoni”, with different authorships. Since no replacement name has been given, and the two genera are now regarded as distinct from each other, the two species names are valid (ICZN 1999 Art. 59.2).
Distribution. Okinawa Island, 13.7 m deep; Macclesfield Bank around Admiralty Island off Papua New Guinea, unknown depth. Type locality: Macclesfield Bank, depth unknown.

*Siphonogorgia cf. godeffroyi* Kölliker, 1874
[New Japanese name: Enji-honkudayagi] (Figs. 10–13)

? *Siphonogorgia godeffroyi* Kölliker 1874: 18–23, pl. 1, fig. 6; Whitelegge 1897: 223; Kükenthal 1906: 71; (reproduced from Kölliker 1874); Thomson & Dean 1931: 156 (reproduced from Kölliker 1874).

Material examined. OCF—Cn20121004-17 (No. 142), West coast of Sesoko Island. Motobu, near Okinawa Island, 26°38′39.95″N, 127°51′11.7″E, 23.9 m deep, October 4, 2012.

Comparative material. BM-1882-4-5-24 (holotype of *Siphonogorgia godeffroyi* Kölliker, 1874), Pelewinseln (Palau Islands), collected from unknown depth (photograph only); NMBE-Challenger (a fragment of *Siphonogorgia godeffroyi* described by Wright & Studer, 1889), Challenger St. 232, Hyalonema-ground (Sagami Bay), Japan, 345 fathoms.

Description. Colony. Simple arborescent, 200 mm high, polypary diameter 32 × 80 mm (Fig. 10D, E). Sterile stalk 54 mm long, maximum proximal cross section 13 × 20 mm, maximum distal 13 × 16 mm. Polypary comprising four main branches, one extending from 83 mm above stalk proximal portion, three diverging >117 mm above stalk proximal portion in one plane. Ten smaller branches 3–19 mm long also diverge >56 mm above stalk proximal portion. Secondary and short terminal branches extend chiefly from main and larger branches on colony front, except several terminal branches arising from colony back (Fig. 10B, C, F). Terminal branches club-shaped, ranging from quite short (3 mm) with maximum 2 × 3 mm size in cross-section, to quite long (10 mm) with maximum 3.5 × 4.0 mm size in cross-section. Stalk exhibits five canals.

Polyps. Monomorphic. Crowded (3–5) around distal end of terminal branches (Fig. 10I, J, K); single polyps and groups of 2–5 polyps distributed widely over branches and stem. Contracted polyps <0.80 mm in diameter, completely retractile into calyces <0.60 mm high, 1.1 mm in diameter. Tentacle rachis with many longitudinally arranged thin rods, up to 0.15 mm long (right five of Fig. 11A), on aboral side. Small slender rods, up to 0.10 mm long (two on the left end of Fig. 11A), invaded into pinnules. Anthocodiae consist of eight points, each comprising three to four sclerite pairs, and crown of eight to nine transversely arranged sclerites. Anthocodial formula 1P + (2–3) p + (8–9) Cr. Point sclerites, up to 0.60 mm long (fig. 11B), upper portions covered with many simple warts, lower portions covered with mix of compound warts. Crown sclerites, up to 0.60 mm long (Fig. 11C), upper portion with a few simple warts, lower portions with many complex warts. Horizontally arranged 5–6 slender spindles, up to 0.30 mm long, on under crown (introvert). Terminal-branch calyces sheath-like (Fig. 10G), with those on front side extruding two large teeth-like spindles (up to 2.8 mm) with many simple warts on upper portions (Fig. 11D1), mix of compound warts on lower portions. Spindles up to 1.0 mm long on lateral side of calyx, with many compound warts. Between spindles, slender blunt-ended spindles up to 0.50 mm long with a few simple warts (Fig. 11D2), and spindles or elongated rods up to 0.35 mm long with a few simple warts. Non-terminal-branch and stem calyces cone-like (Fig. 10H), composed of sclerites, as in calyces on lateral portions of terminal branches and stems.

Sclerites. Terminal-branch surface layer covered with large spindles up to 3.5 mm long, with many simple warts on one end, becoming gradually complex toward other end (right end of Fig. 11E). Between spindles, slender, blunt-ended spindles or needles up to 0.35 mm long with a few simple warts, and spindles or rods up to 0.15 mm long with a few warts. Surface layer of other branches covered with point-ended spindles up to 2.5 mm long, with many compound warts, and thick blunt-ended spindles up to 2.0 mm long, with many compound warts (Fig. 11E). Between spindles, smaller blunt-ended spindles up to 0.50 mm long with a few compound warts, and spindles or rods up to 0.20 mm long with a few simple warts. Branch interiors contain slender, blunt-ended spindles or needles, up to 0.50 mm long with a few simple warts (right five of Fig. 11F), and spindles or rods up to 0.20 mm long with a few simple warts (left two of Fig. 11F). Stalk and stem surface layer covered with spindles up to 3.5 mm long often bent, with many compound warts (Fig. 12A1) and spindles or rods up to 0.70 mm long, with few compound warts (Fig. 12A2). Stem interiors contain a few spindles, up to 2.5 mm long with many compound and rounded warts (Fig. 12B1) and slender spindles, up to 1.0 mm long with a few compound warts (Fig. 12B2). Stalk interior contains many sclerites similar to those in stem interior. Surface-layer sclerites of terminal branches chiefly arranged vertically, branch, stem,
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Fig. 10. *Siphonogorgia* cf. *godeffroyi* Kölliker, 1874, OCF-Cn20121004-17, (No. 142). A: colony *in situ*; B, C: enlargement of distal portion of a branch *in situ*; D, E: colony in ethanol; F: enlargement of distal portion of a branch; G: a polyp on terminal branch, showing arrangement of sclerites; H: a polyp on main branch, showing arrangement of sclerites; I: a terminal branch, showing arrangement of polyps; J: enlargement of around distal portion of a terminal branch; K: enlargement of distal portion of a terminal branch. mb: main branch; pol: polyp; sb: secondary branch; sp: solitary polyp; tb: terminal branch. Scale bars = 1 mm (G, H, J, K), 1 cm (F, I), 10 cm (D, E).

図10. エンジホンクダヤギ *Siphonogorgia* cf. *godeffroyi* Kölliker, 1874, OCF-Cn20121004-17, (No. 142). A: 生態写真; B, C: 枝部頂端部の拡大; D, E: エタノール標本写真; F: 枝部著負担の拡大; G: 端末枝上のポリプ、骨片の配列を示す; H: 主枝上のポリプ、骨片の配列を示す; I: 端末枝、ポリプの配列を示す; J: 端末枝頂端付近の拡大; K: 端末枝頂端. mb: 主枝; pol: ポリプ; sb: 2次枝; sp: 単独のポリプ; tb: 端末枝. スケールバー = 1 mm (G, H, J, K), 1 cm (F, I), 10 cm (D, E).
and stalk sclerites arranged vertically and horizontally, in layers. Branches fragile, but stem and stalk hard with numerous sclerites filling interior.

**Color.** Terminal branches deep-red. Other branches and stem orange-flame, stalk light-orange in situ and in ethanol. Polyps white, point and crown sclerites yellowish. Tentacles white.

**Remarks.** Kölliker (1874) described *S.*
Fig. 12. Sclerites of *Siphonogorgia cf. godeffroyi* Kölliker, 1874, OCF-Cn20121004-17, (No. 142). A: surface layer of stem and stalk; B: interior of stem and stalk. Scale bars = 0.1 mm (A2, B2), 1 mm (A1, B1).

The specimen collected in this study (Fig. 10) closely resembles to the original description, and *godeffroyi*, based on a single specimen from Palau Islands (Fig. 13), collected from unknown depth. He described the branching mode, sclerites of coenenchyme, and colony/polyp color considerably in detail. The specimen collected in this study (Fig. 10) closely resembles to the original description, and
the external form agrees well with the photograph of the holotype (Fig. 13). However, since neither Kölliker (1874) nor others including the current work have described the characteristics of the anthocodial formula of the type specimen, we refrain from identifying the Okinawan specimen as *S. godeffroyi*.

The Okinawan specimen also resembles *S. pendula* Studer, 1889 (type locality Seychelles) in the branching mode and colony/polyp color but differs in the anthocodial formula (1P + (2–3)p + (8–9)Cr vs. 1p + (8–10)Cr in *S. pendula*) and longer sclerites of colony-interior (> 2.5 mm long vs. > 0.952 mm long in *S. pendula*) (Studer 1889). These differences preclude the identification of the Okinawan specimen to *S. pendula*. Wright & Studer (1889) provided a very rough description of a specimen of “*S. godeffroyi*” collected from 630 m depth at Hyalonema-ground (in Sagami Bay, Japan), fragments of which are stored in Naturhistorisches Museum der Burgergemeinde Bern, Switzerland. However, Wright & Studer’s (1889) specimen from Sagami Bay differs from the original description of *S. godeffroyi* in the shape of the terminal branches (club-shaped vs. slender shaped in Wright & Studer’s 1889 specimen). This difference indicates that Wright & Studer’s (1889) specimen appears to be a different species.

**Distribution.** Okinawa Island, 23.9 m deep; *S. godeffroyi* found from Palau Islands and Funafuti in Tuvalu, 73–128 m deep. ? Hyalonema-ground, 630 m deep. Type locality: Palau Islands, depth unknown.

**Overview of the genera Siphonogorgia Kölliker, 1874, and Chironephthya Wright & Studer, 1889.**

**Material examined.** *Chironephthya dipsacea* Wright & Studer, 1889, BM-1890-4-11-23 (holotype), Challenger St. 232, Hyalonema-ground, Japan, 345fms., 12 May 1875; *Chironephthya crassa* Wright & Studer, 1889, BM-90-4-11-26 (holotype), Challenger St. 232, Hyalonema-ground, Japan, 345fms., 12 May 1875; *Chironephthya scoparia* Wright & Studer, 1889, BM-90-4-11-24 (holotype), Challenger St. 232, Hyalonema-ground, Japan, 345fms., 12 May 1875; *Chironephthya caribaea* (Deichmann, 1936), USNM-1025683 (non-type), North Atlantic Ocean, Gulf of Mexico, United States, Texas, Flower Garden Banks National Marine Sanctuary, West Flower Gardens Bank, 27.51.45N 93.49.01W, depth 77 m, Wicksten, Mary K., Date: 26 May 2004, Gear: ROV-Sea Rover, Exped., Flower Garden Survey; *Neospongodes atlantica* Kükenthel, 1903, ZMH-C2350 (paratype), Bahia, Paessler leg, i. d. Kükenthel 1902.

**Overview.** Genus *Siphonogorgia* was established by Kölliker (1874) for the Palauan species *S. godeffroyi*. Regarding genus *Chironephthya*, the external form of the colony is very similar to that in *Siphonogorgia*, and this genus was established by Wright & Studer (1889) based on materials collected from Japan (Hyalonema ground, Sagami Bay) by the Challenger Expedition in 1875. They described three *Chironephthya* species in the Challenger Expedition Monograph, i.e. *C. dipsacea*, *C. crassa* and *C. scoparia* (Fig. 14), without designating a type species, which has not been done yet. In the same
Fig. 14. *Chironephthya* species described by Wright & Studer (1898). A, B: *C. dipsacea* Wright & Studer, 1898 (holotype, BM-1890-4-11-23); C, D: *C. scoparia* Wright & Studer, 1898 (holotype, BM-90-4-11-24); E, F: *C. crassa* Wright & Studer, 1898 (holotype, BM-90-4-11-26). Scale bars = 1 mm (B, D, F), 5 cm (A, C, E).

図 14. Wright & Studer (1898) により記載されたクダヤギ属の 3 種。A, B: アカバナクダヤギ (ホロタイプ, BM-1890-4-11-23); C, D: *C. scoparia* (ホロタイプ, BM-90-4-11-24) (種の和名なし); E, F: *C. crassa* (ホロタイプ, BM-90-4-11-26) (種の和名なし)。スケールバー = 1 mm (B, D, F), 5 cm (A, C, E).
paper, they also described the major taxonomic character to distinguish *Chironephthya* from *Siphonogorgia* as: “This genus comes nearest to *Siphonogorgia* Kölliker, but is essentially distinguished by the fact that the polyps occur along the entire course of the branches, and are less retractile. The habit of the colony is more suggestive of *Nephthyidae*” (Wright & Studer 1889: 231). However, since many known *Siphonogorgia* species at the time contained the diagnostic characters of *Chironephthya*, various authors have discussed whether *Chironephthya* is a valid genus or not, e.g., Hickson (1903), Thomson (1905), Harrison (1909), Charmers (1929). During this process, Thomson & Mackinnon (1910) showed the possibility that *Chironephthya* is a subgenus of *Siphonogorgia*, while Kükenthal (1906) considered that *Chironephthya* is a junior synonym of *Siphonogorgia*. After Kükenthal (1906), except for Harrison (1909) and Tixier-Durivault (1940), there were no additional species described for *Chironephthya* until Cairns & Bayer (2009). Utinomi (1958) did not recognize the validity of *Chironephthya* in the review of the family Nidaliidae, and Bayer (1981) and Tixier-Durivault (1987) accepted his opinion. However, Verseveldt & Bayer

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**Fig. 15. Chironephthya caribaea** (Deichmann, 1936) (USNM-1025683). Scale bars = 1 mm (D), 5 mm (B, C), 5 cm (A). 図 15. *Chironephthya caribaea* (Deichmann, 1936) (種の和名なし) (USNM-1025683). スケールバー = 1 mm (D), 5 mm (B, C), 5 cm (A).
(1988) resurrected genus *Chironephthya* in the key to the genera of the family Nidaliidae without any explanation. The distinctive traits of both genera that they indicated in their key were as follows. *Siphonogorgia*: Polyps clustered at the ends of terminal branchlets, absent from surface of trunk and main branches. *Chironephthya*: Polyps scattered on trunk and main branches as well as at ends of terminal branchlets. Later, Fabricius & Alderslade (2001) redefined the major distinctive traits of both genera as follows. *Siphonogorgia*: Polyps may occur on most of the branches, or they may be restricted to just the terminal branchlets, which can be lobe-like. Calyces low. *Chironephthya*: Polyps are generally found only on the terminal and near terminal branchlets, though in some species they can be found on the main branches, and occasionally on the upper stem. Calyces prominent, shelf-like.

Both genera had only been recorded from the Pacific until Bayer (1961: 56) transferred two species, *Neospongodes agassizii* Deichmann, 1936, and *N. caribaeae* Deichmann, 1936 (Fig. 15) from the West Indies (off Cuba and off Martinique, respectively), to *Siphonogorgia*. He had made this change in the remarks of the genus *Neospongodes* without explanation. *Neospongodes* is a genus of the family Nephtheidae established by Kükenthal (1903) based on two species, *N. atlantica* (Fig. 16) and *N. bahiensis* (this species was considered as a junior synonym of *N. atlantica* by Verseveldt 1983) from Bahia, Brazil. He gave a diagnosis on this genus as follows: Nephtheid of tree-like structure; zooids isolated or in bundles, with supporting bundles; canal walls forming an irregular axis in the center of the stem and larger branches (English translation by Deichmann 1936: 66). Because *Neospongodes* does not have calyces, *N. agassizii* and *N. caribaeae*, both of which have obvious calyces, are not *Neospongodes*. However, it is uncertain why Bayer (1961) considered these two species as nidaliid *Siphonogorgia*. Subsequently Cairns & Bayer (2009) transferred these two species to genus *Chironephthya* in a checklist of the subclass Octocorallia from the Gulf of Mexico. This change is thought to be based on the identification traits of both genera by Verseveldt & Bayer (1988), but they also did not state specific reasons for this decision. Recently, Pérez et al. (2011) reviewed previous discussion on the taxonomic status of genera *Siphonogorgia* and *Chironephthya*, and identified Brazilian specimens as *Chironephthya*, *C.* sp. Moreover, López-González et al. (2014) described a new species of *C. mediterranea* from the Mediterranean Sea. In their paper, they re-described types of both *C. agassizii* and *C. caribaeae* and compared the morphological characters of these two Atlantic species and their new Mediterranean species. In addition, they analyzed molecular data (mtMutS; mtMutS+COI; mtMutS+1g1r1+COI) including these three species and several species of Indo-Pacific *Chironephthya* and *Siphonogorgia*. According to their results, the Mediterranean and Atlantic species have a close relationship and forming a sister group, and this Atlantic-Mediterranean clade is a sister group of the Red Sea species *Chironephthya* sp. 2 with lower support. The remaining Red Sea and Indo-West Pacific sequences were placed in different clades. (López-González et al., 2014: 677). Regarding the relationship between *Siphonogorgia* and *Chironephthya*, they stated that “No shared sequence was found between these specimens assigned to these two genera”; in other words, they could not match obtained molecular information with morphological taxonomy.

The fundamental problem of the systematics of the genera *Siphonogorgia* and *Chironephthya* is that no type species has yet been fixed for *Chironephthya*, which makes it impossible to verify the validity of the genus and, if it is valid, to rearrange constituent species into the two genera. Other recent problem is whether the Atlantic and Mediterranean *Chironephthya* are the same as those in the Indo-Pacific. In Atlantic and Mediterranean *Chironephthya* spindles forming the calyces and covering the outer layer of the terminal branches are somewhat sparse, internal walls between longitudinal canals are thin, and the amount of contained sclerites is less than that of Indo-Pacific species. For these reasons, *Chironephthya* from the Atlantic and the Mediterranean seem to be unlikely to belong to the same genus as *Chironephthya* specimens from the Pacific. The necessity of a review of both genera has been pointed out by both Pérez et al. (2011) and López-González et al. (2014). Furthermore, the taxonomic status of both genera should be reviewed considering these historical problems.

Currently in WoRMS, *Siphonogorgia* and *Chironephthya* include 54 and 3 valid species, respectively (Ofwegen 2017a, b). The three *Chironephthya* species listed therein, however, are the above-mentioned three Atlantic and Mediterranean species only, and no possible type species (*C. dipsacea*, *C. crassa* and *C. scoparia*) are listed. Additionally, in the GBIF list (July 2017), the positioning of species names in both genera is confused as mentioned above (remarks of *Chironephthya hicksoni*). Careful revisions of these
databases are required for systematic studies.

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日本初記録の4種のソフトコーラルの記載、及び琉球列島産浅海性ソフトコーラル類の一覧、およびホンジュクヤギ属とクダヤギ属の分類について

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要旨。琉球列島からはこれまでに121種のソフトコーラル（未公表の4種と石軸亜目のウスカワヤギ属2種を含む）が発見されていた。2011-2012年に（一財）沖縄美ら島財団と（公財）黒潮生物研究所が、本部半島北部沿岸のソフトコーラル相の調査を行った結果、ウミツカ科3属、ウミトサカ科6属、チヂミトサカ科3属、タイマツトサカ科2属、ウミアザミ科2属及び石軸亜目のウスカワヤギ科1属の合計6科17属の標本を得ることができた。それらの中には、日本からの初記録の4種の含まれていることが明らかになった。本報告では、日本初記録の4種（フトエダヤワトサカ、フトユビウネタケ、チガイウミアザミ、エンジホンクダヤギ）を記載すると共に、今回調査で確認された12種、及びこれまでに発見されていながら未公表であった4種（ヤブコエダ、フトジクコエダ、フトクダヤギ、チガイウミアザミ）を含む琉球列島産ソフトコーラル133種のリストを掲載した。
Appendix 1. List of shallow water soft coral species found from the Ryukyu Archipelago.
Notation of the listed species information: Species name, author(s) and published year, recorder from the Ryukyu Archipelago (Omitted if the authorship and the recorder(s) same. If the species was published under a different scientific name, the different name is indicated in parentheses). Japanese name. Following symbols are used: *: species that was newly found from Japan in this survey; **: species that was collected in this survey and is already known from Japan; ?: species that was found by this survey and is probably undescribed.

Phylum Cnidaria Verrill, 1865 [刺胞動物門]
Class Anthozoa Ehrenberg, 1834 [花虫綱]
Subclass Octocorallia Haeckel, 1866 [八放サンゴ亜綱]
Order Alcyonacea Lamouroux, 1812 [ウミトサカ目]

Suborder Stolonifera Thomson & Simpson, 1909 [ウミツタ亜目]
Family Clavulariidae Hickson, 1894 [ウミツタ科]
Subfamily Clavulariinae Hickson, 1894 [ウミツタ亜科]
  2 C. racemosa Utinomi, 1950, Marine Park Center 1990 [ハナツダ]
  3 C. viridis (Quoy & Gaimard, 1833), Imahara 1991 [ナガウミヅタ]
?  4 Clavulariidae gen. sp., present survey [ウミツタ科の未記載属・種]
Subfamily Sarcodictyiinae Bayer, 1981 [アミゴケ亜科]
  5 Sarcodictyon gotoi (Okubo, 1929), Utinomi 1976b [アミゴケ]
Subfamily Telestinae Milne-Edwards & Haime, 1857 [コエダ亜科]
  6 Carijoa sp., Imahara unpublished [ヤブコエダ: 新称]
Family Coelogorgiidae Bourne, 1900 [フトジクコエダ科: 新称]
  7 Coelogorgia sp., Imahara unpublished [フトジクコエダ: 新称]
Family Tubiporidae Ehrenberg, 1828 [クダサンゴ科]
  8 Tubipora musica Linnaeus, 1758, Utinomi 1976b [クダサンゴ]

Suborder Alcyoniina Lamouroux, 1812 [ウミトサカ亜目]
Family Alcyoniidae Lamouroux, 1812 [ウミトサカ科]
** 9 Aldersladum jengi Benayahu & McFadden, 2011, present survey [ナガエダオバナトサカ: 新称]
** 10 Cladiella australis (Macfadyen, 1936), Benayahu 1995, present survey [センジュノウトサカ: 新称]
  11 C. brachyclados Ehrenberg, 1834, Benayahu 1995 [マルエダノウトサカ: 新称]
  12 C. digitulata (Klunzinger, 1877), Utinomi 1977b, Benayahu 1995 [ユビウネタケ]
  13 C. krempfi (Hickson, 1919), Utinomi 1977b [クレンフノウトサカ]
  14 C. pachyclados (Klunzinger, 1877), Utinomi 1977b, Imahara 1991, Benayahu 1995 [フトエダノウトサカ]
  15 C. sphaerophora (Ehrenberg, 1834), Utinomi 1977b [タマノウトサカ]
  * 16 Klyxum molle (Thomson & Dean, 1931), present survey [フトウネタカ: 新称]
  17 K. okinawanum (Utinomi, 1976), Utinomi 1976a, 1977b [オキナワヤワトサカ: 改称]
  18 K. simplex (Thomson & Dean, 1931), Benayahu 2002 [ヌルヤワトサカ: 新称]
  19 K. utinomii (Verseveldt, 1971), Benayahu 2002 [ウチノミヤワトサカ: 新称]
  20 Lobophytum batarum Moser, 1919, Utinomi 1977b [タカウネタケ]
  21 L. catalai Tixier-Durivault, 1957, Marine Park Center 1990 [オヤウネタケ]
  22 L. compactum Tixier-Durivault, 1956, Benayahu 1995 [種の和名なし]
  23 L. crassospiculatum (Moser, 1919), Utinomi 1977b [ハナヅタ]
  25 L. cf. crassum von Marenzeller, 1886, Utinomi 1977b (L. he Dudley'netake)
  26 L. crebrilpicatum von Marenzeller, 1886, Utinomi 1953 [種の和名なし]


Appendix 1 (continued). 附録 1（続き）。

28 L. durum Tixier-Durivault, 1956, Benayahu 2002 [種の和名なし]
29 L. pauciflorum (Ehrenberg, 1834), Utinomi 1977b [イボウネタケ]
30 L. rigidum Benayahu, 1999 [種の和名なし]
* 31 L. salvati Tixier-Durivault, 1970, present survey [ウトユビウネタケ：新称]
32 L. sarcophytoides Moser, 1919, Utinomi 1977b [オオシャコウネタケ]
** 33 L. schoedei Moser, 1919, present survey [バラウネタケ]
34 L. venustum Tixier-Durivault, 1957, Benayahu 1995 [種の和名なし]
35 Parasphaerascera grayi (Thomson & Dean, 1931), Verseveldt & Bayer 1988 (Eleutherobia grayi) [種の和名なし]
36 Protodendron repens (Thomson & Henderson, 1906), Benayahu 2002 [タバネトサカ：新称]
37 Rhytisma fulvum (Forskål, 1775), Benayahu 2002 [ウスカワトサカ：新称]
38 Sarcophytion acutangulum (von Marenzeller, 1886), Utinomi 1977b [ウミキノコ]
40 S. crassocaule Moser, 1919, Benayahu 2002 [種の和名なし]
41 S. cf. crassocaule Moser, 1919, Utinomi 1977b (Lobophytum carnatum) [コブシウミキノコ：新称]
43 S. elegans Moser, 1919, Imahara 1991 [ヒラウミキノコ]
45 S. infundibuliforme Tixier-Durivault, 1958, Benayahu 2002 [種の和名なし]
46 S. roseum Pratt, 1903, Benayahu 2002 [種の和名なし]
47 S. tenuispiculatum Thomson & Dean, 1931, Benayahu 2002 [種の和名なし]
48 S. tortuosum Tixier-Durivault, 1946, Benayahu 1995 [種の和名なし]
50 Sinularia abrupta Tixier-Durivault, 1970, Benayahu 1995 [種の和名なし]
51 S. brassica May, 1898, Benayahu 2002 [種の和名なし]
52 S. cf. brassica May, 1898, Utinomi 1977b (S. triaena) [ミツバカタトサカ]
54 S. ceramensis Verseveldt, 1977, Benayahu 2002 [種の和名なし]
55 S. erecta Tixier-Durivault, 1945, Benayahu 2002 [種の和名なし]
57 S. gardineri (Pratt, 1903), Utinomi 1977b [シバカタトサカ]
60 S. gyrosa (Klunzinger, 1877), Benayahu 1995 [種の和名なし]
61 S. heterospiculata Verseveldt, 1970, Benayahu 2002 [種の和名なし]
62 S. higai Benayahu, 2002 [種の和名なし]
63 S. hirta (Pratt, 1903), Utinomi 1977b [イガカタトサカ]
64 S. humesii Verseveldt, 1968, Benayahu 2002 [種の和名なし]
67 S. macrospodia (Hickson & Hiles, 1900), Utinomi 1977b [フトカブカタトサカ]
71 S. nanolobata Verseveldt, 1977, Benayahu 1995 [種の和名なし]
72 S. notanda Tixier-Durivault, 1966, Benayahu 1995 [種の和名なし]
Appendix 1 (continued). 附録1（続き）.


80. *S. robusta* Macfadyen, 1936, Utinomi 1977b [ドルイカタトサカ]
81. *S. tanakai* Benayahu, 2002 [種の和名なし]
84. *S. yamazatoi* Benayahu, 1995 [種の和名なし]

Family Nephtheidae Gray, 1862 [チヂミトサカ科]

85. *Capnella imbricata* (Quoy & Gaimard, 1833), Imahara 1991 [カワラフサトカサ]
87. *D. gigantea* (Verrill, 1864), Imahara 1991 [オオトゲトサカ]

89. *D. koellikeri* Küenthal 1905, Imahara 1991, present survey [ケリカートゲトサカ]

**90. *D. mollis* (Holm, 1894), the present survey [ヤワトゲトサカ：新称]
91. *D. mucronata* (Pütter, 1900), Imahara 1991 [トゲトゲトサカ]
92. *D. swensonii* (Holm, 1894), Imahara 1991 [スエンソントゲトサカ]
93. *D. thomsonii* Harrison, 1908, Imahara 1991 [アカネトゲトサカ]

? 94. *D. sp. aff. habereri* Küenthal, 1905, present survey [ヒメビロードトゲトサカ：新称]
95. *Lemnalia cervicornis* (May, 1898), Imahara 1991 [ロッカクウミセリ]
96. *Litophyton albida* (Holm, 1894), Imahara 1991 (*Nepthia albida*) [サクラチヂミトサカ]
97. *L. erecta* Küenthal, 1903, Imahara 1991 (*Nepthia erecta*) [タチチヂミトサカ]
98. *L. striata* Küenthal, 1903, Imahara 1991 (*Nepthia striata*) [フジチヂミトサカ]
99. *Paciphyton bollandi* Williams, 1997 [エナガトサカ：新称]
100. *Paralemnalia thyrsoides* (Ehrenberg, 1834), Imahara 1991 [ボウウミワラビ]

?102. *Scleronephthya sp. 1 aff. gracillima* (Küenthal, 1906), present survey [コンボウベニトサカ：新称]
?103. *Scleronephthya sp. 2 aff. gracillima* (Küenthal, 1906), present survey [コギクベニトサカ：新称]
?104. *Nephtheidae gen. sp.* , present survey [ヒメベニトサカ：新称]

Family Nidaliidae Gray, 1869 [タイマツトサカ科]

Subfamily Nidaliinae Gray, 1869 [タイマツトサカ亜科]

105. *Nephthygorgia sp.*, Imahara unpublished [フトクダヤギ：新称]

Subfamily Siphonogorgiidae Kölliker, 1875 [ウダヤギ亜科]

108. *C. dolfeini* (Küenthal, 1906), Imahara 1991 (*Siphonogorgia dolfeini*) [ニクイロクダヤギ]

*110. *C. hicksoni* Harrison, 1908, present survey [チビエダクダヤギ：新称]
?111. *C. sp. aff. lobata* (Verseveldt, 1982), present survey [ナガエダクダヤギ：新称]
?112. *Siphonogorgia sp. aff. pastulosa* Studer, 1889, present survey [モツレホンクダヤギ：新称]

*113. *S. cf. godefroyi* Kölliker, 1974, present survey [エンジホンクダヤギ：新称]

Family Paralcyoniidae Gray, 1869 [カクレトサカ科]

114. *Ceececeus quadrus* Ofwegen & Benayahu, 2006 [シロカワリトサカ：新称]

Family Xeniidae Ehrenberg, 1828 [ウミアザミ科]

115. *Anthelia cf. ternatana* (Schenk, 1896), Utinomi 1977a [テルナタイタアザミ]

?116. *Asterospecificaria sp.* , present survey [コンベイトウアザミ：新称]
120. *Heteroxenia elisabethae* Kölliker, 1874, Imahara unpublished [チガイウミアザミ]

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Appendix 1 (continued). 附録 1（続き）.

121 Sympodium caeruleum Ehrenberg, 1834, Utinomi 1977a [チヂミウミアザミ]
122 Xenia crassa Schenck, 1896, Utinomi 1977a [オオウミアザミ]
123 X. elongata Dana, 1846, Imahara 1991 [ミナミウミアザミ]
124 X. mayi Roxas, 1933, Imahara 1991 [コフキウミアザミ]
125 X. membranacea Schenck, 1896, Utinomi 1977a [キイロウミアザミ]
126 X. plicata Schenck, 1896, Utinomi 1977a [ヒダウミアザミ]
127 X. sp. aff. plicata Schenck, 1896, Utinomi 1977a (X. blumi), Imahara 1991 (X. blumi) [種の和名なし]
128 X. stillifera Verseveldt, 1977, Benayahu 1995 [種の和名なし]
129 X. umbellata Lamarck, 1816, Utinomi 1977a [コダチウミアザミ]
130 Yamazatus iubatum Benayahu, 2010 [ヤマサトウミアザミ: 新称]
131 Xenidae gen. sp., present survey [ウミアザミ科の未記載属: 種]

Suborder Scleraxonia Studer, 1887 [石軸亜目]
Family Briareidae Gray, 1859 [ウスカワヤギ科]
132 Briareum stechei (Kükenthal, 1908), Benayahu 2002 (B. excavatum) [種の和名なし]
**133 B. violaceum (Quoy & Gaimard, 1833), Utinomi 1976b (Pachyclavularia violacea), Imahara 1991 (P. violacea), present survey [ムラサキハナヅタ]