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Review of the Japanese Species of *Alatotrochus* and *Sphenotrochus* (Cnidaria: Anthozoa: Scleractinia: Turbinoliidae), with Description of a New Species, *A. japonicus*.

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Abstract. Japanese species of the two genera of the azooxanthellate scleractinian family Turbinoliidae, *Alatotrochus* Cairns, 1994 and *Sphenotrochus* Milne Edwards and Haime, 1848, are reviewed. Two species are recognized in *Alatotrochus*: *A. rubescens* (Moseley, 1876) and *A. japonicus* n. sp. The new species, collected from the Ogasawara Islands, Izu Islands, and Satsunan Islands, is distinguished from *A. rubescens* by its smaller, flattened and taller corallum, fewer number of the septa, and lamellar columella. Although this new species is assigned to *Alatotrochus* because it shares with *A. rubescens* two apomorphic characters, it is also superficially similar to *Sphenotrochus wellsi* Cairns, 1997 in the calicular and costal morphology. One species of *Sphenotrochus*, *S. hancocki* Durham and Barnard, 1952, is recorded for the first time from Japan.

Key words: Scleractinia, Turbinoliidae, *Alatotrochus, Sphenotrochus*, new species.

Introduction

Alatotrochus Cairns, 1994 is a monotypic genus of the scleractinian family Turbinoliidae that is characterized by having alate thecal edge crests, costal number being twice as many as that of septa, linearly aligned papillose columella, and lacking pali and paliform lobes (Cairns, 1994, 1997). The sole representative of the genus, *Alatotrochus rubescens* (Moseley, 1876), is known from the western Pacific including Japanese waters (Cairns, 1994; Ogawa *et al*., 2002), as well as Pleistocene fossils from the Ryukyu limestone of the Okinawa Island (Cairns, 1994). In the course of examining specimens of *Alatotrochus* collected from Japan, two morphologically distinct species were recognized. One of these species was *A. rubescens* and the other was considered at first to be a species of *Sphenotrochus* Milne Edwards and Haime, 1848, because it bears similarity to *Sphenotrochus wellsi* Cairns, 1997. However, careful examination showed that it could be assigned to *Alatotrochus*, and here described as a new species, *A. japonicus*. In addition, *Sphenotrochus hancocki* Durham and Barnard, 1952, previously known from the eastern Pacific and the tropical western Pacific, is reported for the first time from Japan.

Materials and methods

Most of the material used in this study were collected during research cruises of training or research vessels belonging to Japanese universities: TR/V *Shin'yo-maru* (*SN*), Tokyo University of Marine Science and Technology (formerly Tokyo University of Fisheries); R/V *Tansei-maru* (*TA*), Ocean Research Institute, the University of Tokyo (ORI; now belonging to the Japan Agency for Marine-Earth Science and Technology); TR/V *Toyoshio-maru* (*TO*), Hiroshima University; TR/V *Nagasaki-maru* (*NA*), Nagasaki University. In addition, specimens collected from the Ogasawara Islands by R/V *Koyo* of the Ogasawara Fisheries Center, Tokyo Metropolitan Government, were also examined. Collected specimens

were cleaned with domestic bleach solution and stored as dry specimens and are deposited at Coastal Branch of Natural History Museum and Institute, Chiba, Japan (CMNH), and National Museum of Nature and Science, Japan (NSMT).

Measurements were taken directly with a dial caliper or optically using an eyepiece micrometer attached to a Leica MZ8 binocular microscope. To enhance the contrast in conventional black and white photographs, some specimens were stained dark with cyanine blue solution and then coated with sublimed ammonium chloride prior to taking photographs. The scanning electron micrographs were taken using a JEOL JSM-5310LV scanning electron microscope in CMNH in low vacuum mode. All the photographs were taken by the author.

Abbreviations of morphological terms used in the text are as follows: CD, calicular diameter; GCD, greater calicular diameter; LCD, lesser calicular diameter; HT, height of corallum; Sx and Cx, xth cycle of septa and costae, respectively. In describing the septal insertions, numbering of the half-systems of the calice follows the definition proposed in Cairns (1997: 26): 12 half-systems are numbered in clockwise direction starting with one adjacent to one of the principal septa. In the section of "Material examined", locality name is followed by cruise number and station number of the vessel, then position and depth of the station, number of specimens and their catalogue number in parentheses.

Systematics

Order **Scleractinia**
Family **Turbinoliidae** Milne Edwards and Haime, 1848
Genus ***Alatotrochus*** Cairns, 1994
[New Japanese name: Futaetsutsumisango-zoku]

Platytrochus. – Moseley, 1876: 552 (in part).
Sphenotrochus. – Moseley, 1881: 157 (in part).
Alatotrochus Cairns, 1994: 68; 1995: 84; 1997: 14.

Type species. *Platytrochus rubescens* Moseley, 1876. Original designation.

Emended diagnosis. Corallum solitary, free and cuneiform, with prominent thecal edge crests; calice elliptical in cross section. Corallum medium to large in size for the family, up to 20 mm in GCD. Costae independent in origin, granular, and number twice as many as that of septa (C: S=2); intercostal region shallow, smooth and not pitted. Edge crests transversely ridged. Septa highly exsert and hexamerally arranged in 4 cycles; S4 complete or incomplete (40 to 48 septa). Pali and paliform lobes absent. Columella composed of linearly fused papillae or a lamella aligned in the plane of GCD.

Remarks. The genus *Alatotrochus* was established by Cairns (1994) for *Platytrochus rubescens*. Cairns (1994) suggested similarity between his new genus and *Platytrochus* Milne Edwards and Haime, 1848, but differentiated *Alatotrochus* from *Platytrochus* by having a much larger corallum, an additional cycle of septa, and having twice as many costae as septa. As Cairns (1994) noted, *Alatotrochus* is also very similar to *Sphenotrochus*, and indeed, the type species, *A. rubescens*, was once assigned to *Sphenotrochus* by Moseley (1881). Cairns argued that *Alatotrochus* differs from *Sphenotrochus* in having a papillose (not lamellar) columella, a larger corallum, "serrate" costae and twice as many costae as septa. The new species described in this study is assigned to *Alatotrochus* because it possesses a combination of two apomorphic characters presented by Cairns (1997): cuneiform corallum bearing alate edge crests; and the costal number being twice of the septa (C: S=2). The generic diagnosis given above is amended to accommodate the new species.

Cairns (1997) inferred phylogenetic relatinships among the genera of the family Turbinoliidae based on skeletal morphology. His analysis shows that *Alatotrochus* is placed in one of the three major clades, which contain only two genera, *Alatotrochus* and *Pleotrochus* Cairns, 1997, united by a single apomorphy, i.e., costoseptal ratio of 2. Nevertheless, it has been found that some plesiomorphic character states of *Alatotrochus*

used in Cairns (1997), e.g., morphology of columella, septal cycle, and corallum size, are rather polymorphic, and consequently these characters are difficult to use in phylogenetic analysis. Reassessment of phylogenetic relationships among the turbinoliid genera is strongly recommended.

Alatotrochus rubescens (Moseley, 1876) (Figs. 1, 2) [New Jn.: Futaetsutsumisango]

Platytrochus rubescens Moseley, 1876: 553.

Sphenotrochus rubescens. – Moseley, 1881: 157–159, pl.6, figs. 8, 8a.

Alatotrochus rubescens. – Cairns, 1994: 68–69, pl. 29g–l; 1995: 84, pl. 24a, b; 1998: 390; 1999: 108–109; 2004: 288, fig. 5E. – Cairns and Zibrowius, 1997: 141–142, fig. 18h. – Ogawa *et al*. 2002: 30 (in part: specimens deposited in Tohoku University), pl. 3, fig. 5.

Not *Alatotrochus rubescens*. – Ogawa *et al*. 2002: 30 (in part: specimens from the Ogasawara Is-

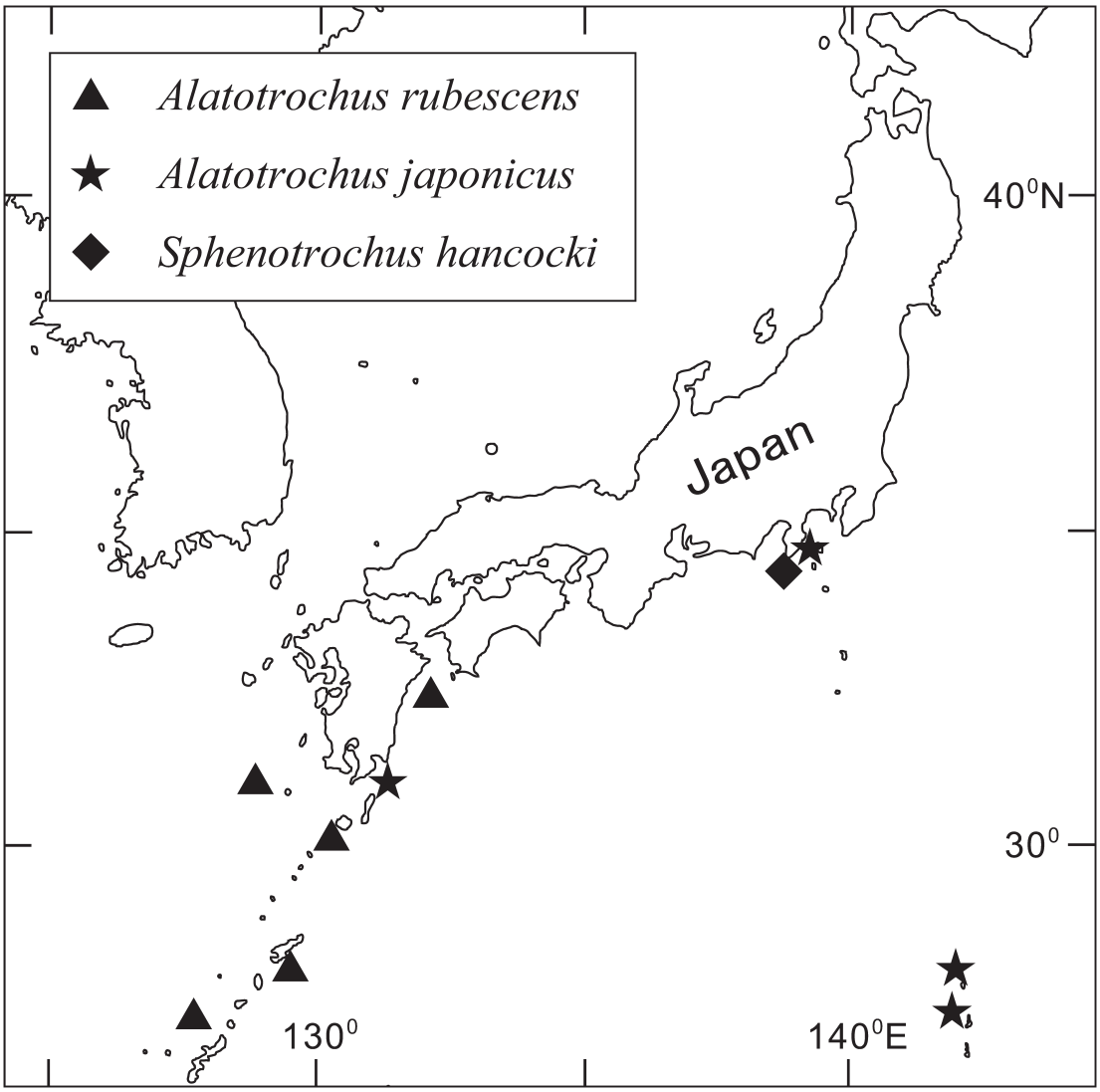


Fig. 1. Sampling localities of specimens used in this study. *Alatotrochus rubescens* (triangle), *Alatotrochus japonicus* (star) and *Sphenotrochus hancocki* (diamond).

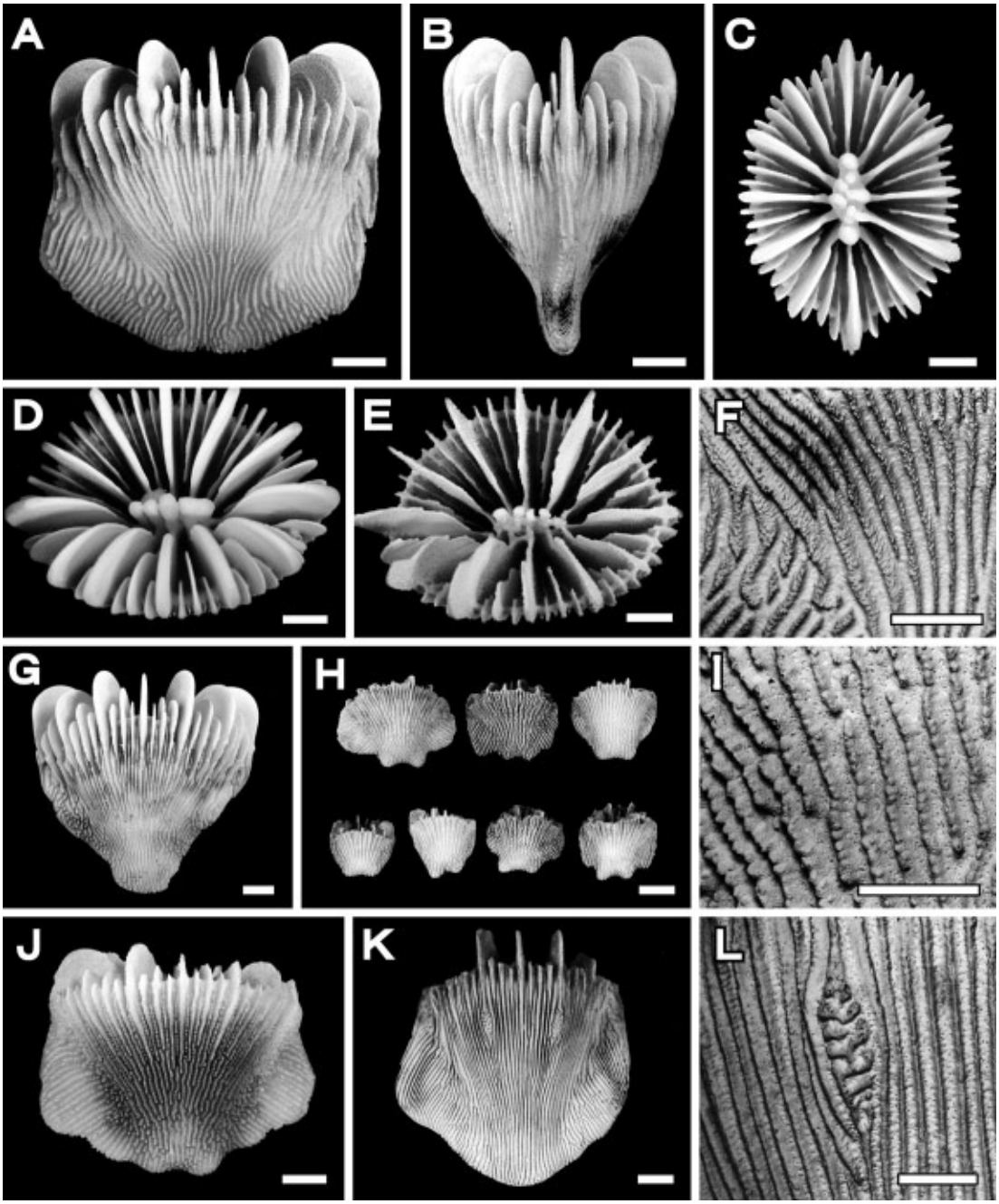


Fig. 2. *Alatotrochus rubescens*. A–C, F, Lateral, edge and calicular views and detail of costae of a corallum (CMNH-ZG 04348-1); D, E, oblique calicular views of two coralla (CMNH-ZG 04348-2 and CMNH-ZG 02678, respectively); G, lateral view of a corallum with low edge crests (CMNH-ZG 04348-3); H, lateral view of seven juvenile coralla showing bifurcate corallum base and variation in development of edge crests; I, J, detail of costae and lateral view of a corallum with prominent edge crests and coarsely granular costal edge (CMNH-ZG 02532); K, L, lateral view and detail of costae of a corallum with enlarged lateral C1 and smooth costal edge (CMNH-ZG 04023). Scale bars: 2 mm in A–E, G, J, K; 1 mm in F, I, L; 5 mm in H.

lands), pl. 3, figs. 4a, b. (=*Alatotrochus japonicus* n. sp.)

Materials examined. Satsunan Islands–Hirase, SW off Yakushima: *TA* KT-02-03, St. A-1, 30°05.08′N, 130°10.08′E, 498 m, Apr. 14, 2002, 1 (CMNH-ZG 02532); *TA* KT-02-03, St. A-1-2, 30°05.13′N, 130°10.09′E, 498 m, Apr. 14, 2002, 25 (CMNH-ZG 02546); *TA* KT-02-03, St. A-2, 30°04.99′N, 130°07.1′E, 376–392 m, Apr. 14, 2002, 2 (CMNH-ZG 02568). Amami Islands–S off Amami-ōshima: *TA* KT-02-03, St. B-1, 28°00.90′N, 129°22.45′E, 263 m, Apr. 16, 2002, 3 (CMNH-ZG 02619); *TA* KT-02-03, St. B-2-2, 28°00.64′N, 129°22.34′E, 269–270 m, Apr. 16, 2002, 3 (CMNH-ZG 02648); *TA* KT-02-03, St. B-3, 28°00.00′N, ca.129°25′E, 340 m, Apr. 16, 2002, 5 (CMNH-ZG 02678). E off Amami-ōshima: *TA* KT-93-09, St. AM7, 28°17.24′N, 129°40.27′E, 191–196 m, June 22, 1993, 3 (ORI); *TA* KT-93-09, St. AM8, 28°11.02′N, 129°43.39′E, 422–425 m, June 22, 1993, 1 (ORI); *TO* 98-1, St. 23, 28°15.20′N, 129°48.20′E, 221 m, May 26, 1998, 2 (CMNH-ZG 03439); *TO* 05-2, St. 4, 28°08.44′N, 129°31.17′E, 348–353 m, May 24, 2005, 1 (CMNH-ZG 04002). East China Sea–SW off Danjo-gunto: *NA* 2005 cruise, St.7′, 31°45′N, 128°10′E, 150 m, Apr. 25, 2005, 5 (CMNH-ZG 04348).

Description of Japanese specimens. Corallum cuneiform, thecal faces meeting in sharp edges that project as solid edge crests 1–4 mm high. Base rounded or slightly bifurcate. Angle of thecal faces 30°–62°. GCD: HT=0.82–1.20. Calice elliptical (GCD: LCD=1.22–1.50), largest specimen 16.5 × 15.4 mm in CD.

Four cycles of granular costae (C1–4) correspond to S1–4; additional costae with similar structure to C1–4 occur in every intercostals region, resulting in total number of costae twice of septa. Edge crests transversely ridged; ridges on crests similar in structure to costae, but oriented obliquely downward, at an angle of 60°–80° to thecal face costae. Septa hexamerally arranged in 4 complete cycles (48 septa) according to formula: S1≥S2>S3>S4. S1–2 up to 3.0 mm exsert and extend to columella. S3 about 1.5 mm exsert and two-thirds width of S1–2. S4 about 1 mm exsert and one-third width of S3. All septa independent. Columella papillose, consisting of papillae linearly arranged in plane of GCD; base of papillae fused into solid plate; linear arrangement of papillae often slightly irregular in center of fossa.

Theca of well-preserved coralla dark reddish brown; septa and columella white.

Distribution. Pleistocene: Ryūkyū limestone of Okinawa Island, Japan (Cairns, 1994). Recent: Kyūshū to Ryūkyū Islands, Japan (Cairns, 1994; present study); New Zealand (Cairns, 1995); Queensland and Western Australia, Australia (Cairns, 1999, 2003); Philippines and Indonesia (Cairns and Zibrowius, 1997); Kai Islands, Banda Sea (Moseley, 1876: type locality). 193–498 m.

Remarks. According to Cairns (1994), some larger syntypes of this species have additional pairs of S5 in the end half-systems and a total of 56 septa, suggesting increasing of the septa with growth. In the specimens examined in this study, the maximum number of the septa is 48, which is attained in a corallum 8.0 mm GCD. Most of the specimens larger than 9.5 mm GCD have 48 septa, although a pair of S4 is lacking in a corallum 12.7 mm GCD.

Cairns (1994, 1995) reported the costal ornamentation of this species as serrate but later he (Cairns, 1997) regarded it as granular. In fact, most of the present Japanese specimens have costae covered with fine to medium sized granules (Fig. 2F), whereas costae in some individuals are ornamented with a unilinear row of large granules (Fig. 2I), showing some similarity to the serrate condition. Some larger specimens examined have almost smooth costae (Fig. 2L). The development of the alate edge crests is also variable from well-developed, highly crested to poorly-developed. Specimens with well-developed, high crests (Fig. 2A) and those with poorly-developed, very low crests (Fig. 2G) were sometimes collected together.

One large corallum from north off Tanegashima Island (CMNH-ZG 04023-1; 14.2 mm in GCD) has four lateral C1 swollen into elliptical protuberance with sinuous (convoluted) edges

(Fig. 2K, L). Similar development of C1 is reported for specimens from Philippines (Cairns and Zibrowius, 1997) and a Pleistocene fossil of Okinawa Island (Cairns, 1994).

Alatotrochus japonicus n. sp. (Figs. 1, 3, 4A–D) [New Jn.: Hime-futaetsutsumisango]

Alatotrochus rubescens. – Ogawa *et al*., 2002: 30 (in part: specimens from the Ogasawara Islands), pl. 3, figs. 4a, b.

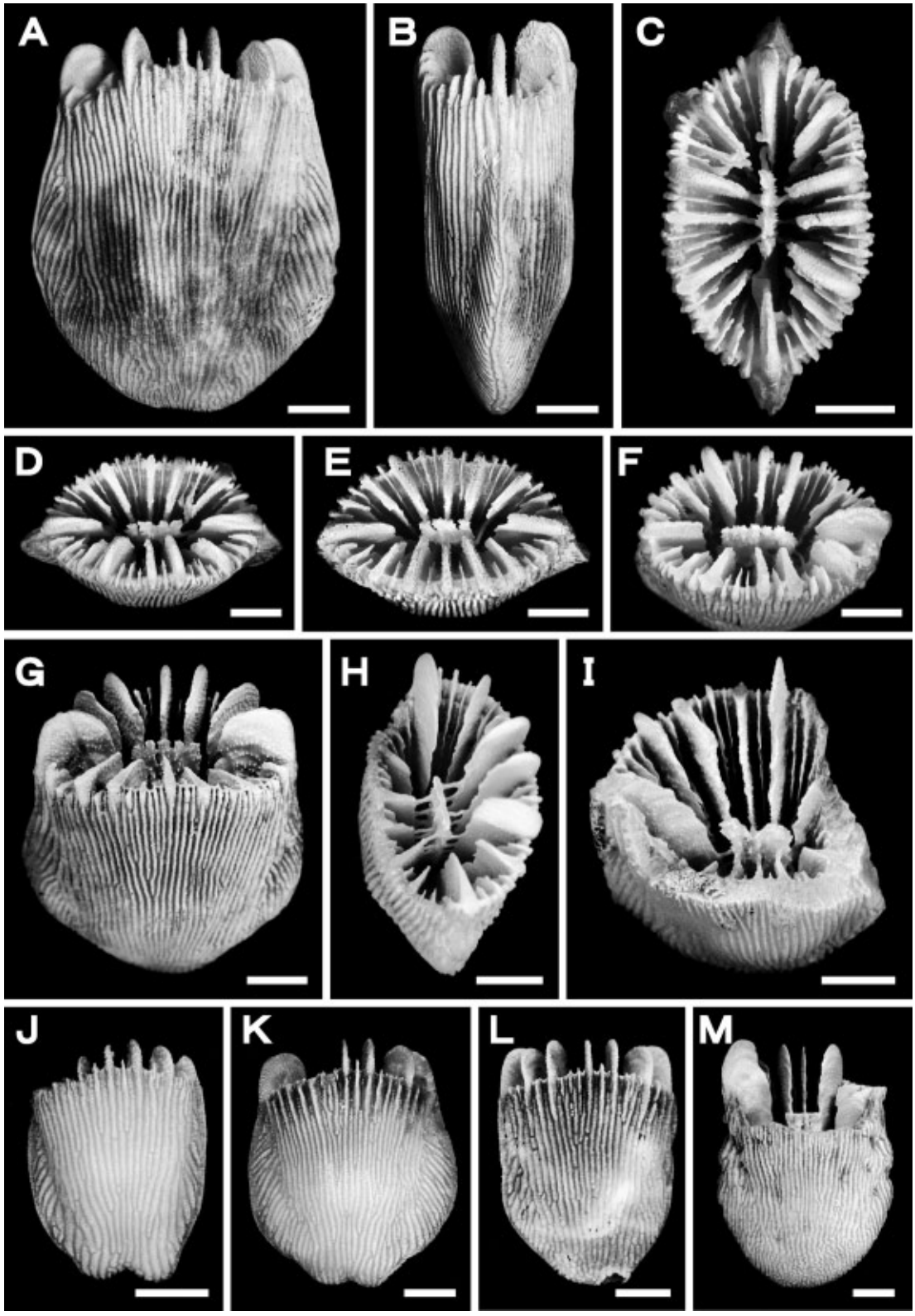
Materials examined. Holotype. North off Mukojima, Ogasawara Islands, *SN* 2009, St. SN 09-01, 27°44.05′N, 142°09.19′E to 27°44.01′N, 142°09.15′E, 109–108 m, Nov. 16, 2009 (CMNH-ZG 06088).

Paratypes. Izu Islands–Southwest off Izu-ōshima: *SN* 2002, St. 32, 34°42.0′N, 139°20.3′E, 106–103 m, Oct. 24, 2002, 5 (CMNH-ZG 03076–03080). Ogasawara Islands–North off Mukojima: *TA* KT-97-7, St. MK 04, 27°49′N, 142°02′E, 192–203 m, June 7, 1997, 12 (CMNH-ZG 01282); *SN* 2009, St. SN 09-01, collected with holotype, 76 (56: CMNH-ZG 05613; 20: NSMT-Co 1534). East off Mukojima: *SN* 2009, St. SN 09-08, 27°41.06′N, 142°10.58′E to 27°41.05′N, 142°10.40′E, 106–99 m, Nov. 16, 2009, 1 (CMNH-ZG 05681); *SN* 2009, St. SN 09-11, 27°42.02′N, 142°12.46′E to 27°42.16′N, 142°12.07′E, 179–161 m, Nov. 16, 2009, 3 (CMNH-ZG 05726). West off Otōtojima, *SN* 1997, St. 12, 27°11.5′N, 142°09.1′E, 150–160 m, Oct. 16, 1997, 1 (CMNH-ZG 02771). West off Anijima, *TA* KT-97-7, St. CC 05, 27°06.5′N, 142°06.7′E, 154–155 m, June 8, 1997, 1 (CMNH-ZG 01410); *SN* 2009, St. SN 09-19, 27°07.62′N, 142°07.35′E to 27°07.62′N, 142°07.60′E, 144–140 m, Nov. 18, 2009, 1 (CMNH-ZG 05681). West off Hahajima: R/V *Koyo* 2009, St. 12, 26°42.24′N, 142°05.80′E to 26°42.30′N, 142°05.79′E, 97–103 m, Jul. 13, 2009, 1 (CMNH-ZG 05455). Satsunan Islands–North off Tanegashima: *TO* 2005-02, St.13-1, 30°56.6′N, 131°06.5′E, 132 m, May 26, 2005, 17 (CMNH-ZG 04025); *TO* 2005-02, St.13-2, 30°56.6′N, 131°06.5′E, 118 m, May 26, 2005, 1 (CMNH-ZG 04049).

Description. Corallum cuneiform and compressed, slightly convex thecal faces meeting in blunt thecal edges. Thecal edges parallel or slightly diverging outward, forming low but distinct crests along edges. Angle of thecal faces usually bimodal, at height of 4 mm changing from 30°–45° to narrower 0°–10° (almost parallel). Base of corallum rounded or slightly bifurcate. Lateral calicular edges slightly arched. Height of corallum greater than GCD (GCD: HT=0.65–0.80). Maximum width of corallum equal to or up to 1.18 in GCD. Calice elliptical to elongate hexagonal (GCD: LCD=1.47–1.84). Holotype 8.3 x 5.2 mm CD and 12.4 mm HT; the largest paratype 10.0 x 6.4 mm CD and 13.6 mm HT, albeit all septal lobes damaged. Lower theca of adult corallum quite thick, exceeding 1.2 mm in thickness (Fig. 3I).

Costae equal in width (0.10–0.14 mm), straight, with rounded ridges. Costae ornamented with rounded granules. In addition to C1–4 corresponding with septa (normal costae), same number of costae present in every intercostal region (additional costae), resulting in costal number twice of septa. Size and ornamentation of normal and additional costae almost similar; additional costae being slightly narrower and lower at calicular edge. Costal origin independent. Most C1–2 including principal costae (costae in plane of GCD) continuous from calice to 2.0–3.0 mm above base; some additional costae continuous from calice to base. Costae occasionally transform into sinuous and discontinuous ridges in

Fig. 3. *Alatotrochus japonicus* n. sp. A–D, lateral, edge, calicular and oblique calicular views of the holotype (CMNH-ZG 06088); E–G, oblique calicular views of paratypes (E, CMNH-ZG 05613-1; F, CMNH-ZG 01282-1; G, CMNH-ZG 04049) showing variations in morphology of columella; H, oblique calicular view of a paratype (CMNH-ZG 02771) showing trabecular processes connecting septa and columella; I, oblique calicular view of a damaged paratype (CMNH-ZG 04025-1) showing thick lower theca; J–M, lateral views of four paratypes showing variation in corallum morphology (J, CMNH-ZG 04025-2; K, CMNH-ZG 04025-3; L, CMNH-ZG03077; M, CMNH-ZG 02771). Scale bars 2 mm.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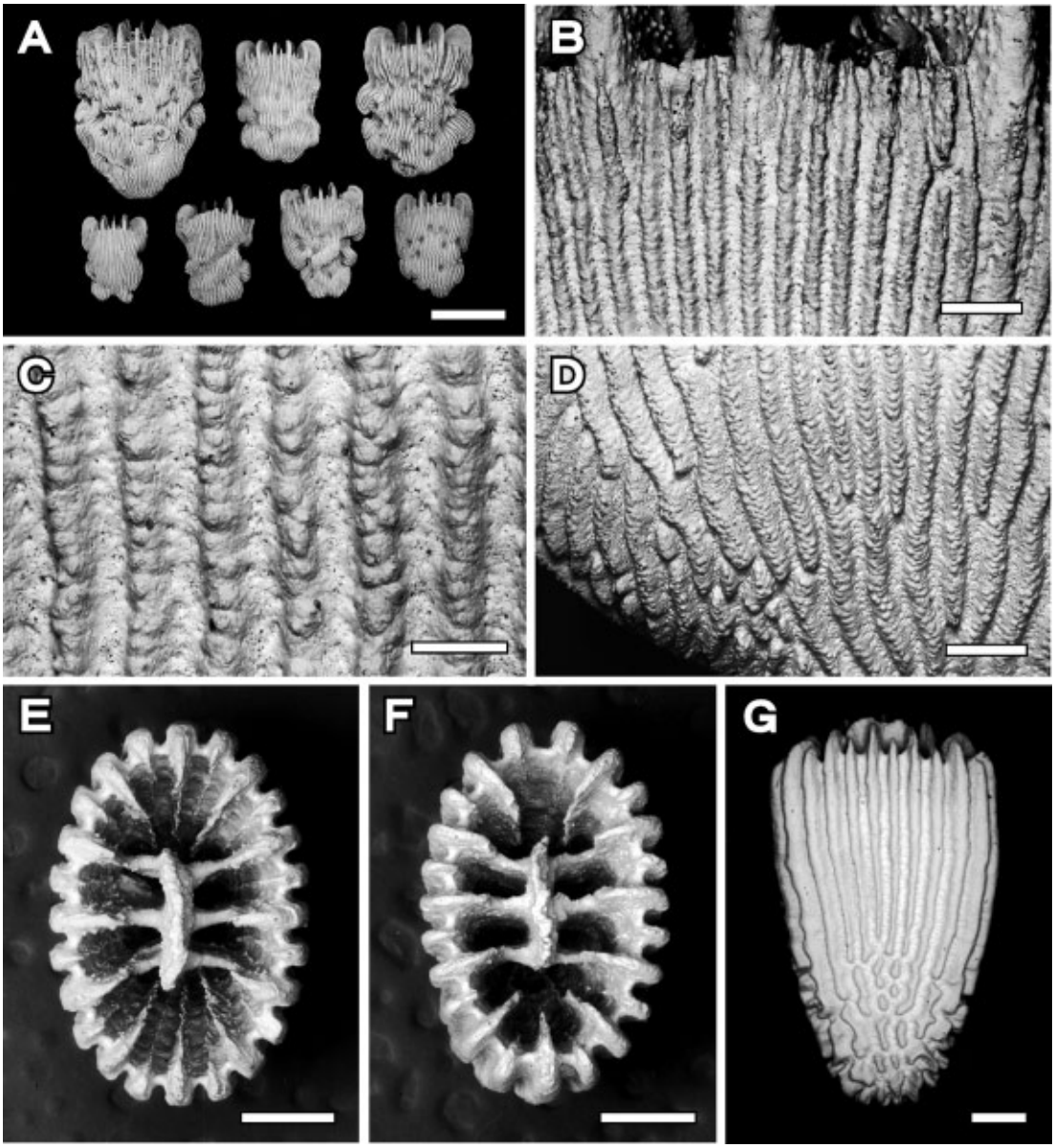

Fig.4. *Alatotrochus japonicus* n. sp. (A–D) and *Sphenotrochus hancocki* (E–G). A, lateral view of seven coralla showing thecal deformation (CMNH-ZG 05613-2–ZG 05613-8); B–D, costal details of a paratype (CMNH-ZG 04049); E, calicular view of a corallum with 24 septa (CMNH-ZG 02426-1); F, G, calicular and lateral views of a corallum with 23 septa (CMNH-ZG 02426-2). Scale bars: 5 mm in A; 0.5 mm in B–F; 0.25 mm in C.

lower part of corallum. On thecal edge crests, several costae adjacent to principal costae divided into many parallel ridges diverging downward at an angle of 60°–80° to thecal face costae. Ridges on crests have same dimension and ornamentation of costae. Interspace between costae equal to or slightly narrower than costae (0.08–0.12 mm). Thecal pits absent; intercostal area roughened with numerous minute depressions.

Septa hexamerally arranged in 4 cycles, last cycle incomplete, according to formula: S1–2>S3>S4. Septal number 32–44, depending on

number of S4 insertion; smallest corallum examined (4.0 mm GCD) containing 28 septa, having S4 pairs in the half-systems 1 and 12 (6: 6: 12: 4); corallum 4.4 mm GCD containing 32 septa, having S4 pairs in each of 4 end half-systems (6: 6: 12: 8); 40-septa coralla (8 pairs of S4) most common, in which S4 pairs inserted in half-systems 1, 2, 4, 6, 7, 9, 11 and 12 (6: 6: 12: 16; Fig. 3C). S1–2 highly exsert, each having a large rounded septal lobe up to 2.3 mm high; axial edges of S1–2 vertical, slightly sinuous, reaching 0.8–0.9 distance to columella. Axial edges of 6 S1–2, i.e. 4 lateral S1 and 2 S2 in lateral systems, invariably connected to columella through series of trabecular processes, not a solid fusion (Fig. 3H). Occasionally, some of axial edges of principal S1 and S2 in end systems also connect to columella through similar trabecular processes deeper in fossa. S3 less exsert (up to 0.8 mm), about half width of S1–2; S3 flanked by S4 slightly wider than unflanked S3. S4 only 0.3–0.5 mm exsert, half width of S3. Each S3–4 have vertical, slightly sinuous axial edge, not reaching columella. All septa independent. Septal face covered with sparse, minute granules which occasionally arranged parallel to septal lobe edge. Pali and paliform lobes absent.

Columella lamellar, aligned in axis of GCD, width 0.25–0.3 in GCD, 0.3–0.5 mm thick. Columellar lobe reaching as high as lateral calicular edge; distal lobe of columella often split into several lobes with rounded or irregular margin (Figs. 3D–G). Columellar face covered with relatively large, sharp, conical granules; occasionally several small perforations or slits occurring on face of columella.

Theca of well-preserved coralla dark reddish brown; septa and columella white.

Etymology. The specific name *japonicus* is named after the locality where the new species occurs.

Distribution. Recent: Southern Japan including Izu Islands (west off Izu-ōshima), Ogasawara Islands (from north off Mukojima to west off Hahajima), and Satsunan Islands (north off Tanegashima). 106–155 m. (Fig. 1).

Remarks. As mentioned above, this new species is assigned to *Alatotrochus* because of the combination of two apomorphic characters proposed by Cairns (1997): cuneiform corallum bearing alate edge crests; and the costal number being twice that of the septa (C: S=2). The presence of the alate edge crests is also found in *Tropidocyathus* Milne-Edwards and Haime, 1848, and the second character (C: S=2) is also seen in *Pleotrochus*, *Wellsotrochus* Squires, 1960, *Holcotrochus* Dennant, 1902, *Conocyathus* d'Orbigny, 1849 and some species of *Turbinolia* Lamarck, 1816 and *Sphenotrochus*. Thus, no autapomorphic characters have been identified for *Alatotrochus*. Nevertheless, *A. rubescens* and *A. japonicus* also share the following characters, although polarities of these characters are variable: there are no thecal pits; the costae are independent; the septa are independent and highly lobed; and pali and paliform lobes are absent. The lamellar columella found in the new species apparently differ from the papillose columella seen in *A. rubescens*. However, close examination revealed that the linearly aligned columellar papillae are partly to completely fused into a solid plate in most of the specimens in *A. rubescens*. On the other hand, the uneven distal lobe and the occasional perforations of the lamellar columella in the new species suggest that separate elements of papillae are fused into a single lamella in early stages. Consequently, the different structure of the columella seen in the two species could be regarded an intermediate between the true papillose and lamellar conditions, and this character also represents a similarity between the two species. Besides the superficial difference in the columella, *A. japonicus* is distinguished from *A. rubescens* by the smaller (GCD less than 10 mm vs. over 10 mm), flatter (GCD: LCD=1.47–1.84 vs. 1.22–1.50) and taller (GCD: HT=0.65–0.80 vs. 0.82–1.20) corallum and the fewer septa (less than 44 vs. 48).

Alatotrochus japonicus is also very similar to *Sphenotrochus wellsi* Cairns, 1997, a Miocene fossil species from Australia. Besides the fish-tail-like corallum shape and much exsert S3 septal lobes (about two-thirds in S1–2 lobe in *S.*

wellsi vs. one-third in *A. japonicus*), *S. wellsi* share most of the diagnostic characters with *A. japonicus*, including corallum size, distally uneven lamellar columella, septal number and S4 insertion pattern. Cairns (1997) noted that *S. wellsi* and *S. trinitatis* Vaughan in Vaughan and Hoffmeister, 1926, a Miocene fossil of Trinidad, are unique in the genus *Sphenotrochus* in having the number of costae being twice of septa, and suggested that they might be treated as a distinct subgenus. Considering the close similarities among these species referred to *Sphenotrochus* and those of *Alatotrochus*, a thorough review is strongly recommended.

With unknown reason, some specimens of *A. japonicus* collected from the Ogasawara Islands exhibit a deformation of the corallum by the presence of many small depressions on the thecal faces (Fig. 4A). No deformation of calicular elements, however, is observed in these aberrant specimens.

Genus ***Sphenotrochus*** Milne Edwards and Haime, 1848
[New Jn.: Mugitsubusango-zoku]

Turbinolia. – Lamarck, 1816: 231 (in part).
Sphenotrochus Milne Edwards and Haime, 1848: 240–241. – Vaughan and Wells, 1943: 211–212. – Wells, 1956: F425. – Cairns, 1989: 37–38; 1995: 84; 1997: 24–26; 2003: 79–80.

Type species. *Turbinolia crispa* Lamarck, 1816. Subsequent designation by Milne Edwards and Haime (1848).

Diagnosis. Corallum solitary, free and cuneiform, rarely exceeding 10 mm GCD, with rounded or fish-tail shaped base; calice elliptical in cross section. Costae smooth or granular; continuous from base to calice, or subdivided into short, parallel ridges. Costae independent in origin, one or two costae corresponding to each septum. Septa hexamerally arranged in 3 to 4 cycles (24–48 septa). Pali and paliform lobes absent. Columella lameller, labyrinthiform or papillose (after Cairns, 1995, 1997, 2003).

Remarks. *Sphenotrochus* comprises about 38 species and subspecies and has geological age from Middle Eocene to Recent, of which 14 species and subspecies are Recent (Cairns 1997, 2000, 2003, 2004). The geographical distribution of the genus is worldwide, including Indo-West Pacific, eastern Pacific, Atlantic as well as Antarctic Oceans. Species of the genus are rather diverse in some important diagnostic characters, including the costal structure and ornamentation, morphology of the columella, and the ratio of the costal and septal numbers (Cairns, 1997), strongly suggesting that the genus is heterogenous (see "Remarks" of *Alatotrochus japonicus* n. sp.).

Sphenotrochus hancocki Durham and Barnard, 1952 (Figs. 1, 4E–G) [Jn.: Mugitsubusango]
Sphenotrochus hancocki Durham and Barnard, 1952: 94–95, pl. 13: figs. 57a,b. – Cairns, 1989: 38–39, pl. 20a–h; 1991: 19, pl. 7c, e–g. – Wells, 1983: 236.

Materials examined. Off Shimoda, Shizuoka Pref., Japan, *TA* KT-93-4, St. SH-1, 112–116 m, Apr. 15, 1993 (exact position of the station could not be traced), 2 (CMNH-ZG 02426).

Description of the Japanese specimens. Corallum cuneiform, minute, with elliptical calice and moderately pointed base; 2.2 × 1.5–2.3 × 1.6 mm CD, 3.6–3.8 mm HT.

Costae round and smooth, equal in number to septa, origin independent. Costae 0.15–0.20 mm in width, continuous in upper two-thirds of thecal face; divided into fragments in lower one-third. Intercostal furrow 0.1–0.12 mm wide; intercostal pits absent, but surface of intercostal area with minute depressions.

Septa hexamerally arranged in 3 cycles according to formula: S1–2>>S3 (23–24 septa: see discussion). S1–S2 0.3 mm exsert, each having rounded distal lobe; axial edges of S1–S2 vertical, slightly sinuous, reaching 0.5 distance to columella. Four lateral S1 and two S2 in lateral systems solidly fused to columella in lower half of fossa. S3 only 0.15 mm exsert, rudimentary, each consisting of discontinuous low ridges or a row of minute spines. Columella lamellar and exsert, with rounded distal lobe; distal lobe reaching

slightly higher than S1–2 lobes. Columellar lamella 1.2 mm long and 0.2 mm wide, aligned in plane of GCD. Septal and columellar faces minutely granulated.

Corallum uniformly white.

Distribution. Miocene: Costa Rica. Recent: Galápagos (type locality); Philippines; South China Sea off Hong Kong; Lower California (after Cairns, 1989a); Japan (this study); 18–274 m.

Remarks. The specimens examined generally agree with the descriptions of *S. hancocki* of Durham and Bernard (1952) and Cairns (1989, 1991). Cairns (1989) noted that the number of S1–2 fused with columella is 10 in the type specimens from the Galápagos and 6 in the specimens from the Philippines, and regarded the difference a geographical variation. In this character, the present specimens agree with the Philippines specimens. Inclusion of the original substrate of the attachment mentioned by Cairns (1989) could not be observed in these specimens.

One of the present specimens has only 23 septa, although the presence of 24 septa is normal for the species. Considering the relative size and configuration of septa, it seems that one of the principal S1 is missing in this aberrant specimen (Fig. 4F).

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References

Cairns, S.D. 1989. A revision of the ahermatypic Scleractinia of the Philippine Islands and adjacent waters, part 1: Fungiacyathidae, Micrabaciidae, Turbinoliinae, Guyniidae and Flabellidae. *Smithsonian Contributions to Zoology*, 486: 136 pp., 42 pls.

Cairns, S.D. 1991. A revision of the ahermatypic Scleractinia of the Galápagos and Cocos Islands. *Smithsonian Contributions to Zoology*, 504: 44 pp., 12 pls.

Cairns, S.D. 1994. Scleractinia of the temperate North Pacific. *Smithsonian Contributions to Zoology*, 557: 150 pp., 42 pls.

Cairns, S.D. 1995. The marine fauna of New Zealand: Scleractinia (Cnidaria: Anthozoa). *New Zealand Oceanographic Institute Memoirs*, 103: 210 pp., 44 pls.

Cairns, S.D. 1997. A generic revision and phylogenetic analysis of the Turbinoliidae (Cnidaria: Scleractinia). *Smithsonian Contributions to Zoology*, 591: 55 pp., 10 pls.

Cairns, S.D. 1998. Azooxanthellate Scleractinia (Cnidaria: Anthozoa) of Western Australia. *Records of the Western Australian Museum*, 18: 361–417, 9 pls.

Cairns, S.D. 1999. Cnidaria Anthozoa: Deep-water azooxanthellate Scleractinia from Vanuatu, and Wallis and Futuna Islands. *Mémoires du Muséum National d'Histoire Naturelle*, 180: 31–167, 22 pls.

Cairns, S.D. 2000. A revision of the shallow-water azooxanthellate Scleractinia of the western Atlantic. *Studies on the Natural History of the Caribbean Region*, 75: 1–231.

Cairns, S.D. 2003. A new species of *Sphenotrochus* (Scleractinia: Turbinoliidae) from the Late Miocene (Tortonian) of Chile. *Zoologische Verhandelingen*, 345: 79–84.

Cairns, S.D. 2004. The azooxanthellate Scleractinia (Coelenterata: Anthozoa) of Australia. *Records of the Australian Museum*, 56: 259–329.

Cairns, S.D. and H. Zibrowius. 1997. Cnidaria Anthozoa: Azooxanthellate Scleractinia from the Philippine and Indonesian Regions. *Mémoires du Muséum National d'Histoire Naturelle*, 172: 27–243, 29 pls.

Durham, J.W. and J.L. Barnard. 1952. Stony corals of the Eastern Pacific collected by the Velero III and Velero IV. *Alan Hancock Pacific Expeditions*, 16 (1): 110 pp., 16 pls.

Lamarck, J.B.P.A. de. 1816. Histoire Naturelle des Animaux sans Vertèbres, 2: Les Polypes. 569 pp, Verdiére, Paris.

Milne Edwards, H. and J. Haime. 1848. Recherches sur les Polipiers, mémoir 2: Monographie des Turbinolides. *Annales des Sciences Naturelles*, *Zoologie*, series 3, 9: 211–344, plates 7–10.

Moseley, H.N. 1876. Preliminary report to Professor Wyville Thomson, F.R.S., director of the civilian staff, on the true corals dredged by H.M.S. Challenger in deep water between the dates Dec. 30th, 1870, and August 31st, 1875. *Proceedings of the Royal Society of London*, 24 (170): 544–569.

Moseley, H.N. 1881. Report on certain hydroid, alcyonarian, and madreporarian corals procured during the voyage of H.M.S. Challenger, in the years 1873–1876. *Challenger Reports, Zoology*, 2: 248 pp., 32 pls.

Ogawa, K., H. Tachikawa and K. Takahashi. 2002. A revision of Japanese ahermatypic corals around the coastal region with guide to identification. VIII. Family Turbinoliidae. *Nankiseibutu*, 44 (1): 27–36, 3 pls. (In Japanese)

Vaughan, T.W. and J.W. Wells. 1943. Revision of the suborders, families and genera of the Scleractinia. *Special Papers of the Geological Society of America*, 44: xv + 363 pp, 51 plates.

Wells, J.W. 1956. Scleractinia. *In* R.C. Moore, ed., Treatise on Invertebrate Paleontology, Part F: Coelenterata, pp. F328–F444. Geological Society of America, New York.

Wells, J.W. 1983. Annotated list of the scleractinian corals of the Galápagos. *In*: P.W. Glynn and G.M. Wellington, eds., *Corals and Coral Reefs of the Galápagos Islands*, pp. 212–291, 21 plates. University of California Press, Berkeley.

日本産イシサンゴ類 *Alatotrochus*（フタエツツミサンゴ属：新称）および *Sphenotrochus*（ムギツブサンゴ属：新称）の再検討と一新種の記載（刺胞動物門：花虫綱：イシサンゴ目：ツツミサンゴ科）

立川浩之

共生藻を持たない（無藻性の）イシサンゴ類であるツツミサンゴ科の 2 属 *Alatotrochus* Cairns, 1994 フタエツツミサンゴ属（新称）および *Sphenotrochus* Milne Edwards & Haime, 1848 ムギツブサンゴ属（新称）の日本産の種を再検討した結果，*Alatotrochus* 属に *A. rubescens*（Moseley, 1876）フタエツツミサンゴ（新称）および *A. japonicus* n. sp. ヒメフタエツツミサンゴ（新称）の 2 種が，*Sphenotrochus* 属に *S. hancocki*（Durham and Barnard, 1952）ムギツブサンゴ（新称）1 種が認められた．伊豆諸島・小笠原諸島・薩南諸島の 106–155 m から採集された *A. japonicus* は，九州～琉球列島を含む西部太平洋に分布する本属の唯一の既知種である *A. rubescens* と比べ，小型でより扁平で，莢の長径より高いサンゴ体を持つこと，隔壁数が少ないこと，軸柱の形態が列生した小柱状ではなく葉状であることにより識別される．*A. japonicus* はまたサンゴ体に発達した翼状隆起縁を持つこと以外の形質ではオーストラリアの新生代中新世化石として知られる *Sphenotrochus wellsi* Cairns, 1997 に形態がよく類似している．*S. wellsi* は *Sphenotrochus* 属のうちで肋の数が隔壁数の 2 倍であることで，同じく中新世化石種の *Sphenotrochus trinitatis* Vaughan in Vaughan and Hoffmeister, 1926 と共に特異であり，その属位については今後の検討が必要と考えられる．なお，小川ほか（2002）は *A. rubescens* にミダレツツミサンゴという和名を提唱しているが，彼らの検討標本には *A. rubescens* の他に *A. japonicus* も含まれており，また和名が形態的特徴をよく表していないため，肋数が隔壁数の 2 倍であるという本属の表徴にちなむ和名新称として，*A. rubescens* に対しフタエ（二重）ツツミサンゴを，*A. japonicus* に対しヒメフタエツツミサンゴを提唱する．*Sphenotrochus hancocki* はこれまで東部太平洋および西部太平洋熱帯域から知られていたが，今回伊豆下田沖の水深 112–116 m から採集された．