

Ophiuroids (Echinodermata) Collected from the Oki Islands in the Sea of Japan

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Abstract Ophiuroids were collected by dredging and skin diving from the shallow water of the Oki Islands in the Sea of Japan. They comprise 29 species of 18 genera of 9 families. *Ophiurodon acanthophora* is transferred to *Ophioconis*. *Amphiura kandai*, *Ophionereis thryptica*, and *Ophiocoonis acanthophora* are reported for the first time from the Sea of Japan.

Key words: Ophiuroidea, echinoderm, taxonomy, new combination, new record, Shimane Prefecture, Japan.

Introduction

The Oki Islands are located in the southern part of the Sea of Japan, about 70 km off Honshu, the main land of Japan, and composed of four big islands and about 180 small islands. They are warmed by the Tsushima Current, and the marine fauna includes the animals which are typically more southerly in distribution; for example, reef building corals were found near Matsushima Island (Miyaoaka, 1997; see Figure 1 for its locality) and also off Dougo Island (T. Kato, unpublished data).

Ishida *et al.* (2001) compiled the ophiuroid fauna of the Sea of Japan. However, the ophiuroid fauna of the Oki Islands has been never studied. One of the authors (TK) collected marine animals of the Oki Islands mainly from 1987 to 1995, some of which have been reported on (Kato, 1993, 1998). In this paper, we examine ophiuroid specimens of Kato's collection from the shallow waters of the Oki Islands.

Materials and Methods

Ophiuroid specimens of Kato's collection are from the intertidal zone to up to the depth of about 130 m around south of Dougo Island and in the strait between Dougo Island and Nakano-shima Island (Fig. 1). They were collected using a dredge during cruises of the research vessels *Pagurus* and *Galathea* of the Oki Marine Biological Station of Shimane University mainly from 1987 to 1992, and by skin diving from intertidal and shallow subtidal waters. Additional specimens were obtained with fishing gear. Material studied also includes specimens dredged by Takeo Yamauchi in 2002. Ophiuroids were fixed in 5% seawater formalin or alcohol and preserved in 80% alcohol, although a few specimens were dried for observation. Photographs were taken of preserved specimens. The specimens are deposited in the National Science Museum, Tokyo (NSMT).

In the Taxonomic Account section, families are arranged according to Smith *et al.* (1995). The Japanese name, important synonymy, materi-

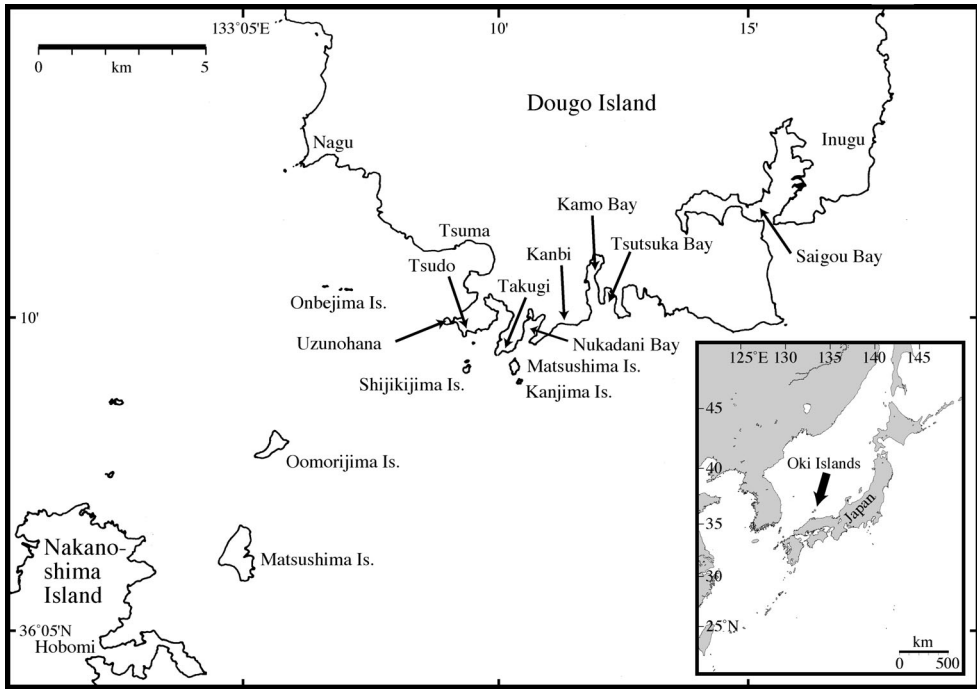


Fig. 1. Sampling localities at the Oki Islands in the Sea of Japan.

al examined, remarks, and geographic distribution are given for each species. Matsumoto (1917) and Irimura (1982) discuss the taxonomical determination of many species found in this study. In Material examined, for each locality, water depth, bottom nature, and specimen registration number are shown if available. Abbreviations for bottom sediment characteristics appearing in parentheses are as follows: G, gravel; M, mud; R, rock; S, sand; Sh, shell.

Taxonomic Account

A total of 860 specimens determined in this study comprise 29 species of 18 genera of 9 families.

Order Euryalida

Family Gorgonocephalidae

Astrocladus coniferus (Döderlein, 1902)

[Japanese name: Seno-tedurumoduru]

Astrophyton coniferum Döderlein, 1902: 325–326.

Astrocladus coniferus: Matsumoto, 1917: 77–79, fig. 23.

Astrocladus dofleini Döderlein, 1910: 256; 1911: 41–46, pl. 2 fig. 6, pl. 4 fig. 4–5, pl. 7 fig. 15–15b; 1927: 35–36, pl. 3 fig. 2–2a.

Material examined. Off Takugi; 120–130 m (R, G), 2 specimens (NSMT E-4793).

Remarks. The specimens have many tubercles on disk and arms. *Astrocladus dofleini* Döderlein, 1910 was distinguished from *A. coniferus* by having tubercles (Döderlein, 1911), but later was synonymized with *A. coniferus* because many intermediate forms were found in Japanese waters (Matsumoto, 1917; Fujita & Kohtsuka, 2003). This is only species of Order Euryalida in the present study, but several other euryalid species have been reported from the Sea of Japan (Ishida *et al.*, 2001) and are probably distributed in the study area.

Geographic range. This species is distributed from the Sea of Japan to the Philippines, and also in India. Widely distributed in the Sea of Japan (see Ishida *et al.*, 2001; present study). Korea (Rho & Shin, 1987; Yi & Irimura, 1987). Pacific

coast of Japan (see Irimura, 1982) from Boso Peninsula (Irimura, 2000) to Tanegashima Strait (H. L. Clark, 1911: 293, *Astrophyton cornutum*), the Ogasawara Islands (Murakami, 1944), and the Yaeyama Islands (Murakami, 1944). Philippines (Döderlein, 1927; Guille, 1981). India (Bomford, 1913). The type locality is Kagoshima Bay, Japan (Döderlein, 1902).

Order Ophiurida

Family Ophiacanthidae

Ophiacantha aff. *prionota* H. L. Clark, 1911

(Fig. 2)

Ophiacantha prionota H. L. Clark, 1911: 213–215, fig. 99.

Material examined. Off Onbejima Island; 71 m, 1 specimen (NSMT E-4794). Locality no data; 1 specimen (NSMT E-4795).

Remarks. One specimen (NSMT E-4795) has 5 arms, and another one (NSMT E-4794) has 6 arms. These specimens resemble *Ophiacantha prionota*, which has been so far reported from Tanegashima Island, Japan (type locality; H. L. Clark, 1911); however, the shape of dorsal and ventral arm plates differs from those of *O. prionota*. The dorsal arm plates are triangular, wider than long, and widely separated by lateral arm plates (Fig. 2C, K). The ventral arm plates are hexagonal with rounded distal margin, and separated by lateral arm plates (Fig. 2E, M). The dorsal surface of disk has spines and granules on thin scales (Fig. 2B, J). There are three oral papillae on each side of the jaw (Fig. 2D, L). The tentacle pores sometimes have two scales at arm base (Fig. 2G), but generally there is only one, large, leaf-like thin scale (Fig. 2H, O). The arm spines (Fig. 2F, N) are serrated and the uppermost one is usually the longest. Maximum number of arm spines is six.

Family Ophiuridae

Ophiura kinbergi (Ljungman, 1867)

[Japanese name: Kushinoha-kumohitode]

Material examined. Off Hobomi; 65 m, 1

specimen (NSMT E-4811). Between Oomorijima Island and Shijikijima Island; 58 m, 1 specimen (NSMT E-4797); 58 m, 12 specimens (NSMT E-4798). Off Onbejima Island; 50 m, 6 specimens (NSMT E-4813); 52 m, 2 specimens (NSMT E-4799); 67 m (S, Sh), 9 specimens (NSMT E-4804). East of Onbejima Island; 54 m, 48 specimens (NSMT E-4803); 60 m (Sh), 24 specimens (NSMT E-4806). Off Tsuma; 50 m, 5 specimens (NSMT E-4802). Off Uzunohana; 50 m (R, G, S), 9 specimens (NSMT E-4796). South-south-east of Tsudo; 62–65 m (G), 6 specimens (NSMT E-4807). Off Shijikijima Island; 36°9'N, 133°14'E, 20–30 m (G, R), 2 specimens (NSMT E-4999); 60 m (R), 5 specimens (NSMT E-4801). East of Shijikijima Island; 15 m (G), 1 specimen (NSMT E-4809). Between Matsushima Island and Kanjima Island; 16–18 m (Sh), 2 specimens (NSMT E-4810). Off Kanbi; 38 m, 5 specimens (NSMT E-4805). Kamo Bay; 17 m, 5 specimens (NSMT E-4819); 37 m, 4 specimens (NSMT E-4800); 38 m, 6 specimens (NSMT E-4818); 53 m, 10 specimens (NSMT E-4815). At the mouth of Kamo Bay; 1 specimen (NSMT E-4812). Off Kamo Bay; 43 m, 1 specimen (NSMT E-4816). Saigou Bay; (M), 2 specimens (NSMT E-4808). South of Dougo Island (no detailed locality data); 1 specimen (NSMT E-4817); 9 specimens (NSMT E-4814).

Geographical range. This species is distributed in the Sea of Japan and widely in Indo-West Pacific (see A. M. Clark & Rowe, 1971). It is a common species in the Sea of Japan (see Irimura, 1982; Ishida *et al.*, 2001; Fujita & Kohtsuka, 2003; present study). The type locality is Sidney, Australia (Ljungman, 1867).

Stegophiura sladeni (Duncan, 1879)

[Japanese name: Aka-hako-kumohitode]

Material examined. At mouth of Nukadani Bay; 57 m (S), 6 specimens (NSMT E-4820); 57 m (S), 1 specimen (NSMT E-4821). South of Dougo Island (no detailed locality data); 2 specimens (NSMT E-4822); 5 specimens (NSMT E-4823); 2 specimens (NSMT E-4824).

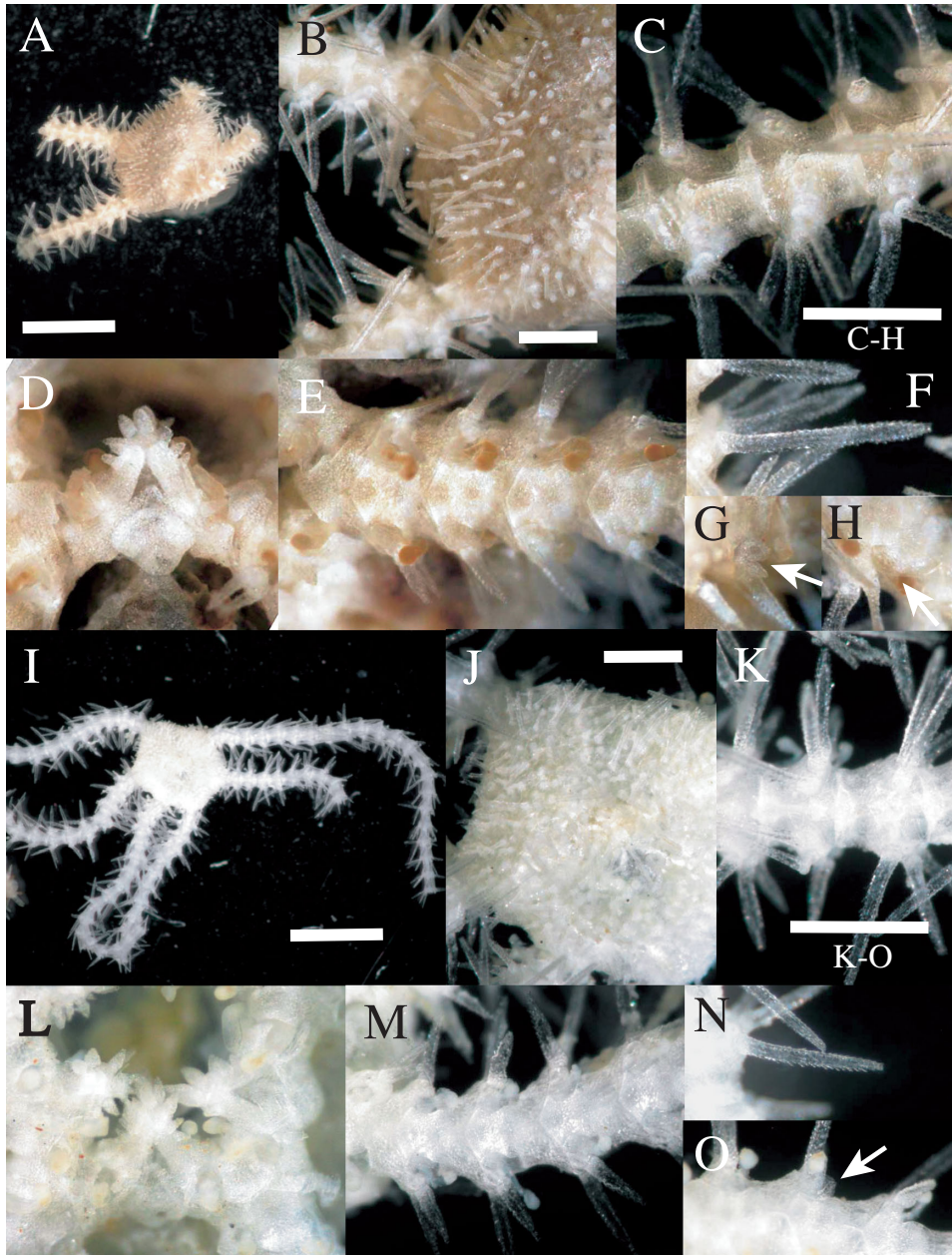


Fig. 2. *Ophiacantha* aff. *prionota*. A–H: NSMT E-4795 (disk diameter 2.6 mm). I–O: NSMT E-4794 (disk diameter 2.1 mm). A: Disk and arms, aboral view. B: Disk spines and granules, aboral view. C: Arm base, aboral view. D: Jaw. E: Arm base, oral view. F: Arm spines near arm base. G–H: Tentacle scales (arrows). I: Disk and arms, aboral view. J: Disk spines and granules, aboral view. K: Basal arm, aboral view. L: Mouth frame. M: Basal arm, oral view. N: Arm spines near arm base. O: Tentacle scales (arrow). A–O: Alcohol specimen. Scales 2 mm (A, I), 0.5 mm (B–H, J–O).

Remarks. Two species of *Stegophiura* were found in this study. *Stegophiura sladeni* was easily distinguished from *S. vivipara* by its dimorphic arm spines (Matsumoto, 1917).

Geographic range. This species is distributed in Korea and Japan. Widely distributed in the Sea of Japan (see Ishida *et al.*, 2001; present study). Korea, the Yellow Sea (Yi & Irimura, 1987). Japan, Hakodate (Koehler, 1922), Kinkasan (Matsumoto, 1918), Boso Peninsula (Irimura, 2000), Sagami Sea (Matsumoto, 1917; Irimura, 1982), Suruga Bay (Fujita *et al.*, 1997), Kii Peninsula (Murakami, 1963; Irimura, 1981), Tosa Bay (Irimura, 1990), Kagoshima Bay (H. L. Clark, 1911 as *Ophiura stiphra*), East China Sea (Irimura & Kubodera, 1998). The type locality is Korea (Duncan, 1879).

***Stegophiura vivipara* Matsumoto, 1915**

[Japanese name: Komochi-kumohitode]

Material examined. Off Hobomi; 18 m (S), 1 specimen (NSMT E-4833). Off Onbejima Island; 50 m, 3 specimens (NSMT E-4834); 52 m, 1 specimen (NSMT E-4839); 52 m, 2 specimens (NSMT E-4825); 60 m (S, Sh), 1 specimen (NSMT E-4830); 67 m (S, Sh), 3 specimens (NSMT E-4831); 67 m, 3 specimens (NSMT E-4838). East of Onbejima Island; 54 m, 15 specimens (NSMT E-4829). Off Tsuma; 50 m, 1 specimen (NSMT E-4827); 50 m, 4 specimens (NSMT E-4828). Off Tsudo; 62 m, 2 specimens (NSMT E-4840). Off Shijikijima Island; 60 m (R), 1 specimen (NSMT E-4826). At mouth of Nukadani Bay; 57 m (S), 1 specimen (NSMT E-4832). Kamo Bay; 53 m, 9 specimens (NSMT E-4836). South of Dougo Island (no detailed locality data); 36 specimens (NSMT E-4835); 4 specimens (NSMT E-4837).

Remarks. Matsumoto (1917) reported the brooding habit of this species.

Geographic range. This species is distributed in Korea and Japan. Korea, the Yellow Sea (Yi & Irimura, 1987). The Sea of Japan, Sado (Kogure, 1999), Tsushima Strait (Ishida *et al.*, 2001), the Oki Islands (present study). Pacific coast of

Japan, Boso Peninsula (Irimura, 2000), Sagami Sea (type locality, Matsumoto, 1915, 1917; Murakami, 1942; Irimura, 1982), Suruga Bay (Fujita *et al.*, 1997), the Ogasawara Islands (Irimura & Tachikawa, 2003).

***Ophiochalcis aspera* Koehler, 1931**

[Japanese name: Samehada-mame-kumohitode]

Material examined. At mouth of Nukadani Bay; 57 m (S), 2 specimens (NSMT E-4841). Kamo Bay; 53 m, 1 specimen (NSMT E-4842).

Geographic range. This species is distributed in Japan and Indonesia. The Sea of Japan, Tsushima Strait (Ishida *et al.*, 2001), the Oki Islands (present study). Pacific coast of Japan, Boso Peninsula (Irimura, 2000), Suruga Bay (Fujita *et al.*, 1997). Indonesia, Ambon (type locality, Koehler, 1931).

Family Amphiuridae

Amphioplus (Amphioplus) asterictus

H. L. Clark, 1915

[Japanese name: Chûrippu-kumohitode]

Amphioplus asterictus H. L. Clark, 1915a: 252, pl. 7 fig. 9–11; Murakami, 1963: 174–175.

Amphioplus diacritus Murakami, 1943c: 225–227, fig. 1.

Material examined. Kamo Bay; 19 m, 1 specimen (NSMT E-4843). Saigou Bay; (M), 28 specimens (NSMT E-4844).

Remarks. Particularly in larger specimens ventral arm plates within the disk have two lateral lobes and one medial lobe at the distal margin. *Amphioplus asterictus* seems to be characterized by tulip-shaped ventral arm plates like those of *Amphioplus diacritus* Murakami, 1943 (see Murakami, 1943c: fig. 1), which was synonymized with *A. asterictus* by Murakami (1963). The ventral arm plate of the holotype of *A. asterictus* (A. M. Clark, 1965: fig. 5) lacks a distinctly tulip-like shape probably due to its small size (disk diameter 8 mm).

Geographic range. This species is distributed in Korea and Japan. Korea, the Yellow Sea (Yi & Irimura, 1987). The Sea of Japan, Notojima Is-

land (Fujita & Kohtsuka, 2003), the Oki islands (present study). Pacific coast of Japan, Tokyo Bay (type locality, H. L. Clark, 1915a), Sagami Bay (A. M. Clark, 1965), Kii Peninsula (Murakami, 1943c; 1963).

Amphioplus (Lymanella) megapomus

H. L. Clark, 1911

[Japanese name: Miyadi-kumohitode]

Amphioplus megapomus H. L. Clark, 1911: 170–171; Irimura, 1981: 25, fig. 2.

Amphioplus miyadai Murakami, 1943c: 227–229, fig. 2.

?*Amphiura laevis* Lyman, 1874: 229, pl. 4 fig. 18–21.

?*Amphioplus (Lymanella) laevis*: A. M. Clark, 1970: 52, 53, 75.

Material examined. Kamo Bay; 10 m (M), 5 specimens (NSMT E-4845).

Remarks. The specimens agree well with the description of *Amphioplus miyadai* by Murakami (1943c). A. M. Clark (1970) suggested that *A. miyadai* may be synonymous with *Amphioplus laevis* (Lyman, 1874), but Irimura (1981) indicated that *A. miyadai* is a junior synonym of *A. megapomus* H. L. Clark, 1911. A. M. Clark (1970) also suggested that *A. megapomus* is synonymous either with *A. laevis* or with *Amphioplus andreae* (Lütken, 1872), so both *A. megapomus* and *A. miyadai* may be possibly a synonym of *A. laevis* though further studies are required to clarify the synonymy.

Geographic range. This species is distributed in Korea and Japan. Korea, the Yellow Sea (Yi & Irimura, 1987). The Sea of Japan, Hakata Bay (Murakami, 1943c), the Oki Islands (present study). Pacific coast of Japan, Kii-suido Channel (type locality, H. L. Clark, 1911), Kii Peninsula (Murakami, 1943c; Irimura, 1981), Beppu Bay (Murakami, 1943c).

Amphipholis squamata (Delle Chiaje, 1829)

[Japanese name: Iso-komochi-kumohitode]

Material examined. Off Onbejima Island; 52 m, 1 specimen (NSMT E-4846); 71 m, 1 specimen (NSMT E-4847). Off Shijikijima Island;

65 m (G), 2 specimens (NSMT E-4848). East of Shijikijima Island; 15 m (G), 1 specimen (NSMT E-4849). Kamo Bay; subtidal, 1 specimen (NSMT E-4850).

Remarks. See A. M. Clark (1987) for the nomenclature of this species. Dupont (2002) discussed the possibility of sibling species.

Geographic range. This species is widely distributed in warm and temperate areas in the world, and has been recorded mainly from intertidal but from depths up to 1200 m (Paterson, 1985). It is widely distributed in the Sea of Japan (see Irimura, 1982; Ishida *et al.*, 2001; present study).

Amphipholis kochii Lütken, 1872

[Japanese name: Suna-kumohitode]

Material examined. Kamo Bay; subtidal, 2 specimens (NSMT E-4851); subtidal 3 specimens (NSMT E-4852).

Geographic ranges. This species is distributed in the Sea of Japan and coastal waters of Japan. The Sea of Japan; Russia, Peter the Great Bay, Tatar Strait (Djakonov, 1954); Korea, East Sea (Shin & Rho, 1996); Japan, Sado (Irimura, 1979), Notojima Island (Fujita & Kohtsuka, 2003), the Oki Islands (present study). Japan, Mutsu Bay (Matsumoto, 1917, 1941), Misaki (Matsumoto, 1917), Izu (Murakami, 1942), Amakusa (Murakami, 1944; Irimura, 1969). The type locality is probably the Sea of Japan (“eastern Manchow” by Lütken, 1872).

Amphiura kandai Murakami, 1942

[Japanese name: Hakkou-kumohitode]

(Fig. 3)

Amphiura kandai Murakami, 1942: 11–12, fig. 3; Irimura *et al.*, 2001: 313, 314.

Material examined. Off Onbejima Island; 67 m, 1 specimen (NSMT E-4853).

Remarks. Disk diameter is 2.1 mm. Arms are six in number, 11.3 mm in length. Disk is circular and covered with many coarse, thin, imbricating scales without any granules or spines (Fig. 3A).

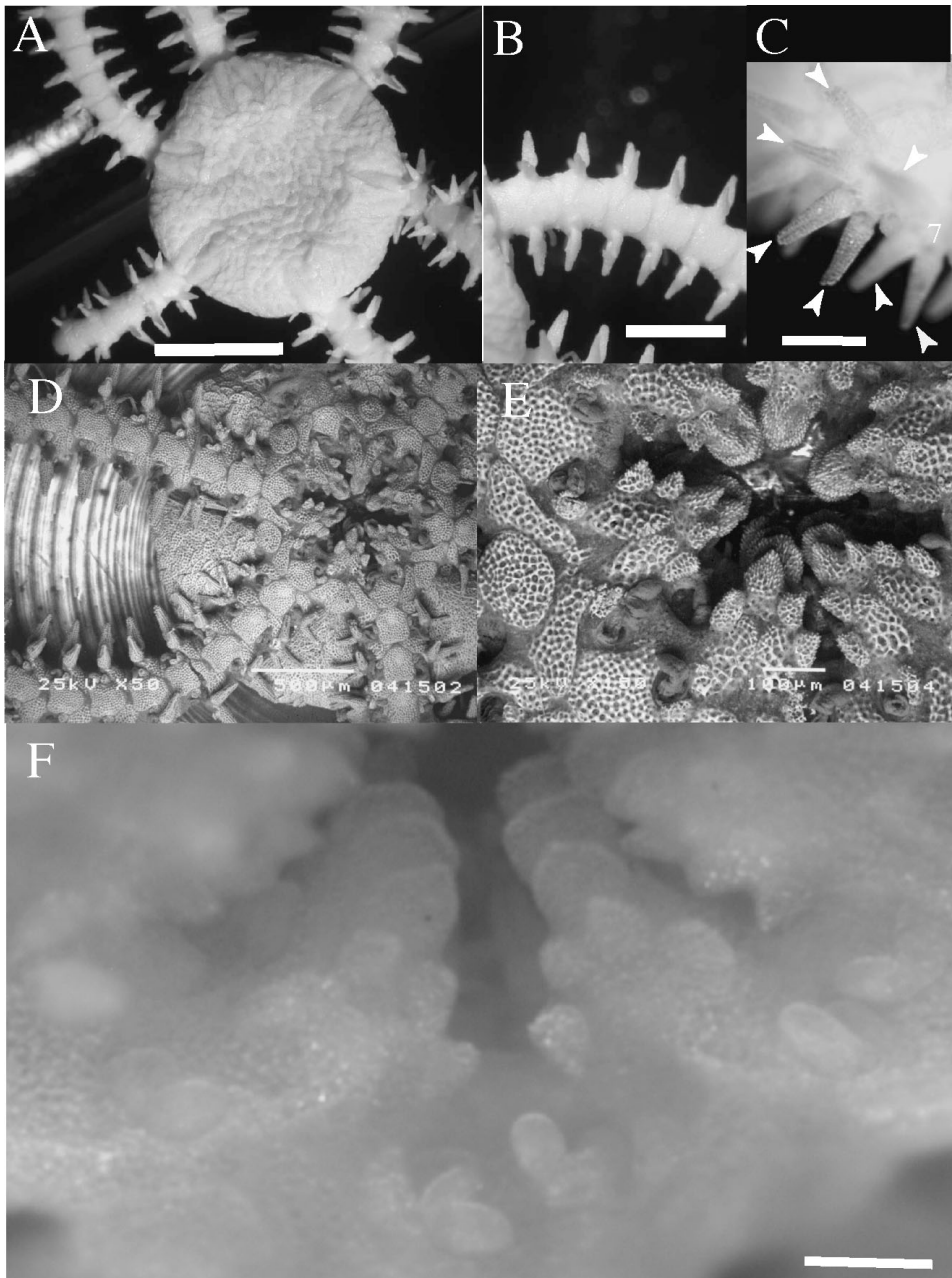


Fig. 3. *Amphiura kandai*. NSMT E-4853 (disk diameter 2.1 mm). A: Disk, aboral view. B: Arm base, aboral view. C: Arm spines (arrows) at 6th and 7th arm segments (corresponding 3rd and 4th free arm segments). Aboral side upward. D: Disk and basal arm, oral view. E: Mouth frame. F: Jaws and teeth, obliquely oral view. A–B: Dry specimen, C, F: Alcohol specimen, D–E: SEM specimen. Scales 1 mm (A), 0.5 mm (B, D), 0.2 mm (C), 0.1 mm (E–F).

Primary plates are indistinguishable. Radial shields are more than twice as long as broad, separated from each other by a few intervening scales except at their distal edge. Oral interradius is covered with scales similar to aboral ones (Fig. 3D). Oral shields are almost circular or rhomboidal with rounded angles, about as long as broad. Adoral plates are in contact or with a small gap radially. Oral plates are small, and in their distal part separated radially. There are two or three oral papillae on each side of the oral plate (Fig. 3D–F). The oral-most teeth are pentagonal with rather pointed edge; two other teeth are rectangular with rounded edges (Fig. 3E–F). Tentacle scale of oral tentacle pores is single and rounded, on proximal edge of adoral plate (Fig. 3D–E). Dorsal arm plates are transversely oval or somewhat triangular with rounded angles, much wider than long, not in contact with each other (Fig. 3B). First ventral arm plates are fan-shaped, slightly longer than broad. Following plates are pentagonal, longer than broad, with acute proximal angle, separated from each other by a narrow interval except first a few plates (Fig. 3D). Lateral arm plates meet on both aboral and oral sides. Arm spines are four on proximal 2–4 free arm segments, and three on more distal segments. They are conical, subequal, and similar in length to the corresponding arm joint (Fig. 3C). Tentacle scales are two to each pore, but one in distal part of arm (Fig. 3D). Color of specimen in alcohol is almost whitish, and light greenish yellow color within body can be seen through dorsal disc scales.

Some deviations from Murakami's (1942) description are recognized. He described the radial shields as completely separated, and the oral shields as rhomboidal or triangular. He mentioned that the species has 'very peculiar mouth parts'. There are no distinct paired infradental papillae in the present specimen, and that seems different from normal mouth structure of *Amphiura* species. Therefore, further studies are required to evaluate the systematic position of this species.

Two small specimens (disk diameter 1.1–1.5

mm) of *Amphiura kandai* were collected from Shimoda (see Irimura *et al.*, 2001), and one of them has three thick arms and three thin arms (T. Fujita, unpublished data), which indicates that the species may be fissiparous although Murakami (1942) did not comment on that. *Amphiura velox* Koehler, 1910 with a junior synonym of *Amphiura sexradiata* Koehler, 1931 is the only other 6-armed fissiparous *Amphiura* species (Devaney, 1974). *Amphiura kandai* is luminous (see Murakami, 1942), and its luminous cells have been studied histologically (Kato, 1947; Okada & Kato, 1950).

Geographic range. This species was previously known only from Shimoda, Izu, Pacific coast of Japan (type locality, Murakami, 1942; Irimura *et al.*, 2001). This is the first record from the Sea of Japan.

***Amphiura (Amphiura) luetkeni* Duncan, 1879**

[New Japanese name: Rutsuken-suna-kumohitode]

(Fig. 4)

Material examined. Off Onbejima Island; 67 m, 1 specimen (NSMT E-4868); 67 m (S, Sh), 2 specimens (NSMT E-4863); 71 m, 2 specimens (NSMT E-4859). East of Onbejima Island; 54 m, 1 specimen (NSMT E-4858). Off Tsudo; 62 m, 1 specimen (NSMT E-4869). South-southeast of Tsudo; 62–65 m (G), 3 specimens (NSMT E-4865). Off Shijikijima Island; 36°9'N, 133°14'E, 20–30 m (G, R), 3 specimens (NSMT E-5004); 56 m, 1 specimen (NSMT E-4854); 60 m (R), 1 specimen (NSMT E-4855); 60 m (R), 3 specimens (NSMT E-4856); 60 m (R), 2 specimens (NSMT E-4857); 65 m (G), 15 specimens (NSMT E-4860); 65 m (G), 2 specimens (NSMT E-4998); 65 m (G), 1 specimen (NSMT E-4861); 65 m (G), 1 specimen (NSMT E-4862). East of Shijikijima Island; 15 m (G), 1 specimen (NSMT E-4866). Off Kanbi; 38 m, 1 specimen (NSMT E-4864). South of Dougo Island (no detailed locality data); 1 specimen (NSMT E-4867).

Remarks. This species is distinguished from the closely related and co-occurring species *Amphiura micraspis* by the form of arm spines. The

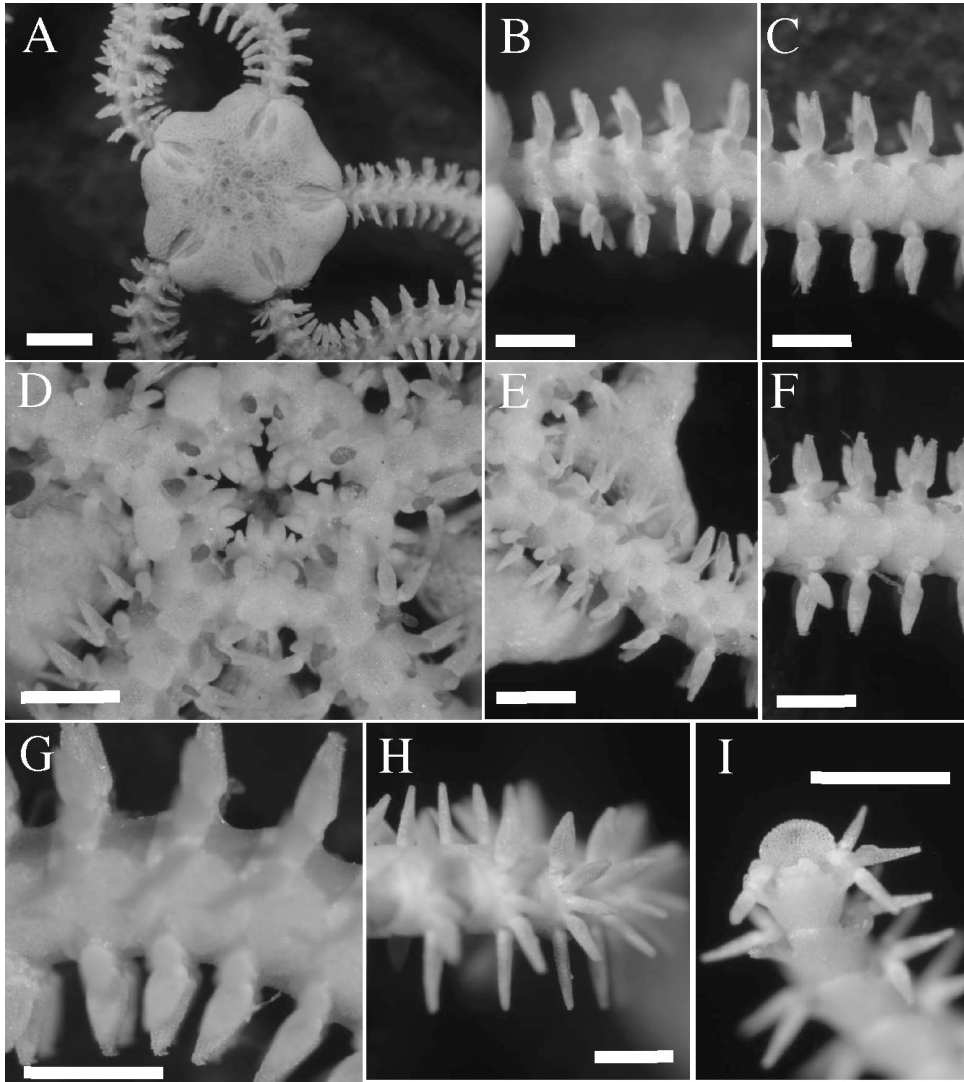


Fig. 4. *Amphiura (Amphiura) luetkeni*. NSMT E-4998 (disk diameter 3.2 mm). A: Disk, aboral view. B: Basal arm, aboral view. C: Middle arm, aboral view. D: Mouth frame. E: Arm base, oral view. F: Middle arm, oral view. G: Arm spines, basal arm, proximal side right. H: Arm spines, middle arm, obliquely distal view. I: Arm spines, distal arm, ventro-distal view. A–I: Dry specimen. Scales 1 mm (A), 0.5 mm (B–I).

oral-most arm spine is not conspicuously longer but rather wider than the others in *A. luetkeni* (Fig. 4H–I), while that of *A. micraspis* is very long (Fig. 5G–I).

Geographic range. This species is distributed in the Sea of Japan and Indo-West Pacific. Korea (type locality, Duncan, 1879). The Sea of Japan, the Oki Islands (present study). Japan, Amakusa (Murakami, 1944); Nagasaki (A. M. Clark &

Rowe, 1971: pl. 13 fig. 6–7). The Philippines, Sulu Sea (Koehler, 1905). Indonesia, Ambon (de Loriol, 1893 as *Amphiura duncani*), Banda Sea, Java Sea, the Sangihe Islands (Koehler, 1905). New Caledonia (Guille *et al.*, 1986); Ceylon (H. L. Clark, 1915b).

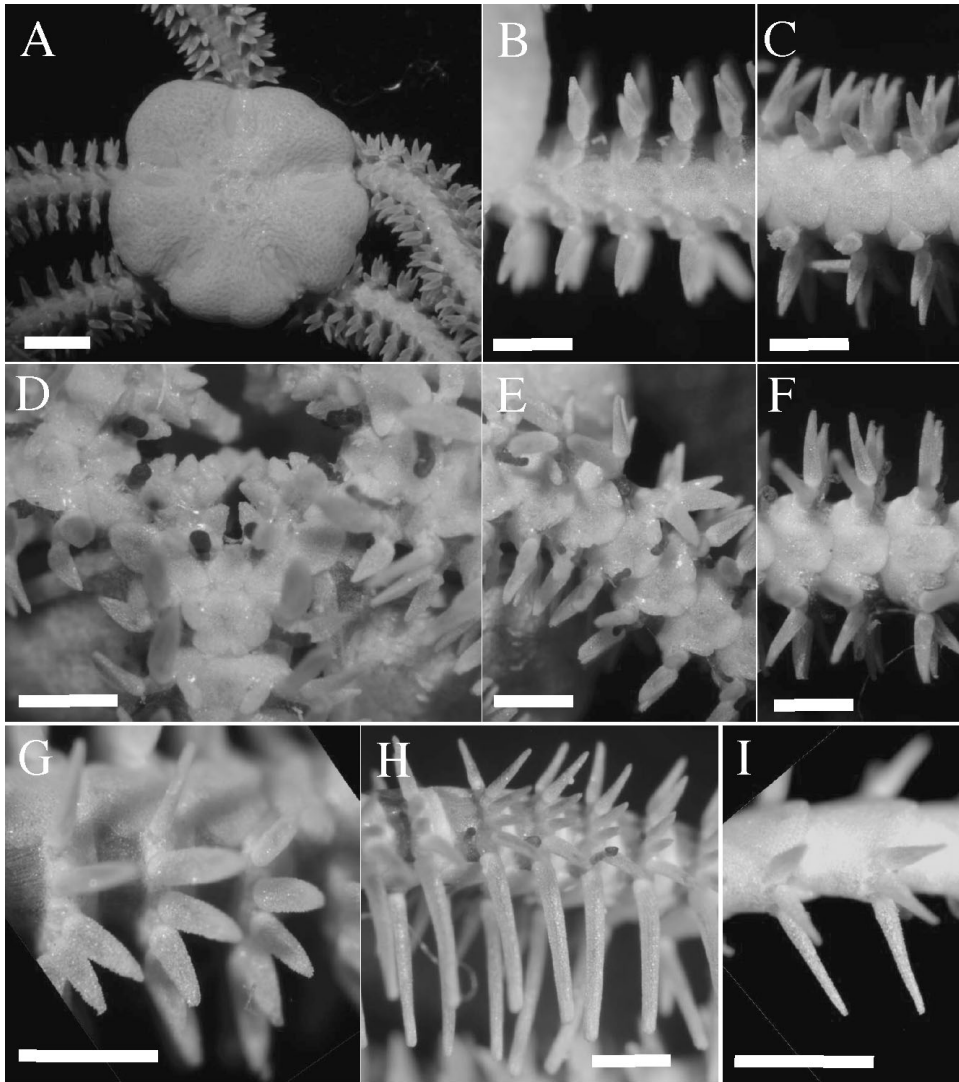


Fig. 5. *Amphiura (Amphiura) micraspis*. NSMT E-4997 (disk diameter 3.7 mm). A: Disk, aboral view. B: Basal arm, aboral view. C: Middle arm, aboral view. D: Mouth frame. E: Basal arm, oral view. F: Middle arm, oral view. G: Arm spines, basal arm, proximal side right. H: Arm spines, middle arm, proximal side right. I: Arm spines, distal arm, proximal side left. A–I: Dry specimen. Scales 1 mm (A), 0.5 mm (B–I).

Amphiura (Amphiura) micraspis

H. L. Clark, 1911

[Japanese name: Chibitate-suna-kumohitode]

(Fig. 5)

Material examined. Off Onbejima Island; 60 m (S, Sh), 1 specimen (NSMT E-4878); 71 m, 1 specimen (NSMT E-4874); 71 m, 7 specimens (NSMT E-4875); 71 m, 1 specimen (NSMT E-

4876); 67 m, 2 specimens (NSMT E-4881). East of Onbejima Island; 54 m, 3 specimens (NSMT E-4873). Shijikijima Island; subtidal, 1 specimen (NSMT E-4882). Off Shijikijima Island; 56 m, 2 specimens (NSMT E-4871); 60 m (R), 27 specimens (NSMT E-4872); 65 m (G), 28 specimens (NSMT E-4877); 65 m (G), 2 specimens (NSMT E-4997); 65 m (G), 15 specimens (NSMT E-4879). South-southeast of Tsudo; 62–65 m (G), 9

specimens (NSMT E-4880). Tsutsuka Bay; subtidal, 1 specimen (NSMT E-4870).

Remarks. See above for the comparison of this species with *Amphiura luetkeni*.

Geographic range. This species is distributed in Korea and Japan. Korea (Yi, 1983). The Sea of Japan, the Oki Islands (present study). Pacific coast of Japan, Boso Peninsula (Irimura, 2000), Suruga Bay (Fujita *et al.*, 1997), Omaizaki (type locality, H. L. Clark, 1911), Amakusa (Irimura, 1969).

Ophiocentrus koehleri Gislén, 1926

[Japanese name: Igaguri-kumohitode]

(Fig. 6)

Ophiocentrus verticillatus: Matsumoto, 1917: 213–214, fig. 59; Murakami, 1942: 20; Irimura, 1969: 42–43 (non *Ophiocnida verticillata* Döderlein, 1896).

Ophiocentrus aculeatus: Koehler, 1922: 196–199, pl. 71 fig. 1–3, pl. 96 fig. 8 (non *Ophiocentrus aculeatus* Ljungman, 1867)

Ophiocentrus koehleri Gislén, 1926:13; Koehler, 1931: 119; Guille and Wolff, 1984: 14–15, pl. 2 fig. A–B; Liao & A. M. Clark, 1995: 204–205, fig. 100; Irimura, 2000: 403, fig. 23–46; Ishida *et al.*, 2001: 4.

Material examined. Off Onbejima Island; 45 m, 1 specimen (NSMT E-4883). Off Shijikijima Island; 65 m (G), 1 specimen (NSMT E-4884).

Remarks. Matsumoto (1917) reported two specimens of *Ophiocentrus verticillatus* (Döderlein, 1896) from Sagami Bay, Japan. Gislén (1926) considered Matsumoto's specimens not as *O. verticillatus* but as *Ophiocentrus vexator* described by Koehler (1922) from the Philippines based on the arm spines with thorny end. But later workers (Murakami, 1942; Irimura, 1969) used *O. verticillatus* for Japanese specimens according to Matsumoto (1917). Gislén (1926) established another species *Ophiocentrus koehleri* for the specimen reported as *Ophiocentrus aculeatus* Ljungman, 1866 by Koehler (1922) from Hong Kong, characterized by naked disk except around radial shields, and, recently, Guille and Wolff (1984) recognized Matsumoto's (1917) *O. verticillatus* as *Ophiocentrus koehleri*. Irimura

(2000) and Ishida *et al.* (2001) adopted Guille and Wolff's (1984) view and determined Japanese *Ophiocentrus* specimens as *O. koehleri*.

The present specimens have no completely naked area and disk scales covers the whole disk. The larger specimen (NSMT E-4883, disk diameter 11.6 mm) has relatively large, thick scales around radial shields which form brighter-color area than the other part of disk where there are small and thin scales in the skin (Fig. 6A). The smaller specimen (NSMT E-4884, disk diameter 2.9 mm) has uniform scaling and shows no large difference in size of scales between around radial shield and the other part of disk (Fig. 6D). Two other NSMT specimens collected from Misaki (NSMT E-1683) and Enoshima (NSMT E-1258), the same locality as Matsumoto's (1917) specimens, were also examined. In the large specimen (NSMT E-1258, disk diameter 16.6 mm), relatively large scales are clearly seen from the surface around radial shields while at the other part of disk small scales are buried in the skin and only spine-supporting scales are visible outside of the skin (Fig. 6H). The smaller one (NSMT E-1683, disk diameter 7.3 mm) has uniform disk scales (Fig. 6I) similar to the smaller Oki specimen (NSMT E-4884). Thus, Japanese specimens seem to have more or less scales on whole disk but smaller scales tend to bury in the skin at center and interradius like as reported by Guille and Wolff (1984). There is a contrastive difference in scaling, at least in large-sized specimens, between around radial shields and at the other part of disk, and this is enough to assign the specimens from the Oki Islands as well as Matsumoto's (1917) and NSMT specimens from Sagami Bay to *O. koehleri* distinguished from *O. vexator* and *O. verticillatus*. In addition, the disk spines of *O. vexator* (Koehler, 1922: pl. 62 fig. 1, 4–5; Guille & Wolff, 1984: pl. 2 fig. C–D) and *O. verticillatus* (Döderlein, 1896: pl. 15 fig. 7–7a) seem to be longer and thinner, and more dense than those of *O. koehleri* (Fig. 6; Guille & Wolff, 1984: pl. 2 fig. A–B). Most of the disk scales bear no spine in the Japanese *O. koehleri* specimens, while the almost all disk scales have spines

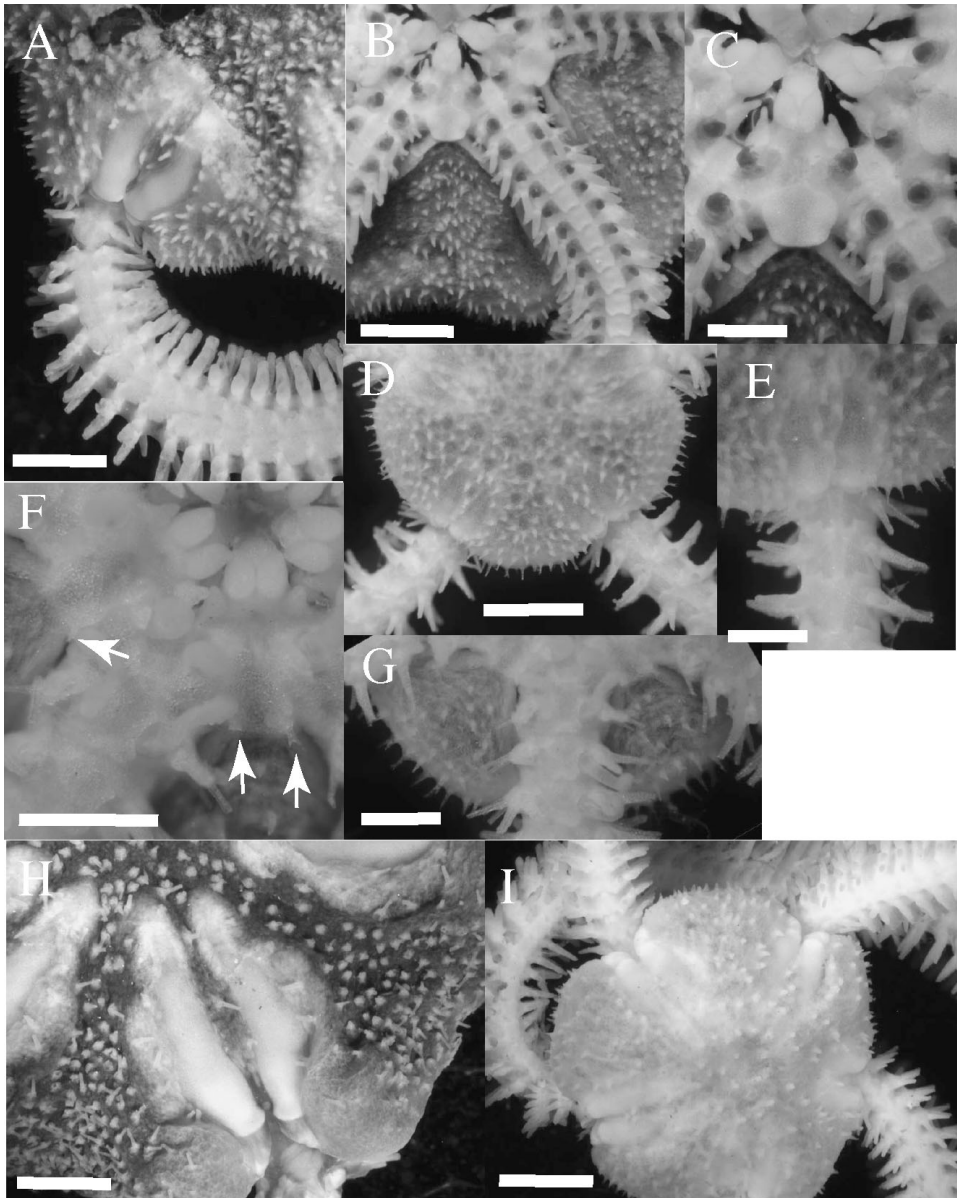


Fig. 6. *Ophiocentrus koehleri*. A–C: NSMT E-4883 (disk diameter 11.6 mm). D–G: NSMT E-4884 (disk diameter 2.9 mm). H: NSMT E-1258 (disk diameter 16.6 mm). I: NSMT E-1683 (disk diameter 7.3 mm). A: Disk and basal arm, aboral view. B: Disk, oral view. C: Jaw. D: Disk, aboral view. E: Radial shield and basal arm. F: Jaw. Spinelets on oral shields shown by arrows. G: Oral interradial. H: A part of disk, aboral view. I: Disk and basal arm, aboral view. A–G: Alcohol specimen. Scales 2 mm (A–B, H–I), 1 mm (C–D), 0.5 mm (E–G).

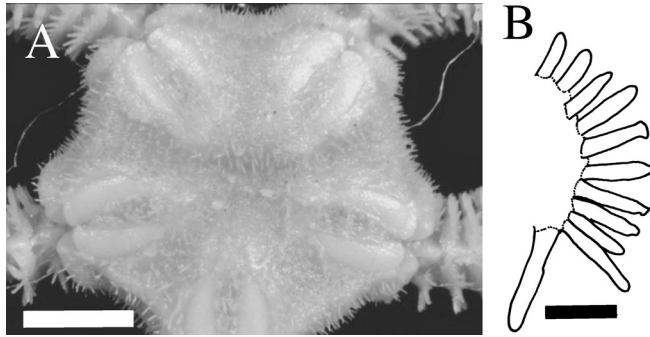


Fig. 7. *Ophiocentrus verticillatus*. Holotype (disk diameter 7.5 mm). Ambon, Indonesia. Musée Zoologique Strasbourg. A: Disk, aboral view. B: Arm spines of 15th arm segment. Scales 2 mm (A), 0.5 mm (B).

in the holotype of *Ophiocentrus verticillatus* (Fig. 7A, Musée Zoologique Strasbourg, disk diameter 7.5 mm). The disk spines of the present specimens are mostly acute, but sometimes with two or more terminals on their tip.

Guille and Wolff (1984) reported that the characteristics of arm spines are very similar between *O. koehleri* and *O. vexator*. The maximum number of arm spines of the specimens from the Oki Islands varies from 7 to 10. They are usually more or less flat, rarely cylindrical, with usually thorny and sometimes blunt tips, and their length is subequal or the lower most one is sometimes longer than the others. Matsumoto (1917) reported that arm spines of his specimens with thorny end are different from flat lancet-form arm spines of *O. verticillatus* (Döderlein, 1896: 287, pl. 14 fig. 2b), though, in fact, some of the arm spines are a little thorny at the end (Fig. 7B). Koehler (1922) also described *O. vexator* which is very close to *O. verticillatus* but distinguished from it by the arm spines. Guille and Wolff (1984) indicated that *O. verticillatus* is rather easily distinguished from *O. vexator* by the characteristics of arm spines and that further detailed studies may need to compare *O. aculeatus* and *O. koehleri* with *O. vexator*, but *O. verticillatus* should be also compared together with them because of variation of the arm spines.

We should suggest one additional character of *O. koehleri* which has not been mentioned in previous works. The oral shields of the smaller spec-

imens have a characteristic pair of spinelets at both sides of the distal edge (Fig. 6F).

Geographic range. This species is distributed in Japan, China and Indonesia. The Sea of Japan, Tsushima Strait (Ishida *et al.*, 2001), the Oki Islands (present study). Japan, Boso Peninsula (Irimura, 2000), Sagami Bay, Enoshima and Misaki (Matsumoto, 1917), Izu (Murakami, 1942), Amakusa (Irimura, 1969), the Ogasawara Islands (Irimura & Tachikawa, 2003). China, Hong Kong (type locality; Koehler, 1922; Gislén, 1926; Liao & A. M. Clark, 1995), Gulf of Tonkin (Liao & A. M. Clark, 1995). Indonesia, Kei (Koehler, 1931), Timor (Guille & Wolff, 1984).

Family Ophiotrichidae

Ophiogymna fulgens (Koehler, 1905)

[Japanese name: Toge-tosaka-kumohitode]

Material examined. Off Shijikijima Island; 65 m (G), 1 specimen (NSMT E-4885).

Remarks. This species is usually epizoic on soft corals (Irimura, 1982), although the host of the present specimen is not known.

Geographic range. This species is distributed from the Sea of Japan to Indonesia in the west Pacific Ocean, and in the Indian Ocean. Korea (Rho & Shin, 1987; Shin & Rho, 1996). The Sea of Japan, Korea Strait (H. L. Clark, 1911 as *Ophiothrix macrobrachia*), the Oki Islands (present study). Pacific coast of Japan from Boso Peninsula to off Kagoshima Bay (see Matsumoto,

1917; Koehler, 1922; Irimura, 1982, 2000); the Ogasawara Islands (Irimura & Tachikawa, 2003); off the Goto Islands (H. L. Clark, 1911 as *Ophiolithrix macrobrachia*); East China Sea (Irimura & Kubodera, 1998). Philippines (Koehler, 1922, 1931). Indonesia (Koehler, 1931). Indian Ocean, south Arabia (H. L. Clark, 1939 as *Placophiothrix phrixa*), south Africa (Mortensen, 1933; A. M. Clark & Courtman-Stock, 1976). The type locality is the Kei Islands and the Paternoster Islands (=Tengah Archipelago), Indonesia (Koehler, 1905).

***Ophiolithrix exigua* Lyman, 1874**

[Japanese name: Naga-toge-kumohitode]

(Fig. 8)

Ophiolithrix exigua Lyman, 1874: 226–237, pl. 4 fig. 24–26; Irimura, 1981: 28–29, pl. 1 fig. 4.

Ophiolithrix (Ophiolithrix) exigua: Irimura, 1982: 43–46, fig. 28, pl. 8 fig. 2–6, pl. 10 fig. 1–3, 5, 6. Liao & A. M. Clark, 1995: 247–248, fig. 131.

Ophiolithrix marenzelleri Koehler, 1904: 103–105, figs. 76–78; Liao & A. M. Clark, 1995: 248–250, fig. 132.

Material examined. Between Oomoriijima Island and Shijikijima Island; 58 m, 3 specimens (NSMT E-4891). Off Nagu; 67 m, 3 specimens (NSMT E-4887). Off Onbejima Island; 45 m, 1 specimen (NSMT E-4889); 52 m, 1 specimen (NSMT E-4892); 52 m, 2 specimens (NSMT E-4924); 60 m (S, Sh), 3 specimens (NSMT E-4900); 67 m (S, Sh), 1 specimen (NSMT E-4901); 67 m, 8 specimens (NSMT E-4923); 71 m, 13 specimens (NSMT E-4895). East of Onbejima Island; 54 m, 3 specimens (NSMT E-4894); 62 m (R), 2 specimens (NSMT E-4886). South-southeast of Tsudo; 62–65 m (G), 1 specimen (NSMT E-4905). Off Shijikijima Island; 36°9'N, 133°14' E, 20–30 m (G, R), 4 specimens (NSMT E-5002); 51 m, 6 specimens (NSMT E-4920); 60 m (R), 11 specimens (NSMT E-4893); 65 m (G), 1 specimen (NSMT E-4896); 65 m (G), 13 specimens (NSMT E-4897); 65 m (G), 4 specimens (NSMT E-4898); 65 m (G), 24 specimens (NSMT E-4902); 70 m (R, S), 5 specimens (NSMT E-4888). East of Shijikijima Island; 13 m

(G), 4 specimens (NSMT E-4910); 15 m (G), 5 specimens (NSMT E-4906); 15 m (G), 8 specimens (NSMT E-4907); 15 m (G), 1 specimen (NSMT E-4908). Between Matsushima Island and Kanjima Island; 16–18 m (Sh), 1 specimen (NSMT E-4909). Off Kanjima Island; 34 m, 1 specimen (NSMT E-4918); 34 m, 4 specimens (NSMT E-4919). Off Kanbi; 38 m, 1 specimen (NSMT E-4904). Kamo Bay; 22 m (seagrass bed), 2 specimens (NSMT E-4903); 53 m, 3 specimens (NSMT E-4916); 30 m (M), 1 specimen (NSMT E-4899). Off Kamo Bay; 43 m, 2 specimens (NSMT E-4917). Tsutsuka Bay; subtidal, 9 specimens (NSMT E-4890). South of Dougo Island (no detailed locality data); 1 specimen (NSMT E-4921); 1 specimen (NSMT E-4922); 1 specimen (NSMT E-4911); 1 specimen (NSMT E-4912); 2 specimens (NSMT E-4913); 1 specimen (NSMT E-4914); 10 specimens (NSMT E-4915).

Remarks. A specimen (NSMT E-4914, disk diameter 12.3 mm; Fig. 8) is very close to *Ophiolithrix marenzelleri* Koehler, 1904, which was synonymized with *O. exigua* by Irimura (1981). Liao and A. M. Clark (1995) recognized a clear distinction between these two species in China seas; in Japanese waters, however, a large variation in disk armature is observed and many intermediate forms were found according to Irimura (1982).

Geographic range. This species is distributed in the Sea of Japan and widely in Indo-west Pacific (see A. M. Clark & Rowe, 1971). It is a common species in the Sea of Japan (see Irimura, 1982; Ishida *et al.*, 2001; Fujita & Kohtsuka, 2003; present study). The type locality is the Philippines (Lyman, 1874)

Family **Ophiactidae**

***Ophiactis affinis* Duncan, 1879**

[Japanese name: Kusairo-chibi-kumohitode]

(Figs. 9–10)

Material examined. Off Shijikijima Island; 65 m (G), 1 specimen (NSMT E-4925). East of Shijikijima Island; 15 m (G), 1 specimen (NSMT E-4926); 15 m (G), 1 specimen (NSMT E-4927).

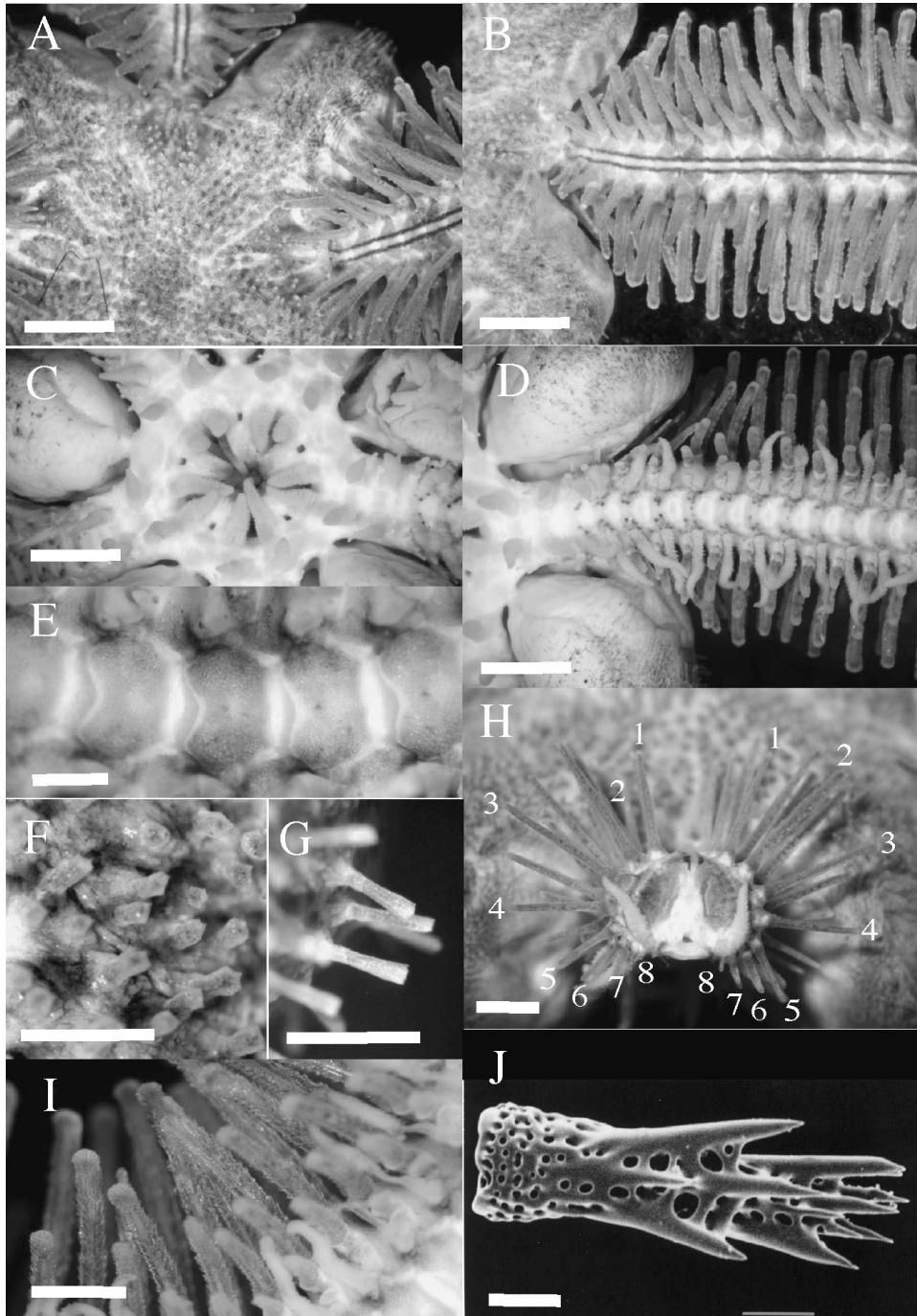


Fig. 8. *Ophiothrix exigua*. NSMT E-4914 (disk diameter 12.3 mm). A: Disk, aboral view. B: Basal arm, aboral view. C: Mouth frame. D: Basal arm, oral view. E: Dorsal arm plate at middle part of arm, proximal side left. F: Disk spines at central disk. G: Disk spines at disk edge. H: Arm spines near arm base. Eight spines present on each side. I: Arm spines at middle part of arm. J: Arm spine. A–G: Alcohol specimen, H–I: Specimen gently bleached to remove skin, J: SEM specimen. Scales 2 mm (A–D), 0.5 mm (E–G), 1 mm (H–I), 0.05 mm (J).

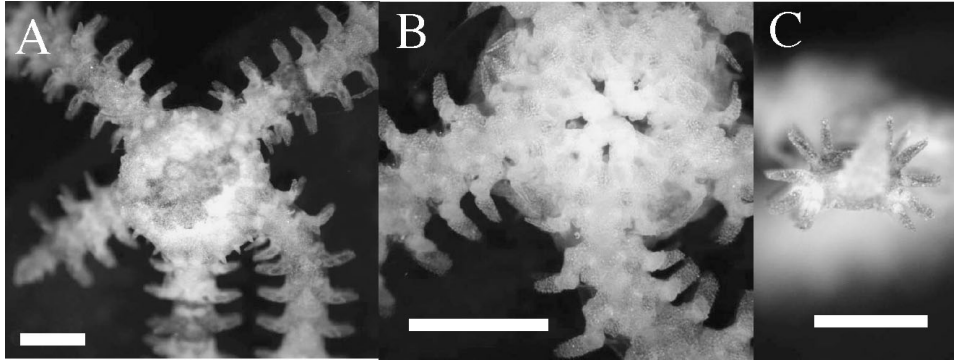


Fig. 9. *Ophiactis affinis*. NSMT E-4926 (disk diameter 1.1 mm). A: Disk and basal arms, aboral view. B: Disk and basal arms, oral view. C: Arm spines. A–C: Alcohol specimen. Scales 0.5 mm (A–C).

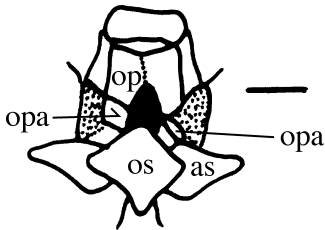


Fig. 10. *Ophiactis affinis*. NSMT E-4926 (disk diameter 1.1 mm). Jaw. Abbreviations. as: adoral shield, op: oral plate, opa: oral papillae, os: oral shield. Scale 0.1 mm.

Remarks. Three small specimens (disk diameter 0.85–1.3 mm) were collected. They have five arms and a few spines on the disk margin (Fig. 9A). The oral shield has a distal lobe (Fig. 10), and this seems a characteristic feature of *Ophiactis affinis* (see Duncan 1879: fig. 24; Koehler 1922: pl. 63 fig. 5; Liao & A. M. Clark, 1995: fig. 107b). Liao and A. M. Clark (1995: 214) reported the dorsal arm plates are elliptical and about twice as broad as long, but those of the present specimens are not so wide but pentagonal in shape and as long as wide probably due to their small size.

Geographic range. This species is distrib-

uted from the Sea of Japan to the Gulf of Thailand in the west Pacific Ocean, and in India. The Sea of Japan, Korean Strait (type locality, Duncan, 1879; Koehler, 1922), Notojima Island (Fujita & Kohtsuka, 2003), the Oki Islands (present study). Korea, the Yellow Sea (Yi & Irimura, 1987). Japan, Boso Peninsula (Irimura, 2000), Kii Peninsula (Irimura, 1981). China (Chang, 1948; Liao & A. M. Clark, 1995). The Philippines, San Juanico Strait (Koehler, 1922). Gulf of Thailand (Koehler, 1931). India, Chilika Lake (Koehler, 1898).

***Ophiactis macrolepidota* Marktanner-Turneretscher, 1887**

[Japanese name: Dairin-chibi-kumohitode]

(Fig. 11)

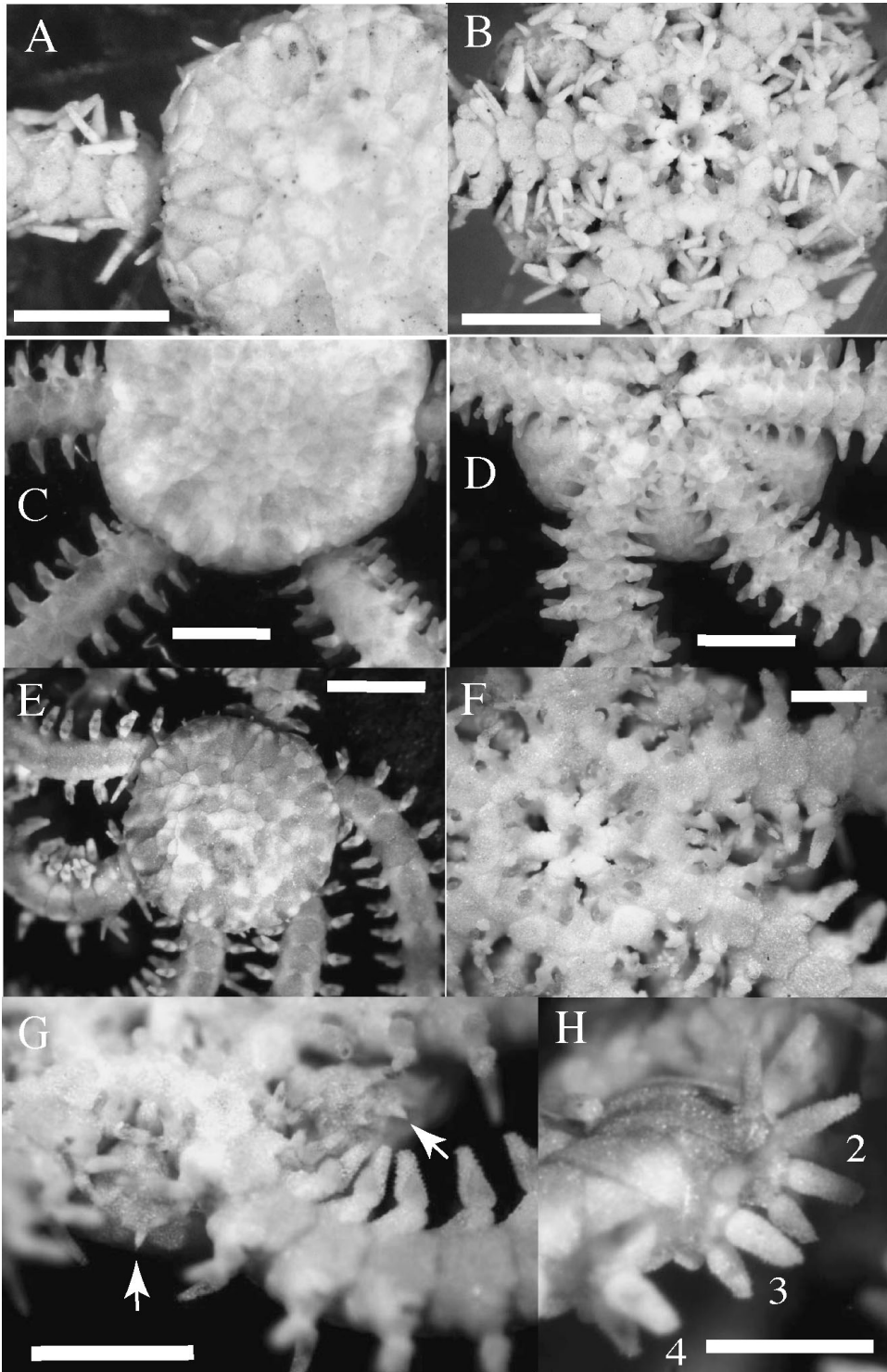
Ophiactis macrolepidota Marktanner-Turneretscher, 1887: 298, pl. 12 fig. 12–13; A. M. Clark & Rowe, 1971: 104; Rowe & Gates, 1995: 379.

Ophiactis delicata H. L. Clark, 1915a: 260–261, pl. 11 fig. 9–10; A. M. Clark & Rowe, 1971: 104.

Ophiactis parva Mortensen, 1926: 123–124, fig. 12; A. M. Clark & Rowe, 1971: 104.

Ophiactis acosmeta H. L. Clark, 1938: 262–264; A. M. Clark & Rowe, 1971: 104.

Fig. 11. *Ophiactis macrolepidota*. A–B: Holotype (Naturhistorisches Museum Wien, Specimen No. T66/2, 10340; disk diameter 3.1 mm). C–D: NSMT E-4932 (disk diameter 3.6 mm). E–H: NSMT E-4935 (disk diameter 2.3 mm). A: Disk and basal arm, aboral view. B: Disk, oral view. C: Disk and basal arm, aboral view. D: Disk and basal arm, oral view. E: Disk and basal arm, aboral view. F: Disk and basal arm, oral view. G: Oral interradius with a few acute spines (arrows). H: Arm spines of between 2nd and 4th free arm segments (shown by 2, 3, 4). A–D: Semi-dry specimen, E–H: Dry specimen. Scales 1 mm (A–E, G), 0.5 mm (F, H).



Material examined. Off Onbejima Island; 67 m, 1 specimen (NSMT E-4943). Shijikijima Island; subtidal, 3 specimens (NSMT E-4942). Off Shijikijima Island; 36°9'N, 133°14'E, 20–30 m (G, R), 11 specimens (NSMT E-5003); 51 m, 18 specimens (NSMT E-4941); 54 m, 1 specimen (NSMT E-4931); 56 m, 1 specimen (NSMT E-4929); 56 m, 1 specimen (NSMT E-4930); 65 m, 3 specimens (NSMT E-4932); 65 m (G), 2 specimens (NSMT E-4933). East of Shijikijima Island; 15 m (G), 2 specimens (NSMT E-4934); 15 m (G), 1 specimen (NSMT E-4935); 15 m (G), 2 specimens (NSMT E-4936); 15 m (G), 6 specimens (NSMT E-4937); 13 m (G), 2 specimens (NSMT E-4939). Between Matsushima Island and Kanjima Island; 16–18 m (Sh), 3 specimens (NSMT E-4938). Kamo Bay; subtidal, 6 specimens (NSMT E-4940). Tsutsuka Bay; subtidal, 3 specimens (NSMT E-4928). ?*Ophiactis macrolepidota*: Kamo Bay; subtidal, 2 specimens (NSMT E-4944).

Remarks. This fissiparous species was described by Marktanner-Turneretscher (1887) based on a specimen presumably collected from Sydney, Australia. He reported that the oral interradius is free of scales; however, the holotype (Naturhistorisches Museum Wien, Specimen No. T66/2, 10340) has rough scales (Fig. 11A–B). Due to the inaccuracy of the original description, *O. macrolepidota* may be known by other names, as suggested by H. L. Clark (1946) and A. M. Clark (1965). Recently Rowe (in Rowe & Gates, 1995) synonymized three Australian species with *O. macrolepidota*, and suggested the possibility of additional synonyms and cosmopolitan distribution of *O. macrolepidota*.

The present specimens have six arms except one specimen with seven arms, two with five arms, and one with only three arms probably collected soon after fission. Some variation was observed for the spinelets in oral interradius and the number of arm spines. Among a total of 66 examined specimens (disk diameter range 0.8–3.6 mm), only six specimens have a small number of acute spines in the oral interradius (Fig. 11F–G). None of the specimens smaller than 1.7 mm in

disk diameter have such spines. Forty-five specimens have segments with four-arm spine segments on at least one arm. Usually, the second free arm segment has four arm spines and the following segments have only three (Fig. 11H). Eleven of the specimens smaller than 1.7 mm in disk diameter have no segment with four arm spines.

Additionally, two specimens with five arms (NSMT E-4944, disk diameter 1.5 and 1.1 mm) are probably *O. macrolepidota*, and both of them have several arm segments with 4 arm spines.

Geographic range. This species is distributed in Korea, Japan, Indonesia, and Australia. The Sea of Japan, Tsushima (Matsumoto, 1917), the Oki Islands (present study). Korea (Rho, 1979; Yi & Irimura, 1987; Shin & Rho, 1996). Pacific coast of Japan, Uruga Channel (Matsumoto, 1917), Shimoda (Murakami, 1942), Jogashima and Katsuyama (referred to Yogashima and Kashiyama in Döderlein's collection: A. M. Clark, 1965), Kii Peninsula (Irimura, 1981). Japan, Amakusa (Irimura, 1969). Indonesia, Ambon (Döderlein, 1898). Australia (Rowe & Gates, 1995), Sydney (presumably type locality, Marktanner-Turneretscher, 1887; A. M. Clark & Rowe, 1971).

***Ophiactis savignyi* (Müller & Troschel, 1842)**

[Japanese name: Chibi-kumohitode]

Material examined. Off Tsuma; 50 m, 1 specimen (NSMT E-4945). Shijikijima Island; subtidal, 1 specimen (NSMT E-4946).

Remarks: This species is also fissiparous and normally has 6 arms, but occasionally 5-arm specimens are found (Liao & A. M. Clark, 1995). It is distinguishable from *Ophiactis macrolepidota* usually by having two oral papillae though Liao & A. M. Clark (1995) reported that some specimens have only one oral papilla.

Geographic range. This species is distributed in the Sea of Japan and widely in temperate and tropical waters in the world (see A. M. Clark & Rowe, 1971). The Sea of Japan, Sado Island (Irimura, 1979), the Oki Islands (present study);

Korea (Rho, 1979; Rho & Shin, 1987). The type locality is the Red Sea (Muller & Troschel, 1842 as *Ophiolepis savignyi*).

Ophiopholis mirabilis (Duncan, 1879)

[Japanese name: Madara-kumohitode]

Material examined. Off Onbejima Island; 67 m (S, Sh), 1 specimen (NSMT E-4948). East of Onbejima Island; 62 m (R), 3 specimens (NSMT E-4947). Off Tsudo; 62 m, 1 specimen (NSMT E-4951). South-southeast of Tsudo; 62–65 m (G), 1 specimen (NSMT E-4949). South of Dougo Island (no detailed locality data); 1 specimen (NSMT E-4950).

Remarks. Four *Ophiopholis* species have been reported from the Sea of Japan: *O. aculeata* (Linnaeus, 1767), *O. brachygenis* H. L. Clark, 1911, *O. japonica* Lyman, 1879, and *O. mirabilis* (Ishida *et al.*, 2001). *Ophiopholis mirabilis* are distinguished from the other three by the presence of large supplemental plates on both side of

arms (see Irimura 1990: 83, fig.).

Geographic range. This species is distributed the Sea of Okhotsk, the Sea of Japan, the Yellow Sea, and Pacific coast of northern Japan. The Sea of Okhotsk (Matsumoto, 1917; Djakonov, 1954). Korea, Sondai Bay (type locality, Duncan, 1879 as *Ophiolepis mirabilis*), Cheju Island (Rho, 1979), the Yellow Sea (Yi & Irimura, 1987). The Sea of Japan, Notojima Island (Fujita & Kohtsuka, 2003), the Oki Islands (present study). Pacific coast of Japan from Hakodate and Mutsu Bay to Sagami Bay (H. L. Clark, 1911; Matsumoto, 1917, 1941; Koehler, 1922; Irimura, 1982, 1990).

Family **Ophionereididae**

Ophionereis dubia (Müller & Troschel, 1842)

[Japanese name: Amime-kumohitode]

(Fig. 12D)

Material examined. Off Onbejima Island; 71 m, 1 specimen (NSMT E-4960). Off Shijikijima Island; 65 m (G), 1 specimen (NSMT E-

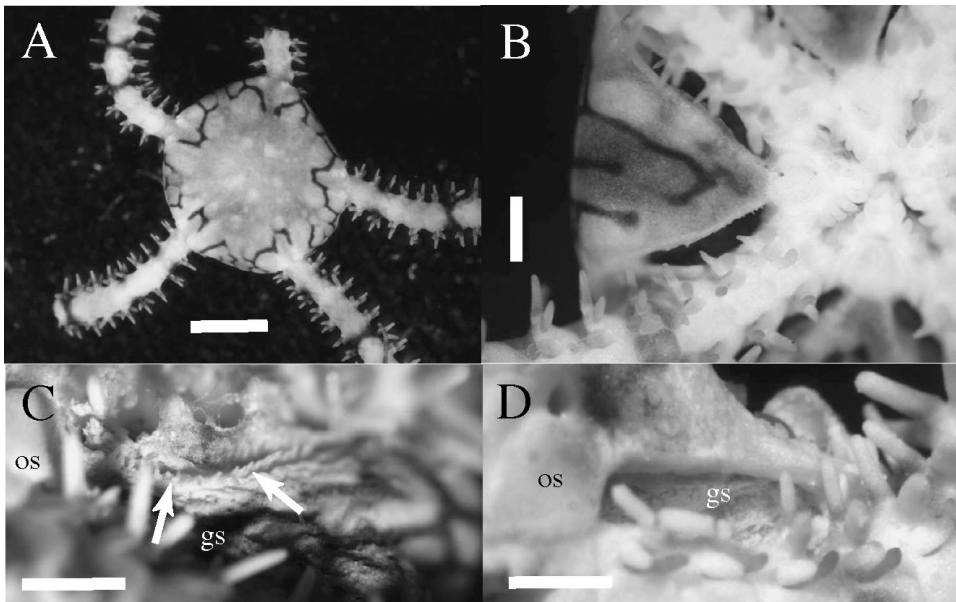


Fig. 12. A–C: *Ophiopholis intermedia*, D: *Ophiopholis dubia*. A–B: NSMT E-4965 (disk diameter 5.1 mm), C: NSMT E-4969 (disk diameter ca. 6 mm). D: NSMT E-4959 (disk diameter 5.9 mm). A: Disk and basal arms, aboral view. B: Disk, oral view. C: Genital papillae (arrows). D: Genital slit without genital papillae. A–B: Alcohol specimen, C–D: Dry specimen. Abbreviations. os: oral shield, gs: genital slit. Scales 2 mm (A), 0.5 mm (B–D).

4961). East of Shijikijima Island; 15 m (G), 1 specimen (NSMT E-4962); 15 m (G), 1 specimen (NSMT E-4963). Tsutsuka Bay; subtidal, 3 specimens (NSMT E-4958); subtidal, 1 specimen (NSMT E-4959).

Geographic range. This species is distributed in the Sea of Japan and widely in Indo-west Pacific (see A. M. Clark & Rowe, 1971). Widely distributed in the Sea of Japan (see Ishida *et al.*, 2001; Fujita & Kohtsuka, 2003). Pacific coast of Japan in Boso Peninsula (Irimura, 2000) and the more southern and western area (see Irimura, 1982). The type locality is the Red Sea (see Lyman, 1865).

Ophionereis intermedia A. M. Clark, 1953

[Japanese name: Nise-amime-kumohitode]

(Fig. 12A–C)

Ophionereis intermedia A. M. Clark, 1953: 90–92, fig. 12.

Material examined. Off Onbejima Island; 71 m, 3 specimens (NSMT E-4966). South-southeast of Tsudo; 62–65 m (G), 2 specimens (NSMT E-4968); 62–65 m (G), 1 specimen (NSMT E-4969). Off Shijikijima Island; 36°9'N, 133°14'E, 20–30 m (G, R), 2 specimens (NSMT E-5000); 60 m (R), 1 specimen (NSMT E-4965); 65 m (G), 1 specimen (NSMT E-4967). East of Shijikijima Island; 13 m (G), 1 specimen (NSMT E-4970). Off Kanjima Island; 34 m, 4 specimens (NSMT E-4971). Kanbi; subtidal, 1 specimen (NSMT E-4964).

Remarks. This species is similar to *Ophionereis dubia*, but differs from it by having very minute, acute genital papillae (Fig. 12C). The scaling of the disk is very fine like *O. dubia*, but is more distinct.

Geographic range. This species is distributed in Japan and Australia. The Sea of Japan, Notojima Island (Fujita & Kohtsuka, 2003), the Oki Islands (present study). Northern Japan, Tsugaru Strait (type locality, A. M. Clark, 1953). Australia, Swain Reef (Kingston, 1980).

Ophionereis sasakii A. M. Clark, 1953

[New Japanese name: Sasaki-kumohitode]

(Fig. 13)

Ophionereis sasakii A. M. Clark, 1953: 75–77, fig. 4, pl. 3 fig. 1–2; Yi & Irimura, 1987: 130–131, fig. 7.

Ophionereis eurybrachioplax: Irimura, 1982: 72–73, fig. 44 (non *Ophionereis eurybrachioplax* H. L. Clark, 1911: 173–175, fig. 78).

?*Ophionereis eurybrachioplax*: Matsumoto, 1918: 479–480, fig. 2.

Material examined. Off Shijikijima Island; 65 m (G), 1 specimen (NSMT E-4972). South-southeast of Tsudo; 62–65 m (G), 1 specimen (NSMT E-4973).

Remarks. This species is close to *Ophionereis eurybrachioplax* H. L. Clark, 1911, but A. M. Clark (1953) described *O. sasakii* based on a specimen from Hakodate. The present specimens were determined to be *O. sasakii* by the subovoidal shape of oral shield (Fig. 13C), the presence of a second tentacle scale (Fig. 13D), and the presence of genital papillae that are visible on the dorsal side of some arm bases (Fig. 13E–F) although often concealed by disk edge. If these two species are distinguishable, the record of *O. eurybrachioplax* from Japanese waters by H. L. Clark (1911) seems doubtful. Irimura (1982) reported *O. eurybrachioplax* from Sagami Bay, central Japan. In his specimen (No. 321, currently deposited in NSMT), which was re-examined, the shape of oral shield is not triangular (see Irimura 1982: fig. 44B), the second tentacle scale is present, and the genital papillae was observed from the dorsal side though only one or two at each arm base. Thus, the Sagami Bay specimen must be conspecific with specimens from the Oki Islands. Some other specimens deposited in NSMT, collected from Sagami Bay, 70 m (NSMT E-1615, 1680) and from the Yellow Sea (NSMT E-1950) are also conspecific to the present specimens. Original description of *O. eurybrachioplax* by H. L. Clark (1911) was based on a large specimen (disk diameter 24 mm). The largest Japanese specimen examined (NSMT E-1680), having a disk diameter of 16.7 mm, has wide dorsal arm plates like *O. eurybrachioplax*,

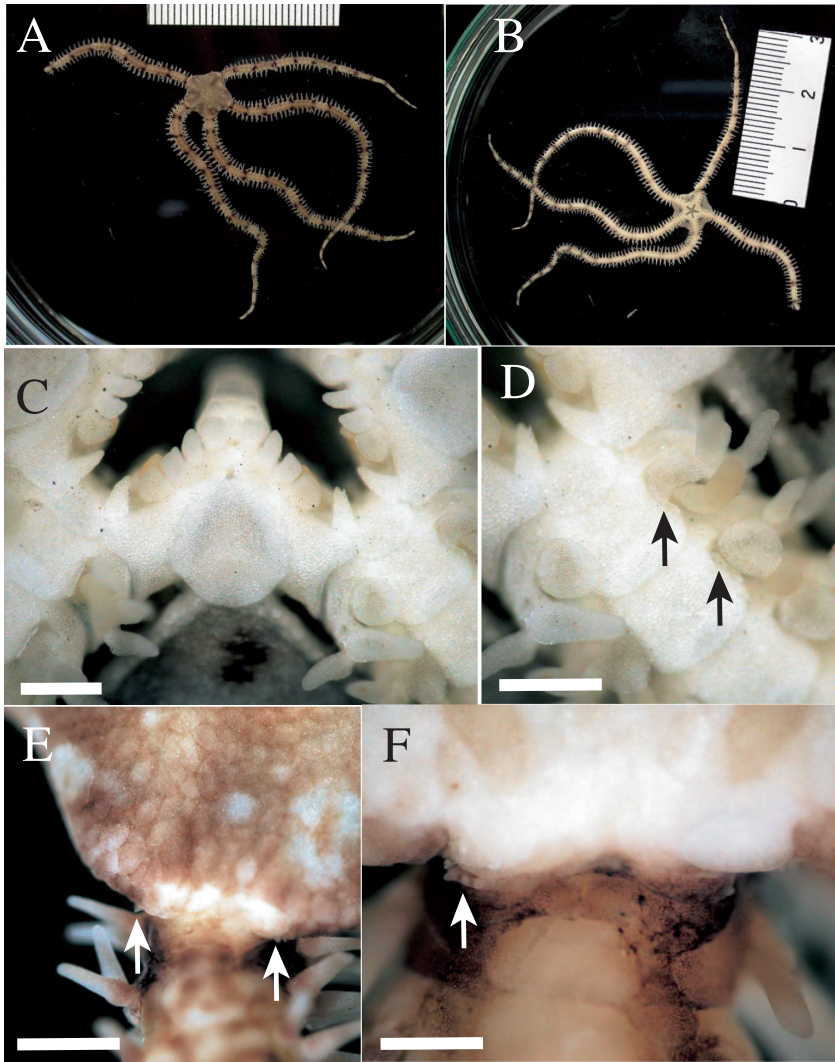


Fig. 13. *Ophioneis sasakii*. A–E: NSMT E-4972 (disk diameter 7.1 mm), F: NSMT E-4973 (disk diameter 10.5 mm) A: Whole body, aboral view. B: Whole body, oral view. C: Jaw. Scale 0.5 mm. D: Second tentacle scales (arrows). Scale 0.5 mm. E: Genital papillae (arrows) viewed from aboral side. Scale 0.5 mm. F: Genital papillae (arrows) viewed aboral-laterally. Scale 0.5 mm. A–F: Alcohol specimen. Scale divisions 1 mm (A–B). Scales 0.5 mm (C–F).

but the shape of oral shield is not triangular, a secondary tentacle scale is present, and genital papillae are partly visible from dorsal side. It's difficult to determine whether *O. eurybrachiplax* from California and *O. sasakii* from Japan are distinct species because of variation in visibility of genital papillae from the dorsal side. It is necessary to evaluate the type specimens of *O. eurybrachiplax* to show the relationships between

these two species. However, for the present, Japanese specimens should be identified as *O. sasakii*. Such variation was also reported in Korean specimens (Yi & Irimura, 1987).

Geographic range. This species is reported Japan and Korea. The Japan Sea, the Oki Islands (present study). Korea, the Yellow Sea (Yi & Irimura, 1987). Japan, Hakodate (type locality, A. M. Clark, 1953), Sagami Bay (Irimura, 1982).

***Ophionereis variegata* Duncan, 1879**

[Japanese name: Sanmen-kumohitode]

Material examined. Off Onbejima Island; 67 m, 1 specimen (NSMT E-4977). East of Onbejima Island; 54 m, 2 specimens (NSMT E-4975). Off Shijikijima Island; 36°9'N, 133°14'E, 20–30 m (G, R), 1 specimen (NSMT E-5001); 56 m, 1 specimen (NSMT E-4974). East of Shijikijima Island; 15 m (G), 1 specimen (NSMT E-4976).

Remarks. This species is close to *Ophionereis porrecta* Lyman, 1860, which is also distributed in southern Japan (see A. M. Clark & Rowe, 1971). The specimens have fan-shaped ventral arm plates (see A. M. Clark, 1953: fig. 7) and one accessory lateral plate (see Matsumoto, 1917: fig. 93d) between the main lateral arm plates, and *O. variegata* can be distinguished from *O. porrecta* by these characteristics (A. M. Clark, 1953).

Geographic range. This species is distributed in Japan and Australia. The Sea of Japan, Korean Strait (type locality, Duncan, 1879), the Oki Islands (present study). Japan, Boso Peninsula (Irimura, 2000), the Goto Islands (Fujita, 1998), Kii (Irimura, 1981), Okinawa (Matsumoto, 1917 as *Ophionereis porrecta*). Australia, Great Barrier Reef (Rowe & Gates, 1995).

***Ophionereis thryptica* (Murakami, 1943)**

[New Japanese name: Mutsuude-amime-kumohitode]

(Fig. 14)

Material examined. Between Oomorijima Island and Shijikijima Island; 58 m, 2 specimens (NSMT E-4979). Off Onbejima Island; 52 m, 3 specimens (NSMT E-4980); 54 m, 2 specimens (NSMT E-4983); 54 m, 3 specimens (NSMT E-4984); 67 m, 2 specimens (NSMT E-4990); 71 m, 1 specimen (NSMT E-4985). Off Shijikijima Island; 60 m (R), 7 specimens (NSMT E-4981); 60

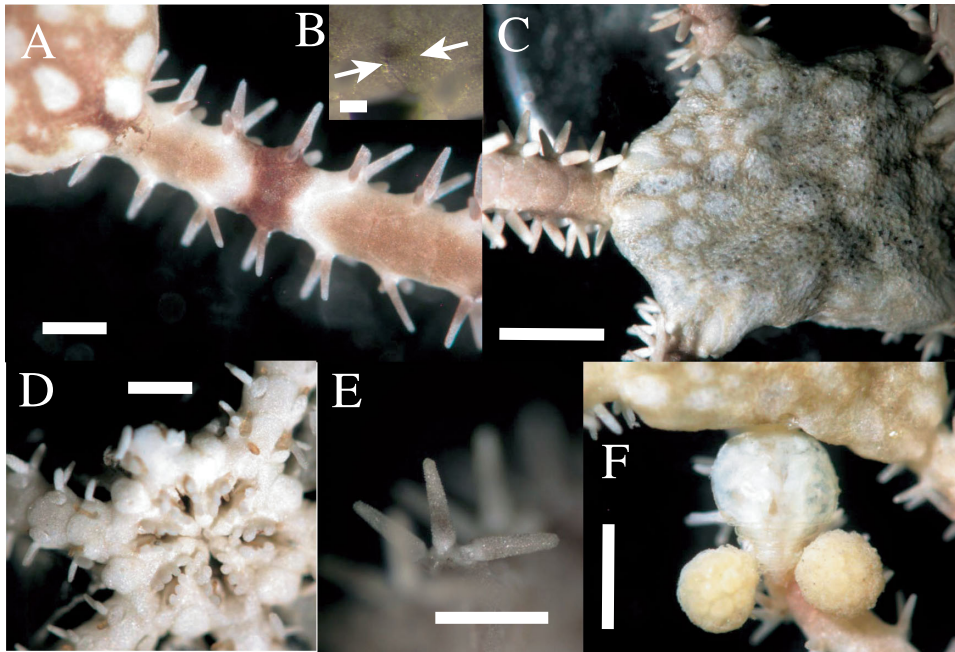


Fig. 14. *Ophionereis thryptica*. A: NSMT E-4981 (disk diameter 2.6 mm), B–E: NSMT E-4982 (disk diameter 3.0 mm), F: NSMT E-4988 (disk diameter 3.1 mm). A: Basal arm, aboral view. B: Supplemental dorsal arm plate (right arrow) and secondary supplemental dorsal arm plate (left arrow). C: Disk, aboral view. D: Mouth frame. E: Arm spines of 17th arm segment, distal view, oral side rightward. F: An ectoparasitic copepod. A, F: Alcohol specimen, B–E: Dry specimen. Scales 0.5 mm (A, D–E), 0.1 mm (B), 1 mm (C, F).

m (R), 1 specimen (NSMT E-4982); 65 m (G), 2 specimens (NSMT E-4986); 65 m (G), 30 specimens (NSMT E-4987); 65 m (G), 3 specimens (NSMT E-4988). Kamo Bay; 53 m, 1 specimen (NSMT E-4989). Tsutsuka Bay; Subtidal, 1 specimen (NSMT E-4978).

Remarks. The specimens agrees well with the description by Murakami (1943a). There are two six-armed *Ophionereis* species, *O. hexactis* H. L. Clark, 1938 and *O. sexradia* Mortensen, 1936. The former has the middle arm spine markedly elongated (A. M. Clark & Rowe, 1971: fig. 56i) instead of subequal as in *O. thryptica* (Fig. 14E). *Ophionereis sexradia* has no small secondary supplementary dorsal arm plate (Fig. 14B). Three specimens each have one unidentified ectoparasitic copepod (Fig. 14F).

Geographic range. This species had been known from the Ogasawara Islands, Japan (Irimura & Tachikawa, 2003), Palau (type locality, Murakami, 1943a as *Ophiocrasis thryptica*), Indonesia (Guille & Wolff, 1984), Madagascar (Cherbonnier & Guille 1978). This is the first record from the Sea of Japan.

Family Ophiidermatidae

Ophiarachnella gorgonia (Müller & Troschel, 1842)

[Japanese name: Toume-kumohitode]

Material examined. Kanbi; subtidal, 1 speci-

men (NSMT E-4952).

Geographic range. This species is distributed in the Sea of Japan and widely in Indo-west Pacific (see A. M. Clark & Rowe, 1971). Korea (Rho, 1979; Yi & Irimura, 1987). The Sea of Japan, Sado (Irimura, 1979), Notojima Island (Fujita & Kohtsuka, 2003), the Oki Islands (present study). Pacific coast of Japan, Inubo-zaki cape and more southern waters (see Irimura, 1982, 2000). The type locality is Mauritius (Müller & Troschel, 1842).

Ophiopsammus anchistus (H. L. Clark, 1911)

[Japanese name: Menashi-kumohitode]

(Fig. 15)

Material examined. Off Onbejima Island; 67 m, 1 specimen (NSMT E-4955). Off Shijikijima Island; 60 m (R), 1 specimen (NSMT E-4954); 70 m (R, S), 1 specimen (NSMT E-4953).

Remarks. This species was originally described as *Pectimura anchista* by H. L. Clark (1911) and was transferred to *Ophiopsammus* by Vail & Rowe (1989). The present specimens (disk diameter 4.3–11.6 mm) have several granules between dorsal arm plates and lateral arm plates, and the shape of dorsal arm plates ranges from fan shape to rectangular shape in individuals of increasing size (Fig. 15A–C).

Geographic range. This species is distributed in Korea and Japan. Korea (Rho, 1979; Rho &

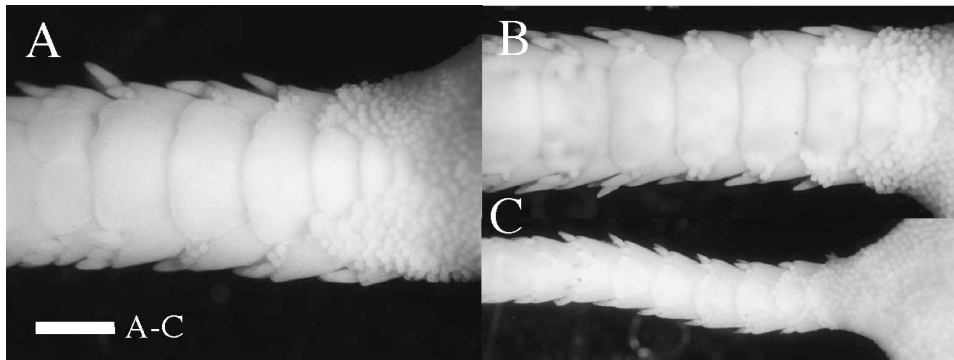


Fig. 15. *Ophiopsammus anchistus*. Basal arm, aboral view. A: NSMT E-4953 (disk diameter 11.6 mm). B: NSMT E-4954 (disk diameter 10.4 mm). C: NSMT E-4955 (disk diameter 4.4 mm). A–C: Alcohol specimen. Scales 1 mm (A–C).

Shin, 1987). The Sea of Japan, Sado (Irimura, 1979), Notojima Island (Fujita & Kohtsuka, 2003), the Oki Islands (present study). Pacific coast of Japan, Boso Peninsula (Irimura, 2000), Sagami Bay (Matsumoto, 1917; Irimura, 1982), Tanabe Bay (Irimura, 1981), the Ogasawara Islands (Irimura & Tachikawa, 2003). Type locality is off Suno-saki, off Goto Island, and Kagoshima Bay, Japan (H. L. Clark, 1911).

Ophioconis acanthophora (Murakami, 1942)
new combination

[Japanese name: Awahada-kumohitode]

(Fig. 16)

Ophiurodon acanthophora Murakami, 1942: 31–33, fig. 12.

Material examined. East of Onbejima Island; 54 m, 1 specimen (NSMT E-4956). South of Dougo Island (no detailed locality data); 1 speci-

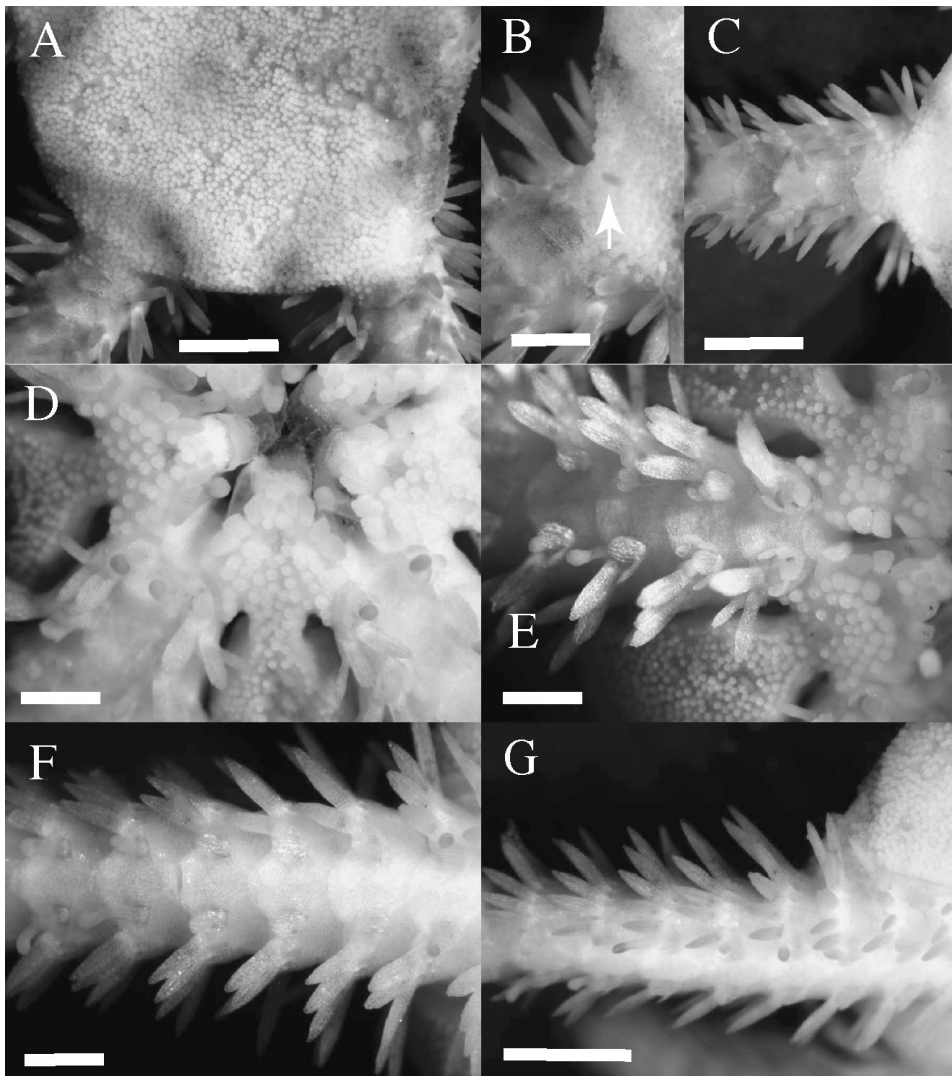


Fig. 16. *Ophioconis acanthophora*. NSMT E-4956 (disk diameter 4.7 mm). A: Disk, aboral view. B: Disk spinelet (arrow). C: Basal arm, aboral view. D: Mouth frame. E: Tentacle scales at arm base. F: Basal arm, oral view. G: Arm spines near arm base, oral-lateral view. A–G: alcohol specimen. Scales 1 mm (A, C, G), 0.5 mm (B, D–F).

men (NSMT E-4957).

Remarks. The present specimens agree well with the description of *Ophiurodon acanthophora* Murakami, 1942, which was characterized by non-serrated teeth, the presence of spinelets on disk, and two tentacle scales (Murakami, 1942). One specimen (NSMT E-4956, disk diameter 4.7 mm) has only one spinelet on the disk (Fig. 16B), there is no spinelet found on the disk of another specimen (NSMT E-4957) though the dorsal disk is so severely damaged. Tentacle scales are 4–5 in number for the first two tentacle pores and 2 for the following pores (Fig. 16E). The teeth have hyaline margin slightly serrated (Fig. 16D). These characteristics suggest that this species is at least congeneric, possibly conspecific, with *Ophiurodon cupidum* (Koehler, 1905) reported from southern Japan by Murakami (1943b).

The generic status of *Ophiurodon* Matsumoto, 1915 is very doubtful (A. M. Clark, 1965; Baker & Devaney, 1981). A. M. Clark (1965) transferred *Ophiurodon cupidum* to *Ophioconis* and likewise *Ophiurodon acanthophora* should be regarded as congeneric with *Ophioconis cupida* Koehler, 1905.

Geographic range. This species had been reported only from the type locality, Izu, Japan (Murakami, 1942). This is the first record from the Sea of Japan.

Family **Ophiolepididae**

Ophioplocus japonicus H. L. Clark, 1911

[Japanese name: Nihon-kumohitode]

Material examined. Shijikijima Island; subtidal, 4 specimens (NSMT E-4996). Kanbi; subtidal, 2 specimens (NSMT E-4993). Kamo Bay; subtidal, 2 specimens (NSMT E-4991); subtidal, 4 specimens (NSMT E-4995). Tsutsuka Bay; subtidal, 5 specimens (NSMT E-4992). Inugui; subtidal, 1 specimen (NSMT E-4994).

Remarks. This species is distributed in Korea (see Rho & Shin, 1987; Yi & Irimura, 1987) and Japan (see Irimura, 1982). It is very common species especially in intertidal zone in the Sea of

Japan & Kohtsuka, 2003).

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References

- Baker, A. N. & D. M. Devaney, 1981. New records of Ophiuroidea (Echinodermata) from Southern Australia, including new species of *Ophiacantha* and *Ophionereis*. *Trans. R. Soc. S. Aust.*, **105**: 155–178.
- Bomford, T. L., 1913. A note on certain ophiuroids in the Indian Museum. *Rec. Indian Mus.*, **9**: 219–225, 1 pl.
- Chang, F. Y., 1948. Echinoderms of Tsingtao. *Contr. Inst. Zool., Natn. Acad. Peiping*, **4**: 33–104, 11 pls.
- Cherbonnier, G. & A. Guille, 1978. *Faune de Madagascar 48. Echinodermes: Ophiurides*. Centre national de la Recherche Scientifique, Paris, 272 pp.
- Clark, A. M., 1953. A revision of the genus *Ophionereis* (Echinodermata, Ophiuroidea). *Proc. Zool. Soc. London*, **123**: 65–94, 3 pls.
- Clark, A. M., 1965. Japanese and other ophiuroids from the collections of the Munich Museum. *Bull. Br. Mus. (Nat. Hist.) Zool.*, **13**: 33–71, 1 pl.
- Clark, A. M., 1970. Notes on the family Amphiuroidae (Ophiuroidea). *Bull. Br. Mus. Nat. Hist. (Zool.)*, **19**: 1–81.
- Clark, A. M., 1987. *Asterias squamata* Delle Chiaje, 1828 (currently *Amphipholis squamata*; Echinodermata, Ophiuroidea): proposed conservation of the specific

- name. *Bull. Zool. Nomen.*, **44**: 246–247.
- Clark, A. M. & Courtman-Stock, J. 1976. *The echinoderms of southern Africa*. British Museum (Natural History), London, 277 pp.
- Clark, A. M. & F. W. E. Rowe, 1971. *Monograph of Shallow-Water Indo-West Pacific Echinoderms*. Trustees of the British Museum (Natural History), London, 238 pp., 31 pls.
- Clark, H. L., 1911. North Pacific ophiurans in the collection of the United States National Museum. *Bull. U. S. Natn. Mus.*, **75**: 1–301.
- Clark, H. L., 1915a. Catalogue of Recent Ophiurans based on the collections of the Museum of Comparative Zoology. *Mem. Mus. Comp. Zool.*, **25**: 165–376.
- Clark, H. L., 1915b. The Echinoderms of Ceylon other than Holothurians. *Spolia Zeylanica*, **25**: 83–102.
- Clark, H. L., 1938. Echinoderms from Australia. *Mem. Mus. Comp. Zool. Harvard Coll.*, **55**: 1–596, 28 pls.
- Clark, H. L., 1939. Ophiuroidea. *Sci. Rep. John Murray Exped. 1933–34*, **6**: 29–135.
- Clark, H. L., 1946. The echinoderm fauna of Australia. Its composition and its origin. *Carnegie Inst. Wash. Publ.*, (566): 1–567.
- de Loriol, P., 1893. Echinodermes de la baie d'Amboine. *Rev. Suisse Zool.*, **1**: 359–426, 3 pls.
- Devaney, D. M., 1974. Shallow-water asterozoans of southeastern Polynesia. II. Ophiuroidea. *Micronesica*, **10**: 105–204.
- Djakonov, A. M., 1954. *Ophiuroids of the USSR Seas*. Izdatel'stvo Akademii Nauk SSSR, Moskva, 132 pp. [English translation in 1967. Israel Program for Scientific Translations, Jerusalem, 123 pp.]
- Döderlein, L., 1896. Bericht über die von Herrn Professor Semon bei Amboina und Thursday Island gesammelten Ophiuroidea. *Jan. Denkschr.*, **8**: 279–300, 5 pls.
- Döderlein, L. 1898. Ueber einige epizoisch lebende Ophiuroidea. *Denkschr. med.-naturh. Ges. Jena*, **8**: 483–488.
- Döderlein, L., 1902. Japanische Euryaliden. *Zool. Anz.*, **25**: 320–326.
- Döderlein, L., 1910. L. Schultze, Forschungsreise im westlichen und zentralen Sudafrica 4 (1). Asteroidea, Ophiuroidea, Echinoidea. *Denkschr. Med.-naturwiss. Ges. Jena*, **16**: 245–258, 2 pls.
- Döderlein, L., 1911. Über japanische und andere Euryalae. *Abh. Math.-Phys. Kl. Kongl.-Bayer. Akad. Wiss.*, (2) **5**: 1–123, 9 pls.
- Döderlein, L. 1927. Indopacifische Euryale. *Abh. Bayer. Akad. Wiss., Math.-natur. Abt.*, **31**: 1–105, 10 pls.
- Duncan, P. M., 1879. On some Ophiuroidea from the Korean seas. *J. Linn. Soc.*, **14**: 444–482.
- Dupont, S. 2002. On the taxonomic status of the brittlestar *Amphipholis squamata* (Delle Chiaje, 1828). *Bull. Inst. Roy. Sci. Nat. Belg., Biol.*, **72**, Supplement: 105–108.
- Fujita, T., 1998. Ophiuroids (Echinodermata) from Fukue Island off Kyusyu, western Japan, including three new records for Japan. *Mem. Natn. Sci. Mus.*, Tokyo, (31): 223–230.
- Fujita, T., Y. Ishida & S. Irimura, 1997. Ophiuroids collected from the deep waters of Suruga Bay, central Japan. *Natn. Sci. Mus. Monogr.*, (12): 257–268, 1 pl.
- Fujita, T. & H. Kohtsuka, 2003. Ophiuroids (Echinodermata) from Notojima Island and its adjacent waters in the Sea of Japan. *Rep. Noto Mar. Cent.*, (9): 25–38. (In Japanese with English abstract)
- Gislén, T., 1926. On the generic types of the ophiurid genus *Ophiocentrus* Ljungman (*Amphiocnida* Verrill). *Kungl. Vet. O. Vitterh. Samh. Handl.*, **30**: 1–16
- Guille, A. 1981. Echinoderms: Ophiuroids. *Res. Musorstom Exped.*, (91): 413–456.
- Guille, A., P. Laboute & J.-L. Menou, 1986. *Guide des étoiles de mer, oursins et autres échinodermes du lagon de Nouvelle-Calédonie. Handbook of the sea-stars, sea-urchins and related echinoderms of New-Caledonia lagoon*. pp. 238. l'ORSTOM, Paris.
- Guille, A. & T. Wolff, 1984. Résultats biologiques de l'Expédition Snellius. Echinodermata: Ophiuroidea I. *Zool. Verhandl.*, **213**: 1–39.
- Irimura, S., 1969. Supplemental report of Dr. Murakami's paper on the ophiurans of Amakusa, Kyushu. *Publ. Amakusa Mar. Biol. Lab., Kyushu Univ.*, **2**: 37–48.
- Irimura, S., 1979. Ophiuroidea of Sado Island, the Sea of Japan. *Annu. Rep. Sado Mar. Biol. Sta., Niigata Univ.*, **9**: 1–6.
- Irimura, S., 1981. Ophiurans from Tanabe Bay and its vicinity, with the description of a new species of *Ophiocentrus*. *Publ. Seto Mar. Biol. Lab.*, **26**: 15–49.
- Irimura, S., 1982. *The Brittle-Stars of Sagami Bay*. Biological Laboratory, Imperial Household, Tokyo, 95 pp., 15 pls.
- Irimura, S., 1990. Ophiuroidea. In *Echinoderms from Continental Shelf and Slope around Japan Vol. I*. Japan Fisheries Resource Conservation Association, Tokyo, pp. 65–100.
- Irimura, S., 2000. Class Ophiuroidea. In Okutani, T. (ed.), *Natural History of Chiba Prefecture, Vol. 7. Animals of Chiba Prefecture, No. 2, Marine Animals*. Chiba Prefecture, pp. 398–410. (In Japanese)
- Irimura, S., T. Fujita & R. Ueshima, 2001. Preliminary report on the ophiuroids (Echinodermata) on the shelf off Shimoda, South of Izu Peninsula, central Japan. *Mem. Natn. Sci. Mus.*, Tokyo, (37): 311–315.
- Irimura, S. & T. Kubodera, 1998. Ophiuroidea in the East China Sea. *Mem. Natn. Sci. Mus.*, (31): 135–143.
- Irimura, S. & H. Tachikawa, 2003. Ophiuroids from the Ogasawara Islands (Echinodermata: Ophiuroidea). *Ogasawara Res.*, (28): 1–27.
- Ishida, Y., S. Ohtsuka, K. Takayasu, I. Kobayashi, Y.-G.

- Lee, K. Seto, H. Tanaka, K. Tamura, A. Go & K. Nakaguchi, 2001. Preliminary faunistic survey of ophiuroids in the westernmost part of the Sea of Japan. *J. Fac. Appl. Biol. Sci. Hiroshima Univ.*, **40**: 1–14.
- Kato, K., 1947. About luminous ophiuroids. *Zool. Mag., Tokyo*, 57: 10. (In Japanese)
- Kato, T., 1993. Sea urchins of the Oki Islands. [Oki no Bunkazai], (10): 54–60. (In Japanese)
- Kato, T., 1998. *Catalogue of animal specimens of the Oki Islands in the Kato Collection — Gastropods Molluscs* —. Catalogue of the materials in the Shimane Prefectural Sanbe Shizenkan Open Field Museum, No. 3. The Foundation of Sanbe Field Museum, Ooda, Japan, 122 pp. (In Japanese)
- Kingston, S. C., 1980. The Swain Reefs Expedition: Ophiuroidea. *Rec. Austr. Mus.*, **33**: 123–147.
- Koehler, R., 1898. Échinodermes recueillis par “Investigateur” dans l’Océan Indien. Les Ophiures littorales. *Bull. Sci. Fr. Belg.*, **31**: 55–125, 4 pls.
- Koehler, R., 1904. Ophiures nouvelles ou peu connues. *Mem. Soc. Zool. Fr.*, **42**: 54–119.
- Koehler, R., 1905. Ophiures de l’Expédition du Siboga. 2^{ème} partie. Ophiures littorales. *Siboga-Exped.*, **45b**: 1–142, 18 pls.
- Koehler, R., 1922. Ophiurans of the Philippine Seas and adjacent waters. *Bull. Smiths. Inst. U. S. Natn. Mus.*, **100**: 51–486.
- Koehler, R., 1931. Papers from Dr. Th. Mortensen’s Pacific Expedition 1914–16. LIV. Ophiures recueillies par le Docteur Th. Mortensen dans les Mers d’Australie et dans l’Archipel Malais. *Vidensk. Med. Dansk. Naturhistor. Foren. Kjøbenhavn*, **89**: 1–295, 20 pls.
- Kogure, Y. 1999. Echinoderms from the lower-sublittoral zone on the north-western coasts of Sado Island, the Japan Sea. *Bull. Japan Sea Natn. Fish. Res. Inst.* (49): 57–67. (In Japanese with English abstract)
- Liao, Y. & A. M. Clark, 1995. *The Echinoderms of Southern China*. Science Press, Beijing, 614 pp., 23 pls.
- Ljungman, A. V., 1867. Om några nya arter af Ophiurider. *Öfvers. Kongl. Vetensk.-Akad. Forh., Stockholm*, 1866: 163–166.
- Lütken, C. F., 1872. Ophiuridarum novarum vel minus cognitatarum descriptiones nonnullae. *Overs. K. Dansk. Vidensk. Selsk. Förh.*, **77**: 75–158, 2 pls. [English version translated and slightly abridged by Dallas, W. S. in 1873. On spontaneous division in the Echinodermata and other Radiata. *Ann. Mag. Nat. Hist.*, (4), **12**: 323–334, 391–399.]
- Lyman, T., 1865. *Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College. No. 1. Ophiuridae and Astrophytidae*. Sever and Francis, Cambridge, 200 pp., 2 pls.
- Lyman, T., 1874. Ophiuridae and Astrophytidae, old and new. *Bull. Mus. Comp. Zool.*, **3**: 221–272, 7 pls.
- Marktanner-Turneretscher, G., 1887. Beschreibung neuer Ophiuriden und Bemerkungen zu bekannten. *Annal. K. Naturhistor. Hofmus.*, Wien, **2**: 291–315, 2 pls.
- Matsumoto, H., 1915. A new classification of the Ophiuroidea: with descriptions of new genera and species. *Proc. Acad. Nat. Sci. Phil.*, **67**: 43–92.
- Matsumoto, H., 1917. A monograph of Japanese Ophiuroidea, arranged according to a new classification. *J. Coll. Sci., Imp. Univ. Tokyo*, **38**: 1–408, 7 pls.
- Matsumoto, H., 1918. On a collection of ophiurans from the vicinity of Kinkwasan, with description of a new species. *Annot. Zool. Japon.*, **9**: 475–480.
- Matsumoto, H., 1941. Report of the biological survey of Mutsu Bay, 36. Ophiuroidea of the Mutsu Bay and vicinities. *Sci. Rep. Tohoku Imp. Univ.*, (4), **16**: 331–344.
- Miyaoka, K., 1997. Reef-building corals. [*Shimane no shizen*], (26): 5. (in Japanese)
- Mortensen, T., 1926. VI. Report on the Echinoderms. *Trans. Zool. Soc. Lond.*, (1): 117–131.
- Mortensen, T. 1933. Ophiuroidea. *Danish Ingolf-Exped.*, **4**: 1–121, 3 pls., 1 Table.
- Müller, J. & F. H. Troschel, 1842. *System der Asteriden*. Braunschweig, xx+134 pp.
- Murakami, S., 1942. Ophiurans of Izu, Japan. *J. Dept. Agr., Kyusyu Imp. Univ.*, **7**: 1–36.
- Murakami, S., 1943a. Report on the ophiurans of Palao, Caroline Islands. *J. Dept. Agr., Kyusyu Imp. Univ.*, **7**: 159–204.
- Murakami, S., 1943b. Report on the ophiurans of Yaeyama, Ryukyu. *J. Dept. Agr., Kyusyu Imp. Univ.*, **7**: 205–222.
- Murakami, S., 1943c. Ophiurans from some gulfs and bays of Nippon. *J. Dept. Agr., Kyusyu Imp. Univ.*, **7**: 223–234.
- Murakami, S., 1944. Note on the ophiurans of Amakusa Kyushu. *J. Dept. Agr., Kyusyu Imp. Univ.*, **7**: 259–279.
- Murakami, S., 1963. On some ophiurans from Kii and vicinities with description of a new species. *Publ. Seto Mar. Biol. Lab.*, **11**: 171–184.
- Okada, Y. & K. Kato, 1950. About two luminous animals in Japan. In Nakamura, K. (ed.), *Questions in Modern Biology*. Zoshindo, Tokyo, pp. 376–388. (In Japanese)
- Paterson, G. L. J., 1985. The deep-sea Ophiuroidea of the North Atlantic Ocean. *Bull. Br. Mus. (Nat. Hist.)*, *Zool.*, **49**: 1–162.
- Rho, B.-J., 1979. A study on the classification and the distribution of the echinoderms in Korea 1. Ophiuroids. *J. Korea. Res. Inst. Liv.*, **23**: 33–60.
- Rho, B.-J. & S. Shin, 1987. Systematic study on the Ophiuroidea from Cheju Island, Korea. *Korean J. Syst. Zool.*, **3**: 208–224.
- Rowe, F. W. E. & J. Gates, 1995. *Zoological Catalogue of Australia. Echinodermata*. CSIRO, Melbourne, 510 pp.

- Shin, S. & B.-J. Rho, 1996. *Illustrated Encyclopedia of Fauna & Flora of Korea. Vol. 36. Echinodermata*. The Ministry of Education, Seoul, 780 pp.
- Smith, A. B., G. L. J. Paterson & B. Lafay, 1995. Ophiuroid phylogeny and higher taxonomy: Morphological, molecular and palaeontological perspectives. *Zool. J. Linn. Soc.*, **114**: 213–243.
- Vail, L. L. & F. W. E. Rowe, 1989. Status of the genera *Ophiopeza* and *Ophiopsammus* (Echinodermata: Ophiuroidea) in Australian waters, with the description of a new species. *Proc. Linn. Soc. N. S. W.*, **110**: 267–288.
- Yi, S.-K., 1983. Studies on the Ophiuroidea in the coastal waters of Korea I. Amphiuroidae. *Bull. Korea Ocean Res. Dev. Inst.*, **5**: 9–17.
- Yi, S.-K. & S. Irimura, 1987. A taxonomic study on the Ophiuroidea from the Yellow Sea. *Korea. J. Syst. Zool.*, **3**: 117–136.