国立科博専報, (47) : 65–81, 2011年4月15日
Mem. Natl. Mus. Nat. Sci., Tokyo, (47): 65–81, April 15, 2011

Chitons (Mollusca: Polyplacophora) from Submarine Banks off Izu Islands and Bōsō Peninsula, Japan

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Abstract. Chitons collected from submarine banks off the northern Izu Islands and Bōsō Peninsula by various cruises from 1970 to 2003 were examined taxonomically. In total, 14 species belonging to 13 genera in 8 families were recognized, including one new *Leptochiton* species which is described as *L. bergenhayni* n. sp. herein, and one undetermined species of the genus *Tegulaplax*. Of the 14 species, additional descriptions and/or illustrations of taxonomically important morphology are given for two less known species, *Leptochiton aequispinus* (Bergenhayn, 1933) and *Connexochiton kaasi* (Saito, 1997). The latter species, *C. kaasi* is the first record from outside the type locality. Except for one species, *Ischnochiton albinus* Thiele, 1911, which is also distributed in the Tropical West Pacific, 12 species were regarded to be endemic in the sublittoral zone of warm water areas around the Japanese Islands and/or the East China Sea, while one species, *Tegulaplax* sp. has an indeterminate distribution.
Key words: chiton, Japan, submarine bank, new species, fauna.

Introduction

The Izu Islands extend southward from the mouth of Sagami Bay off the Pacific coast of central Honshū Island, as a part of the Izu-Bonin-Mariana island arc. There are several small submarine banks around the islands, the tops of which are usually almost flat and lie 80–200 m deep, and which are isolated from the series of islands by depressions deeper than 200 m (Okutani, 1972). The rich molluscan fauna of these banks and its peculiarity has been studied by several researchers (e.g. Niino, 1955; Horikoshi, 1957; Okutani, 1963; 1972). However the chiton fauna of this area is not yet well known. Bergenhayn (1933) reported 27 species (including two subspecies) of chitons collected by the Swedish "Dr Sixten Bock Expedition" in 1914–1916 from the intertidal zone to a depth of 600 m in Sagami Bay area and the Ogasawara (Bonin) Islands area, and four species among them are collected from Okinose Bank (= Okinoyama Bank) off the tip of Bōsō Peninsula, which is included in the present survey area. Subsequently, Wu and Okutani (1984; 1985; 1995) reported the deep-sea chitons collected by the R/V *Sōyō Maru* during 1957–1982 and recorded seven species from the bank area. Among the seven species reported by Wu and Okutani, two species were also recorded by Bergenhayn (1933). The present author recorded three species from the bank area (Saito, 2000), all of which are recorded by the previous authors. In total, nine chiton species are known from this area to date.

The National Museum of Nature and Science, Tokyo (formerly National Science Museum) conducted a research project, "Study on environmental changes in Sagami Sea and adjacent coastal area with time serial comparison of fauna and flora" for six years from 2000 to 2006, which was succeeded by another project "Studies on the origin of biodiversity in the Sagami Sea, Fossa Magna element and the Izu-Ogasawara (Bonin) arc" for four years from 2007–2010. Undertaken as part of these projects, the author examined chitons collected from three submarine banks around the northern Izu Islands, namely Ōmurodashi Bank, Takase Bank and Hyōtanse Bank, as well

as Okinoyama Bank located in the Sagami Sea area for comparison. This paper reports the results of the taxonomic study of chitons collected from these submarine banks.

Materials and Methods

In total, 202 specimens in 102 lots were examined, which were collected by the following ships: R/V *Sōyō Maru* of the Tokai Regional Fisheries Research Laboratory (currently National Research Institute of Fisheries Science, Fisheries Research Agency), R/V *Tansei Maru* of the University of Tokyo (currently belonging to Japan Agency for Marine-Earth Science and Technology), and T/S *Shinyo Maru* of Tokyo University of Fisheries (currently Tokyo University of Marine Science and Technology). The sampling area and the position of the sampling sites are shown in Fig. 1 and Table 1, respectively.

The method of examination, including SEM preparation and observation follows Saito (1997). All specimens are deposited in the molluscan collection of the Department of Zoology, National Museum of Nature and Science, Tokyo.

The systematic arrangement used in this paper follows Sirenko (2006).

List of species

Class **Polyplacophora**
Order **Lepidopleurida** Thiele, 1909
Suborder **Lepidopleurina** Thiele, 1909
Family **Leptochitonidae** Dall, 1889
Genus ***Leptochiton*** Gray, 1847

Leptochiton aeqiuspinus (Bergenhayn, 1933) [Japanese name: Toge-samehada-hizaragai] (Figs.

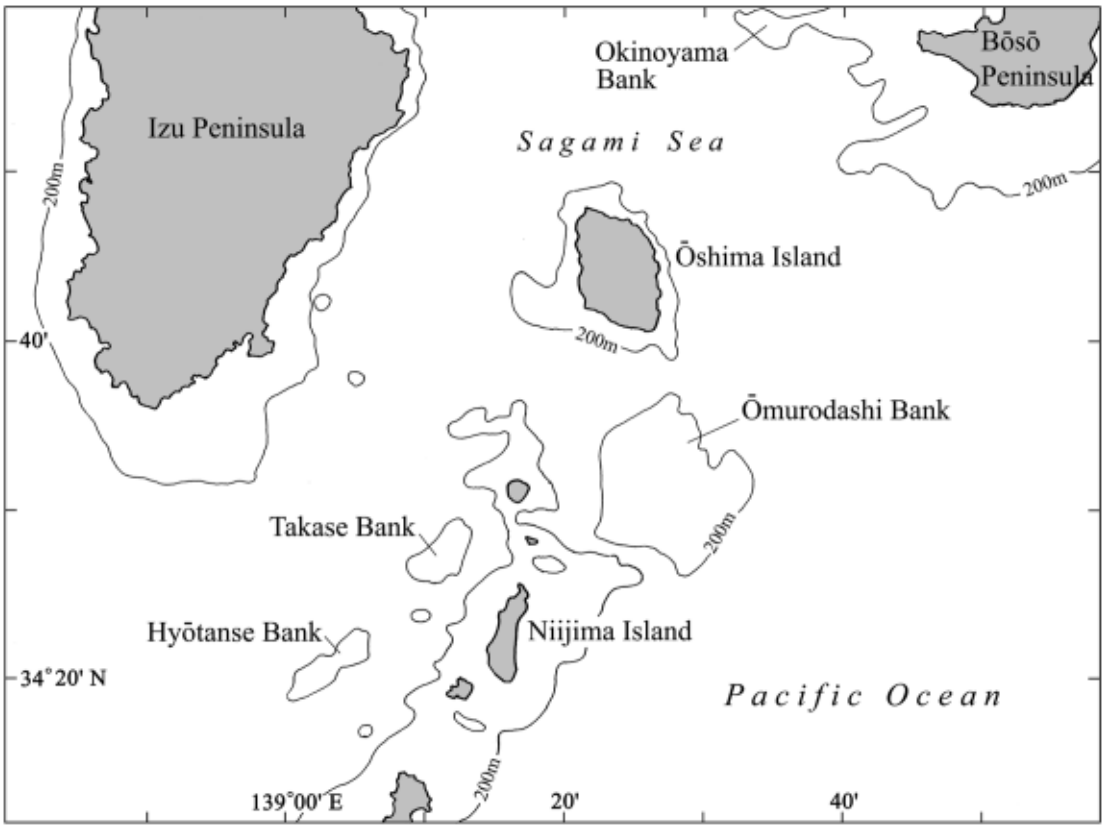

Fig. 1. Sampling area.

Table 1. List of sampling stations.

Station	Date	Locality	Position in		Position out		Depth (m)
			Latitude	Longitude	Latitude	Longitude	
KT-87-19 OM-2	10 Dec. 1987	OM	34°29.8′N	139°29.3′E	34°30.1′N	139°29.4′E	92–95
KT-87-19 OK-1	10 Dec. 1987	OK	34°57.9′N	139°35.6′E	34°58.1′N	139°35.6′E	86–88
KT-95-17 OM-2	13 Dec. 1995	OM	—	—	—	—	119–121
KT-97-7 OY-1	04 June 1997	OK	—	—	—	—	104
KT-97-7 OY-2	04 June 1997	OK	—	—	—	—	344–358
SO71-D63	04 Aug. 1971	OM	34°32.9′N	139°26.9′E	—	—	85
SO71-D64	04 Aug. 1971	OM	34°33.5′N	139°26.8′E	—	—	90–95
SO71-D66	20 Nov. 1971	OM	—	—	—	—	112
SO72-D4(17)	26 June 1972	OM	34°28.1′N	139°27.5′E	—	—	145
SO72-D5(17)	26 June 1972	OM	34°28.4′N	139°24.3′E	—	—	184
SO72-D6(17)	26 June 1972	OM	34°30.9′N	139°24.2′E	—	—	123
SO89-4	14 July 1989	OM	34°34.9′N	139°28.7′E	—	—	90
SY89-1	10 Sep. 1989	OM	34°32.45′N	139°27.27′E	—	—	90
SY89-7	10 Sep. 1989	OM	34°28.50′N	139°28.40′E	—	—	117
SY89-8	10 Sep. 1989	OM	34°28.06′N	139°25.98′E	—	—	117
SY89-9	11 Sep. 1989	T	34°28.64′N	139°12.26′E	—	—	105
SY89-10	11 Sep. 1989	T	34°26.78′N	139°11.27′E	—	—	99
SY89-11	11 Sep. 1989	T	34°26.21′N	139°09.75′E	—	—	112
SY89-12	11 Sep. 1989	H	34°22.35′N	139°05.26′E	—	—	109
SY89-13	11 Sep. 1989	H	34°21.20′N	139°03.71′E	—	—	128
SY89-14	11 Sep. 1989	H	34°19.74′N	139°02.02′E	—	—	129
SY90-3	10 Sep. 1990	T	34°28.32′N	139°11.98′E	—	—	167
SY90-5	10 Sep. 1990	T	34°27.61′N	139°12.70′E	—	—	135
SY90-6	10 Sep. 1990	T	34°26.65′N	139°12.49′E	—	—	143
SY90-7	10 Sep. 1990	T	34°27.97′N	139°10.81′E	—	—	191
SY90-9	10 Sep. 1990	T	34°26.62′N	139°09.11′E	—	—	166
SY90-10	10 Sep. 1990	T	34°26.69′N	139°11.02′E	—	—	71
SY90-12	10 Sep. 1990	T	34°25.72′N	139°09.66′E	—	—	223
SY91-1	17 Oct. 1991	OM	34°31.66′N	139°28.98′E	—	—	90
SY91-2	17 Oct. 1991	OM	34°31.35′N	139°25.39′E	—	—	121–126
SY91-3	17 Oct. 1991	OM	34°31.44′N	139°22.70′E	—	—	202–219
SY91-7	18 Oct. 1991	OK	34°59.00′N	139°34.47′E	—	—	79–80
SY91-10	18 Oct. 1991	OM	34°57.82′N	139°35.20′E	—	—	76
SY93-1	17 Oct. 1993	T	34°25.84′N	139°10.20′E	34°25.82′N	139°10.25′E	154–157
SY93-5	18 Oct. 1993	H	34°21.49′N	139°04.84′E	34°21.41′N	139°05.05′E	135–140
SY93-7	18 Oct. 1993	H	34°20.78′N	139°03.90′E	34°20.71′N	139°04.13′E	192–199
SY93-8	18 Oct. 1993	H	34°20.16′N	139°02.26′E	34°20.02′N	139°02.45′E	124–126
SY93-10	18 Oct. 1993	OM	34°30.18′N	139°23.93′E	34°30.36′N	139°24.01′E	127–129
SY93-12	18 Oct. 1993	OM	34°33.20′N	139°23.33′E	34°33.40′N	139°23.43′E	135–132
SY93-14	18 Oct. 1993	OM	34°35.43′N	139°25.48′E	34°35.66′N	139°25.61′E	187–204
SY95-1	21 Oct. 1995	OM	34°34.53′N	139°28.08′E	34°34.72′N	139°27.87′E	98–86
SY95-2	21 Oct. 1995	OM	34°32.72′N	139°27.72′E	34°32.57′N	139°27.65′E	86–88
SY95-3	21 Oct. 1995	OM	34°31.45′N	139°27.69′E	34°31.15′N	139°27.51′E	90
SY95-7	21 Oct. 1995	OM	34°34.93′N	139°25.04′E	34°34.96′N	139°24.96′E	131–155
SY96-2	22 Oct. 1996	H	34°21.80′N	139°04.75′E	34°22.07′N	139°04.87′E	135–135
SY96-3	22 Oct. 1996	H	34°20.93′N	139°04.78′E	34°20.83′N	139°04.88′E	160–160
SY96-4	22 Oct. 1996	H	34°20.87′N	139°03.77′E	34°20.78′N	139°04.13′E	183–192
SY96-5	22 Oct. 1996	H	34°20.73′N	139°03.03′E	34°20.68′N	139°03.29′E	125–131
SY96-7	23 Oct. 1996	T	34°26.80′N	139°11.17′E	34°27.04′N	139°11.22′E	87–93
SY96-8	23 Oct. 1996	T	34°27.59′N	139°11.92′E	34°27.73′N	139°11.94′E	104–109
SY96-9	23 Oct. 1996	OM	34°26.73′N	139°30.86′E	34°25.89′N	139°30.44′E	333–350
SY96-11	23 Oct. 1996	OM	34°26.50′N	139°35.06′E	34°25.14′N	139°33.79′E	464–490
SY96-19	24 Oct. 1996	OK	34°58.47′N	139°34.13′E	34°58.16′N	139°34.26′E	129–121
SY96-20	24 Oct. 1996	OK	34°57.18′N	139°33.12′E	34°53.88′N	139°34.56′E	190–450
SY03-9	18 Oct. 2003	OK	34°55.5′N	139°40.2′E	34°55.4′N	139°40.5′E	375–275
SY03-10	18 Oct. 2003	OK	34°54.8′N	139°39.7′E	34°54.8′N	139°39.9′E	348–312

Abbreviations for localities: H, Hyōtanse Bank; OK, Okinoyama Bank; OM, Ōmurodashi Bank; T, Takase Bank.

2A–D, 3)

Materials. 66 specimens in total, 5.1–12.9 mm in body length (BL). Okinoyama Bank: 1 ex., NSMT-Mo 77220, SY91-7; 1 ex., NSMT-Mo 77221, SY96-19; 3 ex., NSMT-Mo 77222, KT97-7-OY2. Ōmurodashi Bank: 1 ex., NSMT-Mo 77223, SO71-D66; 5 ex., NSMT-Mo 77224, SO72-D4; 3 ex., NSMT-Mo 77225, SO72-D5; 1 ex., NSMT-Mo 77226, SO72-D6; 1 ex., NSMT-Mo 77227, SY89-1; 3 ex., NSMT-Mo 77228, SY89-8; 2 ex., NSMT-Mo 77229, SY91-2; 2 ex., NSMT-Mo 77230, SY91-3; 1 ex., NSMT-Mo 77231, SY93-10; 4 ex., NSMT-Mo 77232, SY93-12; 4 ex., NSMT-Mo 77233, SY93-14; 1 ex., NSMT-Mo 77234, SY95-2; 1 ex., NSMT-Mo 77235, SY95-3; 7 ex., NSMT-Mo 77236, SY95-7; 1 ex., NSMT-Mo 77237, KT95-17-OM2. Takase Bank: 1 ex., NSMT-Mo 77238, SY89-9; 2 ex., NSMT-Mo 77239, SY89-11; 1 ex., NSMT-Mo 77240, SY90-3; 2 ex., NSMT-Mo 77241, SY90-7; 1 ex., NSMT-Mo 77242, SY90-9; 1 ex., NSMT-Mo 77243, SY93-1. Hyōtanse Bank: 1 ex., NSMT-Mo 77244, SY89-12; 2 ex., NSMT-Mo 77245, SY89-13; 2 ex., NSMT-Mo 77246, SY93-5; 4 ex., NSMT-Mo 77247, SY93-7; 1 ex., NSMT-Mo 77248, SY93-8; 5 ex., NSMT-Mo 77249, SY96-2; 1 ex., NSMT-Mo 77250, SY96-3.

Additional material examined. Holotype of *Lepidopleurus aequispinus*, Museum of Evolution, zoology, Uppsala University Evolutionary Biology Centre, collection 'Bock' No. 142. ca. 10 mm in BL (curled), Okinose, 300 m.

Distribution. Okinoyama Bank, Sagami Sea, 300–600 m (type locality); Sagami Bay, 92–391 m (Saito, 2006); Submarine banks off northern Izu Islands, 79–358 m (present study); Suruga Bay, 92–200 m (Saito, 1997), Tosa Bay, 144–319 m (Saito, 2001).

Remarks. This species was regarded as a synonym of either *Leptochiton alveolus* (Lovén, 1846) (Ferreira, 1979; Kaas and Van Belle, 1985) or *Leptochiton belknapi* Dall, 1878 (Kaas and Van Belle, 1987). The present author regarded this taxon as a distinct species and showed the detailed morphology for the taxonomic features (Saito, 1997), although the holotype of *Lepidopleurus aequispinus* Bergenhayn, 1933 was not examined in that work. Subsequently, four unidentified *Leptochiton* species were found from the Sagami Bay (Saito, 2007), and also another congener was found in the sample treated herein (see the next species). To identify these species, the holotype of *L. aequispinus* deposited in the Museum of Evolution, Uppsala University, was examined. Among the specimens collected in the present study, which have considerable variations in valve sculpture and girdle armatures, the morphology of two specimens (KT97-7-OY2: Okinoyama Bank, 344–358 m, Fig. 2A, B, 3) collected from near the type locality (Okinose=Okinoyama Bank, 300 m) matches especially well with that of the holotype (Fig. 2C, D). Saito (2007) employed the straight anterior margin of the median valves to distinguish the present species from *L. alveolus*. The anterior margin of the present specimen is weakly concave but not as strong as that of *L. alveolus*. The central tooth of the radula is wider, and the centro-lateral (first lateral) tooth is lower than those of *L. alveolus*. The present species differs from *L. belknapi* by its lower and thinner valves, lack of the diagonal depression lines on the central area, and also the bathymetrical range of distribution (92–600 m in *L. aequispinus*, 1840 m in *L. belknapi*).

***Leptochiton bergenhayni* n. sp.** [Jn.: Shiromadara-samehada-hizaragai] (Figs. 2E–F, 4)

Holotype. NSMT-Mo 77251, ca. 11 mm (curled) in BL., KT-87-19 OM-2.

Paratypes. Okinoyama Bank: 1 ex., NSMT-Mo 77252, 7.6 mm in BL., KT-87-19 OK-1. Ōmurodashi Bank: 1 ex., NSMT-Mo 77253, ca. 11 mm in BL., same locality with holotype; 1 ex., NSMT-Mo 77254, 9.3 mm in BL., SO89-4; 1 ex., NSMT-Mo 77255, 7.0 mm in BL., SY89-1. Takase Bank: 1 ex., NSMT-Mo 77256, 8.7 mm in BL., SY89-9; 1 ex., NSMT-Mo 77257, 8.8 mm in BL., SY90-10.

Type locality. Ōmurodashi Bank, 34°29.8′N, 139°29.3′E–34°30.1′N, 139°29.4′E, 92–95 m.

Etymology. The species name is dedicated to

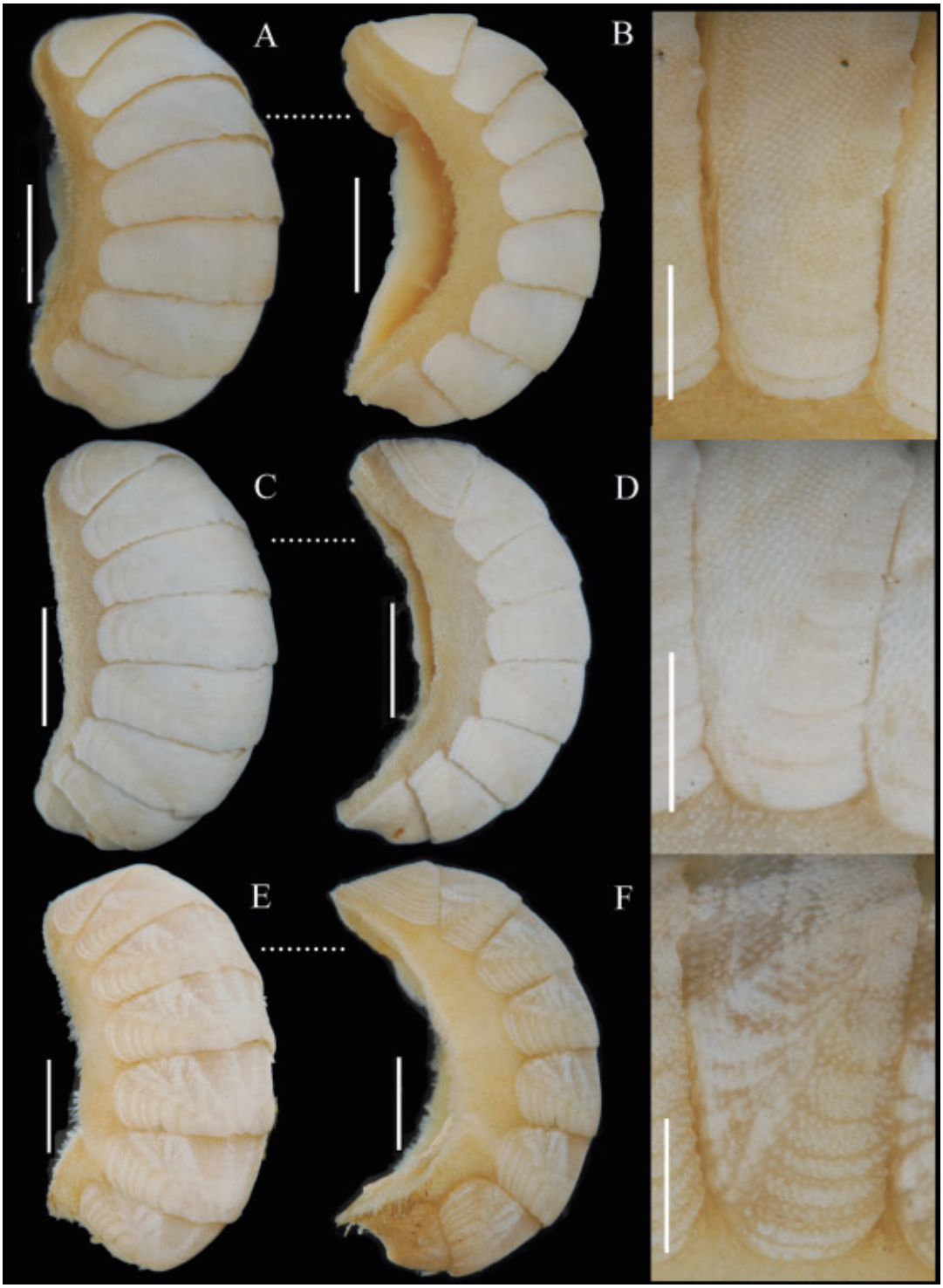

Fig. 2. *Leptochiton* spp. A and B, *Leptochiton aequispinus*, NSMT-Mo 77222; C and D, *Leptochiton aequispinus*, holotype; E and F, *Leptochiton bergenhayni* n. sp., holotype, NSMT-Mo 77251. B, D and F valve IV. Scale for A, C and E, 5 mm; for B, D and F, 1 mm.

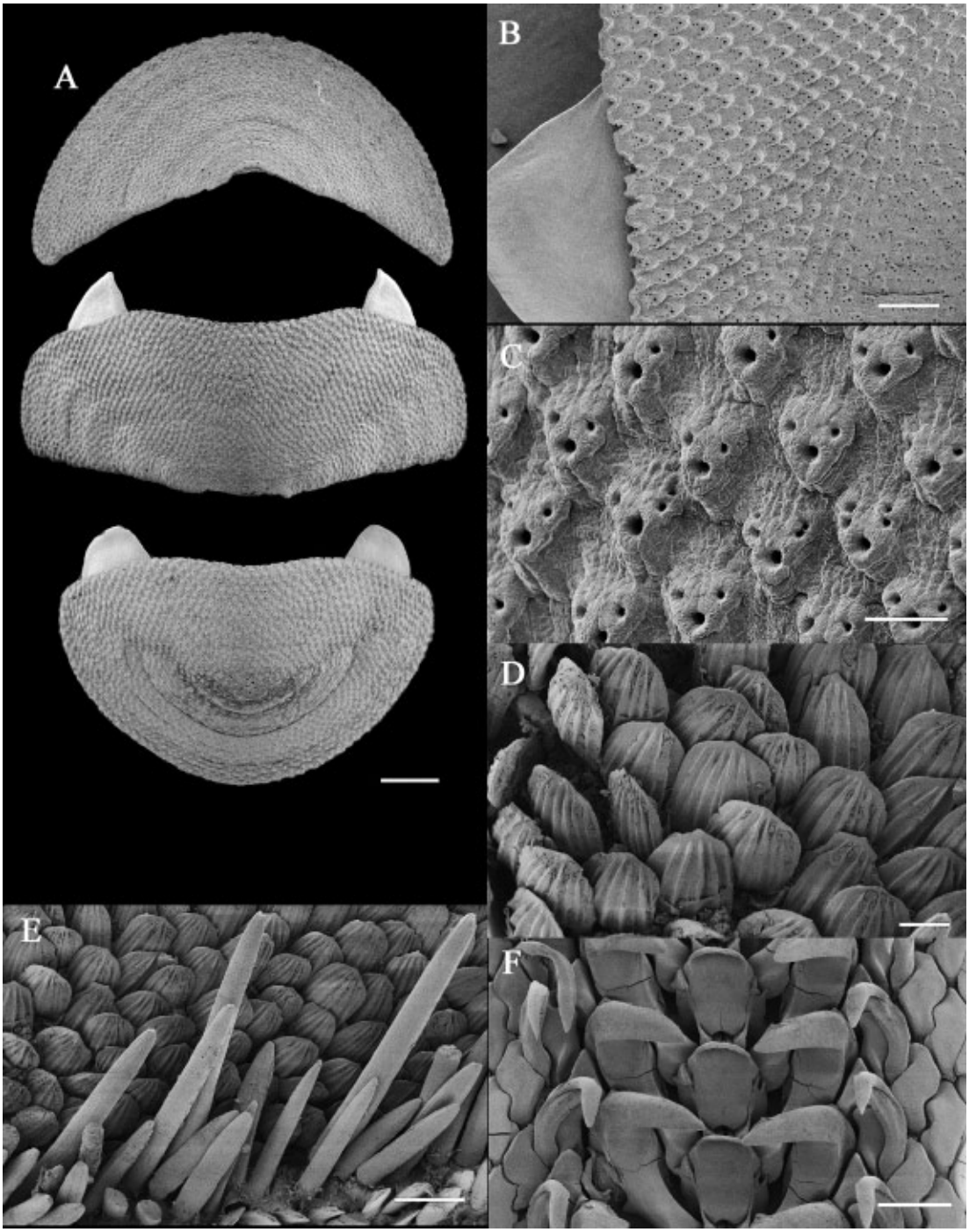

Fig. 3. *Leptochiton aequispinus*, NSMT-Mo 77222. A, valves I, IV and VIII, scale=500 μm; B, sculpture of valve IV, scale=200 μm; C, central area of valve VI, showing aesthete pores on granules, scale=50 μm; D, perinotum, scale=20 μm; E, girdle margin, scale=50 μm; F, radula, scale= 100 μm.

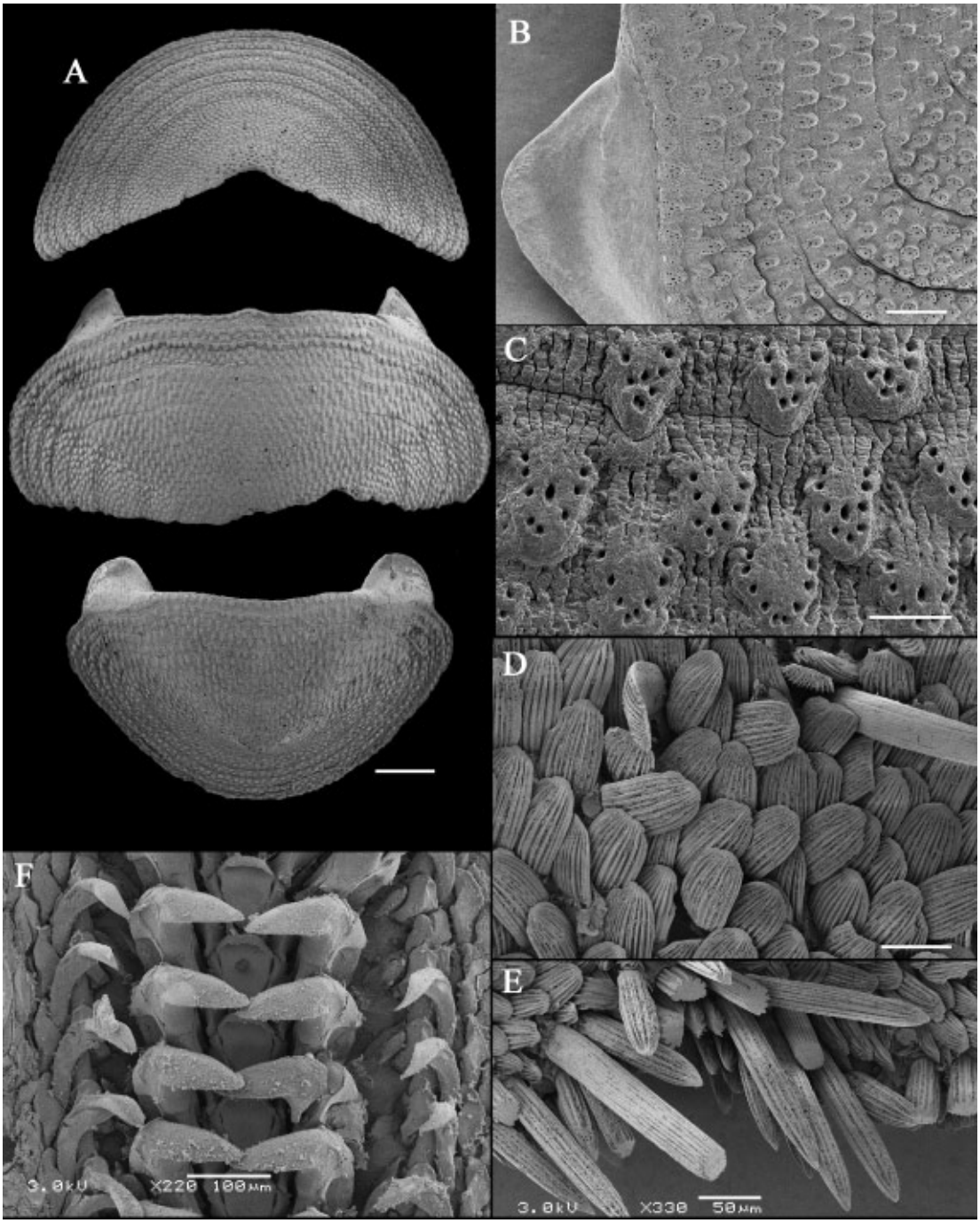

Fig. 4. *Leptochiton bergenhayni* n. sp. holotype, NSMT-Mo 77251. A, valves I, IV and VIII, scale=500 μm; B, sculpture of valve IV, scale=200 μm; C, central area of valve VI, showing aesthete pores on granules, scale=50 μm; D, perinotum, scale=50 μm; E, girdle margin, scale=50 μm; F, radula, scale= 100 μm.

Dr. J. Richard M. Bergenhayn (1889-1966) who studied the chitons in the present survey area.

Description. Body medium in size, elongate oval in outline. Valves moderately elevated. Color of tegmentum beige with irregular white maculation (Fig. 2E, F).

Head valve semicircular, anterior slope almost straight. Median valves broadly rectangular with straight posterior margin, evenly rounded in anterior view. Tail valve semicircular, apparently narrower than head valve. Mucro central with steep, concaved posterior slope (Figs. 2E, 4A).

Tegmentum finely granulose (Fig. 4A–C). On head valve, lateral areas of median valves and postmucronal area of tail valve, granules roundish or semicircular, densely arranged in quincunx order. On central areas of median valves and antemucronal area of tail valve, granules slightly larger than other areas, oval or bell shaped, neatly separated, arranged in quincunx order. Each granule with one central macraesthete pore and four (3–5) micraesthete pores on each side (8–10 in total).

Sutural laminae small, triangular in median valves, roundish in tail valve, widely separated from each other.

Perinotum densely clothed with elongate, obtusely pointed scales, sculptured with 10–12 raised riblets, 92–105 μm in length, 39–48 μm in width (Fig. 4D), intermingling with long needles which are 230–256 μm in length, 23–32 μm in width, and finely grooved. Marginal spicules similar to those on perinotum, but with deeper grooves (Fig. 4E). Hyponotum clothed with elongate, flat, obtusely pointed scales, which are keeled at distal half, 87–100 μm in length, 27–34 μm in width. Distal keel faint on scales near pallial groove, more prominent on those near girdle margin.

Gills melobranchial, adanal type, with 12 on each side.

Radula 4.3 mm in length with 27 transeverse rows of teeth. Central tooth large, roughly squalish, with narrow blade at top. Head of major lateral teeth unicuspid, sharply pointed at tip. Major uncinus very narrow (Fig. 4F).

Distribution. Only known from the submarine banks off northern Izu Islands and off Bōsō Peninsula, 71–105 m deep, in gravel/shell substrate.

Remarks. This species resembles *Leptochiton aequispinus* (Bergenhayn, 1933) by its round backed valves sculptured with fine granules arranged in quincunx order. But the present species is separable from the latter by the white maculation of its valves, the shape of granules on the tegmentum, and larger number of the micraesthetes on the granules.

Genus ***Parachiton*** Thiele, 1909

Parachiton shinyomaruae Saito, 1996 [Jn.: Hime-shiributo-hizaragai]

Material. Takase Bank: 1 ex., NSMT-Mo 77258, 5.6 mm in BL, SY96-7.

Distribution. Off Banda, Bōsō Peninsula, 38 m (type locality); Takase Bank, 87-93 m (present study); Yaneo-jima Island, Gotō Islands, 20 m (Saito, 1998).

Genus ***Hanleyella*** Sirenko, 1973

Hanleyella japonica Saito, 1997 [Jn.: Tsuyuoki-hizaragai] (Fig. 5A)

Material. Okinoyama Bank: 1 ex., NSMT-Mo 77259, 4.6 mm in BL, SY96-20.

Distribution. Ōtsuchi Bay (Saito and Tsuchida, 1998), 80–85 m; Sagami Sea, 160–698 m (Saito, 2006); Suruga Bay, 370–400 m (Saito, 1997); Tosa Bay, 300–302 m (Saito, 2001).

Family **Protochitonidae** Ashby, 1825

Genus ***Deshayesiella*** Carpenter in Pilsbry 1898

Deshayesiella bidentata (Is. Taki, 1938) [Jn.: Futaba-hizaragai]

Material. Ōmurodashi Bank: 1 ex., NSMT-Mo 77260, ca. 30 mm in BL, SY93-10.

Distribution. Sagami Bay, 100–140 m (type locality); Sagami Bay, 225–313 m (Saito, 2006); Off Bōsō Peninsula (Horikoshi, 1988); Ōmurodashi Bank, 127-129 m (present study);

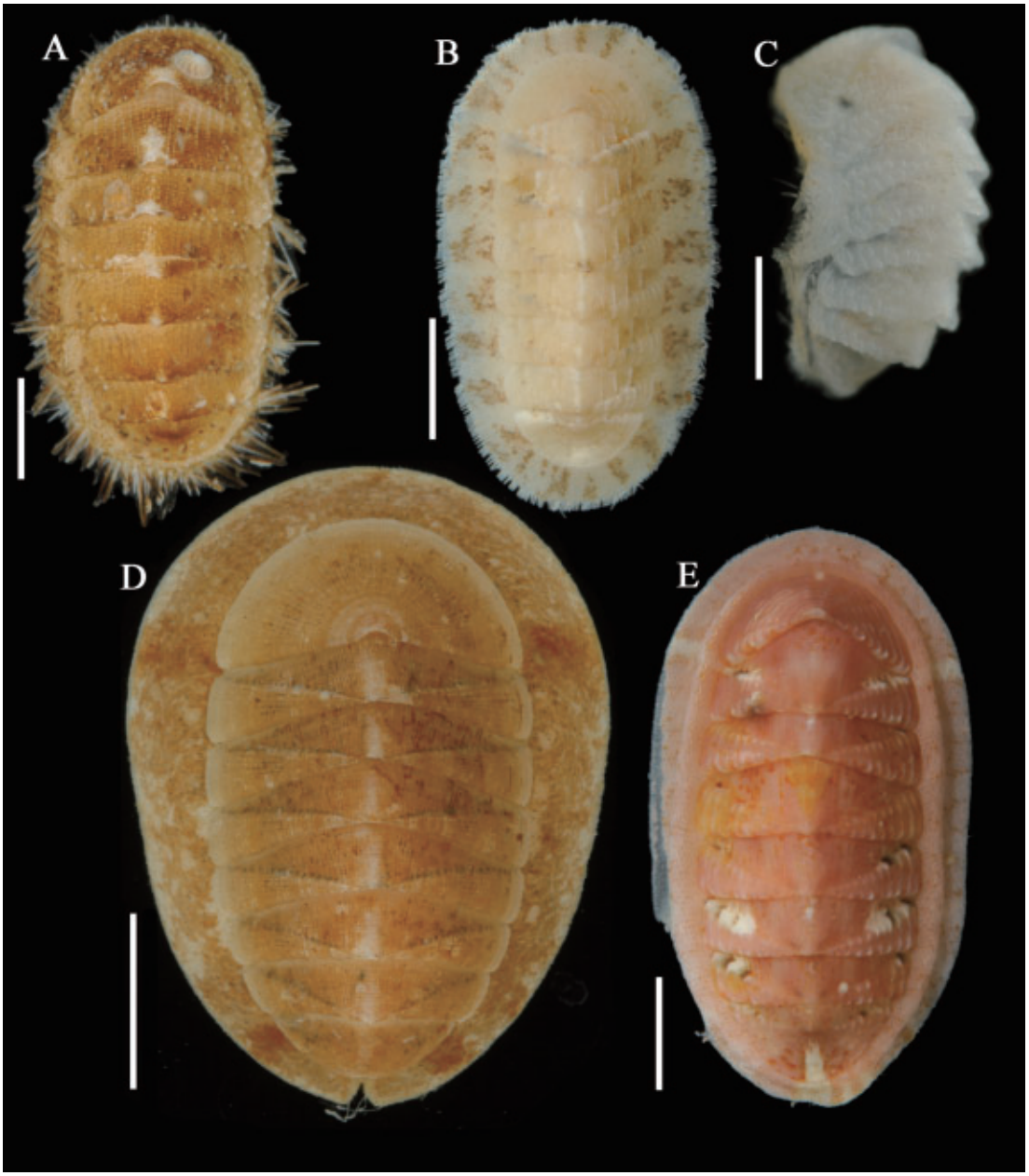

Fig. 5. Whole animals, dorsal view. A, *Hanleyella japonica*, NSMT-Mo 77259, BL. 4.2 mm; B, *Callochiton* (*Icoplax*) *septemcostatus*, NSMT-Mo 77266, BL. 8.2 mm; C, *Connexochiton kaasi*, NSMT-Mo 77267, BL 1.5 mm; D, *Loricella scissulata*, NSMT-Mo 77297, BL. 19.5 mm; E, *Tegulaplax* sp. cf. *boucheti*, NSMT-Mo 77298, BL. 9.8 mm.

Suruga Bay, 551–654 m (disarticulate median valve, Saito, 1997); Tsugaru Strait (Saito, 2000); North off Tobishima Island, Sea of Japan, 122–137 m (Suzuki, 1979); Off Amakusa Islands, west coast of Kyūshū, 100–150 m (Higo and Goto, 1993); West of Amami-Ōshima Island., East China Sea, 167–170 m (Saito, 2005).

Order **Chitonida** Thiele, 1910
Suborder **Chitonina** Thiele, 1910
Family **Callochitonidae** Plate, 1901
Genus ***Callochiton*** Gray, 1847

Callochiton* (*Icoplax*) *septemcostatus Bergenhayn, 1933 [Jn.: Ashigata-hizaragai] (Fig. 5B)

Materials. 9 specimens in total, 5.2–9.1 mm in BL. Takase Bank: 1 ex., NSMT-Mo 77261, SY89-9; 2 ex., NSMT-Mo 77262, SY89-10; 1 ex., NSMT-Mo 77263, SY90-5; 1 ex., NSMT-Mo 77264, SY90-6; 2 ex., NSMT-Mo 77265, SY96-7. Hyōtanse Bank: 2 ex., NSMT-Mo 77266, SY89-14.

Distribution. Okinose (Okinoyama Bank), 150 m (type locality); Submarine banks off northern Izu Islands, 87–135 m (present study).

Remarks. This species is easily recognized by the sculpture of the valves, which has several longitudinal riblets on the pleural and antemucronal areas, and the short imbricating girdle spicules. The coloration of the valves and the girdle is less variable, all specimens have light brown or beige valves of the same color as the girdle, with irregular brownish bands on the girdle.

Family **Ischnochitonidae** Dall, 1889
Genus ***Connexochiton*** Kaas, 1979

Connexochiton kaasi Saito, 1996 [Jn.: Matsukasa-hizaragai] (Figs. 5C, 6)

Material. Takase Bank: 1 ex., NSMT-Mo 77267, ca. 1.5 mm in BL, SY93-1.

Distribution. Only known from the type locality, Senoumi Bank, Suruga Bay, 90 m and Takase Bank, 154–157 m (present study).

Remarks. The present specimen is a juvenile (1.5 mm in body length) but identifiable with the present species by the shape of the valves, arrangement of the aesthetes on the granules, especially the elongate aesthetes caps, and strongly ribbed dorsal girdle scales (Fig. 6A–C). The radula morphology of this species was not well documented in the original description because the radula was lost during the preparation for SEM observation (Saito, 1997). The features of the radula of the present specimen are as follows (Fig. 6D): The central tooth is narrow, with weakly expanded lateral margin at the base, keeled along midline with a small cusp at the tip. The centro-lateral (1st lateral) tooth with wing like cusp which is folded medially. The major lateral tooth with unicuspid head, but with a small cusp at the inner edge of the base, and with a petaloid process at the medial side of the shaft. The major uncinus is long with narrow blade. Those features are quite similar to those of the type species, *Connexochiton platynomenus* Kaas, 1979, and also "*Ischnochiton*" *crassus* Kaas, 1985 from off New Caledonia (Sirenko, 2008). Other species have been attributed to *Connexochiton* on the basis of valve shape, but which are found in Atlantic and Caribbean waters and also have radulae with a tricuspid major lateral: *C. bromleyi* (Ferreira, 1985) (Kaas and Van Belle, 1987), *C. moreirai* (Righi, 1973) (Kaas and Van Belle, 1990). Besides the appearance of the valves, features of the aesthetes and the radula appear to be the diagnostic generic features of *Connexochiton*. Further studies are needed for correct assignment of those "*Connexochiton*" and "*Ischnochiton*" species.

Genus ***Ischnochiton*** Gray, 1847

Ischnochiton albinus Thiele, 1911 [Jn.: Shiratama-hizaragai]

Materials. 5 specimens in total, 3.5–5.4 mm in BL. Takase Bank: 2 ex., NSMT-Mo 77268, SY89-9; 1 ex., NSMT-Mo 77269, SY89-11; 1 ex., NSMT-Mo 77270, SY96-7. Hyōtanse Bank, 1 ex., NSMT-Mo 77271, SY89-12.

Distribution. Western Australia (type locality); Gotō Islands and southward to Nansei Islands, Vietnam (Saito, 2000), Takase and Hyōtanse Banks, 87–112 m (present study); Mindoro Island, Philippines (Saito, 2006), Maldive Islands (Del'Angello *et al*, 2010).

Genus ***Lepidozona*** Pilsbry, 1892

Lepidozona amabilis (Berry, 1917) [Jn.: Aka-ya-

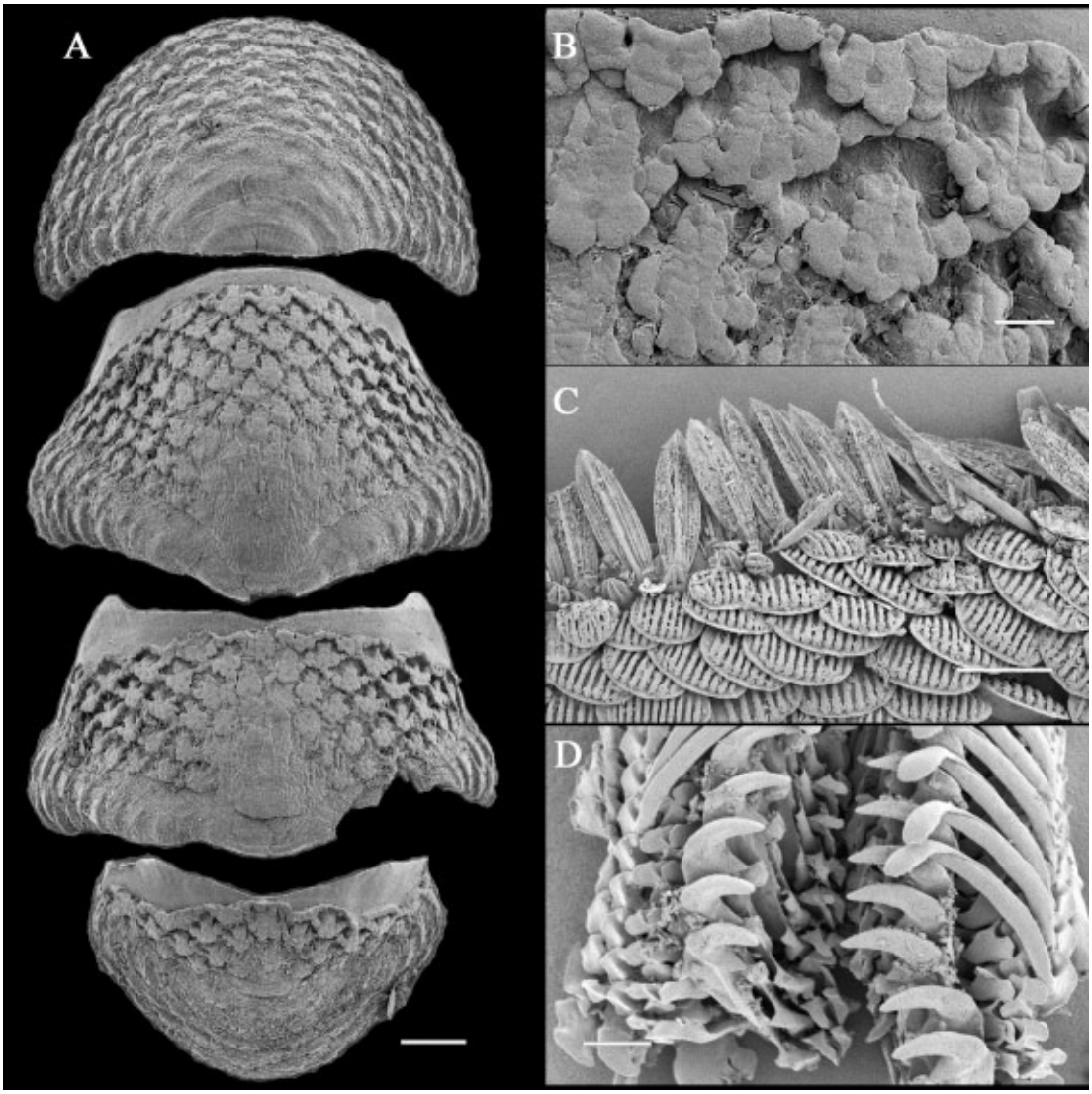

Fig. 6. *Connexochiton kaasi*, NSMT-Mo 77267, BL 1.5 mm. A, valves I, II, IV, VIII, scale=100 μm; B, central area of valve VI, showing aesthete caps, scale=20 μm; C, perinotum and marginal fringe, scale=500 μm; D, radula, scale=10 μm.

suri-hizargai]

Materials. 71 specimens in total, 4.1–24.0 mm in BL. Okinoyama Bank: 1 ex., NSMT-Mo 77272, SY91-7; 2 ex., NSMT-Mo 77273, SY96-19; 1 ex., NSMT-Mo 77274, KT87-19-OK1. Ōmurodashi Bank: 1 ex., NSMT-Mo 77275, SO71-D63; 2 ex., NSMT-Mo 77276, SO71-D64; 2 ex., NSMT-Mo 77277, KT87-19-OM2; 10 ex., NSMT-Mo 77278, SY89-1; 1 ex., NSMT-Mo 77279, SY91-1; 18 ex., NSMT-Mo 77280, SY95-1; 11 ex., NSMT-Mo 77281, SY95-2; 4 ex., NSMT-Mo 77282, SY95-3. Takase Bank: 2 ex., NSMT-Mo 77283, SY89-10; 1 ex., NSMT-Mo 77284, SY89-11; 1 ex., NSMT-Mo 77285, SY90-9; 5 ex., NSMT-Mo 77286, SY96-7; 3 ex., NSMT-Mo 77287, SY96-8. Hyōtanse Bank: 1 ex., NSMT-Mo 77288, SY89-12; 1 ex., NSMT-Mo 77289, SY89-13; 1 ex., NSMT-Mo 77290, SY89-

14; 1 ex., NSMT-Mo 77291, SY93-7; 1 ex., NSMT-Mo 77292, SY96-2; 1 ex., NSMT-Mo 77293, SY96-4; 1 ex., NSMT-Mo 77294, SY96-5.

Distribution. Tsugaru Strait (type locality); Onagawa Bay, Pacific coast of northern Honshū; Sagami Bay; Suruga Bay; Izu Islands; Amakusa Island, west coast of Kyūshū, 9–600 m (Saito, 2001); West of Amami-Ōshima Island, East China Sea, 167-170 m (Saito, 2005).

Remarks. Bergenhayn (1933) described *Lepidozona sahlini* and *Lepidozona pallida* from the present survey area. Wu and Okutani (1985) recorded *L. sahlini* in the present bank area, but synonymized *L. pallida* with the present species. Kaas and Van Belle (1987) also regarded *L. sahlini* to be a junior synonym of the present species. The author considers both *L. sahlini* and *L. pallida* as synonyms of *L. amabilis*.

Family **Loricidae** Iredale and Hull, 1923
Genus ***Loricella*** Pilsbry, 1893

Loricella scissurata (Xu, 1990) [Jn.: Hime-fukami-yoroi-hizaragai] (Fig. 5D)

Materials. 3 specimens in total, 10.7–18.0 mm in BL. Ōmurodashi Bank: 1 ex., NSMT-Mo 77295, SY91-3; 1 ex., NSMT-Mo 77296, SY93-14; 1 ex., NSMT-Mo 77297, SY96-9.

Distribution. East China Sea, 220 m (type locality); East China Sea (West of Yakushima Island and north off Amami-Ōshima Island), 205–520 m (Saito, 2005); Izu Islands, Sagami Bay, 221–233 m (Saito, 2006); Ōmurodashi Bank, 187–350 m (present study).

Family **Chitonidae** Rafinesque, 1815
Genus ***Tegulaplax*** Iredale and Hull, 1912

Tegulaplax* sp. cf. *boucheti (Kaas, 1989) (Figs. 5E, 7)

Material. Ōmurodashi Bank: 1 ex., NSMT-Mo 77298, 10.1 mm in BL, SY95-1.

Remarks. The morphology of valves and girdle elements of the present specimen (Fig. 7) matches that of *Tegulaplax boucheti* (Kaas, 1989) which was previsously known only from the holotype collected in the Philippines, 12°31′N, 120°39′E, 92–97 m. The morphology of the radula matches as well in general, but there is a discordance in the shape of the major lateral tooth. The head of the major lateral tooth of the present specimen is tricuspid (Fig. 7E), but it is round in the holotype of *T. boucheti*. The major lateral teeth of the present specimen have regular accessory deposit on the cusp. In the posterior radula, the cusps, especially the center one has a triangular portion at the medial side and a small spherule on it, but these parts disappear in the anterior teeth. This difference in the radula between the present specimen and the holotype may represent a difference of species level, or that within an intraspecific variation. Examination of more specimens is needed for exact identification.

The present specimen also resembles *Tegulaplax pulchrus* (Kaas, 1991) from New Caledonia, and *Tegulaplax hululensis* (E.A. Smith, 1893) from various localities in Japan and wide areas in the tropical and subtropical Indo-West Pacific, but it differs from the former by having riblets on the dorsal girdle scales, and from the latter by having longitudinal grooves on the pleural area.

Suborder **Acanthochitonina** Bergenhayn, 1930
Suprefamily **Mopalioidea** Dall, 1889
Family **Mopaliidae** Dall, 1889
Genus ***Placiphorella*** Dall, 1879

Placiphorella albitestae Is. Taki, 1954 [Jn.: Shiraga-babagase]

Materials. 7 specimens in total, 3.6-28.8 mm in BL. Okinoyama Bank: 2 ex., NSMT-Mo 77300, SY03-9; 4 ex., NSMT-Mo 77301, SY03-10. Ōmurodashi Bank: 1 ex., NSMT-Mo 77302, SY96-11.

Distribution. Tsugaru Strait to west coast of Kyūshū, on rocks or stones in 80–550 m (Saito, 1997; 2000); Okinoyama Bank and Ōmurodashi Bank, 275–490 m (present study).

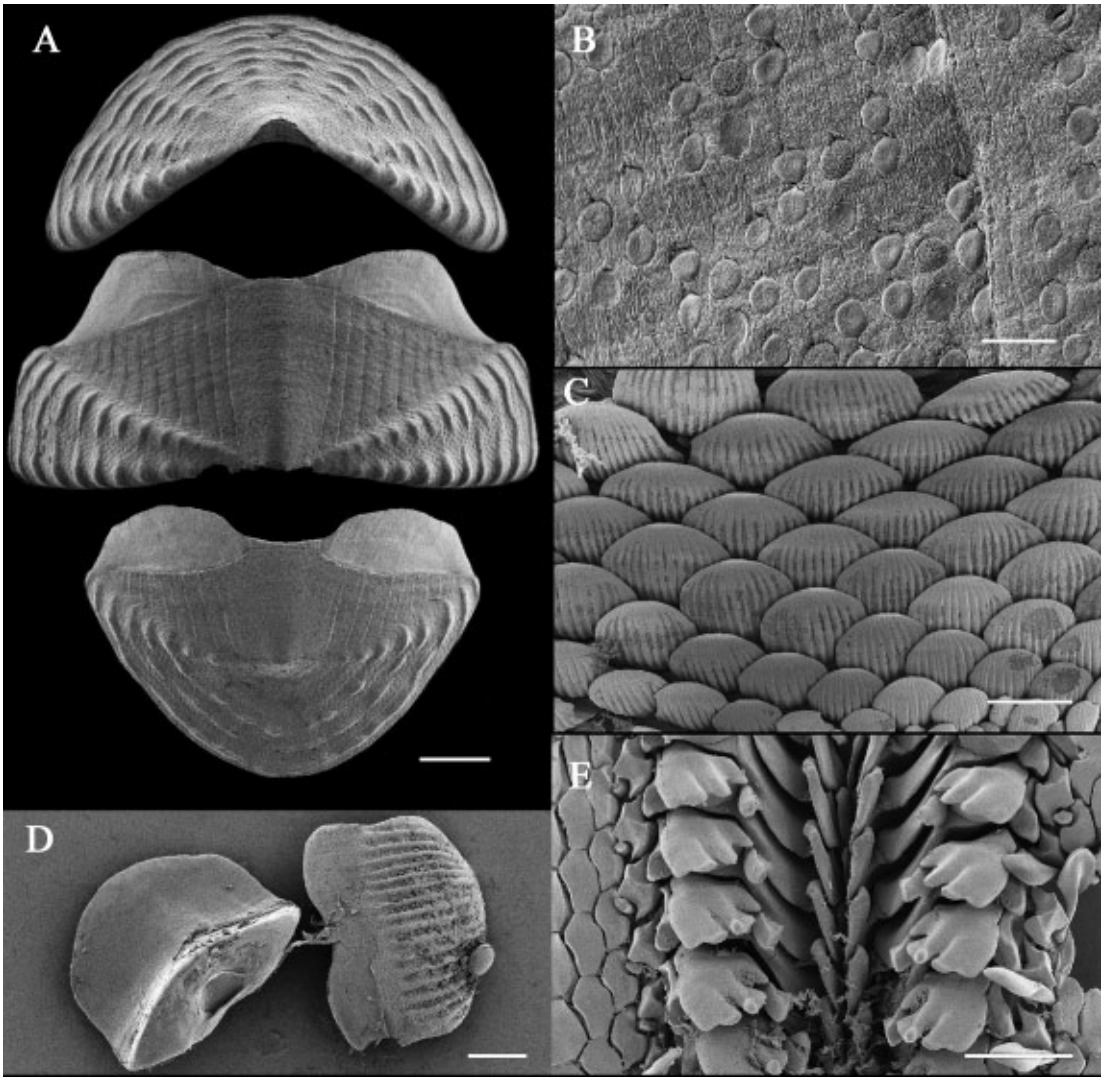

Fig. 7. *Tegulaplax* sp. cf. *boucheti*, NSMT-Mo 77298, BL. 9.8 mm. A, valves I, III and VIII, scale=500 μm; B, central area of valve III, showing aesthete caps, scale=20 μm; C, perinotum, scale=100 μm; D, dorsal scales, scale= 50 μm; E, radula, scale=100 μm.

Superfamily **Cryptoplacoidea**
H. and A. Adams, 1858
Family **Acanthochitonidae** Pilsbry, 1893
Genus ***Craspedochiton*** Shuttleworth, 1853

Craspedochiton pyramidalis (Is. Taki, 1938) [Jn.: Mitsukado-hizaragai]

Materials. 7 specimens in total, 16.6- ca. 30 mm in BL. Okinoyama Bank: 1 ex., NSMT-Mo 77303, KT97-7-OY1. Ōmurodashi Bank: 2 ex., NSMT-Mo 70043, SY89-1; 2 ex., NSMT-Mo 70042, SY91-10. Takase Bank: 1 ex., NSMT-Mo 71462, SY96-8. Hyōtanse Bank: 1 ex., NSMT-Mo 70044, SY93-8.

Distribution. Sagami Bay to west coast of Kyūshū, rocky-gravel bottom in 30–100 m (Saito, 2000): Submarine banks off northern Izu Islands, 76–126 m (present study).

Genus ***Notoplax*** H. Adams, 1861

Notoplax hilgendorfi Thiele, 1909 [Jn.: Usukokehizaragai]

Materials. 19 specimens in total, 5.1–23.6 mm in BL. Okinoyama Bank: 1 ex., NSMT-Mo 77304, SY96-19. Ōmurodashi Bank: 1 ex., NSMT-Mo 77305, SO72-D6; 2 ex., NSMT-Mo 70067, SY89-7; 1 ex., NSMT-Mo 70068, SY91-1; 2 ex., NSMT-Mo 70084, SY91-2; 1 ex., NSMT-Mo 77306, SY93-12; 2 ex., NSMT-Mo 77307, SY95-3. Takase Bank: 1 ex., NSMT-Mo 77308, SY89-9; 1 ex., NSMT-Mo 77309, SY89-10; 2 ex., NSMT-Mo 70071, SY89-11; 1 ex., NSMT-Mo 70070, SY90-7; 1 ex., NSMT-Mo 70072, SY90-12; 1 ex., NSMT-Mo 77310, SY96-7; 2 ex., NSMT-Mo 77311, SY96-8. Hyōtanse Bank: 3 ex., NSMT-Mo 77312, SY96-2.

Distribution. Tsugaru Strait to west coast of Kyūshū, rocky-gravel bottom in 5–450 m (Saito, 2000); Off Amami-Ōshima Island, 290 m (Saito, 2005); Submarine banks off northern Izu Islands, 87–223 m (present study).

Discussion

The present study revealed the occurrence of 14 chiton species in the area surveyed. Of those species, one *Leptochiton* species is described as *L. bergenhayni* n. sp. herein, and four other species are recorded for the first time from the submarine banks off Izu Islands: *Ischnochiton albinus* Thiele, 1911, *Connexochiton kaasi* Saito, 1997, *Craspedochiton pyramidalis* (Taki, 1938) and *Notoplax hilgendorfi* Thiele, 1909. Among the 14 species, 12 are regarded to be endemic in the sublittoral zone of warm water areas around Japanese Islands and/or East China Sea. The distribution of one, *I. albinus*, is known to extend to the tropical Indo-West Pacific. One specimen of an undetermined species in the genus *Tegulaplax* belongs to an indeterminable distribution.

Comparing the constituents of the chiton fauna of the three submarine banks off the Izu Islands with the Okinoyama Bank in the Sagami Sea, *I. albinus* occurs only in the submarine banks off Izu Islands, and one species, *Hanleyella japonica* Saito, 1997 occurs only in Okinoyama Bank. The undetermined *Tegulaplax* species documented here has an unknown distribution, but representatives of the genus *Tegulaplax* are known from the Gotō Islands, East China Sea and southward to the tropical and subtropical Indo-West Pacific including the Red Sea, but none has been found in the Sagami Sea area (Saito, 2006). This difference appears to reflect a difference in environments caused mainly by the warm Kuroshio Current and the cold Oyashio Current, or it may be attributable merely to a difference in the sampling effort for each site. Considering environmental factors, it is interesting to note that the composition of the chiton fauna in the three submarine banks is similar to that of the gastropod, bivalve and scaphopod faunas in this area. Okutani (1972) demonstrated that most of species in this area (among 163 species of those three classes he collected) have been recorded from Kyūshū (or further south) north to Bōsō Peninsula or to southern Hokkaido, 24 among them had been recorded only from the south of Kii Peninsula/Shikoku Island region, and five from the south of Amami Islands/Okinawa region before they were found on the submarine banks. All of those areas are strongly affected by the warm Kuroshio Current. That is, the faunal composition is similar to those of adjacent areas, but some species are replaced by other taxa that are distributed in warmer area. Okutani (1972) also recorded two "boreal" gastropod species, *Acmaea* (*Niveotectura*) *pallida* (Gould, 1859) [= *Niveotectura pallida* (Gould, 1859)] and *Homalopoma amussitatum* (Gould, 1861) which are distributed in northern Japan and northward to Sakhalin and Kuril Islands, but such "boreal" species do not occur in the present chiton material. Further research is required to elucidate the true nature of the chiton fauna in this area.

Acknowledgments

I thank the following people who were kindly placing valuable specimens at my disposal, and/

or provided much needed information: Dr. Takashi Okutani (Japan Agency of Marine Science and Technology), the late Mr. Eiji Tsuchida (Ocean Research Institute, the University of Tokyo) and Dr. Kotaro Tsuchiya (Tokyo University of Marine Science and Technology). Thanks are also due to Dr. Hans Mejlon (Museum of Evolution, Uppsala University) for the loan of the type material and the crews of the T/S *Shinyo Maru*, R/Vs *Tansei Maru*, and *Sōyō Maru* for their cooperation in sampling. I am grateful to Mr. Enrico Schwabe (Zoologische Staatssammlung Muenchen) for information on the type material and to Dr. Julia Sigwart and Mr. Nicholas Carey (both of Queen's University Belfast) for critical review of the manuscript.

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伊豆諸島沖および房総半島沖の礁上から採集された多板類

齋藤　寛

国立科学博物館が中心となって行った調査研究「相模灘における生物多様性の起源探求に関する研究」（平成 19〜22 年度）の一環として北部伊豆諸島沖の礁，大室出し，高瀬，瓢箪瀬および房総半島沖の礁，沖ノ山から得られた多板類標本について分類学的検討を行った結果，8 科 13 属 14 種を確認した．このうちサメハダヒザラガイ科の 1 種を新種として記載した．また，*Tegulaplax* ナミジワヒザラガイ属の 1 未詳種が含まれる．4 種 *Ischnochiton albinus* シラタマヒザラガイ，*Connexochiton kaasi* マツカサヒザラガイ，*Craspedochiton pyramidalis* ミツカドヒザラガイおよび *Notoplax hilgendorfi* ウスコケヒザラガイは伊豆諸島沖の礁上からは初めての記録である．出現種のうちシラタマヒザラガイは西太平洋の熱帯域にも分布する種で，他の 12 種は日本とその周辺の浅海域に固有な種のグループである．未詳種の分布は不明である．

伊豆諸島沖の 3 つの礁と，沖の山の出現種を比較すると，シラタマヒザラガイは伊豆諸島沖の礁のみに出現し，*Hanelyella japonica* ツユオキヒザラガイのみが沖の山のみに出現した．またナミジワヒザラガイ属の未詳種の分布域は不明だが，本属の種は五島列島以南のインド・西太平洋の熱帯，亜熱帯域に広く分布する．このような出現種の構成は主に黒潮・親潮によってもたらされる環境の違いを反映したもとも考えられるが，単に各地点での採集努力の違いによるものかもしれない．環境の違いを反映している場合，伊豆諸島沖の礁上のヒザラガイ類相は相模灘など近隣海域のそれと類似するが，近隣海域には分布しない，より南方の海域に出現するものが含まれる構成となる．出現種のこのような構成は Okutani（1972）が同海域で行った腹足類，掘足類，二枚貝類での調査結果に類似する．ただし，Okutani（1972）では 2 種報告されている北方系の種は多板類では見られなかった．