
Review

Molluscs from Hydrothermal Vents and Cold Seeps in Japan: A Review of Taxa Recorded in Twenty Recent Years (1984–2004)

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Abstract: Molluscs hitherto recorded from deep-sea vent/seep environments in Japan are reviewed and listed based on various literature published up to 2004. Compiled data on holotype depositories and type localities as well as detailed distribution records with geographic and depth ranges, and type of habitat (vents and/or seeps) are given for each of 74 recorded species (2 polyplacophorans, 30 bivalves and 42 gastropods). Comparison of faunas at various localities revealed the following characteristics: 1) The Japanese vent/seep fauna is typified by the highest diversity of *Calyptogena* in the world. 2) *Bathymodiolus* is the second most diversified large-sized bivalve in Japanese vents and seeps. 3) Conspecific populations of *Calyptogena* and *Bathymodiolus* have been proven to occur both in vents and in seeps, but most other molluscan taxa are obviously either vent- or seep-specific. 4) Two major groups of deep-sea bivalves, protobranchs and anomalodesmatans, are rare or totally absent, in contrast to non-vent/seep environments. 5) Vent/seep-endemic limpets are highly diversified. 6) Neomphalids and peltospirids (so-called ‘hot vent taxa’) are absent, except for a single species. 7) Among caenogastropods, small-sized provannids (*Provanna*) are dominant, rather than large-sized ones (*Alviniconcha* and *Ifremeria*). 8) Naticid predators have never been found in the Recent fauna, although fossil records suggest their presence in seeps in the geologic past. 9) Some species of neogastropod predators have been reported as temporal invaders from the ambient environment. 10) Two species of chitons from vents in the Okinawa Trough represent the only record of polyplacophorans from chemosynthetic communities in the world. 11) No aplacophorans, monoplacophorans, scaphopods or cephalopods have been collected at Japanese vent/seep sites.

Keywords: molluscan fauna, hydrothermal vent, cold seep, Japan

Introduction

The Northwest Pacific around the Japanese Islands is well known as a species-rich region in studies of chemosynthesis-based biological communities. The localities are mainly distributed in six areas from north to south/southwest: 1) the Japan Trench (seeps), 2) Sagami Bay (seeps), 3) the Nankai Trough from Suruga Bay to off Shikoku (seeps), 4) submarine volcanoes along the Izu-Ogasawara (Bonin) Islands (vents), 5) the central part of the Okinawa Trough (vents), and 6) sites off the Yaeyama Islands, Okinawa (seeps). In addition, there are a few sites slightly isolated from above areas (e.g., Kagoshima Bay and south off Kikaijima Island) (see Figs. 1–3; Fujikura *et al.*, 2000: figs. 1–7; Kojima *et al.*, 2004: fig. 1 for maps; see Kojima, 2002 for review of biological features of each locality).

Biological deep-sea research on Japanese chemosynthetic communities was initiated in Sagami

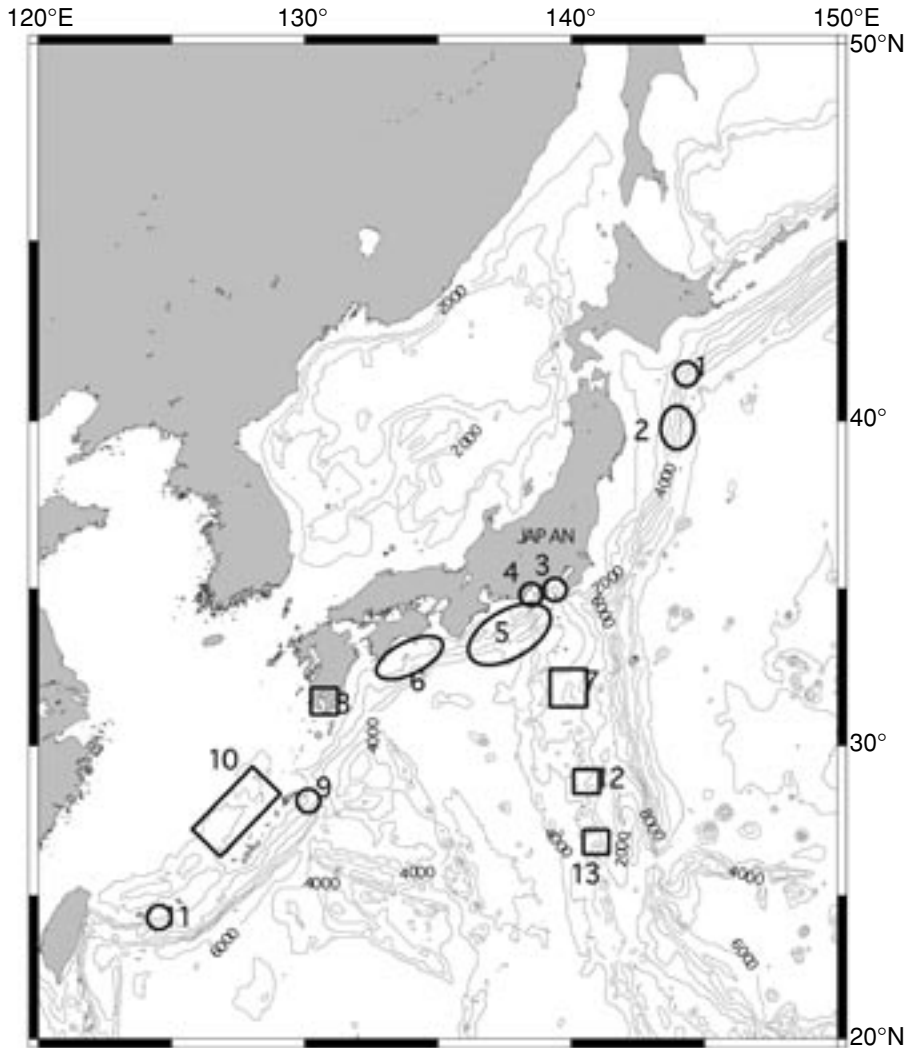


Fig. 1. Map of localities mentioned in the text. Vents are encircled by squares, and seeps by circles or ellipses. **1:** Kurile Trench (southeast off Cape Erimo); **2:** Japan Trench (off Iwate Prefecture); **3:** Sagami Bay (off Hatsushima, Okinoyama Bank and Sagami Knoll) (see Fig. 2); **4:** Suruga Bay (off Toi) (see Fig. 2); **5:** Eastern area of Nankai Trough (see Fig. 2); **6:** Western area of Nankai Trough (see Fig. 2); **7:** South off Izu Islands (Myojin Knoll and Sumisu Caldera); **8:** Kagoshima Bay; **9:** West off Kikaijima Island, Ryukyu Trench (see Fig. 3); **10:** Okinawa Trough (see Fig. 3); **11:** Kuroshima Knoll and off Yaeyama Islands (see Fig. 3); **12:** Suiyo Seamount and Mokuyo Seamount; **13:** Kaikata Seamount.

Bay when a live colony of *Calyptogena soyoae* was accidentally discovered during a dive of the *Shinkai 2000* in 1984 (Okutani & Egawa, 1985). Subsequently, new species of *Calyptogena* were also obtained from the Nankai Trough and Japan Trench through a joint Japanese-French project, using the French submersible *Nautile* (Métivier *et al.*, 1986; Okutani & Métivier, 1986). Thereafter, the survey of deep-sea hydrothermal vents and seeps has been conducted by JAMSTEC (Japan Agency for Marine-Earth Science and Technology), using the submersibles

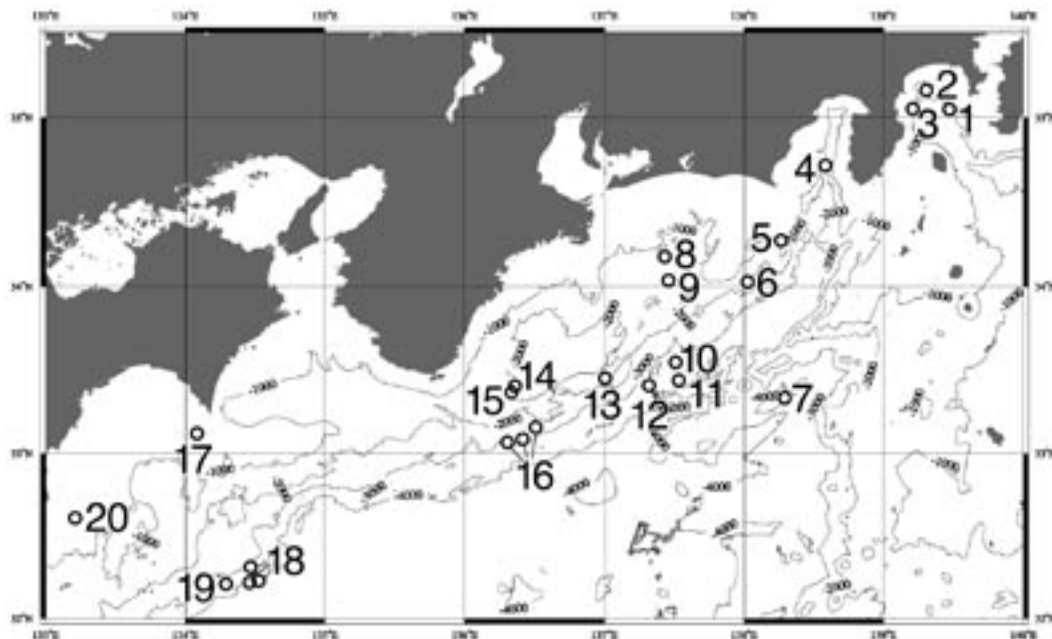


Fig. 2. Map of localities in Nankai Trough and adjacent areas. **1:** Okinoyama Bank; **2:** Sagami Knoll; **3:** Off Hatsuchima; **4:** Off Toi, Suruga Bay; **5:** Kanesanose Bank; **6:** Tokai Thrust; **7:** Zenisu Ridge; **8:** Ryuyo Submarine Canyon; **9:** Daini Tenryu Knoll; **10:** Yukie Ridge; **11:** Daisan Tenryu Submarine Canyon; **12:** Tenryu Submarine Canyon; **13:** Daiichi Kumano Knoll; **14:** Daiyon Kumano Knoll; **15:** Dairoku Kumano Knoll; **16:** off Kumano; **17:** Muroto Knoll; **18:** off Muroto Point; **19:** Daiichi Minami Muroto Knoll; **20:** Ashizuri Knoll.

Shinkai 2000, Shinkai 6500, Kaiko, Dolphin-3K, Hyper-Dolphin and Deep Tow System.

In the early 1990s the research area of the JAMSTEC mission was extended to the Okinawa Trough (e.g. Okutani & Fujikura, 1990; Saito & Okutani, 1990; Okutani *et al.*, 1992a; Okutani *et al.*, 1993b) and off the Ogasawara Islands (Okutani *et al.*, 1989). New chemosynthetic molluscan species were also described from Sagami Bay (Okutani & Fujikura, 1992; Okutani *et al.*, 1992b). A revision of the *Bathymodiolus* species from those three areas was published by Hashimoto & Okutani (1994).

After 1993, new species have been added from a wide area along the Nankai Trough from Suruga Bay to off Shikoku (e.g. Okutani *et al.*, 1993a, 1996, 1997; Okutani & Hashimoto, 1997; Okutani *et al.*, 2002; Okutani & Iwasaki, 2003). The number of *Calyptogena* species described from this area has reached 10. Most of them are distributed over a wide range around the Nankai Trough but were revealed to be genetically distinct (Kojima *et al.*, 2004) and also segregated by depth (Fujikura *et al.*, 2000).

In 1997, a new survey was initiated in the Japan Trench using the *Kaiko*, which was designed to explore hadal depths. A new seep community was discovered below 7000 m deep, making it the deepest chemosynthesis-based community in the world (Fujikura *et al.*, 1999). In addition, interesting new species were collected by the *Shinkai 6500* at slightly shallower sites (Okutani & Fujikura, 2002; Fujikura *et al.*, 2002a).

The newest group of seep localities was found off the Yaeyama Islands, Okinawa in 2003. Two new species of *Bathymodiolus* were described from there (Okutani *et al.*, 2004), and systematic studies of new gastropod species are now in progress (Sasaki *et al.*, in preparation).

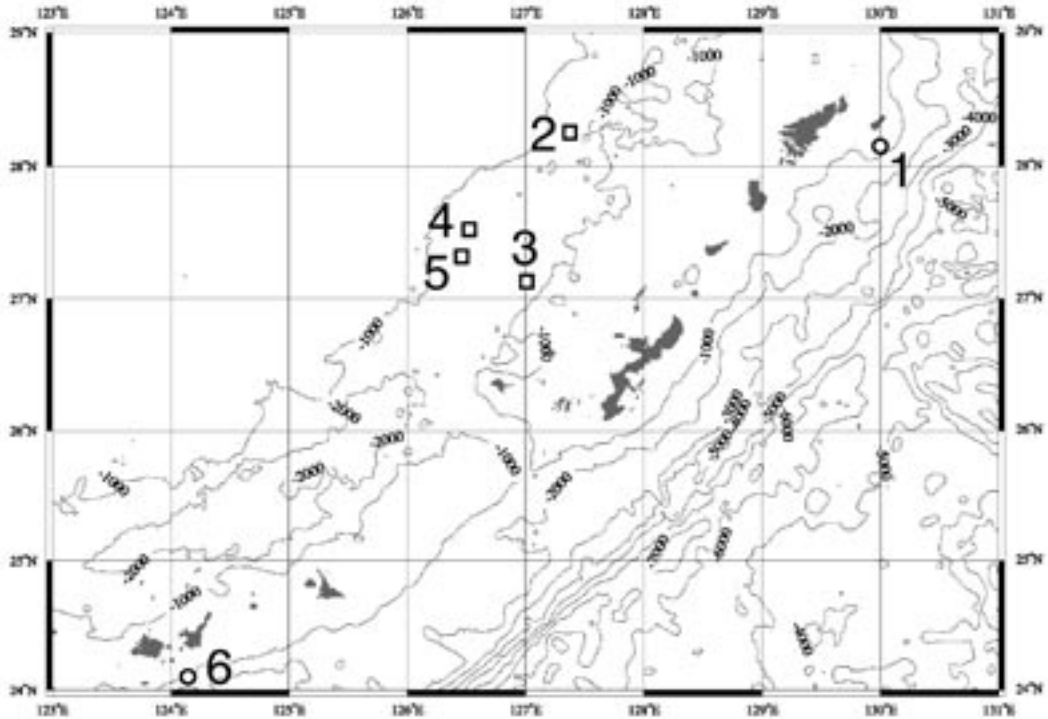


Fig. 3. Map of localities in Okinawa Trough and adjacent areas. **1:** Off Kikajima Island; **2:** Minami-Ensei Knoll; **3:** Izena Hole; **4:** North Knoll of Iheya Ridge; **5:** Iheya Ridge; **6:** Kuroshima Knoll. Squares and circles denote vents and seeps respectively.

Besides descriptions of new species, revisionary work has been undertaken on the distribution, taxonomy and phylogeny of specific groups. Okutani *et al.* (2000a) refined the generic and subgeneric definition of vesicomyid bivalves and presented a complete list of the Japanese species; Fujikura *et al.* (2000) summarized the geographic distributions of *Calyplogena* species. Sasaki *et al.* (2003) revised the systematics of limpet-form gastropods. At the global scale, Warén & Bouchet (1993, 2001) published a comprehensive list of all gastropods described from vents and seeps, including Japanese species. Phylogenetic analyses of *Calyplogena* using DNA sequences have been conducted by Kojima *et al.* (1995a, b) and more extensively by Kojima *et al.* (2004).

During the last 20 years, new species have been described almost every year and relevant published information has accumulated rapidly and haphazardly. For the convenience of readers interested in vent/seep molluscs in Japan, we here attempt a review of all molluscan taxa recorded from Japanese vents and seeps by the end of 2004. Data in publications were compiled regarding holotype depository, type locality, distribution and type of habitat. Based on the completed list, the characteristics of Japanese vent/seep fauna, especially in terms of its taxonomic composition, are discussed in comparison to those from other areas.

Methods of Review

Data in this review are based on published literature and do not include any unpublished new

material. In the list, species are arranged according to published systematic arrangements (e.g. Bouchet & Rocroi, 2005 for gastropods). Within genera, species are arranged alphabetically by species name.

For each species, the following set of information is given. 1) Species name: The scientific name in current use is shown in bold. 2) Japanese name: Except for undetermined species, a Japanese name is given to all species following Higo *et al.* (1999). 3) Synonymy: Scientific names used in the previous literature are listed with the citation of descriptions and figure numbers. 4) Type depository: institute and registration number of the holotype are shown with abbreviations (see below). Holotypes (or paratypes of a few species) are newly photographed and re-illustrated for most species to facilitate reference. 5) Type locality: the name, longitude, latitude, depth, and dive numbers of the type locality are listed. 6) Distribution records: records other than the type localities are cited from various literature. Positional data (latitude and longitude) are not described for each species, but are obtainable from cited references. 7) Depth range and type of habitat: habitat is defined as vents and/or seeps.

Institutional abbreviations: MNHN – Muséum national d’Histoire naturelle, Paris; NSMT – National Science Museum, Tokyo; SMF – Senckenbergisches Museum und Forschungsinstitut, Frankfurt; UMUT – The University Museum, The University of Tokyo; USNM – National Museum of Natural History, Washington, D. C.

List of Species

Class POLYPLACOPHORA Gray, 1821

Order Neoloricata Bergenhayn, 1955

Family Leptochitonidae Dall, 1889

Genus *Leptochiton* Gray, 1847

1. *Leptochiton tenuidontus* Saito & Okutani, 1990

[Japanese name: Usuba-samehada-hizaragai]

Leptochiton tenuidontus Saito & Okutani, 1990: 166, figs. 2–12; pl. 1, figs. 1–4; Saito, 2000: 6 (pl. 3), fig. 11, 7.

Type depository: Holotype, NSMT-Mo 69193.

Type locality: Iheya Ridge, Okinawa Trough, 27°32.70′ N, 126°58.20′ E, 1395 m (*Shinkai 2000* Dive 426). Known only from the type locality.

Type of habitat: Vent.

Family Ischnochitonidae Dall, 1889

Genus *Thermochiton* Saito & Okutani, 1990

2. *Thermochiton undocostatus* Saito & Okutani, 1990

[Japanese name: Yomino-usu-hizaragai]

Thermochiton undocostatus Saito & Okutani, 1990: 171, figs. 13–23; pl. 2, figs. 1–4; Saito, 2000: 11 (pl. 6), 12, fig. 12.

Type depository: Holotype, NSMT-Mo 69194.

Type locality: Iheya Ridge, Okinawa Trough, 27°32.70′ N, 126°58.20′ E, 1395 m (*Shinkai 2000* Dive 426). Known only from the type locality.

Type of habitat: Vent.

Class BIVALVIA Linnaeus, 1758
 Order Solemyoidea Dall, 1889
 Family Solemyidae Gray, 1840
 Genus *Acharax* Dall, 1908

3. *Acharax johnsoni* (Dall, 1891)
 [Japanese name: Suehiro-kinutaregai]

Type depository: Holotype, USNM 106886 (Knudsen, 1970: 72).

Type locality: Off southern California, 1838 m (*Albatross* station 3010).

Distribution records in JAMSTEC dives: East off southern Iwate Prefecture, Japan Trench, 5343 m (*Shinkai 6500* Dive 550), 5379 m (*Shinkai 6500* Dive 553) (Okutani & Fujikura, 2002; Fujikura *et al.*, 2002a: table 1). Off Hatsushima, Sagami Bay, 830–1230 m (dive number not described) (Fujikura *et al.*, 2002b: table 2).

Other distribution records: Off Southern Shikoku, Sagami Bay, off Choshi, Chiba Prefecture, western Americas (Oregon to Peru) (Higo *et al.*, 1999: 413, B91). Alaska to Peru, 400–4100 m (Coan *et al.*, 2000: 66). Sagami Bay and northward, 100–1000 m (Okutani, 2000: 833).

Depth range and type of habitat: 100–5379 m; seep and other reducing environments?

Remarks: This species has been recorded from a wide geographic area and also in numerous fossil localities from northwestern USA to Japan. Because the list would be too enormous, we omitted the synonymy here. At present, four junior names, *Solemya* (*Acharax*) *agassizii* Dall, 1908, *Solemya tokunagai* Yokoyama, 1925, *Solemya* (*Acharax*) *tibai* Kuroda, 1948 and *Solemya tokunagai elongata* Aoki, 1954 are synonymized with *Solemya johnsoni* Dall, 1891 (Coan *et al.*, 2000: 66). The earliest fossil occurrence of the species was recorded from the early Miocene by Kamada (1962) as *Solemya tokunagai* Yokoyama, 1925.

Genus *Solemya* Lamarck, 1818

4. *Solemya* (*Solemya*) *tagiri* Okutani, Hashimoto & Miura, 2003
 [Japanese name: Tagiri-kinutaregai]

Solemya (*Solemya*) *tagiri* Okutani, Hashimoto & Miura, 2003: 91.

Type depository: Holotype, NSMT-Mo 73543 (Fig. 4).

Type locality: Kagoshima Bay, 31°39.55–58′ N, 130°48.14–20′ E, 94–98 m (*Deep Tow*, DT-12).

Other distribution records: Kagoshima Bay, 76–116 m (Okutani *et al.*, 2003).

Depth range and type of habitat: 76–116 m; vent.

Family Nucinellidae Vokes, 1956

Remarks: The family Nucinellidae Vokes, 1956 is sometimes synonymized with Manzanellidae Chronic, 1952 (e.g. Coan *et al.*, 2000: 68).

Genus *Nucinella* Wood, 1851

5. *Nucinella viridis* Matsukuma, Okutani & Tsuchi, 1982
 [Japanese name: Kurumigai-modoki]

Nucinella viridis: Matsukuma, Okutani & Tsuchi, 1982: 180, pl. 1, figs. 7–8; Okutani, 2000: 832 (pl. 414), fig. 4, 833; Okutani & Iwasaki, 2003: 7, fig. 2A.

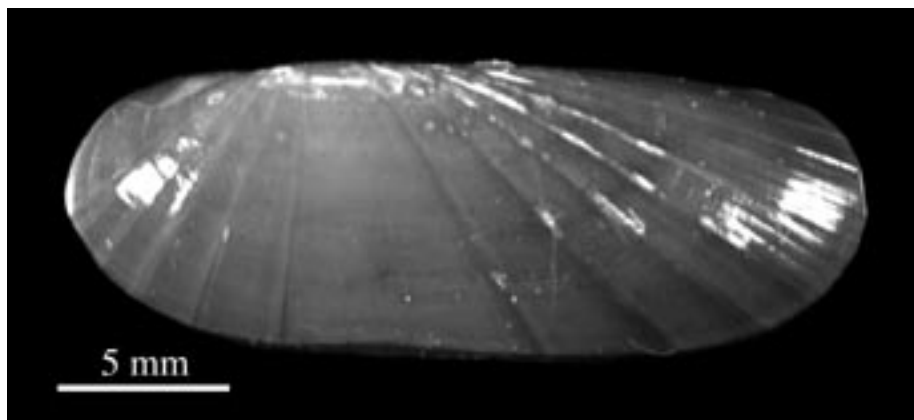


Fig. 4. Solemyidae. *Solemya (Solemya) tagiri* Okutani, Hashimoto & Miura, 2003, holotype, NSMT-Mo 73543.

Type depository: Holotype, NSMT-Mo 58800.

Type locality: Off Nojimazaki, Boso Peninsula, 34°43.0′ N, 139°55.5′ E, 2630–2890 m.

Distribution record in JAMSTEC dive: South-southeast off Cape Muroto, Nankai Trough, 3581 m (*Kaiko* Dive 193) (Okutani & Iwasaki, 2003).

Depth range and type of habitat: 2630–3581 m; seep and non-chemosynthetic communities.

Remarks: This species was collected in a JAMSTEC cruise, but it is uncertain whether it is actually associated with a chemosynthetic environment (Okutani & Iwasaki, 2003). The genus is generally known from normal deep-sea environments.

Order Mytiloida Férussac, 1822

Family Mytilidae Rafinesque, 1815

Genus *Bathymodiolus* Kenk & Wilson, 1985

Remarks: Described species of the genus are listed in Cosel (2002) and Okutani *et al.* (2004: 97–98).

6. *Bathymodiolus aduloides* Hashimoto & Okutani, 1994

[Japanese name: Kazuki-shinkai-hibarigai]

Bathymodiolus aduloides Hashimoto & Okutani, 1994: 69, fig. 4; pl. 1, figs. 5–6; pl. 2, fig. 2; pl. 3, fig. 3; Kurozumi, 2000: 870 (pl. 433), fig. 44, 871.

Type depository: Holotype, NSMT-Mo 70032 (Fig. 5A).

Type locality: Iheya Ridge, Okinawa Trough, 27°33.0′ N, 126°58.1′ E, 1389 m (*Shinkai 2000* Dive 683).

Other distribution records: Okinoyama Bank, Sagami Bay, 1128 m (*Dolphin 3K* Dive 35), Minami-Ensei Knoll, Okinawa Trough, 679 m (*Shinkai 2000* Dive 549) (Hashimoto & Okutani, 1994: 69).

Depth range and type of habitat: 689–1389 m; vent and seep.

7. *Bathymodiolus hirtus* Okutani, Fujikura & Sasaki, 2004

[Japanese name: Kuroshima-shinkai-hibarigai]

Bathymodiolus hirtus Okutani, Fujikura & Sasaki, 2004: 99, figs. 2, 3, 4A, B, E, F, 8A, B.

Type depository: Holotype, UMUT RM28472 (Fig. 5B).

Type locality: Kuroshima Knoll, off Yaeyama Islands, Okinawa, 24°07.81' N, 124°11.54' E, 637 m (*Shinkai 2000* Dive 1356).

Other distribution records: Kuroshima Knoll, off Yaeyama Islands, Okinawa, 637–644 m (*Shinkai 2000* Dives 1355, 1370, *Dolphin 3K* Dives 555, 558) (Okutani *et al.*, 2004: 99).

Depth range and type of habitat: 637–644 m; seep.

8. *Bathymodiolus japonicus* Hashimoto & Okutani, 1994

[Japanese name: Shinkai-hibarigai]

Bathymodiolus japonicus Hashimoto & Okutani, 1994: 67, fig. 3; pl. 1, figs. 3–4; p. 3, fig. 2; Kurozumi, 2000: 879 (pl. 433), fig. 43, 871.

Type depository: Holotype, NSMT-Mo 70029 (Fig. 5C).

Type locality: Minami-Ensei Knoll, Okinawa Trough, 28°23.4' N, 127°38.5' E, 710 m (*Shinkai 2000* Dive 428).

Other distribution records: Okinoyama Bank, Sagami Bay, 1128 m (*Dolphin 3K* Dive 35), off Hatsushima, Sagami Bay, 1170 m (*Shinkai 2000* Dive 519), Minami-Ensei Knoll, Okinawa Trough, 679 m (*Shinkai 2000* Dive 549), 705 m (*Shinkai 2000* Dive 649) (Hashimoto & Okutani, 1994: 67).

Depth range and type of habitat: 679–1170 m, vent and seep.

9. *Bathymodiolus platifrons* Hashimoto & Okutani, 1994

[Japanese name: Heitou-shinkai-hibarigai]

Bathymodiolus platifrons Hashimoto & Okutani, 1994: 64, fig. 2; pl. 1, figs. 1–2; pl. 2, fig. 3; pl. 3, fig. 1; Kurozumi, 2000: 870 (pl. 433), fig. 42, 871.

Type depository: Holotype, NSMT-Mo 70026 (Fig. 5D).

Type locality: Okinoyama Bank, Sagami Bay, 34°58.3' N, 139°31.3' E, 1180 m (*Shinkai 2000* Dive 278).

Other distribution records: Off Hatsushima, Sagami Bay, 1170 m (*Shinkai 2000* Dives 519, 666, *Dolphin 3K* Dive 119), Izena Hole, Okinawa Trough, 1340 m (*Shinkai 2000* Dive 364), 1340 m (DK89-1-OKN), Iheya Ridge, Okinawa Trough, 1410 m (*Shinkai 2000* Dive 366) (Hashimoto & Okutani, 1994: 64).

Depth range and type of habitat: 1170–1410 m; vent and seep.

10. *Bathymodiolus securiformis* Okutani, Fujikura & Sasaki, 2004

[Japanese name: Teono-shinaki-hibarigai]

Bathymodiolus securiformis Okutani, Fujikura & Sasaki, 2004: 105, figs. 4C, D, 7C, D, 8, 9.

Type depository: Holotype, UMUT RM28478 (Fig. 5E).

Type locality: Kuroshima Knoll, off Yaeyama Islands, Okinawa, 24°07.82' N, 124°11.37' E, 644 m, (*Dolphin 3K* Dive 558).

Other distribution records: Kuroshima Knoll, off Yaeyama Islands, Okinawa, 637–642 m (*Shinkai 2000* Dives 1355, 1356, 1370; *Dolphin 3K* Dive 555 [not 444 as described]) (Okutani *et al.*, 2004: 105).

Depth range and type of habitat: 637–642 m; seep.

11. *Bathymodiolus septemdirum* Hashimoto & Okutani, 1994

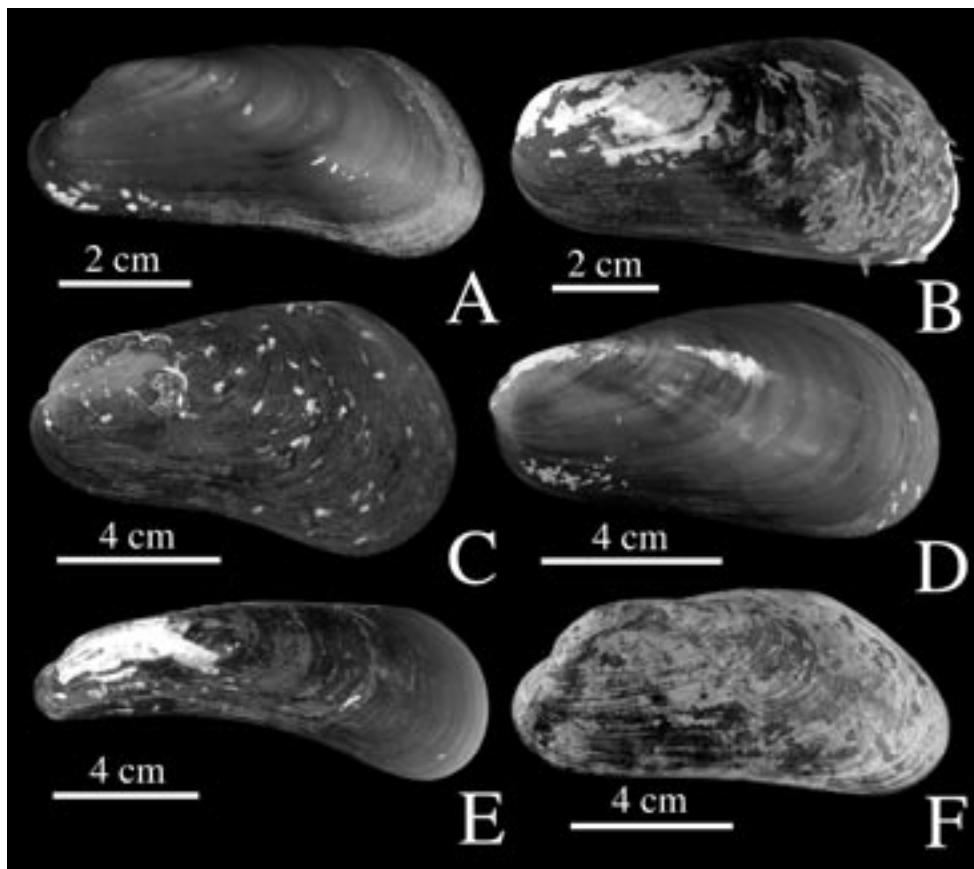


Fig. 5. Mytilidae. **A.** *Bathymodiolus aduloides* Hashimoto & Okutani, 1994, holotype, NSMT-Mo 70032. **B.** *Bathymodiolus hirtus* Okutani, Fujikura & Sasaki, 2004, holotype, UMUT RM28472. **C.** *Bathymodiolus japonicus* Hashimoto & Okutani, 1994, holotype, NSMT-Mo 70029. **D.** *Bathymodiolus platifrons* Hashimoto & Okutani, 1994, holotype, NSMT-Mo 70026. **E.** *Bathymodiolus securiformis* Okutani, Fujikura & Sasaki, 2004, holotype, UMUT RM28478. **F.** *Bathymodiolus septemdierum* Hashimoto & Okutani, 1994, holotype, NSMT-Mo 70035.

[Japanese name: Shichiyou-shinkai-hibarigai]

Bathymodiolus septemdierum Hashimoto & Okutani, 1994: 72, fig. 5, pl. 1, figs. 7-8; pl. 2, fig. 1; pl. 3, fig. 4; Kurozumi, 2000: 870 (pl. 433), fig. 45, 871.

Type depository: Holotype, NSMT-Mo 70035 (Fig. 5F).

Type locality: Suiyo Seamount, northwest off Ogasawara Islands, 28°34.2' N, 140°38.6' E, 1371 m (*Shinkai 2000* Dive 627).

Other distribution records: Suiyo Seamount, 1367 m (*Shinkai 2000* Dive 693), Mokuyo Seamount, northwest off Ogasawara Islands, 1256 m (*Shinkai 2000* Dive 628) (Hashimoto & Okutani, 1994).

Depth range and type of habitat: 1256–1371 m; vent.

Order Veneroida H. Adams & A. Adams, 1856
 Family Lucinidae Fleming, 1828
 Genus *Mesolinga* Chavan, 1951

12. *Mesolinga soliditesta* Okutani & Hashimoto, 1997

[Japanese Name: Fukusuke-tsukigai]

Mesolinga soliditesta Okutani & Hashimoto, 1997: 272, figs. 2–5; Matsukuma, 2000: 930 (pl. 463), fig. 19, 931.

Type depository: Holotype, NSMT-Mo 70967 (Fig. 6A–B).

Type locality: Kanesunose Bank, 34°17.6′ N, 138°14.86′ E, 363 m (*Shinkai 2000* Dive 816). Known only from the type locality.

Type of habitat: Seep.

Remarks: The species is tentatively assigned to this genus based on the cardinal morphology, the shape of the muscle scars and the smooth ventral margin (Okutani & Hashimoto, 1997).

Genus *Lucinoma* Dall, 1901

13. *Lucinoma yoshidai* Habe, 1958

[Japanese name: Yoshida-tsukigai-modoki]

Lucinoma yoshidai Habe, 1958: 27; Okutani & Hashimoto, 1997: 277, figs. 19–25; Matsukuma, 2000: 930 (pl. 463), fig. 15, 931. See Okutani & Hashimoto (1997: 277) for other references before 1997.

Type depository: Holotype, NSMT-Mo 39858.

Type locality: Off Shimane Prefecture, Sea of Japan, 35°17′00″ N, 132°10′20″ E, 146 m (*Soyo-Mar* station 495).

Distribution record in JAMSTEC dives: Off Hatsushima, Sagami Bay, 830–1230 m (Fujikura *et al.*, 2002b).

Other distribution records: Kii Peninsula and northwards, Sagami Bay, northeastern Honshu (Otsuchi Bay, Iwate Prefecture), Sea of Japan (off Shimane Prefecture), 100–200 m (Higo *et al.*, 1999: B605).

Depth range and type of habitat: 100–1230 m; seep and other reducing environments?

Remarks: Although no living specimens were obtained in sites off Hatsushima, Sagami Bay, we regard this species as a member of chemosynthetic communities. Empty shells were collected from among the *Calyptogena* beds (Fujikura *et al.*, 2002b).

Family Thyasiridae Dall, 1900

Genus *Conchocele* Gabb, 1866

14. *Conchocele bisecta* (Conrad, 1849)

[Japanese name: Ouna-gai]

Type depository: Unknown.

Type locality: Astoria, Oregon, USA (Miocene).

Distribution record in JAMSTEC dives: Off Hatsushima, Sagami Bay, 830–1230 m (Fujikura *et al.*, 2002b).

Other distribution records: Tosa Bay and northwards, Sagami Bay, Sea of Japan (off Tajima, Hyogo Prefecture), Hokkaido (off Cape Erimo), Alaska to Oregon, 4–1400 m (Higo *et al.*, 1999: B619). Southern Bering Sea from Pribilof Islands, south to off Humboldt Bay, California, and from the Sea of Okhotsk to Hokkaido and the Sea of Japan, 50–750 m (Coan *et al.*, 2000: 277).

Depth range and type of habitat: 4–1400 m; seep.

Remarks: In addition to publications on Recent molluscan fauna, there are numerous fossil

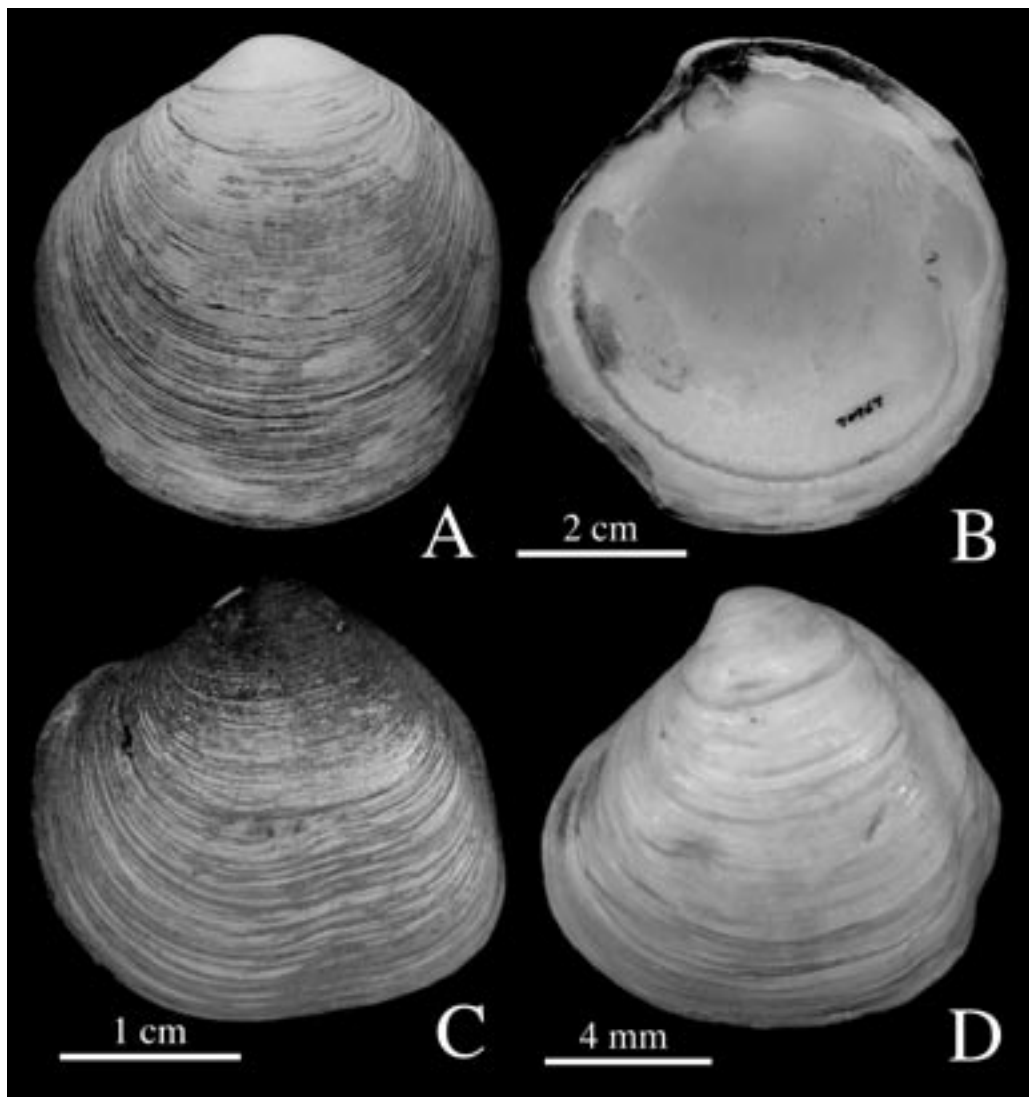


Fig. 6. Lucinidae and Thyasiridae. **A-B.** *Mesolinga soliditesta* Okutani & Hashimoto, 1997, holotype, NSMT-Mo 70967. **C.** *Axinulus hadalis* (Okutani, Fujikura & Kojima, 1999), holotype, NSMT-Mo 71431. **D.** *Thyasira* (*Parathyasira*) *kaireiae* Okutani, Fujikura & Kojima, 1999, holotype, NSMT-Mo 71433.

records from Japan to the western USA since the late Eocene (Coan *et al.*, 2000: 277). We omitted the synonymy for this species, because a complete listing is beyond the scope of this review.

Genus *Axinulus* Verrill & Bush, 1898

15. *Axinulus hadalis* (Okutani, Fujikura & Kojima, 1999)
[Japanese name: Naraku-hanashigai]

Maorithyas hadalis Okutani, Fujikura & Kojima, 1999: 50, figs. 2, 3.

Axinulus hadalis (Okutani, Fujikura & Kojima, 1999): Matsukuma, 2000: 934 (pl. 465), fig. 15, 935.

Type depository: Holotype, NSMT-Mo 71431 (Fig. 6C).

Type locality: East off northern Iwate Prefecture, Japan Trench, 40°02.85' N, 144°16.50' E, 7326 m (*Kaiko* Dive 87).

Other distribution records: East off northern Iwate Prefecture, Japan Trench, 7326 m (Type locality), 7336 m (*Kaiko* Dive 110), 7434 m (*Kaiko* Dive 112) (Okutani *et al.*, 1999).

Depth range and type of habitat: 7326–7434 m; seep.

Genus *Thyasira* Lamarck, 1818

Subgenus *Parathyasira* Iredale, 1930

16. *Thyasira* (*Parathyasira*) *kaireiae* (Okutani, Fujikura & Kojima, 1999)

[Japanese name: Kairei-hanashigai]

Parathyasira kaireiae Okutani, Fujikura & Kojima, 1999: 51, figs. 4, 5; Okutani & Fujikura 2002: 219, fig. 8.

Thyasira (*Parathyasira*) *kairaiiae* [sic] Okutani, Fujikura & Kojima, 1999: Matsukuma, 2000: 932 (pl. 464), fig. 6, 933.

Type depository: Holotype, NSMT-Mo 71433 (Fig. 6D).

Type locality: East off northern Iwate Prefecture, Japan Trench, 40°02.8' N, 144°17.8' E, 6390 m (*Kaiko* Dive 86).

Other distribution records: East off northern Iwate Prefecture, Japan Trench, 6390 m (Type locality), 5791–5793 m (*Kaiko* Dive 111) (Okutani *et al.*, 1999); 6248 m, (*Shinkai 6500* Dive 552) (Fujikura *et al.*, 2002a: table 1). East off southern Iwate Prefecture, Japan Trench, 5343 m (*Shinkai 6500* Dive 550), 5379 m (*Shinkai 6500* Dive 553) (Okutani & Fujikura, 2002; Fujikura *et al.*, 2002a: table 1); 5343–5345 m (*Kaiko* Dive 183) (Fujikura *et al.*, 2002a: table 1).

Depth range and type of habitat: 5343–6390 m; seep.

Family Vesicomysidae Dall & Simpson, 1901

Genus *Calyptogena* Dall, 1891

Remarks: Revised diagnoses of the genus and included subgenera were given by Okutani *et al.* (2000a). For phylogenetic relationships, see Kojima *et al.* (2004).

Subgenus *Calyptogena* Dall, 1891

17. *Calyptogena* (*Calyptogena*) *fausta* Okutani, Fujikura & Hashimoto, 1993

[Japanese name: Suruga-shirourigai]

Calyptogena (*Ectenagena*) *fausta* Okutani, Fujikura & Hashimoto, 1993: 122, figs. 2–5.

Calyptogena (*s.s.*) *fausta*: Okutani, Fujikura & Kojima, 2000: 94; Okutani, 2000: 996 (pl. 496), fig. 6, 997.

Type depository: Holotype, NSMT-Mo 69872 (Fig. 7A–B).

Type locality: Suruga Bay, 34°55' N, 138°39' E, 1489 m (*Shinkai 2000* Dive 596).

Other distribution records: Off Toi, Suruga Bay, 1500 m (*Shinkai 2000* Dive 576) (Kojima *et al.*, 2004). Yukie Ridge, Nankai Trough, 2000 m (*Shinkai 6500*, several dives) (Kojima & Ohta, 1997b), 1900–2000 m (*Nautile* Dive KN14) (Kojima *et al.*, 2004). Daiichi Kumano Knoll, Nankai Trough, 1900 m (*Shinkai 6500* Dive 678) (Kojima *et al.*, 2004).

Depth range and type of habitat: 1489–2000 m; seep.

Subgenus *Ectenagena* Woodring, 193818. *Calyptogena (Ectenagena) fossajaponica* Okutani, Fujikura & Kojima, 2000
[Japanese name: Naraku-shirourigai]

Calyptogena (Ectenagena) fossajaponica Okutani, Fujikura & Kojima, 2000: 90, figs. 5, 8; Okutani & Fujikura, 2002: 220, fig. 10; Okutani, 2000: 998 (pl. 497), fig. 13, 999.

Type depository: Holotype, NSMT-Mo 71494 (Fig. 7C-D).

Type locality: East off northern Iwate Prefecture, Japan Trench, 40°06.40' N, 144°11.22' E, 6329 m (*Kaiko* Dive 85).

Other distribution records: East off northern Iwate Prefecture, Japan Trench, 6804–6809 m (*Kaiko* Dive 114) (Okutani *et al.*, 2000a). East off southern Iwate Prefecture, Japan Trench, 5291 m (*Shinkai 6500* Dive 553), 5343–5345 m (*Kaiko* Dive 183), 5379 m (*Shinkai 6500* Dive 553), East off northern Iwate Prefecture, Japan Trench, 6248 m (*Shinkai 6500* Dive 552) (Fujikura *et al.*, 2002a: table 1). East off Iwate Prefecture, Japan Trench, 5400–6400 m (*Shinkai 6500* Dive 479, *Kaiko* Dive 114) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 5291–6809 m; seep.

19. *Calyptogena (Ectenagena) kaikoi* Okutani & Métivier, 1986
[Japanese name: Kaikou-shirourigai]

Calyptogena (Ectenagena) kaikoi Okutani & Métivier, 1986: 153, fig. 1c; pl. 3, figs. 8–11; Okutani, Fujikura & Kojima, 2000: 96; Okutani, Kojima & Iwasaki, 2002: 136, fig. 4E; Okutani, 2000: 998 (pl. 497), fig. 17, 999.

Type depository: Holotype, MNHN.

Type locality: Tenryu Submarine Canyon, Nankai Trough, 33°36.9' N, 137°32.0' E, 3830 m (*Nautile* Dive KD-5).

Other distribution records: Tenryu Submarine Canyon, Nankai Trough, 3787–3835 m and 3830 m (*Nautile* Dives KD-3, KD-5) (Okutani & Métivier, 1986). Off Cape Muroto, 3540 m (*Kaiko* Dive 190) (Okutani *et al.*, 2002). Daisan Tenryu Submarine Canyon, Nankai Trough, 3800 m (*Shinkai 6500* Dives 402, 404), off Muroto Point, Nankai Trough, 4600 m (*Kaiko* Dive 261) and 4800 m (*Kaiko* Dive 263) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 3540–4800 m; seep.

Remarks: One of the paratypes (NSMT-Mo 64161) is illustrated in Fig. 7E-F.

20. *Calyptogena (Ectenagena) nautilei* Okutani & Métivier, 1986
[Japanese name: Nochiru-shirourigai]

Calyptogena (Ectenagena) nautilei Okutani & Métivier, 1986: 148, fig. 1a; pl. 1, figs. 1–3; Okutani, Fujikura & Kojima, 2000: 96; Okutani, Kojima & Iwasaki, 2002: 138, fig. 5A-I; Okutani, 2000: 998 (pl. 497), fig. 16, 999.

Type depository: Holotype, MNHN.

Type locality: Tenryu Submarine Canyon, Nankai Trough, 33°37.2' N, 137°31.6' E, 3787–3835 m (*Nautile* Dive KD-3).

Other distribution records: Zenisu Ridge, 3300 m (*Shinkai 6500* Dive 555) (Kojima *et al.*, 2004: table 2). Tenryu Submarine Canyon, Nankai Trough, 3830 m (*Nautile* Dive KD-5) (Okutani & Métivier, 1986). Kumano Basin, 3116–3241 m (*Shinkai 6500* Dive 615) (Okutani *et al.*, 2002; Kojima *et al.*, 2004: table 2). Daiichi Minami Muroto Knoll, Nankai Trough, 3620 m (*Kaiko* Dive 40) (Fujikura *et al.*, 2000: 110); 3536–3560 m, 3571 m, 3587 m (*Kaiko* Dives 189, 192, 193

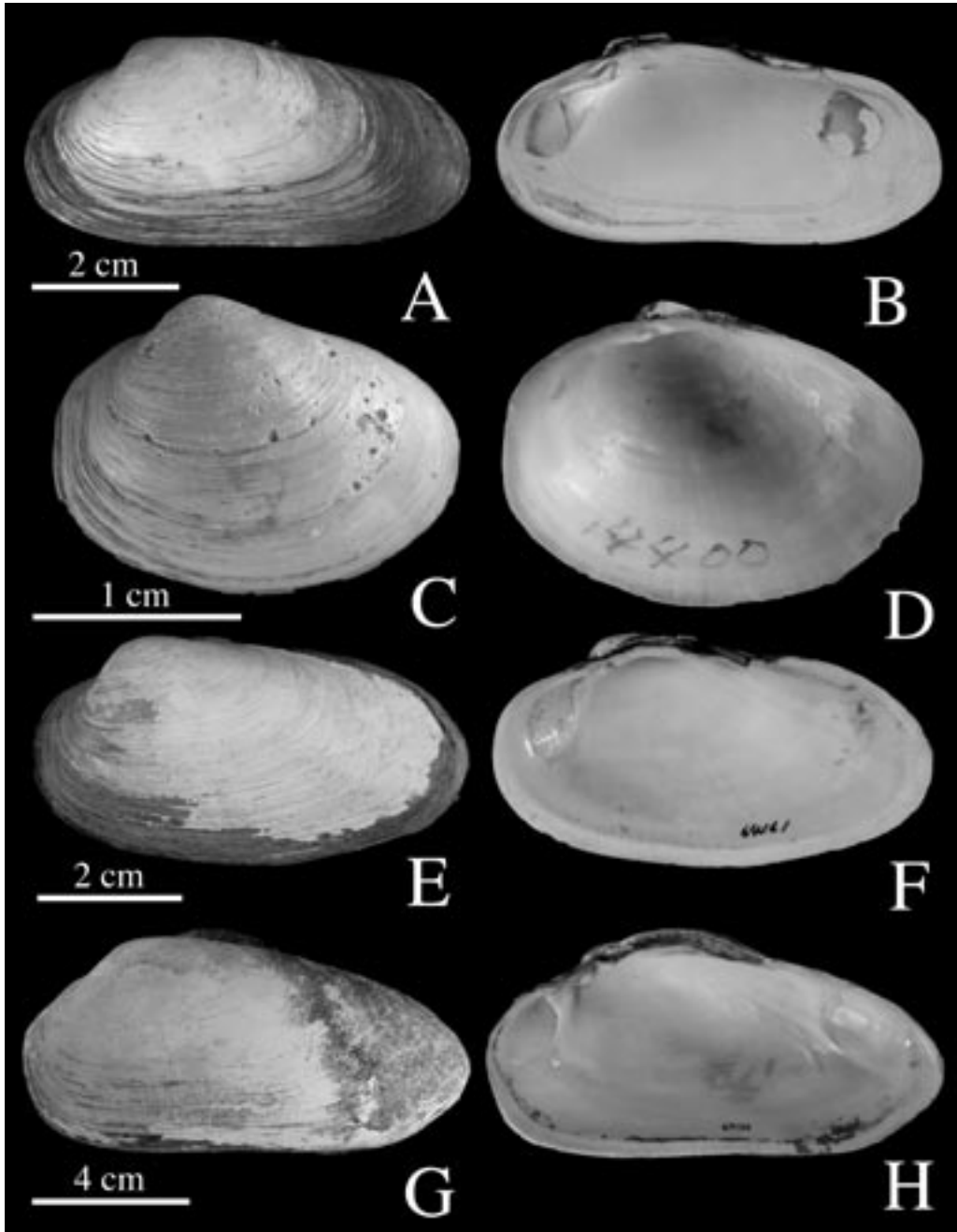


Fig. 7. Vesicomysidae. **A-B.** *Calyptogena (Calyptogena) fausta* Okutani, Fujikura & Hashimoto, 1993, holotype, NSMT-Mo 69872. **C-D.** *Calyptogena (Ectenagena) fossajaponica* Okutani, Fujikura & Kojima, 2000, holotype, NSMT-Mo 71494. **E-F.** *Calyptogena (Ectenagena) kaikoi* Okutani & Métivier, 1986, paratype, NSMT-Mo 64161. **G-H.** *Calyptogena (Ectenagena) nautiliei* Okutani & Métivier, 1986, paratype, NSMT-Mo 64156.

(Okutani, Kojima & Iwasaki, 2002; Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 3300–3835 m; seep.

Remarks: One of the paratypes (NSMT-Mo 64156) is illustrated in Fig. 7G–H.

21. *Calyptogena (Ectenagena) phaseoliformis* Métivier, Okutani & Ohta, 1986

[Japanese name: Naginata-shirourigai]

Calyptogena (Ectenagena) phaseoliformis Métivier, Okutani & Ohta, 1986: 162, fig. 1, pls. 1–2; Okutani, Fujikura & Kojima, 2000: 96; Okutani & Fujikura 2002: 220, fig. 9; Okutani, 2000: 998 (pl. 497), fig. 18, 999.

Type depository: Holotype, NSMT-Mo 64164 (Fig. 8A–B).

Type locality: East off northern Iwate Prefecture, Japan Trench, 35°54.2′ N, 142°30.7′ E, 5640–5695 m (*Nautile* Dive KD-14).

Other distribution records: East off southern Iwate Prefecture, Japan Trench, 5291 m (*Shinkai 6500* Dive 553), 5343 m (*Shinkai 6500* Dive 550), 5343–5345 m (*Kaiko* Dive 183), 5379 m (*Shinkai 6500* Dive 553). East off northern Iwate Prefecture, Japan Trench, 6248 m, 6290 m (*Shinkai 6500* Dive 552) (Fujikura *et al.*, 2002a: table 1). Southeast off Cape Erimo, Kurile Trench, 4700–6200 m (*Shinkai 6500* Dives 623, 671). East off Iwate Prefecture, Japan Trench, 5400–6400 m (*Kaiko* Dive 113) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 4700–6400 m; seep.

Subgenus *Archivesica* Dall, 1908

22. *Calyptogena (Archivesica) laubieri* Okutani & Métivier, 1986

[Japanese name: Tenryu-shirourigai]

Calyptogena (Ectenagena) laubieri Okutani & Métivier, 1986: 151, fig. 1b; pl. 2, figs. 4–7.

Calyptogena (Archivesica) laubieri: Okutani, Fujikura & Kojima, 2000: 95; Okutani, 2000: 996 (pl. 497), fig. 10, 997–998.

Calyptogena (Archivesica) laubierii [sic]: Okutani, Kojima & Iwasaki, 2002: 133, fig. 4C–D.

Type depository: Holotype, NSMT-Mo 64158 (Fig. 8C–D).

Type locality: Tenryu Submarine Canyon, Nankai Trough, 33°37.2′ N, 137°31.6′ E, 3787–3835 m (*Nautile* Dive KD-3).

Other distribution records: Daisan Tenryu Submarine Canyon, Nankai Trough, 3761 m (*Kaiko* Dive 45) (Fujikura *et al.*, 2000: 106). Daisan Tenryu Submarine Canyon, 3386 m (*Shinkai 6500* Dive 558); south-southeast off Cape Muroto, Nankai Trough, 3536–3560 m (*Kaiko* Dive 189) (Okutani *et al.*, 2002). Daisan Tenryu Submarine Canyon, 3800 m (*Shinkai 6500* Dive 404); Tenryu Submarine Canyon, Nankai Trough, 3800 m (*Nautile* Dive KN12) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 3386–3835 m; seep.

23. *Calyptogena (Archivesica) magnocultellus* Okutani, Kojima & Iwasaki, 2002

[Japanese name: Yaiba-shirourigai]

Calyptogena (Archivesica) magnocultellus Okutani, Kojima & Iwasaki, 2002: 135, figs. 3E–F, 4A–B, 5J.

Type depository: Holotype, NSMT-Mo 73190 (Fig. 8E–F).

Type locality: Southeast off Cape Shionomisaki, Kumano Basin, 33°07.2′ N, 136°28.6′ E, 2535 m (*Shinkai 6500* Dive 613).

Other distribution records: Yukie Ridge, Nankai Trough, 1900–2200 m (*Shinkai 6500* Dive

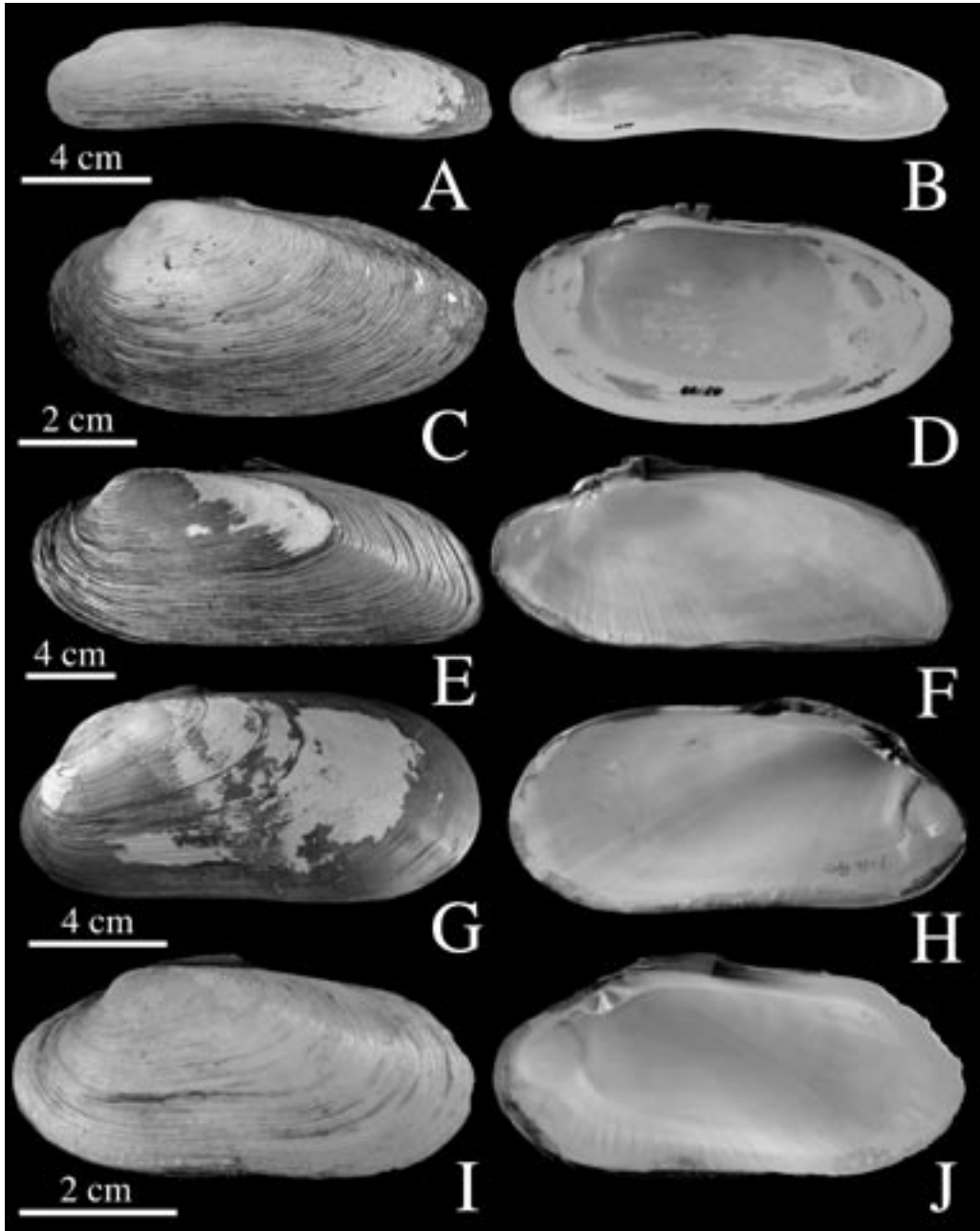


Fig. 8. Vesicomyidae. **A-B.** *Calyptogena (Ectenagena) phaseoliformis* Métivier, Okutani & Ohta, 1986, holotype, NSMT-Mo 64164. **C-D.** *Calyptogena (Archivesica) laubieri* Okutani & Métivier, 1986, holotype, NSMT-Mo 64158. **E-F.** *Calyptogena (Archivesica) magnocultellus* Okutani, Kojima & Iwasaki, 2002, holotype, NSMT-Mo 73190. **G-H.** *Calyptogena (Archivesica) nankaiensis* Okutani, Kojima & Ashi, 1996, holotype, NSMT-Mo 70764. **I-J.** *Calyptogena (Archivesica) okutanii* Kojima & Ohta, 1997, holotype, NSMT-Mo 70909.

520); off Kumano, Nankai Trough, 2100 m (*Shinkai 6500* Dive 676); off Kumano, Nankai Trough, 2500 m (*Shinkai 6500* Dive 613) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 1900–2535 m; seep.

24. *Calyptogena (Archivesica) nankaiensis* Okutani, Kojima & Ashi, 1996

[Japanese name: Nankai-shirourigai]

Calyptogena nankaiensis Okutani, Kojima & Ashi, 1996: 258, figs. 2–4, pl. 1, fig. 1.

Calyptogena (Archivesica) nankaiensis: Okutani, Fujikura & Kojima, 2000: 95; Okutani, 2000: 998 (pl. 497), fig. 11, 999.

Type depository: Holotype, NSMT-Mo 70764 (Fig. 8G–H).

Type locality: Ryuyo Submarine Canyon, Nankai Trough, 34°11.50′ N, 137°46.00′ E, 1100 m (*Shinkai 2000* Dive 821).

Other distribution records: North Knoll of the Iheya Ridge, Okinawa Trough, 1050 m (*Shinkai 2000* Dives 863, 864) (Fujikura *et al.*, 2000: 106). North Iheya Ridge, Okinawa Trough, 1100 m (*Shinkai 2000* Dive 863) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 1050–1100 m; vent and seep.

25. *Calyptogena (Archivesica) okutanii* Kojima & Ohta, 1997

[Japanese name: Shimai-shirourigai]

Calyptogena okutanii Kojima & Ohta, 1997: 192, figs. 3–5.

Calyptogena (Archivesica) okutanii: Okutani, Fujikura & Kojima, 2000: 95; Okutani, 2000: 996 (pl. 496), fig. 9, 997.

Type depository: Holotype, NSMT-Mo 70909 (Fig. 8I–J).

Type locality: Off Hatsushima Island, Sagami Bay, 35°88.88′ N, 139°13.80′ E, *ca.* 1100 m (*Shinkai 2000* Dive 381) (see Hashimoto *et al.*, 1989 for details).

Other distribution records: North Knoll of Iheya Ridge, Okinawa Trough, 1050 m (*Shinkai 2000* Dives 863 and 864) (Fujikura *et al.*, 2000: 105). Off Hatsushima, Sagami Bay, 800–1200 m (*Shinkai 2000* Dive 381); Ryuyo Submarine Canyon, 1100 m (*Shinkai 2000* Dive 897); Iheya Ridge, Okinawa Trough, 1400 m (*Shinkai 2000* Dive 613) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 1050–1400 m; vent and seep.

26. *Calyptogena (Archivesica) similis* Okutani, Kojima & Ashi, 1997

[Japanese name: Niyori-shirourigai]

Calyptogena similis Okutani, Kojima & Ashi, 1997: 186, figs. 2–4.

Calyptogena (Archivesica) similis: Okutani, Fujikura & Kojima, 2000: 96; Okutani, Kojima & Iwasaki, 2002: 133, fig. 4F–G; Okutani, 2000: 998 (pl. 497), fig. 12, 999.

Type depository: Holotype, NSMT-Mo 70765 (Fig. 9A–B).

Type locality: Daini Tenryu Knoll, Nankai Trough, 35°05.6–06.7′ N, 138°07.9–06.8′ E, 2084 m (*Shinkai 6500* Dive 321).

Other distribution records: West off Kikaijima Island, 1438 m (*Shinkai 2000* Dive 972), 1647 m (*Shinkai 2000* Dive 1026) (Fujikura *et al.*, 2000: 108). Tokai Thrust, Nankai Trough, 2100 m (*Shinkai 6500* Dive 321); Yukie Ridge, Nankai Trough, 1900–2200 m (*Nautile* Dive KN5, *Shinkai 6500* Dive 520); Daiyon Kumano Knoll, Nankai Trough, 2000 m (*Kaiko* Dive 267); off Kumano, Nankai Trough, 2100 m (*Shinkai 6500* Dive 676) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 1438–2200 m; seep.

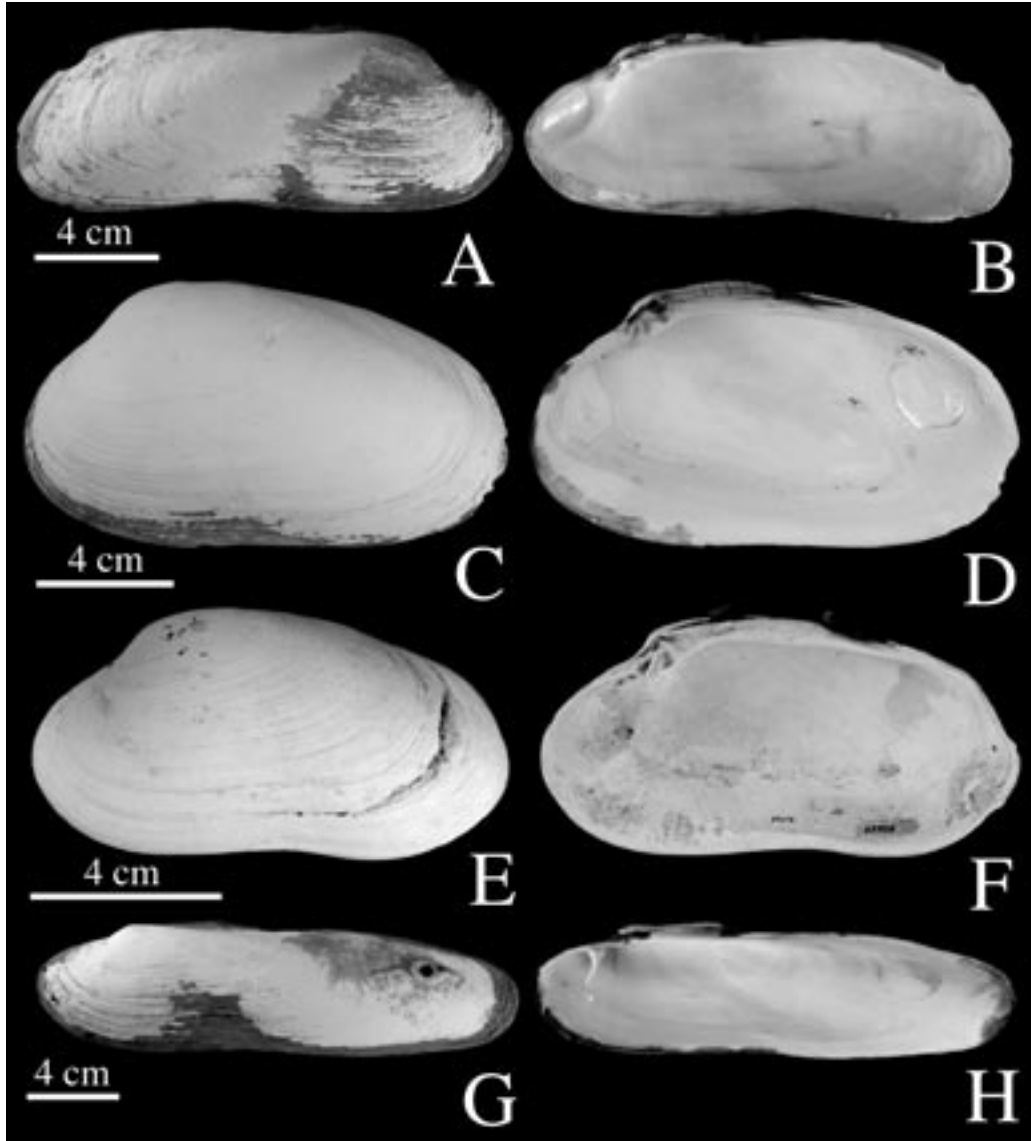


Fig. 9. Vesicomidae. **A-B.** *Calyptogena (Archivesica) similaris* Okutani, Kojima & Ashi, 1997, holotype, NSMT-Mo 70765. **C-D.** *Calyptogena (Archivesica) solidissima* Okutani, Hashimoto & Fujikura, 1992, holotype, NSMT-Mo 69675. **E-F.** *Calyptogena (Archivesica) soyoae* Okutani, 1957, holotype, NSMT-Mo 62756. **G-H.** *Calyptogena (Archivesica) tsubasa* Okutani, Fujikura & Kojima, 2000, holotype, NSMT-Mo 71492.

27. *Calyptogena (Archivesica) solidissima* Okutani, Hashimoto & Fujikura, 1992

[Japanese name: Ensei-shirourigai]

Calyptogena solidissima Okutani, Hashimoto & Fujikura, 1992: 226, figs. 2–8, pl. 1.

Calyptogena (Archivesica) solidissima: Okutani, Fujikura & Kojima, 2000: 96; Okutani, 2000, 998 (pl. 497), fig. 14, 999.

Type depository: Holotype, NSMT-Mo 69675 (Fig. 9C-D).

Type locality: Minami Ensei Knoll, Okinawa Trough, 28°23.49' N, 127°38.43' E, 710 m (*Shinkai 2000* Dive 428).

Other distribution records: Minami Ensei Knoll, Okinawa Trough, 670 m (*Shinkai 2000* Dive 357) (Okutani *et al.*, 1992a). Daini Tenryu Submarine Canyon, Nankai Trough, 594–609 m (*Shinkai 2000* Dive 1059); Muroto Knoll, Nankai Trough, 600 m (*Deep Tow System* Dredge DT-12D); Ashizuri Knoll, Nankai Trough, 650 m (*Deep Tow System* Dredge DT-9D); Kuroshima Knoll, off Yaeyama Islands, Okinawa, 682 m (*Dolphin 3K* Dive 348) (Fujikura *et al.*, 2000: 109). Daisan Tenryu Knoll, Nankai Trough, 600 m (*Shinkai 2000* Dive 1377); Minami-Ensei Knoll, Okinawa Trough 600–700 m (*Shinkai 2000* Dive 615) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 594–710 m; vent and seep.

Remarks: There is possibility that this species is regarded as conspecific with *C. kawamurai* (Kuroda, 1943) at the DNA level (Kojima *et al.*, unpublished data). However, *C. solidissima* is morphologically distinguished from typical *C. kawamurai* (Fig. 10) and other *Calyptogena* chiefly by fine radial threads on the outer shell surface (Okutani *et al.*, 1992a: 230). We did not include *C. kawamurai* in this list, because no specimen identifiable as ‘*C. kawamurai*’ has been collected alive in JAMSTEC cruises. The type locality of *C. kawamurai* is off Odawara, Sagami Bay; the holotype is deposited in NSMT (NSMT-Mo 60915: Fig. 10).

28. *Calyptogena (Archivesica) soyoae* Okutani, 1957

[Japanese name: Shirourigai]

Calyptogena soyoae Okutani, 1957: 27, figs. 1, 4, 5; Okutani, Tagawa & Horikawa, 1989: 142.

Akebiconcha soyoae: Okutani, 1966: 300, pl. 28, figs. 1–2.

Calyptogena (Calyptogena) soyoae: Boss in Boss & Turner, 1980: 189.

“*Calyptogena*” *soyoae*: Horikoshi & Hashimoto, 1992: 73.

Calyptogena (Archivesica) soyoae: Okutani, Fujikura & Kojima, 2000: 95; Okutani, 2000: 996 (pl. 496), fig. 8, 997.

Type depository: Holotype, NSMT-Mo 62756 (Fig. 9E-F).

Type locality: 35°05.1' N, 127°139.3' E, 6 miles WSW off Jogashima, Sagami Bay, 750 m.

Other distribution records: Sagami Bay, 700–750 m (Okutani *et al.*, 1989); off Hatsushima, Sagami Bay, 1150 m (*Shinkai 2000* Dive 228) (Horikoshi & Hashimoto, 1992); Sagami Knoll, Sagami Bay, 1400–1500 m (*Dolphin 3K* Dive 91, *Shinkai 2000* Dives 1041 and 1197); off Hatsushima, Sagami Bay, 800–1200 m (*Dolphin 3K* Dive 167, *Shinkai 2000* Dive 381); Okinoyama Bank, Sagami Bay, 1200–1500 m (*Dolphin 3K* Dive 45, *Shinkai 2000* Dive 382) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 700–1500 m; seep.

29. *Calyptogena (Archivesica) tsubasa* Okutani, Fujikura & Kojima, 2000

[Japanese name: Tsubasa-shirourigai]

Calyptogena (Archivesica) tsubasa Okutani, Fujikura & Kojima, 2000: 87, figs. 7, 9–11; Okutani, Kojima & Iwasaki, 2002: 133; Okutani, 2000: 998 (pl. 497), fig. 13, 999.

Type depository: Holotype, NSMT-Mo 71492 (Fig. 9G-H).

Type locality: Daisan Tenryu Knoll, Nankai Trough, 33°38.8' N, 137°54.5' E, 3761 m (*Kaiko* Dive 45).

Other distribution records: Daisan Tenryu Submarine Canyon, Nankai Trough, 3800 m (*Shinkai 6500* Dive 404); Tenryu Submarine Canyon, Nankai Trough, 3800 m (*Nautile* Dive KN12); Daiichi Minami Muroto Knoll, Nankai Trough, 3600 m (*Kaiko* Dive 189) (Kojima *et al.*,

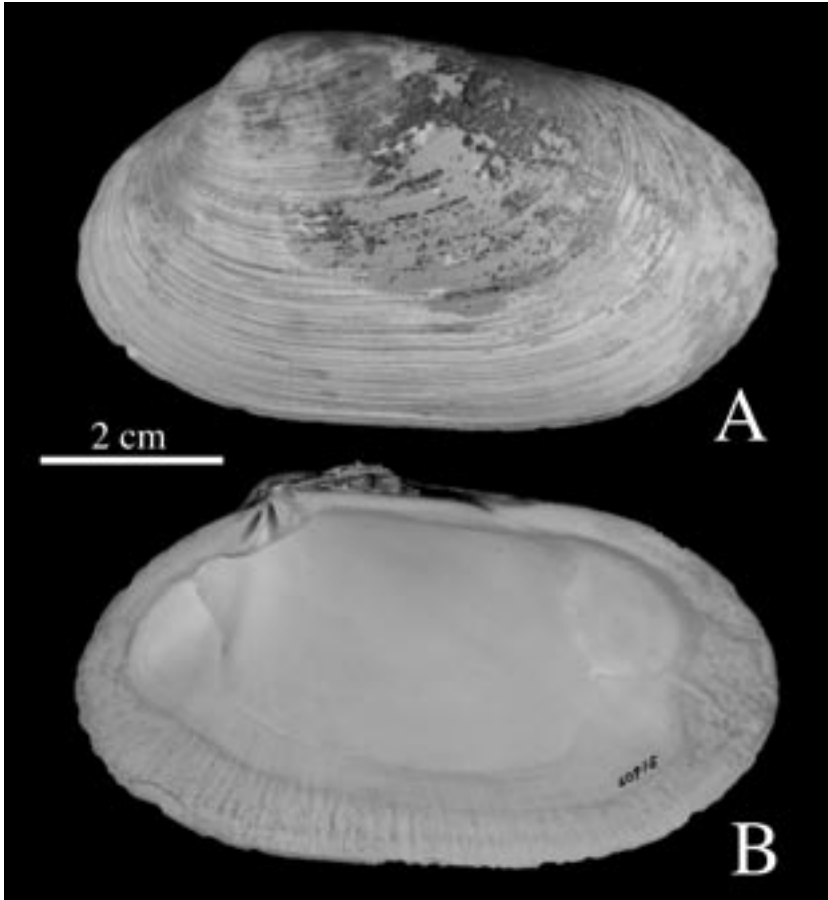


Fig. 10. Vesicomomyidae. *Calyptogena (Archivesica) kawamurai* (Kuroda, 1943), holotype, NSMT-Mo 60915.

2004: table 2).

Depth range and type of habitat: 3600–3800 m; seep.

Genus *Vesicomomya* Dall, 1886

Remarks: Generic relationships of *Vesicomomya* and related genera were discussed by Cosel & Salas (2001).

30. *Vesicomomya crenulomarginata* Okutani, Kojima & Iwasaki, 2002

[Japanese name: Kizami-otohime-hamaguri]

Vesicomomya crenulomarginata Okutani, Kojima & Iwasaki, 2002: 131, figs. 2A–D, 3A–B.

Type depository: Holotype, NSMT-Mo 73188 (Fig. 11A–B).

Type locality: Kumano Basin, 33°40.8′ N, 136°33.6′ E, 2014 m (*Shinkai 6500* Dive 527).

Other distribution records: Kumano Basin, 2517 m (*Shinkai 6500* Dive 614) (Okutani, Kojima & Iwasaki, 2002). Daiyon Kumano Knoll, Nankai Trough, 2000 m (*Kaiko* Dive 267); Dairoku Kumano Knoll, Nankai Trough, 2000 m (*Shinkai 6500* Dive 527) (Kojima *et al.*, 2004:

table 2).

Depth range and type of habitat: 2000–2517 m; seep.

31. *Vesicomya kaikoe* Okutani, Fujikura & Kojima, 2000

[Japanese name: Kaiko-otohime-hamaguri]

Vesicomya kaikoe Okutani, Fujikura & Kojima, 2000: 85, figs. 3, 4; Okutani, Kojima & Iwasaki, 2002: 133, figs. 2E–F, 3C–D; Okutani, 2000: 996 (pl. 496), fig. 4, 997.

Type depository: Holotype, NSMT-Mo 71490 (Fig. 11C–D).

Type locality: Tenryu Submarine Canyon, Nankai Trough, 33°36.3′ N, 137°32.3′ E, 3760 m (*Kaiko* Dive 44).

Other distribution record: Off Muroto Point, Nankai Trough, 3600–3800 m (*Shinkai 6500* Dive 519) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 3600–3800 m; seep.

32. *Vesicomya kuroshimana* Okutani, Fujikura & Kojima, 2000

[Japanese name: Kuroshima-otohime-hamaguri]

Vesicomya kuroshimana Okutani, Fujikura & Kojima, 2000: 83, figs. 2, 6; Okutani, 2000: 996 (pl. 496), 997.

Type depository: Holotype, NSMT-Mo 71488 (Fig. 11E–F).

Type locality: Kuroshima Knoll, off Yaeyama Islands, Okinawa, 24°07.68′ N, 124°12.65′ E, 702 m (*Dolphin 3K* Dive 347).

Other distribution records: Kuroshima Knoll, off Yaeyama Islands, Okinawa, 812 m (*Dolphin 3K* Dive 347) (Okutani *et al.*, 2000a; Kojima *et al.*, 2004: table 2); 700–810 m (*Shinkai 2000* Dive 981) (Kojima *et al.*, 2004: table 2).

Depth range and type of habitat: 702–812 m; seep.

Class GASTROPODA Cuvier, 1795

Remarks: The higher taxonomy of gastropods in this list follows Bouchet & Rocroi (2005).

Clade Patellogastropoda Lindberg, 1986

Family Neolepetopsidae McLean, 1990

Genus *Paralepetopsis* McLean, 1990

33. *Paralepetopsis lepichoni* Warén & Bouchet, 2001

[Japanese name: Rupishon-kasagai]

Paralepetopsis lepichoni Warén & Bouchet, 2001: 125, figs. 2c, 5a–f; Okutani & Iwasaki, 2003: 2, fig. 2B.

Type depository: Holotype, in MNHN.

Type locality: South off Shizuoka Prefecture, Nankai Trough, 33°49.40′ N, 137°55.20′ E, 2140 m (*KAIKO-NANKAI* 14).

Other distribution record: South-southeast off Cape Muroto, Nankai Trough, 3571 m (*Kaiko* Dive 192) (Okutani & Iwasaki, 2003).

Depth range and type of habitat: 2140–3571 m; seep.

Family Acmaeidae Forbes, 1850

Genus *Serradonta* Okutani, Tsuchida & Fujikura, 1992

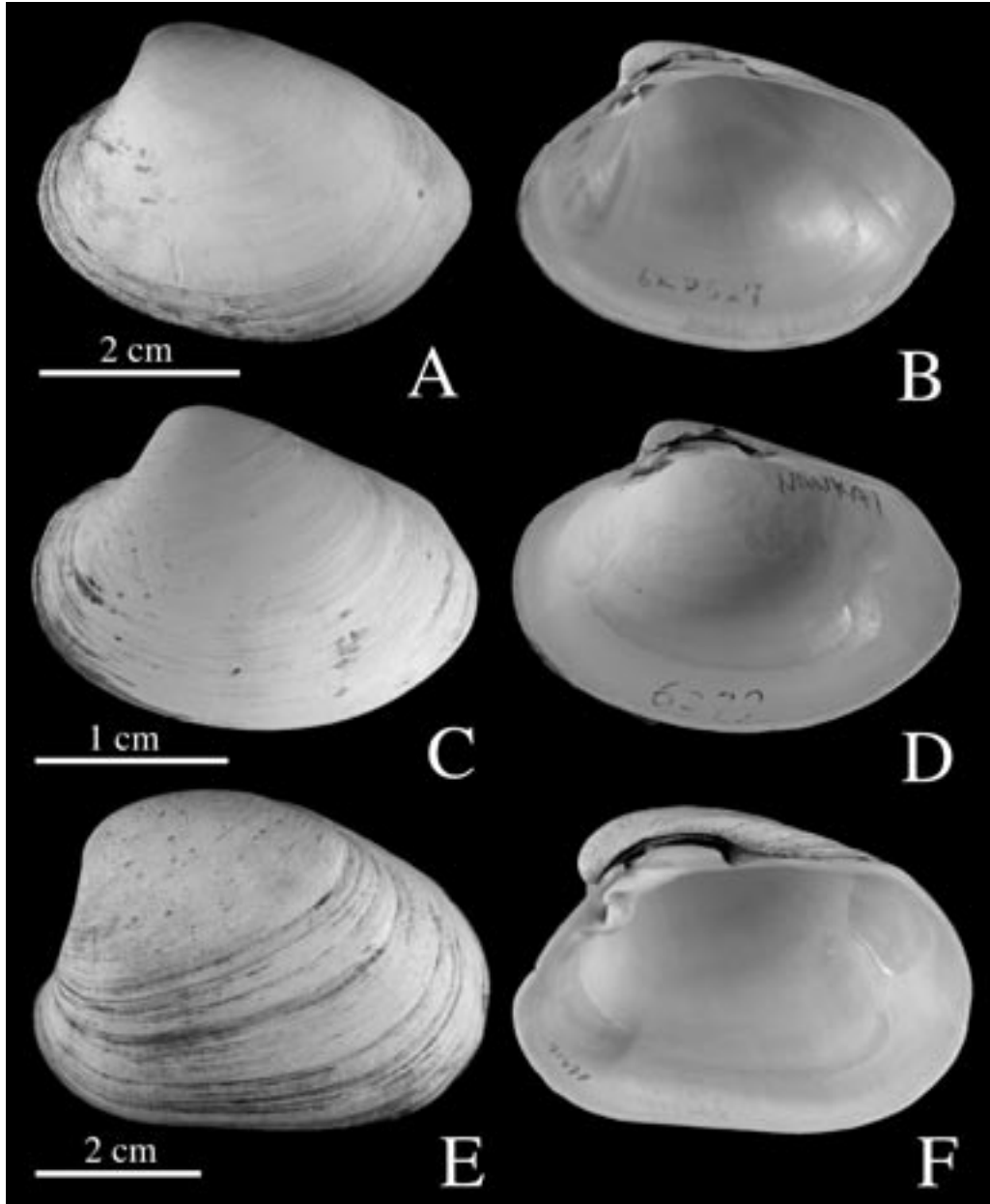


Fig. 11. Vesicomysidae. **A-B.** *Vesicomysa crenulomarginata* Okutani, Kojima & Iwasaki, 2002, holotype, NSMT-Mo 73188. **C-D.** *Vesicomysa kaikoe* Okutani, Fujikura & Kojima, 2000, holotype, NSMT-Mo 71490. **E-F.** *Vesicomysa kuroshimana* Okutani, Fujikura & Kojima, 2000, holotype, NSMT-Mo 71488.

34. *Serradonta kanesunosensis* Sasaki, Okutani & Fujikura, 2003
 [New Japanese name: Kanesunose-watazoko-yadori-kasagai]

Serradonta kanesunosensis Sasaki, Okutani & Fujikura, 2003: 195, fig. 8.

Type depository: Holotype, UMUT 27961 (Fig. 12A).

Type locality: Kanesunose Bank, Nankai Trough, 34°17.06' N, 138°14.86' E, 322 m (*Shinkai 2000* Dive 816).

Other distribution record: Kanesunose Bank, Nankai Trough, 284–304 m (*Shinkai 2000* Dive 772) (Sasaki *et al.*, 2003: 195).

Depth range and type of habitat: 284–322 m; seep.

35. *Serradonta vestimentifericola* Okutani, Tsuchida & Fujikura, 1992

[Japanese name: Watazoko-yadori-kasagai]

Serradonta vestimentifericola Okutani, Tsuchida & Fujikura, 1992: 139, figs. 2–6; Sasaki, 2000: 26 (pl. 13), fig. 3, 27.

Type depository: Holotype, NSMT-Mo 69643 (Fig. 12B–C).

Type locality: Off Hatsushima, Sagami Bay, around 35°00.0' N, 139°13.50' E, 1110–1200 m (*Dolphin 3K* Dive 116). Known only from the type locality.

Type of habitat: Seep. Attached to tubes of a vestimentifera.

Genus *Bathymacrea* Okutani, Tsuchida & Fujikura, 1992

36. *Bathymacrea nipponica* Okutani, Tsuchida & Fujikura, 1992

[Japanese name: Watazoko-shiroamigasagai-modoki]

Bathymacrea nipponica Okutani, Tsuchida & Fujikura, 1992: 140, figs. 7–11; Sasaki, 2000: 26 (pl. 13), fig. 4, 27.

Type depository: Holotype, NSMT-Mo 69641.

Type locality: Off Hatsushima, Sagami Bay, around 35°00.0' N, 139°13.50' E, 1110–1200 m (dive number uncertain).

Other distribution records: Off Hatsushima, Sagami Bay, around 1110–1200 m (*Shinkai 2000* Dives 452, 592, *Dolphin 3K* Dive 118) (Okutani *et al.*, 1992b).

Depth range and type of habitat: 1110–1200 m; seep.

Remarks: This species was attached to shells of *Calyptogena* when collected alive (Okutani, Tsuchida & Fujikura, 1992).

37. *Bathymacrea secunda* Okutani, Fujikura & Sasaki, 1993

[Japanese name: Tsugino-watazoko-shiroamigasagai-modoki]

Bathymacrea secunda Okutani, Fujikura & Sasaki, 1993:130, figs. 13–19; Okutani & Fujiwara, 2000: 124, figs. 2, 3; Sasaki, 2000: 26 (pl. 13), fig. 5, 27; Sasaki, Okutani & Fujikura, 2003: 190, figs. 2, 3A.

Type depository: Holotype, NSMT-Mo 69970 (Fig. 12D).

Type locality: Minami Ensei Knoll, Okinawa Trough, 28°23.3' N, 127°38.4' E, 700 m (*Shinkai 2000* Dive 547).

Other distribution records: Iheya Ridge, Okinawa Trough, 1380 m (*Shinkai 2000* Dive 368) (Okutani *et al.*, 1993b). North Knoll of Iheya Ridge, 1049 m (*Shinkai 2000* Dive 863) (Okutani & Fujiwara, 2000; Sasaki *et al.*, 2003: 190); 990 m (*Shinkai 2000* Dive 978), 1390 m (*Shinkai 2000* Dive 672), Izena Hole, 1340 m (Dredge: DK89-1-OKN Leg. 2) (Sasaki *et al.*, 2003: 190).

Depth range and type of habitat: 700–1049 m; vent.

Remarks: The shell microstructure of this species was described by Fuchigami & Sasaki (2005).

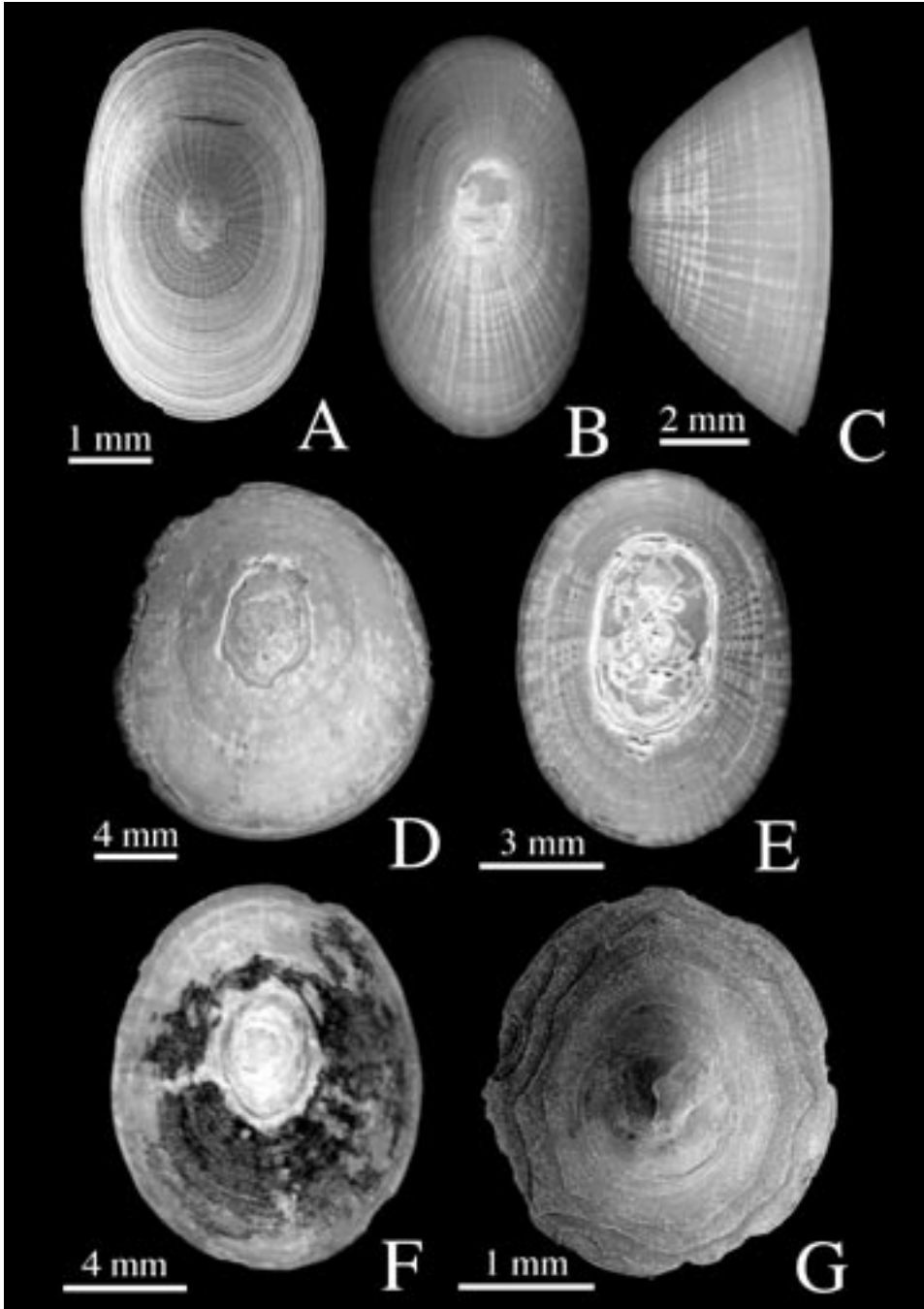


Fig. 12. Acmaeidae and Pyropeltidae. **A.** *Serradonta kanesunosensis* Sasaki, Okutani & Fujikura, 2003, holotype, UMUT RM27961. **B-C.** *Serradonta vestimentifericola* Okutani, Tsuchida & Fujikura, 1992, holotype, NSMT-Mo 69643. **D.** *Bathyacmaea secunda* Okutani, Fujikura & Sasaki, 1993, holotype, NSMT-Mo 69970. **E.** *Bathyacmaea subnipponica* Sasaki, Okutani & Fujikura, 2003, holotype, UMUT RM27959. **F.** *Bathyacmaea tertia* Sasaki, Okutani & Fujikura, 2003, holotype, UMUT RM27955. **G.** *Pyropelta yamato* Sasaki, Okutani & Fujikura, 2003, holotype, UMUT RM27964.

38. *Bathyacmaea subnipponica* Sasaki, Okutani & Fujikura, 2003
[New Japanese name: Ryuyo-watazoko-shiroamigasagai-modoki]

Bathyacmaea subnipponica Sasaki, Okutani & Fujikura, 2003: 193, fig. 6.

Type depository: Holotype, UMUT RM27959 (Fig. 12E).

Type locality: Ryuyo Canyon, Nankai Trough, 34°11.50' N, 137°45.50' E, 1100 m (*Shinkai 2000* Dive 898). Known only from the type locality.

Type of habitat: Seep.

39. *Bathyacmaea tertia* Sasaki, Okutani & Fujikura, 2003
[New Japanese name: Kinume-watazoko-shiroamigasagai-modoki]

Bathyacmaea tertia Sasaki, Okutani & Fujikura, 2003: 190. figs. 3B, 4, 5.

Type depository: Holotype, UMUT RM27955 (Fig. 12F).

Type locality: North Knoll of Iheya Ridge, Okinawa Trough, 27°47.22' N, 126°53.91' E, 996 m (*Shinkai 2000* Dive 1094).

Other distribution record: North Knoll of Iheya Ridge, 1000 m (*Shinkai 2000* Dive 1094) (Sasaki *et al.*, 2003: 191).

Depth range and type of habitat: 996–1000 m; vent.

40. *Bathyacmaea* sp. 1.

Bathyacmaea sp.: Okutani & Iwasaki, 2003: 2.

Distribution record: South-southeast off Cape Muroto, Nankai Trough, 3571 m (*Kaiko* Dive 192) (Okutani & Iwasaki, 2003).

Type of habitat: Seep.

Remarks: The identity of this species is not clear, because the radula was not observable (Okutani & Iwasaki, 2003).

41. *Bathyacmaea* sp. 2.

Bathyacmaea sp.: Sasaki, Okutani & Fujikura, 2003: 195.

Distribution record: Sumisu Caldera, south of Izu Islands, 676 m.

Type of habitat: Vent.

Remarks: This probably represents a new species, especially based on its characteristic cancellate sculpture (Sasaki *et al.*, 2003: fig. 7). However, only an incomplete small specimen has been collected so far.

Clade Vetigastropoda Salvini-Plawen, 1980
Family Fissurellidae Fleming, 1822
Genus *Puncturella* Lowe, 1827

42. *Puncturella parvinobilis* Okutani, Fujikura & Sasaki, 1993
[Japanese name: Chibi-koudaka-sukashigai]

Puncturella parvinobilis Okutani, Fujikura & Sasaki, 1993: 128, figs. 8–12; Okutani & Fujiwara, 2000: 123, fig. 4; Sasaki, Okutani & Fujikura, 2003: 197, fig. 10.

Puncturella [sic] *parvinobilis*: Sasaki, 2000: 50 (pl. 25), fig. 34, 51.

Type depository: Holotype, NSMT-Mo 69968 (Fig. 13A).

Type locality: Minami Ensei Knoll, Okinawa Trough, 28°23.5′ N, 127°38.4′ E, 690 m (*Shinkai 2000* Dive 610).

Other distribution records: North Knoll of Iheya Ridge, Okinawa Trough, 1050 m (*Shinkai 2000* Dive 864) (Okutani & Fujiwara, 2000); 1049 m (*Shinkai 2000* Dive 863) (Sasaki *et al.*, 2003: 199). Izena Hole, Okinawa Trough, 1340 m (*Shinkai 2000* Dive 360) (Sasaki *et al.*, 2003: 199).

Depth range and type of habitat: 690–1340 m; vent.

43. *Puncturella rimaizenaensis* Okutani, Fujikura & Sasaki, 1993
[Japanese name: Izena-koudaka-sukashigai]

Puncturella rimaizenaensis Okutani, Fujikura & Sasaki, 1993: 126, figs. 2–7.

Puncturella [sic] *rimaizenaensis*: Sasaki, 2000: 50 (pl. 25), fig. 33, 51.

Type depository: Holotype, NSMT-Mo 69966 (Fig. 13B).

Type locality: Izena Hole, Okinawa Trough, 27°16.1′ N, 127°04.9′ E, 1340 m (*Shinkai 2000* Dive 360). Known only from the type locality.

Type of habitat: Vent.

Family Pyropeltidae McLean & Haszprunar, 1987
Genus *Pyropelta* McLean & Haszprunar, 1987

44. *Pyropelta yamato* Sasaki, Okutani & Fujikura, 2003
[New Japanese name: Kasane-watazoko-shirogasa]

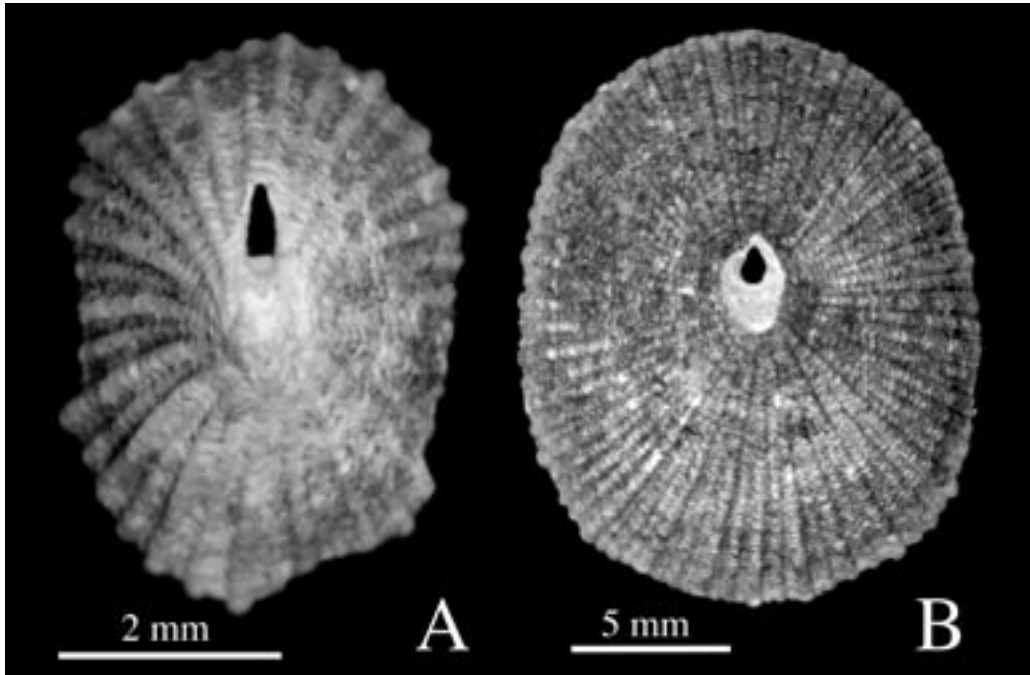


Fig. 13. Fissurellidae. **A.** *Puncturella parvinobilis* Okutani, Fujikura & Sasaki, 1993, holotype, NSMT-Mo 69968. **B.** *Puncturella rimaizenaensis* Okutani, Fujikura & Sasaki, 1993, holotype, NSMT-Mo 69966.

Pyropelta yamato Sasaki, Okutani & Fujikura, 2003: 197, fig. 9.

Type depository: Holotype, UMUT RM27964 (Fig. 12G).

Type locality: Sumisu Caldera, south off Izu Islands, 31°27.97' N, 140°04.44' E, 676 m (*Shinkai 2000* Dive 1017). Known only from the type locality.

Type of habitat: Vent.

Family Lepetodrilidae McLean, 1988

Genus *Lepetodrilus* McLean, 1988

45. *Lepetodrilus japonicus* Okutani, Fujikura & Sasaki, 1993

[Japanese name: Fune-kasagai]

Lepetodrilus japonicus Okutani, Fujikura & Sasaki, 1993: 134, figs. 30–33; Sasaki, 2000: 34 (pl. 17), fig. 2, 35.

Type depository: Holotype, NSMT-Mo 69974 (Fig. 14A).

Type locality: Minami Ensei Knoll, Okinawa Trough, 28°23.3' N, 127°38.4' E, 700 m (*Shinkai 2000* Dive 549).

Other distribution records: Minami Ensei Knoll, Okinawa Trough, 710 m (*Shinkai 2000* Dives 428) (Okutani *et al.*, 1993b).

Depth range and type of habitat: 700–710 m; vent.

Remarks: *L. japonicus* and *L. nux* are similar in shell morphology but strikingly different in the cusp of the central tooth of the radula (Okutani *et al.*, 1993: figs. 28–29, 32–33).

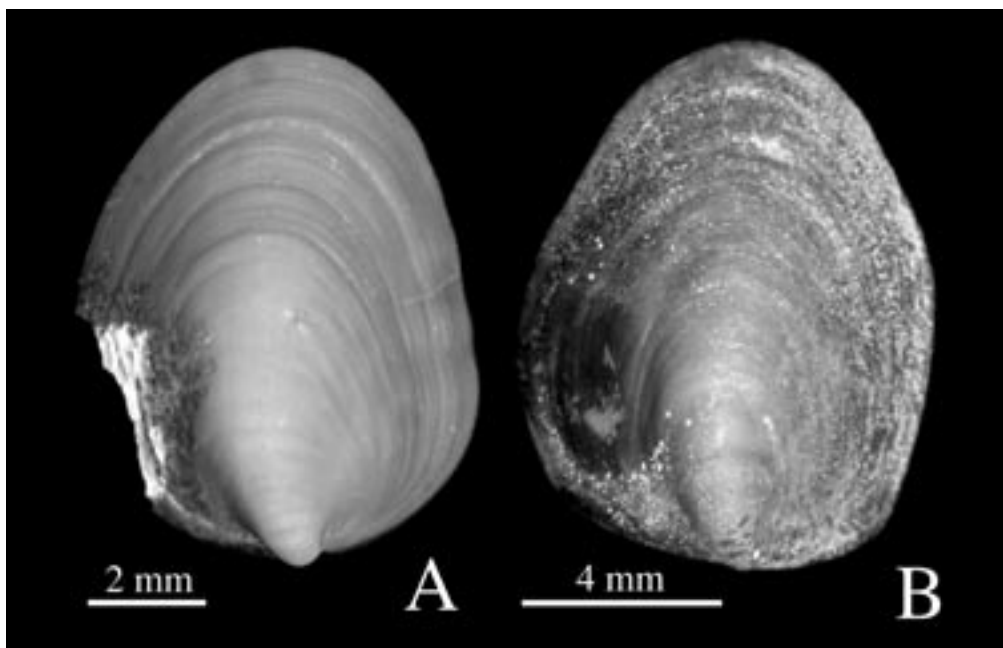


Fig. 14. Lepetodrilidae. **A.** *Lepetodrilus japonicus* Okutani, Fujikura & Sasaki, 1993, holotype, NSMT-Mo 69974. **B.** *Lepetodrilus nux* (Okutani, Fujikura & Sasaki, 1993), holotype, NSMT-Mo 69972.

46. *Lepetodrilus nux* (Okutani, Fujikura & Sasaki, 1993)

[Japanese name: Kinomi-fune-kasagai]

Rynchopelta? *nux* Okutani, Fujikura & Sasaki, 1993: 132, figs. 22–27.*Lepetodrilus nux* (Okutani, Fujikura & Sasaki, 1993): Sasaki, 1998: 94, figs. 62–65; Sasaki, 2000: 34 (pl. 35), fig. 1, 35; Sasaki, Okutani & Fujikura, 2003: 1999, fig. 11.**Type depository:** Holotype, NSMT-Mo 69972 (Fig. 14B).**Type locality:** Izena Hole, 27°16.1′ N, 127°04.9′ E, 1340 m (*Shinkai 2000* Dive 364).**Other distribution records:** Iheya Ridge, Okinawa Trough, 1350 m (*Shinkai 2000* Dive 427) (Okutani *et al.*, 1993b). North Knoll of Iheya Ridge, 990 m (*Shinkai 2000* Dive 978); Iheya Ridge, 1390 m (*Shinkai 2000* Dive 672) (Sasaki *et al.*, 2003: 199, 201).**Depth range and type of habitat:** 990–1390 m; vent.**Remarks:** The exact location of the type locality, either Izena Hole or Iheya Ridge, was not shown in the original description. However, the holotype was revealed to have been collected from Izena Hole (*Shinkai 2000* Dive 364), according to the original label attached to it.

Family Neomphalidae McLean, 1981

Genus *Retiskenea* Warén & Bouchet, 200147. *Retiskenea diploura* Warén & Bouchet, 2001

[Japanese name: Kaikou-keshitsubu-shitadami]

Retiskenea diploura Warén & Bouchet, 2001: 158, figs. 15j, 16g, 18e, 24c; Okutani & Fujikura, 2002: 212, fig. 2A–I.**Type depository:** Holotype, SMF 311984.**Type locality:** Aleutian Trench, Shumagin site, 54°18.17′ N, 157°11.82′ W, 4808 m (TVGKG 40).**Other distribution records in Japan:** East off northern Iwate Prefecture, Japan Trench, 6248 m, 6290 m (*Shinkai 6500* Dive 552) (Fujikura *et al.*, 2002a: table 1). East off southern Iwate Prefecture, Japan Trench, 5343 m (*Shinkai 6500* Dive 550) (Okutani & Fujikura, 2002; Fujikura *et al.*, 2002a: table 1); 5343–5345 m (*Kaiko* Dive 183), 5379 m (*Shinkai 6500* Dive 553) (Fujikura *et al.*, 2002a: table 1).**Distribution records outside Japan:** Aleutian Trench, *ca.* 4800 m (Warén & Bouchet, 2001).**Depth range and type of habitat:** *ca.* 4800–6290 m; seep.

Family Trochidae Rafinesque, 1815

Genus *Margarites* Gray, 184748. *Margarites ryukyuensis* Okutani, Sasaki & Tsuchida, 2000

[Japanese name: Okinawa-shinkai-shitadami]

Margarites ryukyuensis Okutani, Sasaki & Tsuchida, 2000: 273, fig. 6.**Type depository:** Holotype, UMUT 27884 (Fig. 15A).**Type locality:** North Knoll of Iheya Ridge, Okinawa Trough (dive number uncertain).**Other distribution records:** North Knoll of Iheya Ridge, Okinawa Trough, 968 m (*Shinkai 2000* Dive 1092), 1053 m (*Shinkai 2000* Dive 1094) (Okutani *et al.*, 2000b).**Depth range and type of habitat:** 968–1053 m; vent.

49. *Margarites shinkai* Okutani, Tsuchida & Fujikura, 1992

[Japanese name: Shinkai-shitadami]

Margarites shinkai Okutani, Tsuchida & Fujikura, 1992: 142, figs. 12–16; Okutani, Fujikura & Sasaki, 1993: 132, figs. 20–21; Sasaki, 2000: 60 (pl. 30), fig. 34, 61.

Type depository: Holotype, NSMT-Mo 69635 (Fig. 15B).

Type locality: Off Hatsushima, Sagami Bay, around 35°00.0′ N, 139°13.50′ E, 1110–1200 m (dive number uncertain).

Other distribution records: Off Hatsushima, Sagami Bay, around 35°00.0′ N, 139°13.50′ E, 1110–1200 m (*Shinkai 2000* Dives 452, 592; *Dolphin 3K* Dives 78, 79, 115, 118) (Okutani *et al.*, 1992b). Izena Hole, Okinawa Trough, 1340 m (*Shinkai 2000* Dives 360, 364) (Okutani *et al.*, 1993b).

Depth range and type of habitat: 1110–1340 m; seep and vent.

Genus *Iheyaspira* Okutani, Sasaki & Tsuchida, 2000

50. *Iheyaspira lequios* Okutani, Sasaki & Tsuchida, 2000

[Japanese name: Iheya-keshitsubu-shitadami]

Iheyaspira lequios Okutani, Sasaki & Tsuchida, 2000: 268, figs. 2–5.

Type depository: Holotype, UMUT RM27887 (Fig. 15C).

Type locality: North Knoll of Iheya Ridge, Okinawa Trough (dive number uncertain).

Other distribution records: North Knoll of Iheya Ridge, Okinawa Trough, 968 m (*Shinkai 2000* Dive 1092), 1053 m (*Shinkai 2000* Dive 1094) (Okutani *et al.*, 2000b).

Depth range and type of habitat: 968–1053 m; vent.

Family Turbinidae Rafinesque, 1815

Genus *Cantrainea* Jeffreys, 1883

Remarks: The genus *Thermocollonia* Okutani & Fujikura, 1990 was synonymized with this genus by Warén & Bouchet (1993: 8).

51. *Cantrainea jamsteci* (Okutani & Fujikura, 1990)

[Japanese name: Shinkai-sanshogai]

Thermocollonia jamsteci Okutani & Fujikura, 1990: 85, figs. 2–6.

Cantrainea jamsteci: Sasaki, 2000: 92 (pl. 46), fig. 20, 93.

Type depository: Holotype, NSMT-Mo 66235 (Fig. 15D).

Type locality: Minami Ensei Knoll, Okinawa Trough, 28°24.34′ N, 127°38.01′ E, 700 m (*Shinkai 2000* Dive 358).

Other distribution record: Minami Ensei Knoll, Okinawa Trough, 720 m (Dive number unknown) (Okutani & Fujikura, 1990).

Depth range and type of habitat: 700–720 m; vent.

Clade Neritimorpha Koken, 1896

Family Phenacolepadidae Pilsbry, 1895

Remarks: *Shinkailepadidae* Okutani, Saito & Hashimoto, 1989 is now synonymized with *Phenacolepadidae* (Beck, 1992; Warén & Bouchet, 2001: 174; Sasaki *et al.*, 2003; Bouchet & Rocroi, 2005: 246). The relation of *Shinkailepas* and other phenacolepadid genera is to be

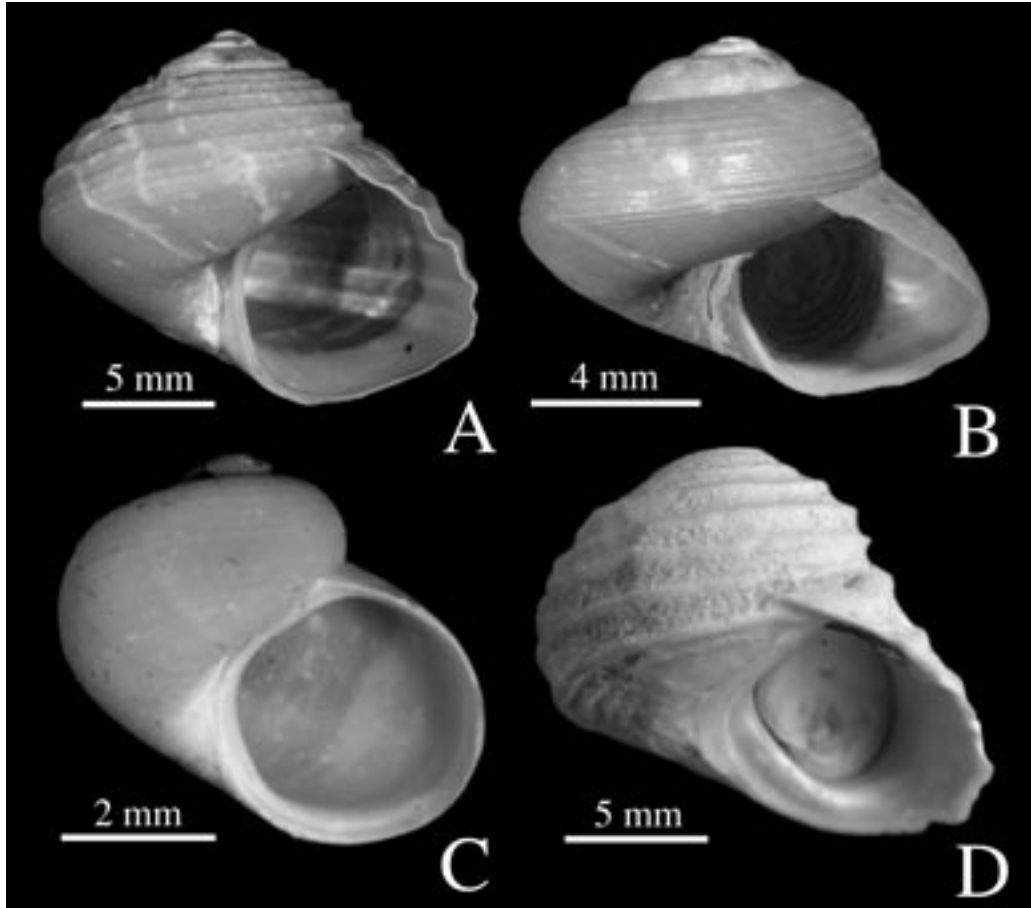


Fig. 15. Trochidae and Turbinidae. **A.** *Margarites ryukyuensis* Okutani, Sasaki & Tsuchida, 2000, holotype, UMUT RM27884. **B.** *Margarites shinkai* Okutani, Tsuchida & Fujikura, 1992, holotype, NSMT-Mo 69635. **C.** *Iheyaspira lequios* Okutani, Sasaki & Tsuchida, 2000, holotype, UMUT RM27887. **D.** *Cantrainea jamsteci* (Okutani & Fujikura, 1990), holotype, NSMT-Mo 66235.

discussed by Sasaki *et al.* (in press).

Genus *Shinkailepas* Okutani, Saito & Hashimoto, 1989

52. *Shinkailepas kaikatensis* Okutani, Saito & Hashimoto, 1989

[Japanese name: Shinkai-funeamagai]

Shinkailepas kaikatensis Okutani, Saito & Hashimoto, 1989: 225, figs. 2–8, 10–15 ; Tsuchiya, 2000: 110 (pl. 55), fig. 1 (Shinkailepadidae), 111.

Type depository: Holotype, NSMT-Mo 66230 (Fig. 16A).

Type locality: Kaikata Seamount, east off Ogasawara Islands, 26°42.32' N, 141°04.60' E, 470 m (*Shinkai 2000* Dive 339). Known only from the type locality.

Type of habitat: Vent.

Distribution: Known only from the type locality.

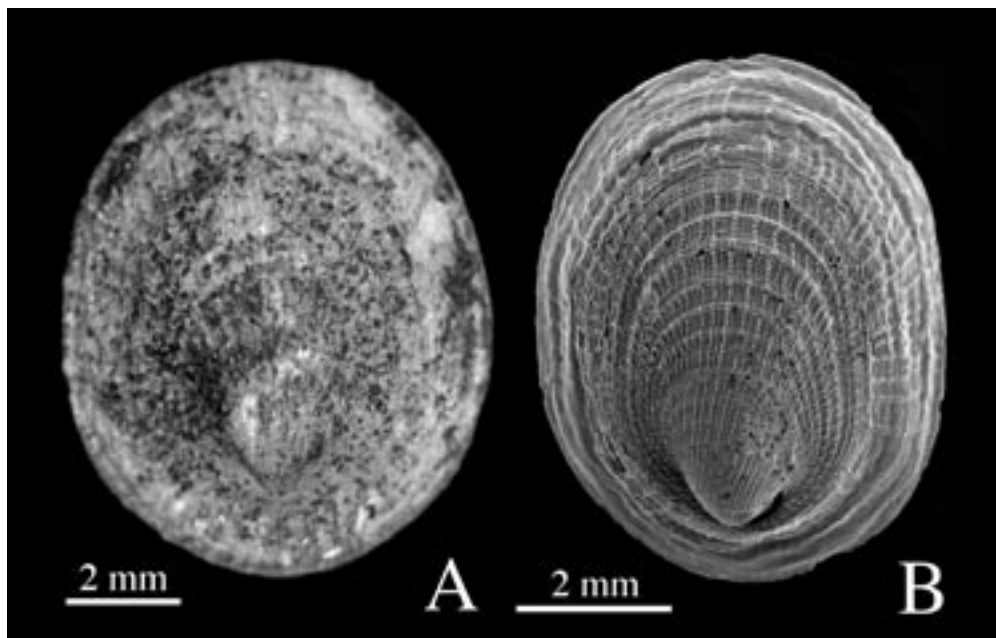


Fig. 16. Phenacolepadidae. **A.** *Shinkailepas kaikatensis* Okutani, Saito & Hashimoto, 1989, holotype, NSMT-Mo 66230. **B.** *Shinkailepas myojinensis* Sasaki, Okutani & Fujikura, 2003, holotype, UMUT RM27970.

53. *Shinkailepas myojinensis* Sasaki, Okutani & Fujikura, 2003

[New Japanese name: Myojin-shinkai-funeamagai]

Shinkailepas myojinensis Sasaki, Okutani & Fujikura, 2003: 201, figs. 12, 13.

Type depository: Holotype, UMUT RM27970 (Fig. 16B).

Type locality: Myojin Knoll, south off Izu Islands, 32°06.2' N, 139°52.0' E, 1288–1340 m (*Shinkai 2000* Dive 1112).

Other distribution record: Myojin Knoll, 1260–1290 m (*Shinkai 2000* Dive 1115) (Sasaki *et al.*, 2003: 201).

Depth range and type of habitat: 1260–1340 m; vent.

54. *Shinkailepas* sp.

Shinkailepas sp.: Sasaki, Okutani & Fujikura, 2003: 203, fig. 14.

Distribution record: North Knoll of Iheya Ridge, Okinawa Trough, 976 m (*Shinkai 2000* Dive 975).

Type of habitat: Vent.

Remarks: We considered this species as possibly distinct but did not give it a new name, since only a single specimen was available (Sasaki *et al.*, 2003).

Clade Caenogastropoda Cox, 1960
Family Provannidae Warén & Ponder, 1991
Genus *Provanna* Dall, 1918

55. *Provanna abyssalis* Okutani & Fujikura, 2002

[Japanese name: Kaikou-haikaburi-nina]

Provanna abyssalis Okutani & Fujikura, 2002: 214, fig. 3A–C.**Type depository:** Holotype, NSMT-Mo 73127.**Type locality:** Japan Trench, east off southern Iwate Prefecture, 39°06.47' N, 143°53.49' E, 5379 m (*Shinkai 6500* Dive 553). Known only from the type locality.**Type of habitat:** Seep.56. *Provanna glabra* Okutani, Tsuchida & Fujikura, 1992

[Japanese name: Sagami-haikaburi-nina]

Provanna glabra Okutani, Tsuchida & Fujikura, 1992: 143, figs. 17–21; Hasegawa, 2000: 112 (pl. 56), fig. 1 (*Provannidae*), 113.**Type depository:** Holotype, NSMT-Mo 69633.**Type locality:** Off Hatsushima, Sagami Bay, around 35°00.0' N, 139°13.50' E, 1110–1200 m (Dive number uncertain).**Other distribution records:** Off Hatsushima, Sagami Bay, around 35°00.0' N, 139°13.50' E, 1110–1200 m (*Shinkai 2000* Dives 452, 592, *Dolphin 3K* Dives 78, 79, 81, 115, 117, 118) (Okutani *et al.*, 1992b).**Depth range and type of habitat:** 1110–1200 m; seep.57. *Provanna shinkaiae* Okutani & Fujikura, 2002

[Japanese name: Shinkai-haikaburi-nina]

Provanna shinkaiae Okutani & Fujikura, 2002: 216, fig. 4A–C.**Type depository:** Holotype, NSMT-Mo 73128.**Type locality:** Japan Trench, east off southern Iwate Prefecture, 39°06.56' N, 143°53.33' E, 5343 m (*Shinkai 6500* Dive 550). Known only from the type locality.**Type of habitat:** Seep.58. *Provanna* sp.*Provanna glabra*: Okutani, Fujikura & Sasaki, 1993: 135, figs. 34–36; Okutani & Fujiwara, 2000: 124, fig. 5 (not *glabra* Okutani *et al.*, 1993).**Distribution records:** Minami Ensei Knoll, 710 m (*Shinkai 2000* Dive 428); Izena Hole, 1340 m (*Shinkai 2000* Dive 364); Iheya Ridge, 1350 m (*Shinkai 2000* Dive 427) (Okutani *et al.*, 1993b, as *P. glabra*). North Knoll of Iheya Ridge, Okinawa Trough, 1049 m (*Shinkai 2000* Dive 863) (Okutani & Fujiwara, 2000, as *P. glabra*).**Depth range and type of habitat:** 710–1049 m; vent.**Remarks:** This species has been identified as *P. glabra* but is distinct in shell characters (Sasaki *et al.* 2004). A new species name will be given elsewhere (Sasaki *et al.*, in preparation).

Clade Sorbeoconcha Ponder & Lindberg, 1997
 Clade Hypsogastropoda Ponder & Lindberg, 1997
 Clade Littorinimorpha Golikov & Starobogatov, 1975
 Family Elachisinidae Ponder, 1985
 Genus *Laeviphitus* van Aartsen, Bogi & Giusti, 1989

59. *Laeviphitus japonicus* Okutani, Fujikura & Sasaki, 1993

[Japanese name: Yomotsu-onsen-tsubo]

Laeviphitus japonicus Okutani, Fujikura & Sasaki, 1993: 135, figs. 37–43; Hasegawa, 2000: 164 (pl. 82), fig. 2 (Elachisinidae), 165.

Type depository: Holotype, NSMT-Mo 69976.

Type locality: Kaikata Seamount, 26°42.5′ N, 141°04.5′ E, 440 m (*Shinkai 2000* Dive 634). Known only from the type locality.

Type of habitat: Vent.

Clade Neogastropoda Wenz, 1938

Family Buccinidae Rafinesque, 1815

Genus *Neptunea* Röding, 1798

60. *Neptunea acutispiralis* Okutani, 1968

[Japanese name: Oshiroi-ezobora]

Neptunea acutispiralis Okutani, 1968: 34, pl. 2, fig. 11; Okutani, Fujikura & Sasaki, 1993: 137, figs. 51–54; Okutani, 2000: 470 (pl. 234), fig. 86, 471.

Type depository: Holotype, NSMT-Mo 60221.

Type locality: Southeast off Miyake Island, Izu Islands, 33°47′ N, 140°33′ E, 1280–1380 m (*Ryofu-Maru* station F22 (JEDS-5)).

Distribution records in JAMSTEC dives: Okinoyama Bank, Sagami Bay, 1110 m (*Dolphin 3K* Dive 45) and 1100 m (*Dolphin 3K* Dive 75) (Okutani *et al.*, 1993b: 137). Off Hatsushima, Sagami Bay, 830–1230 m (dive number not given) (Fujikura *et al.*, 2002b: 24).

Other distribution records: Sagami Bay, off Boso Peninsula, 1100–1380 m (Higo *et al.*, 1999: 233: G2648).

Depth range and type of habitat: 1100–1380 m; seep and normal muddy sea bottom (non-chemosynthetic communities).

Remarks: This species is a scavenger that occasionally invades from a non-seep environment (Okutani, Fujikura & Sasaki, 1993).

61. *Neptunea* sp. cf. *insularis* (Dall, 1895)

Neptunea insularis (Dall, 1895) var.: Okutani, Fujikura & Sasaki, 1993: 138, fig. 55.

Distribution records: Minami-Ensei Knoll, Okinawa Trough, 710 m (*Shinkai 2000* Dive 428), 690 m (*Shinkai 2000* Dive 610) (Okutani, Fujikura & Sasaki, 1993).

Depth range and type of habitat: 690–710 m; vent.

Remarks: This species is most closely similar to *N. insularis convexa* Golikov, 1963, which is possibly endemic to the Sea of Okhotsk (Okutani *et al.*, 1993b: 138).

Genus *Buccinum* Linnaeus, 1758

62. *Buccinum soyomaruae* Okutani, 1977

[Japanese name: Soyo-bai]

Buccinum soyomaruae Okutani, 1977: 75, text-figs. 5–8, 10; Okutani, Tsuchida & Fujikura, 1992: 145, figs. 22–23; Okutani, 2000: 496 (pl. 247), fig. 200, 497.

Type depository: Holotype, NSMT-Mo 58484.

Type locality: Sagami Bay, 35°01.1' N, 139°18.2' E, 1380 m.

Distribution records in JAMSTEC dives: Off Hatsushima, Sagami Bay, around 1110–1200 m (*Shinkai 2000* Dive 452, *Dolphin 3K* Dives 117, 118) (Okutani, Tsuchida & Fujikura, 1992).

Other distribution record: Sagami Bay and Suruga Bay, 1300–1500 m (Higo *et al.*, 1999: 244, G2804).

Depth range and type of habitat: 1110–1500 m; seep and normal muddy sea bottom (non-chemosynthetic communities).

Genus *Bayerius* Olsson, 1971

63. *Bayerius arnoldi* (Lus, 1981)

[Japanese name: Kaikou-tsumubai]

Tacita arnoldi Lus, 1981: 140, figs. 1–4.

Bayerius [sic] *arnoldi*: Warén & Bouchet, 2001: 189, figs. 38b–e, 39b, 49c.

Bayerius arnoldi: Okutani & Fujikura, 2002: 217, fig. 5A–B.

Type depository: Holotype, in the Institute of Oceanology, Moscow (Warén & Bouchet, 2001: fig. 38b).

Type locality: Northeastern Pacific, 37°56' N, 146°24' E, 5471 m (*Vityaz* sta. 3575; Warén & Bouchet, 2001: 189).

Distribution records in JAMSTEC dives: East off southern Iwate Prefecture, Japan Trench, 5379 m (*Shinkai 6500* Dive 553) (Okutani & Fujikura, 2002); 5291 m (*Shinkai 6500* Dive 553), 5343 m (*Shinkai 6500* Dive 550), 5343–5345 m (*Kaiko* Dive 183), 5379 m (*Shinkai 6500* Dive 553) (Fujikura *et al.*, 2002a: table 1).

Other distribution record: Japan, Kuril, and Aleutian Trenches, 4800–6135 m (Warén & Bouchet, 2001: 189).

Depth range and type of habitat: 4800–6135 m; seep.

Genus *Calliloncha* Lus, 1978

64. *Calliloncha nankaiensis* Okutani & Iwasaki, 2003

[Japanese name: Nankai-chijiwa-bai]

Calliloncha nankaiensis Okutani & Iwasaki, 2003: 3, figs. 3A–C, 4A–B.

Type depository: Holotype, NSMT-Mo 73525 (Fig. 17A).

Type locality: South-southeast off Cape Muroto, Nankai Trough, 32°21.3' N, 134°32.0' E, 3540 m (*Kaiko* Dive 190).

Other distribution record: South-southeast off Cape Muroto, Nankai Trough, 3571 m (*Kaiko* Dive 192) (Okutani & Iwasaki, 2003).

Depth range and type of habitat: 3540–3571 m; seep.

Genus *Costaria* Golikov, 1977

65. *Costaria?* sp.

Costaria? sp.: Warén & Bouchet, 1993: 77, fig. 58A–B.

Distribution record: Tenryu Canyon, Nankai Trough (KAIKO 1, PL 28), 33°37' N, 137°32' E, 3800–4020 m (Warén & Bouchet, 1993: 88).

Type of habitat: Seep.

Remarks: The species was identified as *Costaria* aff. *crossnieri* in Warén & Bouchet's figure caption (1993: 76).

Genus *Eosipho* Thiele, 1929

66. *Eosipho desbruyeresi nipponensis* Okutani & Fujiwara, 2000

[Japanese name: Jigoku-tsumubai]

Eosipho desbruyeresi nipponensis Okutani & Fujiwara, 2000: 125, figs. 6–10; Okutani, 2000: 461 (pl. 229), fig. 42, 461.

Type depository: Holotype, NSMT-Mo 71689 (Fig. 17B).

Type locality: North Knoll of Iheya Ridge, Okinawa Trough, 27°47.180' N, 126°54.149' E, 1049 m (*Shinkai 2000* Dive 863).

Other distribution records: Myojin Knoll, south off Izu Islands, 1268 m (*Shinkai 2000* Dive 952), 1362 m (*Shinkai 2000* Dive 1112); Sumisu Caldera, south off Izu Islands, 676 m (*Shinkai 2000* Dive 1017) (Okutani & Fujiwara, 2000).

Depth range and type of habitat: 676–1362 m; vent.

Remarks: *E. desbruyeresi desbruyeresi* is distributed in the North Fiji and Lau Basins (Okutani & Ohta, 1993; Warén & Bouchet, 2001: 191).

Family Turridae H. Adams & A. Adams, 1853

Genus *Oenopota* Mörch, 1852

67. *Oenopota ogasawarana* Okutani, Fujikura & Sasaki, 1993

[New Japanese name: Ogasawara-manji-gai]

Oenopota ogasawarana Okutani, Fujikura & Sasaki, 1993: 138, figs. 47–50.

Type depository: Holotype, NSMT-Mo 69978 (Fig. 17C).

Type locality: Kaikata Seamount, west off Ogasawara Islands, 26°42.5' N, 141°04.5' E, 440 m (*Shinkai 2000* Dive 559).

Other distribution records: Kaikata Seamount, west off Ogasawara Islands, 450 m (*Shinkai 2000* Dive 339) (Okutani *et al.*, 1993b).

Depth range and type of habitat: 440–450 m; vent.

68. *Oenopota sagamiana* Okutani & Fujikura, 1992

[Japanese name: Sagami-manji-gai]

Oenopota sagamiana Okutani & Fujikura, 1992: 2, figs. 2–3, pl. 1; Hasegawa, Okutani & Tsuchida, 2000: 654 (pl. 326), fig. 176, 655.

Type depository: Holotype, NSMT-Mo 69645 (Fig. 17D).

Type locality: Off Hatsushima, Sagami Bay, 35°00.0' N, 139°13.5' E, 1170 m (*Shinkai 2000* Dive 518, *Dolphin 3K* Dive 120) (Okutani & Fujikura, 1992). Known only from the type locality.

Type of habitat: Seep.

69. *Oenopota* sp.

Oenopota sp.: Okutani & Fujiwara, 2000: 126.

Distribution record: North Knoll of Iheya Ridge, Okinawa Trough, 1049 m (*Shinkai 2000*

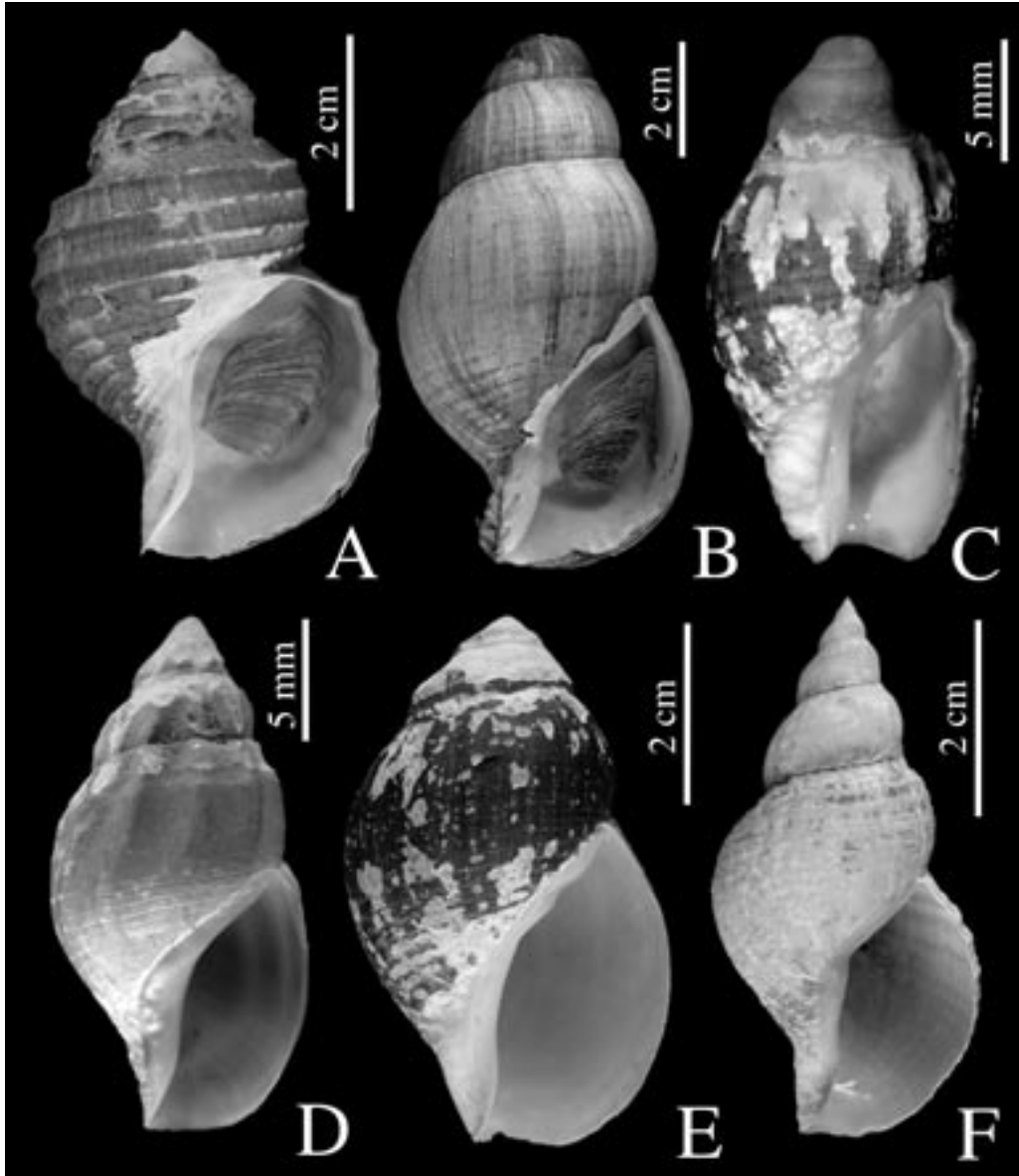


Fig. 17. Buccinidae and Turridae. **A.** *Calliloncha nankaiensis* Okutani & Iwasaki, 2003, holotype, NSMT-Mo 73525. **B.** *Eosipho desbruyeresi nipponensis* Okutani & Fujiwara, 2000, holotype, NSMT-Mo 71689. **C.** *Oenopota ogasawarana* Okutani, Fujikura & Sasaki, 1993, holotype, NSMT-Mo 69978. **D.** *Oenopota sagamiana* Okutani & Fujikura, 1992, holotype, NSMT-Mo 69645. **E.** *Phymorhynchus buccinoides* Okutanai, Fujikura & Sasaki, 1993, holotype, NSMT-Mo 69980. **F.** *Phymorhynchus turris* Okutani & Iwasaki, 2003, holotype, NSMT-Mo 73527.

Dive 863) (Okutani & Fujiwara, 2000).

Type of habitat: Vent.

Genus *Phymorhynchus* Dall, 1908

70. *Phymorhynchus buccinoides* Okutani, Fujikura & Sasaki, 1993

[Japanese name: Tsubunari-shajiku]

Phymorhynchus buccinoides Okutani, Fujikura & Sasaki, 1993: 140, figs. 44–46; Hasegawa, Okutani & Tsuchida, 2000: 666 (pl. 332), fig. 239, 667.

Type depository: Holotype, NSMT-Mo 69980 (Fig. 17E).

Type locality: Off Hatsushima, Sagami Bay, 35°00.2′ N, 139°13.5′ E, 1160 m (*Shinkai 2000* Dive 584). Known only from the type locality.

Type of habitat: Seep.

71. *Phymorhynchus turris* Okutani & Iwasaki, 2003

[Japanese name: Seitaka-watazoko-shajiku]

Phymorhynchus turris Okutani & Iwasaki, 2003: 6, fig. 3D.

Type depository: Holotype, NSMT-Mo 73527 (Fig. 17F).

Type locality: Off Cape Muroto, Nankai Trough, 32°21.3′ N, 134°32.0′ E, 3540 m (*Kaiko* Dive 190).

Other distribution record: Off Cape Muroto, Nankai Trough, 3581 m (*Kaiko* Dive 193) (Okutani & Iwasaki, 2003).

Depth range and type of habitat: 3540–3581 m; seep.

Genus *Benthomangelia* Thiele, 1925

72. *Benthomangelia* sp.

Benthomangelia sp.: Okutani & Iwasaki, 2003: 7, fig. 2C.

Distribution record: South-southeast off Cape Muroto, Nankai Trough, 32°21.3′ N, 134°32.1′ E, 3581 m (*Kaiko* Dive 193) (Okutani & Iwasaki, 2003).

Type of habitat: Seep.

Remarks: This species may be an occasional intruder into the seep.

Family Cancellariidae Forbes & Hanley, 1851

Genus *Admete* Kroyer, 1842

73. *Admete tenuissima* Okutani & Fujikura, 2002

[Japanese name: Garasu-koromogai]

Admete tenuissima Okutani & Fujikura, 2002: 218, fig. 6A–B.

Type depository: Holotype, NSMT-Mo 73129.

Type locality: Japan Trench, 39°06.56′ N, 143°53.33′ E, 5343 m (*Shinkai 6500* Dive 553).

Other distribution records: Japan Trench, 5379 m (*Shinkai 6500* Dive 550) (Okutani & Fujikura, 2002). East off southern Iwate Prefecture, Japan Trench, 5343–5345 m (*Kaiko* Dive 183), 5379 m (*Shinkai 6500* Dive 553) (Fujikura *et al.*, 2002a: table 1).

Depth range and type of habitat: 5343–5379 m; seep.

Clade Heterobranchia Burmeister, 1837
 Family Pyramidellidae Gray, 1840
 Genus *Eulimella* Jeffreys, 1847

74. *Eulimella* sp.

Eulimella sp.: Okutani & Fujiwara, 2000: 126, fig. 11.

Distribution record: North Knoll of Iheya Ridge, Okinawa Trough, 1049 m (*Shinkai 2000* Dive 863) (Okutani & Fujiwara, 2000).

Type of habitat: Vent.

Discussion

As listed above, a total of 74 molluscan species have been recorded from Japanese vent/seep sites (Table 1). Among these, gastropods (42 species: 57% of total) and bivalves (30 species: 41%) constitute a majority. In contrast, the remaining classes are extremely scarce or totally absent.

Caudofoveata and *Solenogastres*: No ‘aplacophorans’ have been collected from Japanese vent/seep localities so far. However, it is uncertain whether they are actually absent. Their absence may be an artifact of limited sampling methods.

Polyplacophora: Two species in different families were described as new taxa from the Okinawa Trough (*Leptochiton tenuidentatus* and *Thermochiton undocostatus*: Saito & Okutani, 1990). They are extremely scarce and have not been reported again. They represent the only record of chitons from chemosynthetic communities in the world to date.

Monoplacophora: No species of monoplacophorans (Neopilinidae and Micropilinidae) have been collected from Japanese waters, although much attention has been paid to limpet-shaped molluscs. Even the examination of small limpets (less than 2 mm) could not reveal the presence of monoplacophorans (Sasaki *et al.*, 2003). The living Monoplacophora are widely distributed mainly in the Eastern Pacific, Antarctic sea, Northeast Atlantic and mid- to southwestern Pacific between 174 and 6489 m deep (Warén & Hain, 1992: fig. 1; Haszprunar & Schaefer, 1997: table 1). The only record of Monoplacophora in vents/seeps is represented by *Rokopella segonzaci* Warén & Bouchet, 2001, which was described from a hydrothermal vent in the Mid-Atlantic Ridge (Warén & Bouchet, 2001: 118). Finding living monoplacophorans is still major unrealized goal in Japanese malacology.

Bivalvia: Among 28 species of recorded bivalves, the diversity is especially high in *Calyplogena* (13 species) and *Bathymodiolus* (6 species) (Table 1). By contrast, other genera are conspicuously restricted.

1) Protobranchia: It is one of notable characteristics that taxodont protobranchs are extremely scarce in deep-sea vents and seeps, although they are often predominant on muddy bottoms at bathyal to abyssal depths (Knudsen, 1970, 1979; Zardus, 2002: 36–41).

Cryptodont protobranchs (Solemyidae) are generally known to have symbiotic sulfide-oxidizing bacteria inside their ctenidia. Their digestive system is reduced or even absent in some species, possibly depending on the intensity of bacterial symbiosis (Reid, 1980, 1990). However, the ecology and anatomy of deep-sea solemyids has been little investigated. It is especially unclear whether an exceptionally large-sized species, *Acharax johnsoni*, is always associated with seeps or not. In contrast, *Solemya tagiri* is endemic to vents in Kagoshima Bay.

2) Pteriomorpha: This group is represented exclusively by the mytilid genus *Bathymodiolus*, which is typical of vents and seeps in the Southwest Pacific, Northwest Pacific, Indian Ocean

Table 1. The number of recorded species at family and genus level.

Family	Genus	Described	Unidentified
Leptochitonidae	<i>Leptochiton</i>	1	0
Ischnochitonidae	<i>Thermochiton</i>	1	0
Solemyiidae	<i>Acharax</i>	1	0
	<i>Solemya</i>	1	0
Nucinellidae	<i>Nucinella</i>	1	0
Mytilidae	<i>Bathymodiolus</i>	6	0
	<i>Mesolinga</i>	1	0
	<i>Lucinoma</i>	1	0
Thyasiridae	<i>Conchocele</i>	1	0
	<i>Axinulus</i>	1	0
	<i>Thyasira</i>	1	0
Vesicomysidae	<i>Calypptogena</i>	13	0
	<i>Vesicomys</i>	3	0
Neolepetopsidae	<i>Paralepetopsis</i>	1	0
Acmaeidae	<i>Serradonta</i>	2	0
	<i>Bathyacmaea</i>	4	2
Pyropeltidae	<i>Pyropelta</i>	1	0
Fissurellidae	<i>Puncturella</i>	2	0
Trochidae	<i>Margarites</i>	2	0
	<i>Itheyaspira</i>	1	0
Turbinidae	<i>Cantrainea</i>	1	0
Lepetodrilidae	<i>Lepetodrilus</i>	2	0
Neomphalidae	<i>Retiskenea</i>	1	0
Phenacolepadidae	<i>Shinkailepas</i>	2	1
Provannidae	<i>Provanna</i>	3	1
Elachisinidae	<i>Laeviphitus</i>	1	0
Buccinidae	<i>Neptunea</i>	1	1
	<i>Buccinum</i>	1	0
	<i>Bayerius</i>	1	0
	<i>Calliloncha</i>	1	0
	<i>Costaria</i>	0	1
	<i>Eosipho</i>	1	0
	<i>Admete</i>	1	0
Turridae	<i>Oenopota</i>	2	1
	<i>Phymorhynchus</i>	2	0
	<i>Benthomangelia</i>	0	1
Pyramidellidae	<i>Eulimella</i>	0	1
Total		65	9

and Atlantic (see Okutani *et al.*, 2003: 97 for species list). Meanwhile, other groups such as the Arcidae, Limopsidae and Propeamussiidae (cf. Knudsen, 1970: table 1) have not been recorded from deep-sea vents and seeps, except for *Bathypecten vulcani* from the East Pacific Rise (Le Pennec *et al.*, 2003). It is interesting that four of six species of Japanese *Bathymodiolus* have been recorded from both vents and seeps. The two remaining species occur in either vents or seeps.

3) Palaeoheterodonta: This group lives primarily in freshwater (Unioidea) and also in marine shallow-water (Trigonioidea) environments. Apparently no species is distributed in vent/seep

communities in any locality in the world.

4) Heterodonta: Heterodonta is the largest bivalve taxon in terms of the number of families and species. However, their occurrence in vents and seeps is strictly restricted to the Lucinidae, Thyasiridae and Vesicomidae, many species of which are known to have symbiotic bacteria.

The Lucinidae are symbiotic with sulfide-oxidizing bacteria (Taylor & Glover, 2000; Williams *et al.*, 2004). However, their occurrence is considerably limited in the vents/seeps of the world (Glover *et al.*, 2004; Salas & Woodside, 2002). So far only two species, *Mesolinga soliditesta* and *Lucinoma yoshidai*, represent records of the family from seeps in Japan.

Some members of the Thyasiridae are also known to harbor symbiotic bacteria inside (Williams *et al.*, 2004). As in lucinids, most species are described from areas outside vents and seeps (e.g. Oliver & Killeen, 2002). In Japan, only two out of 26 species (cf. Higo *et al.*, 1999: B619–B640) inhabit seeps.

An extraordinarily huge species for the family, *Conchocele bisecta* (Conrad, 1849), has been reported to occur in cold seeps in Sagami Bay (Fujikura *et al.*, 2002b: 24) and in the Sea of Okhotsk in Russia (Kamenev *et al.* 2001; Sahling *et al.*, 2003). In Japan, more localities are recorded in literature: Tosa Bay, off Tajima, Hyogo Prefecture, and off Cape Erimo (Higo *et al.*, 1999: B619), but the environments of these habitats have not been described. This implies that there are more unexplored seep sites around Japan. In fossil records, *C. bisecta* has been reported from an autochthonous cold-seep assemblage by Kitazaki & Majima (2003) and Nobuhara (2003).

The Vesicomidae is the most prominent faunal element in Japanese chemosynthetic communities. As listed above, 13 species have been described from Japan. As in *Bathymodiolus*, some species of *Calyptogena* are living in both vents and seeps.

The systematics of the Japanese *Calyptogena* have been repeatedly revised by the second author and are rather well established (see Okutani *et al.*, 2000a for the latest review). However, there are two species excluded from above list, and they need some comment.

Calyptogena pacifica Dall, 1891 was reported from the Sea of Okhotsk by Tiba (1972). The identification of the illustrated specimen by Tiba (1972) is supported by the presence of a large posterior lateral tooth, which is distinctive of the species (also cf. Coan *et al.*, 2000: 341). Although Okutani (2000: 997) illustrated this species and included Hokkaido in its distribution, there is actually no reliable record of living specimens within Japan. Therefore, we eliminated the species from the above list (for fossil records see Kanno *et al.*, 1989; Amano & Kanno, 2005; Majima *et al.*, 2005).

The habitat of *Calyptogena kawamurai* (Kuroda, 1943) is still unknown, although much attention has been paid to this species. This species has not once been collected in dives by JAMSTEC over a period of twenty years. The holotype (Fig. 10) is the only known specimen from off Odawara, Sagami Bay (the type locality), but its environment is uncertain. The specimen reported by Tsuchida (1986) from the Kii Channel is extremely old and possibly derived from the remains of an extinct population. Live specimens were reported from off Choshi, the sea area of Kashima-Nada, by Ozaki (1958) and Shikama (1962), but their environmental condition has not been known. In paleontological studies, *C. kawamurai* was reported to have occurred in fossil cold-seep communities (Nobuhara, 2003).

5) Anomalodesmata: It is interesting that no anomalodesmatans successfully colonize deep-sea chemosynthetic communities, although they are not uncommon in general deep-sea muddy bottoms. In particular, some major groups that characterize a deep-sea fauna (e.g., Cuspidariidae, Verticordiidae, and Poromyidae: Knudsen, 1970, 1979) are entirely missing. The absence of Anomalodesmata and Protobranchia (except Solemyoidea) is one of the prominent characteristics of deep-sea hydrothermal vents and cold seeps.

Scaphopoda: Scaphopods are universally common faunal elements of 'normal' non-chemosynthesis-based deep-sea muddy bottoms at bathyal depths (Reynolds, 2002: 204–207).

Although soft-bottom localities have been intensively surveyed in Japan, no scaphopods have been reported in JAMSTEC cruises. It is unknown why they cannot colonize vent/seep environments.

Cephalopoda: Cephalopods have never been observed or collected in Japanese vent/seep sites, although they are occasionally observed in video images taken during dives. In non-Japanese localities, González *et al.* (1998) described *Vulcanoctopus hydrothermalis* from vents in the East Pacific Rise. *Graneledone* cf. *boreopacifica* (Octopodidae) was reported to feed on molluscs by crushing their shells in vents (Voight, 2000).

Gastropoda: Gastropods have the highest species diversity among vent/seep molluscs. Their taxonomic composition conforms to the general tendency of limpets and basal gastropods formerly called 'archaeogastropods' to be dominant in vents and seeps (Warén & Bouchet: 1989, 1993, 2001). Meanwhile, caenogastropods and heterobranchs are relatively scarce.

1) Patellogastropoda: Two families, Acmaeidae and Neolepetopsidae, represent docoglossate limpets in vents and seeps. In the Acmaeidae, *Bathyacmaea* is typical of Japanese chemosynthetic communities. Some species are still unidentifiable due to an insufficient number of specimens (Sasaki *et al.*, 2003), which suggests that more new species will be added in future. The genus *Serradonta* is known strictly from Japanese seep sites. In contrast, neolepetopsids are diversified chiefly in the Eastern Pacific and extremely rare in the Northwest Pacific.

2) Vetigastropoda: Various groups of vetigastropods, including fissurellids, turbinids, trochids, lepetodrilids and neomphaloids (see Bouchet & Rocroi, 2005: 244), have been recorded from Japanese chemosynthetic sites. However, the vent-endemic slit-bearing limpets of the family Sutilizonidae (Warén & Bouchet, 2001: 141), are entirely lacking in Japan.

The occurrence of vetigastropods is generally sporadic, except for *Lepetodrilus*. In terms of collected sample number, *Lepetodrilus nux* is the most abundant species in hydrothermal vents in the Okinawa Trough. Meanwhile, *Lepetodrilus japonicus* is only known from the type locality and has not been found since.

The majority of the Neomphaloidea (Neomphalidae, Melanodrymiidae and Peltospiridae: so-called 'hot vent taxa'; see Ponder & Lindberg, 1997: 219–220; Warén & Bouchet, 2001: 157–173; Bouchet & Rocroi, 2005: 244) have never been collected in Japanese localities. A single species of neomphalid (*Retiskenea diploura*), described from the Aleutian Trench (Warén & Bouchet, 2001: 158), was also recorded from cold seeps in the Japan Trench (Okutani & Fujikura, 2002).

3) Cocculiniformia: Cocculiniform limpets are scarce in vents and seeps other than the Pyropeltidae (McLean & Haszprunar, 1987; Warén & Bouchet, 2001: appendix 2). The holotype of *Pyropelta yamato* (Fig. 9G) is the only record of the Pyropeltidae from the Northwest Pacific.

4) Neritopsina: Of the two phenacolepadid genera (*Shinkailepas* and *Olgasolaris*) that are adapted to chemosynthetic communities, only *Shinkailepas* is distributed in Japan (Okutani *et al.*, 1989; Sasaki *et al.*, 2003). Another vent-associated neritopsine genus, *Bathynnerita*, is confined to the Caribbean (Warén & Bouchet, 1993, 2001).

5) 'Taenioglossate' caenogastropods: Caenogastropods from vents and seeps are characterized by provannids, which form large colonies. Species of *Alviniconcha* and *Ifremeria* attain relatively large size (more than 5 cm in shell length), and colonize vents at a notably high density. *Ifremeria* (Windoffer & Giere, 1997) and *Alviniconcha* (Suzuki *et al.*, 2005, in press) harbor innumerable symbiotic bacteria in their ctenidia. These large-sized provannids are not distributed in Japanese localities at all, although *A. hessleri* is abundant in the Mariana Back-Arc Basin (Okutani & Ohta, 1988; Hasegawa *et al.*, 1997).

It is difficult to explain why naticids are absent from the Recent vent/seep fauna. In non-chemosynthesis-based communities at bathyal depths, some naticids (e.g. *Euspira* spp.) are relatively common, often together with turrid predators. In fossil seep communities, drilling by naticids on *Calyptogena pacifica* and *Conchocele bisecta* was confirmed in a Miocene locality by

Amano (2003).

6) Neogastropoda: Neogastropods from vents and seeps are represented by only three families (Buccinidae, Cancellariidae and Turridae). While the number of recorded species of Neogastropoda (11 Species: Table 1) is not very small, the number of collected specimens of each is extremely limited in all neogastropod species. This suggests that the population density of these predatory gastropods is generally low compared to that of other gastropods and bivalves. Some species (e.g. *Eosipho desbruyeresi nipponensis*) are endemic to vents or seeps, whereas others (e.g. *Buccinum soyomaruuae*) are obviously temporary invaders from ambient environments into seep sites.

7) Heterobranchia: Heterobranchs ('Heterostropha,' opisthobranchs and pulmonates) are nearly absent from in vents and seeps worldwide, except for lower heterobranchs such as *Lurifax*, *Xylodiscula* and *Hyalogyrina* (Warén & Bouchet, 2001; Sasaki & Okutani, 2005). In the northwest Pacific, only a pyramidellid has been recorded (Okutani & Fujiwara, 2002). Shelled cephalaspideans (e.g., Cylichnidae), which are typical gastropods in deep-sea soft bottoms, have never been collected in seeps. No pulmonates live in deep-sea environments.

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日本の熱水噴出域および冷水湧出域に生息する軟体動物：
過去 20 年間に記録された分類群の総括

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要 旨

2004 年までに日本の熱水噴出域および冷水湧出域から記録された軟体動物を総括し、リストを作成した。記録された 74 種（多板綱 2 種，二枚貝綱 30 種，腹足綱 42 種）のそれぞれについて，ホロタイプの所蔵先と登録番号，模式産地，地理的分布域・生息深度，生息環境を列挙した。他の環境・地域との比較により，日本の熱水噴出域および冷水湧出域に生息する軟体動物相には下記のような特徴があるといえる。(1) 日本の周辺はシロウリガイ属の多様性が世界で最も高い海域である。(2) 大型になる二枚貝類では，シンカイヒバリガイ属がその次に多様性が高い。(3) 多くの種は熱水噴出域または冷水湧出域のどちらかに固有であるが，シロウリガイ属とシンカイヒバリガイ属には両者の環境に生息する種がある。(4) 深海の軟体動物相を特徴づける原鰓亜綱はきわめて乏しく，異韌帯亜綱は全く記録されていない。(5) 熱水噴出域または冷水湧出域に固有の笠型貝類の種が多い。(6) ネオンファルス科に分類されているカイコウケシツブシタダミを除き，ネオンファルス上科の種は分布していない。(7) 新生腹足類ではハイカブリナ属が多く，ハイカブリナ科の大型種，アルビンガイ属 (*Alviniconcha*) やヨモツヘゲイニナ属 (*Ifremeria*) は日本には分布していない。(8) タマガイ科の捕食者は化石記録では過去にシロウリガイ類を捕食していたことが知られているが，現生の群集では確認されていない。(9) 新腹足目に属する肉食者の一部は，周囲の環境から一時的に化学合成群集に侵入する種である。(10) 沖縄トラフから記載された多板綱 2 種は，熱水噴出域に生息する多板類の世界で唯一の記録である。(11) 溝腹綱，尾腔綱，単板綱，掘足綱，頭足綱は海外の産地では報告例があるが，国内の産地からは発見されていない。