Abyssal Gastropods and Bivalves Collected by *Shinkai 6500* on Slope of the Japan Trench

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Abstract: During recent dives by the crewed submersible *Shinkai 6500* in abyssal depths on the landward slope of the Japan Trench (5343-5379 m), five gastropod and four bivalve species were collected from seep environments. The gastropods include a recently described species in the Neomphalidae, two new species in the Provannidae, a single species in the Buccinidae, and a new species in the Cancellariidae. Bivalves are represented by a single species of the Solemyidae, a single species of the Thyasiridae and two species of the Vesicomyidae, the most of which were previously described from greater depths in the same trench.

Keywords: gastropods, bivalves, abyssal, Japan Trench, new species

Introduction

The deep-sea research systems of the Japan Marine Science & Technology Center (JAMSTEC), including the crewed submersible *Shinkai 6500* and the ROV *Kaiko*, have collected some interesting abyssal and hadal mollusks from the Japan Trench. Most of these have been new bivalves (Okutani *et al.*, 1999, 2000). During dives by the *Shinkai 6500* in abyssal depths (5343-5379 m) on the landward slope of this trench (Fig. 1) in June 2000, more bivalve and gastropod mollusks were discovered that may be associated with seeps (Fujikura *et al.*, 2001).

The benthic molluscan fauna of this trench was briefly reviewed by Belyaev (1966, 1989), particularly that of below 6000 m, but apart from taxonomic papers by Filatova (1964), Filatova & Schileiko (1984, 1985), and some others, little systematic study of the abyssal mollusks of this trench has been published. The present paper offers taxonomic accounts of material recovered as a contribution to the knowledge of the molluscan fauna of the vast slope and bottom of the Japan Trench. The micro-scale distribution of these mollusks is discussed elsewhere in this issue by Fujikura *et al.* (2002).

Source of Material

*Shinkai 6500* Dive 550 (June 15, 2000): Lat. 39°06.56'N, long. 143°53.33'E, 5343 m.
*Shinkai 6500* Dive 553 (June 18, 2000): Lat. 39°06.47'N, long. 143°53.49'E, 5379 m.

The larger specimens were collected with a scoop sampler operated by the manipulator of the *Shinkai 6500*, but minute material was recovered by sieving sediments aboard the R/V *Yokosuka*.

Abbreviations: JAMSTEC—Japan Marine Science & Technology Center; NSMT—National Science Museum Tokyo; SL—Shell length (=shell height); SW—Shell width (=shell diameter).
Fig. 1. Locations of Dives 550 and 553 of Shinkai 6500 (June 2000).

Taxonomy

Class GASTROPODA

Family Neomphalidae

*Retiskenea diploura* Waren & Bouchet, 2001
(Fig. 2A-I)

Material examined: 39 specimens from Dive 550.

Observations: Shell minute, measuring SL2.6 × SW2.2 mm to 1.9 × 1.6 mm. General shape skeneiform to naticoid, with a slit-like umbilicus (Fig. 2A). Protoconch ornamented by a finely reticulate sculpture (Fig. 2B). Teleoconch whorls thin, fragile, opaque, and ornamented by crowded, irregular growth lines. Surface covered by yellowish periostracum, which is rather rough and carries patches of black deposits. Sutures moderately stepped. Body whorl large and globose, with oval aperture. Outer margin thin, but columellar lip weakly calloused and slightly thickened, reflecting over slit-like umbilicus. Operculum thin, conoform, and multispiral, with centrally situat-
Fig. 2. *Retiskenea diploura* from Dive 550. A. Shell. B. Protoconch. C. Operculum. D. Head-foot part, mantle partially removed. E. Left side view of the same. F-I. Radula.
ed nucleus. Distalmost part of each spiral somewhat flared, creating a rather ovo-quadrate outline (Fig. 2C).

Head of animal has cylindrical snout with truncated tip and thick cephalic tentacles as long as snout and slightly papillate near distal end. No eyes present (Fig. 2E). Propodium truncated in front. Superficially papillate epipodal tentacle present (Fig. 2D). Ctenidium monopectinate, situated near the neck.

Radula formula n-1-1-1-n (n < 10) (Fig. 2F). Central tooth with strongly incurved head and trapezoid base. Central cusp sharp, long and prominent, accompanied by 6-8 lateral cusps that diminish in size distally. Lateral wings of base expanded, with strong ridges running towards both protruding postero-basal corners. Medial part of the base convex, with shallow bays formed between this convexity and both postero-basal protrusions (Fig. 2G). Lateral tooth with triangular cutting head carrying many long and sharp cusps, which are strongest around distal tip but weaken towards the lateral side to create serrated cutting edge (Fig. 2G). Inner marginal teeth arched and sickle-shaped, with cuspidate distal ends and more finely and regularly serrated edges (Fig. 2H). Outer marginal teeth shorter than inner marginals and spatulate; less arched, with digitate distal tips and smooth edges (Fig. 2I).

Remarks: The shape of the central radular tooth is similar to that of some Heterostropha, such as Hyalogyrina Marshall, 1988 [originally in Skeneidae, but placed in Hyalogyrinidae by Warén & Bouchet (1993) and Hasegawa (1997)], but the morphology of the lateral and marginal teeth is different. A rather small number of marginal teeth and the spatulate outer marginals with digitate tips are noticeable characters of this species. The central tooth of Hyalogyrina is laterally interlocked with the laterals (Marshall, 1988), but that of the present taxon is not. The non-heterostrophic protoconch, reticulate protoconch sculpture, papillate cephalic tentacle and the presence of an epipodal tentacle could lead us to place this species in the trochoidean family Skeneidae, which is never monophyletic (Hickman & McLean, 1990). However, Warén & Bouchet (2001) have placed this taxon in the family Neomphaliidae for its morphological affinities with Melanodrymia. This species has recently been described from 4808 m in the Aleutian Trench, and now from the Japan Trench at a depth of 5379 m. Our finding thus represents an extension of its range slightly southward and deeper, in a different trench.

Family Provannidae

Provanna abyssalis n. sp.

(Fig. 3A-C)

Material examined: Two specimens (holotype and paratype) from Dive 553.

Description: Shell short and melanioid in shape, with only body and penultimate whorls remained. Whorls moderately convex, thin and dull amber in color, ornamented by growth lines of irregular prominence and extremely delicate spiral lirae or microscopic granulate sculpture possibly created by sporadic periostracal erosion or encrustation. Suture well constricted. Aperture oval. Outer lip thin and smooth. Basal lip very weakly reflected. Inner lip and columellar lip with dark brown margins (Fig. 3A). Operculum corneous, paucispiral and yellowish orange in color.

Radula taenioglossate, typical for genus, formula 2-1-1-2. Central tooth unicuspid with sharp, triangular and sharply pointed median cusp with concave top. Base trapezoid in outline with convex lunate medial lobe and tapering postero-lateral lobes. Lateral wings demarcated by oblique ridges running along postero-lateral lobes. Lateral teeth with broadly triangular cutting heads and broad shafts. Cutting edge with only small blunt denticles on weak flexure near middle, but 3-4 incurved lateral denticles present behind head. Rectangular buttress present on shaft below cutting head. Marginals typical for genus, spatulate in shape, with 9-10 cusps in front and several small
denticles just behind them (Figs. 3B-C).

**Measurements** (*SH × SW in mm*): Holotype (NSMT-Mo 73127) 6.8 × 4.3; paratype (JAMSTEC-026136) 7.1 × 3.9.

**Remarks**: Together with the following taxon, this is the deepest record of the Provannidae among the 15 species of *Provanna* and *Desbruyeresia* hitherto described from vent/seep areas and non-chemosynthetic environments. Two species from the Mariana Back-Arc Basin, *P. nassariaeformis* and *D. marianaensis*, have been recorded from upper abyssal depths (3670-3680 m, Okutani, 1990), but the remaining species were taken mostly at depths from 2500 m to as little as 576 m (*P. sculpta* from the Gulf of Mexico by Warén & Ponder, 1991).

The almost smooth shell of this taxon has a lot in common with those of *P. laevis* Warén & Ponder, 1991 from the Guyamas Basin and *P. glabra* Okutani, Tsuchida & Fujikura, 1992 from the northwestern Pacific. However, *P. abyssalis* has more elongate whorls, more strongly constricted sutures, an oval aperture and a periostracum that is amber in color rather than greenish-brown.

The basic configuration of the radula is quite consistent throughout *Provanna* and *Desbruyeresia*. Differences among species are not always very remarkable, but are still useful for taxonomic differentiation. All species have unicuspid central teeth which usually have tripod-like
bases. The sharp central cusp with no lateral denticles is common to several species, including *P. lomana, P. goniata, P. muricata*, and *P. sculpta* (Warén & Bouchet, 1986; Warén & Ponder, 1991), which are considered to be plesiomorphic. However, the morphology of the lateral teeth of the present species, especially that of the barely dentate cutting head, is distinctive. A similar morphology is found in *P. goniata* (from 2020 m in the Guayamas Basin; Warén & Bouchet, 1986, fig. 19), but that species has a heavily ribbed shell.

**Distribution:** Known only from the type locality.

**Etymology:** The species name refers to the abyssal habitat of this species.

**Provanna shinkaiae** n. sp.

(Fig. 4A-C)

**Material examined:** Two specimens (holotype and paratype) from Dive 550.

**Description:** Shell very thin and almost translucent, with only 3 whorls remaining; moderately inflated, with deeply constricted suture, and covered by pale straw-colored periostracum. Penultimate and upper whorls ornamented by three spiral ribs; furthest abapical rib weakest and merging into suture, remaining two strong and beaded or even spinous. Body whorl and base with

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![Image](image_url)

*Fig. 4. Provanna shinkaiae* n. sp. A. Holotype. B, C. Radula.
6 spiral ribs; subsutural rib weakest, appearing only near end of penultimate whorl. Two very strong, beaded ribs continuous from upper whorls. Obsolete intercalate cord likely appearing between them near labral margin. Three more ribs present on base; furthest abapical rib is very weak, but other two as strong as upper two and weakly beaded. Interspaces between basal spiral ribs smooth on penultimate and body whorls, but indication of axial ribs apparent in uppermost whorl, forming cancellate sculpture (Fig. 4A).

Aperture lunate, with external sculpture visible through thin wall. Outer lip made uneven by extremities of spiral ribs. Columellar lip smooth but very weakly twisted, forming obsolete fasciole and partial shallow anterior canal. Operculum thin, yellow, conoconus, oval, with subcentral nucleus.

Radula taenioglossate, with a formula 2-1-1-1-2. Central tooth with blunt-tipped cusp carrying no lateral denticles. Base with extended lateral projections and tongue-like central lobe. Lateral tooth with broad, triangular cutting head bearing 2 blunt cusps with deep cut in between, and with rounded folding at distinctly upheaved distal end continuing downward to axe-shaped buttress on shaft. No lateral denticle, but peculiar structure present at distal end of lateral margin of shaft. Marginal teeth with rake-like head carrying 10-14 cusps (Figs. 4B-C).

**Measurements (SH × SW in mm):** Holotype (NSMT-Mo 73128) 11.0 × 7.5; Paratype (JAMSTEC-026140) 9.0 × 5.8.

**Remarks:** The present new species superficially resembles both *Provanna pacifica* (Dall, 1908) and *P. goniata* Warén & Bouchet, 1986, both from eastern Pacific. Both the latter, however, have more solid shells and somewhat differing sculpture. The rounded folding at the distal end of the lateral teeth of the radula has also been illustrated in *P. lomana* and *P. ios* (Warén & Bouchet, 1989) as well as in *P. sculpta* and *P. laevis* (Warén & Ponder, 1991). However, the strong upheaving in this fold seen in *P. shinakiae* is not comparable to any other known species.

**Distribution:** Known only from the type locality.

**Etymology:** Named for the crewed submersible *Shinkai 6500*, which, together with the ROV *Kaiko*, has been very successful in exploring the deep-sea fauna of the Japan Trench.

Family Buccinidae

**Bayerius arnoldi** (Lus, 1981)

(Fig. 5A-B)

**Material examined:** Three specimens from Dive 553.

**Remarks:** The largest specimen measures 11.7 mm SL. All the present specimens are characterized by a large, bulbous protoconch, a spirally striate shell, a short but distinct and slightly recurved anterior canal, and a conoconus operculum with the nucleus in the lower part (Fig. 5A). The smallest specimen (5.9 mm SL) bears cancellate sculpture on the protoconch and early teleoconch whorls. The radula of the medium-sized specimen exhibits the typical configuration of the family. The central tooth has a rectangular base with three equal cusps. The lateral teeth are as large as the central tooth, with two strong, weakly recurved cusps accompanied by a smaller one near the inner cusp. Both tips of the base of the lateral teeth protrude strongly (Fig. 5B). The present specimens agree well with a juvenile specimen from the Aleutian Trench described by Warén & Bouchet (2001) who compared it with the type specimen. This species had hitherto been known from Japan and the Kuril and Aleutian Trenches at 4800-6135 m, and the present record thus falls within the known range of distribution. In the same paper, Warén & Bouchet quoted Sahling (1997), who had found this whelk to be common on colonies of *Calyptogena phaseoliformis*; however, this species is thought to be a vagrant scavenger, not physiologically associated with chemosynthetic environments.
Family Cancellariidae

Admete tenuissima n. sp.
(Fig. 6A-B)

Material examined: Two specimens (holotype and paratype) from Dive 553 [type locality] and two paratypes from Dive 550.

Description: Shell obese fusiform, thin, almost translucent, covered by a thin, light yellowish periostracum (Fig. 6A). Protoconch and early teleoconch so heavily eroded that no more than 3 teleoconch whorls remain. Whorls well-inflated with constricted sutures. Sutural ramp somewhat flat, creating ill-defined, rounded shoulder. Surface with no visible axial sculpture, but ornamented by more or less regularly spaced, continuous slender spiral cords, about 20 on penultimate whorl and about 40 on body whorl including base. Spiral cords distinctly narrower than interstices, sometimes becoming delicately wrinkled where crossed by growth lines; occasionally delicate periostracal lamellae occur in interstices between spiral cords (Fig. 6B). Base gently tapering. Aperture lunate, with thin but smooth outer lip. Inner to columellar lip covered by thin, transparent callus. Columella white, twisted so gently that no fold is present, but very slightly raised near abapical end. Basal lip without apparent anterior canal but weakly curved and expanded, indicating development of canal. No operculum or radula present.

Measurements (SH × SW in mm): Holotype (NSMT-Mo 73129) 19.3 × 9.0 (Dive 553); paratype (JAMSTEC-026108) 16.9 × 12.0 (Dive 550).

Remarks: The shell of this species closely resembles that of A. bruuni Knudsen, 1964 from between 6660 and 6770 m in the Kermadec Trench in bearing only spiral cords and no axial sculpture. Knudsen (1964) thoroughly reviewed the other Admete comparable with his species. A. bruuni has many general morphological characters in common with the present new species, but apparently bears low, flattened spiral riblets which are wider than their interstices, whereas the cords on A. tenuissima are markedly narrower than the wide interstices. Among others, the general shape of A. tenuissima recalls the related shelf species A. watanabei Shikama, 1962; that species, however, has a thicker shell bearing axial riblets.

Distribution: Known only from the type locality: Japan Trench, 5343-5773 m deep.

Etymology: The species name means “very thin”.

Fig. 5. Bayerius arnoldi from Dive 553. A. Juvenile specimen (SL 11.7 mm). B. Radula.
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Class BIVALVIA

Family Solemyidae

_Acharax johnsoni_ (Dall, 1891)

(Fig. 7)

*Material examined:* 16 specimens from Dive 550 and 3 specimens from Dive 553.

*Remarks:* This is the deepest record yet for _A. johnsoni_. Knudsen (1970) took the view that _Solemya agassizii_ Dall, 1891 is synonymous with this species, and thoroughly reviewed its geographical distribution. He gave the known bathymetric range as from 675 to 3500-3600 m. This is here extended down to 5379 m. The present specimens range in size from 6.8 to 55.6 mm SL. Although there is a considerable variability in SL/SW (2.12-2.59), the essential morphological characters are consistent.

Family Thyasiridae

_Parathyasira kaireiae_ Okutani, Fujikura & Kojima, 1999

(Fig. 8)

*Material examined:* 17 specimens from Dive 550 and 12 specimens from Dive 553.

*Remarks:* This small thyasirid was first described from material collected by the ROV _Kaiko_ operated by the R/V _Kairei_ at between 5695 and 5793 m and at 6390 m in the Japan Trench. The present finding thus represents a slight upward extension of the bathymetrical distribution. The present specimens measure 2.3 mm to 9.8 mm SL. Living specimens were collected with sediments from about 20 cm below the seabed surface.
Family Vesicomyidae

*Calyptogena (Ectenagenae) phaseoliformis* Métivier, Okutani & Ohta, 1986  
(Fig. 9)

**Material examined:** 35 specimens from Dive 550 and 40 specimens from Dive 553.

**Remarks:** Since this species was first discovered at between 5640 and 5960 m by the submersible *Nautilie*, intensive studies on its ecological significance and other biological aspects have been made (e.g. KAIKO I Research Group 1986; Juniper & Sibuet 1987; Ohta & Laubier 1987; Sibuet et al. 1988). The present specimens measure 71.6 mm to 173.3 mm SL.

*Calyptogena (Ectenagenae) fossajaponica* Okutani, Fujikura & Kojima, 2000  
(Fig. 10)

**Material examined:** Two specimens from Dive 553.

**Remarks:** This is an exceptionally small species for the genus. The present specimens measure 4.7 mm and 14.1 mm SL.

**Discussion**

The present study of the *Shinkai 6500* material has revealed the following important facts concerning the molluscan fauna associated with cold seeps on the abyssal slope of the Japan Trench.

1. The existence of a unique taxon of the Neomphalidae.
2. The deepest occurrence of provannids.
3. A patchy occurrence of *Acharax johnsoni* with a large extension of its bathymetric distribution.
4. Some elements common to the seep fauna of the Aleutian Trench.

Some of the mollusks in the present study have never been reported from this trench. The discovery of a skeneid-like neomphalid snail is interesting. The taxonomic position of a skeneid reported by Belyaev (1989) from 6290 to 6330 m in the Philippine Trench may need to be reexamined in the light of recent developments in our knowledge of the systematics of skeneid-like taxa from the deep sea. The finding of a member of the Neomphalidae in the Japan Trench is noteworthy. This family is present with some diversity in chemosynthetic environments in the eastern Pacific, but with the exception of a few taxa of *Symmetropleus* records are still scarce in the western Pacific. The bathymetrical distribution of the genera *Provanna* and *Desbruyeresia* are discussed under 'remarks' above. The periostracum of the present material in both species is very thin, which is related to the fact that the shell of mollusks living at such great depths, *e.g.* *Calyptogena phaseoliformis*, are usually thin and heavily eroded.

The patchy occurrence of specimens of *Acharax johnsoni* of various sizes is unusual and suggests that it is reproductive in this locality. Empty shells of the same clam are quite common among large colonies of *Calyptogena* at bathyal depths in Sagami Bay, but living specimens representing various growth stages have never been collected there.

The present results indicate that the molluscan biomass at this locality is quite high for the depth, although, as is usual in chemosynthesis-based communities, distribution is patchy. The benthic biomass at such great depths usually varies in the order of between $10^{-1}$ and $10^{-2}$ g/m² (Belyaev, 1972). Mollusca thus greatly contribute to benthic production on the abyssal slope of the Japan Trench.
Fig. 7. *Acharax johnsoni* from Dive 550.
Fig. 8. *Parathyasira kaireiae* from Dive 550.
Fig. 9. *Calyptogena (Ectenagena) fossajaponica* from Dive 553.
Fig. 10. *Calyptogena (Ectenagena) phaseolliformis* showing the smallest specimen (SL 51.6 mm) from Dive 553 and the largest one (SL 173.3 mm) from Dive 550.
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「しんかい6500」によって日本海溝斜面から採集された腹足類と二枚貝類

奥谷兼司・藤倉克則

要 約

海洋科学技術センターの「しんかい6500」が日本海溝の陸側斜面の水深5343 m（第550潜水）及び5379 m（第553潜水）から採集した貝類について研究した結果、腹足類5種と二枚貝類4種が同定された。

1. Retiskenea diploura Warén & Bouchet, 2001 カイコウケジツプシタダミ（新種）（Fig. 2）

殻は微小形（殻高2.6 mm, 殻幅2.2 mm)で白色で平滑、隔壁はスリット状。新生殻には亀甲状形の有する。蓋は角質多旋形。歯舌は扇舌型n-1-1-1-n (n は10以下)。中歯の中央の歯舌は著大で、6〜8の側歯舌がある。基板の後側凹は突出する。側歯舌の頂部は合形で、多数の歯舌があり、先端部ではやや長く、縁辺部は錐状長。内縁歯は線形で、側歯舌に似て先端部には長い歯舌があり、縁辺は線状。外縁歯は内縁歯より短く線状。先端は指状。日本海溝の水深5379 m。本報を制作中、アリューシャン海溝から記載され、ネオンファルス科に置かれている（日本新記録）。

2. Provanna abyssalis, n. sp. カイコウハイカプリニナ（新種）（Fig.3）

殻は薄く、体層と次体層しか残っていない（ホロタイプ：殻高6.8 mm, 殻幅4.3 mm)。殻表は鰾色の殻皮に被われ、微細な顕粒があるように見える。歯舌中歯に側歯舌はない。側歯舌の前縁には微小な歯舌があるのみ。日本海溝の水深5379 m。

3. Provanna shinkaiae n. sp. シンカハイカプリニナ（新種）（Fig.4）

殻は薄く3層を残すのみ（ホロタイプ：殻高11.0 mm, 殻幅7.5 mm)。殻表に3本の螺肋（殻底には更に3螺肋）があり、それらは成長勢によって多少粒列状になる。歮舌の中歯は鰾く側歯舌はない。側歯舌には大きい2歯舌があり、大きくねじれて生じた螺は柱状にある筍型の稜肋に続く。日本海溝の水深5343 m。

上記2種はハイカプリニナ類（Provanna 属および Desbruyeresia 属）中最も深いところに生息する種である。
4. Bayerius arnoldi (Lus, 1981) カイコウツムバイ（新称）（Fig. 5）
第553 潜航で得られた3個体（最大標本の殻高11.7 mm）は大きな初生殻および歯舌の形状からアリューシャン, 千島, 日本海溝の水深4800 ～ 6153 mから知られる本種に同定される。

5. Admete tenuissima, n. sp. ガラスコロコガイ（新種）（Fig. 6）
殻は薄く半透明で淡黄色の殻皮を被る（ホロタイプ：殻高19.3 mm, 殻幅9.0 mm）。上方の蝶層は侵食されて、後生殻3層しか残っていない。殻表には肋間より細い、ほぼ膨脹の等しい螺肋で被われ、次体層では約20条、体層では約40条数えられる。螺肋は所々で成長期のため縮み、また肋間の殻皮が立ち上がる。蓋も歯舌も欠く。日本海溝の水深5343 ～ 5773 m。ケルマデック海溝の水深6660 ～ 6770 mから記載されたA. bruuni Knudsen, 1964 に似るが、その種類の螺肋は平坦で肋間より遥かに幅広い。

6. Acharax johnsoni (Dall, 1891) スエヒキミタレガイ（Fig. 7）
本種はこれまで太平洋の水深675 mから3500 ～ 3600 mまで知られていたが、本調査により深度分布範囲を著しく拡大した。本種は相模湾などの化学合成生物群集から知られるが、今回の標本は殻長6.8 mmから55.6 mm（両潜航で合計19個体）に及びこの場所で再生産が行われていることを示唆する。

7. Parathyarsira kaireiae Okutani, Fujikura & Kojima, 1999 カイレハナシガイ（Fig. 8）
本種はかつて「かいこう」によって日本海溝の水深5695 ～ 5793 mと6390 mから採集され、新種記載されたものであるが、今回2潜航で合計29個体採集された。

8. Calyptogena (Ectenagena) phaseoliformis Métivier, Okutani & Ohta, 1986 ナギナタシロウリガイ（Fig. 9）
2潜航により合計75個体（殻長51.6 ～ 173.3 mm）採集された。

9. Calyptogena (Ectenagena) fossajponica Okutani, Fujikura & Kojima, 2000 ナラクシロウリガイ（Fig. 10）
第553 潜航（水深5379 m）から2個体。原記載は水深6329 mと6804 ～ 6809 mであるから、僅かに棲息深度が拡大された。