

Abyssal Bivalves Collected from beyond 3,000 m in the Northwest Pacific and Shikoku Basins by the R/V *Soyo-Maru*, 1977–1981

Takashi Okutani* and Reiko Kawamura

College of Bioresource Sciences, Nihon University,
1866 Kameino, Fujisawa City, Kanagawa, 252–8510 Japan

Abstract Between 1977 and 1981, 22 species of bivalve mollusk were collected by the R/V *Soyo-Maru* at depths from 3,140 to 6,340 m at 27 stations in the Northwest Pacific and Shikoku Basins. Five new species have been recognized and are here described: *Neilonella politissima*, *Neilonella abyssopacifica*, *Tindaria rodent*, *Cuspidaria arcoida* and *Halonympha soyomaruae*. A new subgenus in the Cuspidariidae is proposed for *C. arcoida*. Ten further species are recorded from these areas for the first time. *Pristigloma japonica* is recorded for the first time since its discovery and description by Smith in 1884.

Key words: Abyssal bivalves; new species; first records; rediscovery; *Soyo-Maru*

Introduction

Abyssal bivalve faunae are seldom studied, because sampling calls for large vessels fitted with suitable equipment for deep sea trawling. Recent studies using submersibles have focused mainly on chemosynthesis-based communities rather than those of the 'normal' (non-chemosynthetic) sea floor. The abyssal bivalves of the Northwest Pacific Basin and its trenches are known chiefly from reports based on post-war Russian expeditions (*e.g.* Filatova, 1958, 1969 *etc.*), and only a few monographs have been published (Knudsen, 1967, 1970; Potiers & Bernard, 1995).

Between 1977 and 1981, the R/V *Soyo-Maru* conducted extensive beam-trawl sampling in the western sector of the Northwest Pacific Basins and eastern sector of the Shikoku Basin (approx. 13°–39°N, 137°–152°E), to monitor the influence of low-level radioactive dumping on marine ecosystems. Bivalve specimens from 27 stations ranging in depth from 3,140 m to 6,340 m were examined. The results of taxonomic studies of

this material are given here, with a brief discussion of the fauna.

Source of Material

Sampling was carried out with the beam-trawl described by Nakai (1962) and Okutani (1968, 1969). It has a 2 m span with an Agassiz shoe and double bags of Russell's type. The sampling stations are shown in Fig. 1 and the relevant data are given in Table 1. The geographical coverage of the survey was from off Kinkazan southwards to the Northern Marianas. Megalobenthos samples taken together with sediments were all sieved through 5 mm and 2 mm meshes on board the R/V *Soyo-Maru* (494.4 GT). The present study treats bivalves collected from stations deeper than 3,000 m. The specimens had been initially fixed and preserved in ethanol, but were all dried before examination. Anatomical examination of the soft parts was thus almost impossible in the present study.

Abbreviations used

BMNH: The Natural History Museum, London, UK; NSMT: National Science Museum

* Corresponding address: 714, Takaishi 4–17–1, Asao-ku, Kawasaki City, Kanagawa, 215–0003 Japan.
t_okutani@mac.com

Table 1. Positive stations for abyssal bivalves (R/V *Soyo-Maru*, 1977–1981)

St.	Date	Depth	Position		
R5	June 25 1977	5820	29°59.2N	147°07.0E–29°58.7N	147°05.8E
R7	July 1	5360	26°28.1N	146°12.3E–26°29.7N	146°12.0E
R9	July 7	4160	27°37.1N	141°32.9E–27°30.2N	141°31.5E
R10	July 7	3140	28°45.7N	139°24.0E–28°42.8N	139°25.0E
R11	July 8	4560–4540	29°58.0N	137°00.0E–30°00.0N	137°00.9E
R12	July 10	3910	32°00.7N	137°55.3E–31°59.5N	137°57.0E
R17	June 23 1978	4680–4130	38°08.9N	143°40.0E–38°09.4N	143°37.2E
R18	June 26	5440	38°29.4N	145°43.0E–38°29.3N	145°41.1E
R21	July 2	6320–6340	29°16.0N	147°29.0E–29°23.2N	147°25.0E
R23	July 8	4460	27°40.0N	141°37.5E	
R30	June 24 1979	6190	30°07.8N	147°08.2E	
R31	June 29	5780	26°35.1N	150°38.0E	
R32	July 1	5680	23°08.8N	150°57.3E	
R33	July 2	5850	20°40.9N	151°57.9E	
R46	June 20.2 1980	6090	30°52.2N	146°03.9E	
R47(3)	June 24	6180	30°05.6N	147°09.4E	
R47(5)	June 26	6190	30°06.7N	146°53.3E	
R47(6)	June 26	6210	30°02.9N	146°53.3E	
R47(7)	June 27	6170	30°17.2N	146°54.2E	
R47(10)	June 29	6180	29°42.1N	146°53.2E	
R48	June 30	5920	28°34.5N	144°40.9E	
R52(2)	June 20 1981	5660	32°03.8N	143°34.5E	
R53(1)	June 21	6010	30°09.1N	146°12.7E	
R53(3)	June 22	6160	30°29.1N	147°07.8E	
R57	June 30	3340	25°56.3N	141°28.2E	
R58	June 30	3600	26°39.4N	141°44.2E	
R59(1)	July 5	3240	30°07.2N	140°56.8E	

Tokyo; SL: shell length; SH: shell height; SB: shell breadth

Systematic Account

Order NUCULOIDA

Family Malletiidae H. & A. Adams, 1857

Malletia cuneata (Jeffreys, 1876)

(Fig. 2A)

Malletia cuneata Jeffreys, 1876a, p. 435; Knudsen, 1970, p.64, text-fig. 42, 43, pl.6, fig. 13.

Occurrences: R18 (5,440 m) 8 specimens; R30 (6,190 m) 3 specimens; R46 (6,090 m) 7 specimens; R47(3) (6,180 m) 2 specimens; R47(5) (6,190 m) 3 specimens; R47(6) (6,210 m) 1 specimen; R47(7) (6,170 m) 2 specimens; R47(10) (6,170 m) 13 specimens; R48 (5,920 m) 1 specimen; R53(3) (6,170 m) 16 specimens.

Measurements (in mm) of 10 selected specimens:

	SL	SH	SB	SH/SL	SB/SL
	11.9	6.9	3.9	0.580	0.328
	11.3	6.9	3.9	0.611	0.345
	11.2	6.7	3.9	0.598	0.348
	11.1	6.6	3.7	0.595	0.333
	10.7	6.3	3.4	0.589	0.318
	10.7	6.2	3.6	0.579	0.336
	10.6	6.3	3.7	0.594	0.349
	10.5	6.3	3.6	0.600	0.343
	10.5	6.0	3.3	0.571	0.314
	10.5	6.0	3.2	0.571	0.305
Mean				0.597	0.337
S.D.				0.033	0.022

Remarks: This species is characterized by a thin and weakly inflated shell, with an obtuse posterior end. The anterior arc of the hinge plate bears 9–11 teeth and the posterior arc 16–19. The present specimens ranged in SL from 5.7 mm to 11.9 mm. Knudsen (1970) noted that this is the most widely distributed abyssal bivalve, an observation supported by Okutani (1975). The present material does not conflict with the thorough

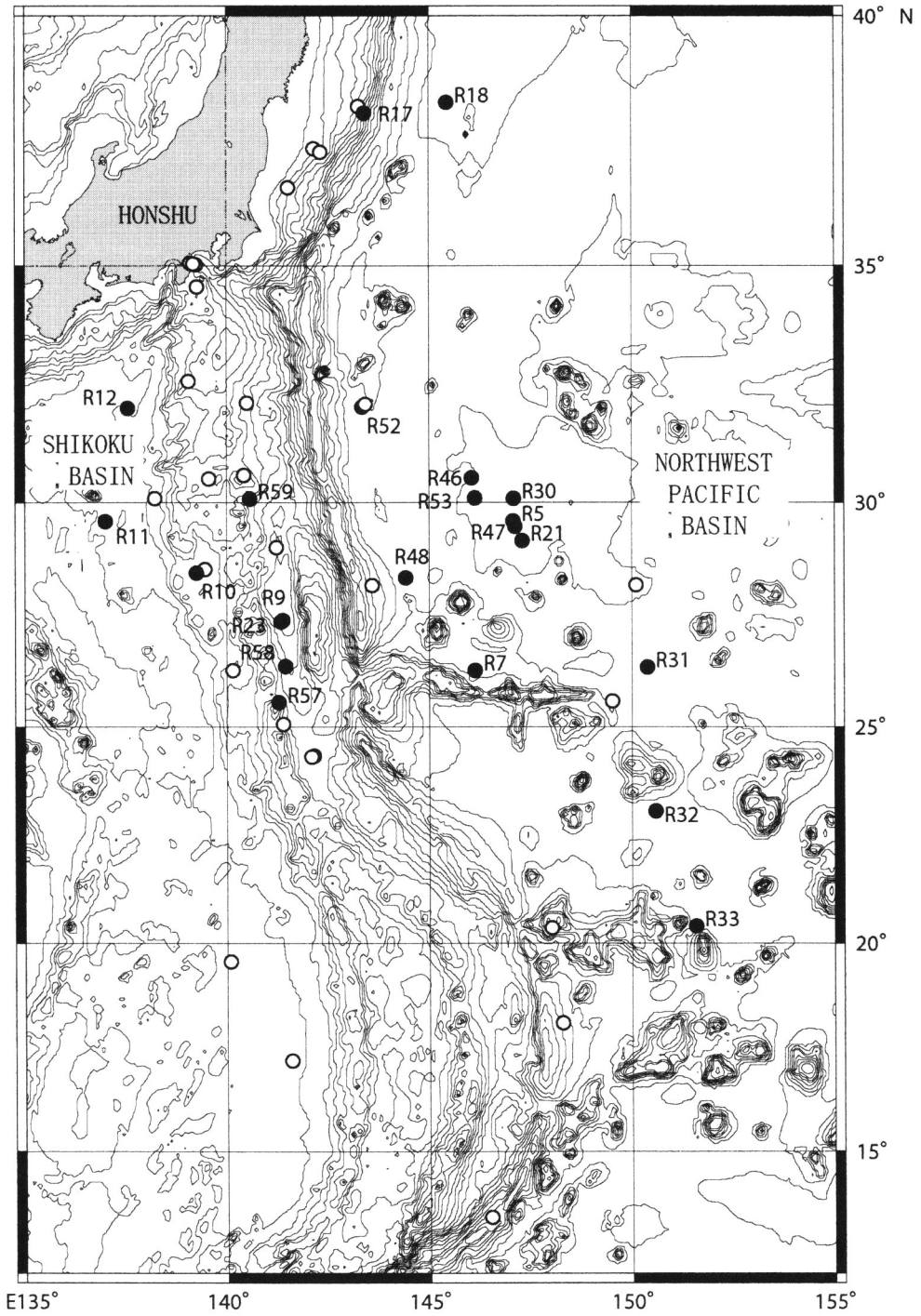


Fig. 1. Positive stations (solid circles) for abyssal bivalves occupied by the R/V *Soyo-Maru*, 1977–1981. Open circles indicate negative stations, otherwise shallower than 3,000 m. Depth contours every 1000 m.

survey of worldwide material by Knudsen (1970). The shallowest record of this species is 1,977 m (by HMS *Porcupine*). The present occurrences, along with previous records (Okutani, 1975), include the deepest record so far for this species (6,210 m).

Family Tindariidae Verrill & Bush, 1897

Tindaria antarctica Thiele & Jaeckel, 1931

(Fig. 2B)

Tindaria antarctica Thiele & Jaeckel, 1931, p. 51, pl. 3, fig. 71.

Occurrences: R5 (5,820 m) 1 specimen; R7 (5,360 m) 1 specimen; R18 (5,440 m) 4 specimens; R46 (6,090 m) 1 specimen; R47(3) (6,180 m) 1 specimen; R47(6) (6,210 m) 1 specimen; R53(1) (6,010 m) 2 specimens.

Measurements (in mm) of 10 selected specimens:

	SL	SH	SB	SH/SL	SB/SL
	13.7	8.7	6.4	0.635	0.467
	13.1	9.1	6.7	0.695	0.511
	13.0	8.6	6.3	0.662	0.485
	13.0	8.2	6.6	0.631	0.508
	12.6	8.5	5.9	0.675	0.468
	12.3	8.0	5.5	0.650	0.447
	10.8	7.4	5.2	0.685	0.481
	10.0	8.5	4.2	0.650	0.420
	9.4	6.5	4.1	0.691	0.436
	9.2	6.9	4.7	0.750	0.511
Mean				0.677	0.477
S.D.				0.037	0.032

Remarks: This species has an oval profile, concentric sculpture and a pattern of radiating lines on the anterior and posterior areas of the shell. Before it was reported from the northwestern Pacific at 3,450–6,044 m (Okutani, 1975), it had been reported from the Antarctic waters at 4,636 m (*Valdivia*: Thiele & Jaeckel, 1931), the Tasman Sea at 4,400 m, and the Kermadec Trench at 4,540 m (*Galathea*: Knudsen, 1970). The present batch of 11 live specimens, which are twice as large (6.5–13.7 mm SL) as those described by Knudsen (1970), supplements the records of this species from the Northern Hemi-

sphere. In the present specimens, the anterior arc of the hinge plate bears 13 teeth, among which the eighth to tenth are strongest. The posterior arc bears 27 teeth, with the 18th–21st strongest. This is a far larger number than in a smaller specimens studied by Knudsen (1970) of 7.6 and 8.1 mm SL that bore 7–9 teeth on the anterior arc and 22–23 on the posterior arc. The record is the deepest (6,210 m) so far for this species.

Tindaria sundaensis Knudsen, 1970

(Fig. 3A)

Tindaria sundaensis Knudsen, 1970, p. 56, text-fig. 37, pl. 2, fig. 16, pl. 4, fig. 4.

Occurrences: R11 (4,560–4,540 m) 1 specimen; R18 (5,440 m) 5 specimens; R59(1) (3,240 m) 1 specimen.

Measurements (in mm) of 6 selected specimens:

	SL	SH	SW	SH/SL	SB/SL
	8.5	6.8	4.1	0.800	0.482
	8.2	6.7	3.9	0.817	0.476
	8.2	6.5	3.9	0.793	0.476
	7.9	6.1	3.8	0.722	0.481
	7.5	5.7	4.2	0.760	0.560
	7.2	5.7	3.4	0.792	0.472
Holotype (after Knudsen, 1970)	9.1	7.2	—	0.79	—

Remarks: The general characters of the present specimens (6.0–8.5 mm SL) agree for the most part with the original description. The shell is oval, ornamented with regular commarginal ribs and covered with a yellow periostracum. The ligament is amphidetic, with no resilium. The anterior arc of the hinge plate bears 10 teeth and the posterior arc 14. There is no pallial sinus. The morphology of the soft parts (especially the siphonal tentacles) could not be examined. The only apparent difference from the original description is the number of posterior teeth (23 in the holotype). This species was originally described from a depth of 2,780 m in the Sunda Trench. The present record extends the range geographically to the Shikoku and Northwest Pacific Basins and bathymetrically to 5,440 m.

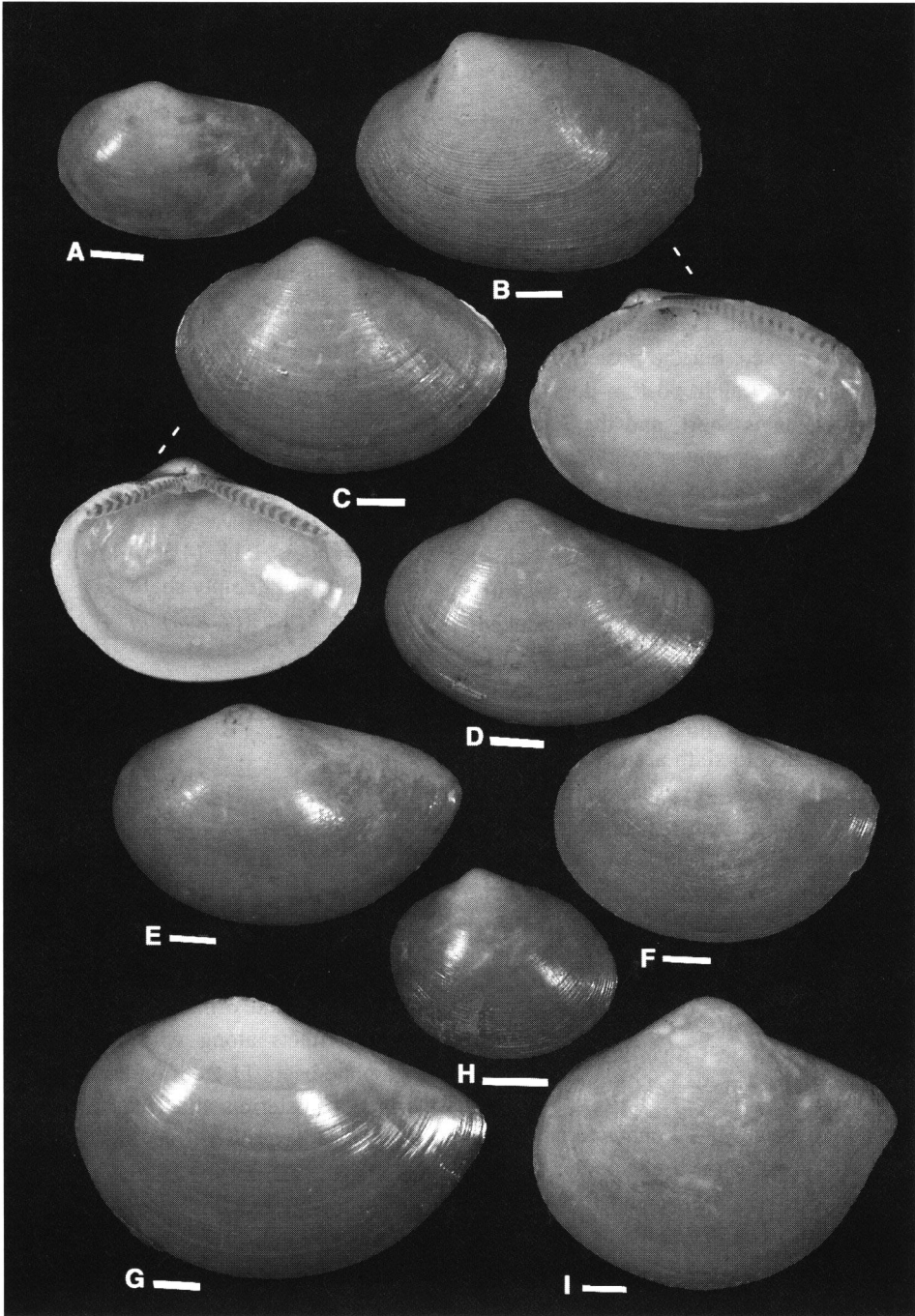


Fig. 2. Nuculoida and Cuspidariidae (Scale bars=2 mm).

A. *Malletia cuneata* (Jeffreys, 1876), St. R46; B. *Tindaria antarctica* Thiele & Jaeckel, 1931, St. R5; C. *Tindaria rodent* n. sp. (holotype), St. R18; D. *Neilonella schepmani* Prashad, 1932, St. R18; E. *Neilonella abyssopacifica* n. sp. (paratype), St. R52(2); F. *Neilonella sumatrensis* (Thiele & Jaeckel, 1931), St. R11; G. *Neilonella politissima* n. sp. (paratype), St. R18; H. *Pristigloma japonica* (E. A. Smith, 1885), St. R18; I. *Halonympha soyomaruuae* n. sp. (paratype), St. R9.

Tindaria rodent n. sp.

(Figs. 2C, 3B)

Occurrence: R18 (5,440 m) 1 specimen

Description: The shell is thick, oval, inflated, equivalve, inequilateral, and abruptly compressed postero-dorsally. The surface is ornamented with weak growth lines and impressed radial lirae, and covered by a polished, olive-colored periostracum. The umbo is low and situated about 40% from the anterior margin. The anterior to ventral margin is gently curved, but the posterior end is obtuse with a nearly straight postero-dorsal margin. The escutcheon is short, and the lunule is faintly marked. The ligament is amphidetic, with no resilium below the umbo. The hinge plate is thick. The anterior and posterior arcs are separated by an edentulous narrow triangular slit below the umbo. The anterior arc bears 15 teeth, with the first to sixth below the umbo tightly packed and vertical. The other teeth are arranged in the common fashion of the family, with the 9th to 11th strongest. The posterior arc bears 19 teeth, among which the first to sixth are likewise vertical; the remainder are in the usual arrangement, with the 12th to 15th strongest. The inner surface is porcellaneous and white, with a smooth ventral margin. The anterior adductor scar is indistinct, but the posterior one is distinct and bean-shaped. The pallial line is sinuous below the posterior adductor scar.

Measurements (in mm):

Holotype (NSMT-Mo73213) SL 12.0, SH 8.6, SB 5.7, SH/SL 0.717, SB/SL 0.475

Remarks: This species has a characteristic feature in the central part of the hinge plate: the anterior and posterior arcs are separated by a narrow triangular slit. The six teeth on both arcs closest to this slit are arranged vertically, in contrast to the oblique arrangement common in other nuculoid bivalves. The section of the hinge plate carrying these vertical teeth is somewhat expanded vertically, with an undulating ventral margin. This species resembles *T. murrayi* Knudsen, 1967 from 2,312 m in the Gulf of Aden, in having an edentulous space between the anterior and poste-

rior arcs; however, in *T. murrayi* the hinge plate has more teeth (12+21) and does not expand. In *T. murrayi*, furthermore, there is no pallial sinus.

Distribution: Hitherto known only from the type locality: Northwest Pacific Basin off Kinkazan, Honshu, 5,440 m deep.

Etymology: the vertical configuration of the teeth in the central part of the hinge plate is reminiscent of the incisor teeth of a rodent.

Family Neilonellidae Allen, 1978

Neilonella sumatrensis (Thiele & Jaeckel, 1931)

(Figs. 2F, 3F)

Malletia sumatrensis Thiele & Jaeckel, 1931, p. 50, pl. 3, fig. 69.

Occurrences: R11 (4,560–4,540 m) 7 specimens including 4 empty shells.

Measurements (in mm) of 4 selected specimens:

	SL	SH	SW	SH/SL	SB/SL
	12.0	8.3	5.9	0.692	0.492
	11.7	8.8	5.9	0.752	0.504
	10.6	7.6	5.2	0.717	0.491
	9.1	6.3	4.7	0.892	0.516
After Thiele & Jaeckel (1931)	5.75	3.8	3.0	0.660	0.522

Remarks: This species has a short shell that is compressed posteriorly and distinctly convex ventrally. The surface is covered by a yellowish periostracum, and ornamented with weak com-marginal riblets along with growth lines. The hinge plate bears 11 teeth on the anterior arc and 21 on the posterior, and lacks a resilium. This species was described from *Valdivia* St. 191 (off Sumatra, 0°39.2'S, 98°52.3'E, 750 m deep). The type specimen, which is about half the size of the present specimens, has 12 anterior hinge teeth and 20 posterior.

Neilonella schepmani Prashad, 1932

(Figs. 2D, 3E)

Neilonella schepmani Prashad, 1932, p. 2, pl. 1, figs. 50, 51.

Occurrences: R18 (5,440 m) 82 specimens.

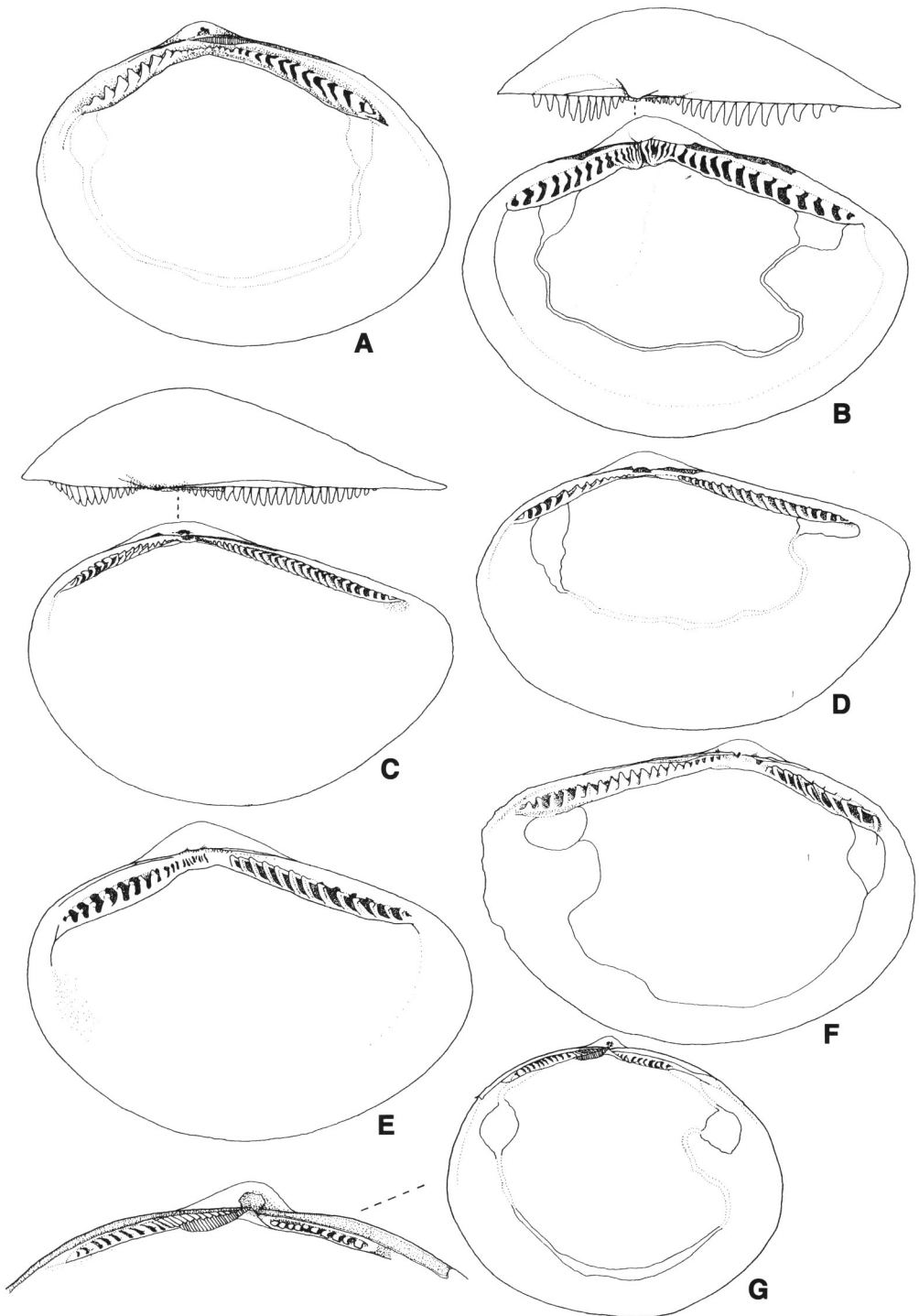


Fig. 3. Nuculoida. A, *Tindaria sundaensis* Knudsen, St. R18. SL=8.5 mm; B, *Tindaria rodent* n. sp. (holotype) St. R18. SL=12.0 mm; C, *Neilonella politissima* n. sp. (paratype), St. R18. SL=18.3 mm; D, *Neilonella abyssopacifica* n. sp. (paratype), St. R52(2). SL=14.3 mm; E, *Neilonella schepmani* Prasad, St. R18. SL=12.7 mm; F, *Neilonella sumatrensis* (Thiele & Jaekel), St. R11. SL=11.7 mm; G, *Pristigloma japonica* (Smith), St. R18. SL=7.1 mm.

Description: The shell is thick, inflated, equi-valve, donaciform and gradually compressed posteriorly. The surface is covered by a straw-colored periostracum and ornamented with rather regular growth lines. The beak is small and situated a little anteriorly. Both lunule and es-cutcheon are ill-defined. The postero-dorsal margin is almost straight or very weakly convex, with a rather acute posterior profile. The ligament is poorly developed and amphidetic. No resilium is present. The hinge plate is thick. The anterior arc bears 13 teeth, of which the eighth and ninth are strongest; the posterior arc bears 17, of which the 11th is strongest. The proximal first to third teeth on both arcs are minute. The interior has a weak luster, and there is a deep pallial sinus.

Measurements (in mm) of 10 selected specimens:

	SL	SH	SB	SH/SL	SB/SL
	12.7	8.7	5.7	0.685	0.449
	12.7	8.6	5.7	0.677	0.449
	12.7	8.5	5.7	0.669	0.449
	12.6	8.5	6.1	0.675	0.484
	12.3	8.4	6.0	0.683	0.488
	12.3	8.0	5.7	0.650	0.463
	12.1	8.5	6.0	0.702	0.496
	12.0	8.3	5.8	0.692	0.483
	12.0	8.1	5.8	0.675	0.483
	12.0	8.0	5.4	0.677	0.450
Mean				0.694	0.458
S.D.				0.028	0.025

Remarks: The majority of the present specimens (SL 6.3–12.7 mm) are around twice as large as the *Siboga* specimen (SL=6.5, SH=4.6, SB=3.7 mm), but both the number of hinge teeth (Holotype : 12+18) and SH/SL ratio (0.71) are close. Prasad (1932) described this species from *Siboga* St. 221 in the Banda Sea at 2,798 m.

Neilonella politissima n. sp.

(Figs. 2G, 3C)

Occurrences: R18 (5,440 m) 16 specimens.

Description: The shell is rather thick, inflated, equi-valve, inequilateral and elongate donaciform. The surface is covered by a thick, strongly pol-

ished, straw-colored periostracum, with occasional iridescence that is seldom eroded except in the umbonal area, and is ornamented with rather irregular commarginal lines. The beaks are low and situated about 40% anteriorly. The anterodorsal margin is nearly straight; it is continuous to the round anterior margin, and then to the smoothly curved ventral margin. The postero-dorsal margin is straight up to the obtusely angulate posterior end. The lunule is indistinct; the es-cutcheon is very narrow and demarcated by ridges. The ligament below the umbo is very weak, and no resilium is present. The hinge plate is rather thick, bearing 17 teeth on the anterior arc and 29 on the posterior. The first to third teeth on the anterior arc are minute; thereafter, the teeth strengthen and the eighth to 13th are strongest. The first to eighth teeth on the posterior arc are minute, but the 13th to 24th are very strong. The internal surface is white, with a weak gloss. The anterior adductor scar is indistinct; the posterior is oval and situated below the posterior hinge plate. The pallial sinus is deep and the ventral margin is continuous.

Measurements (in mm) of 10 selected specimens:

	SL	SH	SW	SH/SL	SB/SL
Holotype (NSMT-Mo73214)	18.4	12.3	8.1	0.668	0.440
Paratype #1 (NSMT-Mo73215a)	18.3	11.8	8.3	0.645	0.454
Paratype #2 (NSMT-Mo73215b)	18.0	11.3	7.6	0.628	0.422
Paratype #3 (NSMT-Mo73215c)	17.1	11.6	7.8	0.678	0.456
	16.9	10.8	7.3	0.639	0.432
	16.8	11.3	7.4	0.673	0.440
	16.8	11.0	7.4	0.655	0.440
	16.5	10.8	7.2	0.655	0.436
	16.3	11.0	7.5	0.675	0.460
	16.1	10.3	6.7	0.640	0.416
Mean				0.656	0.435
S.D.				0.014	0.014

Remarks: The present species is large for the genus, and is characterized by its strongly polished, intact periostracum. The bathyal species *N. soyoae* Habe, 1958 differs in having a smaller shell ornamented with regular concentric riblets. The abyssal species *N. brunnea* Dall, 1916 and *N. japonica* Okutani, 1962 both have a smaller and shorter shell, a dull surface, and a much

smaller number of hinge teeth.

Distribution: So far known only from the type locality : off Kinkazan, Honshu, at 5,440 m.

Etymology: The species name refers to the very polished periostracum.

***Neilonella abyssopacifica* n. sp.**

(Figs. 2E, 3D)

Occurrences: R52(2) (5,660 m) 13 specimens.

Description: The shell is rather thick, equi-
valve, inequilateral, elongate donaciform and
moderately inflated, but laterally compressed
posteriorly. The surface is covered by a yellow-
ish, weakly lustrous periostracum that is occa-
sionally eroded in the umbonal region. Ornamen-
tation is limited to irregular growth lines. The
beak is small and situated about 40% anteriorly,
with a small, amphidetic ligament below. The an-
tero-dorsal margin is nearly straight; the anterior
margin is round, with a gentle curve connecting it
to the convex ventral margin. The postero-dorsal
margin is also straight and the posterior end is
obtusely pointed. The lunule and escutcheon are
both indistinct. The hinge plate is strong with no
resilium, but with 15 teeth on the anterior arc and
25 on the posterior. The first to third teeth on the
anterior arc are minute; at the eighth to tenth, the
teeth abruptly become strong and then weaken
distally. The first to eighth teeth on the posterior
arc are minute, but the 14th to 19th are strong.
The internal surface is rather dull white; the an-
terior and posterior adductor scars and pallial line
are barely traceable.

*Measurements (in mm) of 10 selected speci-
mens:*

	SL	SH	SW	SH/SL	SB/SL
Holotype (NSMT-Mo73216)	15.5	9.8	6.2	0.632	0.400
Paratype #1 (NSMT-Mo73217a)	14.3	9.0	6.0	0.629	0.420
Paratype #2 (NSMT-Mo73217b)	14.3	8.8	5.9	0.615	0.413
	14.0	8.8	6.1	0.629	0.436
	13.7	8.9	5.9	0.650	0.431
Paratype #3 (NSMT-Mo73217c)	13.0	8.5	5.7	0.654	0.438
	12.6	8.2	5.1	0.636	0.395
	12.3	8.2	5.2	0.667	0.423
	12.3	8.0	5.1	0.650	0.415
	10.6	6.7	4.3	0.632	0.406
Mean				0.640	0.418
S.D.				0.019	0.015

Remarks: *N. abyssopacifica* somewhat resem-
bles the preceding new species, *N. politissima*,
but the latter has a strongly polished surface. In
addition, *N. abyssopacifica* is less inflated
(SB/SL=0.418) than *N. politissima* (0.435), and
both the numbers of hinge teeth and their pattern
of size differ between the two.

Distribution: So far known from the type lo-
cality: the Northwest Pacific Basin, east off the
Izu Islands, at 4,660 m.

Etymology: The species name refers to the
abyssal habitat in the Pacific Ocean.

Family Pristiglotmatidae Sanders & Allen, 1973

***Pristiglotma japonica* (E. A. Smith, 1885)**

(Figs. 2H, 3G)

Glomus japonicus E. A. Smith, 1885, p. 325, fig.

Pristiglotma japonica: Okutani, 1976, p. 26, text-figs. 4–6.

Occurrences: R18 (5,440 m) 2 specimens.

Measurements (in mm):

	SL	SH	SB	SH/SL	SB/SL
	7.1	5.8	3.2	0.817	0.451
	6.8	5.6	3.4	0.824	0.500
Lectotype (BMNH 87.2.9.3355)	5.45	4.15	3.20*	0.76	0.58

(*Depth of odd valve ×2)

Remarks: This is the first discovery of this
species since it was originally collected by the
HMS *Challenger* at St. 237 at a depth of 1875
fathoms (=3,400 m) in the Enshu-Nada Sea
(Shikoku Basin : 34°97'N, 138°00'E) and de-
scribed by Smith (1885 as *Glomus*). Okutani
(1976) selected the lectotype by citing a syntype
from the BMNH specimens.

The shell is thin, oval, and weakly inflated.
The hinge plate bears 10 teeth on the anterior arc
and 11 on the posterior. The first to seventh teeth
are minute; the 8th is strongest, with the remain-
der weakening distally. The most striking charac-
ter is the resilium, which is oblique, elongate and
attached below the posterior arc of the hinge
plate. The present specimen differs from the lec-
totype in the number of hinge teeth: Okutani
(1976) noted 7 teeth on the anterior arc and 14 on
the posterior. This species is now known from

both the Shikoku Basin (3,400 m) and Northwest Pacific Basin (5,440 m).

Family Spinulidae Allen & Sanders, 1972

Spinula calcar (Dall, 1908)

(Fig. 4B)

Leda (*Spinula*) *calcar* Dall, 1908, p. 378, pl. 10, figs. 1, 10.

Spinula (*Spinula*) *calcar*: Filatova, 1958, p. 211, fig. 1.

Occurrences: R9 (4,160 m) 7 specimens; R12 (3,910 m) 5 specimens; R23 (4,460 m) 1 specimen.

Measurements (in mm) of 10 selected specimens:

	SL	SH	SB	SH/SL	SB/SL
	16.2	8.3	4.5	0.512	0.278
	16.1	8.6	4.6	0.534	0.286
	16.0	8.4	4.7	0.525	0.294
	15.4	8.8	4.7	0.571	0.305
	15.3	8.6	4.7	0.562	0.307
	13.6	7.4	4.0	0.544	0.294
	12.7	7.5	3.9	0.591	0.307
	12.5	7.0	3.8	0.560	0.304
	11.6	6.6	3.7	0.569	0.319
	10.1	5.6	3.0	0.554	0.297
Mean				0.567	0.303
S.D.				0.029	0.013

Remarks: Besides the live specimens, 3 odd right valves and 6 odd left valves were collected in the present survey. Shell length ranges from 7.7–16.2 mm. This species had been reported exclusively from the Pacific Ocean (e.g. Filatova, 1958; Knudsen, 1970; Okutani, 1975) since it was originally described from the eastern Pacific (Dall, 1908). The depth range of this species is from 3,610 m (*Soyo-Maru*: Okutani, 1975) to 6,096 m (*Vityaz*: Filatova, 1958). The present occurrences fall within this range.

Spinula* (*Bathyspinula*) *oceanica Filatova, 1958

(Fig. 4A)

Spinula (*Bathyspinula*) *oceanica* Filatova, 1958, p. 213, figs. 3, 4.

Occurrences: R5 (5,820 m) 1 specimen; R7 (5,360 m) 1 specimen; R18 (5,440 m) 48 speci-

mens; R21 (6,320–6,340 m) 3 specimens; R31 (5,780 m) 2 specimens; R46 (6,060 m) 3 specimens; R47(3) (6,180 m) 1 specimen; R47(3) (6,170 m) 1 specimen; R52(2) (5,660 m) 11 specimens; R53(3) (6,160 m) 4 specimens.

Measurements (in mm) of 10 selected specimens:

	SL	SH	SB	SH/SL	SB/SL
	19.3	11.8	4.8	0.611	0.249
	19.2	11.8	4.6	0.615	0.240
	19.1	11.5	4.3	0.602	0.225
	19.0	11.7	4.4	0.616	0.232
	18.6	11.2	4.0	0.602	0.215
	18.4	11.2	4.5	0.609	0.245
	18.3	11.7	4.5	0.639	0.246
	18.3	11.3	4.8	0.617	0.262
	17.9	11.6	4.3	0.648	0.240
	17.8	10.9	4.0	0.612	0.225
Mean				0.618	0.243
S.D.				0.018	0.01

Remarks: Beside the live specimens enumerated above, three other specimens (two dead and one fragmented) were available with SL 7.3–19.3 mm. The morphological characters agree with the original description by Filatova (1958) and subsequent descriptions and illustrations by Knudsen (1970) and Okutani (1975). This species is confined to abyssal depths in the Northwest Pacific, with the sole exception a specimen from the Tasman Sea at a depth of 4,670 m (*Galathea*: Knudsen, 1970). Knudsen (1970) cited the principal habitat of this species as the Kurile-Kamchatka Trench region between 36°N and 52°N and between 144°E and 172°E, from 4,670 m to 6,272 m in depth. However, subsequent surveys of the deep sea molluscan fauna of the Northwest Pacific by Okutani (1974, 1975) and the present study have extended the distribution range southwards to 26°N in the Northwest Pacific Basin east of Japan and the Izu-Ogasawara Trenches. The bathymetrical range in this area is from 5,020 m to 7,500 m (Okutani, 1974). The occurrences in the present survey fall within this depth range, in lower abyssal to upper hadal habitats. The record from 4,670 m in Tasman Sea is exceptionally shallow. A few examples of sympatric occurrence with the preceding species

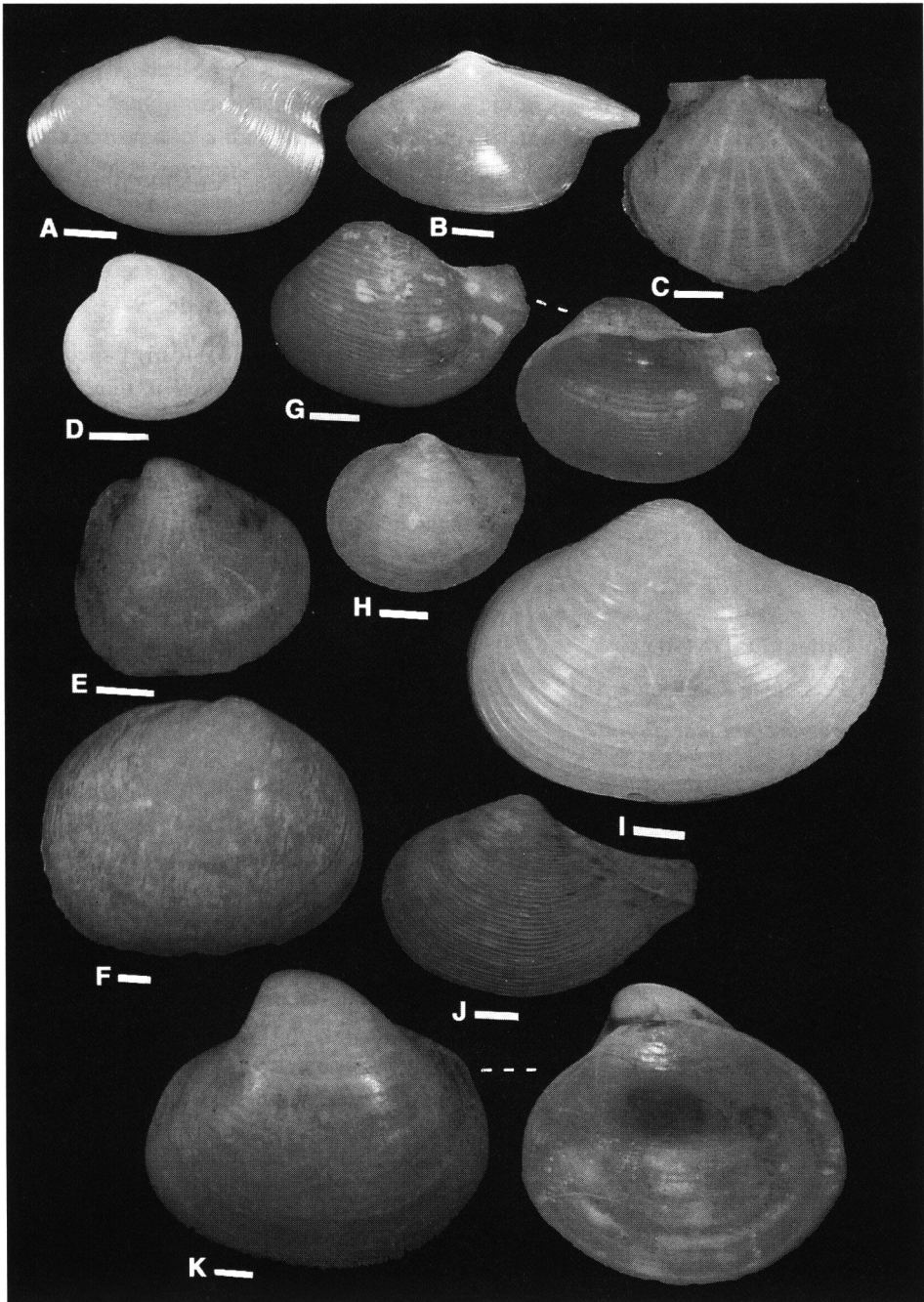


Fig. 4. Nuculoida, Pectinoidea, Veneroidea and Pholadomyoidea (Scale bars=2 mm)

A. *Spinula (Bathyspinula) oceanica* Filatova, 1958, St. R18, B. *Spinula calcar* (Dall, 1908), St. R9, C. *Propeamussium meridionale* (E. A. Smith, 1885), St. R18, D. *Kelliella pacifica* (E. A. Smith, 1885), St. R17, E. *Laevicordia abscissa* (Pelseneer, 1911), St. R21, F. *Montacuta* sp., St. R57, G. *Cuspidaria (Shinkaimya* n. subgen.) *arcoidea* n. sp. (holotype), St. R17, H. *Protocuspidaria thomassini* Poutier, 1984, St. R21, I. *Myonera undata* (Verrill, 1884), St. R9, J. *Cuspidaria (Rhinoclama) dubia* Prashad, 1911, St. R17, K. *Poromya tornata* (Jaffreys, 1876), St. R9.

have hitherto been reported (Horikoshi, 1971; Okutani, 1974).

Order ARCOIDA

Family Arcidae Lamarck, 1809

Bentharca asperula (Dall, 1881)

Macrodon asperula Dall, 1881, p. 120.

Bentharca asperula: Okutani, 1968, p. 13, pl. 1, fig. 6.

Occurrences: R58 (3,600 m) 10 specimens.

Remarks: This species has been frequently reported from bathyal (430 m) to lower abyssal depths (5,005 m) in all world oceans except in the polar regions (Knudsen, 1970). The present occurrences from the Northwest Pacific augment those recorded by Okutani (1962, 1968, 1974, 1975).

Order PECTINOIDA

Family Pectinidae Rafinesque, 1815

Propeamussium meridionale

(E. A. Smith, 1885)

(Figs. 4C, 5C)

Amussium meridionale Smith, 1885, p. 316, pl. 24, figs. 1, 1a.

Propeamussium meridionale: Knudsen, 1967, p. 277, text-fig. 17, pl. 1, fig. 16.

Occurrences: R18 (5,440 m) 4 specimens.

Measurements (in mm):

SL	SH	SB	SH/SL	SB/SL
9.6	8.1	2.7	0.844	0.281
9.6	7.9	2.9	0.832	0.302
9.3	8.6	—	0.925	—
8.1	7.5	2.6	0.926	0.321

Remarks: This is the one of the most common bivalves on bathyal to abyssal bottoms in the Indo-Pacific. The present specimens agree with the revised descriptions of Knudsen (1967, 1970) and Dijkstra (1995). This species was originally collected by the HMS *Challenger* at Sts. 146, 158, and 302 in the subantarctic region at depths of 1,375 fathoms (2,515 m), 1,800 fathoms (3,292 m) and 1450 fathoms (2652 m), respective-

ly. Dijkstra (1995, 2001) gave the bathymetrical range of this species 649–2,470 m, and the present records thus represent a significant downward extension.

Order VENEROIDA

Family Montacutidae Clarke, 1855

Montacuta sp.

(Figs. 4F, 5B)

Occurrence: R57(3,340 m) 1 specimen.

Description: The shell is thin, equivalve, inequilateral, ovo-quadrate in profile, and moderately inflated. The surface is covered by a thin, golden yellowish periostracum, which gradually thickens towards the margin and is delicately foliaceous along the irregular growth lines. The beaks are small and low, situated 60% posteriorly, and weakly prosogyrous. Both lunule and escutcheon are indistinct, but a weak ligament is present along the postero-dorsal margin. The antero-dorsal margin is convex up to the beak. The anterior margin is round but weakly angular at the meeting point with the smooth and less convex ventral margin. The postero-ventral, posterior and postero-dorsal margins are smoothly curved. The hinge plate is very thin and almost edentulous. The anterior lateral tooth is very delicate and slender; it is almost straight, and ridge-like. The posterior lateral tooth is also very delicate, weakly curved, and duplicated on the right valve. The internal surface is dull white; the adductor scars and pallial line are indistinct.

Measurements (in mm): SL 18.7, SH 15.0, SB 9.6.

Remarks: The single specimen could not be identified to species level. It is large for the genus.

Family Kelliellidae Fischer, 1887

Kelliella pacifica (E. A. Smith, 1885)

(Figs. 4D, 5A)

Collocardia (?) *pacifica* E. A. Smith, 1885, p. 156, pl. 6, figs. 9–9b.

Occurrences: R17 (4,680–4,130 m) 3 specimens; R18 (5,440 m) 10 specimens.

Description: The shell is veneriform, strongly inflated, equivalve and inequilateral. The surface is pellucid and covered by a thin, weakly lustrous periostracum, which becomes somewhat foliaceous marginally and is ornamented with dense growth lines. The beak is prominent and strongly prosogyrous. The lunule is depressed and indistinctly defined. The postero-dorsal margin is rather straight, but the antero-ventral, ventral and postero-ventral margins are smoothly convex. The ligament is external, very short and opisthodontic. The hinge plate is delicate. The anterior tooth on the right valve is linear; the posterior tooth is curved, slightly erected anteriorly and demarcated by an upturned cardinal tooth that bears a slit. On the left valve, the anterior tooth is simple; the posterior tooth is erected dorsally in a crescent shape and is slightly swollen ventrally, partially overlapping the small, lunate cardinal tooth. The internal surface is dull white; adductor scars and pallial line are indistinct.

Measurements (in mm) of 10 selected specimens:

	SL	SH	SW	SH/SL	SB/SL
	SL	SH	SW	SH/SL	SB/SL
	6.6	6.0	4.9	0.909	0.742
	6.0	5.8	4.6	0.967	0.767
	6.0	5.6	4.5	0.933	0.750
	5.4	5.0	3.9	0.926	0.722
	5.3	5.4	4.4	1.019	0.830
	5.3	5.4	4.1	1.019	0.774
	5.3	4.8	3.8	0.906	0.717
	5.2	5.3	4.2	1.019	0.808
	5.1	4.7	3.6	0.922	0.706
	5.0	5.0	4.0	1.000	0.800
Mean				0.962	0.756
S.D.				0.043	0.040

Remarks: The present specimens agree with the original description by Smith (1885) who collected this species at HMS *Challenger* St. 244, Mid-North Pacific at a depth of 2,900 fathoms (=5,304 m). There is a slight resemblance to *Kelliella bruuni* (Filatova, 1969). The *Vityaz* collected that species from a depth of 8,928–9,174 m (St. 3827) in the Kermadec Trench, and it was

subsequently taken by the *Galathea* from depths of 5,850–5,900 m (St. 654) to 8,210–8,300 m (St. 649) in the same trench (Knudsen, 1979). *K. bruuni* is higher than long, unlike *K. pacifica*, and is a trench-associated species. Another trench species, *Vesicomya sergeevi* Filatova, 1971 from the Kurilo-Kamtschatka Trench at depths 6,090–9,530 (Filatova, 1971) has more roundish shell. St. R17 is located on the landward slope of the Japan Trench, but St. R18 is on an abyssal flat at a similar depth to the *Challenger* station.

Order PHOLADOMYOIDA

Family Poromyidae Dall, 1868

Poromya tornata (Jeffreys, 1876)

(Fig. 4k)

Pecchiola tornata Jeffreys, 1876b, p. 494.

Verticordia tornata: Smith, 1885, p. 170, pl. 25, figs. 9, 9b.

Poromya tornata: Knudsen, 1970, p. 124, text-figs. 82–84, pl. 14, fig. 9.

Occurrences: R9 (4,160 m) 4 specimens; R11 (4,560–4,540 m) 1 specimen.

Measurements (in mm):

	SL	SH	SW	SH/SL	SB/SL
	SL	SH	SW	SH/SL	SB/SL
	16.4	14.1	12.4	0.860	0.756
	15.8	14.8	—	0.937	—
	14.6	14.5	—	0.993	—
	13.8	12.9	—	0.935	—
	13.7	12.6	11.1	0.920	0.810

Remarks: This species was originally described from the Northwest Atlantic, at a depth of 3,038 m (*Valorous*). Knudsen (1970) confirmed it also to be distributed in the Indian Ocean at depths of 3,310 to 4,810 m (*Galathea*). The present findings represent a further range extension eastward to the Shikoku Basin. This species is characterized by a thin and inflated shell with a pronounced umbo, a weakly rostrate posterior margin, a convex ventral margin, and a short but pronounced ligament. The right valve has a single tooth corresponding to a socket on the left valve. The general morphological features are somewhat similar to those of *Cetomya*

voskresenskii Krylova, 2001, which differs from the present species in having a granulate shell surface.

Laevicordia abscissa (Pelseneer, 1911)

(Fig. 4E)

Lyonsiella abscissa Pelseneer, 1911, p. 76.

Lyonsiella smithi Prasad, 1932, p. 325, pl. 7, figs. 25, 26 (non Dautzenberg, 1927)

Occurrences: R21 (6,320–6,340 m) 1 right valve.

Measurements (in mm): SL 8.7, SH 8.0.

Remarks: The odd right valve recovered in the present survey agrees with the material collected by the *Siboga* from a depth of 835 m in the Ceram Sea (St. 178). This species is characterized by a thin, subquadrate shell that is ornamented by radial lines and covered by a thick periostracum in the marginal region. The anterior margin is regularly truncate, creating a blunt antero-ventral angle. The descending postero-dorsal margin is long and straight. This species is also close to *L. smidti* Friele, 1886 from the abyssal Atlantic (3,300–4,400 m), but the latter has a shorter postero-dorsal margin resulting in a rounder shell profile (Soot-Ryen, 1966). *Policordia* (*Latebranchia*) *obliqueivata* Ivanova, 1977 from the bathyal North Pacific (1,180–1,640 m) is also similar but has a longer and more weakly concave antero-ventral margin.

Family Cuspidariidae Dall, 1886

Protocuspidaria thomassini Poutier, 1984

(Fig. 4H)

Protocuspidaria (*Edentaria*) *thomassini* Poutier, 1984, p. 295, figs. 6a, b.

Occurrences: R21(6,320–6,340 m) 1 specimen.

Measurements (in mm): SL 8.3, SH 6.4, SB 4.1, SH/SL 0.771 SB/SL 0.494

Remarks: The holotype, collected from the western Indian Ocean at 3,710 m, is far smaller than the present specimen (SL 3.8, SH 3.1, SB 1.7); however, in general morphology they are

consistent. This species is characterized by a well rounded profile, a short rostrum, dense and partially wrinkled commarginal lamellae, and poor development of the hinge teeth. Poutier (1984) originally placed this species in the subgenus *Edentaria* Allen & Morgan, 1981, but Poutier & Bernard (1995) stated that the division of this genus into three subgenera 'may be premature, as the hinge dentition may be mutable.' The present specimen has low, ridge-like swellings representing remnants of both anterior and posterior teeth.

Shinkaimya n. subgen. of

Cuspidaria Nardo, 1840

A new subgenus is here proposed for *Cuspidaria* that have separated beaks with a flat space between them. The hinge bears a posterior tooth. The resilium is not in the chondrophore but in a vertical resilifer between the anterior and posterior arcs of the hinge plate.

Type species: *Cuspidaria arcoida* n. sp.

Remarks: This subgenus is distinguishable from all other subgenera within the genus *Cuspidaria* in having a flat space between separated beaks. The resilium in other Cuspidariid taxa is usually located in the chondrophore or fossette, inclined and attached to the hinge plate; however, the resilifer in *Shinkaimya* is vertical and lies in a narrow incision between both arcs of the hinge plate.

Cuspidaria* (*Shinkaimya*) *arcoida n. sp.

(Figs. 4G, 5E)

Occurrences: R21(6,320–6,340 m) 1 specimen, fractured; R32 (5,680 m) 1 specimen.

Description: The shell is thin, inflated, equivalve, inequilateral and elongate oval, with the posterior rostrum demarcated by a shallow groove running from the umbo to the postero-ventral corner. The white shell surface is translucent and ornamented with regularly spaced commarginal riblets that are pronounced in the central region but diminish on the rostrum. The beaks are low, eroded and prosogyrous; they lie

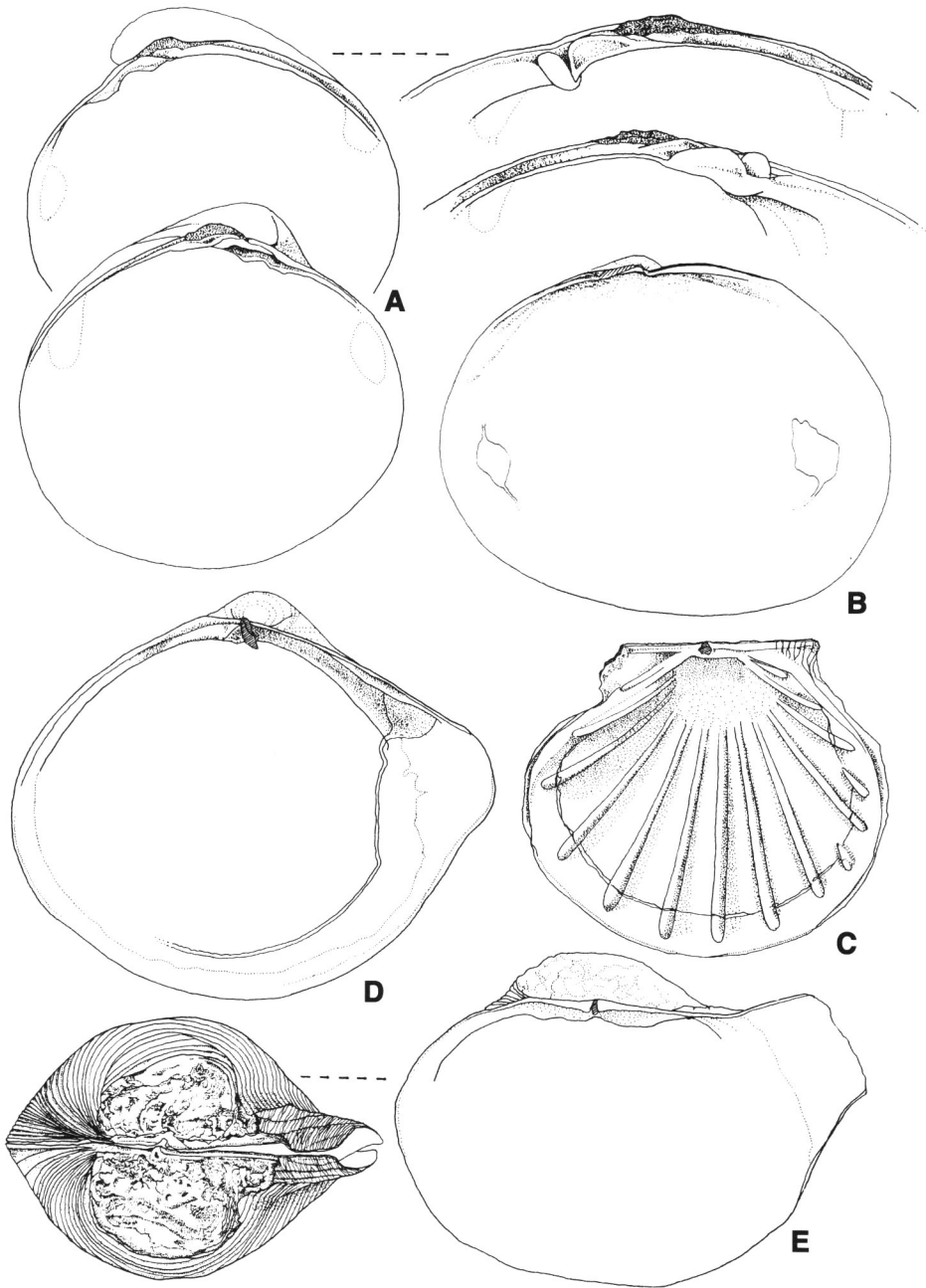


Fig. 5. Pectinoida, Veneroida and Pholadomyoida. A, *Kelliella pacifica* (Smith), St. R18. SL=6.0 mm; B, *Montacuta* sp., St. R57. SL=18.7 mm; C, *Propeamusium meridionale* (Smith), St. R18. SL=9.6 mm; D, *Halonympha soyomaruae* n. sp. (paratype), St. R. 23. SL=15.7 mm; E, *Cuspidaria* (*Shinkaimya* n. subgen.) *arcoida* n. sp. (holotype), St. R17. SL=14.5 mm.

separate from each other with a narrow flat space between them. The antero-dorsal and anterior margins are smoothly rounded. The ventral margin is less convex as far as the postero-ventral margin. The rostrum is short, very weakly upturned and ornamented with 3–4 radial riblets that are crossed by fine commarginal threads and partly covered by the periostracum. The internal surface is white, with commarginal grooves corresponding to the external riblets. The hinge plate is separated into anterior and posterior arcs by a narrow resilium below the umbo. The anterior arc is almost smooth, but the posterior bears a low, elongate, crescent-shaped swelling (=posterior tooth). Both adductor scars and pallial line are indistinct.

Measurements (in mm): Holotype (NSMT-Mo73218) SL 10.7, SH 7.5, SB 7.5, SH/SL 0.701, SB/SL 0.701 (R32)

Remarks: See Remarks for the new subgenus.

Distribution: So far known from two stations, both in the Northwest Pacific Basin at 5,680–6,340 m.

The Cuspidariidae illustrated by Belyaev & Mironov (1977) from 24°06.9'N, 143°06.9'E at a depth of 6,330 m seems to be the present species.

Etymology: The prefix *Shinkai* means deep sea in Japanese. The species name is derived from the flat space between the separated beaks, a feature that is frequently observed in the genus *Arca*, which means a vessel (ship).

Cuspidaria (Rhinoclama) dubia Pelseneer, 1911
(Fig. 4J)

Cuspidaria (Rhinoclama) dubia: Prashad, 1932, p. 333, pl. 7, figs. 49, 50.

Occurrence: R17 (4,680–4,130 m) 1 specimen.

Measurements (in mm): SL 14.5, SH 8.9, SB 6.3, SH/SL 0.614, SB/SL 0.434

Remarks: This species is characterized by equally spaced, sharp, commarginal riblets and two strong radial ridges on the rostrum. The right valve bears a short anterior and an elongated posterior tooth; on the left valve only a faint anterior

tooth is visible. This is the second occurrence of this species in the Northwest Pacific since it was first reported from Japanese waters by Okutani (1962: Off Izu-Oshima Isl., 1560–1640 m and off Miyake Isl., 1350 m). The *Siboga* collected *R. dubia* from depths of 1,158 m in the Flores Sea (St. 211) and 2,798 m in the Banda Sea (St. 221). Poutier & Bernard (1995) cited a bathymetrical range of 200 to 2,798 m, and the present record from beyond 4,000 m is thus a significant bathymetrical extension.

Halonympha soyomaruae n. sp.

(Figs. 2I, 5D)

Occurrences: R9 (4,160 m) 56 specimens; R10 (3,140 m) 2 specimens; R23 (4,460 m) 6 specimens; R58 (3,600 m) 1 specimen.

Description: The shell is thin, well inflated, equivalve and inequilateral veneriform with compressed posterior rostration. The surface is translucent white and lustrous, ornamented with indistinct growth lines and covered by a dark yellowish periostracum that tends to thicken in the marginal areas and on the rostrum. The beaks are situated almost centrally and are weakly opisthogyrous. The antero-dorsal and anterior to antero-ventral margins are smoothly rounded and convex. The postero-ventral corner is slightly concave at a point corresponding to the rostrum. The postero-dorsal margin runs nearly straight to the short rostrum, with a blunt end that gapes slightly. The internal surface is dull white. The hinge plate is moderately strong with a triangular, oblique resilium below the umbo. A small, knobbed cardinal tooth is present just in front of the right resilium, and the left valve bears a small socket. Both anterior and posterior teeth are thin and long. The right valve slightly overlies the left near the umbo. A buttress is present below and along the posterior arc of the hinge plate. The anterior adductor scar is elongate; the posterior one is oval and situated on the buttress.

Measurements (in mm) of 10 selected specimens:

	SL	SH	SB	SH/SL	SB/SL
Holotype (NSMT-Mo73219)	18.7	14.8	10.7	0.791	0.578
Paratype #1 (NSMT-Mo73220 a)	18.2	14.4	10.7	0.791	0.588
Paratype #2 (NSMT-Mo73220 b)	17.7	13.8	9.6	0.780	0.542
Paratype #3 (NSMT-Mo73220 c)	17.4	14.0	10.1	0.805	0.580
	17.4	13.9	10.0	0.799	0.575
	17.3	13.9	9.8	0.803	0.566
	17.2	13.4	10.0	0.779	0.581
	16.8	13.8	9.7	0.821	0.577
	16.8	13.0	9.3	0.774	0.554
	16.3	13.3	8.9	0.816	0.546
Mean				0.798	0.544
S.D.				0.002	0.026

Remarks: This species has a characteristic buttress running below the posterior hinge plate. It is very close to the type species of the genus, *H. claviculata* (Dall, 1881), but Dall's species has a longer rostrum and a prosogyrous umbo. Poutier & Bernard (1995) cited 11 species in the genus *Halonympha*, but they are mostly from the shelf of the Atlantic. *H. leiomyoides* (Poutier, 1981) from the Philippines (415–510 m) differs from the present species in having a glossy shell with a strongly prosogyrous umbo and slender rostrum.

Myonera undata (Verrill, 1884)

(Fig. 4I)

Neaera undata Verrill, 1884, p. 223.

Cuspidaria undata: Verill & Bush, 1898, p. 798, pl. 72, fig. 1, pl. 78, figs. 3, 4.

Myonera undata: Knudsen, 1970, p. 136, text-figs. 93, 94.

Occurrences: R9 (4,160 m) 1 specimen and 1 right valve.

Measurements (in mm): SL 23.8, SH 17.3, SB 12.5, SH/SL 0.727, SB/SL 0.525

Remarks: The present specimens are easily identifiable as *M. undata* by the short, indistinctly demarcated rostrum and translucent shell ornamented by low, spaced commarginal ribs. Knudsen (1980) carefully surveyed existing collections and concluded that this species is distributed widely from the northwest, central and south Atlantic to the central Indian Ocean at depths of 4,320 to 5,300 m. This is the first occurrence of this species from the Pacific, at a slightly smaller depth than previous records.

Discussion

Twenty-two bivalve species were identified among the biological samples from 27 stations (hauls) from deeper than 3,000 m in the Northwest Pacific Basin (19 stations: 4,680–6,340 m) and the Shikoku Basin (8 stations: 3,140–4,560 m). Although the R/V *Soyo-Maru* carried out beam-trawl samplings at more stations in similar or shallower depths in the same areas during the same period, only 27 stations yielded living bivalves from deeper than 3,000 m. Most stations yielded between one and four species, each usually represented by fewer than 20 specimens. This suggests low diversity in the abyssal fauna. A remarkable exception was St. R18, one of the northernmost stations off Kinkazan, which yielded 180 specimens in ten species. Such a high yield from an abyssal basin may reflect the fact that this station is located beneath the productive cold current. Another unusual occurrence was the confirmation of a cuspidarid species at St. R9 near the Ogasawara Islands, below the west slope of the Izu-Ogasawara Ridge. The existence there of a patch of a carnivorous species cannot be explained.

In line with the typical composition of abyssal bivalve fauna (Knudsen, 1979), the present material is dominated by protobranchs (11 species: 50%) and septibranchs (7 species: 32%). The remainder comprises two species of the Pteriomorpha and two of the Veneroidea.

Of the 22 species recovered, five (23%) are new to science: *Neilonella politissima*, *Neilonella abyssopacifica*, *Tindaria rodent*, *Cuspidaria (Shinkaimya* n. subgen.) *arcoida* and *Halonympha soyomaruuae*. The rediscovery of *Pristigloma japonica* (E. A. Smith, 1885) is also noteworthy. Among the known species, nine (41%) are here recorded from Japanese waters for the first time: *Tindaria sundaensis* Knudsen, 1970 (type locality: Sunda Trench), *Neilonella sumatrensis* (Thiele & Jaeckel, 1931) (off Sumatra), *Neilonella schepmani* Prashad, 1932 (Banda Sea), *Propeamussium meridionale* (E. A. Smith, 1885) (southern Indian Ocean), *Kelliella pacifica*

(Smith, 1885) (Mid-North Pacific), *Poromya tornata* (Jeffreys, 1876) (Northwest Atlantic), *Laevicordia abscissa* (Pelseneer, 1911) (Ceram Sea), *Protocuspidaria thomassini* Poutier, 1984 (Western Indian Ocean) and *Myonera undata* (Verrill, 1884) (North Atlantic). A single species, *Monat-acuta* sp. could not be identified to species level.

The geographical coverage of the present study was limited to the western sector of the Northwest Pacific Basin and the eastern margin of the Shikoku Basin. Faunal data from such a limited area may not permit a generalized biogeographical argument, but the occurrences of some species that had previously been known from either the Atlantic or Indian Ocean support the wide distribution of abyssal bivalves proposed by Knudsen (1970, 1979). The present results will help to understand the diversity, productivity and distribution pattern of animals in 'normal' abyssal basins, which have been rather ignored by the recent research activity that is more or less concentrated to the chemosynthetic environment.

Acknowledgements

We owe many thanks to the personnel who conducted the survey cruises of the R/V *Soyo-Maru* during the years 1977–1981: The staff of the Marine Resources Section, Oceanography Section and Radioactivity Section of the Tokai Regional Fisheries Research Laboratory, and captains and crew of the R/V *Soyo-Maru* at that time. The junior author (RK) acknowledges Prof. J. Hiromi and Dr. K. Ara, Marine Environment Laboratory, College of Marine Bioresource Sciences, Nihon University, for their encouragements and warm help in completing her graduation thesis in FY 2000. Mr. P. Callomon, Academy of Natural Sciences of Philadelphia, kindly made a thorough review on the manuscript to improve grammar.

References

Belyaev, G. M. and Mironov, A. N., 1977. Bottom fauna

- of the west Pacific deep-sea trenches. *Trudy Inst. Okeanol.*, **108**: 7–24. (In Russian.)
- Dall, W. H., 1881. Reports on the results of dredging, under the supervision of Alexander Aggasiz, in the Gulf of Mexico, and in the Caribbean Sea, 1877–79, by the U.S. coast survey steamer "Blake". XV. Preliminary report on the Mollusca. *Bull. Mus. Comp. Zool. Harvard*, **5**: 60–62.
- Dall, W. H., 1908. The Mollusca and the Brachiopoda. Report on the dredging operations off the west coast of Central America by the U.S. Fish Commission steamer "Albatross". *Bull. Mus. Comp. Zool. Harvard*, **43**: 205–487.
- Dall, W. H., 1916. Diagnoses of new species of marine bivalve mollusks from the northwest coast of America in the collection of the United States National Museum. *Bull. Mus. Comp. Zool. Harvard*, **52**: 393–417.
- Dijkstra, H. H., 1995. Bathyal Pectinoidea (Bivalvia: Propeamussiidae, Entoliidae, Pectinidae) from New Caledonia and adjacent areas. In: Bouchet, P. (ed.) *Result. Camp. MUSORSTOM, 14.*, *Mem. Mus. natn. Hist. nat.*, **167**: 9–73.
- Dijkstra, H. H., 2001. Bathyal Pectinoidea (Bivalvia: Propeamussiidae, Entoliidae and Pectinidae) from Wallis and Futuna Islands, Vanuatu Archipelago and New Caledonia. In: Bouchet, P. & B. A. Marshall (eds.) *Tropical Deep-Sea Benthos, 22.*, *Mem. Mus. natn. Hist. nat.*, **185**: 73–95.
- Filatova, Z. A., 1958. On some new species of bivalve molluscs from the northwestern part of the Pacific Ocean. *Trudy Inst. Okeanol.*, **27**: 208–218. (In Russian.)
- Filatova, Z. A., 1969. Deep-sea bivalve molluscs from the Kermadec Trench (Pacific Ocean). *Byull. mosk. Obshch. Ispyt. Prir.*, **3**: 44–49. (In Russian.)
- Filatova, Z. A., 1971. On some mass species of bivalve molluscs from the ultra-abyssal zone of the Kurile-Kamchatka Trench. *Trans. P. P. Shirshov Inst. Oceanol.*, **92**: 46–60, 3 pls. (In Russian.)
- Friele, H. 1886., Mollusca-II. *Norw. North-Atl. Exped., 1876–78. Zoology*: 1–4.
- Habe, T. 1958. Report on the Mollusca chiefly collected by the S. S. *Soyo-Maru* of the Imperial Fisheries Experimental Station on the continental shelf bordering Japan during the years 1922–1930. Part 3. Lamelli-branchia (1). *Publ. Seto Mar. Biol. Lab.*, **6**(3): 241–280.
- Horikoshi, M., 1971. Bathyal fauna on the deep-sea shelf and on the top of rise and seamount. *La Mer*, **9**(9): 46–53. (In Japanese.)
- Ivanova, V. L., 1977. New data on the composition and distribution of the deep-sea Bivalvia of genus *Policordia* (Fam. Verticordiidae). *Trans. P. P. Shirshov Inst. Oceanol.*, **108**: 173–197.
- Jeffreys, J. G., 1876a. New and peculiar Mollusca of the

- Pecten*, *Mytilus* and *Arca* families procured in the "Valorous" Expedition. *Ann. Mag. Nat. Hist.*, 4, ser., **18**: 424–436.
- Jeffreys, J. G., 1876b. New and peculiar Mollusca of the *Kellia*, *Lucina*, *Cyprina* and *Corbula* families procured in the "Valorous" Expedition. *Ann. Mag. Nat. Hist.*, 4 ser., **18**: 490–499.
- Knudsen, J., 1967. The deep sea Bivalvia. *Sci. Rep. John Murray Exped.*, **11** (3): 237–343.
- Knudsen, J., 1970. The systematics and biology of abyssal and hadal Bivalvia. *Galathea Rep.*, **11**: 9–241.
- Knudsen, J., 1979. Deep-sea bivalves. In: Spoel, S. van der, A. C. van Bruggen, & J. Lever (eds.) *Pathways in Malacology*, pp. 195–194. Bohn, Scheltema & Holkema, Utrecht.
- Krylova, E. M., 2001. Septibranchiate molluscs of the family Poromyidae (Bivalvia: Poromyoidea) from the tropical western Pacific Ocean. In: Bouchet, P. & Marshall, B. A. (eds.) *Tropical Deep-Sea Benthos 22*. Mem. Mus. natn. Hist. nat., **185**: 165–200.
- Nakai, Z., 1962. Apparatus for collecting macroplankton in the spawning surveys of Iwashi (sardine, anchovy, round herring and others). *Bull. Tokai Reg. Fisher. Res. Lab.*, (9): 221–236.
- Okutani, T., 1962. Report on the archibenthal and abyssal lamellibranchiate Mollusca mainly collected from Sagami Bay and adjacent waters by the R.V. *Soyo-Maru* during the years 1955–1960. *Bull. Tokai Reg. Fisher. Res. Lab.*, (32): 1–40.
- Okutani, T., 1968. bathyal and abyssal Mollusca trawled from Sagami Bay and south off Boso Peninsula by the R/V *Soyo-Maru*, 1965–1967. *Bull. Tokai Reg. Fisher. Res. Lab.*, (56): 6–49.
- Okutani, T., 1969. Synopsis of bathyal and abyssal megallo-invertebrates from Sagami Bay and the south off Boso Peninsula trawled by the R/V *Soyo-Maru*. *Bull. Tokai Reg. Fisher. Res. Lab.*, (57): 1–62.
- Okutani, T., 1974. Review and new records of abyssal and hadal molluscan fauna in Japanese and adjacent waters. *Venus (Jap. Jour. Malac.)*, **33**(1): 23–39.
- Okutani, T., 1975. Deep-sea bivalves and scapholods collected from deeper than 2,000 m in the northwestern Pacific by the R/V *Soyo-Maru* and the R/V *Kaiyo-Maru* during the years 1969–1974. *Bull. Tokai Reg. Fisher. Res. Lab.*, (82): 57–87.
- Okutani, T., 1976. Notes and illustrations of four abyssal protobranchiate bivalves collected from the North Pacific by the H. M. S. *Challenger* in 1875. *Venus (Jap. Jour. Malac.)*, **35**(1): 24–26. (In Japanese).
- Pelseneer, P., 1911. Les lamellibranches de l'expédition du Siboga. *Siboga Exped.*, **53a**: 1–125.
- Poutier, J.-M., 1981. Resultats des campagne Musorstom-I. Philippines (18–28 mars 1976). Mollusques: Bivalves. *Mem. ORSTOM*, **91**: 325–356.
- Poutier, J.-M., 1984. Septibranches abyssaux de l'Océan Indien occidental (Mollusques bivalves Anomalodesmata). *J. Conch.*, **31**: 281–306.
- Poutiers, J.-M. & F. R. Bernard, 1995. Carnivorous bivalve molluscs (Anomalodesmata) from the tropical western Pacific Ocean, with a proposed classification and a catalogue of Recent species. In: Bouchet, P. (ed.) *Res. Camp. MUSORSTOM, 14*. Mem. natn. hist. nat., **167**: 107–187.
- Prashad, B., 1932. The Lamellibranchia of the Siboga Expedition. Systematic Part II. *Siboga. Exped.*, **53c**: 1–353.
- Smith, E.A., 1985. Report on the Lamellibranchiata. *Challenger Rept., Zoology*, **13**: 1–341.
- Soot-Ryen, T., 1966. Revision of the pelecypods from the *Michael Sars* North Atlantic Deep-sea Expedition 1910. *Sarsia*, **24**: 1–31.
- Thiele, J. & S. Jaeckel, 1931. Muscheln der Deutschen Tiefsee Expedition. *Wiss. Ergebn. dt. Tiefsee-Exped. "Valdivia"*, **21**(1): 159–268.
- Verrill, A. E., 1884. Second catalogue of Mollusca recently added to the fauna of the New England coast. *Trans. Conn. Acad. Arts Sci.*, **6**: 139–294.
- Verrill, A. E. & K. Bush, 1898. Revision of the deep-water Mollusca of the Atlantic coast of North America, with descriptions of new genera and species. Part I. Bivalvia. *Proc. U.S. nat. Mus.*, **20**: 775–901.

