

# GENUS SAMACAR IREDALE, 1936 (BIVALVIA: ARCIDAE) WITH DESCRIPTIONS OF A NEW SUBGENUS AND TWO NEW SPECIES FROM THE NORTHERN PACIFIC

G.M. KAMENEV

A.V. Zhirmunsky Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Sciences,  
Vladivostok 690041, Russia

*Abstract* A new subgenus, *Pseudoporterius*, of the genus *Samacar* Iredale, 1936, and two new species, *Samacar* (*Samacar*) *kurilensis* and *S. (Pseudoporterius) aleutica*, are described from the Kuril (depth 170-368 m) and Aleutian (depth 70-168 m) Islands. The new subgenus has no radial sculpture; the hinge plate is strongly curved, most concave and thin under beaks, strongly widening anteriorly and posteriorly, with horizontal anterior and posterior teeth separated by a very wide edentulous gap with three ligamental grooves. A direct development is inferred for the both new species. They have a very large (length to 640  $\mu\text{m}$  for *S. (Samacar) kurilensis* and to 790  $\mu\text{m}$  for *S. (Pseudoporterius) aleutica*), distinctly marked, bowler-shaped prodissoconch. Expanded descriptions of *Samacar (Samacar) strabo* (Hedley, 1915) are also given.

*Key words* *Samacar*, North Pacific, systematics, new species

## INTRODUCTION

A study of bivalve molluscs collected in the shelf and bathyal zones of the Kuril Islands revealed a species belonging to the family Arcidae. In the North-west Pacific, arcids were earlier recorded farther south, at the coast of Japan (Habe, 1977; Higo, Callomon & Goto, 1999; Okutani, 2000), and along the continental coast as far north as Peter the Great Bay (Sea of Japan) (Scarlato, 1981; Scarlato & Kafanov, 1988). The shell morphology and anatomy indicate that this bivalve mollusc is a new species of the genus *Samacar* Iredale, 1936.

The genus *Samacar* in the North Pacific is represented by *Samacar pacifica* (Nomura & Zinbo, 1934) and *Samacar* sp. A (Coan, Scott & Bernard, 2000; Okutani, 2000). A study of materials and descriptions of the type species *Samacar strabo* (Hedley, 1915), *S. pacifica*, and *Samacar* sp. A shows that *S. pacifica* is a synonym of *S. strabo* and *Samacar* sp. A is a new species which is here referred to a new subgenus of the genus *Samacar*.

The diagnoses and descriptions of the genus *Samacar* and description of the type species given in the literature are brief and often merely schematically illustrated (Hedley, 1915; Iredale, 1936; Newell, 1969; Kilburn, 1983; Lamprell & Healy, 1998; Coan, Scott & Bernard, 2000). The thorough study of shell morphology of *S. strabo* and other northern Pacific species has enabled an expanded and modified diagnosis of the genus and expanded description of *S. strabo* to be made. This paper provides new data on its shell morphology, and describes a new subgenus of *Samacar* and two new species.

Contact author : Gennady.kamenev@mail.ru

## MATERIAL AND METHODS

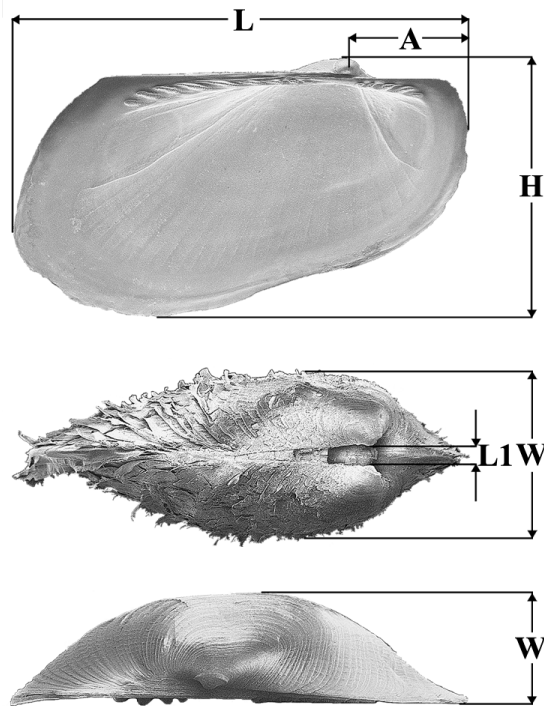
### MATERIAL STUDIED

The material from the Kuril Islands was collected by the joint IMB-PRIFO expedition to the Kuril Islands (July-November 1987, R/V "Tikhookeansky"), joint IMB-PIBOC expedition to the Kuril and Commander Islands (July-August 1993, R/V "Akademik Oparin"), international expedition ("International Kuril Islands Project" program, leader of program – Professor T.W. Pietch (UW)) to the Kuril Islands (August-September 1995, R/V "Professor Bogorov"), and joint IBM-PIBOC expedition to Sakhalin Island and the Kuril Islands (July-August 2003, R/V "Akademik Oparin"). All material of this species was fixed with 70% ethanol and stored in 70% ethanol and dry at the IMB.

Also, collection material of the following taxa was used: *S. strabo* (AMS); *Samacar* sp. A (LACM); *S. pacifica* (NSMT, SBMNH); *Asperarca nodulosa* (Müller, 1776) (NMW); *Bentharca asperula* (Dall, 1881) (LACM, MIMB, NMNZ, NMW, NSMT); *Bentharca rubrotincta* Kuroda & Habe in Habe, 1958 (NSMT); *Bentharca xenophorica* (Kuroda, 1930) (NMW); *Bentharca* sp. B (NMNZ); different species of *Bathyarca* Kobelt, 1891 (CAS, MIMB, NSMT, RBCM, SBMNH, ZIN) and *Barbatia* Gray, 1842 (CAS, NSMT, SBMNH, UW).

### SHELL MEASUREMENTS

Figure 1 shows the shell morphology measurements. Shell length (L), anterior end length (A), height (H), width (W), and interumbonal distance (L1) were measured for shell and each valve. The



**Figure 1** Placement of shell measurements: L – shell length; H – height; A – anterior end length; W – width; L1 – interumbonal distance.

ratios of these parameters to shell length ( $A/L$ ,  $H/L$ ,  $W/L$ ,  $L1/L$ , respectively) were determined. Anterior and posterior teeth in each valve were also counted. Shell measurements were made using calipers and an ocular micrometer with an accuracy of 0.1 mm.

#### METHODS USED

For scanning electron microscopy, shells were cleaned of traces of soft tissues and periostracum in a strong commercial bleach, washed in distilled water and dried. They were then mounted to aluminium stubs using adhesive tape and coated with gold for examination with a LEO 430.

For anatomical studies, several specimens were dissected in 70% ethanol, photographed and drawn schematically. Additionally, bodies of two specimens were embedded in paraffin and sectioned at 6  $\mu\text{m}$ . Serial sections were stained with haematoxylin and eosin.

#### ABBREVIATIONS

The following institutional abbreviations are used in the paper:

- AMS Australian Museum, Sydney  
 CAS California Academy of Sciences, San Francisco  
 IMB Institute of Marine Biology, Russian Academy of Sciences, Vladivostok  
 LACM Natural History Museum of Los Angeles County, Los Angeles  
 MIMB Museum of the Institute of Marine Biology, Vladivostok  
 NMNZ Museum of New Zealand Te Papa Tongarewa, Wellington  
 NMW National Museums & Galleries of Wales, Cardiff  
 NSMT National Science Museum, Tokyo  
 PIBOC Pacific Institute of Bioorganic Chemistry, Russian Academy of Sciences, Vladivostok  
 PRIFO Pacific Research Institute of Fisheries and Oceanography, Vladivostok  
 RBCM Royal British Columbia Museum, Victoria  
 SBMNH Santa Barbara Museum of Natural History, Santa Barbara  
 UW University of Washington, Seattle  
 ZIN Zoological Institute, Russian Academy of Sciences, St.-Petersburg

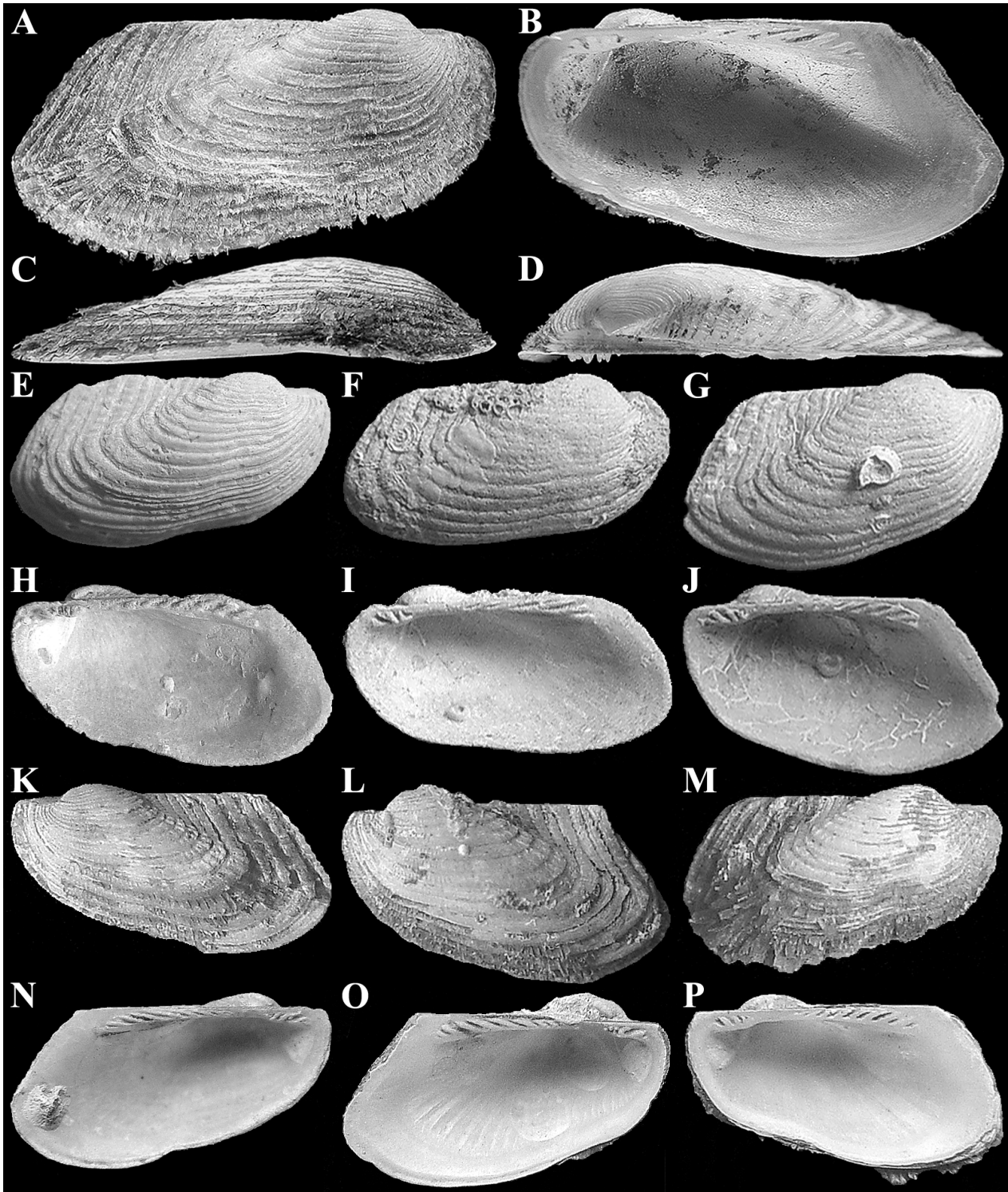
#### SYSTEMATICS

Family Arcidae Lamarck, 1809  
 Genus *Samacar* Iredale, 1936

*Samacar* Iredale, 1936. Type species (OD): *Arca strabo* Hedley, 1915

*Pseudogrammatodon* Nomura & Niino, 1940. Type species (OD) *Pseudogrammatodon pacificus* Nomura & Zinbo, 1934.

*Diagnosis* Shell small (< 25 mm), thin, moderately inflated, ovate to trapezoidal, slightly inequivalve (left valve larger and more inflated), strongly inequilateral. Umbones strongly anterior, prosogyrate. Cardinal area narrow. Sculpture of commarginal lamellar ridges and faint, widely spaced, radial riblets; sometimes radial sculpture absent. Periostracum strongly hirsute, extending beyond shell margins. Hinge plate narrow, curved. Teeth divided into ante-



**Figure 2** *Samacar (Samacar) strabo* (Hedley, 1915). **A-D** Holotype (AMS C 37752), exterior, interior, ventral, and dorsal views of the right valve, length 11.0 mm (photos by H. Barlow). **E-J** Paratypes (AMS C 17084), exterior and interior views of the right valves (length 9.9 mm (E,H); 7.7 mm (F, I); 7.6 mm (G, J)). **K-P** Exterior and interior views of the left valves (length 11.1 mm (K, N); 10.6 mm (L, O)) and right valve 7.8 mm (M, P)) (AMS C 433165).

rior and posterior sets by a wide edentulous gap; anterior teeth short, oblique, sometimes horizontal; posterior teeth longer, more oblique, sometimes horizontal. Adductor scars ridged or slightly raised. Ligament external, sometimes partly sunken, opisthodontic.

*Remarks* Iredale (1936) created a new genus for *Arca strabo* Hedley, 1915 based on the presence of long and oblique teeth in this species. However, examination of photos of the holotype and a large number of paratypes and extensive additional materials has shown that the length and inclination of the posterior teeth in *S. strabo* are highly variable (Figs. 2-4). Clearly, length of posterior teeth is related to their inclination. Compared to the holotype, most paratypes and additional materials have markedly less oblique (canting angle 40-45°) and hence much shorter posterior teeth. Moreover, some of the anterior teeth of the holotype are forked at the upper ends. No forked anterior teeth were observed in the investigated type specimens and additional materials. Therefore, the holotype of *S. strabo* is not quite a typical specimen. Long posterior teeth, subparallel to the dorsal margin, are the extreme extent of variability of these characters.

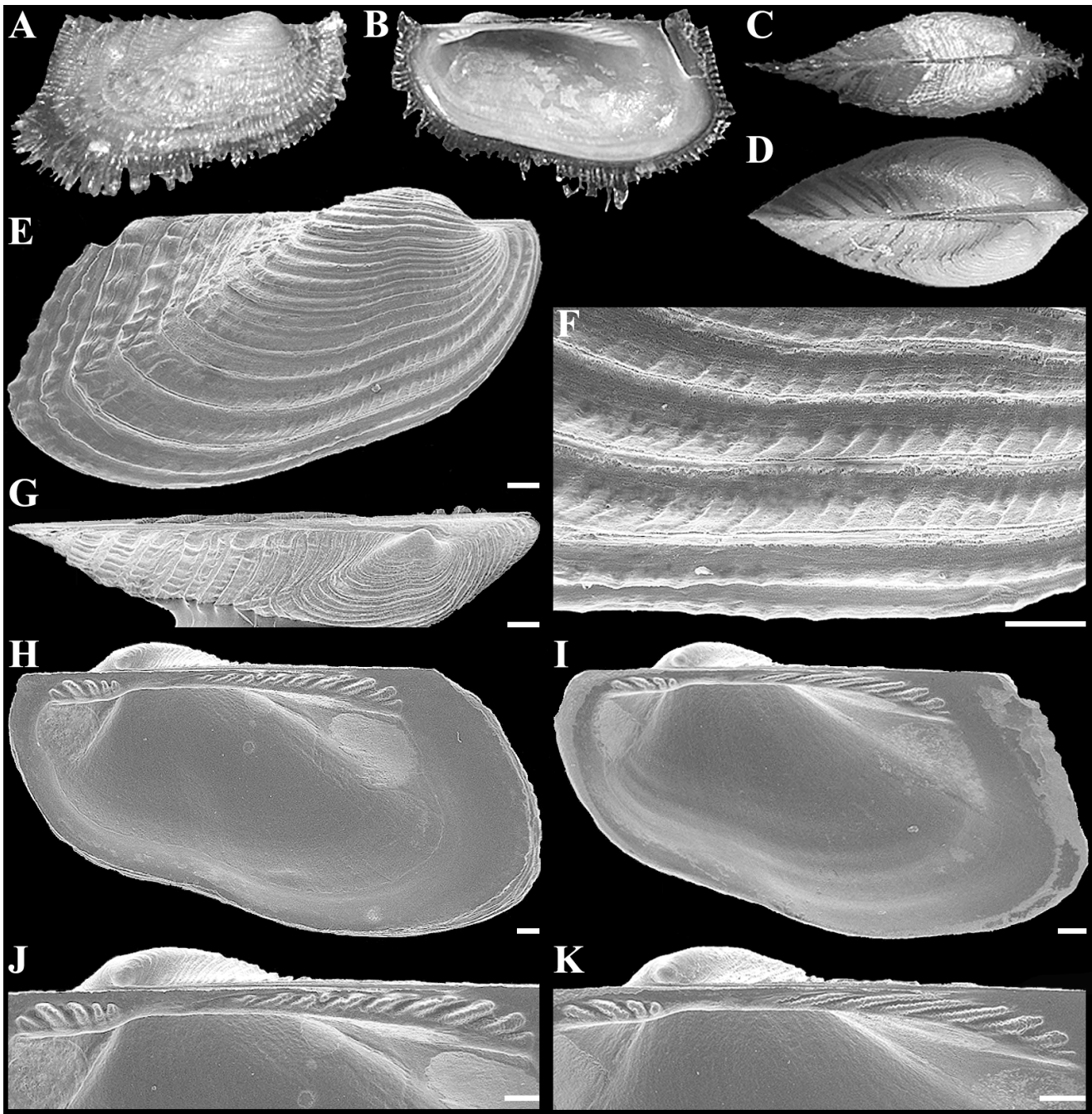
Kilburn (1983) recognized two subgenera within the genus *Samacar*: *Samacar* s. s. and *Deltaodon* Barnard, 1962. *Deltaodon* was originally described by Barnard (1962) as a genus. However, because the posterior teeth of the type species, *Deltaodon tugelae* Barnard, 1962, are subparallel to the dorsal shell margin, as in the holotype of *S. strabo*, Kilburn (1983) considered this genus to be a subgenus of *Samacar*. However, unlike *Samacar*, *Deltaodon* has a very high shell ( $H/L=0.725-0.800$ ) lacking periostracal hairs, with a very broad hinge plate and teeth separated into anterior and posterior sets by a shallow, very narrow, oblique groove. The anterior teeth of *Deltaodon* form an oval group with 8-9 very long, more or less angular teeth, sometimes bifid at the lower ends; posterior teeth form a row of 9-13 very long, more or less curved, oblique, sometimes almost horizontal teeth (Barnard, 1962; Kilburn, 1983). Taking into account these marked differences in shell and hinge morphology, *Samacar* and *Deltaodon*, are here considered to be distinct genera.

*Samacar* differs from most genera of the family Arcidae in having two rows of teeth separated by

a wide edentulous gap (Newell, 1969; Kilburn, 1983; Lamprell & Healy, 1998; Okutani, 2000). Generally, the hinge of *Samacar* is most similar to the hinge of *Bentharca* Verrill and Bush, 1898, *Asperarca* Sacco, 1898, *Pugilarca* Marwick, 1928, and *Notogrammatodon* Maxwell, 1966 (Dall, 1881; Sacco, 1898; Verrill & Bush, 1898; Marwick, 1928; Maxwell, 1966; Knudsen, 1967, 1970; Oliver & Allen, 1980; Oliver & Von Cosel, 1993; La Perna, 1998; Coan *et al.*, 2000; Maxwell, in press). These taxa have a wide edentulous gap between the posterior and anterior rows of teeth. The edentulous gap is present also in *Barbatia*, but only in juveniles, becoming almost lost in adults. The teeth in both rows are oblique and diverging to various degrees. The posterior teeth are longer and usually more oblique than anterior teeth. However, unlike *Samacar*, *Bentharca* has a more straight and narrow hinge plate with a larger number of anterior teeth and fewer posterior teeth because the antero-dorsal margin is relatively longer than the postero-dorsal. Furthermore, *Bentharca* has a less elongate shell with a much more expanded posterior end and narrowed anterior end, with a much broader cardinal area and nonraised muscle scars.

Hinge and shell proportions of *Samacar* are more similar to those of *Asperarca* and *Pugilarca*. *Samacar* differs from *Asperarca* in having a less inflated shell with noticeably weaker radial sculpture and less expressed radial carina, a narrower radial area, a more hirsute periostracum and a smaller number of longer and more oblique posterior teeth. Unlike *Pugilarca*, *Samacar* has a weaker radial sculpture, a less expressed radial carina and an expanded posterior shell end, less anteriorly placed umbones, and a concave ventral margin.

*Pugilarca* was described as a subgenus of *Barbatia* and subsequently placed in synonymy with this genus (Marwick, 1928; Newell, 1969). However, adult individuals of most taxa of *Barbatia* lack an edentulous gap between the anterior and posterior teeth. Moreover, *Barbatia* is characterized by a more equilateral and weakly keeled shell, lacking any lamellar sculpture and in having subvertical teeth in the hinge (Newell, 1969; Kilburn, 1983; La Perna, 1998). Hinge, shell proportions and external sculpture of *Pugilarca* are most similar to the genus *Asperarca*. *Pugilarca* differs from *Asperarca* only in that it has a less angular shell, without an expanded posterior



**Figure 3** *Samacar (Samacar) strabo* (Hedley, 1915). **A-C** Exterior and interior views of the right valve, and dorsal view of both valves of specimen from Japan, length 15.2 mm (Honsu, Izu Islands, off Miyake Island, 34°09.54'N, 139°34.37'E, 171-143 m) (SBMNH 345657, photos by P.V. Scott). **D** Dorsal view of both valves, length 6.5 mm (AMS C 019797). **E, F** Exterior view and sculpture of the right valve without periostracum (AMS C 433165). **G** Dorsal view of the right valve without periostracum (AMS C 019797). **H-K** Interior view and hinge of the right valves (ASM C 433165). Scale bars = 300  $\mu$ m.

shell end and less anteriorly placed umbones.

By shell morphology and hinge structure, *Samacar* is most similar to *Notogrammatodon*. This taxon was omitted by Newell (1969). Originally, *Notogrammatodon* was described as a subgenus

of the genus *Pseudogrammatodon* Arkell, 1930 with the type species *Pseudogrammatodon (Notogrammatodon) inexpectatus* Maxwell, 1966 described from the Eocene of New Zealand (Maxwell, 1966). Recently, Maxwell (in

**Table 1** *Samacar (Samacar) strabo*. Summary statistics of shell ratios for left valves, n=36, (AMS C170841 – 12 valves (paratypes); AMS C433165 – 9; AMS C047185 – 11; AMS C019797 – 4), size range of valves used 2.9 to 9.9 mm.

Statistics	H/L	W/L	A/L	L1/L	Number of teeth	
					Anterior	Posterior
Mean	0.573	0.224	0.207	0.060	-	-
SE	0.006	0.003	0.004	0.002	-	-
SD	0.035	0.017	0.023	0.014	-	-
Min	0.511	0.200	0.163	0.031	3	5
Max	0.656	0.295	0.267	0.092	5	10

**Table 2** *Samacar (Samacar) strabo*. Summary statistics of shell ratios for right valves, n=31, (AMS C170841 – 12 valves (paratypes); AMS C433165 – 9; AMS C047185 – 5; AMS C019797 – 5), size range of valves used 2.7 to 11.0 mm.

Statistics	H/L	W/L	A/L	L1/L	Number of teeth	
					Anterior	Posterior
Mean	0.599	0.237	0.198	0.056	-	-
SE	0.006	0.004	0.004	0.004	-	-
SD	0.034	0.020	0.021	0.020	-	-
Min	0.536	0.191	0.144	0.029	2	4
Max	0.667	0.267	0.235	0.110	5	10

press) separated this species into the genus *Notogrammatodon* of the family Arcidae. The type species of this genus is similar to *S. strabo* in the proportions, cardinal areas and external sculpture of the shell. However, it differs from *S. strabo* in having a wider edentulous gap and the presence of only three horizontal subparallel widely spaced posterior teeth.

#### Subgenus *Samacar*, s.s.

**Diagnosis** Shell small (< 25 mm), thin, moderately inflated, trapezoidal to ovate-trapezoidal, slightly inequivalve (left valve larger and more inflated), strongly inequilateral. Umbones strongly anterior, prosogyrate. Cardinal area narrow. Posterior end expanded, with a noticeable radial carina. Anterior end reduced. Shell surface with a byssal sulcus more expressed in left valve. Sculpture of commarginal lamellae and faint, widely spaced, radial riblets. Periostracum strongly hirsute, extending beyond shell margins. Hinge plate narrow, gently curved. Teeth divided into anterior and posterior sets by a wide edentulous gap; anterior teeth short, oblique; posterior teeth longer, more oblique. Adductor

scars ridged or slightly raised. Ligament external, opisthodontic.

#### *Samacar (Samacar) strabo* (Hedley, 1915) Figs 2-4, Tables 1, 2

- Arca strabo* Hedley, 1915: 697, pl. 78, figs. 19, 20.  
*Pseudogrammatodon pacificus* Nomura & Zinbo, 1934: 114(6), 153(45), pl. 5(1), figs. 6a-b, 7a-b.  
*Paragrammatodon pacificus* Nomura & Zinbo, Nomura & Niino, 1940: 42.  
*Samacar pacifica* (Nomura & Zinbo, 1934), Habe, 1958: 13, pl. 11, figs. 14, 15; Li, 1984: 158, 159, pl. 2, fig. 2.  
*Samacar strabo pacifica* (Nomura & Hatai, 1940), Habe, 1977: 36, pl. 5, figs. 3, 4, 5.  
*Samacar strabo* (Hedley, 1915), Habe, 1981: 35; Lamprell & Healy, 1998: 60, fig. 96.  
*Samacar (Samacar) strabo* (Hedley, 1915), Kilburn, 1983: 532, figs. 33, 34.  
*Porterius pacificus* (Nomura & Zinbo, 1934), Noda, 1988: 124, pl. 1, fig. 6a-b.  
*Samacar strabo* (Hedley, 1915 in 1906-23), Higo *et al.*, 1999: 424.  
*Samacar pacifica* (Nomura & Hatai, 1940), Okutani, 2000: 851, pl. 423, fig. 24.

*Holotype* 1 right v, north-east of Port Macquarie, New South Wales, (approximately ( $\pm 10$  km)  $31^{\circ}23'S153^{\circ}12'E$ ), 183m, coll C. Hedley, 14 x 1913, SS "Undaunted", AMS C 37752 (Hedley, 1915; Alison Miller, personal communication).

*Paratypes* 28 right and 27 left v, from holotype locality, AMS C 170841.

*Material examined* Paratypes 55 v, AMSC 170841; 20 right and 17 left v, Capricorn Channel, 18.5 miles E of North Reef  $23^{\circ}11.5'S 152^{\circ}14.5'E$ , 188m, thick blue-grey mud, coll P.H. Colman & F. Rowe, 18 xi 1977, HMAS "Kimba", AMS C 433165; 26 right and 26 left v, 22 miles E of Narrabeen, N of Sydney, New South Wales  $33^{\circ}42'S 151^{\circ}43'E$ , 146m, coll W.A. Haswell, 7 vi 1906, HMCS "Miner", AMS C 047185; 1 sp, 15 right and 24 left v, 12.5 miles E of Cape Byron  $28^{\circ}38'S 153^{\circ}52'E$ , 203m, coll G.H. Halligan, 10 xi 1902, AMS C 019797. Total of 1 sp, 89 right and 94 left v.

*Measurements* see tables 1 and 2

*Diagnosis* Shell small (to 25 mm), trapezoidal, elongate, slightly inequivalve, strongly inequilateral. Cardinal area narrow. Sculpture of wide, low, slightly imbricated commarginal lamellae and widely spaced, delicate, radial riblets. Periostracum thick, brown, extending beyond shell margin, strongly hirsute. Teeth divided into anterior and posterior sets by an elongate edentulous gap. Anterior set of 2-5 teeth, posterior of 4-10 teeth. Anterior teeth short, subvertical to oblique. Posterior teeth longer and more oblique than anterior teeth, diverging in varying degree, sometimes almost horizontal. Adductor scars ridged or slightly raised. Prodissoconch small (length 181-190  $\mu\text{m}$ ), D-shaped, pitted.

*Description* (expanded from Hedley, 1915) Exterior shell morphology: Shell small (to 25 mm), trapezoidal, elongate (H/L right valve = 0.573 (0.511-0.656); H/L left valve = 0.599 (0.536-0.667)), slightly inequivalve (left valve slightly larger and more inflated), moderately inflated (W/L right valve = 0.224 (0.200-0.295); W/L left valve = 0.237 (0.191-0.267)), strongly inequilateral, thin, solid, white under periostracum, with a byssal gape. Sculpture of wide, low, slightly imbricated commarginal lamellae and widely

spaced, delicate, radial riblets. Periostracum thick, brown, extending beyond shell margins, strongly hirsute, with long, broad setae, stiffest and longest along postero-ventral shell margin. Umbones small, low, rounded, prosogyrate, strongly anterior to midline (A/L right valve = 0.207 (0.163-0.267); A/L left valve = 0.198 (0.144-0.235)). Interumbonal distance small (L1/L = 0.058 (0.029-0.110)). Cardinal area arrowhead-shaped (in dorsal view), narrow, widest in front of umbones, roof-shaped (in cross section), anteriorly delineated by termination of sculpture and hirsute periostracum, posteriorly demarcated by ridges. Anterior shell end reduced, rounded. Posterior end slightly expanded, obliquely truncated, with a noticeable radial carina from beaks to ventral limit of posterior end. Central part of valves with a faint byssal sulcus (more expressed in left valve), noticeable on umbones, extending from beaks to a ventral byssal gape. Antero-dorsal shell margin straight, forming a rounded angle at transition to anterior shell margin. Anterior shell margin slightly rounded, directed slightly posteriorly, smoothly transitioning to ventral margin. Postero-dorsal margin straight, forming a noticeable obtuse angle at transition to posterior margin. Posterior margin concave, sometimes straight, strongly directed posteriorly, forming a slightly rounded sharp angle at transition to ventral margin. Ventral margin slightly concave in area of byssal gape (concavity more conspicuous in left valve). Ligament opisthodontic, narrow, long (more than 1/2 of posterior part of cardinal area). Prodissoconch small (length 181-190  $\mu\text{m}$ ), D-shaped, pitted, without bordering collar.

Interior shell morphology: Hinge plate narrow, gently curved, most concave just posterior to beaks, slightly widening anteriorly and posteriorly. Teeth divided into anterior and posterior sets by an elongate, smooth edentulous gap. Anterior set of 2-5 teeth, posterior one 4-10. Anterior teeth short, subvertical to oblique (very seldom some of them bifurcated), becoming larger and more oblique towards anterior shell end. Posterior teeth longer and more oblique than anterior teeth, diverging in varying degree, sometimes almost horizontal. Adductor scars rounded-triangular, ridged or raised, unequal; posterior adductor scar larger than anterior. Shell interior white, with weak radial lines more conspicuous near pallial line.

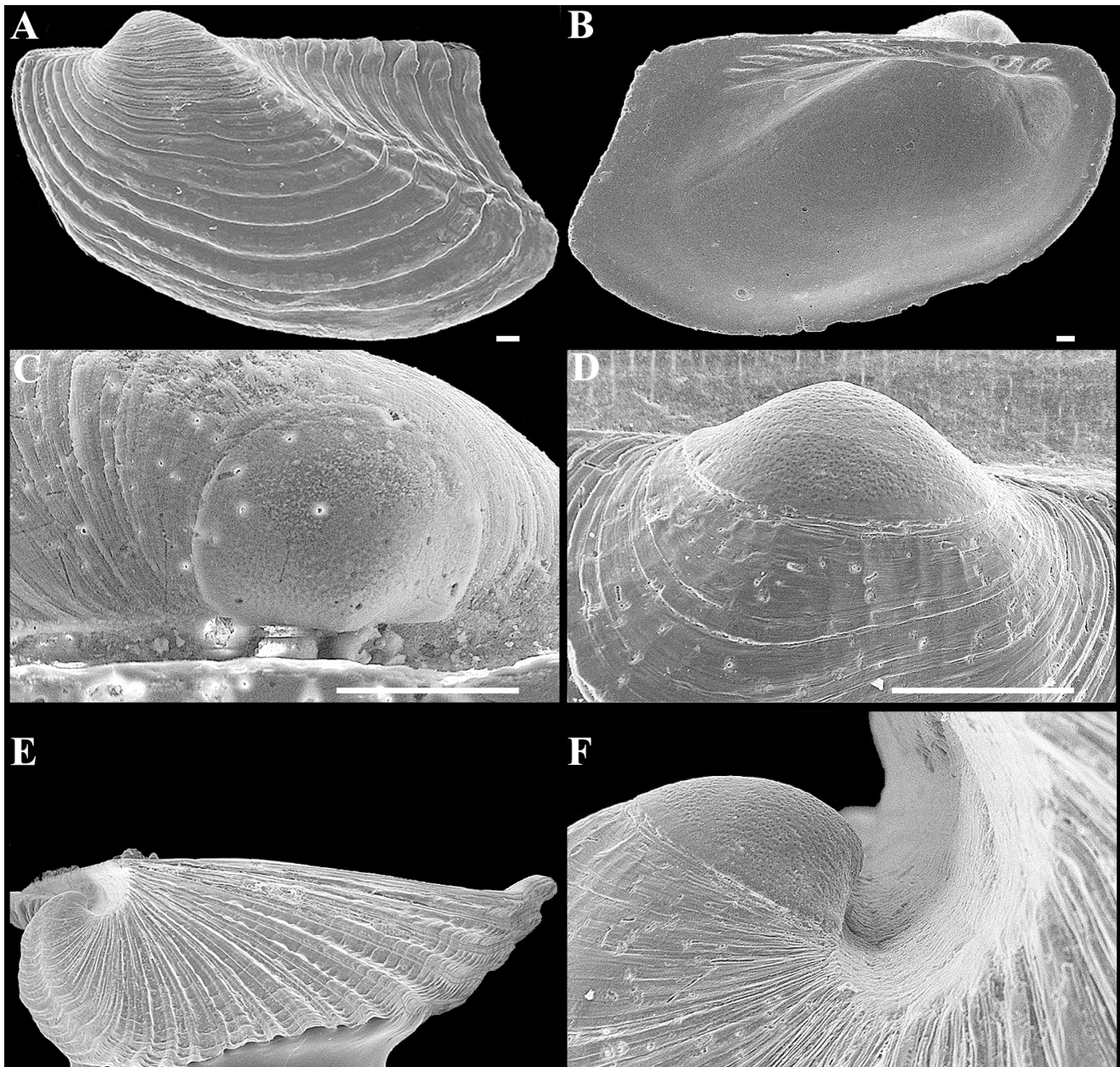
**Table 3** Differentiating characters of *Samacar* spp. L – shell length; H – height.

Characters	<i>Samacar (Samacar) strabo</i>	<i>Samacar (Samacar) kurilensis</i>	<i>Samacar (Pseudoporterijs) aleutica</i>
Shell shape (H/L)	Trapezoidal, with slightly expanded posterior end; elongate (0.511-0.656)	Ovate-trapezoidal, with slightly expanded posterior end; elongate (0.433-0.611)	Ovate, with expanded, broadly rounded posterior end; high (0.613-0.714)
Radial carina on shell surface	Present	Present	Absent
Posterior shell margin	Concave, strongly directed posteriorly	Slightly curved, directed posteriorly	Rounded, slightly directed posteriorly
Sculpture	Wide, slightly imbricated commarginal lamellae and delicate radial riblets	Wide, slightly imbricated commarginal lamellae and delicate radial riblets	Wide, lamellar, commarginal ridges
Cardinal area	Roof-shaped	Flat	Flat
Prodissoconch	Small (181-190 µm), D-shaped, without bordering collar	Very large (to 640 µm), bowler-shaped, with a strong salient central part and marginal collar	Very large (to 790 µm), with a strong salient central part and marginal collar
Ligament	External, occupied more than 1/2 of posterior part of cardinal area	External, occupied more than 1/2 of posterior part of cardinal area	External, partly sunken, occupied all posterior part of cardinal area
Hinge plate	Gently curved, slightly widening anteriorly and posteriorly	Gently curved, slightly widening anteriorly and posteriorly	Strongly curved, strongly widening anteriorly and posteriorly
Edentulous gap	Elongate, smooth	Elongate, smooth	Very wide, with fine vertical notches and deep ligamental grooves posterior to beaks
Teeth (number of teeth)	Anterior teeth (2-5) short, subvertical to oblique; posterior teeth (4-10) longer, more oblique, diverging in varying degree, sometimes almost horizontal	Anterior teeth (3-7) short, subvertical to oblique; posterior teeth (6-12) longer, more oblique, diverging in varying degree	Anterior teeth (3) short, horizontal, parallel; posterior teeth (5) long, horizontal, subparallel



**Table 4** *Samacar (Samacar) kuriensis* n. sp. Shell measurements (mm), indices and summary statistics of holotype and paratypes characters, n=22, size range of valves used 8.6 to 20.9 mm. Numerator indicates shell measurements, indices and summary statistics for the right valve, denominator - for the left valve.

Depository	L	H	W	A	H/L	W/L	A/L	Number of teeth	
								Anterior	Posterior
Holotype MIMB 12364	<u>20.8</u>	<u>10.2</u>	<u>4.2</u>	<u>5.4</u>	<u>0.490</u>	<u>0.202</u>	<u>0.260</u>	<u>6</u>	<u>6</u>
	20.9	10.6	4.6	5.5	0.507	0.220	0.263	6	6
Paratype MIMB 12365	<u>19.5</u>	<u>10.2</u>	<u>3.8</u>	<u>4.8</u>	<u>0.523</u>	<u>0.195</u>	<u>0.246</u>	<u>6</u>	<u>12</u>
	19.9	10.4	4.2	4.9	0.522	0.211	0.246	6	12
Paratype MIMB 12366	<u>15.2</u>	<u>8.5</u>	<u>3.3</u>	<u>3.6</u>	<u>0.559</u>	<u>0.217</u>	<u>0.237</u>	<u>4</u>	<u>8</u>
	15.5	8.9	3.6	3.6	0.574	0.232	0.232	3	8
Paratype MIMB 12365	<u>13.8</u>	<u>6.8</u>	<u>2.7</u>	<u>3.8</u>	<u>0.493</u>	<u>0.196</u>	<u>0.275</u>	<u>7</u>	<u>10</u>
	14.1	7.4	3.1	3.8	0.525	0.220	0.270	7	10
Paratype MIMB 12366	<u>10.3</u>	<u>5.6</u>	<u>1.9</u>	<u>2.8</u>	<u>0.544</u>	<u>0.184</u>	<u>0.272</u>	<u>6</u>	<u>7</u>
	10.7	5.9	1.9	2.8	0.551	0.178	0.262	6	7
Paratype MIMB 12366	<u>8.6</u>	<u>4.8</u>	<u>1.6</u>	<u>2.3</u>	<u>0.558</u>	<u>0.186</u>	<u>0.267</u>	<u>4</u>	<u>9</u>
	8.8	4.9	1.6	2.3	0.557	0.182	0.261	5	9
Statistics	L	H	W	A	H/L	W/L	A/L	Number of teeth	
								Anterior	Posterior
Mean	-	-	-	-	<u>0.539</u>	<u>0.200</u>	<u>0.256</u>	-	-
	-	-	-	-	0.553	0.214	0.255	-	-
SE	-	-	-	-	<u>0.005</u>	<u>0.003</u>	<u>0.003</u>	-	-
	-	-	-	-	0.005	0.004	0.003	-	-
SD	-	-	-	-	<u>0.024</u>	<u>0.015</u>	<u>0.014</u>	-	-
	-	-	-	-	0.024	0.020	0.014	-	-
Min	-	-	-	-	<u>0.490</u>	<u>0.170</u>	<u>0.235</u>	<u>4</u>	<u>6</u>
	-	-	-	-	0.507	0.178	0.232	3	6
Max	-	-	-	-	<u>0.590</u>	<u>0.230</u>	<u>0.287</u>	<u>7</u>	<u>12</u>
	-	-	-	-	0.613	0.266	0.282	7	12



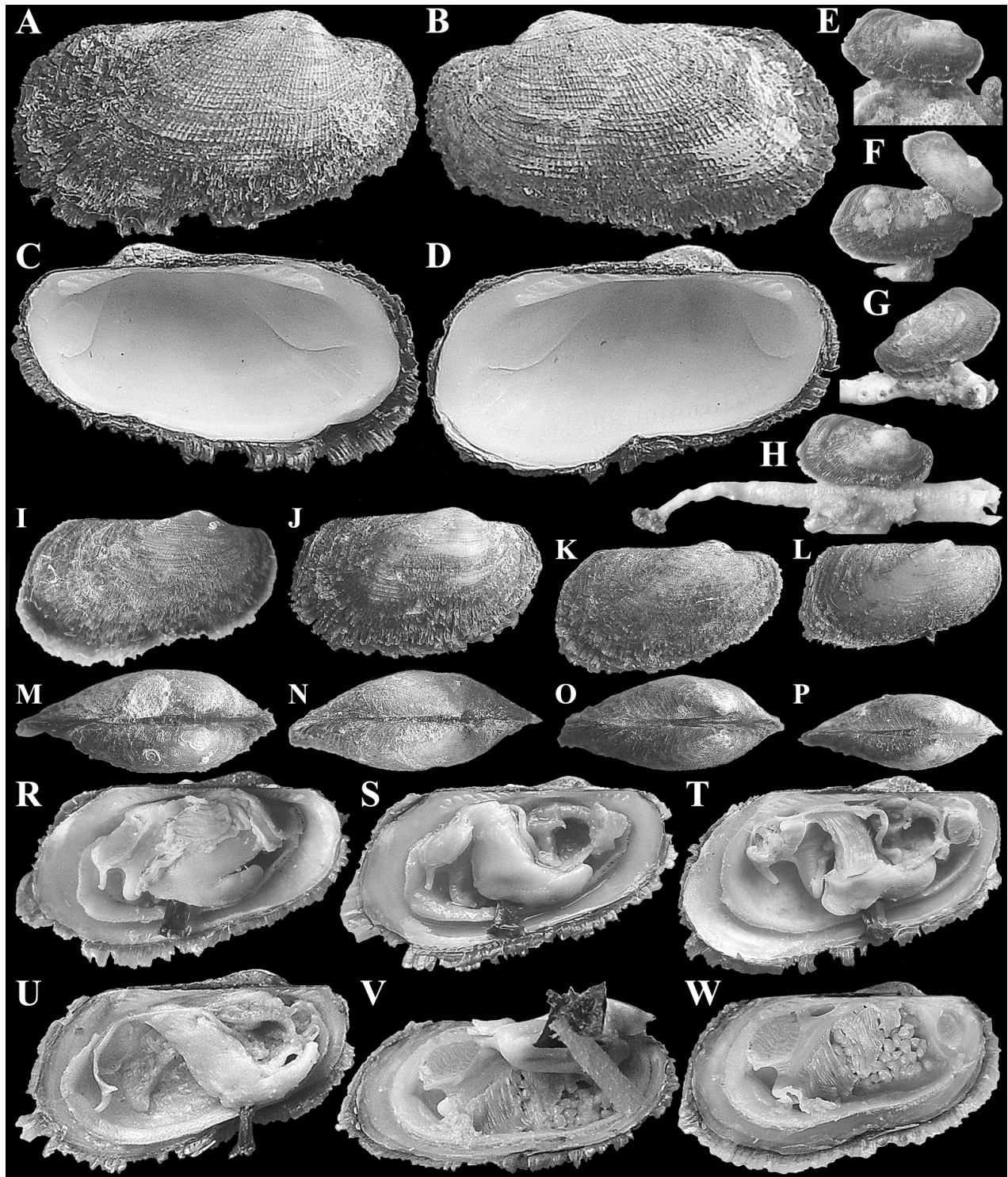
**Figure 4** *Samacar (Samacar) strabo* (Hedley, 1915). **A, B** Exterior and interior views of the left valves of young specimens without periostracum (ASM C 019797). **C-F** Prodossoconch (ASM C 019797). Scale bars = 100  $\mu$ m.

**Variability** The shell shape variability of *S. strabo* is difficult to evaluate because the investigated materials of this species consisted of old separate valves with partly damaged or obsolete margins. Relative height and convexity of the shell and position of beaks are slightly variable. Some valves have a straight posterior margin. The number of hinge teeth is related to shell length. Posterior and anterior teeth diverge to varying degrees. The canting angle of the posterior teeth varies from 10° to 45°. The length of posterior

teeth is related to their canting angle. If posterior teeth are strongly oblique, the longest are teeth in the middle of row. The canting angle of anterior teeth varies in a much lesser degree. Usually, these teeth are subvertical.

In young specimens (< 5 mm), in contrast to adults, the shell is relatively higher ( $H/L = 0.58-0.67$ ), the posterior shell margin is strongly concave, the radial carina is more marked and the posterior teeth are almost horizontal.

**Habitat** This species was recorded at depths from 20



**Figure 5** *Samacar (Samacar) kurilensis* n. sp. **A-D** Holotype (MIMB 12364), exterior and interior views of the right (length 20.8 mm) and left (length 20.9 mm) valves. **E-H** Paratypes (MIMB 12366), attachment of specimens to different kinds of substratum. **I-P** Shells of different age specimens: **I, M** Paratype (MIMB 12366), length 20.5 mm; **J, N** (MIMB 12368), length 17.9 mm; **K, O** Paratype (MIMB 12366), length 15.5 mm. **L, P** Paratype (MIMB 12366), length 8.8 mm. **R, S** Paratype (MIMB 12366), left valve, length 12.8 mm: **R**. The right side after removal of the right shell valve and mantle; **S**. The right side after removal of the right shell valve, mantle, gill, and part of the body. **T, U** Paratypes (MIMB 12366), alimentary canal (length 14.2 mm (**T**); 14.0 mm (**U**)). **V, W** Paratype (MIMB 12366), larvae between the inner and outer demibranches of the left gill, length 12.9 mm.

**Table 5** *Samacar (Samacar) kurilensis* n. sp. Summary statistics of shell measurements (mm) and indices of paratypes for whole shells, n=67 (MIMB 12365 - 4 spec., MIMB 12366 - 63).

Statistics	L	H	W	A	L1	H/L	W/L	A/L	L1/L
Mean	11.98	6.59	4.78	2.73	0.54	0.553	0.394	0.227	0.045
SE	0.34	0.18	0.17	0.08	0.03	0.004	0.004	0.003	0.001
SD	2.82	1.47	1.39	0.67	0.21	0.029	0.032	0.022	0.011
Min	5.4	3.3	2.1	1.2	0.2	0.443	0.326	0.167	0.022
Max	17.8	10.1	8.1	4.4	1.2	0.611	0.479	0.276	0.086

to 500 m, attached by the byssus to rocks and sponges (Kilburn, 1983; Higo *et al.*, 1999).

**Geographic range** Off Japan (from Bōsō Peninsula (Honshu) to Kyushu) (Habe, 1958, 1977, 1981; Higo *et al.*, 1999; Okutani, 2000), off China (Li, 1984), off eastern coast of Australia (from Capricorn Channel to Sydney) (Hedley, 1915; Lamprell & Healy, 1998), off South Africa (Natal) (Kilburn, 1983).

**Comparison** I refer three species to the genus *Samacar* – *Samacar (Samacar) strabo* and two species described below. *S. (Samacar) strabo* well differs from other species of this genus in its obliquely truncated posterior shell end with concave posterior margin, weaker radial sculpture and distinct radial carina, roof-shaped (in cross section) cardinal area, and small, ill-defined, simple prodissoconch (Table 3).

**Remarks** Comparison of the type material of *S. (Samacar) strabo* with figures of the holotype and paratype of *S. pacifica* as well as with photographs and materials of recent individuals (Figs 3A-C) shows that the two species are very similar. Therefore, following a number of authors (Habe, 1981; Kilburn, 1983; Lamprell & Healy, 1998; Higo *et al.*, 1999), *S. pacifica* is regarded here as a synonym of *S. (Samacar) strabo*.

In some works, *S. pacifica* is considered as a distinct species (Li, 1984; Noda, 1988; Okutani, 2000). This species was originally described as *Pseudogrammatodon pacificus* Nomura & Zinbo,

1934 from the Pleistocene of southern Japan (Ryūkyū Limestone of Kikai-zima) (Nomura & Zinbo, 1934). Afterward it was reported as living off Japan, China, and Philippines from 20 to 500 m (Habe, 1958, 1977, 1981; Li, 1984; Higo *et al.*, 1999; Okutani, 2000). In a work of Noda (1988), this species is referred to as *Porterius pacificus* (Nomura & Zinbo, 1934) and figured on Pl. 1, figs. 5 a-b, 6 a-b. However, only the specimen on figs. 6 a-b should be assigned to this species. Figures 5 a-b depict a different species, which is currently identified by Japanese malacologists as *B. rubrotincta*.

In some works of Habe (1958, 1977), *S. pacifica* is figured with a rounded posterior shell end, without a hirsute periostracum and with very long horizontal posterior teeth. Moreover, in a lot from the National Science Museum containing 14 specimens that were identified by T. Habe as being *S. pacifica*, I could assign to this species only one specimen, the largest (L=15.4 mm). Probably, there are at least 3 species of Arcidae in this lot. Some specimens corresponding to the diagnosis of the genus *Samacar* had an expanded, straight truncate posterior shell end with vertical posterior margin, very long, almost horizontal posterior teeth and short anterior teeth diverging in a fan-like fashion. It is thus possible that along with *S. (Samacar) strabo*, another species of this genus, which is erroneously referred to as *S. pacifica*, occurs off the coasts of Japan.

*Samacar (Samacar) kurilensis* new species  
(Figs. 5-10; Tables 4, 5)

*Holotype* 1 sp, off Skaly Lovushki, Kuril Islands 48°27'N 153°51.5'E, 368m, boulders, coll. G.M. Kamenev, 9 vii 1993, R/V "Akademik Oparin", MIMB 12364.

*Paratypes* 6 sp from holotype locality, MIMB 12365; 122 sp, off Brouton Island, Kuril Islands 46°45.9'N 150°43.4'E, 170-180m, rocks covered by sponges, coll. G.M. Kamenev, 21 vii 2003, R/V "Akademik Oparin", MIMB 12366.

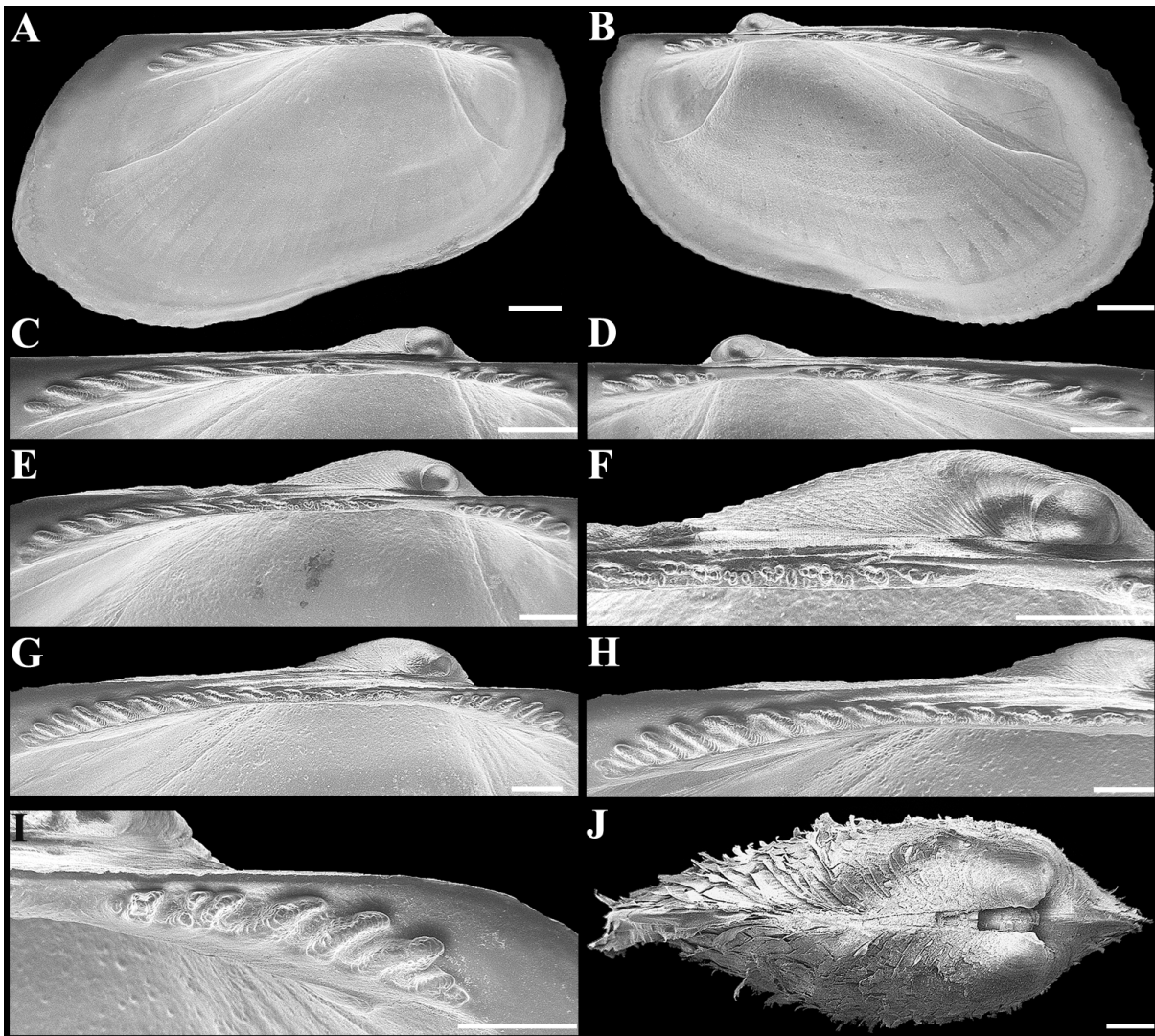
*Material examined* 38 sp, 43 v from type locality, MIMB 12367; 1 sp, off Lidin Cape, Urup Island, Kuril Islands 45°46.3'N 150°05.7'E, Pacific Ocean, 200m, sand and shells, coll. V.I. Lukin, 8 viii 1987, R/V "Tikhookeansky", MIMB 12368; 1 sp, off Skaly Lovushki, Kuril Islands 48°27.6'N 153°50.8'E, 188m, boulders, coll. G.M. Kamenev, 9 vii 1993, R/V "Akademik Oparin", MIMB 12369; 5 sp, 1 v, Malenkaya Bight, Rashua Island, Kuril Islands 47°42.3'N 152°54.3'E, Sea of Okhotsk, 220m, boulders, coll. G.M. Kamenev, 13 viii 1995, R/V "Professor Bogorov", MIMB 12370; 11 sp, off Rifovy Cape, Brouton Island, Kuril Islands 46°46.06'N 150°41.39'E, Sea of Okhotsk, 200-250m, shells and sponges, coll. G.M. Kamenev, 23 viii 1995, R/V "Professor Bogorov", MIMB 12371; 1 sp, off Skala Revun, Urup Island, Kuril Islands 45°29.97'N 149°27.86'E, 195m, silty gravel and shells, coll. G.M. Kamenev, 27 viii 1995, R/V "Professor Bogorov", MIMB 12372. Total of 57 sp and 44 v.

*Measurements* see tables 4 and 5

*Diagnosis* Shell small (to 20.9 mm), ovate-trapezoidal, elongate, slightly inequivalve, strongly inequilateral. Cardinal area narrow. Sculpture of wide, lamellar commarginal ridges and widely spaced, delicate, radial riblets. Periostracum thick, brown, extending beyond shell margin, strongly hirsute. Hinge plate gently curved. Teeth divided into anterior and posterior sets by an elongate edentulous gap. Anterior set of 3-7 teeth, posterior one 6-12. Anterior teeth short, oblique. Posterior teeth longer and more oblique than anterior teeth. Adductor scars raised. Prodissoconch very large (length to 640  $\mu$ m), bowler-shaped, with a strongly salient, knobby central part and a flat, smooth marginal collar.

*Description* Exterior shell morphology: Shell small (to 20.9 mm), ovate-trapezoidal, elongate ( $H/L=0.553$  (0.443-0.611)), slightly inequivalve (left valve slightly larger and more inflated), moderately inflated ( $W/L=0.394$  (0.367-0.479)), strongly inequilateral, thin, solid, white under periostracum, with a byssal gape. Sculpture of wide, lamellar commarginal ridges and widely spaced, delicate, radial riblets. Periostracum thick, brown, extending beyond shell margin, strongly hirsute, with long, broad setae, stiffest and longest along postero-ventral shell margin. Umbones small, low, rounded, prosogyrate, more projecting above dorsal margin in left valve, strongly anterior to midline ( $A/L=0.227$  (0.167-0.276)). Interumbonal distance very small ( $L1/L=0.045$  (0.022-0.086)). Cardinal area lanceolate, very narrow, widest in front of umbones, flat, delineated anteriorly by termination of sculpture and hirsute periostracum, posteriorly demarcated by ridges. Anterior shell end reduced, rounded. Posterior end slightly expanded, rounded-angular, with a faint radial carina from beaks to ventral limit of posterior end. Central part of valves with a faint byssal sulcus (more expressed in left valve) extending from beaks to ventral byssal gape. Antero-dorsal margin straight, forming a rounded angle at transition to anterior margin. Anterior margin slightly rounded, directed slightly posteriorly, sometimes vertical, smoothly transitioning to ventral margin. Postero-dorsal margin straight, forming a noticeable obtuse angle at transition to posterior margin. Posterior margin slightly curved, sometimes almost straight, directed posteriorly, forming a rounded angle at transition to ventral margin. Ventral margin slightly concave in area of byssal gape (concavity more conspicuous in left valve). Ligament opisthodontic, narrow, long (more than  $\frac{1}{2}$  of posterior part of cardinal area). Prodissoconch very large (length to 640  $\mu$ m), distinctly marked, bowler-shaped, with a strongly salient, knobby central part and a flat, smooth marginal collar; posterior end slightly more expanded than anterior; dorsal margin straight; other margins broadly rounded.

Interior shell morphology: Hinge plate narrow, gently curved, most concave under umbones, slightly widening anteriorly and posteriorly. Teeth divided into anterior and posterior sets

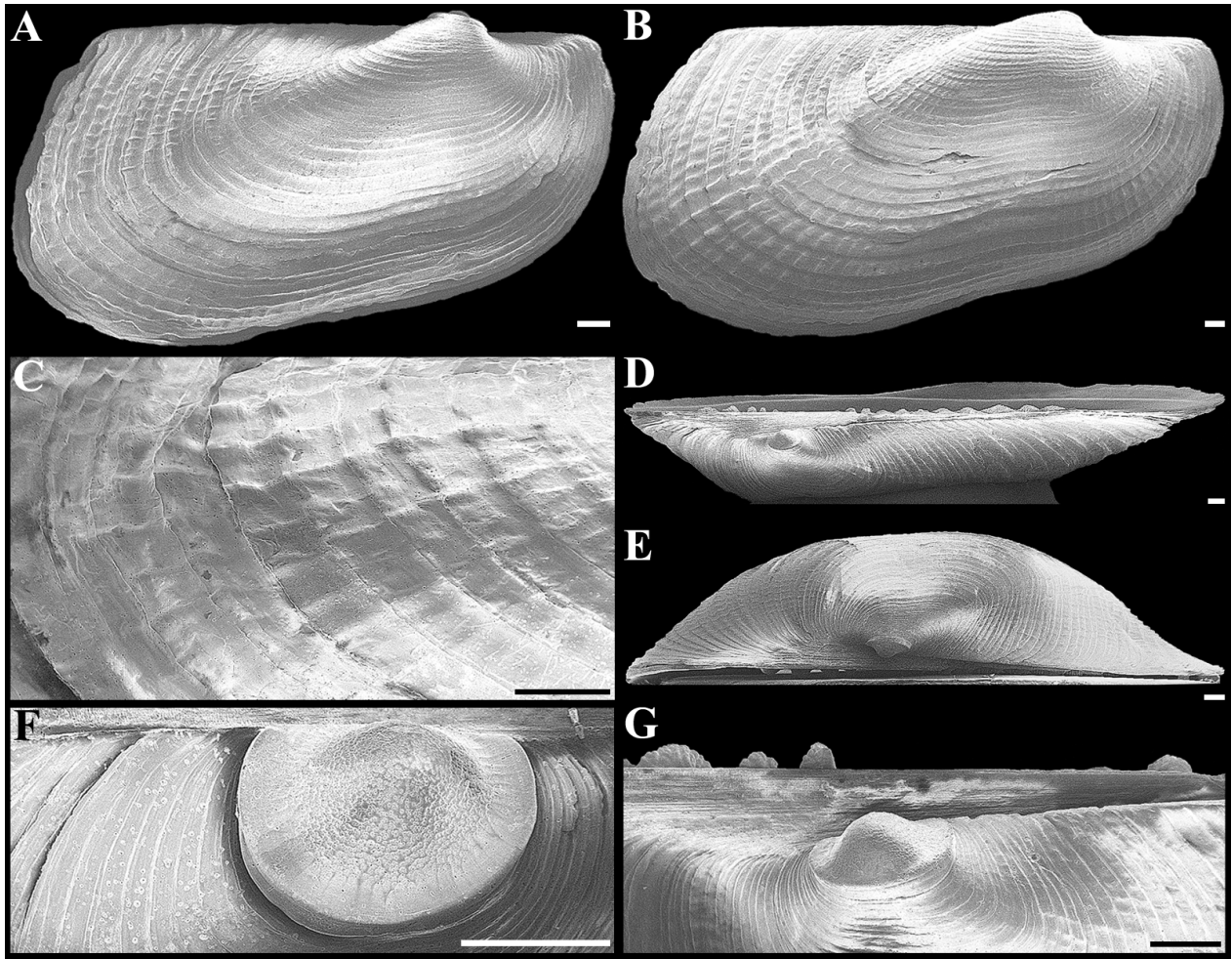


**Figure 6** *Samacar (Samacar) kurilensis* n. sp. **A-D** Paratype (MIMB 12366), interior view and hinge plate of the left and right valves. **E, F** Hinge plate and minute irregular nodes of the left valve, (MIMB 12370). **G-I** Paratype (MIMB 12365), hinge plate, posterior and anterior sets of teeth of the left valve. **J** Dorsal view of both valves with periostracum, (MIMB 12370). Scale bars = 1 mm.

by an elongate, smooth edentulous gap. Anterior set of 3-7 teeth, posterior one 6-12. Anterior teeth short, oblique (very seldom some of them bifurcated or fused); posterior teeth of anterior set subvertical; anterior teeth of this set more oblique. Posterior teeth longer and more oblique than anterior teeth, diverging in varying degree, becoming smaller towards edentulous gap, often reducing to small accessory denticles. Adductor scars rounded-triangular, raised, unequal; posterior adductor scar larger than anterior. Shell interior white, with weak radial lines more conspicuous near pallial line. In larval shell teeth divided into anterior and posterior sets by an elongate edentulous gap; anterior and posterior teeth uniformly shaped, short, vertical; anterior

adductor scar distinctly marked, rounded.

**Anatomy** (Figs. 9, 10) Mantle thin, except thickened ventral margin. Mantle edge muscular, simple; postero-ventral margin enlarged. Gills homorhabdic, small; gill axis muscular, solid, anteriorly curved. Paired labial palps medium sized, elongate, expanded ventrally. Mouth large. Oesophagus wide, circular in cross section, long, curved, opening into anterodorsal part of stomach. Stomach, globular, with a combined style sac and midgut. Combined style sac and midgut leaving stomach at posteroventral border, passing into visceral mass, curving slightly anteriorly. Hindgut slightly extending anteriorly into dorsal part of foot, turning dorsally, forming a few weak

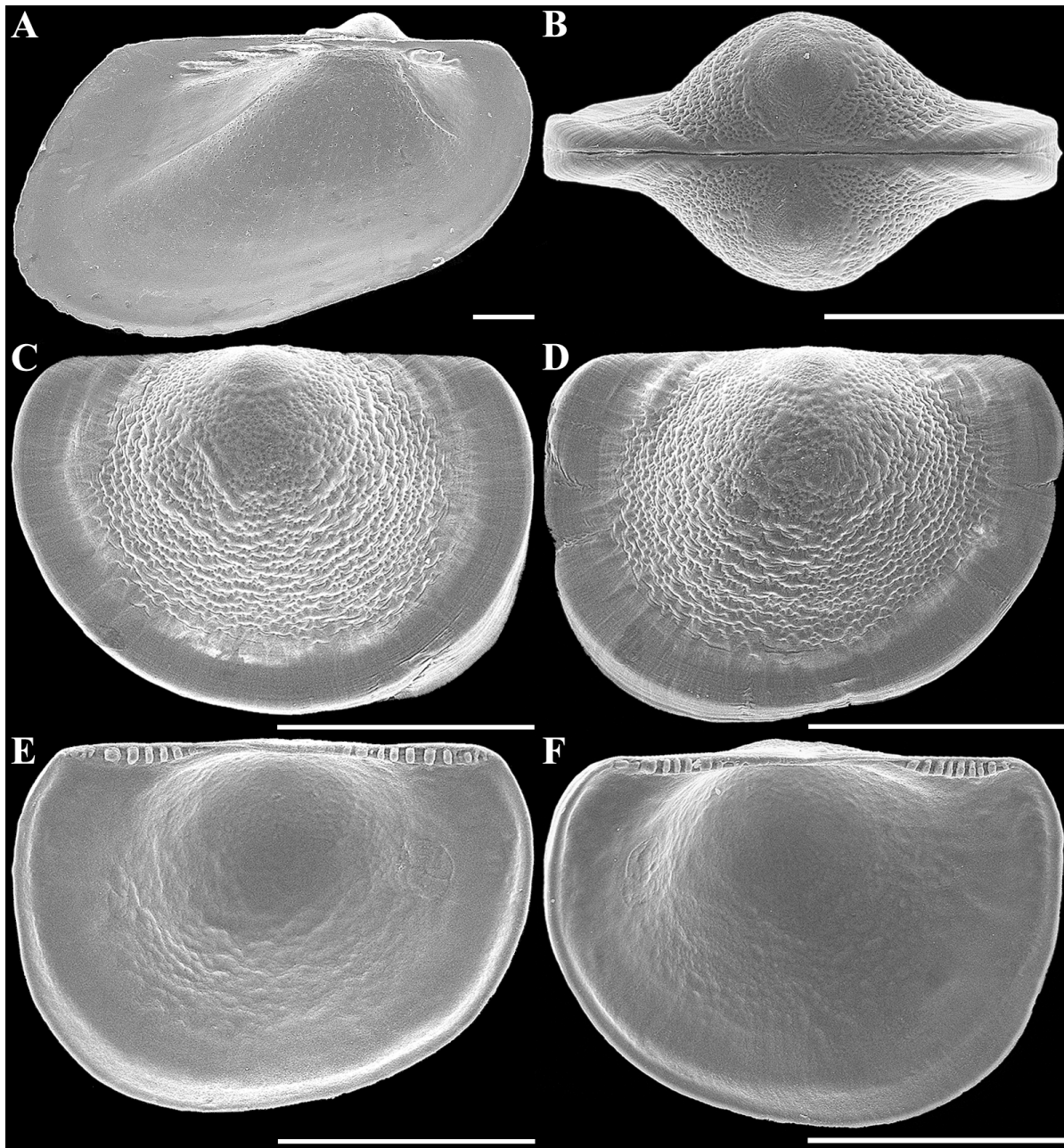


**Figure 7** *Samacar (Samacar) kurilensis* n. sp. **A** Paratype (MIMB 12366), exterior view of the right valve of young specimen without periostracum. **B, C** Paratype (MIMB 12366), exterior view and sculpture of the right valve without periostracum. **D, E** Dorsal view of the right valve without periostracum (MIMB 12370). **F, G** Paratypes (MIMB 12366), prodissoconch. Scale bars = 300  $\mu\text{m}$ .

loops of varying diameter (sometimes hindgut straight, without loops), passing on right side of body near posterior part of stomach through heart, over kidney, between paired byssus retractor muscles, partly circling posterior adductor muscle, terminating as an anal papilla free of attachment to ventral edge of adductor. Anterior adductor muscle small, almost round. Posterior adductor muscle large, elongate dorsoventrally. Foot large, with a large anterior toe and a small posterior heel, separated by byssus. Byssus large, wide. Byssus retractor muscles large, elongate-oval in section, attaching to postero-dorsal shell margin. Anterior pair of narrow pedal retractor muscles ascending almost vertically from base of foot, passing dorsally posterior to anterior adductor muscle, attaching to antero-dorsal

shell margin. Visceral mass occupied by digestive diverticula and gonad. Digestive diverticula surrounding oesophagus and stomach. Gonad occupying ventral and posterior parts of visceral mass. This species is dioecious with direct development. Larvae occupy space between the demibranches. A specimen with a shell length of 12.9 mm had 236 larvae in the mantle cavity. Larval shell 600-640  $\mu\text{m}$ . Kidneys large, ramified, consisting of two sacs extending from posterior adductor muscle to byssus retractor muscles. Cerebral ganglia consisting of two commissural bodies lateral to oesophagus. Pedal ganglia large, lying in base of visceral mass over foot. Visceral ganglia large, anterior to adductor muscle.

*Derivation of name* The specific name *kurilensis*



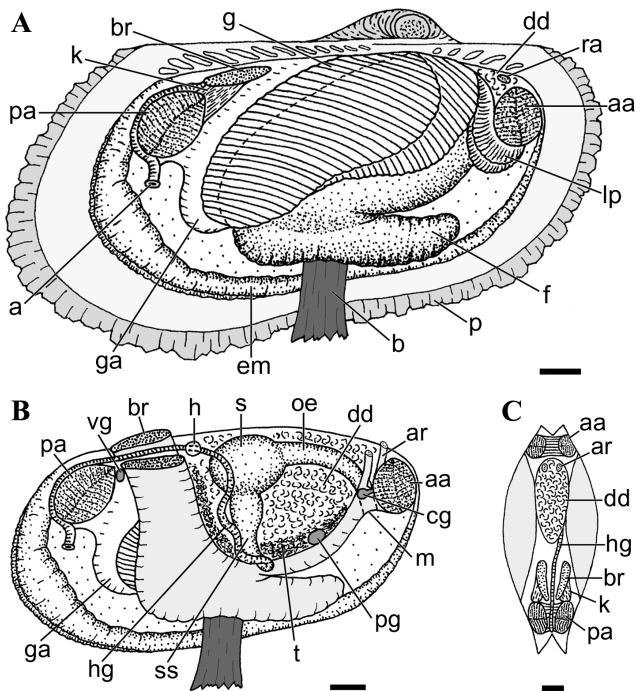
**Figure 8** *Samacar (Samacar) kurilensis* n. sp. **A** Interior view of the left valve of young specimen (MIMB 12367). **B-F** Shells of larvae from the mantle cavity **B** Dorsal view of both valves **C**, **D** Exterior view of the left and right valves **E**, **F** Interior view of the left and right valves. Scale bars = 300  $\mu$ m.

derives from the name of the Kuril Islands, where the new species was found.

**Variability** Shell shape varies from elongate and ovate-trapezoidal with relatively small shell height to angular-trapezoidal with higher shell. The shell is most often slightly angular but sometimes it is almost ovate without distinct angles and with anterior and posterior shell ends of equal height. Usually the anterior shell

margin is posteriorly directed but sometimes it is vertical. Sometimes the posterior margin is almost straight. In young specimens (< 7 mm), in contrast to adults, the shell is relatively higher ( $H/L=0.6-0.61$ ) and more angular. For shells between 8.5 and 20.8 mm in length, the number of teeth in the anterior and posterior sets is not related to the shell length. In very young specimens (< 5 mm) there are fewer teeth in both sets, with the posterior teeth parallel to the postero-





**Figure 9** *Samacar (Samacar) kurilensis* n. sp. A. Organs of mantle cavity as seen from right side with right shell valve and mantle removed. B. Internal morphology as seen from right shell with right shell valve, mantle, gill, labial palps, and part of the body removed. C. Anatomy as seen dorsally with shell valves removed. Abbreviations: a anus; aa, anterior adductor muscle; ar, anterior retractor muscle; b, byssus; br, byssus retractor muscle; cg, cerebral ganglion; dd, digestive diverticula; em, edge of mantle; f, foot; g, gill; ga, gill axis; h, heart; hg, hindgut; k, kidney; lp, labial palp; m, mouth; oe, oesophagus; p, periostracum; pa, posterior adductor muscle; pg, pedal ganglion; s, stomach; ss, style sac; t, testes; vg, visceral ganglion. Scale bars = 1 mm.

dorsal margin (Fig. 8A). The posterior teeth in adult specimens diverge to varying degrees, from subvertical to nearly parallel to the dorsal margin. Often the anterior teeth of the posterior set are reduced to minute irregular nodules (Fig. 6F), it is therefore difficult to determine the exact number of hinge teeth.

**Habitat** Near the Kuril Islands, this species was found at depths from 170 m (Brouton Island) to 368 m (Skaly Lovushki) on boulders, rocks covered by sponges, silty gravel, sand with an admixture of empty shells, and sponges.

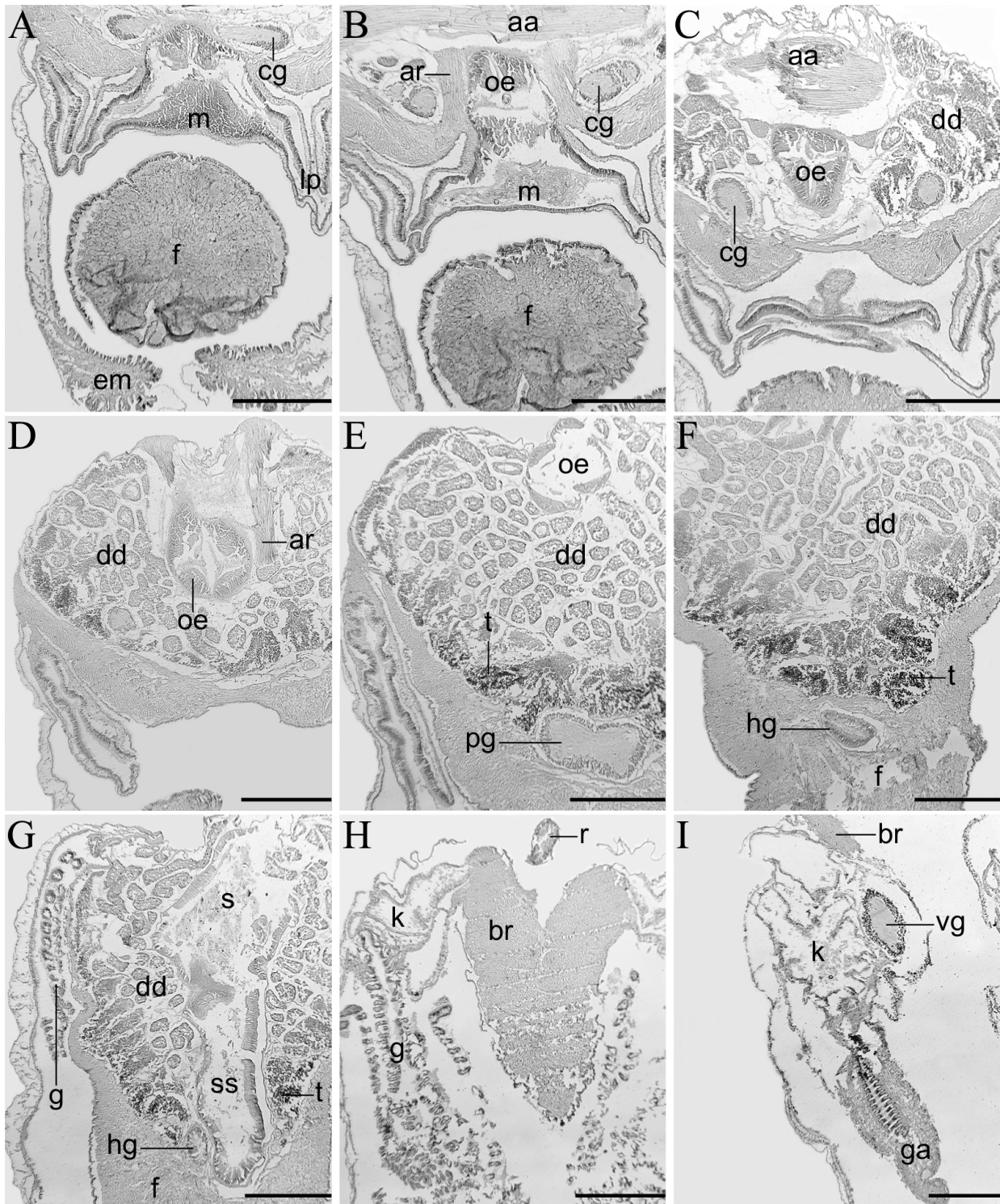
**Geographic range** (Fig. 11) Off the middle Kuril Islands: Urup Island, Brouton Island, Rashua Island, Skaly Lovushki.

**Attachment** (Figs. 5E-H) In the Kuril Islands all specimens were found attached to different kinds of substrates: boulders, gravel, dead corals and bryozoans, empty shells of the bivalve mollusc *Limopsis kurilensis* Scarlato, 1981, sponges, calcareous tubes of sedentary polychaetes, or attached to larger specimens of the same species.

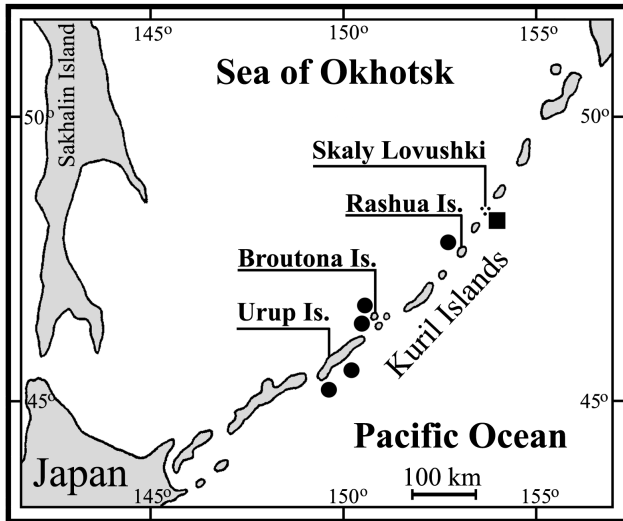
**Shell epifauna** Epifauna was found in 50 out of 70 investigated specimens which were collected at Brouton Island (depth 170-180 m) from rocks covered by sponges. The prevailing epifaunal organisms were bryozoans (found on 46% of specimens) and sponges (42%). In addition, calcareous tubes of polychaetes (16%), hydroids (14%) and juveniles of the same species (4%) were observed. Often, several taxonomic groups of epifauna were present simultaneously. Epifauna occurred mainly on the umbones and the dorsal margin of both valves, and on the middle and posterior parts of left valve. It can therefore be suggested that in nature molluscs of this species are most often inclined to the right side.

**Comparison** *S. (Samacar) kurilensis* differs from *S. (Samacar) strabo* in having a less angular posterior shell end with a curved posterior margin, stronger radial sculpture, a less distinct radial carina, flat cardinal area, and very large, distinctly marked, bowler-shaped prodissoconch (Table 3).

**Remarks** *S. (Samacar) kurilensis* was found off the Kuril Islands at a depth of 170-368 m. Very likely, this is a bathyal species which can be found in the Pacific at yet greater depths. The finding of *S. (Samacar) kurilensis* at the relatively small depths off the Kuril Islands may be related to the sea bottom topography and the hydrological regime in this region. The shelf off the middle Kuril Islands is very narrow and the sea bottom slopes steeply at the small depths. On the Pacific side, already at 41 to 189 m depth it extends into the western wall of the Kuril-Kamchatkan deep-water trench with depths exceeding 9000 m, and on the Sea of Okhotsk side, it extends into a steep eastern slope of the Kuril Basin over 3000 m deep.



**Figure 10** *Samacar (Samacar) kurilensis* n. sp. Cross-sections of the body (male specimen). **A** Mouth and cerebral ganglia with commissure. **B** Mouth, cerebral ganglia, and anterior retractor muscles. **C** Oesophagus and cerebral ganglia. **D** Oesophagus, anterior retractor muscles, and digestive diverticula. **E** Pedal ganglion and testes. **F** Hindgut and testes. **G** Stomach, style sac, and hindgut. **H** Kidney, byssus retractor muscle, and rectum. **I** Visceral ganglion, kidney, and gill axis. Abbreviations: aa anterior adductor muscle; ar anterior retractor muscle; br byssus retractor muscle; cg cerebral ganglion; dd digestive diverticula; em edge of mantle; f foot; g gill; ga gill axis; hg hindgut; k kidney; lp labial palp; m mouth; oe oesophagus; pa posterior adductor muscle; pg pedal ganglion; r rectum; s stomach; ss style sac; t testes; vg visceral ganglion. Scale bars = 500  $\mu$ m.



**Figure 11** Distribution of *Samacar (Samacar) kurilensis* n. sp. (■ - holotype locality).

(Sirenko, 1993). Besides, the middle Kurils area is characterized by a strong upward movement (at a rate of 2 km/h) of deep cold (to 2°C) water to the surface (Lukin, 1979; Sirenko, 1993). As a result, in the middle Kuril Islands some deep-water species can penetrate into relatively small depths of the shelf (Antsulevich, 1987).

Probably, *S. (Samacar) kurilensis* has a direct development. The female bears in the mantle cavity a relatively small number of very large larvae. The size and shape of prodissoconch of the larva within the female mantle cavity coincide with those of larvae on the beaks of the adults. This also supports my assumption that this species lacks a planktonic larva.

#### *Pseudoporterius*, new subgenus

Type species *Samacar (Pseudoporterius) aleutica*, new species

**Description** Shell small (to 18.0 mm), thin, moderately inflated, ovate, slightly inequivalve (left valve larger and more inflated), strongly inequilateral. Umbones strongly anterior, prosogyrate. Cardinal area very narrow. Posterior end expanded, broadly rounded, without radial carina. Anterior end reduced. Shell surface with a faint byssal sulcus. Sculpture of commarginal lamellate ridges. Periostracum strongly hirsute, extending beyond shell margins. Hinge plate, strongly curved, most concave and thin under

beaks, strongly widening anteriorly and posteriorly. Teeth divided into anterior and posterior sets by a very wide edentulous gap; anterior teeth short, horizontal, subparallel; posterior teeth long, horizontal, subparallel. Adductor scars unequal, raised. Ligament opisthodontic, external, partly sunken, long, occupying entire posterior part of cardinal area.

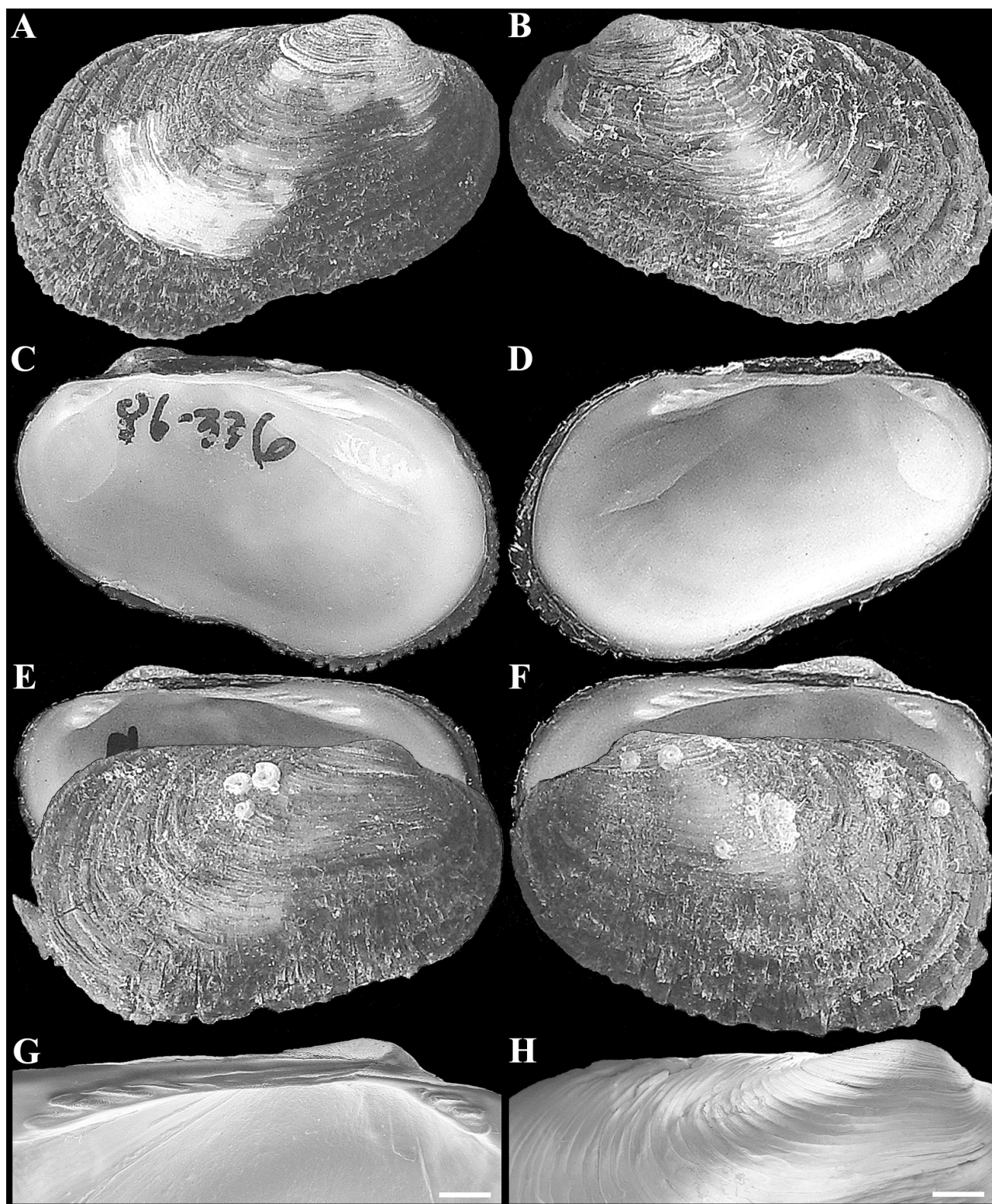
**Remarks** The new subgenus differs from other genera of the Arcidae in having no radial sculpture on the shell (Newell, 1969; Kilburn, 1983; Lamprell & Healy, 1998; Coan *et al.*, 2000; Okutani, 2000). It differs from most genera of this family in having a wide edentulous gap between anterior and posterior teeth.

*Pseudoporterius* is similar to *Asperarca* and *Bentharca* in the hinge structure. However, it differs from them in having a strongly curved hinge plate, fewer posterior teeth, fewer horizontal anterior and posterior teeth, a partly sunken and longer ligament occupying the entire posterior part of cardinal area, a very narrow cardinal area, an ovate and less inflated shell without radial sculpture. The new subgenus is also very similar to *Notogrammatodon* in hinge structure; however it differs in having a strongly curved hinge plate, horizontal anterior teeth, shorter and closely spaced posterior teeth, three ligamental grooves extending from beaks to posterior teeth, ovate shell, and lacking radial sculpture.

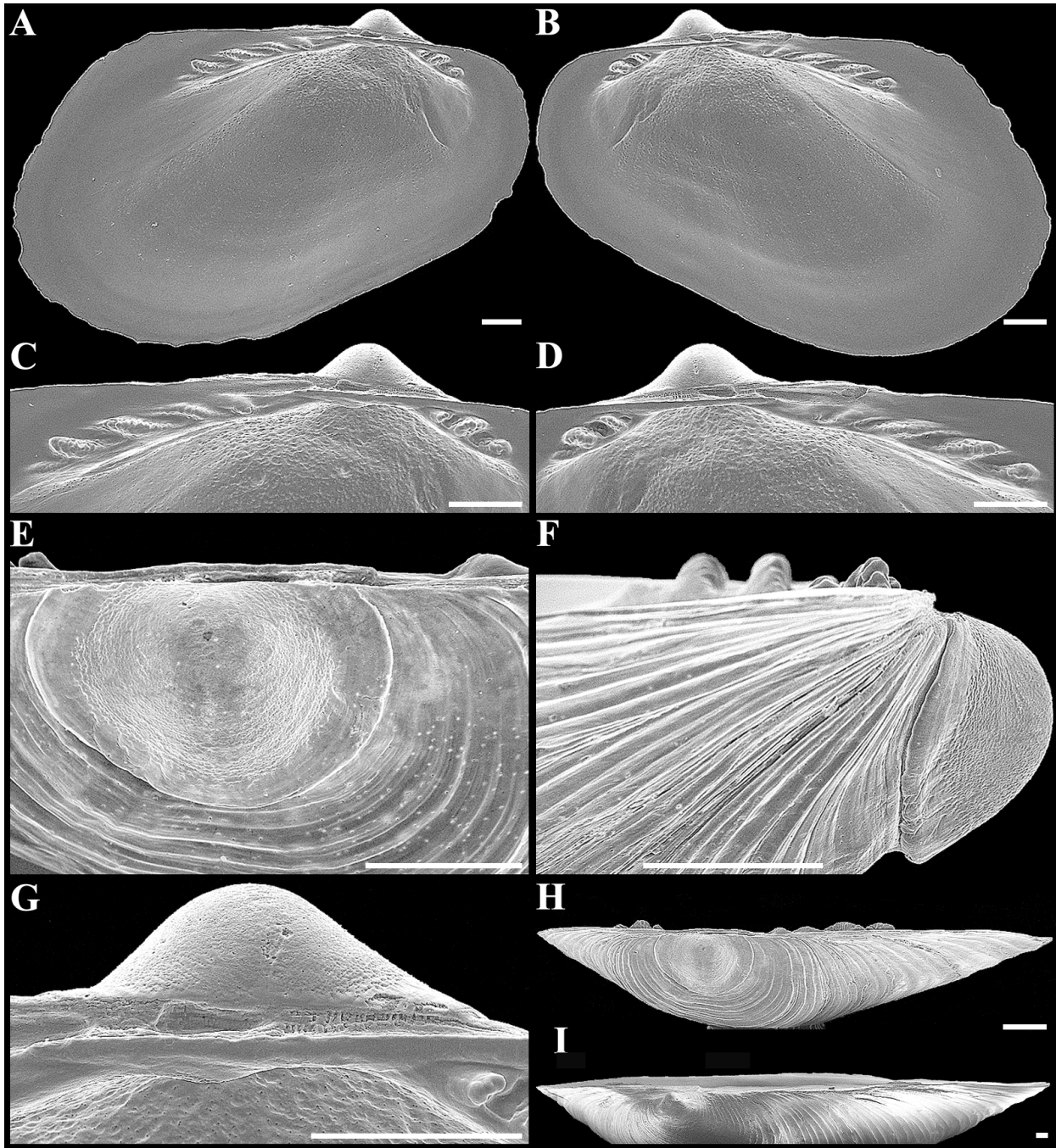
The new subgenus is most similar to *Samacar* s.s. in hinge structure and shell morphology, from which it differs in lacking radial sculpture on the shell and radial carina in posterior shell end, in having a strongly curved hinge plate, a partly sunken and longer ligament extending from beaks, a wider edentulous gap, and horizontal anterior teeth.

Taking into account large variations of the canting angle and length of hinge teeth in many taxa of the Arcidae and limited materials of the type species at my disposal, it is not improbable that further specimens of this species can have a somewhat different position of the hinge teeth. Now I assign *Pseudoporterius* as a subgenus of *Samacar*, to which it is most similar in shell morphology.

The subgenus name signifies that originally the type species described below was placed by F.R. Bernard in the genus *Porterius* Clark,



**Figure 12** *Samacar* (*Pseudoporterijs*) *aleutica* n. sp. **A-D** Holotype (LACM 3067 [ex LACM 57901]), exterior and interior views of the right (length 17.8 mm) and left (length 18.0 mm) valves. **E-H** Paratype (LACM 3069 [ex LACM 1986-359.3]), exterior view, hinge and sculpture of the right (length 15.5 mm) and left (length 15.5 mm) valves. Scale bars = 1 mm.



**Figure 13** *Samacar (Pseudoportierius) aleutica* n. sp. **A-D** Paratype (LACM 3068 [ex LACM 57901]), interior view and hinge of the left and right valves of young specimen. **E-G** Paratype (LACM 3068 [ex LACM 57901]), prodissoconch. **H, I** Dorsal view of left valves of young (paratype, LACM 3068 [ex LACM 57901]) and adult (paratype, LACM 3069 [ex LACM 1986-359.3]) specimens. Scale bars = 300  $\mu$ m.

1925 (Coan *et al.*, 2000). This genus also has a curved hinge plate with horizontal posterior teeth. However, in contrast to the new subgenus, *Portierius* has a broad cardinal area, its hinge plate is strongly curved just behind beaks, edentulous gap is lacking, anterior row of the hinge teeth has 3 large and 15 to 16 much smaller subverti-

cal teeth (Clark, 1925).

*Samacar (Pseudoportierius) aleutica* new species  
(Figs. 12, 13, Table 6)

*Samacar* sp. A, Coan *et al.*, 2000: 138, pl. 18

*Holotype* 1 sp, off Western Aleutians, Aleutian Islands, coll Rae Baxter, ix 1986, LACM 3067 [ex LACM 57901].

*Paratypes* 1 sp from holotype locality, LACM 3068 [ex LACM 57901]; 1 sp, off SSW of Cape Lutke, Unimak Is, Aleutian Islands 54°24,13N 165°37,78W, coll Rae Baxter, 24 vii 1986, LACM 3069 [ex LACM 1986-359.3].

*Measurements* see table 6

*Diagnosis* Shell small (to 18 mm), ovate, slightly inequivalve, strongly inequilateral, without umbonal carina in posterior end. Cardinal area very narrow. Sculpture of wide, low, commarginal, lamellar ridges. No radial sculpture. Periostracum thick, brown, extending beyond shell margin, strongly hirsute. Hinge plate strongly curved, most concave and thin under beaks, strongly widening anteriorly and posteriorly. Teeth divided into anterior and posterior sets by a very wide edentulous gap. Anterior set of 3 teeth, posterior one 5. Anterior teeth short, horizontal, subparallel. Posterior teeth long, horizontal, subparallel. Adductor scars raised. Ligament strong, partly sunken, occupying entire posterior part of cardinal area. Prodissoconch very large (length to 790 µm), with a strongly salient, knobby central part and a flat, smooth marginal collar.

*Description* Exterior shell morphology: Shell small (to 18 mm), ovate, high (H/L right valve = 0.640 (0.613-0.683); H/L left valve = 0.666 (0.639-0.714)), slightly inequivalve (left valve slightly larger and

more inflated), moderately inflated (W/L right valve = 0.202 (0.191-0.219); W/L left valve = 0.215 (0.213-0.217)), strongly inequilateral, thin, solid, white under periostracum. Sculpture of wide, low, commarginal, lamellar ridges. Periostracum thick, brown, extending beyond shell margins, strongly hirsute, with short, very broad, imbricated scales, longest along postero-ventral shell margin. Umbones small, low, rounded, prosogyrate, strongly anterior to midline (A/L right valve = 0.255 (0.245-0.268); A/L left valve = 0.252 (0.245-0.262)). Interumbonal distance very small (L1/L = 0.026 (0.024-0.028)). Cardinal area needle-shaped, very narrow, widest in front of umbones, flat; weakly delineated anteriorly by termination of sculpture, posteriorly demarcated by high ridges. Anterior shell end reduced, rounded. Posterior end expanded, broadly rounded, without a radial carina. Central part of valves with a very faint byssal sulcus, extending from beaks to ventral byssal gape. Antero-dorsal shell margin straight, smoothly transitioning to anterior margin. Anterior margin rounded, vertical, smoothly transitioning to ventral margin. Postero-dorsal margin straight, smoothly transitioning to posterior margin. Posterior margin rounded, slightly directed posteriorly, smoothly transitioning to ventral margin. Ventral margin slightly concave in area of byssal gape. Ligament opisthodontic, partly sunken, narrow, strong, long, occupying entire posterior part of cardinal area. Prodissoconch very large (length to 790 µm), distinctly marked, with a strongly salient, knobby central part and a narrow, flat, smooth marginal collar; posterior prodissoconch end slightly more expanded than anterior.

**Table 6** *Samacar (Pseudoporterius) aleutica*. Shell measurements (mm) and indices of the characters. Numerator indicates shell measurements and indices for the right valve; denominator - for the left valve.

Depository	L	H	W	A	L1	H/L	W/L	A/L	L1/L	Number of teeth	
										Anterior	Posterior
Holotype LACM 57901	<u>17.8</u>	<u>11.1</u>	<u>3.4</u>	<u>4.5</u>	0.5	<u>0.624</u>	<u>0.191</u>	<u>0.253</u>	0.028	<u>4</u>	<u>5</u>
	18.0	11.6	3.9	4.5		0.644	0.217	0.262		3	5
Paratype LACM 57901	<u>4.1</u>	<u>2.8</u>	<u>0.8</u>	<u>1.1</u>	0.1	<u>0.683</u>	<u>0.195</u>	<u>0.268</u>	0.024	<u>3</u>	<u>5</u>
	4.2	3.0	0.9	1.1		0.714	0.214	0.262		3	5
Paratype LACM 1986-359.3	<u>15.5</u>	<u>9.5</u>	<u>3.4</u>	<u>3.8</u>	0.4	<u>0.613</u>	<u>0.219</u>	<u>0.245</u>	0.026	<u>3</u>	<u>5</u>
	15.5	9.9	3.3	3.8		0.639	0.213	0.245		4	5

Interior shell morphology: Hinge plate strongly curved, most concave and thin under beaks, strongly widening anteriorly and posteriorly with three conspicuous, deep ligamental grooves extending from beaks to posterior teeth. Teeth divided into anterior and posterior sets by a very wide edentulous gap with faint vertical notches in its posterior part. Anterior set of 3 teeth, sometimes with one small accessory denticle; posterior one 5. Anterior teeth short, horizontal or almost horizontal, parallel. Posterior teeth long, horizontal, subparallel. Adductor scars rounded-triangular, raised, unequal; posterior adductor scar larger than anterior. Shell interior white, with weak radial lines more conspicuous near pallial line.

*Derivation of name* The specific name *aleutica* derives from the name of the Aleutian Islands, where the new species was found.

*Habitat* This species was recorded at depths from 70 to 168 m (Coan *et al.*, 2000).

*Geographic range* Off Aleutian Islands from Kiska Island (52.1°N, 177.3°E) (Coan *et al.*, 2000) to Unimak Island (54°24.13N, 165°37.78W).

*Comparison* The new species differs from other species of the genus *Samacar* in having no radial sculpture on the shell. It is most similar to *S. (Samacar) kurilensis* but differs from the latter species in having a higher and less angular shell without radial sculpture, a more curved hinge plate with horizontal anterior and posterior teeth and with three conspicuous, deep ligamental grooves, and a longer and partly sunken ligament.

*Remarks* Coan *et al.* (2000), in the section on geographic range of *Samacar* sp. A, erroneously stated that the materials of this species from Kiska Island and Atka Island are deposited in LACM. Actually, they are deposited in CAS.

Because of the size and shape of prodissoconch, it is probable that *S. (Pseudoportierius) aleutica* has a direct development, as does *S. (Samacar) kurilensis*.

#### ACKNOWLEDGEMENTS

I am very grateful to Mrs. N. V. Kameneva

(MIMB, Vladivostok) for great help during work on this manuscript; to Professor T. W. Pietsch, Dr. K. Stiles, Professor A. J. Kohn and Dr. G. Jensen (UW, Seattle) for all-round help during my time in Seattle; to Dr. P. D. Roopnarine, Mrs. E. Cools (Department of Invertebrate Zoology, CAS, San Francisco) and Mr. Gary Cook (Berkeley) for all-round help during my time in San Francisco; to Drs. V. B. Durkina, E. P. Kotsyuba, E. A. Pimenova, and L. N. Usheva, (IMB, Vladivostok) for help with anatomy; to the following for loans and literature: to Dr. B. I. Sirenko and all collaborators of Marine Research Laboratory (ZIN, St. Petersburg); to Dr. H. Saito (NSMT, Tokyo); to Dr. G. Oliver and Ms. Harriet Wood (NMW, Cardiff); to Dr. B. A. Marshall (NMNZ, Wellington); to Dr. R. La Perna (Università di Bari); to L. T. Groves (LACM, Los Angeles); to Drs. I. Loch and A. Miller (AMS, Sydney); to Drs. G. W. Hughes and K. Sendall (RBCM, Victoria); to Dr. E. V. Coan (Department of Invertebrate Zoology, CAS, San Francisco); to Dr. Paul V. Scott (Department of Invertebrate Zoology, SBMNH, Santa Barbara) for arrangement of my work with the bivalve molluscs collection at the SBMNH, for sending the photos of *S. pacifica*, and great help during this work; to Mr. D. V. Fomin (IMB, Vladivostok) for help with the scanning microscope; to Ms. T. N. Koznova (IMB, Vladivostok) for help with translating of the manuscript into English.

#### REFERENCES

- ANTSULEVICH AE 1987 *Hydroids from the shelf waters of the Kuril Islands*. Zoological Institute of USSR Academy of Sciences Press, Leningrad, 165pp.
- BARNARD KH 1962 New species and records of South African Marine Mollusca from Natal, Zululand, and Moçambique. *Annals of the Natal Museum* 15(19): 247-254.
- CLARK BL 1925 Pelecypoda from the marine Oligocene of Western North America. *University of California Publications, Bulletin of the Department of Geological Sciences* 15(4): 69-136.
- COAN EV, SCOTT PH & BERNARD FR 2000 *Bivalve seashells of western North America. Marine bivalve mollusks from Arctic Alaska to Baja California*. Santa Barbara Museum of Natural History, 764pp.
- DALL WH 1881 Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico, and in the Gulf of Mexico, and in the Caribbean Sea, 1877-79, by the United States Coast Guard Steamer "Blake," .... XV. Preliminary report on the Mollusca *Bulletin of the Museum of*

- Comparative Zoology* 9(2): 33-144.
- HABE T 1958 Report on the Mollusca chiefly collected by the S. S. Sôyô-Marû of the Imperial Fisheries Experimental Station on the continental shelf bordering Japan during the years 1922-1930. Part 3. Lamellibranchia (1) *Publications of the Seto Marine Biological Laboratory* 6(3): 241-280.
- HABE T 1977 Systematics of Mollusca in Japan. *Bivalvia and Scaphopoda*. Zukan-no-Hokuryukan, Tokyo, 372pp.
- HABE T 1981 Bivalvia. *Publications of the Seto Marine Biological Laboratory, Special Publication Series «A catalogue of molluscs of Wakayama Prefecture, the Province of Kii. I. Bivalvia, Scaphopoda and Cephalopoda»* 7(1): 25-224.
- HEDLEY C 1915 Studies on Australian Mollusca. Part XII. *Proceedings of the Linnean Society of New South Wales* 39: 695-755.
- HIGO S, CALLOMON P & GOTO Y 1999 *Catalogue and bibliography of the marine shell-bearing Mollusca of Japan*. Elle Scientific Publications, 749pp.
- IREDALE T 1936 Australian Molluscan notes. No. 2. *Records of the Australian Museum* 19: 267-340.
- KILBURN RN 1983 The recent Arcidae (Mollusca: Bivalvia) of southern Africa and Mozambique. *Annals of the Natal Museum* 25(2): 511-548.
- KNUDSEN J 1967 The deep sea Bivalvia. *John Murray Expedition 1933-34, Scientific Reports* 11(3): 237-343.
- KNUDSEN J 1970 The systematics and biology of abyssal and hadal Bivalvia. *Galathea Report* 11: 7-241.
- LA PERNA R 1998 On *Asperarca* Sacco, 1898 (Bivalvia, Arcidae) and two new Mediterranean species. *Bollettino Malacologico* 33(1-4): 11-18.
- LAMPRELL KL & HEALY JM 1998 *Bivalves of Australia*. Vol. 2 Backhuys Publishers, Leiden, 288pp.
- LI F 1984 A study of the Arcinae from China coasts. I. Arcinae. *Studia Marina Sinica* 23: 145-161.
- LUKIN VI 1979 Macrobenthos communities of the upper sublittoral of Simushir Island In O.G. Kusakin (ed) *Shelf zone biology of the Kuril Islands*. 11-60 "Nauka" Press, Moscow.
- MARWICK J 1928 The Tertiary Mollusca of the Chatham Islands including a generic revision of the New Zealand Pectinidae. *New Zealand Institute, Transactions* 58: 432-506.
- MAXWELL PA 1966 Some Upper Eocene Mollusca from New Zealand. *New Zealand Journal of Geology and Geophysics* 9(4): 439-457.
- MAXWELL PA (in press) Cenozoic Mollusca. In DP Gordon (ed) *The New Zealand inventory of biodiversity: a species 2000 symposium review* Canterbury University Press, Christchurch.
- NEWELL ND 1969 Family Arcidae. In RC Moore (ed) *Treatise on Invertebrate Paleontology Part N. Mollusca 6 (Bivalvia)* 250-256 The Geological Society of America, Inc. and The University of Kansas.
- NODA H 1988 Neogene Arcoids (Mollusca; Bivalvia) from the Ryukyu Islands, Southwest Japan. Saito Ho-on Kai Special Publication (Professor Tamio Kotaka Commemorative Volume) 107-127.
- NOMURA S & NIINO H 1940 Mollusca dredged from off the coast of Hukui Prefecture in the Japan Sea. *Records of Oceanographic Works in Japan* 12(1): 23-79.
- NOMURA S & ZINBO N 1934 Marine Mollusca from the "Ryukyu Limestone" of Kikai-zima, Ryuku Group. *The Science Reports of the Tohoku Imperial University (2 - Geology)* 16(2): 109-164.
- OKUTANI T 2000 *Marine molluscs in Japan*. Tokai University Press, Tokyo, 1175pp.
- OLIVER G & ALLEN JA 1980 The functional and adaptive morphology of the deep-sea species of the Arcacea (Mollusca: Bivalvia) from the Atlantic. *Philosophical Transactions of the Royal Society of London (B)* 291(1045): 45-76.
- OLIVER G & VON COSEL R 1993 Taxonomy of tropical West African Bivalves. IV. Arcidae. *Museum National d'Histoire Naturelle, Bulletin (A-Zoologie)*, 4 14(2): 293-381.
- SACCO F 1898 *I molluschi dei terreni terziarii del Piemonte e della Liguria. Parte XXVI. (Arcidae, Pectunculidae, Limopsidae, Nuculidae, Ledidae, Malletidae)*. Clausen, Torino, 92pp.
- SCARLATO OA 1981 *Bivalve molluscs of temperate waters of the northwestern Pacific*. "Nauka" Press, Leningrad, 480pp.
- SCARLATO OA & KAFANOV AI 1988 Contribution to the fauna of bivalve molluscs in the USSR Far East Seas. *Zoological Journal* 67: 937-942.
- SIRENKO BI 1993 Distribution of the benthos in some areas of the continental slope of the Kurile Islands. In B.I. Sirenko & S.V. Vassilenko (eds) *The fauna of the continental slope of the Kurile Islands. Based on collections of 33 voyage r/v "Odyssey" Explorations of the fauna of the seas* 46 (54): 5-44 Zoological Institute of Russian Academy of Sciences Press, Saint-Petersburg.
- VERRILL AE & BUSH KJ 1898 Revision of the deep-water Mollusca of the Atlantic coast of North America, with descriptions of new genera and species. *Proceedings of the United States National Museum* 20: 775-932.