

Two new species of the Vesicomidae (Bivalvia: Mollusca) from the Pliocene Shiramazu Formation of the Chikura Group in the Boso Peninsula, Japan

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房総半島の鮮新統千倉層群白間津層より産出した巨大な シロウリガイ科二枚貝の2新種

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Key words: ***Calyptogena*, *Vesicomya*, Boso Peninsula, Pliocene, chemosynthesis**
キーワード: ***Calyptogena*, *Vesicomya*, 房総半島, 鮮新世, 化学合成**

Two new species of the Vesicomidae formed by the huge shells were described. The fossils were embedded in the Pliocene (3-2 Ma) Shiramazu Formation of the Chikura Group. One of new species was named *Vesicomya ellipsoidea* n. sp. of ellipsoid form, thick shell and large beak wrapping the dorsal part of shell inside. These characters are common to those of the genus *Vesicomya*, but no huge species has ever been reported. The remnant new species was named *Calyptogena bosoensis* n. sp. of slightly thick shell extending to anterior part and its beak situates at the antero-dorsal part. The dental morphology is similar to that of the subgenus *Ectenagena*, but common to some species, which were transferred to the subgenus *Archivesica* based on the molecular analyses.

殻長 20 cm 以上の巨大なオトヒメハマグリ科化石の 2 新種を記載した。化石は、千葉県千倉町の鮮新統 (3-2 Ma) 千倉層群白間津層から産出した。一種は、*Vesicomya ellipsoidea* n. sp. と命名され、楕円の殻形態・厚い殻・背部内側に深く包まれる大きな殻頂など、*Vesicomya* 属の特徴を有しているが、同属では最大種である。もう一種は、*Calyptogena bosoensis* n. sp. と名づけられ、やや厚い殻は後方に長く延び、殻頂は小さく前背部にある。殻歯の形態は、*Ectenagena* 亜属のものに似るが、遺伝子解析で *Calyptogena* 亜属から *Archivesica* 亜属に移された種とも類似性がある。

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Introduction

KANIE *et al.* (1997) discovered two species of Vesicomimid fossils extending to 235 mm of shell length from Kawaguchi (川口), Kotto (忽戸) and the environs, Chikura-cho, Chiba Prefecture. The fossils were embedded in the Pliocene Shiramazu Formation of the Chikura Group. We observed the occurrence of the fossils, considering the mode of their life, and concluded that the fossils had native preservation of the

bivalves as chemosynthetic mollusca. They correlated the fossil bed to CN 12 calcareous nannofossil zone.

In this paper, we describe two new species from the Shiramazu Formation, and discuss the fossil occurrences and their fossilization.

Occurrences of the vesicomimid fossils

Fossil localities (Fig. 1)

1. Kawaguchi beach (Locs. 01~05, 11~15, 21,

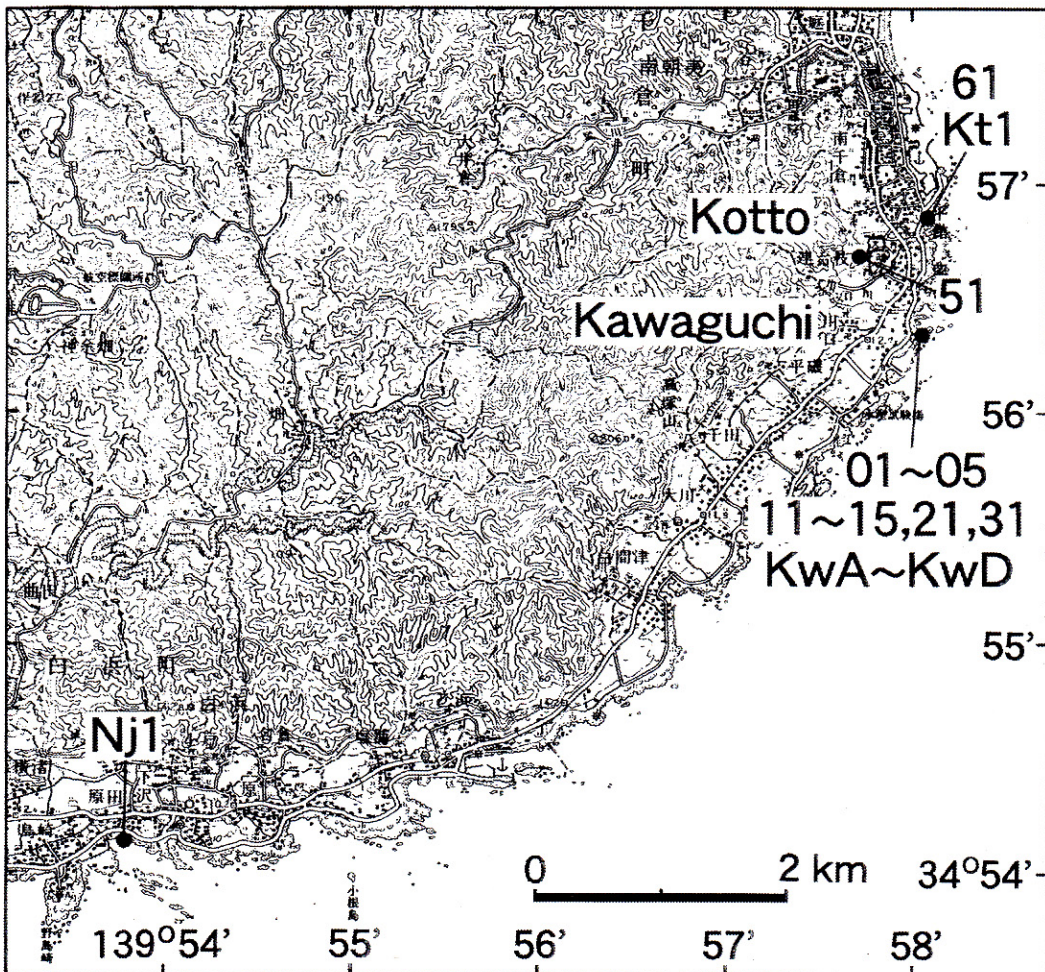


Fig. 1. Localities of vesicomimid bivalves and calcareous nannofossils from the Shiramazu Formation of the Chikura Group. 6=Kt1 is locality number at Kotto. 01~05, 11~15, 21, 31=KwA ~KwD are locality numbers at Kawaguchi. The map based on "1:50,000 Tateyama" made by the Geographical Institute of Japan. The map adapted from KANIE *et al.* (1997).

31)

2. Beach, south of Hedate, Kotto (Loc. 61)
3. Yakushido cemetery, south of Kotto Primary School, Kotto (Loc. 51)

Occurrence of fossils

Most vesicomiyid fossils with bivalves were embedded among the matrices in coarse-grained tuffaceous sandstone bearing siltstone breccias. The valves of the specimen YCM-GP1145 from Kotto beach was paralleled to the bedding plane. One specimen YCM-GP1144 from Yakushido cemetery was vertical to the strike of the bed and the other specimen YCM-GP1143 from Kawaguchi beach was paralleled to the bedding. The strike of siltstones is generally E-W trending and the dip is about 70°. The mean value of the Shiramazu Formation is N80°W, 70°N in Kawaguchi area; N60°E, 52°N in Yakushido area; E-W, 60°N in Kotto area. Therefore, the direction of anterior parts of shells (at umbonal area) situates in the bottom of each bed. It is considered that these vesicomiyid animals buried themselves along the ocean floor.

The shells of these vesicomiyids are excellently and finely preserved. But, most shells except the specimen YCM-GP1145 lack their posterior margin. The matrices among coarse-grained tuffaceous sandstone often include massive fine-grained carbonates. The shells were fragmentally observed in host siltstones, which will be described later.

The paleodepth of the major part of the Shiramazu Formation was estimated about 2000 m (KOTAKE, 1988).

Process on the fossilization of the Vesicomiyid bivalves

Isotope ratio on the carbonates of the Shiramazu Formation

Carbonate isotope (ratio on $\delta^{13}\text{C}$ vs. PDB) of seven samples (one sample from Kawaguchi, 2 from

Yakushido and 4 from Kotto) were analyzed (KANIE *et al.*, 1997). The result of the carbonate isotope ratio shows $-8.979 \sim -35.153\%$ vs. PDB. In this data, the ratio on $\delta^{13}\text{C}$ vs. PDB was $-29.412 \sim -35.153\%$ based on two samples from Kawaguchi and one from Kotto. The ratio of -8.979% is interpreted by recrystallization. According to HATTORI *et al.* (1995, 1996), the ratio of cold and high-thermal seepages is lower than -5% , and that of biogenetic-originate carbonates is nearly 0% . Therefore, the carbonates occurred from Boso and Miura areas are cold seepage-origin.

Massive fine-grained carbonates often co-occur in tuffaceous sandstone including vesicomiyids. These deposits were transported into close range by submarine sliding.

These types of native carbonates are now producing off Hatsushima Island, Sagami Bay (HATTORI *et al.*, 1994). Consequently, it is conceivable that the carbonates including vesicomiyids from the Shiramazu Formation are native.

Calcareous nannofossil age of the geological horizon including the present fossils

KANIE *et al.* (1997) reported the nannofossil age of the Shiramazu Formation is as follows:

Sample Nj1 from the east of Nojima-zaki where MAJIMA *et al.* (1997) reported *Calyptogena* sp. can be correlatable with the uppermost part of CN11 nannofossil zone (ca. 3.8 Ma).

The two samples (KwB-KwD, siltstone host rocks) from Kawaguchi coast are correlated with the subzone CN12a (3.8-2.7 Ma) to CN12b (2.7-2.55 Ma), respectively. On the other hand, the sample KwA (siltstone breccias in the matrix) from the same locality shows CN10 (5.6-4.8 Ma) zone or CN11a (4.8-4.2 Ma subzone).

Based on the data above mentioned, the age of the host rocks including vesicomylid fossils show CN12 nannofossil zone (3.8-2.55 Ma), but the age of breccia is ancient. Therefore, the siltstone breccias were derived from the lower part of the Shiramazu Formation. The siltstones from Kawaguchi beach are compared with the upper part of the Shiramazu Formation. The deposit from the east of Nojima-zaki situates at the lower part of the Shiramazu Formation.

Systematic description

Family Vesicomylidae DALL, 1908

Genus *Vesicomya* DALL, 1891

Generic diagnosis: The shell is ovate and it is covered by a thin or thick periostracum, with strongly gyrate umbo. Lunule is distinctly demarcated by incised line. Cardinal teeth are distinct, but lateral teeth are indistinct. Pallial sinus absents or weakly recognizable. This genus includes four subgenera (KEEN, 1969).

The type species of *Vesicomya atlantica* (SMITH, 1885) distributes in the recent waters of Atlantic, Pacific and Indian Oceans of abyssal zones.

Vesicomya ellipsoidea n. sp.

(Figs. 2; 4-Ve R)

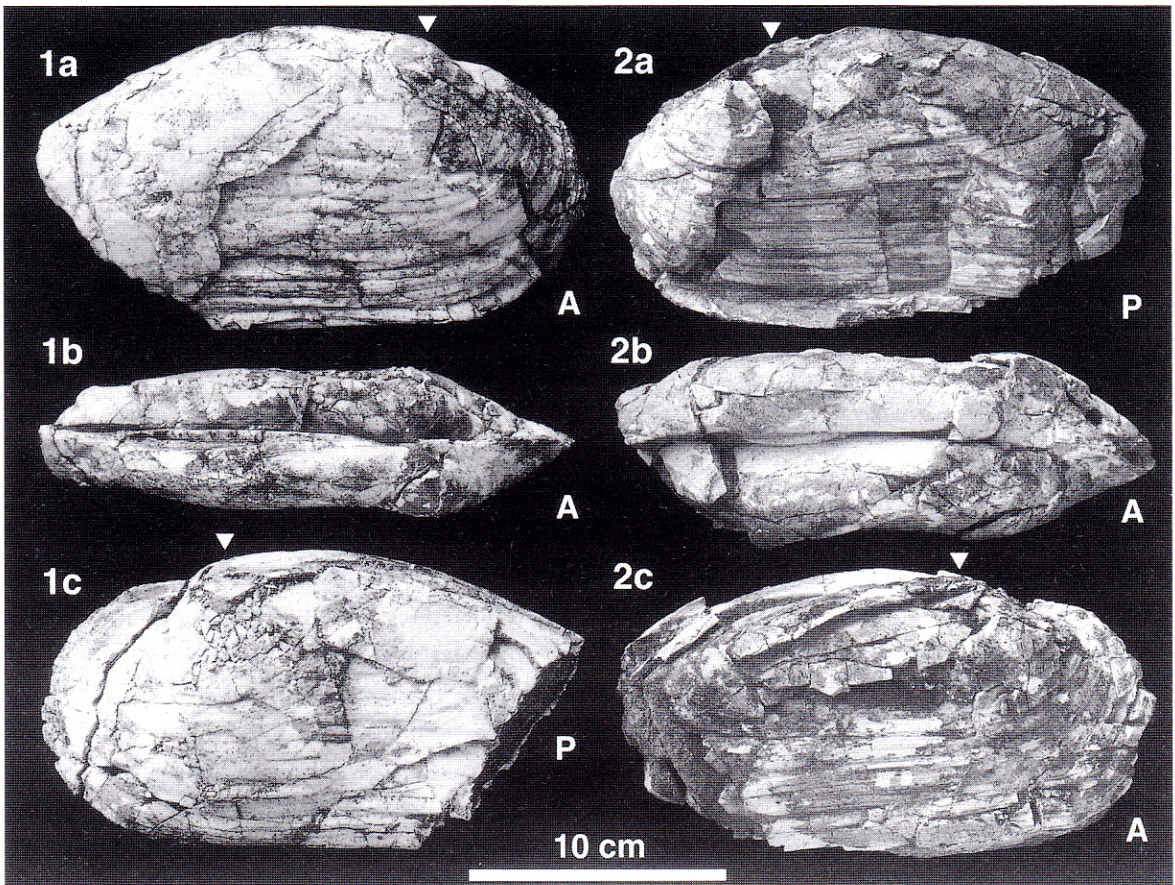


Fig. 2. *Vesicomya ellipsoidea* n. sp.

1a-c. holotype, YCM-GP1145 from Loc. 31, Kawaguchi; 2a-2c. paratype, YCM-GP1146 from Loc. Kotto. A: anterior part. P: posterior part. ▼: umbonal part.

1997. *Calypptogena* (s.l) sp. B. KANIE, HATTORI, KURAMOCHI, OKADA, OHBA and HONMA. *Jour. Geol. Soc. Japan*, **103**: 795, fig. 2. 2a-c.

Specimens studied: Holotype, (YCM-GP1145=Sm11 in KANIE *et al.*, 1997 from Loc. 31, Kawaguchi); paratypes, (YCM-GP1146=Sm12 and YCM-GP1152=Sm13 from Loc. 61=Kt1, Kotto); referred specimens: YCM-GP1149~1155.

lateral tooth is not preserved. In the left valve (YCM-GP1154), the cardinal teeth are (2) and (4a. not preserved). (2) is high and solid. Postero-lateral tooth (PII) is large and strong. Antero-lateral tooth is not preserved.

Measurements

Table 1. Shell measurements of *Vesicomys ellipsoidea* n. sp. in mm.

Specimen	Length (L)	Height (H)	H/L	Width (W)(*2)	Ua (Ua/L)
Holotype	235	91	0.38	64 ^C	62 (0.26)
YCM-GP1143					
Paratype	220 ^R	76	0.35	66	51 (0.23)
YCM-GP1144					

Ua: distance between umbo and anterior end, R: restored, C: compressed, *2: conjoined.

Type locality: Kawaguchi, Chikura-cho, Awa-gun, Chiba Prefecture.

Description: Shell is huge and it attains about 220.0 mm in length and 102 mm in height on the holotype specimen. Shell is thick. Ellipsoid shell elongates to the posterior part. Shell surface is chalky white, and it has spaced strong ribs. There are faint growth lines from beak to the antero-ventral margin. Ventral margin is linear with faint arch. The anterior margin is circular. Posterior margin is arched. Large and elevate beak situates at anterior (32 %), and gyrates the dorsal part of the shell. Ligament is long and deep, and it situates at the posterior, extending more than half of the dorsal area. Shell section between anterior and posterior margin is heart-shaped, expanding at the umbonal part.

Hinge plate is strong and large. In the right valve (YCM-GP1152. Fig. 4-Ve R), cardinal teeth are composed of (1) and (3b). (1) is high and solid. (3b) is lower than (1). Socket between (1) and (3b) is deep. Postero-lateral tooth (PI) is large and strong. Antero-

Comparison: *Vesicomys ellipsoidea* n. sp. is characterized by ellipsoid form and gyrating umbo at dorsal part. These characters are common to subgenera *Vesicomys*, *Callogonia*, *Veneriglossa* and *Waisiuconcha* under the genus *Vesicomys*, but huge species was unknown.

The present new species differs from *Vesicomys kuroshimana* OKUTANI, FUJIKURA & KOJIMA, 2000 which has long ligament and larger size of the shell.

V. ellipsoidea n. sp. is dissimilar to *V. kaikoe* OKUTANI, FUJIKURA & KOJIMA, 2000 from thick shell, elongate veneriform, long ligament and larger size.

V. ellipsoidea n. sp. close to the young shell of *Calypptogena (Calypptogena) pacifica* DALL, 1891, but differs from it in larger, thick and anterior umbonal part.

The present new species is similar to *Calypptogena (Archivesica) gigas* (DALL, 1890) (elected by OKUTANI *et al.*, 2000), however the latter is distinguished by the shorter ligament and weak hinge teeth.

Fossil localities and the geological horizon

Kotto beach, south of Hedate port, Chikura-cho. Upper part of the Shiramazu Formation correlated with the Pliocene (CN12 zone of the calcareous nannoflora).

Genus *Calyptogena* DALL, 1891

Generic diagnosis: The shell is covered with periostracum which is elongate, large and smooth. Ligament is long and deep. Pallial line situates in center. This genus is divided into 3 subgenera, i.e., *Calyptogena*, *Archivesica* and *Ectenagena* (OKUTANI *et al.*, 2000). This taxonomy is based on molecular analyses and it is different from phylogenetic systematic basis of the shell morphology. In this paper, we can not settle the subgenus because of extinct species.

The type species of *C. (Calyptogena) pacifica* DALL, 1891 is the recent species distributing in the Pacific coast waters of North America, Okhotsk Sea and Bering Sea.

Calyptogena bosoensis n. sp.
(Figs. 3, 4-Cb L)

1992. *Calyptogena* sp. MAJIMA, TANASE, UCHIMURA and HONME. *Jour. Geol. Soc. Japan*, **98**: 373-376, fig. 3.

1997. *Calyptogena (Ectenagena)* sp. A. KANIE, HATTORI, KURAMOCHI, OKADA, OHBA &

HONMA. *Jour. Geol. Soc. Japan*, **103**: 794-795, fig. 2. 1a-c.

Specimens studies: Holotype (YCM-GP1143=Sm01 in KANIE *et al.*, 1997 from Loc. Loc. 21, Kawaguchi) Gparatypes (YCM-GP1144=Sm02 from Loc. 51, Yakushido) and YCM-GP 1151(=Sm05) from Loc. 61, Kotto; referred specimens: YCM-GP1156 (=Sm03) from Loc. 61, Kotto.

Type locality: Kawaguchi, Chikura-cho, Awa-gun, Chiba Prefecture.

Description: Shell is huge, and it attains 235.0 mm long, most elongate. Shell surface covered by weak growth lines is chalky and smooth. Ventral margin is linear. The anterior margin is circular and the posterior margin is arched. Beak is small and low and it situates at the anterior (26-23%). Long and deep ligament extends 2/3 of postero-ventral part. The antero-posterior section is inflated as heart form.

Hinge plate is weak and small. In the left valve (YCM-GP1151), the cardinal teeth are composed of (2a), (2b) and (4b). (2a-b) are low and weak. (4b) is indistinct and low. The postero-lateral tooth (Pll) is indistinct.

Measurements

See Table 2.

Comparison: *Calyptogena bosoensis* n. sp. is identified with *Calyptogena* sp. reported by MAJIMA *et*

Table 2. Shell measurements of *Calyptogena bosoensis* n. sp. in mm.

Specimen	Length (L)	Height (H)	H/L	Width (W)(*2)	Ua (Ua/L)
Holotype	235	91	0.38	64 ^C	62 (0.26)
YCM-GP1143					
Paratype	220 ^R	76	0.35	66	51 (0.23)
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Ua: distance between umbo and anterior end, R: restored, C: compressed, *2: conjoined.

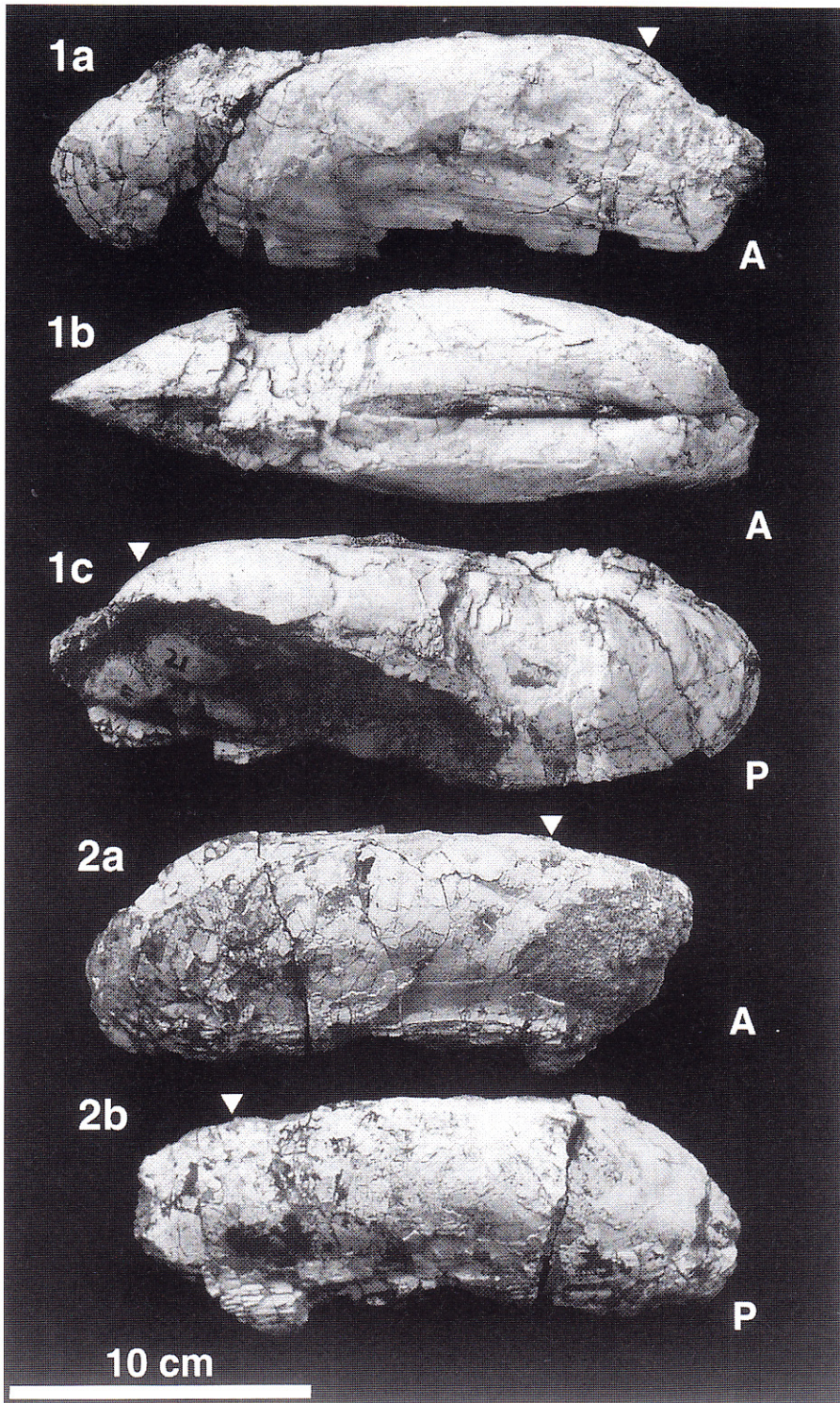


Fig. 3. *Calyptogena bosoensis* n. sp.

1a-c. Holotype, YCM-GP1143 from Loc. 21, Kawaguchi; paratype, 2a-2b. YCM-GP1144 from Yakushido, Kotto. A: anterior part, P: posterior part. ▼: umbonal part.

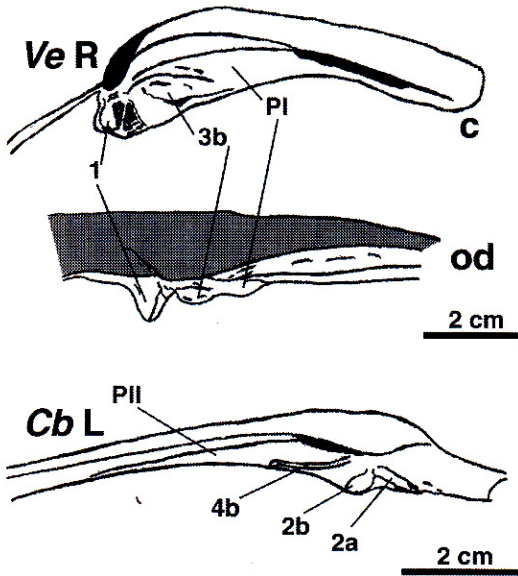


Fig. 4. Cardinal teeth of two new species.

Ve R. Vesicomya ellipsoidea n. sp. Right valve, YCM-GP1152 from Kotto. Commissar plane (c); obliquesdorsal view (od). 1, 3b: cardinal teeth. PI: posterior lateral tooth.

Cb L. Calyptogena bosoensis, left valve, YCM-GP1151 from Kotto. 2a-2b, 4b: cardinal teeth; PII: posterior lateral tooth.

al. (1992). This new species is close to *C. (Archivesica) similis* OKUTANI, KOJIMA & ASHI, 1997 from the off Tokai Thrust, Nankai Trough, 2084 m depth, but distinguished in rather thin shell, surrounded form at antero-dorsal part, with larger-shell (than the holotype of *C. (Archivesica) similis*, L=161.1 mm) and existence of anterior lateral tooth.

This new species is similar sized to *C. (Archivesica) tsubasa* OKUTANI, FUJIKURA & KOJIMA, 2000 from the Daisan Tenryu Knoll, Nankai Trough, 3761 m depth (holotype L=212.1 mm, H=57.2, W=43.8) and referred to the specimen preserved in the Japan Marine Science & Technology Center, JAMSTEC, (L=234 mm, C H=68 mm, H/L=0.29, Ua=41.8, Ua/L=0.18) of thin shell, but discriminated in small and weak hinge.

C. bosoensis n. sp. is similar to *C. (Ectenagena) phaseoliformis* METIVIER, OKUTANI & OHTA, 1986

from the off Japan Sea 5640-5695 m depth. The small shell (holotype in 139.6 mm) is thinly and mostly elongate. Postero-dorsal margin is long and nearly straight, while the anterior dorsal margin is short and incurved. The ventral margin is arched. The shell surface is strongly ornamented with undulated growth lines.

Fossil localities and the geological horizon

Kawaguchi beach, Chikura-cho. Upper part of the Shiramazu Formation correlated with the Pliocene (CN12 zone of the calcareous nannoflora).

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