Online ISSN 2435-0931 Print ISSN 0385-0900
DOI: 10.50897/bmfm.53.1_9

Bulletin of the Mizunami Fossil Museum, vol. 53, no. 1, p. 9–21, 3 pls.

Manuscript accepted on December 17, 2025; online published on February 20, 2026
https://zoobank.org/urn:lsid:zoobank.org:pub:5CC185B2-5672-4CA5-9B00-A4E5FD18D6E1

Some new records for cirripedes from the Pliocene–Pleistocene of Southwest Japan, with two new species of Balanomorpha

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Abstract

Barnacles (Cirripedia, Thoracica) from the Pliocene–Pleistocene deposits of Southwest Japan are examined. As a result of this study, six species in six genera, representing new records for the Japanese Pliocene–Pleistocene, are reported. Two new species, *Tubicinella nodai* from the Lower Pleistocene Shinzato Formation and *Striatobalanus makiyamai* from the Lower Pleistocene Dainichi Formation are described. *Conopea granulata* (Hiro, 1937) from the Shinzato Formation is recorded for the first time from the Lower Pleistocene of Japan. *Octolasmis orthogonia* (Darwin, 1852 [1851]) from the Dainichi Formation is the oldest record of Japan. The occurrences of *Verruca stroemia* (O. F. Müller, 1776) from the Zukawa and Dainichi formations show that this species survived in Japan from the Late Pliocene to Early Pleistocene. *Cetopirus complanatus* (Mörch, 1853) from the Upper Pleistocene Wan Formation represents the youngest fossil record of Japan.

Key words: Thecostraca, Scalpellomorpha, Verrucomorpha, *Tubicinella*, *Striatobalanus*, Late Cenozoic

1. Introduction

Cirripeds from the Upper Pleistocene Wan Formation, the Lower Pleistocene Dainichi and Shinzato formations, and the Upper Pliocene Zukawa Formation in Southwest Japan, are clarified, based upon examinations of the paleontological collection in the Mizunami Fossil Museum (MFM). As a result of our study, six species are the new records from the Pliocene–Pleistocene of Southwest Japan. The purpose of the paper is to record these species including the descriptions of two new species.

2. Systematics

Order Scalpellomorpha Buckeridge and Newman, 2006

Family Poecilasmatidae Annandale, 1909

Genus Octolasmis Gray, 1825

***Octolasmis orthogonia* (Darwin, 1852 [1851])**

[Japanese name: usueboshi]

(Pl. 1, Figs. 1–2)

Synonymy and diagnosis: see Karasawa (2020, p. 28).

Remarks: Karasawa (2020) first reported this species from the Middle Pleistocene Atsumi Group and the Upper Pleistocene Kioroshi Formation of the Shimosa Group. The present record extends the known geologic range for the species back to the Early Pleistocene (Gelasian; ca 2.4–1.9 Ma).

Material examined: MFM144000-1–2 from Hongo (Loc. C05 of Karasawa (2023)), Kakegawa City,

Shizuoka Prefecture; Dainichi Formation of the Kakegawa Group; Early Pleistocene (Gelasian; ca 2.4–1.9 Ma).

Order Verrucomorpha Pilsbry, 1916
Family Verrucidae Darwin, 1854
Genus *Verruca* Schumacher, 1817

***Verruca stroemia* (O. F. Müller, 1776)**
[Japanese name: hanakago]
(Pl. 1, Fig. 3; Pl. 2, Figs. 1–12)

Lepas strömia O. F. Müller, 1776, p. 251.
Verruca strömia (O. F. Müller). Darwin, 1854, p. 518, pl. 21, figs. 1a–f.
Verruca stroemia (O. F. Müller). Nilsson-Cantell, 1978, p. 48, fig. 23–24; Gale and Sadorf, 2025, p. 9, text-fig. 4A–M, 5A–C, 6A–C, 11A–T; fig. 5A–5D (synonymy).

Diagnosis: *Verruca* with moveable scutum lacking an adductor ridge; moveable tergum kite-shaped, height greater than breadth; carina and rostrum articulating by 5 or fewer ridges and intervening grooves [Gale and Sadorf (2025, p. 10)].

Remarks: The specimen (MFM144001) collected from the Upper Pliocene Zukawa Formation is represented by over one-hundred articulated shells attached to *Mizuhopecten poculum* (Yokoyama). Most specimens from the Lower Pleistocene Dainichi Formation (MFM144002-1–12) are isolated compartments of shells and opercular valves.

The hitherto known fossil records of this species are reported from the Upper Pliocene Ogikubo Formation (Koike et al., 2006) and the Pliocene–Pleistocene Ananai Formation (Mimoto, 2009). Gale and Sadorf (2025) thought that *Verruca stroemia* briefly colonized the North Pacific Ocean via the Bering Strait during the Late Pliocene. However, the occurrences of *V. stroemia* from the Zukawa, Ananai, and Dainichi formations show that this species survived in Japan from the Late Pliocene (Zanclean) to Early Pleistocene (Gelasian).

Material examined: MFM144001 from Horita (=around locality of Furumi et al. (2014)), Himi City, Toyama Prefecture; the upper part of the Zukawa Formation; Late Pliocene (Piacenzian; ca 2.75–2.59 Ma). MFM144002-1–12 and other specimens from Ukari (=around locality of Kimura et al. (2011)), Fukuroi City, Shizuoka Prefecture; Dainichi Formation of the Kakegawa Group; Early Pleistocene (Gelasian; ca 2.4–1.9 Ma).

Order Balanomorpha Pilsbry, 1916
Superfamily Coronuloidea Leach, 1817
Family Coronulidae Leach, 1817
Genus *Cetopirus* Ranzani, 1817

***Cetopirus complanatus* (Mörch, 1853)**
[New Japanese name: zaruonifujitsubo]
(Pl. 2, Fig. 13)

Synonymy and diagnosis: see Karasawa (2023, p. 3).

Remarks: This species is the obligate epibiont on skins of the right whales, *Eubalaena australis* (Desmoulins) and *E. glacialis* (Müller), from the Arctic, Atlantic, North Pacific, and Antarctica (Ten et al., 2022). The extant record has not yet been known from Japan. Karasawa (2023) recorded this species from the Middle Pleistocene Ichijuku and Miyata formations of the Kantō region, central Honshu. The present record represents the youngest fossil record of Japan.

Material examined: MFM144003 from Sadeku (=around Loc. 9 of Yamashita et al. (1998)), Kikaicho, Kagoshima Prefecture; Wan Formation of the Ryukyu Group; Late Pleistocene (MIS5b–3; ca 93–54 ka) by $^{230}Th/^{234}U$ ages (Inagaki et al., 2005).

Genus *Tubicinella* Lamarck, 1802

***Tubicinella nodai* new species**
[New Japanese name: nodafujitsubo]
(Pl. 2, Figs. 14–15)
urn:lsid:zoobank.org:act:73756D3B-4D7F-491B-AD15-B89DE11DE0B9

Diagnosis: *Tubicinella* with external lamina of paries flattened, striated longitudinally, with irregular-sized, transverse terraced ridges, sloped steeply upward and fringed with upturned, short spines at lateral corners.

Derivation of name: The species name is dedicated to the late Dr. H. Noda (Tsukuba University, Tsukuba), who contributed greatly to the geology and paleontology of the Shimajiri Group.

Description: Compartments thin, longer than wide; external lamina of paries flattened, striated

longitudinally, with irregular-sized, transverse terraced ridges, sloped steeply upward and fringed with upturned, short spines at lateral corners; internal lamina smooth, connected to external lamina by longitudinal septa; radius narrow externally, wide internally; lateral margins strongly dentate externally; ala narrow, smooth; sheath long, narrow, concave longitudinally, bounded on concave areas by longitudinal ridges; transverse grooves running from concave areas at radii across sheath.

Remarks: Although Karasawa (2023) reported the paratype (MFM143098) as a carinolateral/lateral of an undetermined genus and species of Coronulidae, the examination of an additional specimen (holotype, MFM142045) shows that this species is assigned to *Tubicinella.* This genus is represented by two extant species, *Tubicinella major* Lamarck, 1802, an obligate epibiont on skins of the southern right whale, *Eubalaena australis,* from the Atlantic and South oceans, and *T. cheloniae* Monroe and Limpus, 1979, attached to sea turtles from the Indo-West Pacific (Hayashi, 2013). This new species is similar to *T. major*, but differs in having the paries with irregular-sized, transverse terraced ridges on the external surface. The well-developed external spines on parietes readily distinguish *T. cheloniae* from *T. major* and *T. nodai* new species.

The previously known fossil record of *Tubicinella* is represented by only one, *T. major* from the Upper Pleistocene of Spain (Álvarez-Fernández et al., 2014); therefore, the present record expands the known geologic range for the genus back to the Early Pleistocene (Gelasian).

Material examined: holotype (MFM142045, rostrum) and paratype (MFM143098, carinolateral/lateral) from Shikenbaru (type locality) (=Loc. C15 of Karasawa (2023)), Nanjyo City, Okinawa Prefecture; Shinzato Formation of the Shimajiri Group; Early Pleistocene (Gelasian; ca 2.5–1.9 Ma).

Superfamily Balanoidea Leach, 1817
Family Balanidae Leach, 1817
Genus *Conopea* Say, 1822

***Conopea granulata* (Hiro, 1937)**
[Japanese name: umikaramatsufujitsubo]
(Pl. 3, Fig. 1)

Balanus granulatus Hiro, 1937, p. 444, fig. 29–30.
Conopea granulata (Hiro). Newman and Ross, 1976, p. 55; Kim, 2011, p. 101, fig. 55 (synonymy).

Diagnosis: Shell, white with granule-like tubercles; plates and basis hard, not easily separable from one another; orifice small, oblique in lateral view; rostrum curved, shortest among plates; basis as deep as height of plates, its apex positioned at carinal side. Scutum nearly circular; occludent margin straight, about 1.5 times as long as articular margin; articular margin straight, slightly longer than basal margin; growth ridges on external surface thick, smooth; articular ridge well-developed; articular furrow narrow, deep; adductor ridge absent; adductor muscle pit located in the middle of scutum, broad, deep; pit for lateral depressor deep, with distinct boundary of articular side; internal surface with minute tubercles. Tergum also subcircular, with flat, smooth external surface; growth ridges weak; spur broad, short, half as wide as basal margin; articular ridge long; articular furrow narrow, shallow; nearly all internal surface with minute tubercles; crests for depressor muscle about 5 in number, long, distinct [emended from Kim (2011, p. 101)].

Remarks: The present fossil record is the first and oldest record for the species. This species attached to gorgonians and antipatharians is known from the West Pacific ranging from southwest Japan to Philippines at depth of between 90–200 m (Jones et al., 2000).

Material examined: MFM144005 from Shikenbaru (Loc. C15 of Karasawa (2023)), Nanjyo City, Okinawa Prefecture; Shinzato Formation of the Shimajiri Group; Early Pleistocene (Gelasian; ca 2.5–1.9 Ma).

Genus *Striatobalanus* Hoek, 1913

***Striatobalanus makiyamai* new species**
[New Japanese name: makiyamafujitsubo]
(Pl. 3, Figs. 2–13)
urn:lsid:zoobank.org:act:2D10F32A-08ED-435E-8BE5-8F2132C4CC17

Diagnosis: Shell and opercular valves reddish. Shell conical; orifice large, pentagonal; parietes smooth externally with weak growth lines; radii narrow, smooth externally and internally, with oblique summits; sutural edge smooth; alae with oblique

summits; sheath short; inner lamina strongly ribbed; basis calcareous. Scutum triangular, flattened externally, with weak growth lines intersected faint, longitudinal striae; articular ridge short; articular furrow shallow; adductor muscle ridge weak, straight, not connected with articular ridge; adductor muscle scar faint; pit for lateral depressor muscle shallow. Tergum flattened externally with weak growth lines intersected faint, longitudinal striae; spur furrow opened; articular ridge well-developed; articular furrow shallow; spur well-developed, slightly longer than wide at base; crests for depressor muscle distinct, 3 or 4 in number.

Derivation of name: The species name is honor to the late Dr. J. Makiyama (Kyoto University, Kyoto), who made significant contributions to the geology and paleontology of the Kakegawa Group.

Description: Shell conical, reddish; orifice relatively large, pentagonal; parietes smooth externally with weak growth lines; radii relatively narrow, smooth externally and internally, with oblique summits; sutural edge smooth without teeth; alae with oblique summits; sheath short with weak transverse striations; inner lamina strongly ribbed; basis calcareous. Opercular valves reddish. Scutum triangular, flattened externally, with weak growth lines intersected faint, longitudinal striae; occludent margin straight, about 1.6 times as long as tergal margin; tergal margin nearly straight; basal margin gently convex, about half height of tergal margin; articular ridge short, about half height of tergal margin; articular furrow shallow; adductor muscle ridge weak, straight, not connected with articular ridge, nearly parallel to occludent margin; adductor muscle scar faint; pit for lateral depressor muscle shallow. Tergum flattened externally with weak growth lines intersected faint, longitudinal striae; spur furrow relatively board, opened; scutal margin nearly straight; articular ridge well-developed, reflexed to apex; articular furrow shallow; carinal margin gently convex; spur well-developed, slightly longer than wide at base, distance from basiscutal angle to spur about one-third spur length; crests for depressor muscle distinct, 3 or 4 in number.

Remarks: The extant species belonging to *Striatobalanus* from the Japanese waters comprise three species, *S. amaryllis* (Darwin, 1854), *S. krugeri* (Pilsbry, 1916), and *S. tenuis* (Hoek, 1883) (Newman and Ross, 1976). Among these, the present new species has close affinities with *S. tenuis*, but differs in that the shell and opercular valves are reddish, the tergum has a straight carinal margin with a long spur, and the external surface of the scutum lacks a shallow groove near the occludent margin. The opened spur furrow of tergum readily distinguishes this species from *S. amaryllis*. This species differs from *S. krugeri* by having a long spur of tergum.

Material examined: holotype (MFM142046, shell) and 11 paratypes (MFM142047-1–3, tergum; MFM142047-4–6, scutum; MFM142047-7–11, shell) from Hongo (type locality) (=Loc. C05 of Karasawa, 2023)), Kakegawa City, Shizuoka Prefecture; Dainichi Formation of the Kakegawa Group; Early Pleistocene (Gelasian; ca 2.4–1.9 Ma), and other specimens from Hongo and Ukari (=around locality of Kimura et al. (2011)), Fukuroi City, Shizuoka Prefecture; Dainichi Formation of the Kakegawa Group; Early Pleistocene (Gelasian; ca 2.4–1.9 Ma).

3. Acknowledgements

I thank T. Goda (Kōnan, Aichi) for providing additional samples collected from Ukari. The manuscript benefited greatly from the critical review of Dr. Stephen K. Donovan (Manchester, UK).

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Some new records for cirripedes from the Pliocene–Pleistocene of Southwest Japan, with two new species of Balanomorpha

Hiroaki Karasawa and Nobuaki Kobayashi

Plates 1–3

Plate 1

Figs. 1–2. *Octolasmis orthogonia* (Darwin, 1852 [1851]) ウスエボシ

Hongo, Dainichi Formation, Early Pleistocene (Gelasian).

1a–b, MFM144000-1, carina. a, carinal; b, lateral views.

2a–b, MFM144000-2, carina. a, carinal; b, lateral views.

Figs. 3a–c. *Verruca stroemia* (O. F. Müller, 1776) ハナカゴ

Horita, Zukawa Formation, Late Pliocene (Piacenzian).

3a–c, MFM144001, articulated shells attached to *Mizuhopecten poculum* (Yokoyama). a, overall image; b, c, close-up image of each individual.

Figs. 1–2, 3b, 3c, scale bars = 2 mm; fig. 3a, scale bar = 5 mm.

Plate 1

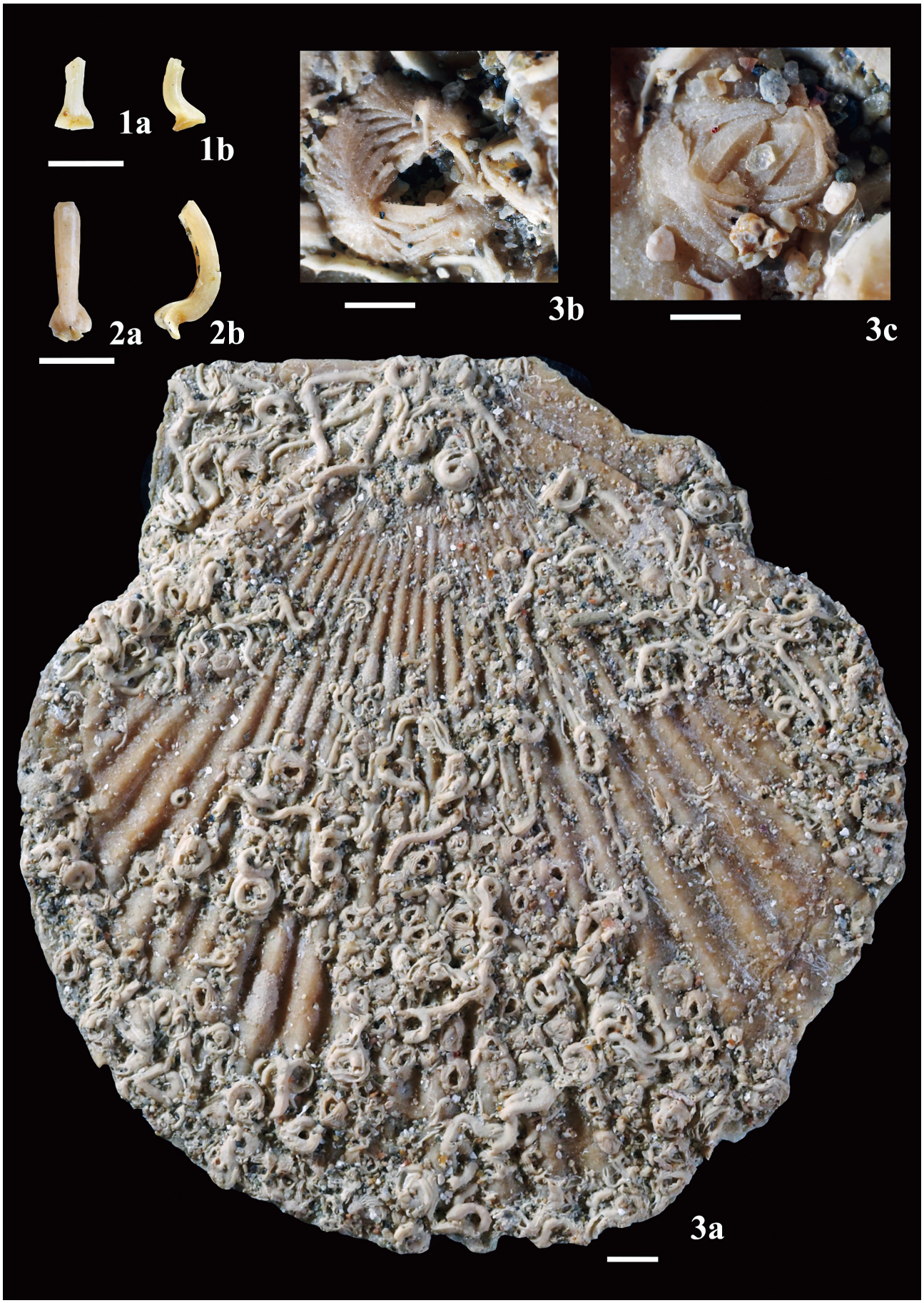


Plate 2

Figs. 1–12. *Verruca stroemia* (O. F. Müller, 1776) ハナカゴ

Ukari, Dainichi Formation, Early Pleistocene (Gelasian).

1a–b, MFM144002-1, movable scutum. a, external; b, internal views.

2a–b, MFM144002-2, movable scutum. a, external; b, internal views.

3a–b, MFM144002-3, movable tergum. a, external; b, internal views.

4a–b, MFM144002-4, movable tergum. a, external; b, internal views.

5a–b, MFM144002-5, fixed tergum. a, external; b, internal views.

6a–b, MFM144002-6, fixed tergum. a, external; b, internal views.

7a–b, MFM144002-7, fixed tergum and fixed scutum. a, external; b, internal views.

8, MFM144002-8, fixed scutum. external view.

9a–b, MFM144002-9, fixed scutum. a, external; b, internal views.

10a–b, MFM144002-10, carina. a, external; b, internal views.

11a–b, MFM144002-11, rostrum. a, external; b, internal views.

12a–b, MFM144002-12, rostrum. a, external; b, internal views.

Figs. 13a–d. *Cetopirus complanatus* (Mörch, 1853) ザルオニフジツボ（新称）

Sadeku, Wan Formation, Late Pleistocene.

13a–d, MFM144003, rostrum. a, external; b, internal; c, lateral; d, ventral views.

Figs. 14–15. *Tubicinella nodai* new species ノダキリカブフジツボ（新称）

Shikenbaru, Shinzato Formation, Early Pleistocene (Gelasian).

14, MFM142045, holotype, rostrum. a, external; b, internal; c, lateral; d, ventral views.

15, MFM143098, paratype, lateral/carinolateral. a, external; b, internal; c, lateral; d, ventral views.

Figs. 1–12, scale bars = 2 mm; figs. 13–15, scale bar = 5 mm.

Plate 2


1a
1b
2a
2b
3a
3b
4a
4b
5a
5b
6a
6b
7a
7b
8
9a
9b
10a
10b
11a
11b
12a
12b
13a
13b
13c
13d
15d
14a
14b
14c
14d
15a
15b
15c

Plate 3

Figs. 1a–d. *Conopea granulata* (Hiro, 1937) ウミカラマツフジツボ

Shikenbaru, Shinzato Formation, Early Pleistocene (Gelasian).

5a–d, MFM144005, shell. a, dorsal view; b, c, lateral view; d, close-up image of external surface.

Figs. 2–13. *Striatobalanus makiyamai* new species マキヤマフジツボ（新称）

Hongo, Dainichi Formation, Early Pleistocene (Gelasian).

2a–b, MFM142047-1, paratype, tergum. a, external; b, internal views.

3a–b, MFM142047-2, paratype, tergum. a, external; b, internal views.

4a–b, MFM142047-3, paratype, tergum. a, external; b, internal views.

5a–b, MFM142047-4, paratype, scutum. a, external; b, internal views.

6a–b, MFM142047-5, paratype, scutum. a, external; b, internal views.

7a–b, MFM142047-6, paratype, scutum. a, external; b, internal views.

8a–b, MFM142047-7, paratype, shell. a, external; b, internal views.

9a–b, MFM142047-8, paratype, shell. a, external; b, internal views.

10, MFM142047-9. paratype, shell. dorsal view.

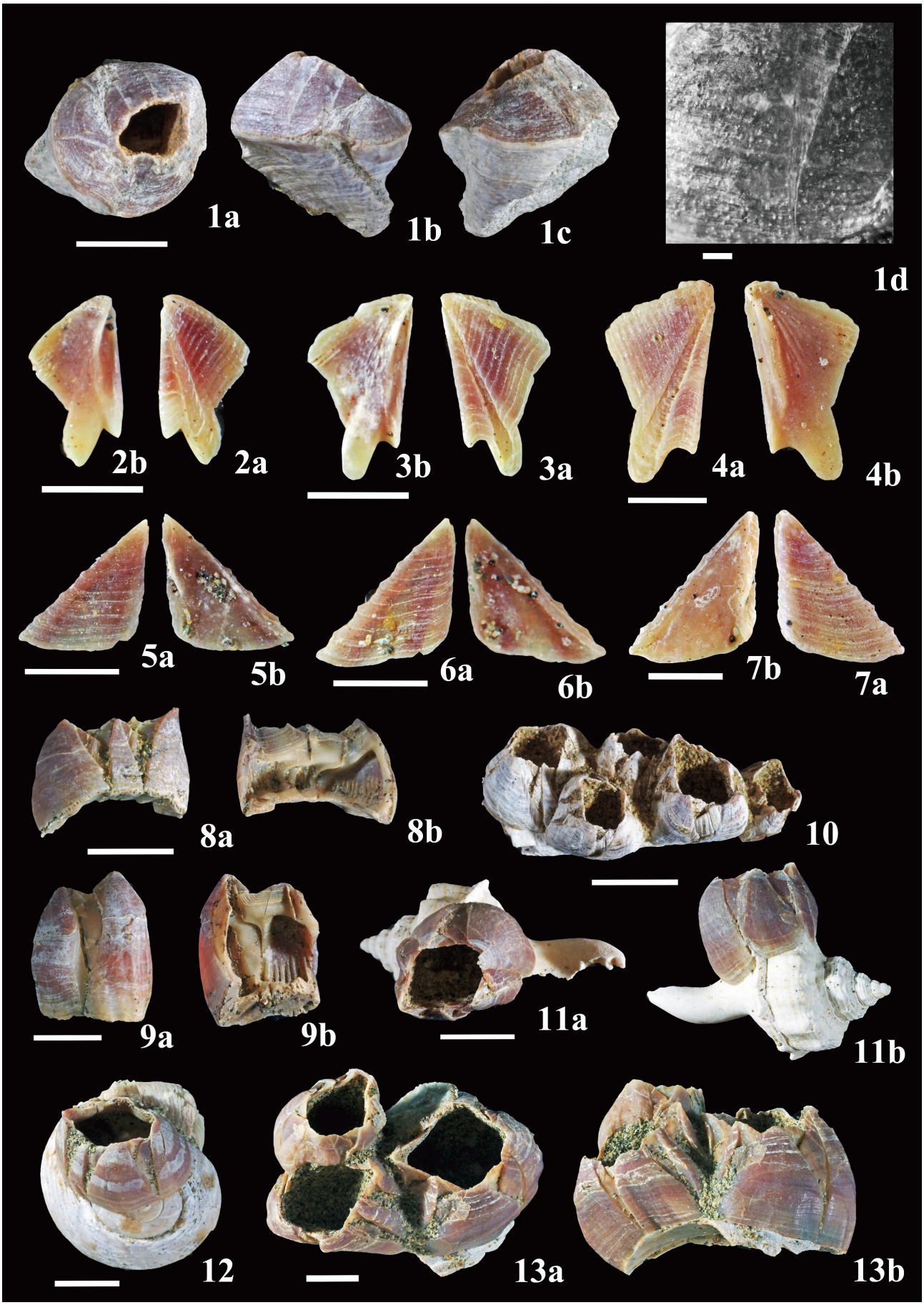
11a–b, MFM142047-10. paratype, shell. a, dorsal; b, lateral views.

12, MFM142047-11. paratype, shell. dorsal view.

13a–b, MFM142046, holotype, shell. a, dorsal; b, lateral views.

Figs. 1, 8–13, scale bars = 5 mm; figs. 2–7, scale bars = 2 mm.

Plate 3


1a
1b
1c
1d
2b
2a
3b
3a
4a
4b
5a
5b
6a
6b
7b
7a
8a
8b
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9a
9b
11a
11b
12
13a
13b