Molluscan shells on Ikarashi beach, Niigata, Japan

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Abstract

It has been suggested that beachcombing for biological material is a simple, powerful approach to understanding shallow marine ecosystems. Because of the lack of information on the molluscan shells that have washed up along the beach of the Sea of Japan, we presented a list of molluscan species collected from Ikarashi beach, Niigata, Japan. Using the molluscan shells collected between 2014 and 2023, a total of 123 species were identified: 40 gastropods, 3 cephalopods, 2 scaphopods and 78 bivalves at the species level. Several freshwater species are believed to have been possibly transported via the nearby Shin-kawa River. Holoplanktonic and nektobenthic species originally inhabited temperate sea, suggesting drift along the Tsushima Warm Current. Because benthic animals have changed their distribution in the Sea of Japan, episodic reports of molluscan fauna washing up on beaches could help to understand the environmental changes associated with the seawater temperature.

Key words: flotsam, Mollusca, Sea of Japan, Tsushima Current, beachcombing.

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Introduction

Understanding biodiversity in ecosystems is crucial not only for monitoring current environmental conditions but also for predicting biological resources (e.g., Desa, 2016). Beachcombing is a powerful and simple monitoring technique in which shallow marine biota washed up on a beach (e.g., Donovan, 2011; Seo and Tanangonan, 2014; Yoshioka, 2016; Davies et al., 2022; Ishizaki and Shiino, 2023), although the material lacks information of spatial distribution under the sea. This approach requires the periodic recording of marine biota, and it enables the provision of basic knowledge about the relationship between local evidence and global environmental changes.

Molluscs are one of the major taxonomic groups of modern benthic fauna. There are many ecological studies on habitat depth and adaptation to environment, which are utilised to understand the marine environment and how it changes over time (e.g., Amano, 2001; Okutani, 2017; Enya and Suzuki, 2020). Molluscan shells washed up on beaches have been reported along the Sea of Japan (e.g., Takagi, 1992; Amano, 2001; Takada et al., 2015), while there is less information on molluscan shells collected from the area between Hokkaido and Niigata, except for living molluscs (Takada et al., 2015). The aim of this study is to create a database of molluscan shells collected from Ikarashi beach, Niigata, Japan.

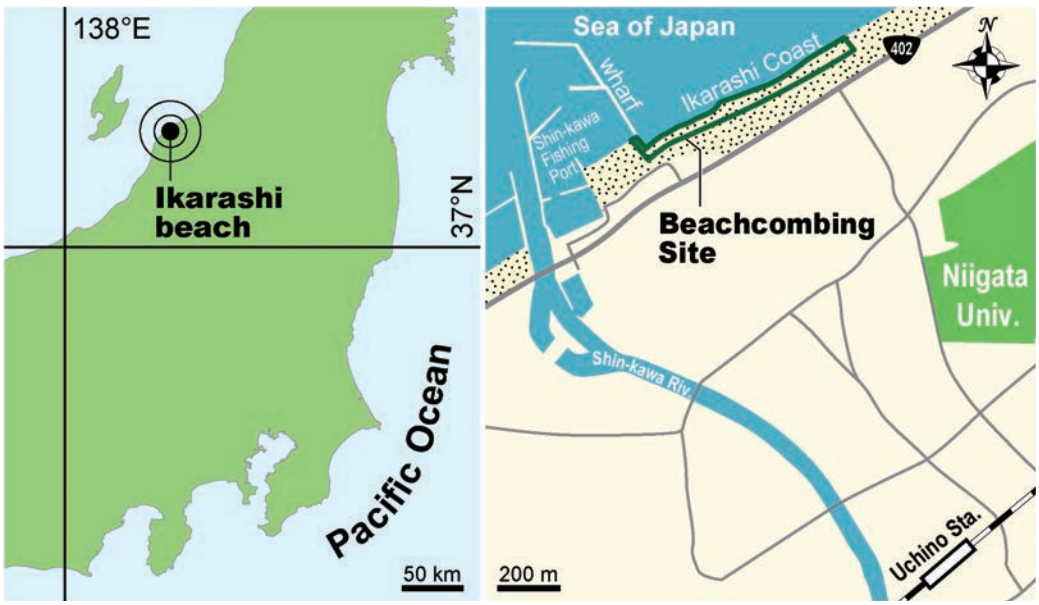

Fig. 1. Map showing the beachcombing site of Ikarashi beach, Niigata, Japan. Modified from Ishizaki and Shiino (2023).

Material and methods

1. Sampling locality

Molluscan shells were collected from 2014 to 2023 at Ikarashi beach, Niigata, Japan, located 900 m northwest of Niigata University (Fig. 1). Ikarashi beach consists mainly of fine-grained sand with abundant flotsam such as fishing tools, bottles, driftwoods and organic material (Ishizaki et al., 2023; Ishizaki and Shiino, 2023). Terrestrial organisms and products such as Chinese pond turtles and ceramics sometimes wash up on beaches after storms. Ikarashi beach's topography changes seasonally, with sand grains accumulating in summer and being removed in winter. The drift lines at which the molluscan shells wash up on the backshore vary within a backshore. The assemblage of molluscan shells differs on each drift line because the wave influences change during the tidal cycle.

2. Identification of molluscan shells

We identified the species of all the molluscan specimens stored in 200 L containers. Before identification, we cleaned the specimens with freshwater to remove sand and other unknown material unrelated to the molluscan shells. A Sony α7R IV digital camera (Sony Corporation, Japan) was used to make photographic plates of the present collection. We used a MACRO Nikkor 120 mm F6.3 lens (Nikon, Japan) for larger specimens and a MACRO Nikkor 35 mm F4.5 lens (Nikon, Japan) for specimens less than 5 mm in length; both lenses were equipped with auto bellows (Canon, Japan).

The identification of the present marine molluscs was based on Okutani (2017). The nomenclature was also based on Okutani (2017), except for some species that have recently been revised to different names. Although the molluscan shells were collected from the beach, our collection includes several species of freshwater molluscs. The nomenclature of the freshwater species was based on Okutani (2004).

All the specimens are stored in the collections of Palaeontology Laboratory by the last author, Niigata University.

Table 1. List of molluscan species.

Class	Oder	Family	Species	Japanese name	Plate and figure number
Gastropoda	Patellogastropoda	Nacellidae	*Cellana toreuma* (Reeve)	Yomegakasa	Pl. 1, Fig. 1
			Cellana grata (Gould)	Bekkougasa	Pl. 1, Fig. 2
			Cellana orientalis (Pilsbry)	Kurumagasa	Pl. 1, Fig. 3
		Lottiidae	*Patelloida lanx* (Reeve)	Unoashi	Pl. 1, Fig. 4
			Patelloida pygmaea (Dunker)	Himekozara	Pl. 1, Fig. 5
			Lottia dorsuosa (Gould)	Kamogai	Pl. 1, Fig. 6
			Lottia tenuisculpta Sasaki and Okutani	Komorebikogamogai	Pl. 1, Fig. 7
	Vetigastropoda	Trochidae	*Umbonium costatum* (Valenciennes)	Kisago	Pl. 2, Fig. 1
		Turbinidae	*Turbo* (*Batillus*) *cornutus* Lightfoot	Sazae	Pl. 2, Fig. 2
		Tegulidae	*Chlorostoma lischkei* Tapparone-Canefri	Kubogai	Pl. 2, Fig. 3
			Chlorostoma turbinatum A. Adams	Hesoakikubogai	Pl. 2, Fig. 4
		Fissurellidae	*Tugali decussata* A. Adams	Shirosusokakegai	Pl. 2, Fig. 5
	Caenogastropoda	Cerithiidae	*Rhinoclavis kochi* (Philippi)	Kanimorigai	Pl. 2, Fig. 6
		Hipponicidae	*Sabia conicus* (Schumacher)	Kikusuzume	Pl. 2, Fig. 7
		Eulimidae	*Eulima bifascialis* (A. Adams)	Hanagouna	Pl. 2, Fig. 8
		Strombidae	*Strombus* (*Doxander*) *japonicus* Reeve	Shidorogai	Pl. 2, Fig. 9
		Calyptraeidae	*Crepidula* (*Bostrycapulus*) *gravispinosus* (Kuroda and Habe)	Awabunegai	Pl. 2, Fig. 10
		Vermetidae	*Thylacodes adamsii* (Mörch)	Oohebigai	Pl. 2, Fig. 11
		Naticidae	*Glossaulax didyma* (Röding)	Tsumetagai	Pl. 3, Fig. 1
		Cassidae	*Phalium flammiferum* (Röding)	Kazuragai	Pl. 3, Fig. 2
		Tonnidae	*Tonna lischkeana* (Küster)	Uzuramiyashirogai	Pl. 3, Fig. 3
		Epitoniidae	*Epitonium auritum* (G.B. Sowerby II)	Odamaki	Pl. 3, Fig. 4
		Janthinidae	*Janthina globosa* Swainson	Rurigai	Pl. 3, Fig. 5
		Columbellidae	*Mitrella bicincta* (Gould)	Mugigai	Pl. 3, Fig. 6
		Nassariidae	*Nassarius conoidalis* (Deshayes)	Araregai	Pl. 3, Fig. 7
			Nassarius (*Niotha*) *livescens* (Philippi)	Mushirogai	Pl. 3, Fig. 8
		Fasciolariidae	*Fusinus perplexus* (A. Adams)	Naganishi	Pl. 4, Fig. 1
		Babyloniidae	*Babylonia japonica* (Reeve)	Bai	Pl. 4, Fig. 2
		Muricidae	*Reishia bronni* (Dunker)	Reishigai	Pl. 4, Fig. 3
			Reishia clavigera (Küster)	Ibonishi	Pl. 4, Fig. 4
		Olivellidae	*Olivella fulgurata* (Adams and Reeve)	Mushibotaru	Pl. 4, Fig. 5
		Olividae	*Oliva mustelina* Lamarck	Makuragai	Pl. 4, Fig. 6
		Cancellariidae	*Momoebora sinensis* (Reeve)	Momoebora	Pl. 4, Fig. 7
			Sydaphera spengleriana (Deshayes)	Koromogai	Pl. 4, Fig. 8
			Cancellaria (*Habesolatia*) *nodulifera* G.B. Sowerby I	Tokashioriire	Pl. 4, Fig. 9
	Euopisthobranchia	Philinidae	*Philine argentata* Gould	Kisewatagai	Pl. 4, Fig. 10
	Mesogastropoda	Viviparidae	*Cipangopaludina japonica* (Martens)	Ootanishi	Pl. 15, Fig. 1
			Sinotaia quadrata histrica (Gould)	Himetanishi	Pl. 15, Fig. 2
		Pleuroceridae	*Semisulcospira libertina* (Gould)	Kawanina	Pl. 15, Fig. 3
	Bassommatophora	Physidae	*Physella acuta* Draparnaud	Sakamakigai	Pl. 15, Fig. 4
Cephalopoda	Octopoda	Argonautidae	*Argonauta argo* Linnaeus	Aoigai	Pl. 5, Fig. 1
	Sepioida	Sepiidae	*Acanthosepion esculenta* (Hoyle)	Kouika	Pl. 5, Fig. 2
			Doratosepion kobiensis (Hoyle)	Himekouika	Pl. 5, Fig. 3
Scaphopoda	Dentaliida	Gadilinidae	*Compressidens kikuchii* (Kuroda and Habe)	Hinatsunogai	Pl. 5, Fig. 4
	Gadilida	Gadilidae	*Siphonodentalium isaotakii* Habe	Kuchikiretsunogai	Pl. 5, Fig. 5
Bivalvia	Nuculanoida	Nuculanidae	*Nuculana* (*Saccella*) *sematensis* (Suzuki and Ishizuka)	Arasujisodegai	Pl. 6, Fig. 1
	Arcoida	Arcidae	*Arca boucardi* Jousseaume	Koberutofunegai	Pl. 6, Fig. 2
			Barbatia (*Ustularca*) *stearnsii* (Pilsbry)	Hanaegai	Pl. 6, Fig. 3
			Scapharca inaequivalvis (Bruguière)	Kuichigaisarubou	Pl. 6, Fig. 4
			Scapharca satowi (Dunker)	Satougai	Pl. 6, Fig. 5
		Parallelodontidae	*Porterius dalli* (E.A. Smith)	Shikoroegai	Pl. 6, Fig. 6
		Noetiidae	*Arcopsis symmetrica* (Reeve)	Mimiegai	Pl. 6, Fig. 7
		Glycymerididae	*Glycymeris* (*Veletuceta*) *albolineata* (Lischke)	Benkeigai	Pl. 6, Fig. 8
	Mytiloida	Mytilidae	*Mytilus galloprovincialis* Lamrck	Murasakiigai	Pl. 7, Fig. 1
			Mytilus coruscus Gould	Igai	Pl. 7, Fig. 2
			Septifer virgatus (Wiegmann)	Murasakiinko	Pl. 7, Fig. 3
			Septifer keenae Nomura	Himeigai	Pl. 7, Fig. 4
			Modiolus nipponicus (Oyama)	Hibarigai	Pl. 7, Fig. 5
			Gregariella barbata (Gmelin)	Chijimitamaegai	Pl. 7, Fig. 6
	Pterioida	Ostreidae	*Crassostrea gigas* (Thunberg)	Magaki	Pl. 7, Fig. 7
			Crossostrea nippona (Seki)	Iwagaki	Pl. 7, Fig. 8

Class	Oder	Family	Species	Japanese name	Plate and figure number
	Limoida	Limidae	*Limaria hakodatensis* (Tokunaga)	Fukureyukimino	Pl. 8, Fig. 1
	Pectinoida	Pectinidae	*Chlamys* (*Azumapecten*) *farreri nipponensis* Kuroda	Azumanishiki	Pl. 8, Fig. 2
			Swiftopecten swiftii (Bernardi)	Ezokinchaku	Pl. 8, Fig. 3
			Pecten albicans (Schröter)	Itayagai	Pl. 8, Fig. 4
		Spondylidae	*Spondylus cruentus* Lischke	Chiribotan	Pl. 8, Fig. 5
		Anomiidae	*Anomia chinensis* Philippi	Namimagashiwa	Pl. 8, Fig. 6
			Monia macroschisma (Deshayes)	Namimagashiwamodoki	Pl. 8, Fig. 7
	Carditoida	Carditidae	*Cardita leana* Dunker	Tomayagai	Pl. 9, Fig. 1
	Anomalodesmata	Lyonsiidae	*Agriodesma navicula* (A. Adams and Reeve)	Obikui	Pl. 9, Fig. 2
		Laternulidae	*Laternula anatina* (Linnaeus)	Okinagai	Pl. 9, Fig. 3
	Veneroida	Lucinidae	*Epicodakia delicatula* (Pilsbry)	Umiasagai	Pl. 9, Fig. 4
		Ungulinidae	*Joannisiella nomurai* (Habe)	Hirashiogama	Pl. 9, Fig. 5
			Joannisiella tsuchii (Yamamoto and Habe)	Atsushiogama	Pl. 9, Fig. 6
		Chamidae	*Chama japonica* Lamarck	Kikuzaru	Pl. 9, Fig. 7
		Lasaeidae	*Kellia porculus* Pilsbry	Kohakunotsuyu	Pl. 9, Fig. 8
		Sportellidae	*Basterotia stimpsoni* (A. Adams)	Soyokazegai	Pl. 9, Fig. 9
		Trapezidae	*Coralliophaga coralliophaga* (Gmelin)	Tagasodegai	Pl. 9, Fig. 10
			Trapezium liratum (Reeve)	Unenashitomayagai	Pl. 9, Fig. 11
		Corbiculidae	*Corbicula japonica* Prime	Yamatoshijimi	Pl. 9, Fig. 12
		Cardiidae	*Fulvia mutica* (Reeve)	Torigai	Pl. 10, Fig. 1
		Veneridae	*Placamen foliaceum* (Philippi)	Hanagai	Pl. 10, Fig. 2
			Protothaca jedoensis (Lischke)	Oniasari	Pl. 10, Fig. 3
			Pitar japonicus Kuroda and Kawamoto	Usuhamaguri	Pl. 10, Fig. 4
			Phacosoma troscheli (Lischke)	Maruhinagai	Pl. 10, Fig. 5
			Ruditapes philippinarum (A. Adams and Reeve)	Asari	Pl. 10, Fig. 6
			Paphia amabilis (Philippi)	Satsumaakagai	Pl. 10, Fig. 7
			Irus mitis (Deshayes)	Matsukazegai	Pl. 10, Fig. 8
			Irus macrophyllus (Deshayes)	Hanematsukaze	Pl. 10, Fig. 9
			Irus ishibashianus (Kira)	Okinamatsukaze	Pl. 10, Fig. 10
			Macridiscus melanaegis (Römer)	Kotamagai	Pl. 10, Fig. 11
			Callista chinensis (Holten)	Matsuyamawasure	Pl. 10, Fig. 12
			Meretrix lamarckii Deshayes	Chousenhamaguri	Pl. 11, Fig. 1
			Meretrix petechialis (Lamarck)	Shinahamaguri	Pl. 11, Fig. 2
			Clementia vatheleti Mabille	Fusumagai	Pl. 11, Fig. 3
		Petricolidae	*Petricolirus aequistriatus* (G.B. Sowerby)	Shiotsugai	Pl. 11, Fig. 4
		Donacidae	*Chion semigranosa* (Dunker)	Fujinohanagai	Pl. 11, Fig. 5
			Latona cuneata (Linnaeus)	Naminokogai	Pl. 11, Fig. 6
		Tellinidae	*Pharaonella sieboldii* (Deshayes)	Benigai	Pl. 11, Fig. 7
			Tellinides ovalis (G.B. Sowerby I)	Hirazakura	Pl. 11, Fig. 8
			Megangulus zyonoensis (Hatai and Nisiyama)	Arasujisaragai	Pl. 11, Fig. 9
			Nitidotellina iridella (Martens)	Kabazakura	Pl. 11, Fig. 10
			Macoma praetexta (Martens)	Oomomonohana	Pl. 11, Fig. 11
			Macoma sectior Oyama	Sagigai	Pl. 12, Fig. 1
			Heteromacoma irus oyamai Kira	Marushiratorimodoki	Pl. 12, Fig. 2
		Psammobiidae	*Soletellina boeddinghausi* Lischke	Fujinamigai	Pl. 12, Fig. 3
			Nuttallia japonica (Reeve)	Isoshijimi	Pl. 12, Fig. 4
		Solecurtidae	*Solecurtus divaricatus* (Lischke)	Kinutaagemaki	Pl. 12, Fig. 5
		Solenidae	*Solen strictus* Gould	Mategai	Pl. 12, Fig. 6
			Solen kurodai Habe	Dandaramategai	Pl. 12, Fig. 7
		Cultellidae	*Siliqua pulchella* (Dunker)	Mizogai	Pl. 12, Fig. 8
		Mactridae	*Mactra chinensis* Philippi	Bakagai	Pl. 13, Fig. 1
			Coelomactra antiquata (Spengler)	Arisogai	Pl. 13, Fig. 2
			Pseudocardium sachalinense (Schrenck)	Ubagai	Pl. 13, Fig. 3
			Lutraria maxima Jonas	Ootorigai	Pl. 13, Fig. 4
			Raetellops pulchellus (A. Adams and Reeve)	Chiyonohanagai	Pl. 13, Fig. 5
	Myoida	Cardiliidae	*Cardilia semisulcata* (Lamarck)	Kisagai	Pl. 13, Fig. 6
		Corbulidae	*Solidicorbula erythrodon* (Lamarck)	Kuchibenigai	Pl. 13, Fig. 7
		Pholadidae	*Penitella* sp.	Kamomegai	Pl. 14, Fig. 1
			Zirfaea constricta (G.B. Sowerby)	Niogaimodoki	Pl. 14, Fig. 2
			Barnea (*Anchomasa*) *fragilis* (G.B. Sowerby)	Niogai	Pl. 14, Fig. 3
			Barnea (*Umitakea*) *japonica* (Yokoyama)	Umitake	Pl. 14, Fig. 4
	Unionoida	Unionidae	*Sinohyriopsis schlegelii* (Martens)	Ikechougai	Pl. 15, Fig. 5

Results and discussion

Examining the collected molluscan shells, we identified a total of 123 species, consisting of 40 gastropods, 3 cephalopods, 2 scaphopods and 78 bivalves (Table 1, Plates 1–15). According to Amano (2001), the molluscan fauna washed up on the coasts of four sites in Joetsu, Niigata, 90 km southwest of Ikarashi beach, included 126 species. Such a similarity in the number of species may suggest that the present collection reflects the shallow molluscan fauna available from beachcombing sampling.

The molluscan shells included five freshwater species, *Cipangopaludina japonica* (Martens), *Sinotaia quadrata histrica* (Gould), *Semisulcospira libertina* (Gould), *Physella acuta* Draparnaud and *Hyriopsis schlegelii* (Martens) (Plate 15). Given that the Chinese pond turtle *Mauremys reevesii* (Gray) washed up on the beach, the shells of freshwater species indicate to have been transported via the Shin-kawa River near the present beachcombing site (Fig. 1).

Among the present marine molluscs, common species on Ikarashi beach are *Scapharca inaequivalvis* (Bruguière), *Mactra chinensis* Philippi, *Macridiscus melanaegis* (Römer) and *Chion semigranosa* (Dunker). The latter two are the most abundant living species on the sandy shore around Ikarashi beach (Takada et al., 2015) and seem to be para-autochthonous elements for the present beachcombing.

Well-preserved shells of *Corbicula japonica* Prime, *Ruditapes philippinarum* (A. Adams and Reeve), *Nuttallia japonica* (Reeve) and *Solen strictus* Gould frequently washed up around the wharf. These species are known to inhabit shallow, calm benthic conditions such as inner bays and estuaries (Okutani, 2017), which could be present in the Shin-kawa Fishing Port, as it is surrounded by wharfs. On the wharf, we recognised the presence of *Crassostrea nippona* (Seki), but not *Crassostrea gigas* (Thunberg) or *Neopycnodonte cochlear* (Poli). Because all the shells of *C. gigas* and *N. cochlear* were solitary on the beach even if they were far from the wharf, both species may adapt to deeper hard substrates such as tetrapod blocks and gravels under the shallow sea, which we cannot observe during beachcombing.

The holoplanktonic gastropod *Janthina globosa* Swainson, the pelagic octopus *Argonauta argo* Linnaeus and the cuttlefish *Acanthosepion esculenta* (Hoyle) originate in temperate seas (Okutani, 2017), and can drift along with the Tsushima Warm Current, as is observed in the case of planktonic animals (e.g., Matsuoka et al., 2001, 2002; Itaki, 2003; Itaki et al., 2003; Kurihara et al., 2006, 2007, 2008; Kurihara and Matsuoka, 2009, 2010). The benthic molluscan fauna includes both cool and warm water species, e.g., cool water for *Megangulus zyonoensis* (Hatai and Nisiyama) and warm water for *Tellinides ovalis* (G. B. Sowerby I) (Amano, 2001). Previous studies have shown that the ratio of both types of species varies from south to north due to the influence of seawater temperature (Amano, 2001; Takebayashi and Wada,

2010). Furthermore, the distributions of some benthic animals appear to expand northward along the coast of the Sea of Japan (e.g., Gallagher et al., 2015; Yoshioka, 2020), which seems to reflect climatic changes. Based on these biogeographic findings, episodic reports of molluscan fauna washing up on beaches may help us to understand the environmental changes in the Sea of Japan (e.g., Enya and Suzuki, 2020), contributing to Sustainable Development Goal 13: climate action.

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*English translation from the original written in Japanese

Explanation of Plate 1
Patellogastropoda (JN: Japanese name).
Fig. 1. *Cellana toreuma* (Reeve). JN: Yomegakasa.
Fig. 2. *Cellana grata* (Gould). JN: Bekkougasa.
Fig. 3. *Cellana orientalis* (Pilsbry). JN: Kurumagasa.
Fig. 4. *Patelloida lanx* (Reeve). JN: Unoashi.
Fig. 5. *Patelloida pygmaea* (Dunker). JN: Himekozara.
Fig. 6. *Lottia dorsuosa* (Gould). JN: Kamogai.
Fig. 7. *Lottia tenuisculpta* Sasaki and Okutani. JN: Komorebikogamogai.

Explanation of Plate 2
Vetigastropoda and Caenogastropoda (JN: Japanese name).
Fig. 1. *Umbonium costatum* (Valenciennes). JN: Kisago.
Fig. 2. *Turbo* (*Batillus*) *cornutus* Lightfoot. JN: Sazae.
Fig. 3. *Chlorostoma lischkei* Tapparone-Canefri. JN: Kubogai.
Fig. 4. *Chlorostoma turbinatum* A. Adams. JN: Hesoakikubogai.
Fig. 5. *Tugali decussata* A. Adams. JN: Shirosusokakegai.
Fig. 6. *Rhinoclavis kochi* (Philippi). JN: Kanimorigai.
Fig. 7. *Sabia conicus* (Schumacher). JN: Kikusuzume.
Fig. 8. *Eulima bifascialis* (A. Adams). JN: Hanagouna.
Fig. 9. *Strombus* (*Doxander*) *japonicus* Reeve. JN: Shidorogai.
Fig. 10. *Crepidula* (*Bostrycapulus*) *gravispinosus* (Kuroda and Habe). JN: Awabunegai.
Fig. 11. *Thylacodes adamsii* (Mörch). JN: Oohebigai.

Explanation of Plate 3
Caenogastropoda (JN: Japanese name).
Fig. 1. *Glossaulax didyma* (Röding). JN: Tsumetagai.
Fig. 2. *Phalium flammiferum* (Röding). JN: Kazuragai.
Fig. 3. *Tonna lischkeana* (Küster). JN: Uzuramiyashirogai.
Fig. 4. *Epitonium auritum* (G.B. Sowerby II). JN: Odamaki.
Fig. 5. *Janthina globosa* Swainson. JN: Rurigai.
Fig. 6. *Mitrella bicincta* (Gould). JN: Mugigai.
Fig. 7. *Nassarius conoidalis* (Deshayes). JN: Araregai.
Fig. 8. *Nassarius* (*Niotha*) *livescens* (Philippi). JN: Mushirogai.

Explanation of Plate 4
Caenogastropoda and Euopisthobranchia (JN: Japanese name).
Fig. 1. *Fusinus perplexus* (A. Adams). JN: Naganishi.
Fig. 2. *Babylonia japonica* (Reeve). JN: Bai.
Fig. 3. *Reishia bronni* (Dunker). JN: Reishigai.
Fig. 4. *Reishia clavigera* (Küster). JN: Ibonishi.
Fig. 5. *Olivella fulgurata* (Adams and Reeve). JN: Mushibotaru.
Fig. 6. *Oliva mustelina* Lamarck. JN: Makuragai.
Fig. 7. *Momoebora sinensis* (Reeve). JN: Momoebora.
Fig. 8. *Sydaphera spengleriana* (Deshayes). JN: Koromogai.
Fig. 9. *Cancellaria* (*Habesolatia*) *nodulifera* G.B. Sowerby I. JN: Tokashioriire.
Fig. 10. *Philine argentata* Gould. JN: Kisewatagai.

Explanation of Plate 5
Cephalopoda and Scaphopoda (JN: Japanese name).
Fig. 1. *Argonauta argo* Linnaeus. JN: Aoigai.
Fig. 2. *Acanthosepion esculenta* (Hoyle). JN: Kouika.
Fig. 3. *Doratosepion kobiensis* (Hoyle). JN: Himekouika.
Fig. 4. *Compressidens kikuchii* (Kuroda and Habe). JN: Hinatsunogai.
Fig. 5. *Siphonodentalium isaotakii* Habe. JN: Kuchikiretsunogai.

Explanation of Plate 6
Nuculanoida and Arcoida (JN: Japanese name).
Fig. 1. *Nuculana* (*Saccella*) *sematensis* (Suzuki and Ishizuka). JN: Arasujisodegai.
Fig. 2. *Arca boucardi* Jousseaume. JN: Koberutofunegai.
Fig. 3. *Barbatia* (*Ustularca*) *stearnsii* (Pilsbry). JN: Hanaegai.
Fig. 4. *Scapharca inaequivalvis* (Bruguière). JN: Kuichigaisarubou.
Fig. 5. *Scapharca satowi* (Dunker). JN: Satougai.
Fig. 6. *Porterius dalli* (E.A. Smith). JN: Shikoroegai.
Fig. 7. *Arcopsis symmetrica* (Reeve). JN: Mimiegai.
Fig. 8. *Glycymeris* (*Veletuceta*) *albolineata* (Lischke). JN: Benkeigai.

Explanation of Plate 7
Mytiloida and Pterioida (JN: Japanese name).
Fig. 1. *Mytilus galloprovincialis* Lamrck. JN: Murasakiigai.
Fig. 2. *Mytilus coruscus* Gould. JN: Igai.
Fig. 3. *Septifer virgatus* (Wiegmann). JN: Murasakiinko.
Fig. 4. *Septifer keenae* Nomura. JN: Himeigai.
Fig. 5. *Modiolus nipponicus* (Oyama). JN: Hibarigai.
Fig. 6. *Gregariella barbata* (Gmelin). JN: Chijimitamaegai.
Fig. 7. *Crassostrea gigas* (Thunberg). JN: Magaki.
Fig. 8. *Crossostrea nippona* (Seki). JN: Iwagaki.

Explanation of Plate 8
Limoida and Pectinoida (JN: Japanese name).
Fig. 1. *Limaria hakodatensis* (Tokunaga). JN: Fukureyukimino.
Fig. 2. *Chlamys* (*Azumapecten*) *farreri nipponensis* Kuroda. JN: Azumanishiki.
Fig. 3. *Swiftopecten swiftii* (Bernardi). JN: Ezokinchaku.
Fig. 4. *Pecten albicans* (Schröter). JN: Itayagai.
Fig. 5. *Spondylus cruentus* Lischke. JN: Chiribotan.
Fig. 6. *Anomia chinensis* Philippi. JN: Namimagashiwa.
Fig. 7. *Monia macroschisma* (Deshayes). JN: Namimagashiwamodoki.

Explanation of Plate 9
Veneroida (JN: Japanese name).
Fig. 1. *Cardita leana* Dunker. JN: Tomayagai.
Fig. 2. *Agriodesma navicula* (A. Adams and Reeve). JN: Obikui.
Fig. 3. *Laternula anatina* (Linnaeus). JN: Okinagai.
Fig. 4. *Epicodakia delicatula* (Pilsbry). JN: Umiasagai.
Fig. 5. *Joannisiella nomurai* (Habe). JN: Hirashiogama.
Fig. 6. *Joannisiella tsuchii* (Yamamoto and Habe). JN: Atsushiogama.
Fig. 7. *Chama japonica* Lamarck. JN: Kikuzaru.
Fig. 8. *Kellia porculus* Pilsbry. JN: Kohakunotsuyu.
Fig. 9. *Basterotia stimpsoni* (A. Adams). JN: Soyokazegai
Fig. 10. *Coralliophaga coralliophaga* (Gmelin). JN: Tagasodegai.
Fig. 11. *Trapezium liratum* (Reeve). JN: Unenashitomayagai.
Fig. 12. *Corbicula japonica* Prime. JN: Yamatoshijimi.

Explanation of Plate 10
Veneroida (JN: Japanese name).
Fig. 1. *Fulvia mutica* (Reeve). JN: Torigai.
Fig. 2. *Placamen foliaceum* (Philippi). JN: Hanagai.
Fig. 3. *Protothaca jedoensis* (Lischke). JN: Oniasari.
Fig. 4. *Pitar japonicus* Kuroda and Kawamoto. JN: Usuhamaguri.
Fig. 5. *Phacosoma troscheli* (Lischke). JN: Maruhinagai.
Fig. 6. *Ruditapes philippinarum* (A. Adams and Reeve). JN: Asari.

Fig. 7. *Paphia amabilis* (Philippi). JN: Satsumaakagai.
Fig. 8. *Irus mitis* (Deshayes). JN: Matsukazegai.
Fig. 9. *Irus macrophyllus* (Deshayes). JN: Hanematsukaze.
Fig. 10. *Irus ishibashianus* (Kira). JN: Okinamatsukaze.
Fig. 11. *Macridiscus melanaegis* (Römer). JN: Kotamagai.
Fig. 12. *Callista chinensis* (Holten). JN: Matsuyamawasure.

Explanation of Plate 11
Veneroida (JN: Japanese name).
Fig. 1. *Meretrix lamarckii* Deshayes. JN: Chousenhamaguri.
Fig. 2. *Meretrix petechialis* (Lamarck). JN: Shinahamaguri.
Fig. 3. *Clementia vatheleti* Mabille. JN: Fusumagai.
Fig. 4. *Petricolirus aequistriatus* (G.B. Sowerby). JN: Shiotsugai.
Fig. 5. *Chion semigranosa* (Dunker). JN: Fujinohanagai.
Fig. 6. *Latona cuneata* (Linnaeus). JN: Naminokogai.
Fig. 7. *Pharaonella sieboldii* (Deshayes). JN: Benigai.
Fig. 8. *Tellinides ovalis* (G.B. Sowerby I). JN: Hirazakura.
Fig. 9. *Megangulus zyonoensis* (Hatai and Nisiyama). JN: Arasujisaragai.
Fig. 10. *Nitidotellina iridella* (Martens). JN: Kabazakura.
Fig. 11. *Macoma praetexta* (Martens). JN: Oomomonohana.

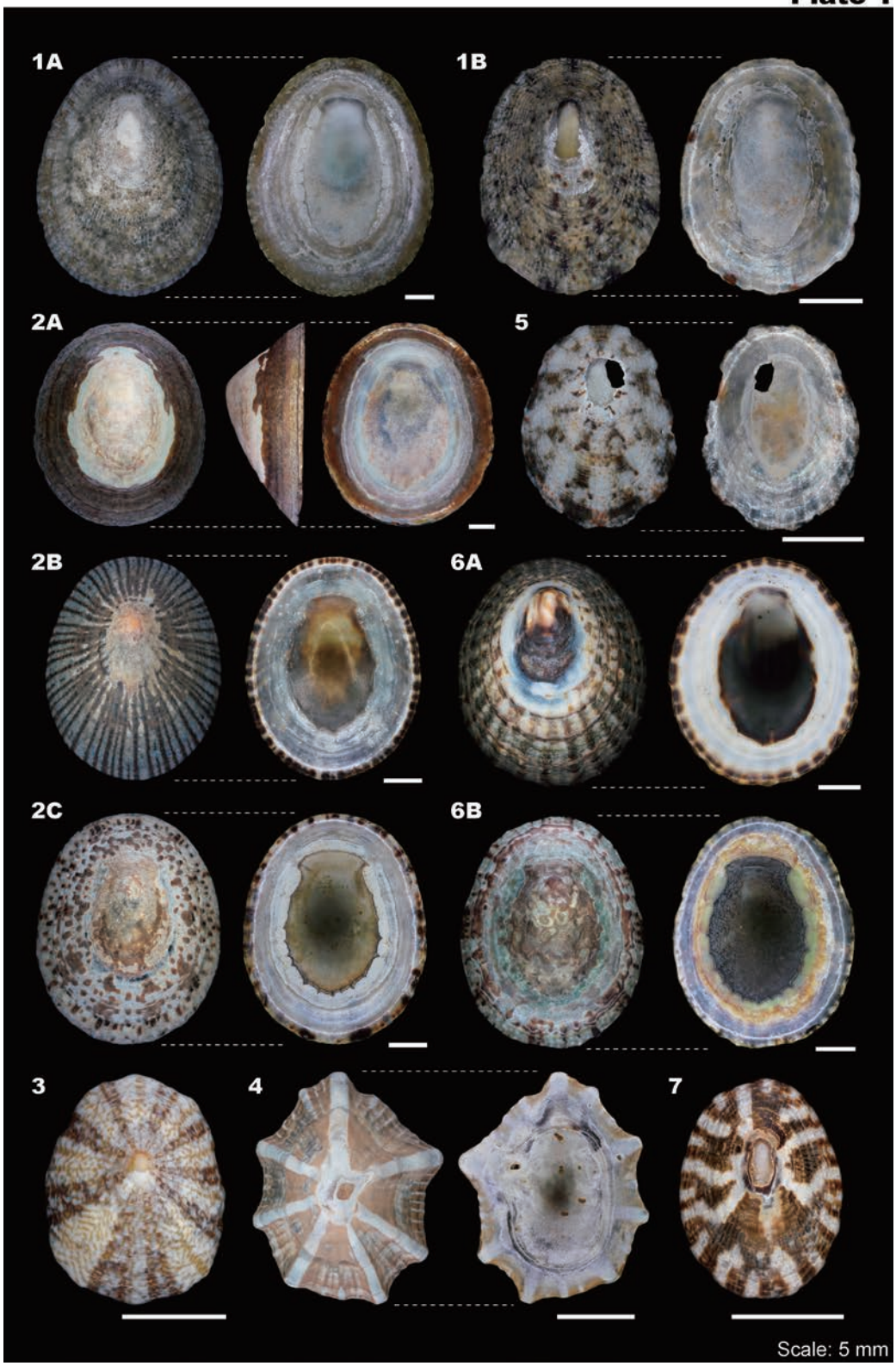
Explanation of Plate 12
Veneroida (JN: Japanese name).
Fig. 1. *Macoma sectior* Oyama. JN: Sagigai.
Fig. 2. *Heteromacoma irus oyamai* Kira. JN: Marushiratorimodoki.
Fig. 3. *Soletellina boeddinghausi* Lischke. JN: Fujinamigai.
Fig. 4. *Nuttallia japonica* (Reeve). JN: Isoshijimi.
Fig. 5. *Solecurtus divaricatus* (Lischke). JN: Kinutaagemaki.
Fig. 6. *Solen strictus* Gould. JN: Mategai.
Fig. 7. *Solen kurodai* Habe. JN: Dandaramategai.
Fig. 8. *Siliqua pulchella* (Dunker). JN: Mizogai.

Explanation of Plate 13
Veneroida and Myoida (JN: Japanese name).
Fig. 1. *Mactra chinensis* Philippi. JN: Bakagai.
Fig. 2. *Coelomactra antiquata* (Spengler). JN: Arisogai.
Fig. 3. *Pseudocardium sachalinense* (Schrenck). JN: Ubagai.
Fig. 4. *Lutraria maxima* Jonas. JN: Ootorigai.
Fig. 5. *Raetellops pulchellus* (A. Adams and Reeve). JN: Chiyonohanagai.
Fig. 6. *Cardilia semisulcata* (Lamarck). JN: Kisagai.
Fig. 7. *Solidicorbula erythrodon* (Lamarck). JN: Kuchibenigai.

Explanation of Plate 14
Myoida (JN: Japanese name).
Fig. 1. *Penitella* sp. JN: Kamomegai.
Fig. 2. *Zirfaea constricta* (G.B. Sowerby). JN: Niogaimodoki.
Fig. 3. *Barnea* (*Anchomasa*) *fragilis* (G.B. Sowerby). JN: Niogai.
Fig. 4. *Barnea* (*Umitakea*) *japonica* (Yokoyama). JN: Umitake.

Explanation of Plate 15
Mesogastropoda, Bassommatophora and Unionoida (JN: Japanese name). Freshwater species.
Fig. 1. *Cipangopaludina japonica* (Martens). JN: Ootanishi.
Fig. 2. *Sinotaia quadrata histrica* (Gould). JN: Himetanishi.
Fig. 3. *Semisulcospira libertina* (Gould). JN: Kawanina.
Fig. 4. *Physella acuta* Draparnaud. JN: Sakamakigai.
Fig. 5. *Sinohyriopsis schlegelii* (Martens). JN: Ikechougai.

Plate 1



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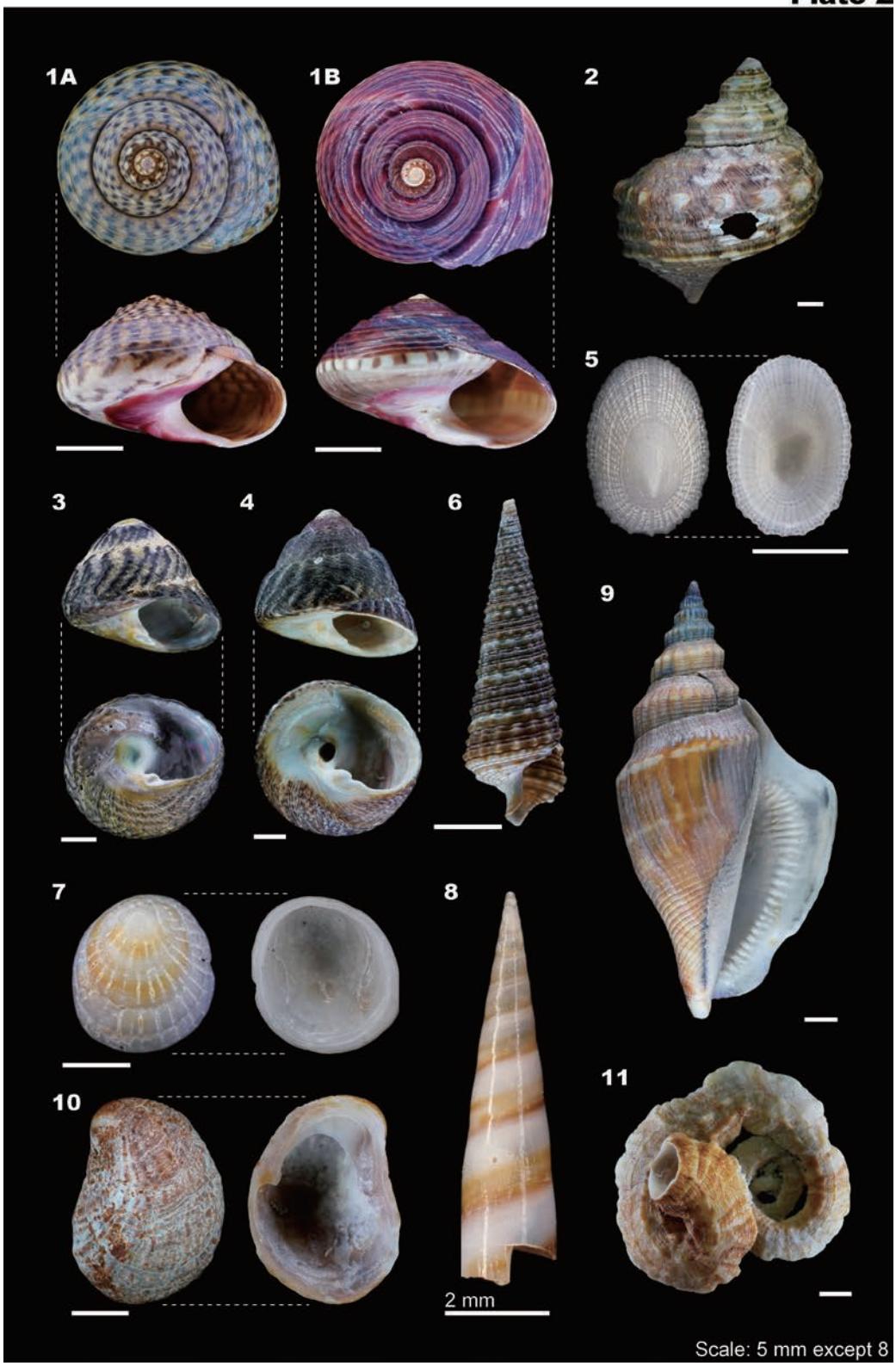

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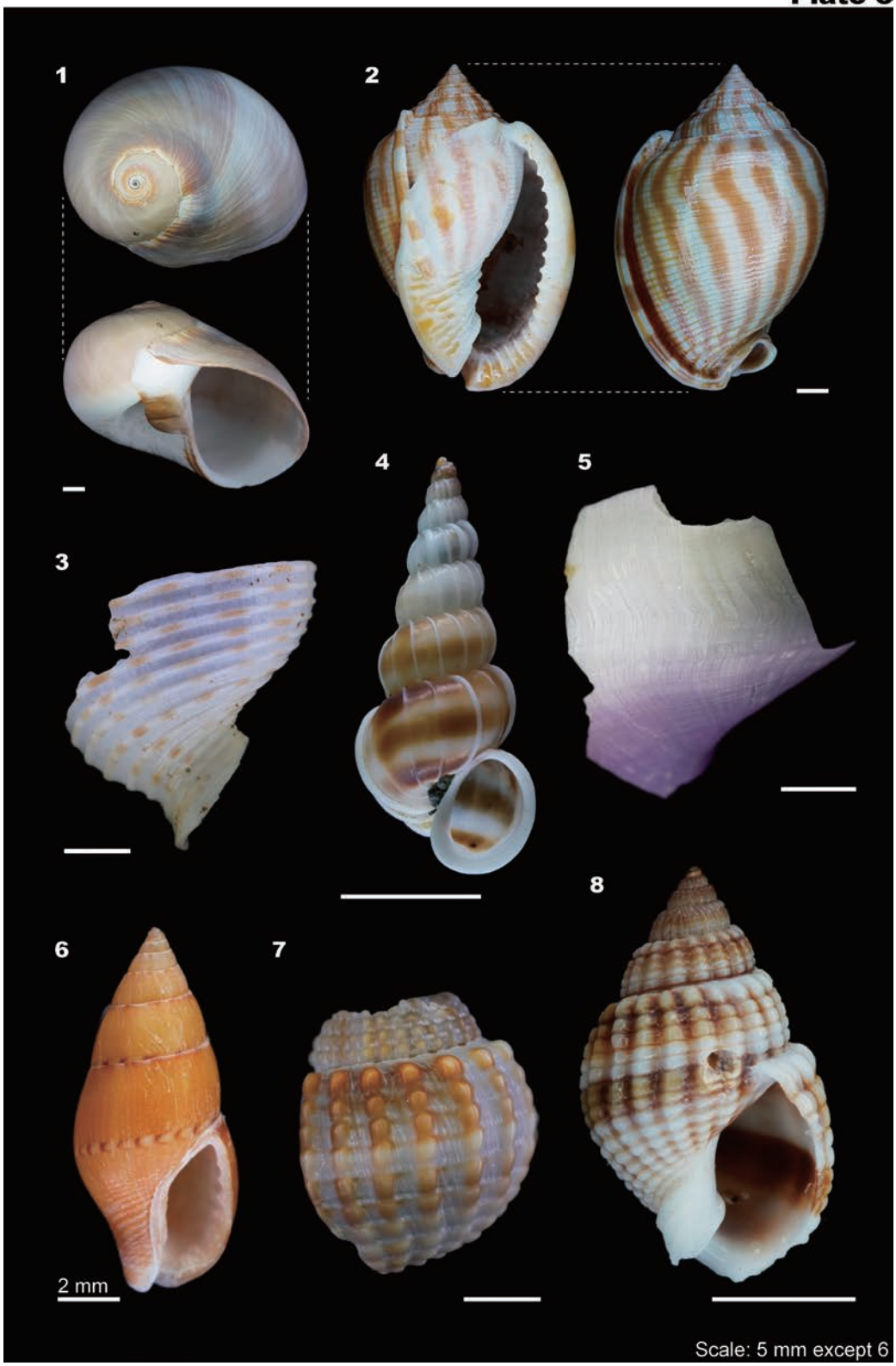

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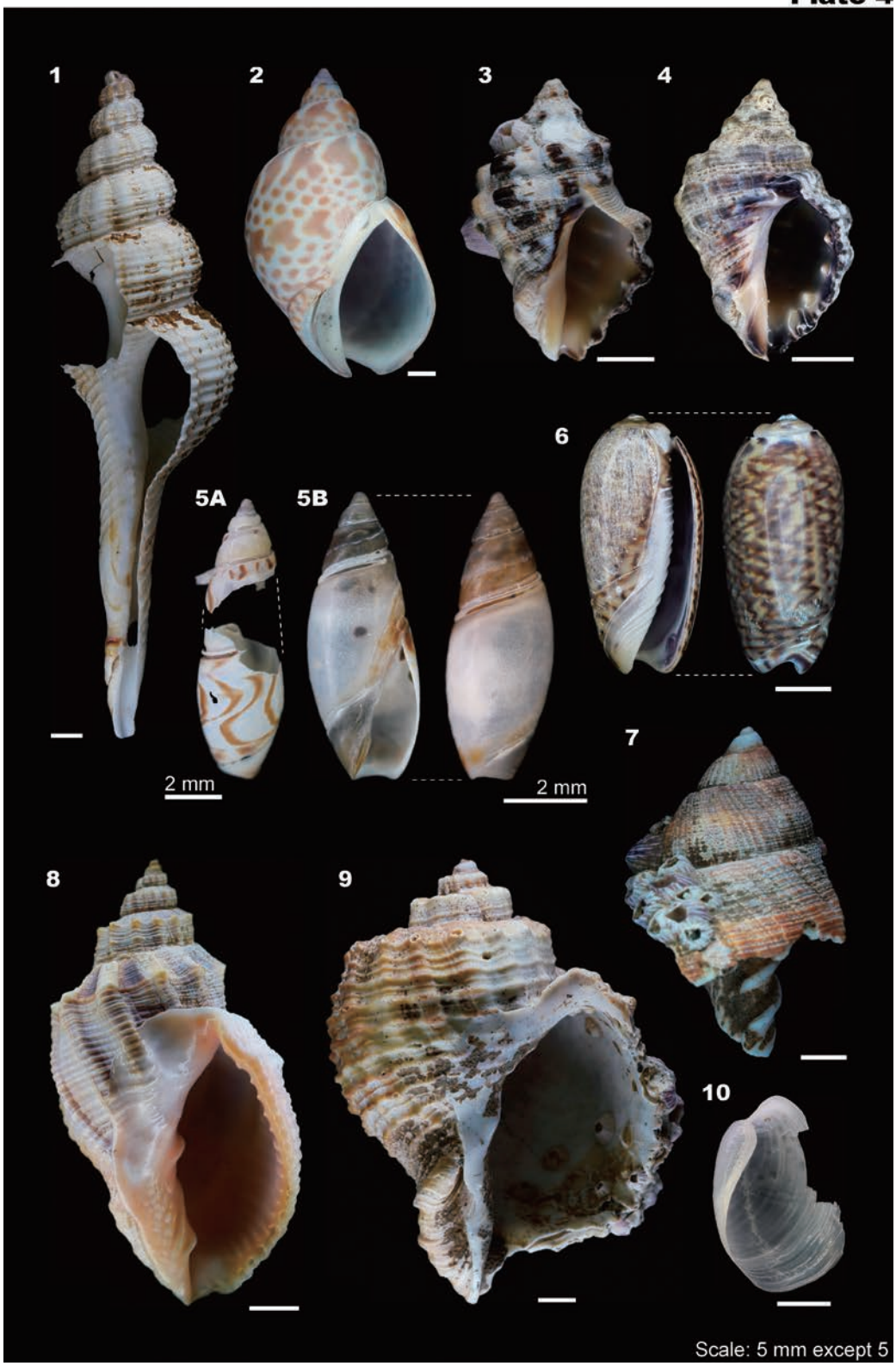

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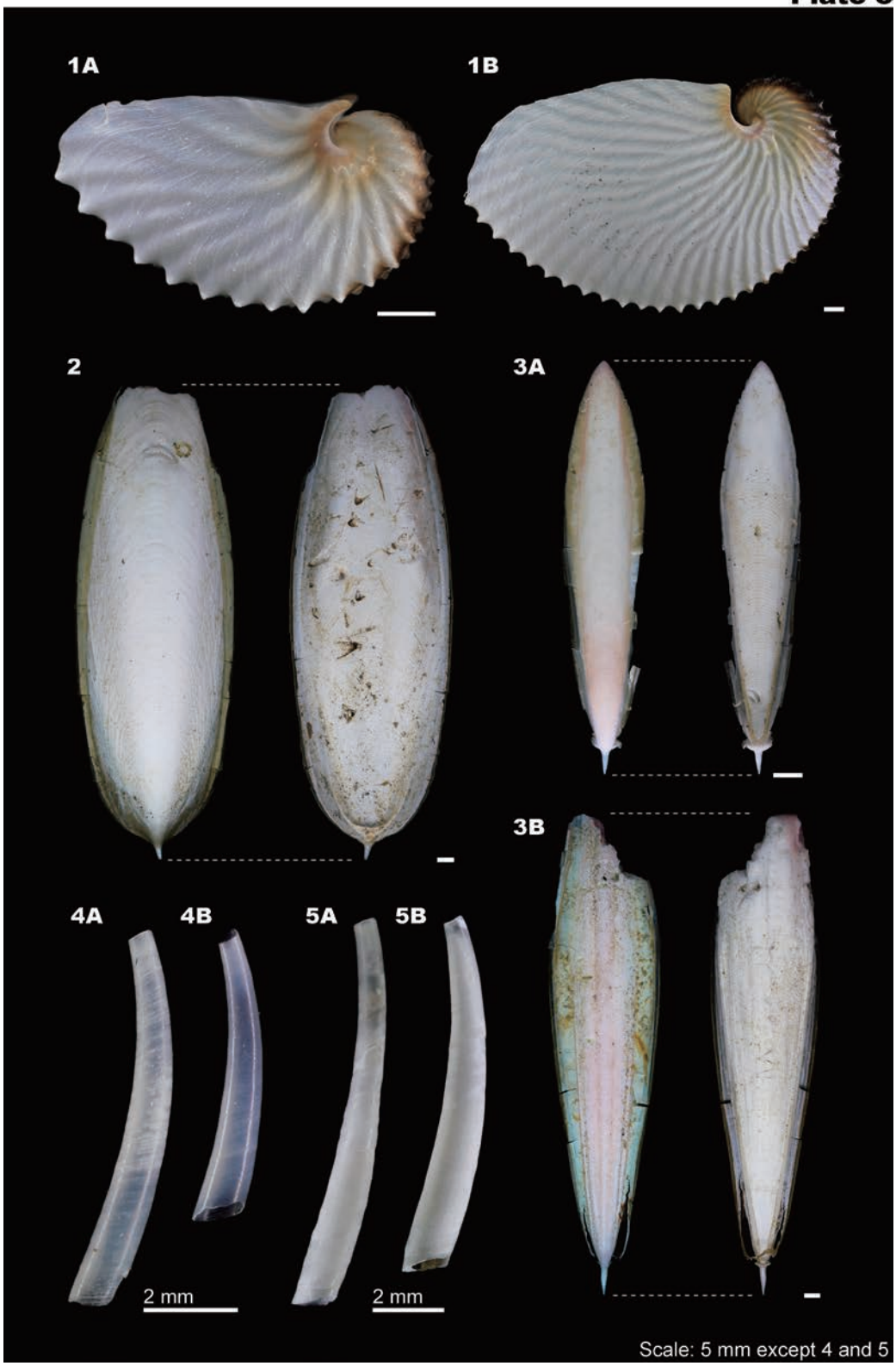

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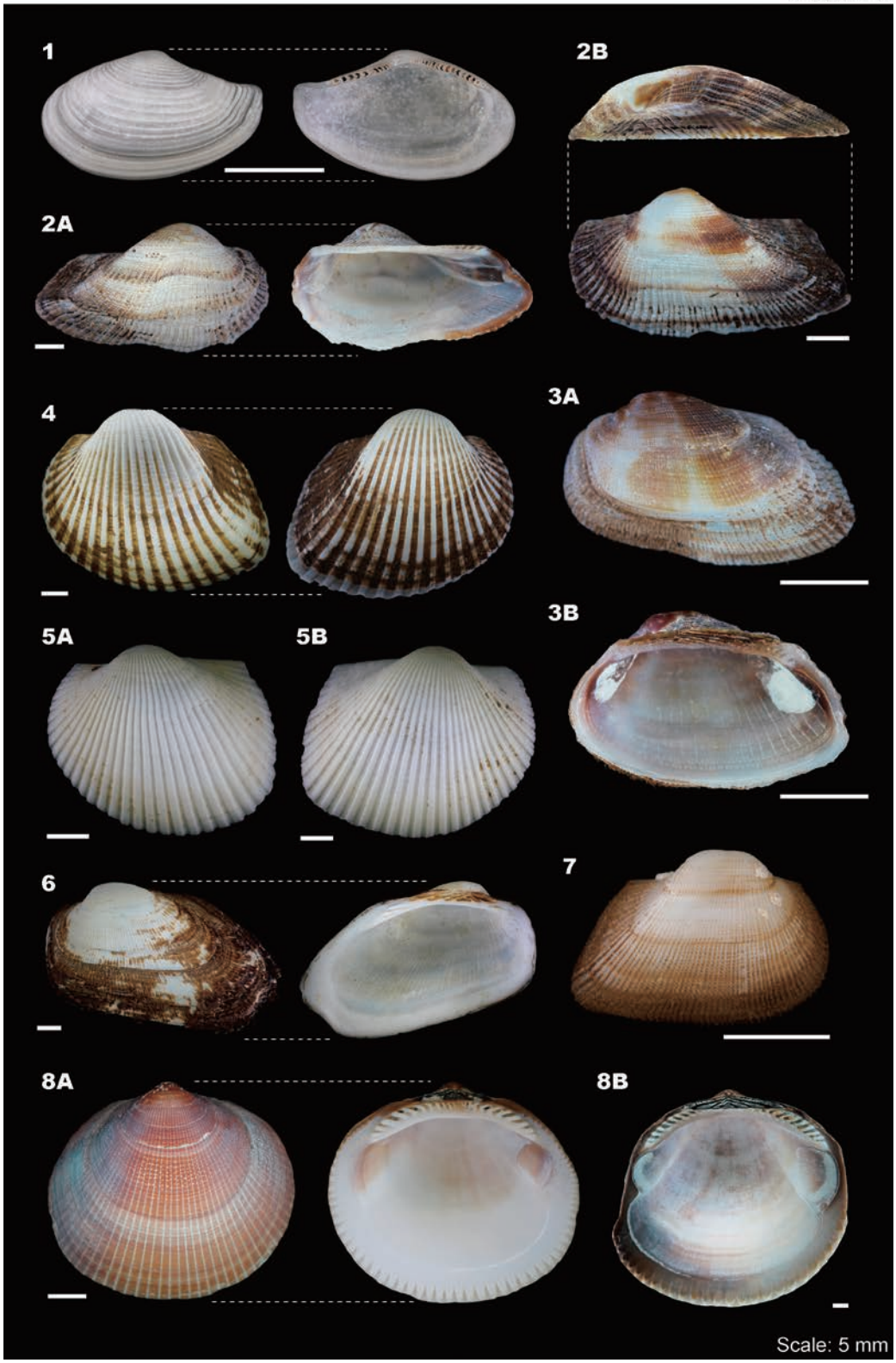

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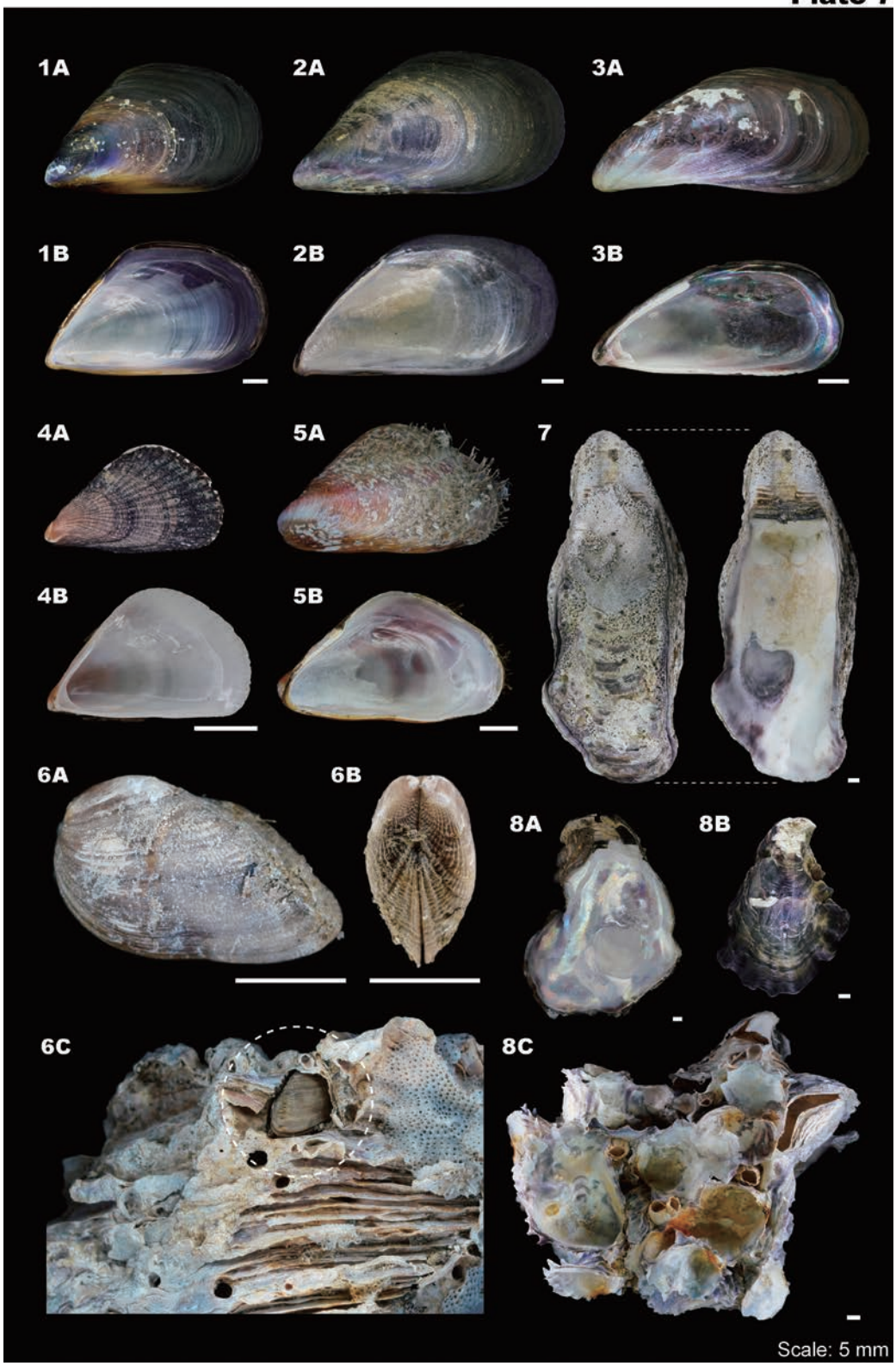

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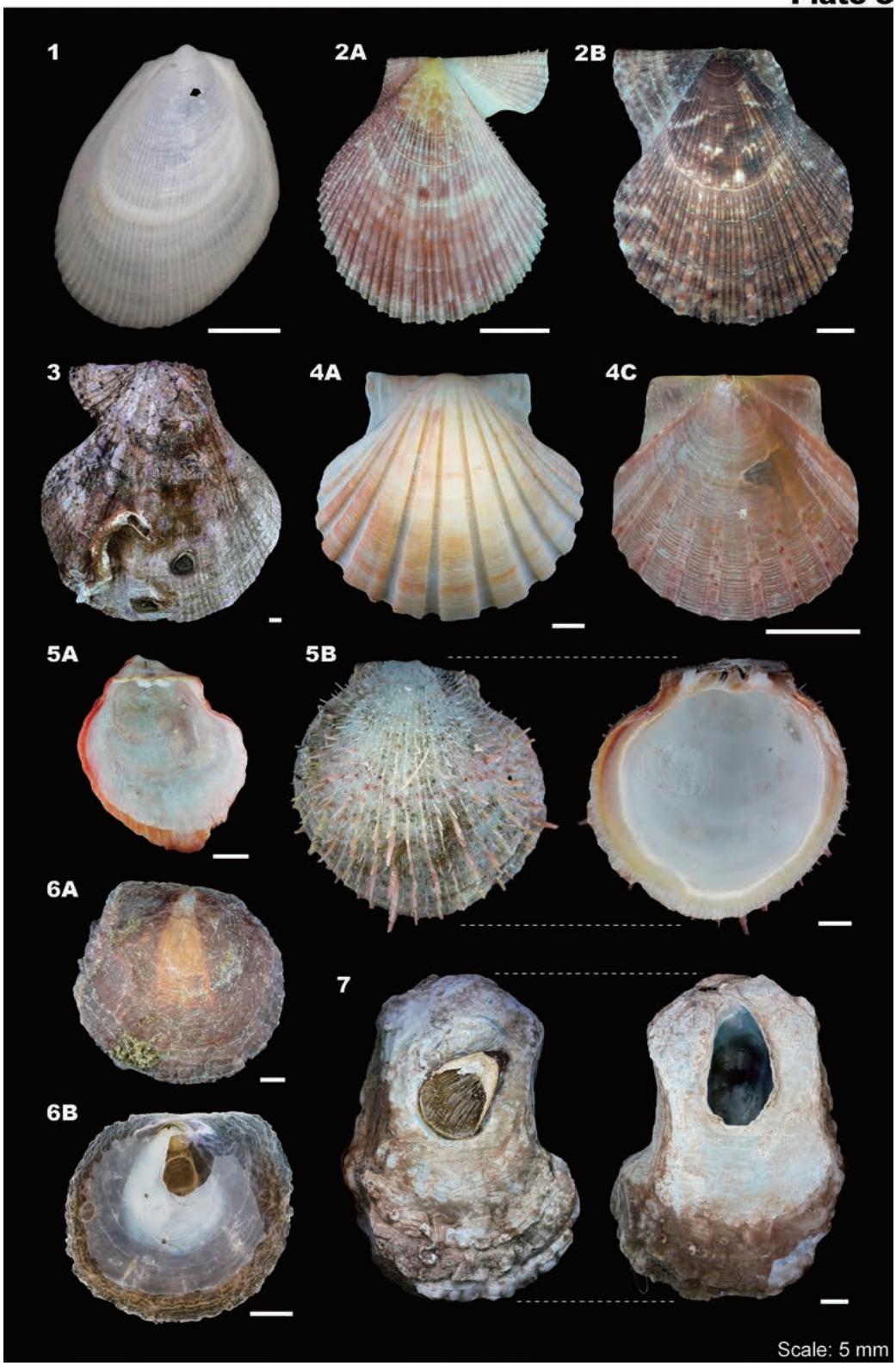

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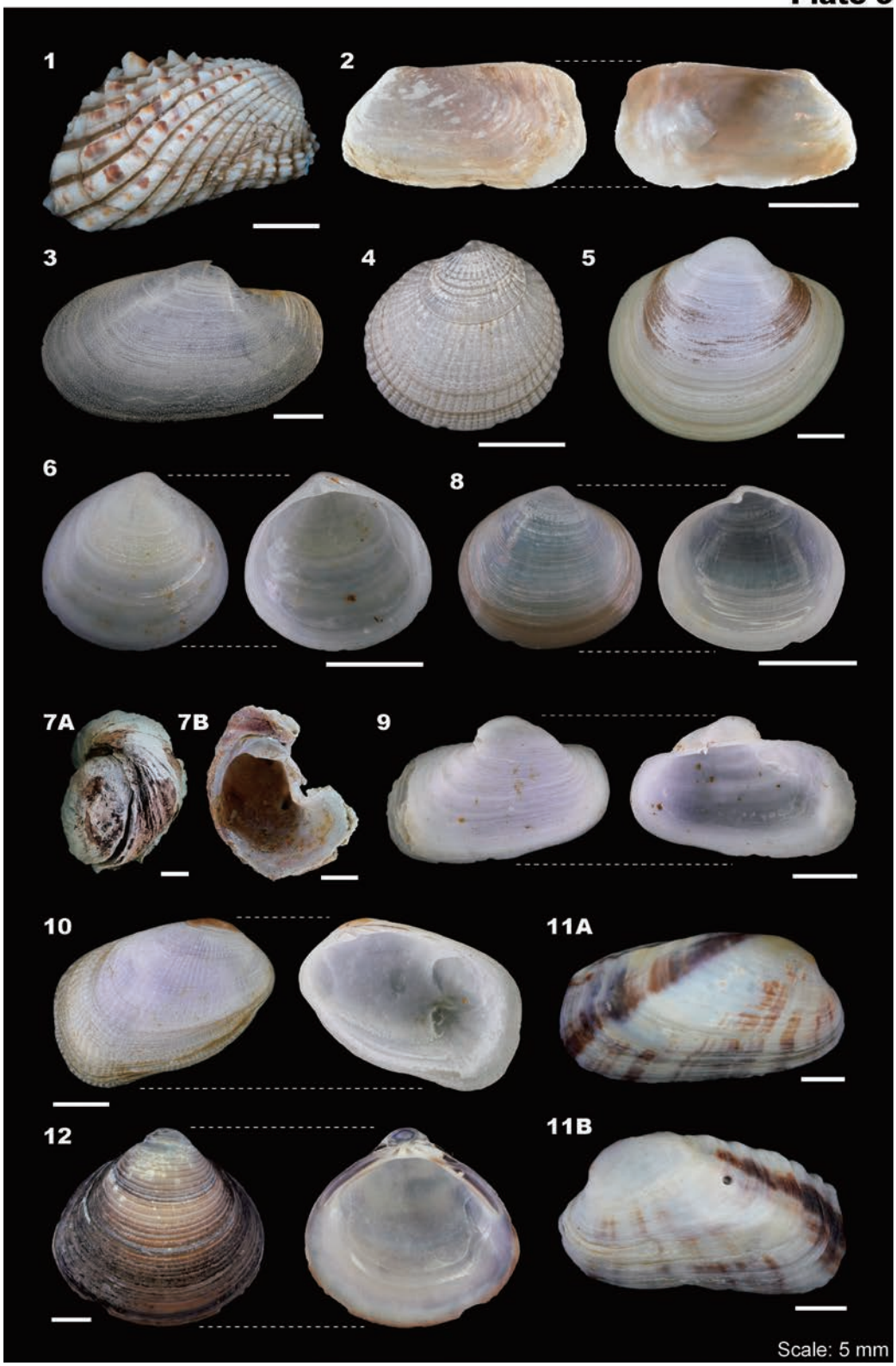

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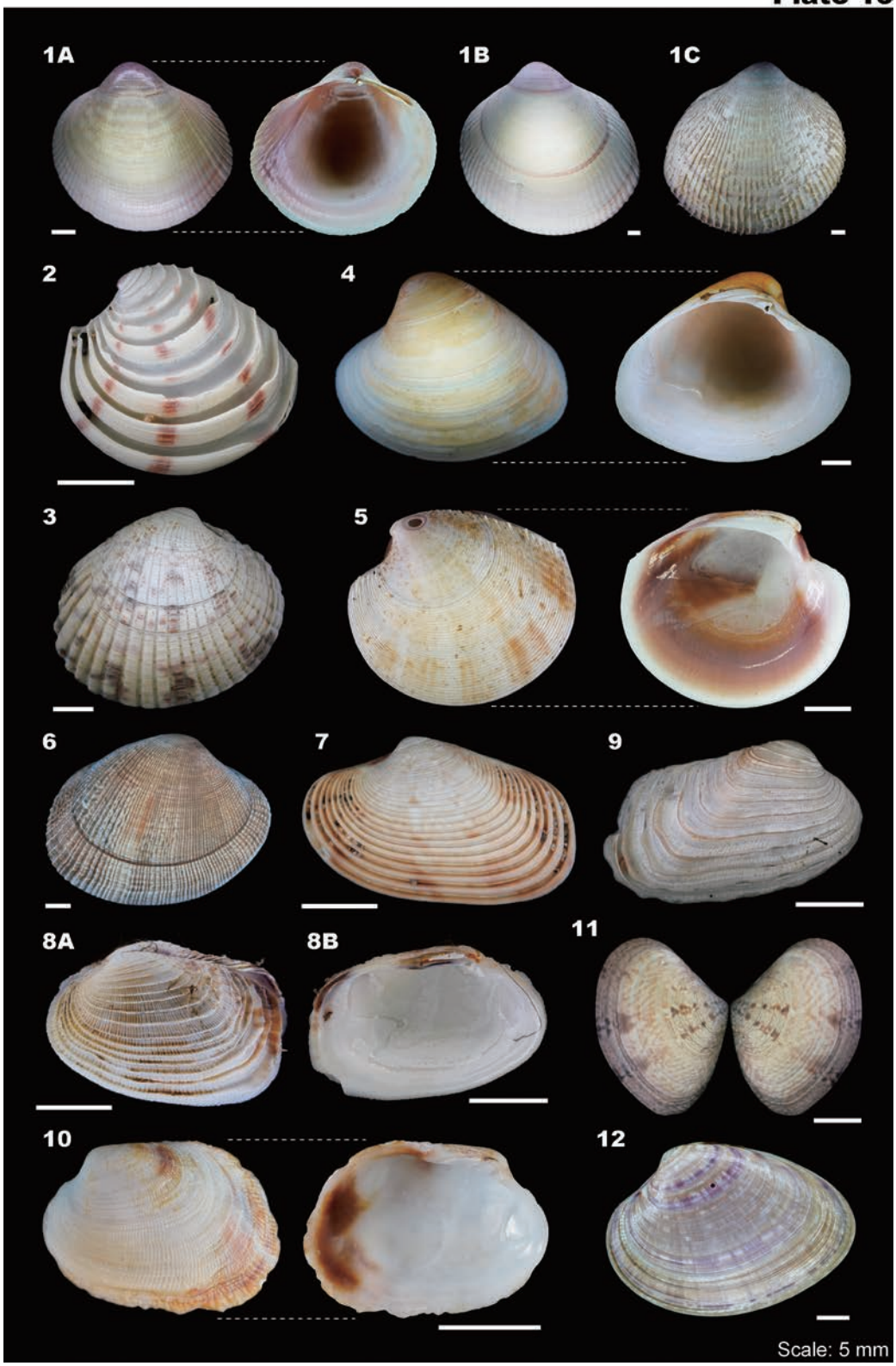

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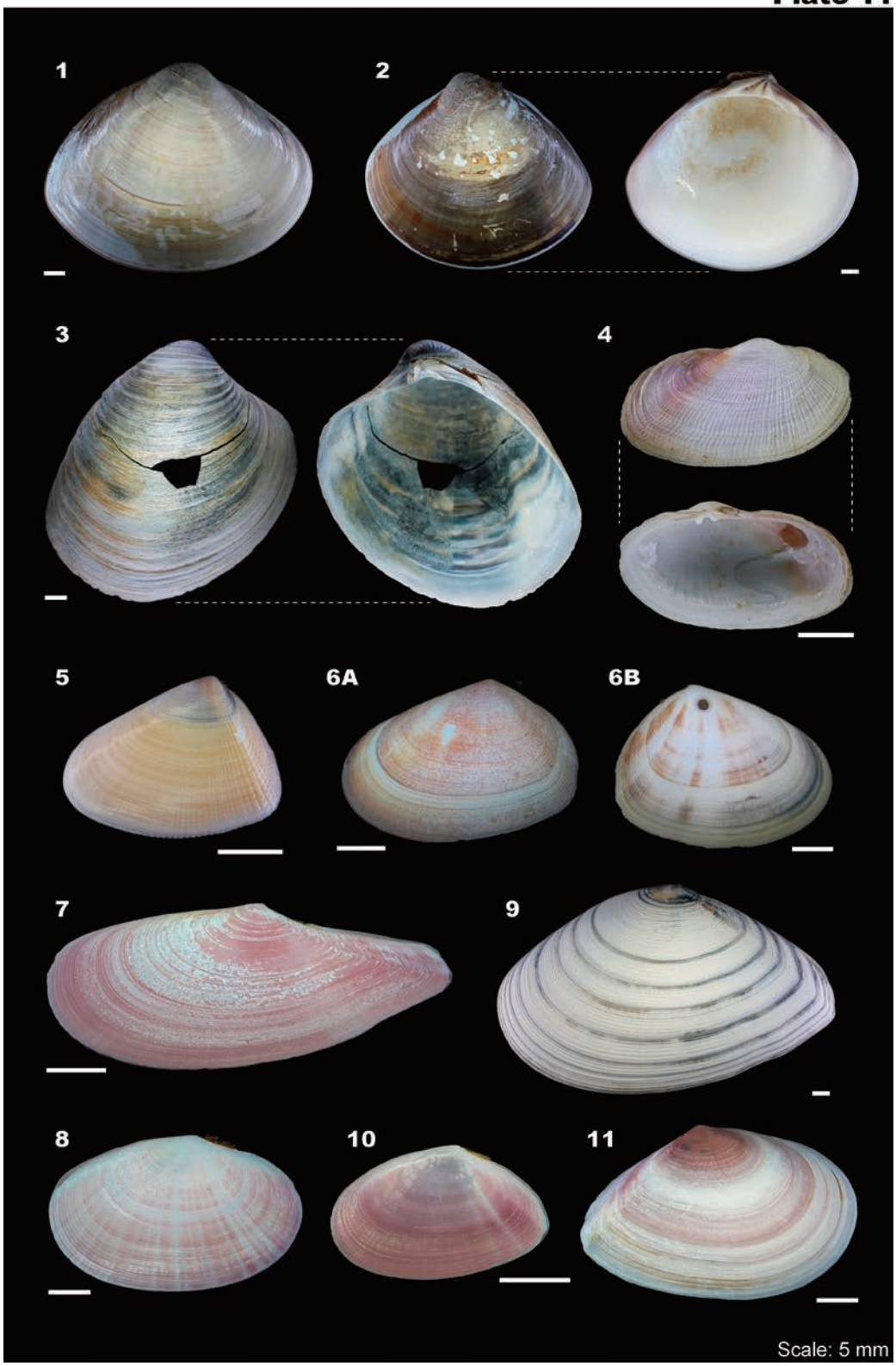

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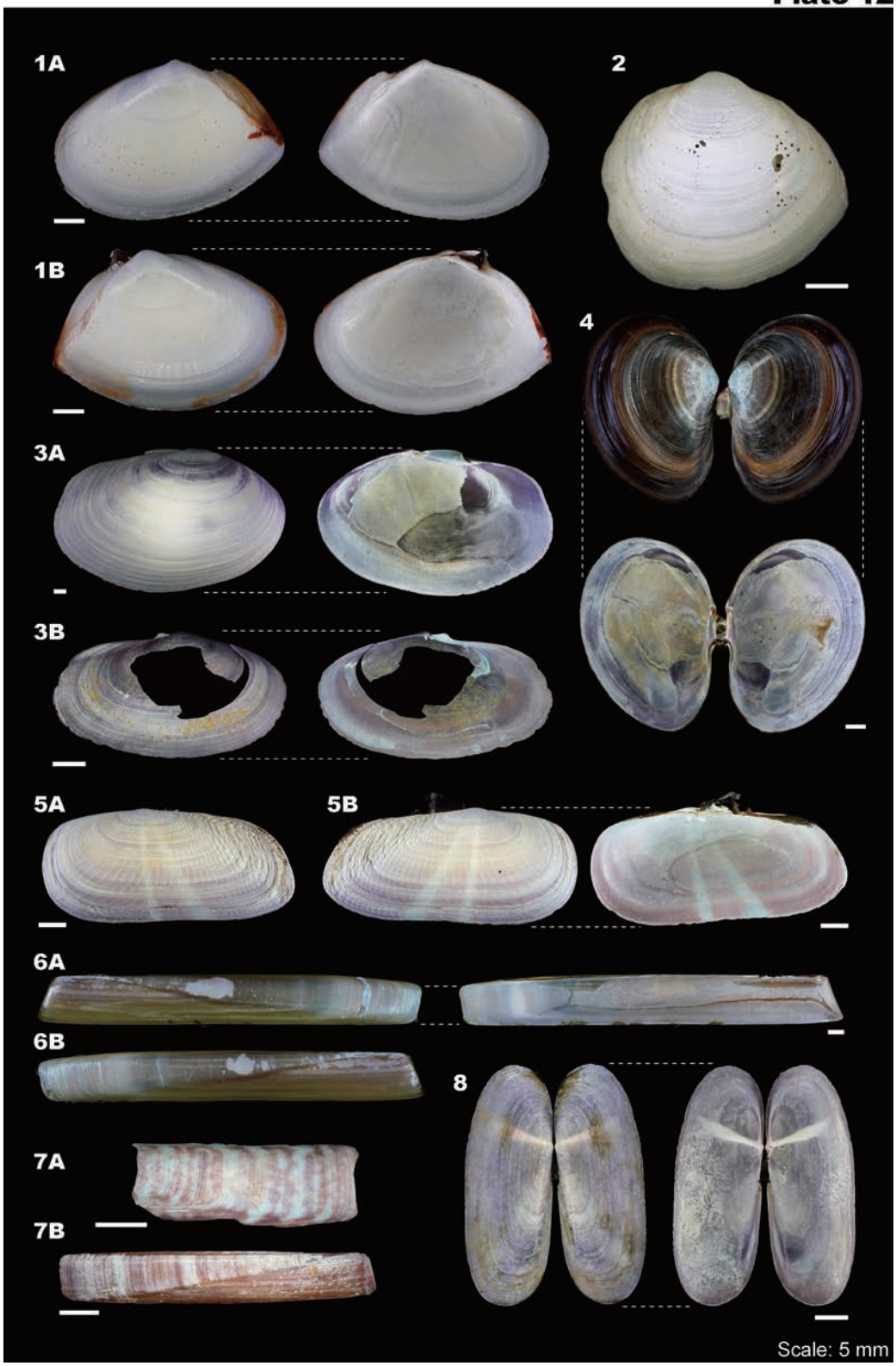

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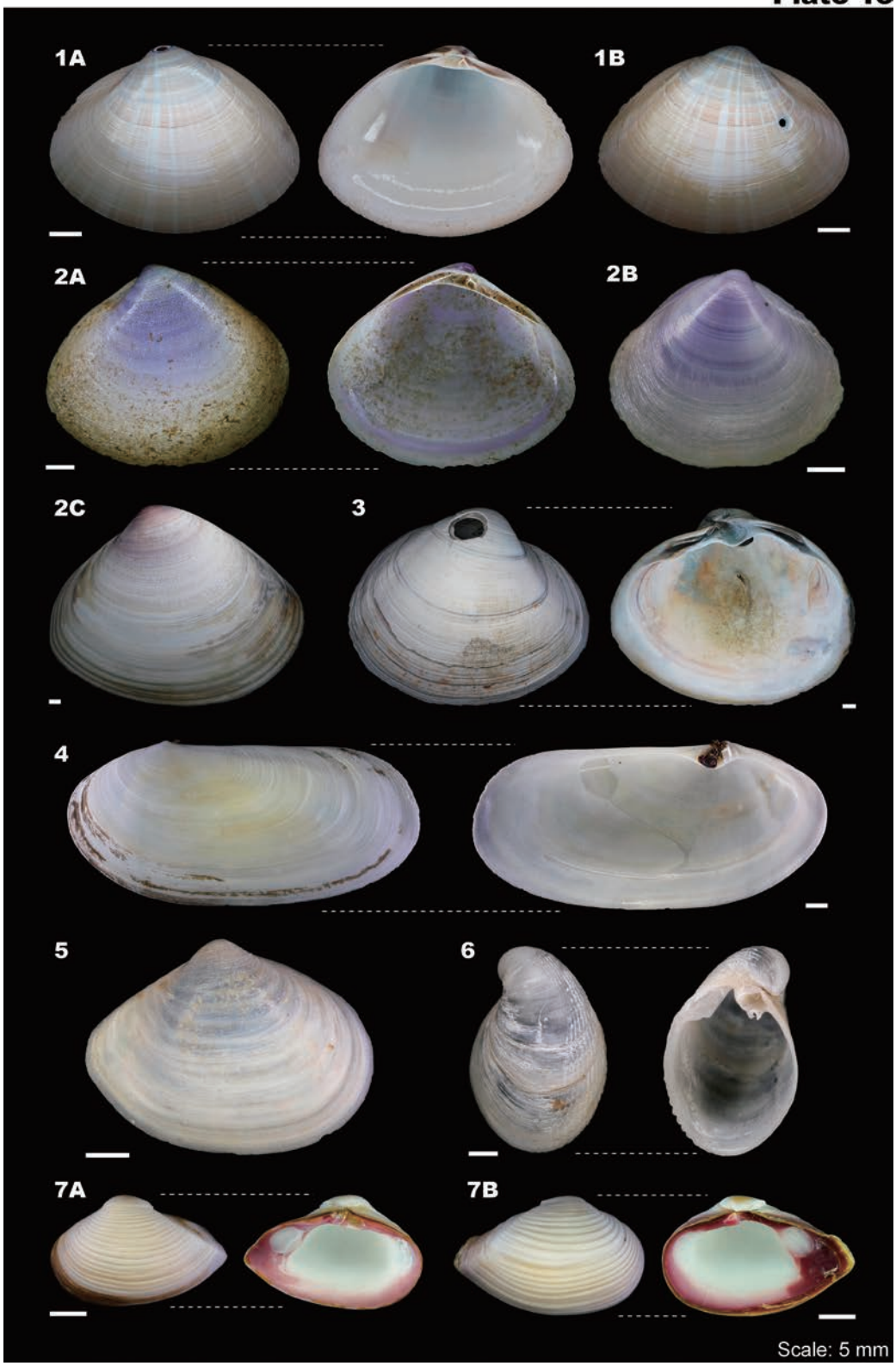

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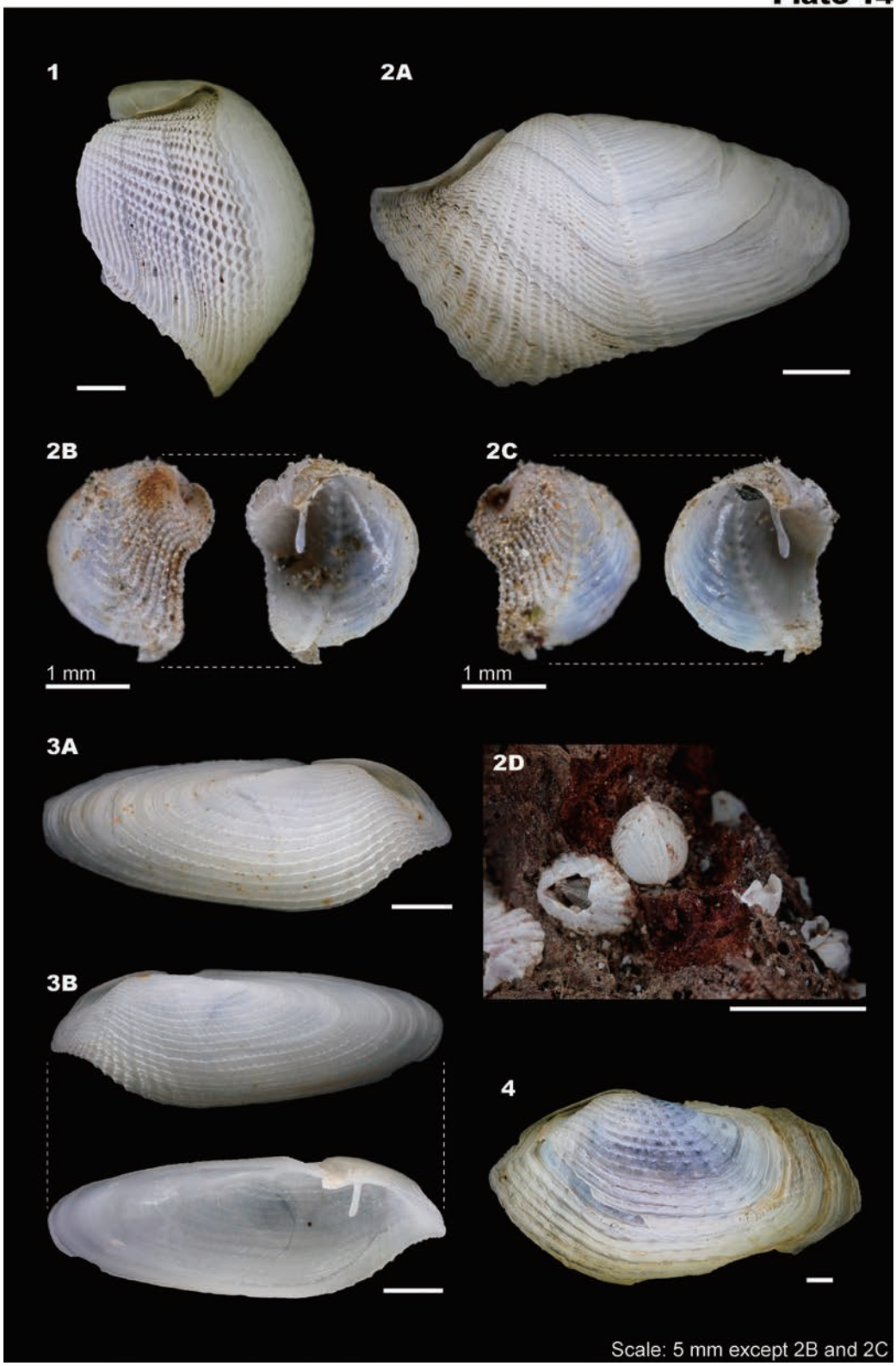

Plate 15