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First Record of Tropical-Subtropical Xanthid Crab *Liomera venosa* from Korean Waters

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ABSTRACT

An Indo-West Pacific species, *Liomera venosa*, is newly reported based on specimens collected from subtidal rocky reefs around Jejudo Island, South Korea. Examination of the Korean specimens revealed that the gastric region is divided by five longitudinal ridges and that the dorsal surfaces of the carpus and propodus of the ambulatory legs are undulated; these characters are consistent with the original description of *L. venosa*. Comparative observations with the morphologically similar species *L. cinctimanus* confirmed that these characters are absent in that species, clearly distinguishing the Korean specimens from *L. cinctimanus*. Molecular analyses of the mitochondrial 16S rDNA and cytochrome *c* oxidase subunit I (COI) gene regions supported the identification of the Korean specimens as *L. venosa*, and genetic divergences based on combined sequences of Korean and previously reported specimens corresponded to intraspecific levels (0.18–1.77% for COI and 0–1.19% for 16S rDNA), whereas genetic distances to *L. cinctimanus* corresponded to interspecific levels (11.7–11.88% for COI and 10.48–11.43% for 16S rDNA). The observation of ovigerous females and of their eggs hatching into zoeal larvae suggests that this species may have established a reproducing population around Jejudo Island. The occurrence of *L. venosa* in Korean waters may be associated with recent ocean warming driven by the Tsushima Warm Current surrounding Jejudo Island, highlighting the biogeographical significance of the presence of a tropical-subtropical species in Korean waters.

Keywords: xanthid crab, *Liomera*, tropical-subtropical species

INTRODUCTION

The genus *Liomera* Dana, 1851, belonging to the family Xanthidae MacLeay, 1838, comprises more than 30 species worldwide (Ng et al., 2008; WoRMS Editorial Board, 2025). Members of this genus are widely distributed across the Indo-West Pacific, including the East Asian waters encompassing Korea, Japan, and Taiwan. Species of *Liomera* are generally found in subtidal habitats, often beneath coral rubble, shell gravel, or within rock crevices (Serène, 1984). Because many species inhabit cryptic microhabitats and are relatively small in size, they are frequently overlooked during faunal surveys, and the regional diversity of the genus remains incompletely documented in many parts of the Indo-West Pacific. Similarly, in Korean waters only a single species, *Liomera margaritata* (A. Milne-Edwards, 1873), has been reported to date, indicating that the distribution and diversity of the genus in this region remain poorly known (Lee and Ko, 2011).

In recent years, several tropical and subtropical decapod species have been reported from Korean waters, particularly from the waters surrounding Jejudo Island, where relatively warm sea temperatures are maintained year-round under the influence of the Tsushima Warm Current (Park et al., 2021, 2022a; Lee et al., 2023). Such changes have been suggested to be associated with ongoing ocean warming and the poleward range expansion of marine organisms observed worldwide (Poloczanska et al., 2016; Pecl et al., 2017).

During a faunal survey of invertebrate diversity in subtidal rocky reef habitats off Seogwipo, Jejudo Island, specimens of *Liomera venosa* (H. Milne Edwards, 1834), a tropical to subtropical species, were collected for the first time from Korean waters. The specimens showed diagnostic characters of the genus *Liomera* described by Sakai (1976) and Serène (1984), including a transversely broad, oval carapace with anterolateral margins divided into several broad lobes, a dorsal surface with distinct regions, and somewhat depressed ambulatory legs.

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In this study, we report the first record of *L. venosa* from Korean waters and provide morphological diagnostic features and mitochondrial cytochrome *c* oxidase subunit I (COI) and 16S sequences of the specimens, together with comparative remarks on closely related congeners.

MATERIALS AND METHODS

Collection of specimens and morphological observations

Specimens were collected during faunal surveys of invertebrate diversity conducted in subtidal rocky reef habitats off Seogwipo, Jejudo Island, South Korea, between 2023 and 2025. Collecting was carried out by SCUBA diving at depths of approximately 15 m near Munseom and Seopseom Islets, where the individuals were found hiding beneath rocks. For detailed morphological examination, the specimens were frozen and subsequently thawed slowly at low temperature to prevent autotomy before being fixed in 80% ethanol. Morphological characters were examined under a stereomicroscope (SZX7, Olympus, Japan), and photographs were taken using a digital camera (Z8, Nikon, Japan) and processed with Helicon Focus 8 (Helicon Soft, Kharkiv, Ukraine). Gonopods were illustrated using a drawing tube attached to the microscope and subsequently digitized using Adobe Photoshop (Adobe Inc., San Jose, CA, USA). General taxonomic terminology follows Davie et al. (2015) and Ng et al. (2008), and the definitions and measurement methods of the abbreviations "cl" and "cw" follow Lee et al. (2022). All examined specimens are deposited in the National Institute of Biological Resources (NIBR), Korea.

Molecular analysis

Total genomic DNA was extracted from the ambulatory legs using the DNeasy Blood and Tissue Kit (Qiagen, Valencia, CA, USA) following the manufacturer's instructions. Polymerase chain reaction (PCR) amplification was performed using the primer sets listed in Table 1. The COI gene was amplified following the methods described by Astrin and

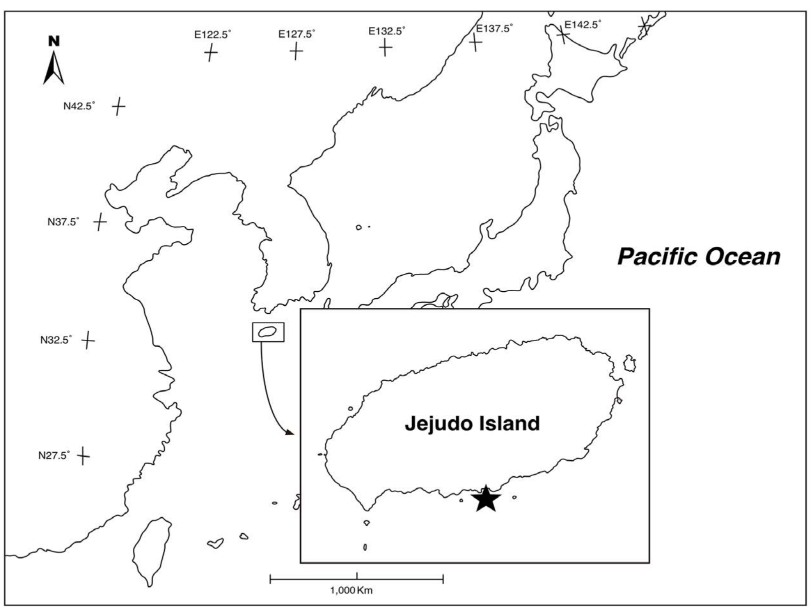

Fig. 1. Localities of specimen collection on Jejudo Island, including Munseom and Seopseom islets.

Table 1. Primer sequences used for COI and 16S rDNA amplification

Gene	Primer	Sequence (5′-3′)	Reference
COI	LCO1490-JJ-al	TAYTCHACYAAYCAYAAAGAYATYGG	Astrin and Stüben (2011)
	HCO2198-JJ	AWACTTCVGGRTGVCCAAARAATCA	Astrin and Stüben (2008)
16S rDNA	16Sar	CGCCTGTTTATCAAAAACAT	Palumbi et al. (1991)
	16S1472	AGATAGAAACCAACCTGG	Crandall and Fitzpatrick (1996)

COI, cytochrome *c* oxidase subunit I.

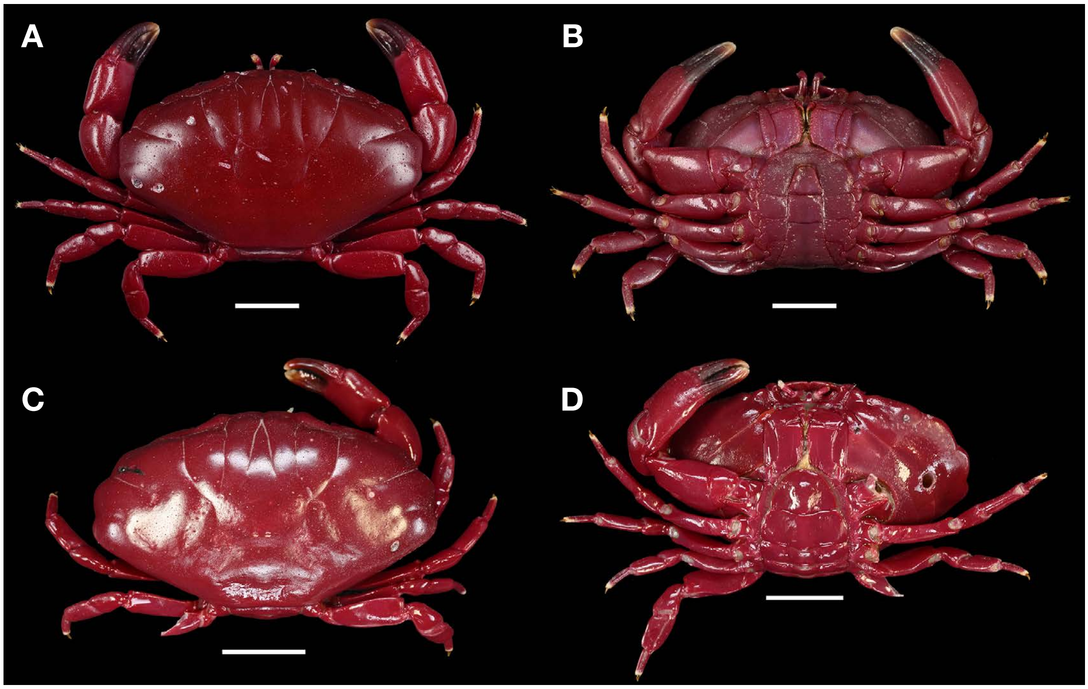

Fig. 2. Dorsal and ventral views of *Liomera venosa* (H. Milne Edwards, 1834). A, B, Male (NIBRIV0000927426); C, D, Female (NIBRIV 0000922266). Scale bars: A–D = 1 cm.

Stüben (2011), whereas the 16S rDNA gene was amplified following the protocols of Palumbi et al. (1991) and Crandall and Fitzpatrick (1996). PCR products were purified and sequenced by a commercial sequencing service. The sequence data generated in this study are presented in Table 2, and the newly obtained sequences were deposited in GenBank with accession numbers provided therein. Genetic distances were calculated based on the obtained sequences and compared with previously published sequences of *Liomera* species available in GenBank. Intra- and interspecific genetic distances were calculated as p-distances using Geneious v.8.1.9.

SYSTEMATIC ACCOUNTS

Order Decapoda Latreille, 1802
Family Xanthidae MacLeay, 1838
Genus *Liomera* Dana, 1851

[1]* ***Liomera venosa* (H. Milne Edwards, 1834) (Figs. 1–7)**
Carpilius venosus H. Milne Edwards, 1834: 383.
Cancer (*Xantho*) *obtusus* De Haan, 1835: 47–48, Pl. 13, fig. 5.
Carpilodes granulosus Haswell, 1882: 751–752.

Fig. 3. Portions of the dorsal carapace. A, *Liomera venosa*; B, *Liomera cinctimanus*. Modified from Poupin et al. (2018), licensed under CC BY-NC 4.0.

Carpilodes socius Lanchester, 1900: 731–732, Pl. 44, fig. 4.
Liomera venosa: Sakai, 1976: 394, Pl. 139, fig. 1; Dai and Yang, 1991: 272, Pl. 34(5–6), fig. 146A(1); Yamaguchi and Baba, 1993.

Korean name: [1]*다섯줄이마주름부채게 (신칭)

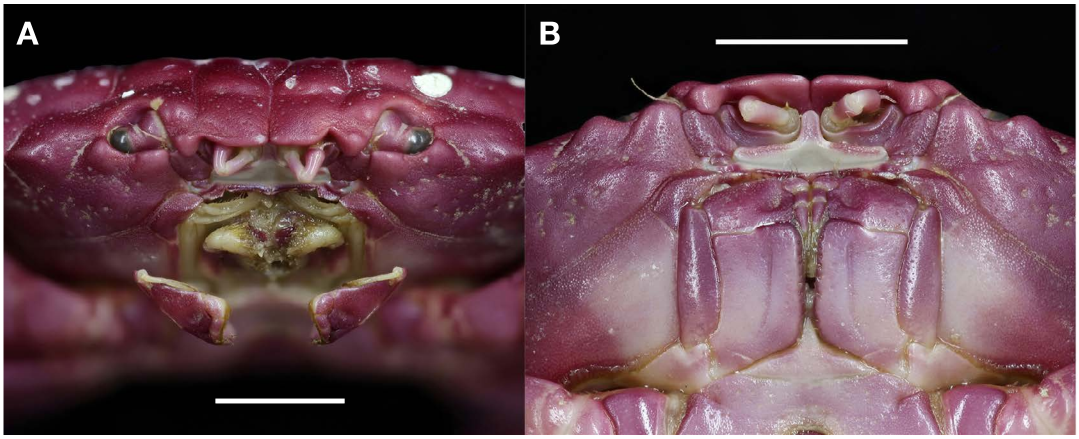

Fig. 4. Frontal and ventral views of the anterior portion of carapace of *Liomera venosa* (NIBRIV0000927958). A, Frontal view of carapace; B, Ventral view of carapace. Scale bars: A, B=0.5 cm.

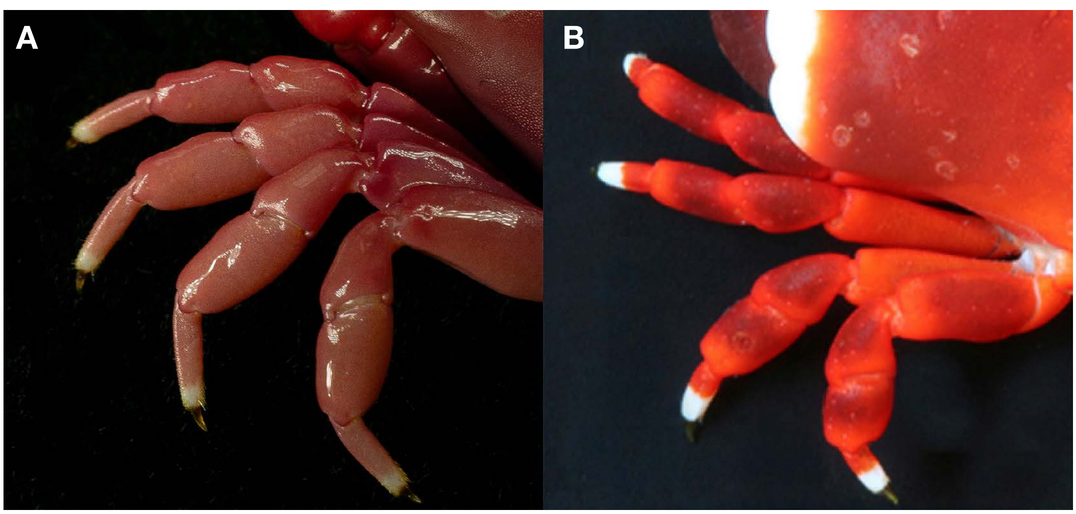

Fig. 5. Dorsal views of the ambulatory legs. A, *Liomera venosa*; B, *Liomera cinctimanus*. Modified from Poupin et al. (2018), licensed under CC BY-NC 4.0.

Material examined. Korea: 1♀ (cl 24 mm, cw 40 mm), Jeju-do: Seogwipo-si, Seopseom Islet, 21 Nov 2023, scuba diving, depth 17 m, coll. Ha-Eun Lee, Taeseo Park, Bomi Kim (NIBRIV0000922266); 1 ovig.♀ (cl 23 mm, cw 36 mm), Seopseom Islet, 29 Oct 2024, scuba diving, depth 14 m, coll. Taeseo Park, Chan Yong Park (NIBRIV0000927425); 1♂ (cl 14 mm, cw 27 mm), Munseom Islet, 14 Aug 2024, scuba diving, coll. Chan Yong Park (NIBRIV0000927426); 1♂ (cl 21 mm, cw 30 mm), Munseom Islet, 21 May 2025, scuba diving, coll. Chan Yong Park (NIBRIV0000927958); 1♀ (cl 16 mm, cw 23 mm), Seogwipo-si, Seopseom Islet, 20 Jun 2025, scuba diving, coll. Taeseo Park, Chan Yong Park (NIBRIV0000927959).

Description. Carapace (Figs. 2A, C, 3A, 4A) broad, transversely ovate; maximum carapace width 40 mm, length 24 mm. Dorsal surface with minute, flat granules and sparse small pores. Epigastric region with five longitudinal ridges; gastro-cardiac groove (H-shaped groove) weak; longitudinal ridges merge medially in mesogastric region. Branchial regions with two furrows between anterolateral lobes 2–3 and 3–4; furrow between lobes 2–3 straight, that between 3–4 curved posteriorly. Frontal margin with two broad lobes; Y-shaped furrow reaching between lobes. Orbit small, shallow; orbital margin separated from other margins by curved furrow. Antennae (Fig. 3A, B) very short, confined within orbit. Antennules (Figs. 2A, 3A, 4A, B) folding transversely with short yellow setae distally. Anterolateral margin (Fig. 2A, C) with four broad, low, rounded lobes. Posterolater-

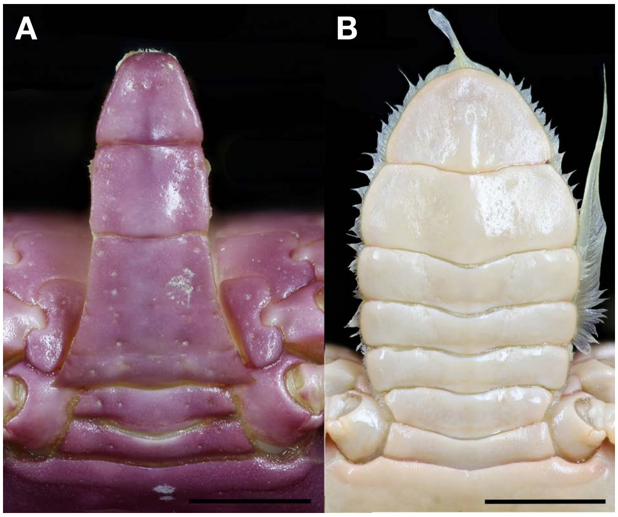

Fig. 6. Abdominal segments and telson of *Liomera venosa*. A, Male (NIBRIV0000927958); B, Female (NIBRIV0000922266). Scale bars: A=0.35 cm, B=0.5 cm.

Fig. 8. Gonopores of *Liomera venosa* (NIBRIV0000922266). Scale bar=1 mm.

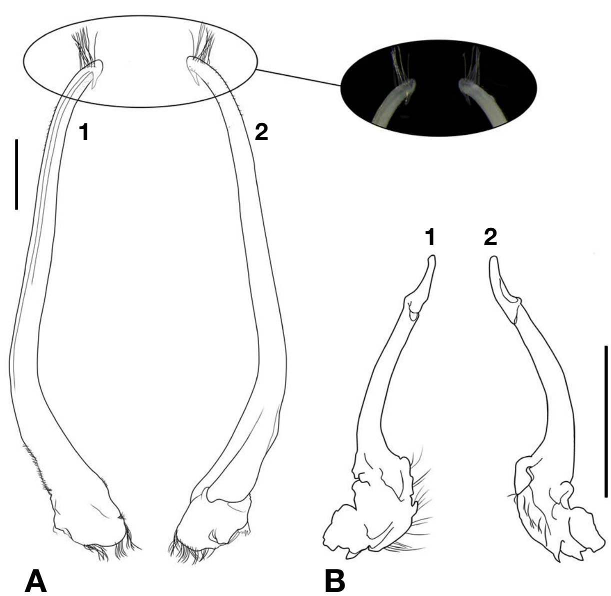

Fig. 7. Gonopods of *Liomera venosa*. A, First gonopod, 1: ventral view; 2: dorsal view; B, Second gonopod, 1: ventral view; 2: dorsal view. Scale bar: A, B=1 mm.

al and posterior margins substraight; posterolateral margin shorter than anterolateral margin.

Pterygostome (Figs. 2B, D, 4B) with oblique line; upper side with small pores; lower side smooth. Third maxilliped (Fig. 4B) merus and basis-ischium part subquadrate; merus shorter than basis-ischium; inner ischium and distal palp with yellow setae. Epistome (Fig. 4A) sinuous.

Chelipeds (Figs. 2A, C, 3A, 5A) subequal, short, stout, smooth; merus and chela without teeth; carpus with one blunt tooth. Ambulatory legs (Figs. 2A, B, 3A, 5A) short, smooth, without teeth; outer carpus and propodus undulating; dactylus covered with densely short setae on distal end.

Male abdomen (Figs. 2B, 6A) with six segments and telson; A3–A5 fused; faint trace remaining; segments narrowing from A3 to A4; A5 and A6 parallel; telson (Figs. 2B, 6A) trapezoidal with rounded end. Abdomen of female (Figs. 2D, 6B) with six segments and telson, longitudinally ovate.

First gonopod (G1) (Fig. 7A) long, straight, bending twice at basal 1/5 and tip; tip with long, straight setae, one hook-like transparent spine. Second gonopod (G2) (Fig. 7B) short, about 1/4 length of G1, slightly curved. Gonopore (Fig. 8) oblique oval, closely spaced.

Color. In life, body deep crimson; fingertips dark brown; distal ivory; ambulatory legs with white ring on distal dactylus.

Habitat. Under rocks, coral, and sand in subtidal zone.

Distribution. Type locality: unknown (original description: "Habite?", H. Milne Edwards, 1834).

Other localities: Australia, Japan (Sakai, 1976); Mauritius (Serène, 1984), Tahiti (Poupin, 1996), Thailand (Ng and Davie, 2002); China, Taiwan, Vietnam, Indonesia (Wong et al., 2024); Korea (this study).

Genetics. Genetic distances were calculated based on the mitochondrial COI and 16S rDNA sequences. The intraspecific genetic divergence of *Liomera venosa* ranged from 0.18–1.77% for COI and 0–1.19% for 16S rDNA. In contrast, the interspecific genetic distances among closely related congeners ranged from 10.64–14.54% for COI and 6.67–13.3% for 16S rDNA. The genetic divergence between *L.*

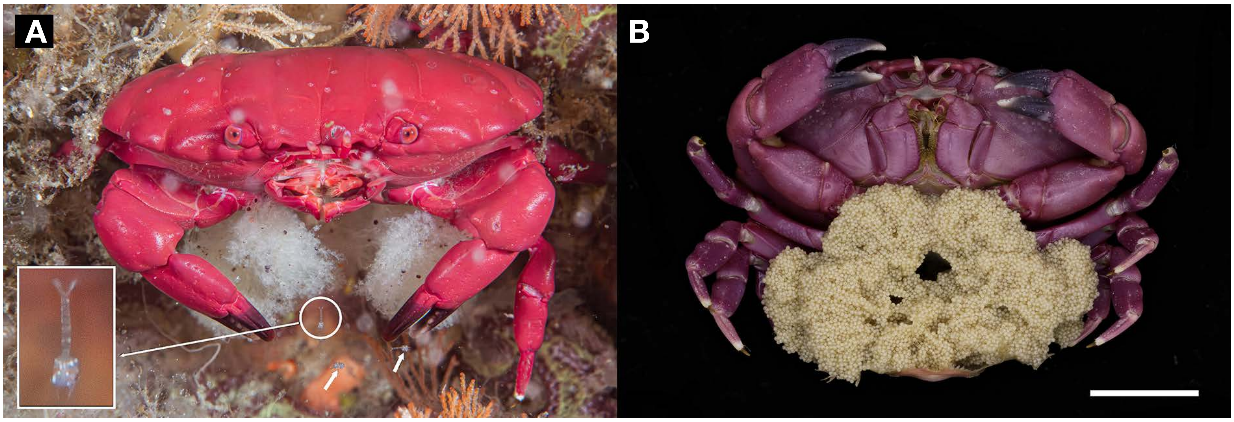

Fig. 9. Ovigerous female and larval release of *Liomera venosa*. A, Ovigerous female releasing zoea in natural habitat (white arrows and inset showing zoea); B, Ventral view of an ovigerous female (NIBRIV0000927425) showing the egg mass attached to pleopods. Scale bar = 1 cm. Photo A taken by Jinho Lee.

Table 2. List of sequences used for molecular analyses in this study

Species	GenBank accession No.	Sequence region	Location	Voucher No.	References
Liomera venosa	PX352009	16S rDNA	Korea	NIBRIV0000922266	Present study
	PX352018	COI			
	PX353454	16S rDNA		NIBRIV0000927425	
	PX352027	COI			
	PX353347	16S rDNA		NIBRIV0000927426	
	PX352031	COI			
	HM798490	16S rDNA	Indonesia	ZRC 1999.0383	Lai et al. (2011)
	HM751011	COI			
L. trisris	HM798488	16S rDNA	Japan	ZRC 1993.653–656	
	HM798489	16S rDNA	Philippines	ZRC 2010.0144	Lai et al. (2011)
	HM751010	COI			
L. bella	HM798485	16S rDNA	Japan	ZRC 1993.646–652	Lai et al. (2011)
	HM751007	COI			
	MW277959	COI	USA: Hawaii	UF:45582	–
L. cinctimanus	MW264153	16S rDNA	West-Indian Ocean	MEGML52	Marco-Herrero et al. (2021)
	HM798486	16S rDNA	Guam	ZRC 2000.0730	Lai et al. (2011)
	HM751008	COI			

COI, cytochrome *c* oxidase subunit I.

venosa and the morphologically similar species *L. cinctimanus* was 11.7–11.88% for COI and 10.48–11.43% for 16S rDNA (Table 3).

Remarks. *Liomera venosa* exhibits a dark reddish coloration and a transversely elongated, smooth ovoid carapace. It is morphologically similar to *L. cinctimanus* in having short, robust chelipeds and short ambulatory legs. However, *L. venosa* possesses five ridges arranged radially behind the frontal margin, a character consistent with the original description of the species (Milne Edwards, 1834) and absent in *L. cinctimanus* (Fig. 3B). In addition, the dorsal surfaces of the carpus and propodus of the ambulatory legs are slightly undulating in *L. venosa*, as noted in the redescriptions by De Haan (1835) and Serène (1984), whereas this feature is lacking in *L. cinctimanus* (Fig. 5B).

Further morphological differences are evident in the overall carapace shape of the two species. *Liomera cinctimanus* generally has a carapace that is more transversely expanded than that of *L. venosa*, and the lobes on the anterolateral margin are more swollen and rounded. The dorsal regions

Table 3. Pairwise genetic distances (p-distance, %) among *Liomera* species based on mitochondrial COI (564 bp) and 16S rDNA (426 bp) aligned sequences

Species	*Liomera venosa* a0-1.19 (0.59)	*Liomera bella*	*Liomera cinctimanus* a0.48	*Liomera tristis* a0.24
Liomera venosa (nCOI, n16S = 4) a0.18–1.77 (0.92)	–	10.24	10.48–11.43 (10.83)	6.67–7.38 (6.9)
Liomera bella (nCOI = 2, n16S = 1) a0.36	10.64–11.35 (10.99)	–	12.83–13.3 (13.06)	9.26–9.5 (9.38)
Liomera cinctimanus (nCOI = 1, n16S = 2)	11.7–11.88 (11.79)	14.54	–	11.4–11.88 (11.64)
Liomera tristis (nCOI = 1, n16S = 2)	11.88–12.06 (11.97)	14.01–14.18 (14.1)	12.23	–

Lower left: COI; Upper right: 16S rDNA
COI, cytochrome *c* oxidase subunit I; a, intraspecific divergence; n, number of specimens; numbers in parentheses indicate ranges of mean divergence.

Table 4. Morphological comparison between *Liomera venosa* and *L. cinctimanus*

Characters	Species	
	L. venosa	*L. cinctimanus*
Carapace		
Outline	Less expanded than *L. cinctimanus*	More transversely expanded
Dorsal margins	2F and 1M, 2L and 3L, as well as 4L, 5L, and 6L, are fused, whereas 2M and 3M are separated by a shallow furrows but remain partially connected at their ends	Dorsal regions are poorly indicated
Anterolateral margin	Third and fourth lobes less rounded and small	Third and fourth lobes more swollen and rounded
Posterolateral margin	Nearly straight	Slightly concave
Pereiopods	Carpus and propodus dorsal margins undulating	Carpus and propodus dorsal margins not undulating

are more distinctly delimited in *L. venosa*, whereas they are less clearly defined in *L. cinctimanus* (Fig. 3B). The posterolateral margin is nearly straight in *L. venosa*, while it is slightly concave in *L. cinctimanus* (Figs. 2A, C, 3B, 5B) (Table 4).

In Korea, the genus *Liomera* has been represented solely by *L. margaritata*, which possesses a wrinkled carapace conspicuously subdivided into numerous regions with distinct granules, as described by Lee and Ko (2011), in sharp contrast to the relatively smooth and less divided dorsal surface of *L. venosa*.

The genetic distances observed between the Korean specimens and previously reported sequences of *Liomera venosa* fall within the range of intraspecific variation. In contrast, the genetic divergence between *L. venosa* and its congeners, including the morphologically similar *L. cinctimanus*, corresponds to the typical level of interspecific divergence observed in brachyuran crabs. These molecular results further support the identification of the Korean specimens as *L. venosa*.

DISCUSSION

The present study confirms that the specimens collected from Jejudo Island belong to *Liomera venosa*. Both morphological observations and molecular analyses support this identification. To date, the genus *Liomera* has been represented in Korean waters only by *L. margaritata*; therefore, the present study represents the first record of *L. venosa* from Korea and expands the known diversity of the genus in the region.

Liomera venosa is widely distributed in tropical and subtropical regions of the Indo-West Pacific. The occurrence of this species in Korean waters may therefore reflect recent biogeographic changes associated with regional ocean warming. Sea temperature measurements from 2004 to 2022 revealed an overall increase in mean annual temperature, particularly pronounced in the southern region of Jejudo Island. The Jejudo coastal system is influenced year-round by the Tsushima Warm Current, a branch of the Kuroshio Current, resulting in persistently high temperatures that rarely fall below 14°C even in winter, thereby providing favorable conditions for the survival and establishment of subtropical benthic organisms (Perrois et al., 2024). In recent years, tropical and subtropical decapods have been continuously reported from Korean waters (Park et al., 2021, 2022a; Lee et al., 2023), particularly in the waters surrounding Jejudo Island, and some of these species have been observed to extend their distributions beyond the Jejudo region (Park et al., 2022b). The present record of *L. venosa* may represent another example of this ongoing northward range expansion of warm-water marine fauna.

In the present study, ovigerous females of *L. venosa* were repeatedly observed over multiple years, and the hatching of eggs into zoeal larvae was directly observed *in situ* under natural conditions (Fig. 9). These observations suggest that the species is not merely an occasional or transient occurrence in the Jejudo coastal ecosystem but may have established a reproducing population capable of sustaining successive generations around Jejudo Island. Such evidence of successful reproduction is important for determining whether newly recorded warm-water species represent temporary vagrants or established components of the local fauna. Continued monitoring of the Jejudo coastal habitats will therefore be necessary to evaluate the long-term persistence and potential expansion of *L. venosa* populations in Korean waters. These findings further suggest that the coastal waters of Jejudo Island may represent an important region for the recent northward expansion of warm-water marine species.

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CONFLICTS OF INTEREST

Although corresponding author, serves as an Associate Editor for *Animal Systematics*, *Evolution and Diversity*, he had no involvement in the editorial decision or peer review of this manuscript. The authors declare no other conflict of interest.

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