

MARINE RECORD

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Range extension of the sesarmid crab *Clistocoeloma villosum* along the eastern Pacific coast of the Izu Peninsula, Japan

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Abstract

Background: The Pacific coastline along the southern Izu Peninsula, Japan, is strongly influenced by warm tropical waters of the Kuroshio Current. A new easternmost record of the near-threatened sesarmid crab *Clistocoeloma villosum* is reported from the southern part of Izu Peninsula.

Methods: The present study was conducted in August 2014 and February 2015, on tidal flats in the mouth of the Aono River, draining the southern part of Izu Peninsula. Crabs were collected by hand on the tidal flat substrate, under cobble stones and on the periphery of associated mangrove forests.

Results and conclusion: Body sizes and morphological characteristics closely matched existing descriptions of *C. villosum*, the distribution range having been extended ca. 350 km eastward from the Kii Peninsula (traditional eastern boundary of the species), suggesting broad northeastwardly directed planktonic larval transport by the warm Kuroshio Current along the Pacific coast of Japan. The survival and settlement of larvae of this southern species along the southern coast of the Izu Peninsula, is evidence of the suitability of the small gravel dominated tidal flats in the region as habitat for the species.

Keywords: *Clistocoeloma villosum*, Brachyura, Near-threatened species, New record, Izu Peninsula, Kuroshio current, Larval dispersion

Background

The coastline of southern Izu Peninsula, southeastern Honshu Island, Japan is strongly influenced by the Kuroshio Current, which carries warm tropical waters in a northeastwardly direction (Yamano et al., 2011). Although the short steeply graded rivers characteristic of the peninsula largely restrict the formation of tidal flats at the river mouths, the Aono River mouth is characterized by very small tidal flats, including salt marshes and semi-mangrove forests. General investigations of benthic macro-invertebrates on the tidal flats have included accounts of a number of crab species (Tanaka et al., 2004; Ito, 2014; Yokooka et al., 2015), as well as snails (Nishiwaki et al., 1991; Murase & Yuhara, 2011). However, detailed investigations of the tidal flats and associated semi-mangrove areas have not yet been undertaken.

The present report details the first records of the sesarmid crab *Clistocoeloma villosum* (A. Milne Edwards, 1869) on the tidal flats and in the semi-mangrove forest area of the Aono River mouth, southern Izu Peninsula. Previously, the distribution range of this crab in Japan had been recognized as between the Ryukyu Islands and Kii Peninsula, southern Honshu Island (see Karasawa et al., 2006), approximately 350 km distant from Izu Peninsula.

Methods

The present study was conducted in August 2014 and February 2015. *Clistocoeloma villosum* was monitored along the Aono River (34°38'06" N, 138°53'11" E) at Minami-Izu Town, Izu Peninsula, Shizuoka, Japan (Fig. 1), the intertidal zone habitat of the river mouth being characterized by mud flats, gravels, cobble stones, oyster beds and salt marshes. Plants included the common reed (*Phragmites australis*), semi-mangrove plants, such as *Hibiscus hamabo* (Nakanishi, 2001), and the

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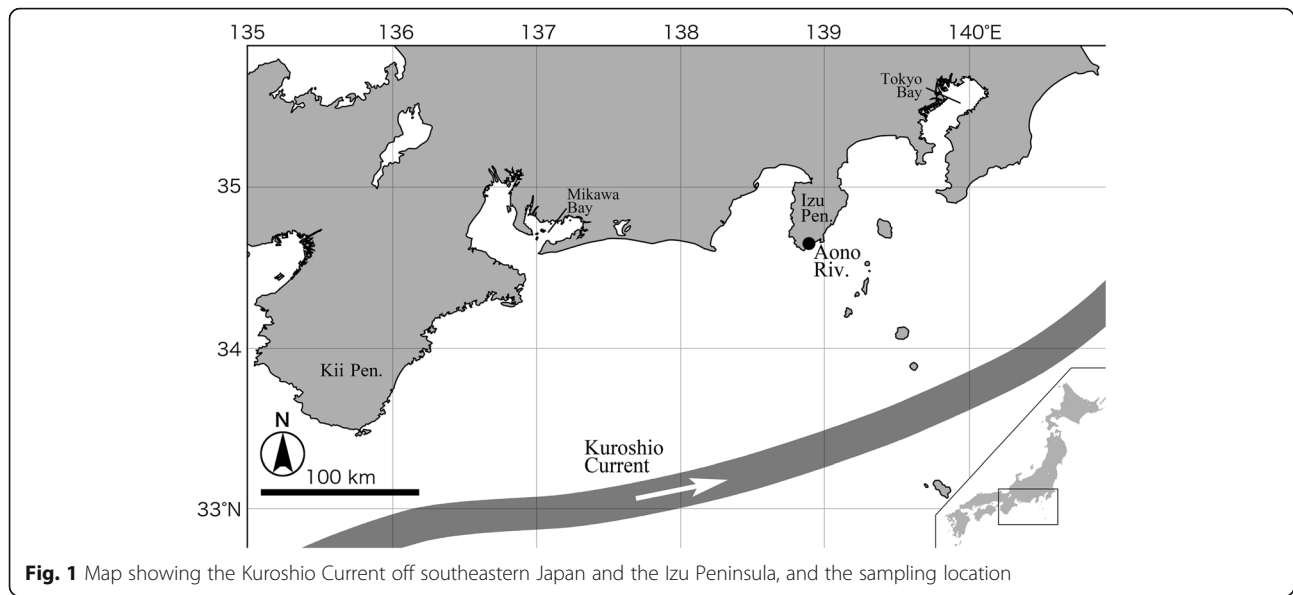


Fig. 1 Map showing the Kuroshio Current off southeastern Japan and the Izu Peninsula, and the sampling location

mangrove *Kandelia obovata*, introduced from Iriomote Island, Japan in 1959 (Masuda, 1999).

Brachyuran crabs were collected by hand from the mud flat surface, under gravels and cobble stones around the mangrove forest edges. All crabs collected were stored in 70% ethanol and representative specimens deposited in the Osaka Museum of Natural History. Familial and generic classification followed the guidelines proposed by de Grave et al. (2009). Descriptions and specific keys used for identifying *C. villosum* included Tesch (1917), Crosnier (1965), Nomoto et al. (1999), Komai et al. (2004) and Lee et al. (2010).

Results

Systematics

Order DECAPODA (Latreille, 1802)

Infraorder BRACHYURA (Linnaeus, 1758)

Family SESARMIDAE (Dana, 1851)

Genus *Clistocoeloma* (A. Milne Edwards, 1873)

Clistocoeloma villosum (A. Milne Edwards, 1869) Fig. 2

Sesarma villosum A. Milne-Edwards, 1869:31.

Sesarma (*Holometopus*) *villosa*: Tesch, 1917:208, pl. 17, Fig. 2.

Sesarma (*Holometopus*) *villosum*: Crosnier, 1965:55, figs 75, 76, 77a, 78.

Chiromantes villosum: Nomoto et al., 1999:9, pls. 1-6; Kishino et al., 2001:17, pl. 2,2; Shokita et al., 2002:78, photo 4A-1.

Clistocoeloma villosum: Davie, 2002:221; Komai et al., 2004:39, fig. 3; Lee et al., 2010:180, Fig. 1; Maenosono & Saeki, 2016:5, Fig. 2d.

Material examined (all from Aono River mouth, southern Izu Peninsula, Shizuoka, Japan): OMNH-Ar10119, 1 male, CW: 11.6 mm, CL: 9.6 mm, 1 female,

CW: 10.3 mm, CL: 8.4 mm, upper intertidal, mud bottom under cobble stone, coll. T. Yuhara, 31 August 2014; OMNH-Ar10120, 1 male, CW: 15.1 mm, CL: 12.7 mm, 1 female, CW: 9.1 mm, CL: 7.8 mm, upper intertidal, mud bottom under cobble stone, coll. T. Yuhara, 7 February 2015.

Diagnosis

Carapace rectangular (Fig. 2a), greatest width across middle, about 1.2 times length; dorsal surface with numerous very short stiff setae, often in small groups; lateral margins slightly sinuous, anterior part slightly convex, lined with short stiff setae similar to those on dorsal surface; frontal margin moderately deflexed with faint median notch. No trace of epibranchial tooth. Antennule and antenna contiguous. Basal antennular segment subrectangular. Antenna set oblique; flagellum relatively long, extending into orbit. Third maxilliped with well development flagellum on exopod.

Chelipeds of male (Fig. 2b) and female (Fig. 2c) subequal; palm of male with 1 lined, partially pectinated ridge along entire length of dorsal surface, comprising a few small granules and 20-38 small to large corneous teeth; inner surface comprising a row of small tubercles adjacent to dorsal margin (Fig. 2d); palms of females with a few small granules only on dorsal surface; upper border of dactylus of male bearing ca. 30 rectangular tubercles in a line toward lower tip (Fig. 2e), that of female bearing 15 small tubercles in a line becoming base toward middle of dactylus.

Ambulatory legs (Fig. 2f) (second to fifth pereopods) moderately short, third and fourth legs of similar length, longer than second and fifth, covered with short stiff setae; merus broad, terminal of anterior upper margin

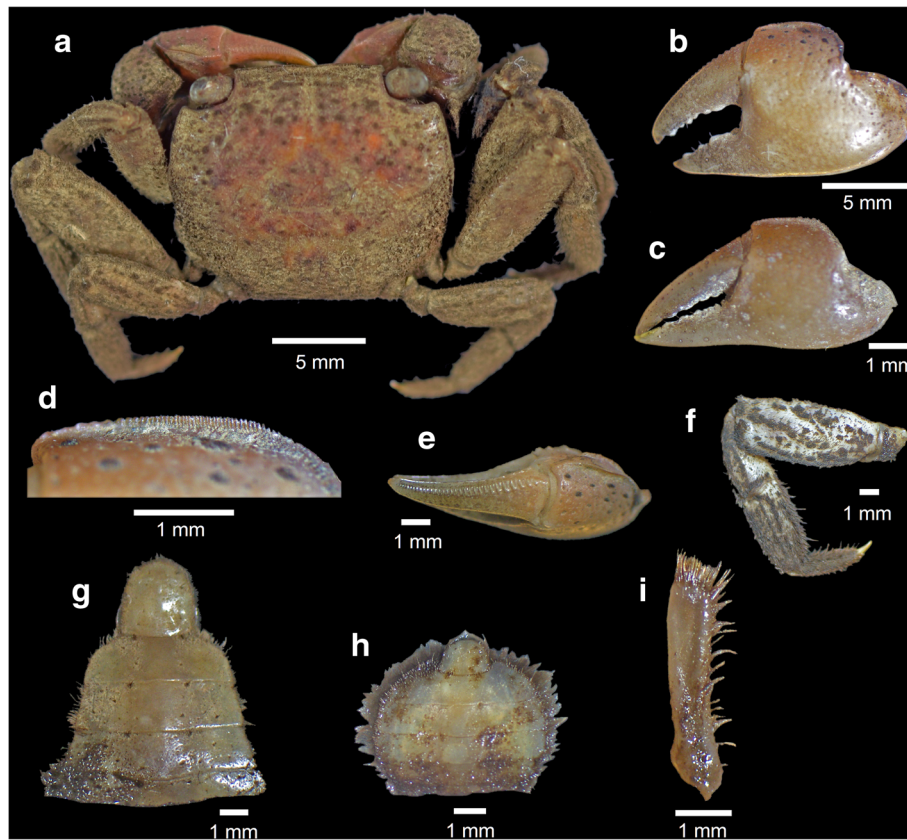


Fig. 2 *Clistocoeloma villosum* (A. Milne Edwards, 1869), male, CW 15.1 mm, CL 12.7 mm, female, CW 9.1 mm, CL 7.8 mm (OMNH-Ar10120), Aono River. **a** morphology of dorsal view of carapace of male; **b** left cheliped of male, outer view; **c** left cheliped of female, outer view; **d** inner dorsal margin of left palm of male, showing crest, outer view; **e** left cheliped of male, dorsal view; **f** left fifth pereopod of male, dorsal view; **g** abdomen of male; **h** abdomen of female; **i** left first pleopod, outer view

without corneous spinules; propodus and dactylus covered with numerous short stiff setae, upper and lower margins lined with rows of longish setae, dactylus terminating in corneous claw, tip without hairs.

Abdomen of male (Fig. 2g) wide, narrowest at base of telson, covered with short setae; fifth and sixth abdominal somites of similar length; telson slightly longer than basal width. Abdomen of female (Fig. 2h) with telson evenly rounded, as long as basal width and longer than mid-line length of sixth abdominal somite. The anterior of sixth abdominal somite gently sunk and put the telson in it.

First gonopod (Fig. 2i) stout, nearly straight; terminal process short, with shallow notch distally.

Crosnier (1965) and Lee et al. (2010) reported that the male chelipeds in this species have 15–16 corneous teeth on the dorsal surface of the palm, whereas Tesch (1917) and Komai et al. (2004) reported males with 20–30 teeth. The present male specimens had 20–38 such teeth, the number varying with body size.

The collected specimens corresponded closely to the descriptions of *Sesarma (Holometopus) villosa* provided

by Tesch (1917), *Sesarma (Holometopus) villosum*, provided by Crosnier (1965), *Chiromantes villosum* provided by Nomoto et al. (1999), and *Clistocoeloma villosa*, provided by Komai et al. (2004) and Lee et al. (2010).

Coloration

Generally in life, carapace muddy colour; palm of cheliped purplish.

Distribution

Clistocoeloma villosum is widely distributed in the Indo-Pacific Ocean, including Madagascar, Aceh, Sumatra, New Guinea, Queensland, Australia, Caroline Islands, Samoa Islands and Korea (Jejudo Island) (Tesch, 1917; Crosnier, 1965; Komai et al., 2004; Lee et al., 2010). Previous records along Japanese coastal regions include the central and southern Ryukyu Islands (Miyako, Iriomote, Ishigaki, Okinawa and Amami-Oshima Islands), Kyushu Island (Miyazaki Prefecture, Nagasaki Prefecture), Shikoku Island (Ehime Prefecture) and the Kii Peninsula, extending from the Honshu mainland (Wakayama Prefecture) (Kishino et al., 2001; Shokita et

al., 2002; Komai et al., 2004; Kawakubo et al., 2005; Ministry of the Environment, 2005; Karasawa et al., 2006; Miura & Jitsumasa, 2010; Wada, 2013; Maenosono & Saeki, 2016).

Ecological note

Clistocoeloma villosum dwells under stones on the upper intertidal zone of tidalflats, in salt marshes and on the landward edges of semi-mangrove forests. Uncommon, except in the southern Ryukyu Islands, the species is recognized as near threatened in Japan (Japanese Association of Benthology, 2012; Ministry of the Environment, 2017). The new locality is approximately 350 km northeast of the Kii Peninsula, being the easternmost reported to date (see Karasawa et al., 2006).

Discussion

Although the Kii Peninsula has been the traditionally-recognized eastern boundary of *Clistocoeloma villosum*, that species, along with several other crabs, i.e., *Ptychognathus capillidigitatus* (Yokooka et al., 2015), *Macrophthalmus banzai* (Yokooka & Nomoto, 2013), *Tubeuca arcuata* (Yuhara & Aizawa, 2016) and *Austruca lactea* (Tamura & Narita, 2013), is now established as having extended northeastward to the Izu Peninsula and Tokyo Bay, although still rare at that site. In addition, other southern-based marine invertebrates have been reported from corals (Yamano et al., 2011), nemerteans (Yamamori et al., 2013) and snails (Hayase et al., 2013).

The Kuroshio Current, which flows southwest to northeast along the Pacific coast of Japan, has enriched the communities of southern-based species on the southern Izu Peninsula area by providing aquatic environments suitable for their larvae. Planktonic crab larvae are generally dispersed over relatively long periods in the water column (Cuesta et al., 2006). Although larval development of *C. villosum* have not yet been reported, that of a closely related species [*Clistocoeloma sinense* (three zoeal stages; Saba, 1972, Cuesta et al., 2006)] has been observed. Because the entire brachyuran larval stage (including three zoeal stages) has been estimated as ca. 16 days (Fukuda, 1980), it is likely that a portion of juveniles originating from around the Kii Peninsula can survive transportation via coastal waters to the Izu Peninsula because of the rapid speed of the Kuroshio Current, which sometimes exceeds 2 m/s (Teramoto, 1987). This suggests that the warm Kuroshio Current can transport planktonic larvae from the southwestern subtropical zone to the northeastern temperate zone along the Pacific coast of Japan. The larvae of southwestern-based crabs can settle and survive along the coast of the southern Izu Peninsula near the Kuroshio Current due to the favorable habitat,

comprising small tidal flats with reed vegetation, gravels, cobble stones and semi-mangrove communities.

Clistocoeloma villosum dwells under stones on the upper intertidal region of tidal flats and salt marshes, as well as under leaf litter over moist soil on the landward of edges of semi-mangrove forests (Komai et al., 2004, Lee et al., 2010, Japanese Association of Benthology, 2012). However, tidal flats encompassing such environments are generally rare along the Pacific coast in approximately 250 km between Mikawa Bay and Tokyo Bay. Furthermore, an earlier study that revealed a salient genetic differentiation in the closely-related saltmarsh crab *C. sinense*, suggested the existence of a barrier to larval transport between these two bays (Yuhara et al., 2014). Therefore, the upper intertidal area of Aono River mouth in southern Izu Peninsula provides a vital habitat for this northeasternmost population of *C. villosum*.

Conclusion

The present study has clarified that the distribution range of the near-threatened sesarmid crab *Clistocoeloma villosum* had been extended eastward from the Kii Peninsula to the Izu Peninsula. It suggests that the larvae of this crab can be transported northeastwardly along the Pacific coast of Japan by the warm Kuroshio Current in planktonic period and can be settled in the southern Izu Peninsula due to the existence of suitable habitat, comprising small tidal flats with reed vegetation, gravels, cobble stones and semi-mangrove communities.

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Authors' contributions

TY, HY and MT collected the specimens. TY drafted the manuscript. TY and HY took the photographs of the specimens, checked the identification of the specimens and helped to improve the manuscript. MT prepared the map and helped to improve the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Ethics approval

Not applicable.

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