

Searching for land hermit crabs using artificial debris as shells on Ishigakijima Island, Japan

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Abstract

Land hermit crabs of the genus *Coenobita* typically occupy empty gastropod shells as shelters but occasionally use artificial debris. To document the occurrence of artificial shell use and provide a basis for future shell-selection experiments, field surveys were conducted on sandy beaches of Ishigakijima Island, Okinawa Prefecture, Japan, in June 2024 and June 2025. Nighttime surveys at multiple sites yielded a total of 325 individuals representing five species (*C. brevimanus*, *C. cavipes*, *C. purpureus*, *C. rugosus*, and *C. violascens*). Among these, a single individual of *C. purpureus* was found occupying a polyvinyl chloride adapter shell. The shield length of this individual fell within the major size class of the population. Together with earlier surveys, the rarity of artificial shell use observed in this study suggests that encounters with individuals occupying artificial debris in the field may largely reflect stochastic events rather than a consistent preference for artificial shells.

Key words: Crustacea; *Coenobita purpureus*; plastic debris; marine litter; shell preference

Introduction

Land hermit crabs of the genus *Coenobita* Latreille, 1829 (Decapoda: Anomura: Coenobitidae), which comprises 21 species, are distributed mainly in subtropical and tropical coastal regions and occupy habitats ranging from the supralittoral zone to inland areas, except during the larval stage, which occurs in the sea (Hartnoll 1988; Greenaway 2003; Hamasaki et al. 2015; Shih et al. 2025). Although land hermit crabs typically use empty gastropod shells as shelters, they sometimes occupy beach debris, such as plastic caps, as substitute shells (e.g., Imafuku 2001; Barreiros and Luiz 2009; Laidre and Vermeij 2013; Sharma 2018; Sasazuka et al. 2019; Sanda et al. 2026).

The use of artificial shells by land hermit crabs may occur on a global scale. Jagiello et al. (2024) compiled photographs of land hermit crabs from Internet sources and social media platforms and recorded 386 individuals from 10 species carrying artificial shells, including plastic caps, glass, metal, and combinations of glass and metal. Jabillo et al.

(2024) suggested that the use of anthropogenic materials may be driven by higher availability relative to natural gastropod shells and/or individual preferences for artificial materials during shell selection. They further proposed four non-exclusive mechanisms that may reinforce such preferences: novelty effects influencing female mate choice; reduced transport costs associated with lighter plastic shells compared with heavier natural shells; odor cues derived from chemical compounds in plastics; and an anti-predator function acting as effective camouflage in polluted environments.

In contrast, Cotton et al. (2025) reported that none of 714 individuals of *C. compressus* H. Milne Edwards, 1837 occupied plastic shells, despite the high availability of lighter plastic debris along surveyed Pacific shorelines in Costa Rica. They also conducted shell-choice experiments at the study site in which naked hermit crabs were offered a natural gastropod shell previously occupied by a test individual and an artificial plastic shell (mainly bottle

and pen tops) collected locally. All test crabs selected natural shells, occasionally entering but never retaining plastic shells. Based on these results, Cotton et al. (2025) concluded that land hermit crabs exhibit a strong preference for natural shells even when artificial shells are highly available. However, in their experiments, test individuals may have shown a strong preference for gastropod shells that they had previously occupied.

An alternative approach to assessing preferences for natural versus artificial shells in land hermit crabs is to examine shell-selection behavior toward artificial shells that have previously been occupied by conspecifics. As a basis for conducting shell-selection experiments within this framework, the objective of the present study was to locate and capture land hermit crabs using artificial shells on Ishigakijima Island, Japan, where the use of beach debris by land hermit crabs has been documented (Sanda et al. 2026).

Materials and Methods

All species of *Coenobita* in Japan are collectively designated as a Natural Monument to promote their conservation. Accordingly, specimens were collected under permission from the Agency for Cultural Affairs, Ministry of Education, Culture, Sports, Science and Technology of Japan (License Certificate no. 5-5613).

Field surveys were conducted from 21–23 June 2024 and 24–26 June 2025 on sandy beaches of Ishigakijima Island, Okinawa Prefecture, Japan. Nine survey sites were established (Fig. 1), at which all five species of land hermit crabs inhabiting Ishigakijima Island had been collected in a previous study (Fujikawa et al. 2017). Searches for land hermit crabs were conducted at eight sites (A–E, G–I) in 2024 and at four sites (A, B, E, F) in 2025. At each site, three observers searched for land hermit crabs for 30 min using artificial LED lights during nighttime surveys conducted between 20:00 and 22:00. Air temperature and relative humidity during survey periods ranged

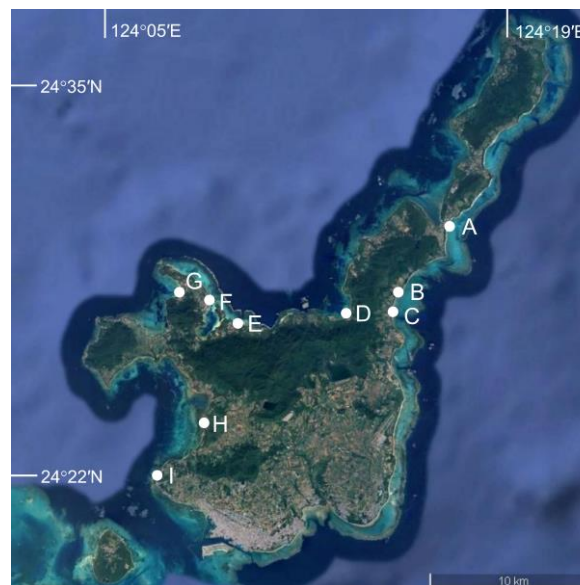


Fig. 1. Google Earth image showing the survey sites (A–I) on Ishigakijima Island, Okinawa Prefecture, Japan, where land hermit crabs were collected.

from 25.1 to 30.2 °C and from 84.6 to 99.9 %, respectively.

Land hermit crabs were located and collected by walking along the beach. Collected specimens were identified to species following Nakasone (1988) and Asakura (2004). The dactylus length of the left third pereopod of each specimen was measured at the survey sites using a digital caliper to the nearest 0.1 mm, following Fujikawa et al. (2017), and converted to shield length using the species-specific conversion factors provided by Fujikawa et al. (2017). Dimensions of the plastic shell used by the crab were measured in the laboratory using a digital caliper to the nearest 0.1 mm.

Results

A total of 142 and 183 land hermit crabs were collected during the 2024 and 2025 surveys, respectively, representing all five species recorded from Ishigakijima Island: *C. brevimanus* Dana, 1852; *C. cavipes* Stimpson, 1858; *C. purpureus* Stimpson, 1858; *C. rugosus* H. Milne Edwards, 1837; and *C. violascens* Heller, 1862 (Table 1). Among these specimens, one individual of *C. purpureus* was found

Table 1. Number of individuals and shield length (mean \pm standard deviation and range) of land hermit crabs of the genus *Coenobita* collected during the 2024 and 2025 surveys.

Species	2024		2025	
	N	Shield length (mm)	N	Shield length (mm)
<i>C. brevimanus</i>	8	18.8 \pm 1.7 16.9–21.5	38	18.0 \pm 2.5 12.1–23.9
<i>C. cavipes</i>	4	17.1 \pm 3.2 13.3–20.8	8	17.0 \pm 3.4 12.1–21.2
<i>C. purpureus</i>	44	21.1 \pm 2.5 16.1–28.7	62	21.4 \pm 3.5 11.9–31.7
<i>C. rugosus</i>	85	11.0 \pm 4.8 3.5–25.7	75	10.9 \pm 3.2 5.3–21.3
<i>C. violascens</i>	1	15.9	-	-

Discussion

In the present study, we collected all five species of land hermit crabs known to inhabit Ishigakijima Island (Fujikawa et al. 2017). However, only a single specimen of *C. violascens* was obtained. This low number likely reflects limited access to site H, where this species is known to be abundant (Fujikawa et al. 2017), because high sea levels prevented surveys at that location during the study period.

We found one individual of *C. purpureus* occupying a PVC adapter shell. In future studies, this PVC adapter shell can be used in shell-selection experi-

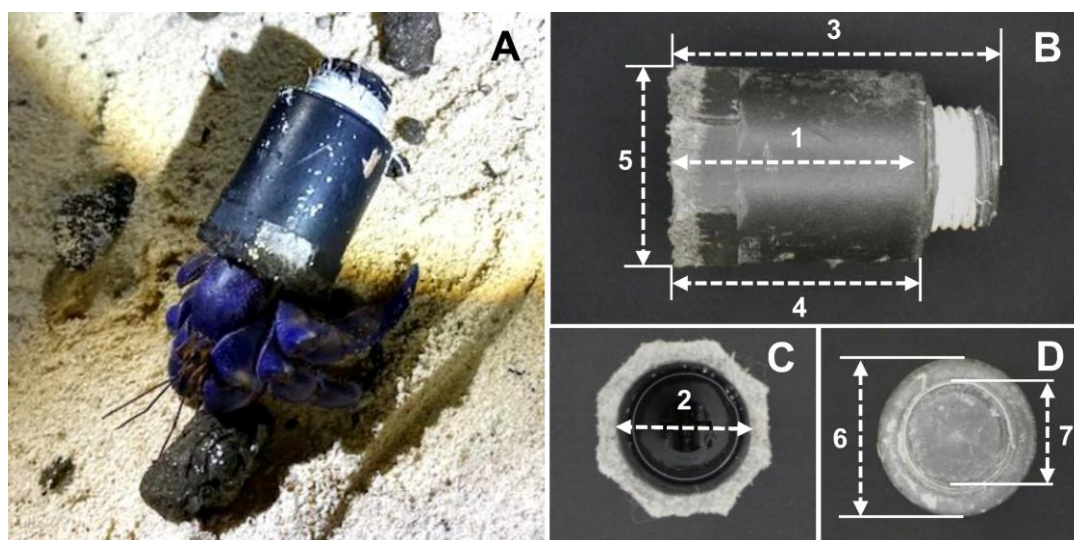


Fig. 2. *Coenobita purpureus* occupying a polyvinyl chloride (PVC) adapter shell (A), and lateral (B), aperture (C), and top (D) views of the adapter. Measurements showing internal (1, 2) and external dimensions (3–7) are indicated. Dimensions: 1, 39.4 mm; 2, 26.1 mm; 3, 52.8 mm; 4, 40.2 mm; 5, 32.2 mm; 6, 32.0 mm; and 7, 19.8 mm.

occupying a closed-end polyvinyl chloride (PVC) male-threaded adapter, which provided a hollow interior, at site A during the 2024 survey (Fig. 2A), whereas all other individuals carried gastropod shells.

The shield length of this individual was 20.8 mm. The dimensions of the PVC adapter are shown in Fig. 2B–D; the inner length (dimension 1 in Fig. 2B) and inner diameter (dimension 2 in Fig. 2C) were 39.4 mm and 26.1 mm, respectively. The shield length of the *C. purpureus* individual occupying the PVC adapter fell within the major size class of the population (Fig. 3).

ments to examine the behavior of land hermit crabs toward an artificial shell that has previously been occupied by a conspecific, in comparison with natural gastropod shells.

Sanda et al. (2026) documented photographic records of land hermit crabs using beach debris as shells during surveys conducted to investigate their biogeography and microhabitats in 2011 and 2012 on Ishigakijima Island. Artificial shells were occupied by two of 31 individuals of *C. brevimanus* (6.5 %) and one of 274 individuals of *C. rugosus* (0.4 %) in the 2011 survey, whereas none of 116 *C. cavipes*, 101 *C.*

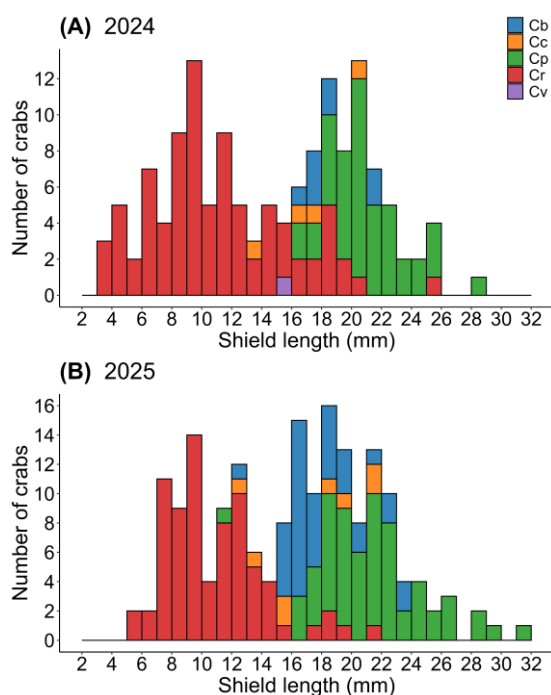


Fig. 3. Size–frequency distributions of individuals of five land hermit crab species collected during the 2024 (A) and 2025 (B) surveys. Abbreviations: Cb, *Coenobita brevimanus*; Cc, *C. cavipes*; Cp, *C. purpureus*; Cr, *C. rugosus*; and Cv, *C. violascens*.

purpureus, or 180 *C. violascens* used artificial shells. In the 2012 survey, no individuals of 11 *C. brevimanus*, 75 *C. purpureus*, 4759 *C. rugosus*, or 347 *C. violascens* occupied artificial shells; however, one of 52 individuals of *C. cavipes* (1.9 %) occupied an empty palm (propodus) of the right chela of a coconut crab.

In the present study, 2.3 % (1/44) of *C. purpureus* individuals carried an artificial shell in the 2024 survey, whereas none did so in the 2025 survey. None of the other four species occupied artificial shells in either year. Together with earlier surveys, these observations suggest that encounters with land hermit crabs using artificial debris in the field on Ishigakijima Island largely reflect stochastic events rather than a consistent preference for artificial shells. Nevertheless, examining shell-selection behavior using the PVC adapter shell found in the present study may help evaluate the degree of preference for artificial shells.

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