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A new record of the hermit crab *Dardanus callichela* Cook, 1989 (Paguroidea: Calcinidae) from the Visayan Sea, Philippines

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Abstract

A new record of the diogenid hermit crab *Dardanus callichela* Cook 1989 is described from the Visayan Sea, Central Philippines. Four specimens of *D. callichela* were caught in fish traps deployed at depths of about 30–40 m adjacent to islands to the north (Nagarao Island, Masbate) and south (Baliguian Island, Iloilo) of the Visayan Sea. The morphological description and colour photographs are provided. Partial sequences of the cytochrome oxidase subunit I (COI) are provided for two specimens and deposited in GenBank. This new record brings the total number of known *Dardanus* in the Philippines to 16 species.

Introduction

Over 150 species of hermit crabs have been documented from the Philippines from the families Coenobitidae, Calcinidae, Diogenidae, Paguridae, Parapaguridae and Pylochelidae (Malay *et al.*, 2018; Komai & Rahayu, 2021). The genus *Dardanus,* a large calcinid hermit crab, is known to occur in marine habitats worldwide from shallow waters to deeper slopes (Lemaitre & McLaughlin, 2021). Presently, there are 46 accepted species of *Dardanus* listed in the World Register of Marine Species (Lemaitre & McLaughlin, 2021). Fifteen species are known to occur in the Philippines including the recently described species, *Dardanus balhibuon* from Pamilacan Island, Bohol, central Visayas region (Malay *et al.*, 2018).

The Visayan Sea, bordered by Masbate, Northern Iloilo, Northern Negros and Northern Cebu, is one of the most productive and diverse fishing grounds in the Philippines (Hermes *et al.*, 2004; Mequila & Campos, 2007) and is part of the Coral Triangle global centre of marine biodiversity (Stehli *et al.*, 1967; Carpenter & Springer, 2005; Hoeksema, 2007). However, in the past decades the Visayan Sea has been under high pressure from multiple threats, causing a decline in species richness of reef-associated fishes (Nañola *et al.*, 2011) and overexploitation of commercially important marine species (e.g., Guanco *et al.*, 2009; Del Norte-Campos *et al.*, 2021). High fishing pressure in the Visayan Sea could also harm bycatch species including crustaceans such as hermit crabs, which may be of negligible economic importance yet play a significant role as a food source for many larger marine organisms.

The diversity and distribution of tropical Indo-West Pacific marine decapods is still poorly known, and the knowledge gap is particularly acute for deeper water species. In this study, we took advantage of incidental bycatch in fish traps laid at 30–40 m to report for the first time the occurrence of a strikingly coloured and large-bodied hermit crab, *Dardanus callichela* Cook, 1989.

Materials and methods

The specimens were collected off two islands in the Visayan Sea: Nagarao Island in Masbate Province (11.673915°N–11.741104°N 123.773909°E–123.896744°E; collection date 26 August 2019) and Baliguian Island in Concepcion, Iloilo Province (11.143460°N–11.252414°N 123.402144°E–123.476194°E; collection date 6 November 2019) (Figure 1). The specimens were incidentally caught together with fish (mostly breams) in traps of various sizes (not more a square metre) deployed at about 30–40 m. Fishers noted that hermit crabs are a common bycatch of their traps. Specimens were purchased from the fishers and were preserved in 90–95% analytical grade ethanol and brought to the laboratory for identification and systematic examination. Names were checked for validity against the World Register of Marine Species (Lemaitre & McLaughlin, 2021). Specimens are deposited in the Philippine National Museum, Manila (NMCR).

The shield length, carapace length, ocular peduncles, carpus length and carpus width were measured using digital vernier callipers. Shield length (SL) was measured from the midline of rostral lobe to the posterior cephalothoracic shield.

For the genetic analysis, DNA was extracted from two specimens using Vivantis GF-1 Tissue DNA Extraction Kit (Vivantis Technologies, Selangor, Malaysia). A 660-bp fragment

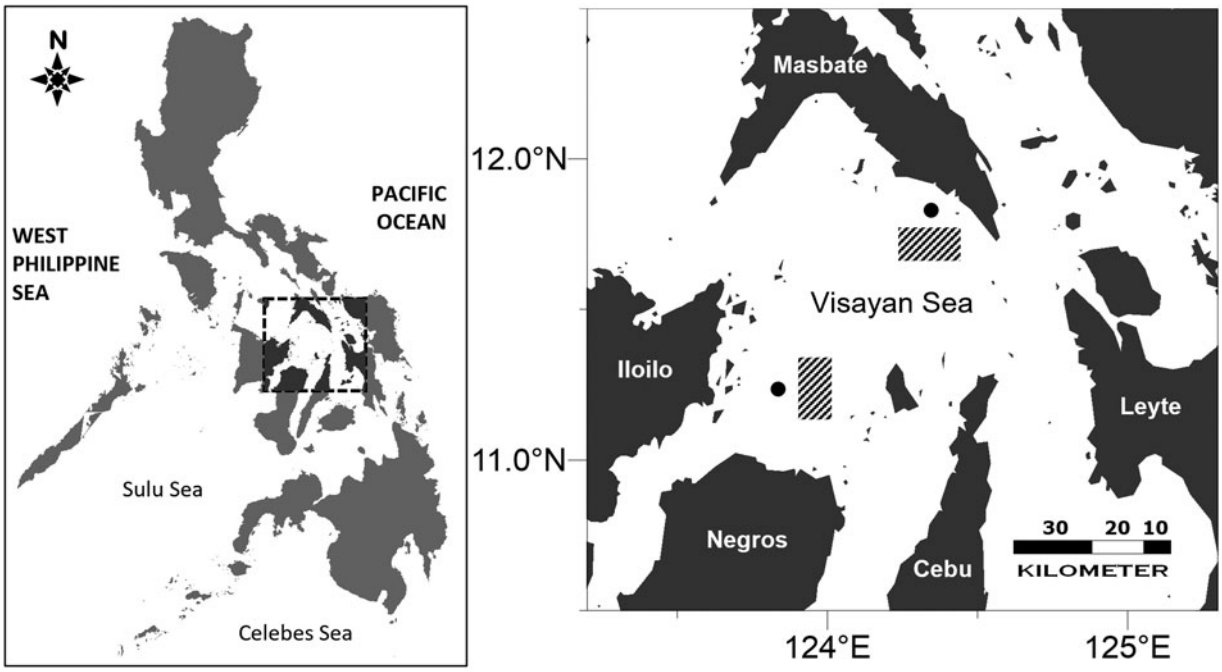

Fig. 1. Location of the Visayan Sea showing the islands (filled circles) and adjacent areas (rectangles) where the specimens were collected.

of the cytochrome c oxidase I (COI) mitochondrial gene was amplified using the degenerate Folmer primers dgLCO and dgHCO (Meyer, 2003) and using the following thermocycler conditions: an initial denaturation for 1 min at 95°C; 37 cycles of denaturation for 40 s at 95°C, annealing for 40 s at 42°C, and extension for 40 s at 72°C; and final extension for 1 min at 72°C (following Meyer, 2003). PCR products were cleaned using the Vivantis GF-1 PCR Clean-up kit then sent to a commercial sequencing facility. Resulting chromatograms were checked and edited using Chromas 2.6.6 (Technelysium Pty Ltd, 2018) and assembled into contigs using Unipro UGENE (Okonechnikov *et al.*, 2012). Sequences were deposited in GenBank [ON807356, ON807357] while the voucher specimens were deposited in the National Museum of the Philippines [NMCR 9102–9105]. GenBank contains COI sequence data for less than half of the extant 46 *Dardanus* species, with taxonomic coverage biased towards shallow-water species. Given the low and biased taxonomic coverage, and the little resolving power of the COI gene at deeper nodes, we deemed it premature to do phylogeny reconstruction.

Results

Taxonomic account

Genus *Dardanus* Paul'son, 1875

Dardanus callichela Cook, 1989

Pagurus imbricatus – Alcock, 1905: 92, pl. 9, figure 8; Fize & Serène, 1955: 220, figure 35A–C, pl. 6, figures 11–14 (Not *Dardanus imbricatus* Milne Edwards, 1948).

Dardanus callichela – Cook, 1989: 115–117, figures 3, 6B, 8A.

Dardanus callichela – Rahayu, 1996: 338; Rahayu & Wahyudi, 2007: 13; McLaughlin, 2002: 427–428; Xiao *et al.*, 2014: 212–215, figures 1 & 2.

Material examined. One male SL 19.5 mm (BIPH1901/ NMCR99102/GenBank accession number ON807356), Baliguian Island, Iloilo, Philippines; one ovigerous female 14.4 mm SL (BIPH1902/ MCR99103/GenBank accession number ON807356), Baliguian Island, Iloilo, Philippines; one ovigerous female 20.1 mm SL (BIPH1903/NMCR99104), Baliguian Island, Iloilo, Philippines; one damaged female 18.1 mm SL (NIPH1904/NMCR99105), Nagarao Island, Masbate, Philippines. Other measurements are presented in Table 1.

Brief description

Ocular peduncles shorter than antennular peduncles; cornea diameter one-third of ocular peduncle; ocular acicles broad, well separated basally, with 3 spines on distal margins.

Palm of left cheliped with a row of 4–7 spines on the upper inner margin, outer surface strongly convex and scutellated, with flat fringe of plumose setae on the distal edge of each scute; lower margin with brush of long plumose setae partially concealing robust spines. Carpus with row of spines on upper margin, smaller spines on upper half of outer surface, spinose scutes on lower half. Ambulatory legs with dactyls longer than propodi. Dactyl of left third pereopod bordered by dense brush of long bristles and plumose setae, dorsal and ventral margins with row of long sharp spines partially obscured by setae; lateral surface flattened, with smooth, longitudinal, median area, sometimes ill-defined and flanked by transverse scutes with flat fringe of plumose setae on distal edge of each scute. Propodus with row of large simple and multifid spines on the dorsal and ventromesial margins, partly concealed by brush of long plumose setae; lateral surface convex, with 2 rows of scutes. Carpus with spinose scutes fringed distally with plumose setae on lateral face; dorsal surface with some spines, tufts of setae, and bristles; mesial face smooth, slightly convex, with 3–5 large spines on ventrodistal margin, 2 large and 2 small spines on dorsodistal margin.

Telson with roundly triangular, slightly asymmetrical posterior lobes; oblique terminal and rounded lateral margins armed with several spines.

Fresh colouration. Body cream-coloured with scattered red and white dots. Dactylus of left second pereopod, right second pereopod, right third pereopod, and distal half of fingers of right cheliped brick red, with white blotches at the base of tufts of bristles. Scutes on fingers and palm of left cheliped and outer surface of left third pereopod pink-lilac bordered with red. Ocular peduncles proximal half royal purple, bordered by red-orange proximally, distal half light orange.

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Table 1. Morphological measurements and observations of the four specimens of *D. callichela* collected in the Visayan Sea, Philippines

Characteristics	NMCR99102	NMCR99103	NMCR99104	NMCR991025
Shield length (SL, mm)	19.5	14.4	20.1	18.1
Carapace length (CL, mm)	38.1	30.3	33.7	38.6
Sex	M	OF	OF	F
Ocular peduncles				
Length (mm)	9.8	8.6	9.4	9.9
Eye/eyestalk proportion	1/3	1/3	1/3	1/3
Left 3rd pereopod (LP3)				
Carpus length (mm)	18.5	13.7	15.1	18.4
Carpus width (mm)	7.6	5.8	6.1	8.5
Carpus length/width ratio	2.4	2.4	2.5	2.2
Measurements (%CL)				
Ocular peduncle length	25.7	28.2	27.9	25.8
Carpus length of LP3	48.4	45.2	44.9	47.7
Carpus width of LP3	19.9	19.0	18.0	22.1

M, male; F, female; OF, ovigerous female; D, damaged.

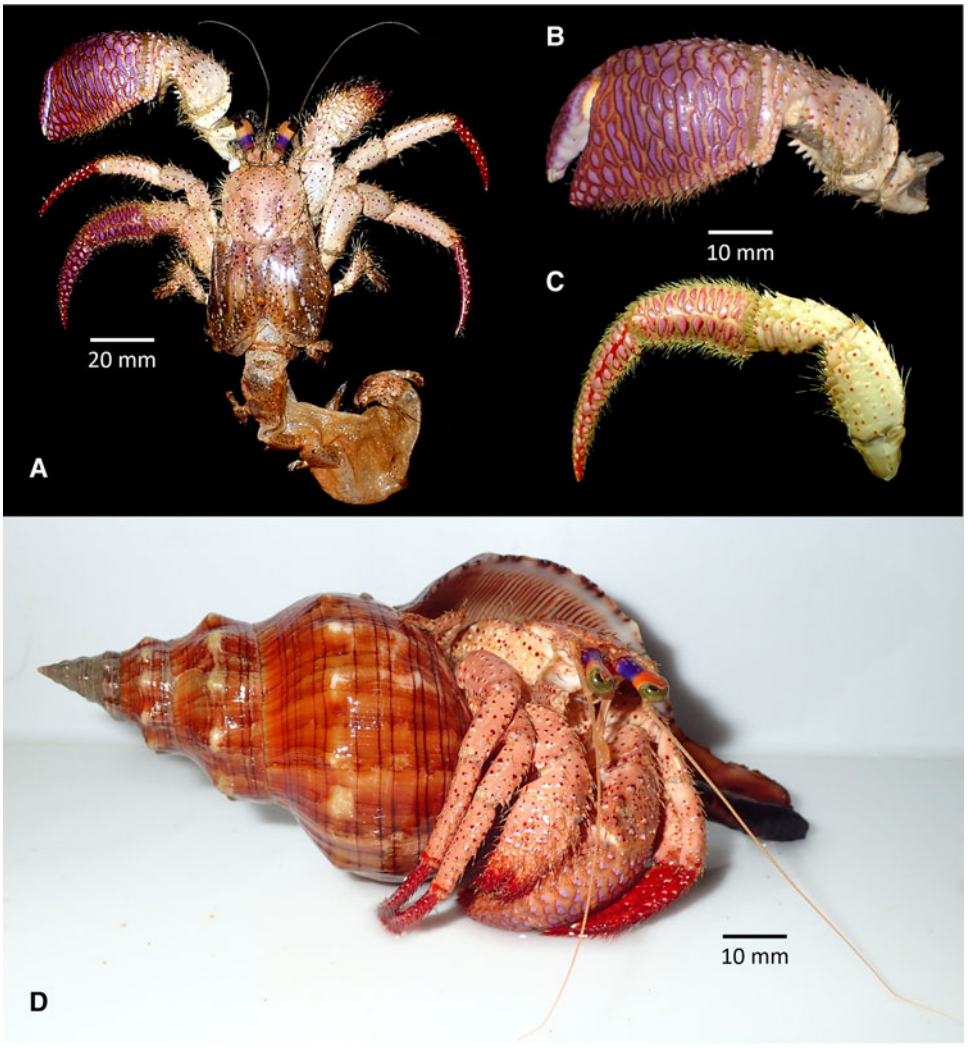

Fig. 2. *Dardanus callichela.* (A) Dorsal view, (B) left cheliped, (C) left third pereopod, (D) live specimen inside a *Filifusus filamentosus* shell. (A–C) NMCR99105; (D) NMCR99104.

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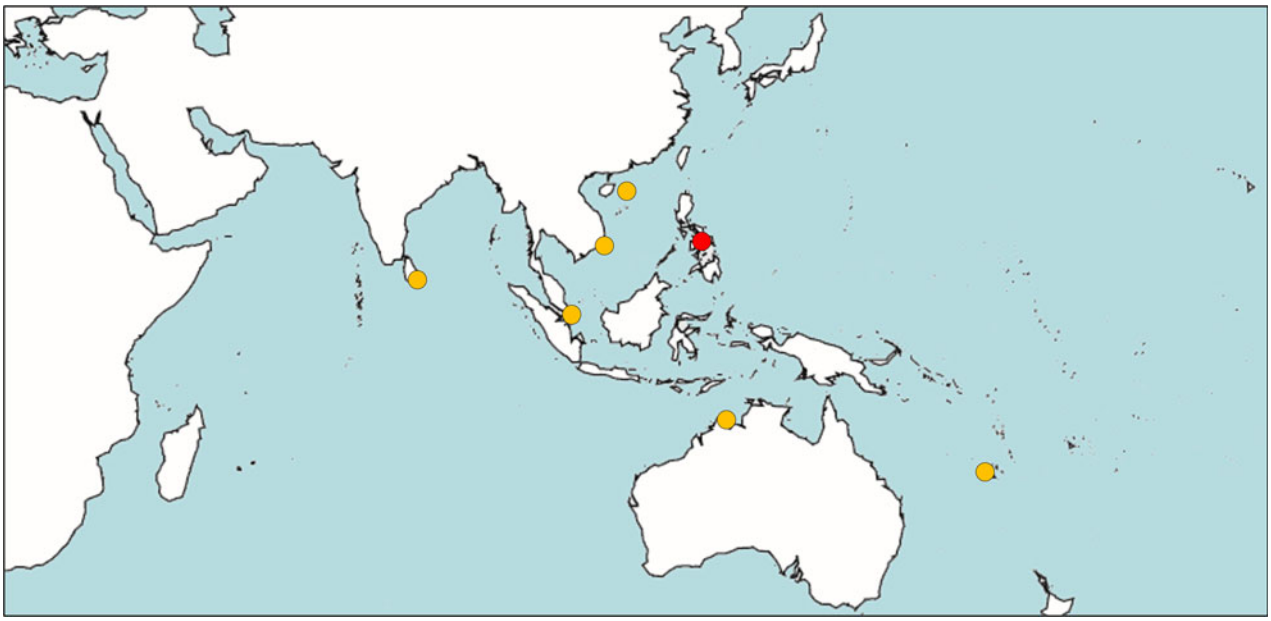

Fig. 3. Recorded distribution of *Dardanus callichela* in the Indo-West Pacific region (yellow filled circles) including the new record in the Philippines (red filled circle).

Remarks

Dardanus species that closely resemble *D. callichela* include *D. imbricatus* (Milne Edwards, 1848), *D. corrugatus* Cook, 1989, *D. squarrosus* Cook, 1989 and *D. undulatus* (Balss, 1921) (Cook, 1989). This species group is easily distinguished from all other Indo-West Pacific *Dardanus* by the degree of sculpturing on the outer surface of the left cheliped, which is consistent with our specimens (Figure 2A & B). *Dardanus callichela* and *D. imbricatus* can be distinguished from *D. corrugatus*, *D. squarrosus* and *D. undulatus* by the length of their eyestalks. All four specimens examined in this study have short eyestalks, where the eye diameter is 1/3 of the eyestalk length, consistent with both *D. imbricatus* and *D. callichela*. *Dardanus imbricatus* is then separated from *D. callichela* by the presence of tubercles on scutes of the left cheliped and the smooth surface of the outer face of carpus of the third left leg (Cook, 1989). The collected specimens do not have tubercles on scutes on the left cheliped (Figure 2B) and the outer surface of carpus of the third pereopod (Figure 2C) is scutellated, not smooth. In addition, the colouration of fresh specimens (Figure 2) closely matches colour notes on recently preserved specimens (Cook, 1989). Therefore, we identify the specimens as *D. callichela*, a new record for the Philippines, bringing the total count of *Dardanus* in the country to 16 species.

Distribution

Indo-West Pacific: Sri Lanka; Gulf of Thailand; South China Sea; NW Australia; Coral Sea; Singapore; Visayan Sea, Philippines (Figure 3). From 30–88 m and one questionable report from 350 m.

Discussion

Dardanus callichela is found in waters >30 m from only a handful of Indo-West Pacific locations. However, as with other deeper-water species, its true distribution may be more extensive. Deeper waters are rarely explored, and its inhabitants are sometimes erroneously classified as rare or endemic (Mendoza *et al.*, 2010). The new record of *D. callichela* from the Philippines was due to fortuitous collection of bycatch from fish traps set by municipal fishers in the Visayan Sea. Bycatch from traps and other low-cost artisanal methods such as tanglenets (Mendoza *et al.*, 2010) can be explored as alternative survey methods for deep benthic habitats that are inaccessible through conventional scuba diving surveys.

Dardanus is in need of a global taxonomic revision (Landschoff, 2018) to resolve species complexes; date divergences between Indo-West Pacific, East Pacific and West Atlantic taxa; and understand key evolutionary events, such the transition between deep- and shallow-water species. While the molecular data currently available for the genus is insufficient to resolve these questions, sequence data from rarer, deeper-water species such as *D. callichela* will be instrumental in fully resolving the phylogeny of the genus *Dardanus*.

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Author contributions. Study conception and design: LRF, MACM, MCDM; Data collection: LRF, MACM, MCDM, KCSE, WLC; Analysis and interpretation of results: LRF, MACM; Wrote first draft: MACM, LRF; Revision and edits to manuscript: LRF, MACM, MCDM, KCSE, WLC; Final approval of submitted manuscript: all authors.

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Ethical standards. This study does not contain sampling procedure and technique involving vertebrates and regulated invertebrates performed by any of the authors. The specimens were purchased from the fishers, thus no collection permits were required.

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