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New record of *Calcinus morgani* (Crustacea: Decapoda: Anomura: Diogenidae) from the Andaman Islands, and a key to *Calcinus* species in the Andaman and Nicobar Islands

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Abstract

The diogenid hermit crab, *Calcinus morgani* Rahayu & Forest, 1999, is reported from the Andaman Islands in the eastern Indian Ocean. It was previously recorded as *Calcinus gaimardii* (H. Milne Edwards, 1848) from the Nicobar Islands, south of the Andaman Islands, in 1865 about 160 years ago, but there were no additional records of the species in the Andaman and Nicobar Islands. The diagnosis of *C. morgani* is provided on the basis of the present specimens for helping the identification. A key to species of the genus *Calcinus* known from the Andaman and Nicobar Islands is also provided.

Introduction

The Andaman and Nicobar Islands are located in the eastern Indian Ocean and known as the 'Paradise of Biodiversity' (Ramakrishna *et al.*, 2010). The major coastal and marine habitats of the island groups include coral reefs, mangrove creeks, mudflats, seaweed and seagrass beds, estuaries, and lagoons, and these various habitats are home to numerous organisms, including hermit crabs (Mukhopadhyay and Karisiddaiah, 2014). Hermit crabs belong to the superfamily Paguroidea of the infraorder Anomura. Among 114 species of the hermit crabs reported from India, 55 species are known from the Andaman and Nicobar Islands, including 6 from the family Coenobitidae, 37 from the family Diogenidae, 8 from the family Paguridae, 2 species from the family Parapaguridae, and 2 species from the family Pylochelidae (Patel *et al.*, 2022).

There are very few studies on hermit crabs from the Andaman and Nicobar Islands; mainly the distribution and diversity of these organisms has been studied here, and the pioneering works include Heller (1865) and Alcock (1905). Other works on additional hermit crab species recorded from there include those by Reddy and Ramakrishna (1972), Thomas (1977, 1989), Tikader *et al.* (1986), Venkataraman *et al.* (2004), Rao (2010), and Kariathil *et al.* (2010).

The family Diogenidae includes about 70% of the hermit crab species that have been reported from the Andaman and Nicobar Islands, which comprises one species each from the genera *Aniculus* (*A. ursus* (Olivier, 1812)) and *Ciliopagurus* (*C. strigatus* (Herbst, 1804)); four species from *Calcinus* (*C. gaimardii* (H. Milne Edwards, 1848), *C. laevimanus* (Randall, 1840), *C. latens* (Randall, 1840), and *C. morgani* Rahayu & Forest, 1999); nine species each from *Clibanarius* (*C. arethusa* De Man, 1888, *C. corallinus* (H. Milne Edwards, 1848), *C. demani* Buitendijk, 1937, *C. humilis* (Dana, 1851), *C. longitarsus* (De Haan, 1849), *C. merguensis* De Man, 1888, *C. olivaceus* Henderson, 1915, *C. signatus* Heller, 1861, and *C. striolatus* Dana, 1852) and *Dardanus* (*D. deformis* (H. Milne Edwards, 1836), *D. guttatus* (Olivier, 1812), *D. lagopodes* (Forskål, 1775), *D. megistos* (Herbst, 1804), *D. pedunculatus* (Herbst, 1804), *D. setifer* (H. Milne Edwards, 1836), *D. tinctor* (Forskål, 1775), *D. vulnerans* (Thallwitz, 1891), and *D. woodmasoni* (Alcock, 1905)); five species from *Diogenes* (*D. alias* McLaughlin & Holthuis, 2001, *D. avarus* Heller, 1865, *D. custos* (Fabricius, 1798), *D. dubius* (Herbst, 1804), and *D. merguensis* De Man, 1888); and eight species from *Paguristes* (*P. balanophilus* Alcock, 1905, *P. calvus* Alcock, 1905, *P. ciliatus* Heller, 1862, *P. incomitatus* Alcock, 1905, *P. longirostris* Dana, 1851, *P. mundus* Alcock, 1905, *P. puniceus* Henderson, 1896, and *P. pusillus* Henderson, 1896) (Patel *et al.*, 2022). The present study reports a diogenid hermit crab, *C. morgani* Rahayu & Forest, 1999, after a span of about 160 years recorded by Heller (1865) as *C. gaimardii* H. Milne Edwards, 1848 from the Andaman and Nicobar Islands, and also provides a key to the species of the genus *Calcinus* reported from these islands.

Materials and methods

The specimens examined were collected from four sites along the southeastern coast of South Andaman, Andaman Islands, viz., Science Centre (11°39'19.404"N, 92°45'25.848"E), Corbyn's Cove (11°38'43.044" N, 92°44'56.184"E), Burmanallah (11°33'16.956"N, 92°43'51.24"E), and Kodyaghat (11°31' 48.349"N, 92°43' 24.362"E) (Figure 1). They were handpicked from the intertidal region of the four sites during the lowest tide period from January to March, 2023. The specimens then were brought to the laboratory and washed with water and kept

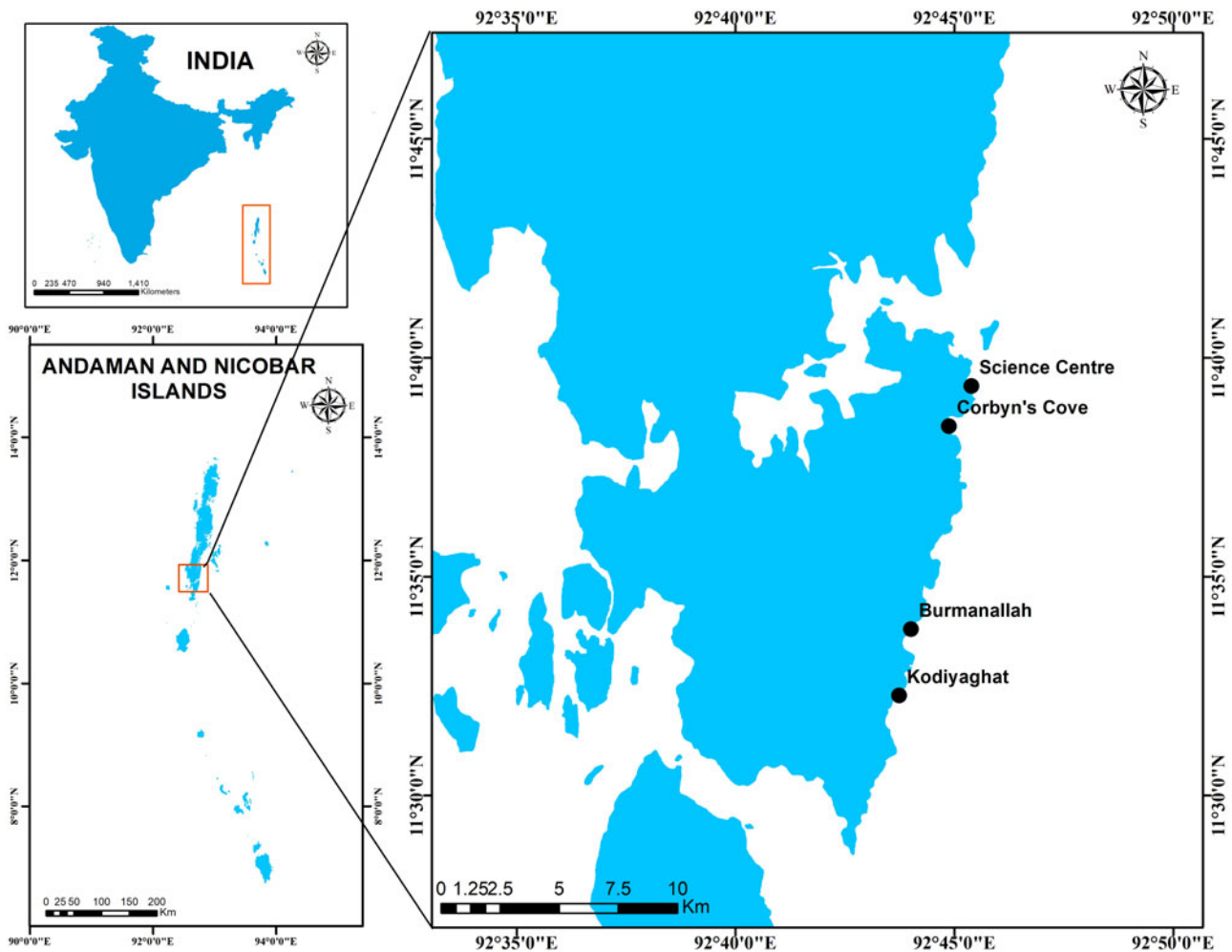


Figure 1. Study area: sampling sites of the present specimens of *Calcinus morgani* Rahayu and Forest, 1999.

in a small amount of sea water, which resulted in a low oxygen level and caused the crabs to come out of the shells; when those crabs did not come out of the shells, they were taken out by breaking the shell with a vise. After the live coloration of a specimen was recorded, all the specimens were preserved in 7% formalin and are deposited in the Museum of the Department of Ocean Studies and Marine Biology, Pondicherry University, Port Blair Campus (PU/MB/551, dt. 27.03.2023). Shield length (SL), the size of specimens, was measured from the tip of rostrum to the posterior median margin of the shield.

Results

Calcinus morgani Rahayu & Forest, 1999 (Figure 2A–G)

Calcinus gaimardii Alcock, 1905: 56, pl. 5, fig. 5; Miyake, 1956: 326, figs 16, 17; Ball & Haig, 1972: 101; Lewinsohn, 1982: 52; Haig & Ball, 1988: 159; Poupin, 1997: 688, figs 2B, 5D [not *Calcinus gaimardii* (H. Milne Edwards, 1848)].

Calcinus areolatus Rahayu & Forest, 1999: 468, fig. 4

Calcinus morgani Rahayu & Forest, 1999: 465, figs 1B, 2C–D, G–H, J; McLaughlin & Dworschak, 2001: 154 (in part); Asakura, 2002: 43, figs. 1D, 9–11, 21E–I; McLaughlin *et al.*, 2007: 159, 3 figures – unnumbered; Reshmi & Bijukumar, 2011: 1771, figs. 1 A–F.

Materials Examined

PU/MB/551, dt. 27.03.2023: 1 male (SL: 4.85 mm), Kodyaghat, 25 January 2023 – PU/MB/551/KD; 2 males (SL: 5.62 and 6.79 mm), 1 female (SL: 4.96 mm), Science Centre, 5 February 2023 – PU/MB/

551/SC; 1 female (SL: 6.94 mm) Corbyn's Cove, 24 February 2023 – PU/MB/551/CC; 2 males (SL: 5.93 and 7.94 mm), Burmanallah, 22 March 2023 – PU/MB/551/BN.

Diagnosis

Shield longer than broad, rostrum acutely triangular. Ocular peduncles slender, shorter than shield; ocular acicles subtriangular, each with a single distal spine. Antennular peduncle shorter than ocular peduncle, basal segment with 3–5 small spines on lateral face. Antennal acicle with a single terminal spine, lateral margin with 2 or 3 spines, mesial margins with 3–5 spines.

Left cheliped smoother and distinctly larger than right. Dactylus and fixed finger with 4 or 5 teeth and 2 or 3 teeth on respective cutting edge. Fixed finger and distal part of dactylus with tubercles on outer surface. Palm convex on outer surface.

Right cheliped dactylus with row of 5 or 6 spines on dorsal margin and with 2 or 3 teeth on cutting edge. Fixed finger with 3 or 4 teeth on cutting edge. Palm with tubercles on outer surface. Both chelipeds each with tubercle on dorsodistal margin of carpus and spine on ventrodistal margin of merus.

Ambulatory pereopods nearly smooth on surfaces. Propodi of second and third pereopods longer than dactyli, carpi each with dorso-distal spine; meri each with distal spine on ventral margin. Second pereopods with widely spaced small tufts of setae on ventral margins of propodi and dactyli. Third pereopods with dense tufts of setae on ventral margins of distal part of propodi and entire dactyli. Telson terminal lobes with 1–3 spines and 3–9 spines on right and left sides, respectively.

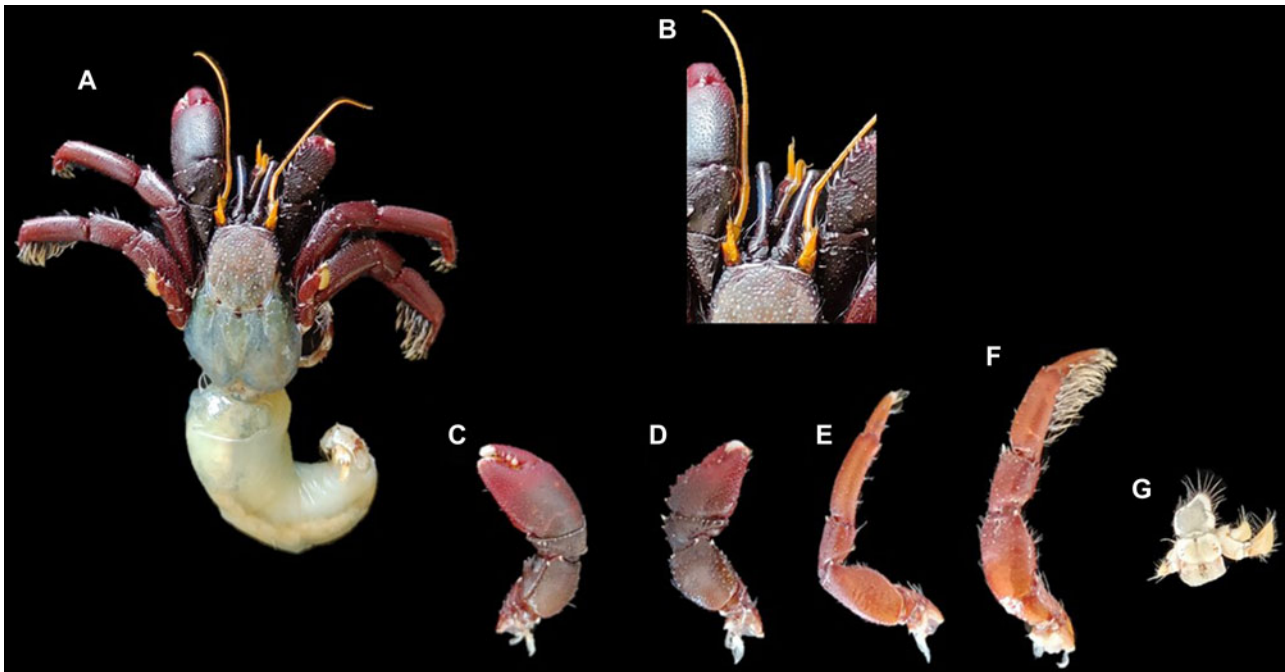


Figure 2. *Calcinus morgani* Rahayu and Forest, 1999, male, SL: 6.79 mm; (A) entire specimen, dorsal view; (B) ocular peduncles and cephalic appendages, dorsal view; (C) left cheliped, lateral view; (D) right cheliped, lateral view; (E) right second pereopod, lateral view; (F) right third pereopod, lateral view; (G) sixth abdominal somite, telson, and uropods, dorsal view.

Colour in life: Shield bluish-grey to greyish-green or creamish, with anterior and lateral margins brown; rostral lobe also brown. Ocular peduncles dark brown on proximal half and blue on distal half. Antennular peduncles dark greenish brown, flagella orange. Antennal peduncles and flagella yellowish orange. Chelipeds reddish brown, paler towards distal part of palm and brownish on proximal part of palm and whole of merus and carpus; tips of fixed finger and dactylus, and teeth on cutting edge of chelipeds white. Second and third pereopods pale reddish-brown entirely, tips of dactyli white.

Colour in preservative: Shield becoming more creamish colour than in life. Blue colour of ocular peduncles disappearing, becoming light orange; dark brown colour getting paler. Brownish colour of chelipeds and second and third pereopods also getting paler.

Habitat and ecology: The present specimens were mainly found in small tide pools, associated with corals in the wave exposed intertidal region of rocky shores and were observed to co-exist with *C. gaimardii*. They inhabited the shells of gastropods of the families Fasciolaridae, Muricidae, and Trochidae.

Distribution: Wide Indo-West Pacific region, from south and east African coasts to the Society and Hawaiian Islands and Japan, through the southwestern coast of India, and Nicobar

Islands (Haig and Ball, 1988; Rahayu and Forest, 1999; McLaughlin and Dworschak, 2001; Asakura, 2002; Reshmi and Bijukumar, 2011). The present study shows a new record of *C. morgani* from the Andaman Islands.

Calcinus species recorded from the Andaman and Nicobar Islands (Patel et al., 2022)

Calcinus gaimardii (H. Milne Edwards, 1848) (Heller, 1865*; Alcock, 1905; Reddy and Ramakrishna, 1972; Tikader et al., 1986; Kariathil et al., 2010; Rao, 2010).

Calcinus laevimanus (Randall, 1840) (Heller, 1865* as *C. tibicen* (Herbst, 1791); McLaughlin and Dworschak, 2001 re-identified Heller’s specimen as *C. laevimanus*; Alcock, 1905; Reddy and Ramakrishna, 1972; Tikader et al., 1986; Rao, 2010, as *C. herbstii* De Man, 1888; Thomas, 1989; Kariathil et al., 2010, as *C. herbsti*).

Calcinus latens (Randall, 1840) (Reddy and Ramakrishna, 1972*; Thomas, 1977; Tikader et al., 1986; Rao, 2010).

C. morgani Rahayu and Forest, 1999 (Heller, 1865*, as *C. gaimardii*; McLaughlin and Dworschak, 2001, re-identified part of Heller’s material as *C. morgani*).

[* indicates the first record of the species from the Andaman and Nicobar Islands.]

A Key to *Calcinus* species recorded from the Andaman and Nicobar Islands

1. Ocular peduncles stout, same length as shield; dorsal margin of palm of right cheliped smooth; palms of chelipeds dark brown with white coloration; second and third pereopods with dark brown longitudinal stripes. *C. laevimanus*
 - Ocular peduncles slender, shorter than shield; outer margin of right cheliped with spines. 2
2. Third pereopod without brush of setae on ventral margins of dactylus and propodus; dactyli of second and third pereopods longer than propodi, with purplish-blue band proximally *C. latens*
 - Third pereopod with brush of setae on ventral margins of entire dactylus and of distal part of propodus; dactyli of second and third pereopods shorter than propodi, without purplish-blue band proximally 3

3. Ocular peduncles orange with dark brown longitudinal stripe dorsally, narrow blue ring below corneas; shield dark brown; chelipeds and ambulatory pereopods dark brown; 2 or 3 anterodorsal plates of branchiostegites brown *C. gaimardii*
- Ocular peduncles dark brown proximally and blue distally; shield grey or greyish white, anterior and lateral margins brown; chelipeds and ambulatory pereopods reddish brown; only first anterodorsal plate of branchiostegite brown
- *C. morgani*

Discussion

The diogenid genus *Calcinus* is characterized by a triangular rostrum without a rostriform process formed between the ocular acicles, 13 pairs of gills, left cheliped larger than the right; cheliped fingers with calcareous tips, and colourful carapace and pereopods (Reay and Haig, 1990; McLaughlin, 2002, 2003; McLaughlin *et al.*, 2007; Naderloo *et al.*, 2012). Species of this genus show very much morphological similarity, so their characteristic colour patterns in fresh condition are very important for the species identification (Poupin, 1997; McLaughlin *et al.*, 2007; Jung and Park, 2023).

Calcinus morgani is differentiated from its closest *Calcinus gaimardii* by the coloration of the ocular peduncles, shield, and ambulatory legs (Rahayu and Forest, 1999). Asakura (2002) recognized an additional colour difference in the branchiostegites between the two species; in *C. gaimardii*, two or three anterodorsal plates are brown, whereas in *C. morgani*, only the first anterodorsal plate is brown. Asakura (2002) also noticed habitat differences between the two species. *Calcinus morgani* inhabits the intertidal areas of rocky shores or coral reefs with direct wave action; whereas *C. gaimardii* is found in the subtidal zones of wave-sheltered regions. In the present study, both species were found together in tide pools of the intertidal region near corals with direct wave action, and *C. gaimardii* was also found in the subtidal region. In India, *C. morgani* has only been recorded from the Nicobar Islands (as *C. gaimardii*) and Kerala (McLaughlin and Dworschak, 2001; Reshmi and Bijukumar, 2011). Heller (1865) had recorded *C. gaimardii* from the Nicobar Islands, but McLaughlin and Dworschak (2001) re-examined Heller's (1865) specimens and showed they actually belong to *C. morgani* instead. The present specimens represent the first record of *C. morgani* from the Andaman Islands, situated north to the Nicobar Islands.

During the present research in South Andaman Island, *C. morgani* was found to be more abundant and widely distributed than *C. gaimardii* along the southeastern coast. However, the former species has never been reported from the Andaman coasts, including the North and Middle Andamans. This primarily demonstrates that only very limited study on hermit crabs has been performed in the Andaman and Nicobar Islands. Research on hermit crabs in India mainly focuses on their distribution, diversity, and choice of shell (Alcock, 1905; Henderson, 1915; Kamalaveni, 1950; Khan and Natarajan, 1981; Thomas, 1989; Reshmi and Bijukumar, 2011; Vaghela and Kundu, 2012; Jigneshkumar *et al.*, 2015; Raval *et al.*, 2015; Jhala *et al.*, 2017; Trivedi and Vachhrajani, 2017; Sardar *et al.*, 2019). Further studies are needed to gain a deeper understanding of the behaviour and ecology of hermit crabs in the Andaman and Nicobar Islands.

Data. Data will be made available on request.

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Author contributions. Navyashree Aravind initiated the fieldwork, specimen collection, identification, and manuscript preparation. Ganesh Thiruchitrambalam reviewed the manuscript and made corrections.

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Competing interests. None.

Ethical standards. No animal testing was performed during the study.

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