



ISSN Print: 2664-9926
 ISSN Online: 2664-9934
 Impact Factor: RJIF 5.45
 IJBS 2022; 4(2): 229-234
www.biologyjournal.net
 Received: 04-09-2022
 Accepted: 08-10-2022

Thet htwe aung
 Assistant Lecturer, Marine
 science, Mawlamyine
 University, Myanmar

Morphology and their abundance of marine hermit crabs In Zee-Phyu-Thaung coastal areas, Mon state, Myanmar

Thet htwe aung

DOI: <https://dx.doi.org/10.33545/26649926.2022.v4.i2d.124>

Abstract

The morphological characters of marine hermit crabs from mangrove forests and rocky and sandy shores around Zee-phyu-thaung and its adjacent coastal areas were conducted from September to November 2018. Consequently, a total of 5 species in 2 genera and 1 family were identified with their distinguished characters including *Clibanarius infraspinus* (Hilgendorf, 1869), *Clibanarius padavensis* De Man, 1888, *Clibanarius merguensis* de Man, 1888, *Diogenes edwardsii* (De Haan, 1849) and *Diogenes alias* McLaughlin & Holthuis, 2001. Among them, *C. padavensis* (Bosc, 1802) and *D. alias* McLaughlin & Holthuis, 2001 were first records for Myanmar's hermit crabs. Moreover, *C. padavensis* and *D. edwardsii* was the most abundance species in Zee-phyu-thaung.

Keywords: Hermit crabs, *C. padavensis*, *D. alias*, Zee-phyu-thaung, Myanmar

Introduction

Hermit crabs are decapod crustaceans of the superfamily *Paguroidea* (Patsy McLaughlin & Michael Türkay 2011) ^[10]. Most of the approximately 1100 species possess an asymmetrical abdomen that is concealed in a scavenged mollusc shell carried around by the hermit crab. Most species have long, spirally curved abdomens, which are soft, unlike the hard, calcified abdomens seen in related crustaceans. The vulnerable abdomen is protected from predators by a salvaged empty seashell carried by the hermit crab, into which its whole body can retract (Ray 1997) ^[21]. Most frequently, hermit crabs use the shells of sea snails (although the shells of bivalves and scaphopods and even hollow pieces of wood and stone are used by some species). Most hermit crabs are nocturnal.

Despite Myanmar have extensively long coastlines and diverse marine environments, the studies of hermit crabs are very rare to absent. The present study is the second record of systematic account on the marine hermit crabs in Myanmar after Yu Yu May 2014 ^[28].

The aim of the present study is

1. To record the hermit crab species in Zee-phyu-thaung, Myanmar,
2. To study their morphological characters and
3. To know the abundance of their species in Zee-phyu-thaung.

Materials and Methods

The studies on the systematic classification of Anomuran hermit crabs from Zee-phyu-thaung coastal areas including Payarthaung, Kamawkin and Sitaw were conducted from September to November 2018. Zee-phyu-thaung is located in Mon State and around the mouth of Ye river, Myanmar. The general morphology and terminology used for identification of the typical hermit crabs were presented. The samples were collected by hand during the low tide along the coast. Most of the samples were collected in plastic vials containing a little amount of seawater and carried to the laboratory for identification work. All samples were preserved with ice and carefully remove the hermit crabs body from the hard shells by crushing the shells using a hammer. Then the bodies of hermit crabs were photographed using digital camera and measure the body length and shell length. After that the samples were preserved in 10% formalin. The samples were then identified under the

Corresponding Author:
Thet htwe aung
 Assistant Lecturer, Marine
 science, Mawlamyine
 University, Myanmar

compound and dissecting microscopes. The distinctive characters of appendages or segments of the body were drawn on the tracing paper by using stereomicroscope with Camera Lucida and dotted or shaded.

The sketch drawings showing the taxonomic keys characteristics of each hermit crab were presented. The artificial key to the species of hermit crabs collected from Zee-phyu-thaung coastal area was provided in the present study.

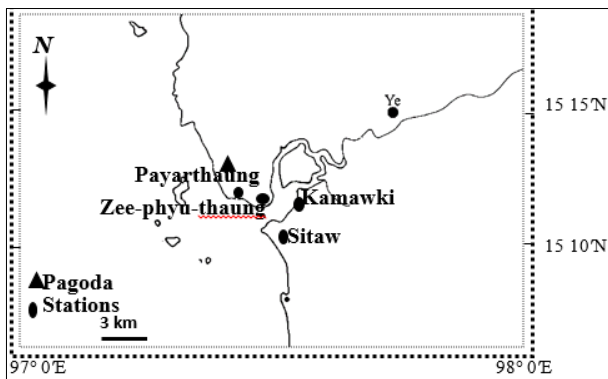


Fig 1: Map showing the collection sites of hermit crabs from the Zee-phyu-thaung coastal areas, Mon State, Myanmar

Result

Terminology

The following characters were reviewed and used in this study based on Provenzano Jr., Anthony J. 1959 [18].

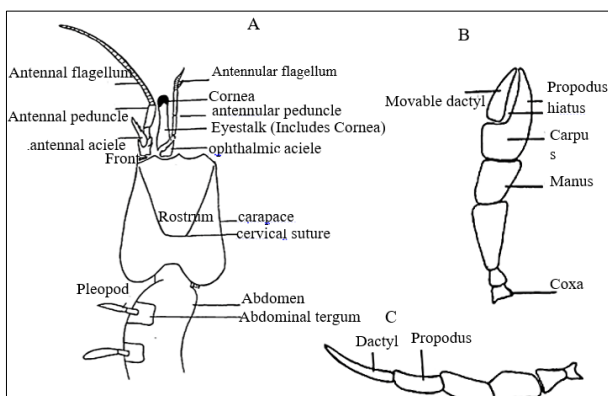


Fig 2: Diagram of external features of a hermit crab. A). Dorsal aspect of body: B). Parts of a cheliped: C). A typical pereopod

Results

Phylum: Anthropoda

Class: Malacostraca

Subclass: Eumalacostraca

Order: Decapoda

Family: Diogenidae Ortmann 1892

Genus: *Clibanarius* Dana, 1852

Species: (i) *Clibanarius infraspinus* (Hilgendorf, 1869)

(ii) *C. padavensis* (Bosc, 1802)

(iii) *C. Merguiensis* de Man, 1888

Genus: *Diogenes* Dana, 1851

Species: (i) *Diogenes edwardsii* (De Haan, 1849)

(ii) *D. alias* McLaughlin & Holthuis, 2001 [12]

Key to the species of Anomuran hermit crabs

1a. Left cheliped are larger than right. 2 1b. Left cheliped are not larger than right 3 2a. Left cheliped longer, with

prominent hiatus between dactyl and fixed finger. *Diogenes edwardsii*

2b. Left cheliped shorter, without prominent hiatus between dactyl and fixed finger *D. alias*

3a. Without color stripes on ocular peduncles *Clibanarius merguiensis*

3b. With color stripes on ocular peduncles 4

4a. Orange stripes on ocular peduncles *C. infraspinus*

4b. White or grey stripes on ocular peduncles *C. padavensis*

Clibanarius infraspinus (Hilgendorf, 1869) figure 4

Vernacular (common) names: Orange-striped hermit crab.

References

Rahayu, 1996 [19]: 336, Rahayu, 2000 [20]: 383, McLaughlin 2002 [11]: 395, Siddiqui and Kazmi, 2003 [22]: 88, Osawa and Yoshida 2009 [15]: 273, fig. 3D-F, Trivedi 2015 [26]: 34, fig. 1.

Description

Shield longer than broad. Ocular peduncles long, slender, ocular acicles multidenticulate. Antennular peduncles equal to or slightly longer than ocular peduncles; antennal peduncles shorter, not reaching to base of corneas; antennal acicle reaching beyond base of ultimate segment. Chelipeds generally equal, or right slightly smaller, similar in armament; palms each with numerous spiniform tubercles on dorsal surface. Ambulatory legs with dactyls longer than propod; dorsal surfaces each with slightly raised but smooth longitudinal margin; ventral margins each with 7 or 8 corneous spines in distal half; carpi each with row of spines on dorsal surface (second) or single dorsodistal spine (third). Telson margins each with 5 or 6 prominent, corneous-tipped spines.

Shield length: 1-1.8 cm.

Colouration

The cheliped are of brown-orange colouration but has no visible stripes. It is sparsely hairy and has pale white pimples on its entire ventral surface. Pincers (or claws) are coloured towards orange and are lined black. The 2 pairs of walking legs are brown with sparse hair, decorated with orange stripes along both longitudinal margins. Its eye stalks are brown, lined with pale orange stripes along both its longitudinal margins. Its antennae are short orange tips that are feathery. Its long antennules are pale or dark brown and are non-feathery.

Habitats

Low intertidal to shallow subtidal. Associated with sand, especially near river mouths. Inhabits mangrove areas with sandy and muddy substrates.

Distribution

Red Sea, Arabian Sea, Bay of Bengal, Singapore, Tavoy, Philippines, Sydney and Taiwan (McLaughlin 2002) [11].

Clibanarius padavensis De Man, 1888 figure 5

References.- Alock, 1905 [1]: 42, 44, pl. 4, fig. 2, Southwell 1906 [23], p. 215; McCulloch, 1913 [9]: 349, 352; Sundara Raj 1927 [24], p. 130; Dechance, 1964 [6]: 32, text fig. 5; Panikkar and Aiyar 1937 [16], p. 296; Ball and Haig, 1972 [2]: 95-96, fig 4; Thomas 1989 [25]: 65, FIG. 1 o-q, PI. IC, McLaughlin 2002 [11]; 402-403; Trivedi 2015 [26]: 37-38, fig 3.

Description

Carapace longer than broad, fine silky setae present on the sides of the carapace. Rostrum prominent, reaching beyond the antennal angles of the carapace. Eye stalk about one sixth longer than the anterior border of the carapace, ophthalmic scales with spinose edges, antennal peduncles with fine silky setae. Antennal acicle setae, indistinctly serrulate, not overlapping base of the terminal joint of the peduncle, Flagellum twice as long as carapace.

Cheliped equal and similar, little stouter than legs, merus with 1 or 2 spinules on the far end of the lower outer border; inner border of carpus indistinctly, and of propodus distinctly serrulated; distinct spine presents on the far end of inner border of carpus. Outer surface of the fingers studded with small dark tipped spinules; the palm ornamented with little elevations covered with sparse setae, surface of palm not studded with spinules; fingers when closed leave gap. Second and third walking leg longer than chelipeds, merus flattened; carpus with sharp spinule on the distal end of upper border, propodus of walking leg sub cylindrical. Telson with upper border rounded in shape, median cleft barely detectible, posterior lobes asymmetrical, terminal margins with long setae.

Shield length: 0.25-1.5cm

Coloration in life

The shield and carapace off white in color with no stripes, the ocular peduncle off white in color with dark brown stripe in the middle; longitudinal dark brown stripes present on eye stalk with off white background. Cornea jet black in color. Merus and carpus of chelipeds dark green in color and covered by white stripes with dark brown border; the outer surface of the palm dark green in color with dark brown line on upper part; the inner surface of palm off white in color. Walking leg off white with four or five dark brown longitudinal lines with white border on all the segments; tips of the dactylus black.

Coloration in formalin

Shield pale orange to white, with brownish longitudinal markings tending toward broad, much diffused stripes; in some specimens there are two distinct longitudinal stripes. Eye scales mostly reddish brown. Eyestalks orange-brown to pale orange dorsally, pale on outer and ventral surfaces; a distinct, narrow, longitudinal stripe on mesial surface. Basal segment of antennule white mottled with orange-brown; rest of peduncle orange-brown; flagellum white. Antennal scale and basal segment of peduncle mostly orange-brown; distal segment pale, with a brown longitudinal stripe on each lateral surface; flagellum pale for about half its length, orange-brown in distal half. Chelipeds mottled dark brown and pale orange; two distinct longitudinal stripes on each movable finger. Ground color of walking legs pale orange to nearly white propodus and dactyl with a broad band of white at each end of segment. Merus, carpus, propodus, and dactyl with longitudinal stripes of dark brown or dark orange-red; in some specimens these stripes extend to the ends of the segments, in others they do not cross them white band at either end of the propodus and dactyl.

Habitats

Intertidal areas in muddy substrates and in the mangrove forest.

Distribution

East Coast of Africa from Delagoa Bay northwards and Madagascar, West Coast of India, Bay of Bengal, Singapore and East Indies to Australia. (Ball and Haig, 1972) ^[2]

Clibanarius merguiensis* de Man, 1888 figure 6*References**

Thomas 1989 ^[25]: 68, Fig. 1, Rahayu 2000 ^[20]: 384, McLaughlin 2002 ^[11]: 398, Davie 2002 ^[5]: 45, Markham 2003 ^[8]: 72.

Description

Shield longer than broad. Ocular peduncles orange with blue band on dorsal surfaces. Ocular acicles each with 5 or 6 spines. Chelipeds black with light colored tubercles. Ambulatory legs black with light colored stripe on dactyls and often some part of propodi. Chelipeds equal, or slightly subequal; similar in armament; chelae each with dorsal surface covered with tubercles or spines. Ambulatory legs with dactyls shorter than propod; dorsal surfaces and lateral faces of dactyls and propodi unarmed. Telson with posterior lobes subequal to distinctly unequal.

Colouration

Shield mottled olive, blue and white. Ocular peduncle orange with dorsal stripe. Antennular and antennal peduncles dark blue, antennular flagella orange. Ambulatory leg with background color of dark blue; dactyls each with orange band proximally. Carpi of third pereopods each with orange patch on lateral face, meri each with patch of orange on lateral face proximally, largest on third pereopods.

Shield length: 0.25-1.5 cm

Habitats

This common intertidal hermit crab inhabits seagrass beds, rocky shores, reef flats, and pebble beach. It is also found on coral rubble and sandy muddy substrates near mangrove areas ([www. Sealifebase.org](http://www.Sealifebase.org)).

Distribution

Mozambique; Mergui Archipelago; Andaman Sea and Gulf of Thailand; Vietnam; Malaysia and Indonesia (McLaughlin 2002) ^[11].

***Diogenes edwardsii* (De Haan, 1849) figure 7**

Vernacular (common) names: Edward's hermit crab

References

Chou *et al.*, 1999 ^[4]: 28, Rahayu 2000 ^[20]: 389-390, Markham 2003 ^[8]: 72.

Description

Shield longer than broad. Ocular peduncles moderately sort. Intercalary rostriform process slender, terminally acute, shorter than ocular acicles; antennal peduncles shorter than antennular peduncles. Left cheliped with prominent hiatus between dactyl and fixed finger, upper surface with 1 or 2 rows of spines and long setae; upper outer surface of carpus with rows of acute spines, 2 rows distinct, distal margin with prominent spines. Ambulatory legs long and slender, right longer than left; dactyl longer than propodi. Telson with left lobe larger than right, terminal margins each with 5 or 6 spines, lateral margins with 6-12 spines; lateral and terminal margins also with sparse long setae.

Colouration

Carapace light brown, pale red, brownish-gray or mottled tan and brown. Ocular peduncles yellow, light brown, each with darker band proximally. Left chela white or light reddish-brown to orange; carpus and merus reddish-brown to brownish-gray mottled with white. Ambulatory legs gray, tan to light brown, white pale to dark reddish-brown of bluish-brown bands.

Habitats

Inhabits sandy bottoms at depths of 30 to 40 m.

Distribution

Indo-West Pacific and Atlantic Ocean (www.Sealifebase.org).

Diogenes alias McLaughlin & Holthuis, 2001 ^[12] figure 8 References

McLaughlin & Holthuis 2001 ^[12]: 256, Siddiqui & Kazmi 2003 ^[22]: 88, Trivedi 2015 ^[26]: 39-40, fig. 4. Nirmal *et al.* 2017 ^[14]: 2873, fig 4.

Description

Shield broader than long; rostrum weakly developed; lateral projections each with small submarginal spinule. Ocular peduncles equal in length, long and stout cornea not dilated, ocular acicles with straight mesial margins. The intercalary rostral process usually reaching beyond anterior margins of ocular acicles. Antennal flagella sparsely setose. Antennal acicles outer branches reaching to or beyond the last peduncular segment. Chelipeds unequal, left cheliped larger than right, left cheliped with acute spines near the upper

margin of dactylus. Fixed finger with outer margin flattened and armed with row of prominent spines. Outer surface of palm convex with five or six row of acute and slightly curved spines, upper margins of palm with two or three irregular row of smaller spines and tufts of moderately long setae. Carpus upper margin with row of strong spines. Right cheliped with one or two rows of spines on upper surface with obscured long setae. Carpus with row of strong spines on upper margin with long setae. Ambulatory legs with dactylus longer than propodus; dactylus with row of prominent spine on the dorsal margin, lateral faces of pereopods second and third with two longitudinal rows of small tubercles; carpus of second and third pereopods with dorsal row of spines, lateral faces of both the pereopods with two or three irregular rows of spinule or tubercles. Median cleft separating asymmetrical posterior lobes is absent in telson, left terminal margin with 5-6 corneous tipped spines noticeably increasing towards posterior margin.

Coloration

Shield cream coloured with a brownish tinge, ocular peduncle with light pink to brown longitudinal lines. Chelipeds with cream base with large brown spots, spines dark brown in color, walking leg with dark brown spines and bands. Specimen color is light cream in formalin preservation.

Shell length: 7.45-10.73 mm

Habitats: Inhabits sandy bottoms.

Distribution: Indo-West pacific (www.Sealifebase.org).

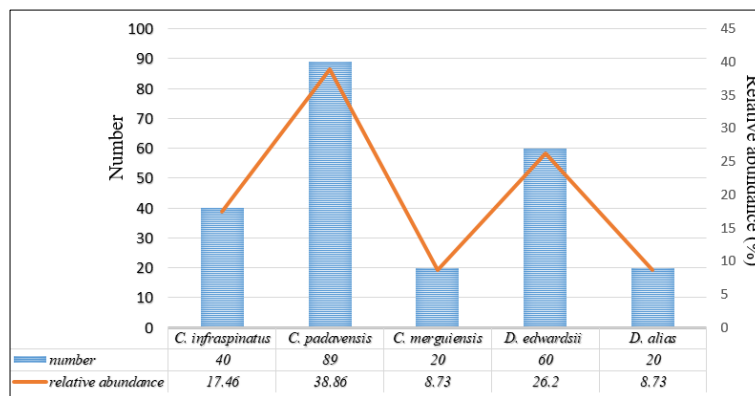


Fig 3: Relative abundance of marine hermit crabs in Zee-phy-thaung and its adjacent coastal areas during September to November 2018

Discussion

In Myanmar, the studies and literatures about hermit crabs are meager and there has been only one study by Yu Yu May 2014 ^[28] in which the diversity of Anomuran hermit crabs from Ka Byar wa, Zeephythaung and Phayartaung of Ye coastal area, Mon state were observed. In her study, a total of 8 species in 3 genera and 2 families were identified as *coenobita violascens*, *Clibanarius sp.1*, *C. merguensis*, *C. infraspinus* and *C. sp. 2*, *Diogenes penicillatus*, *D. edwardsii* and *D. rectimanus*. The present study conducted the morphological characters of the Anomuran hermit crabs from the beaches and the rocky shores around Zee-phy-thaung. As a result, a total of 5 species in 2 genera and 1 family was identified with their distinguished characters. The names of the species identified in the present study are *Clibanarius infraspinus*, *C. padavensis*, *C. merguensis*,

Diogenes edwardsii and *D. alias*. Among them, *C. padavensis* and *D. alias* were new records of hermit crabs for Myanmar because Yu Yu May 2014 ^[28] were not reported this species. On the other hand, morphologically the specimens of *C. padavensis* in the present study were like to *C. sp 2* in Yu Yu May 2014 ^[28] but she could not identify it up to the species level perhaps due to the lack of literatures available.

In relation with their morphological characters, ocular peduncles of *Clibanarius* are longer than *D. edwardsii*. Left cheliped of *Diogenes* are always larger than right. And then the species of *Clibanarius* spp are with longitudinal stripe on the ambulatory legs except *C. merguensis* whereas all the species of *Diogenes* are with sectional cross color bands. The shield shapes of *Clibanarius* spp are longer than broad whereas *Diogenes* is approximately as long as broad.

Moreover, the stripes of *C. infraspinus* were orange and the stripes of *C. padavensis* were white or grey color. Although hermit crabs colour is determined mostly by its species and colour is a reliable character in separating species of *Clibanarius* (Khan and Natarajan 1984)^[7], Wilby *et al.* 2018^[27] and Briffa and Twyman 2011^[29] asserted that hermit crabs have the potential to change their colouration via choice of shell over relatively short periods of time and shell colour will influence the conspicuousness of hermit crab. Likewise, many authors also described the colour of hermit crab separating the fresh specimens in life and specimens in alcohol or formalin because the specimens have been changed their colour after preservation in alcohol or formalin.

The morphological characters of the hermit crab species are showing similarity with the description given by Trivedi *et al.* 2015^[26], Alcock 1905^[1], Khan and Natarajan 1984^[7], Ball and Haig 1972^[2] and Thomas 1989^[25]. However, it had an exception that their colour was not agreed with some literatures.

In the present study, *Clibanarius* spp was the most abundant species in the study area representing over 60% of the total sample (figure 3). McLaughlin *et al.* 2007^[13] reported that species of *Clibanarius*, more than any other paguroid genus, are able to live and reproduce in waters of low salinities such as estuarines and around the mouths of river. Since the study area is located near the Ye river mouth. Among them, *C. padavensis* which was collected over 38% seems to be the most abundance species. *Diogenes edwardsii* with over 28% was also the most abundant of genus *Diogenes*.

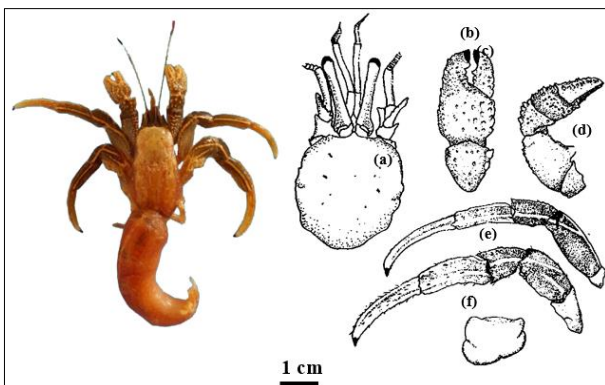


Fig 4: The characters of *Clibanarius infraspinus* a) shield and cephalic appendages, b) left cheliped (dorsal view), c) left cheliped (mesial view), d) second left pereopod (lateral view), e) third left pereopod (lateral view), and f) telson (dorsal view).

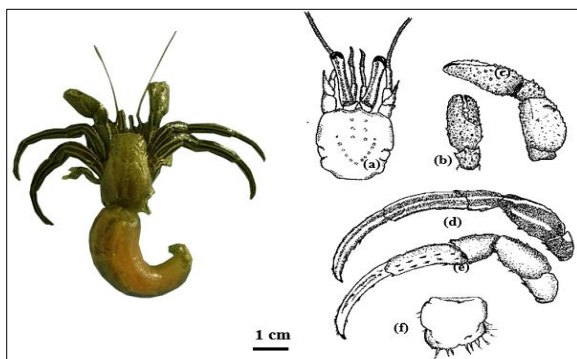


Fig 5: The characters of *Clibanarius padavensis* a) shield and cephalic appendages, b) left cheliped (dorsal view), c) left cheliped (mesial view), d) second left pereopod (lateral view), e) third left pereopod (lateral view), and f) telson (dorsal view)

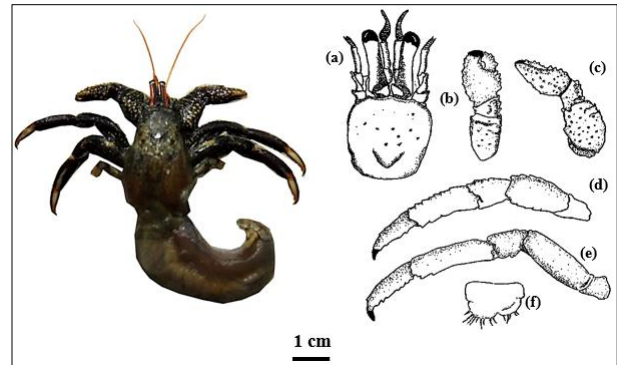


Fig 6: The characters of *Clibanarius merguiensis* a) shield and cephalic appendages, b) left cheliped (dorsal view), c) left cheliped (mesial view), d) second left pereopod (lateral view), e) third left pereopod (lateral view), and f) telson (dorsal view)

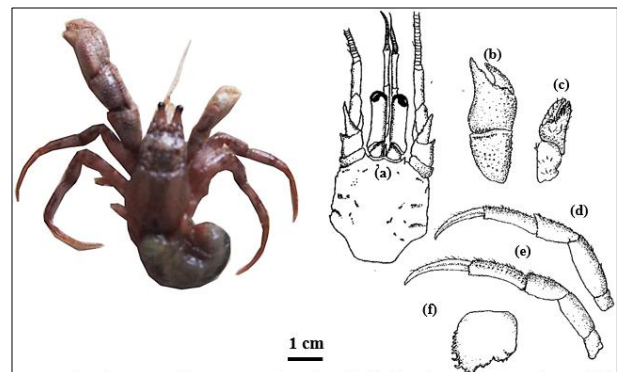


Fig 7: The characters of *Diogenes edwardsii* a) shield and cephalic appendages, b) left cheliped (dorsal view), c) left cheliped (mesial view), d) second left pereopod (lateral view), e) third left pereopod (lateral view), and f) telson (dorsal view)

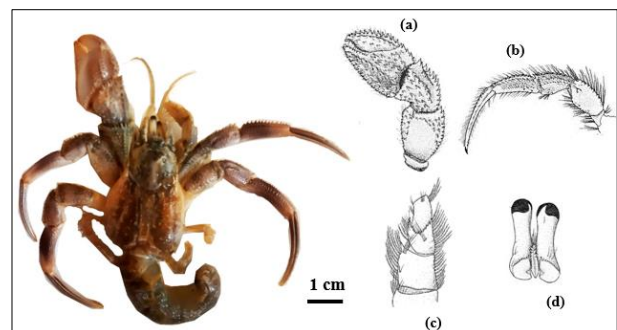


Fig 8: The characters of *Diogenes alias* a) left cheliped (dorsal view), b) left first ambulatory leg, lateral face, c) left antennal peduncle with acicle, d) eyestocks

References

1. Alcock A, Anomura Fasc I. Pagurides. Catalogue of the Indian decapod Crustacea in the collections of the Indian Museum, Indian Museum, Calcutta. 1905;2:1-197.
2. Ball EE Jr, Haig J. Hermit Crabs from Eastern New Guinea. Pac sci. 1972;26(1): -107.
3. Briffa M, Haskell P, Wilding C. Behavioural colour change in the hermit crab *Pagurus bernhardus*: reduced crypticity when the threat of predation is high. Behavior. 2008;145:915-929.
4. Chou W-R, Lai S-H, Fang L-S. Benthic crustacean communities in waters of southwestern Taiwan and their relationships to environmental characteristics. Acta Zoologica. 1999;10(1):25-33.

5. Davie PJF. Crustacea: Malacostraca: Eucarida (Part 2): Decapoda - Anomura, Brachyura. In A. Wells and W.W.K. Houston (eds.) Zoological Catalogue of Australia. Vol. 19.3B. Melbourne: CSIRO Publishing, Australia. 2002;15:641.
6. Dechance Michele. Sur une collection de Crustaces Pagllrides de Madagascar des Pty. Ltd., Sydney. xiii + 209 pp., 2 frontis., Comores. Cahiers O.R.S.T.O.M., Serie Océ- 168 pls. Anographie. 1964;2:27-45.
7. Khan SA, Natarajan R. Hermit crabs of Proto Novo Coast. Records of the Zoological Survey of India, Occasional Paper. 1984;67:1-25.
8. Markham JC. A worldwide list of hermit crabs and their relatives (Anomura: Paguroidea) reported as hosts of Isopoda Bopyridae. In R. Lemaitre and C.C. Tudge (eds.) Biology of Anomura. Proceedings of a symposium at the Fifth International Crustacean Congress, Melbourne, Australia, 9-13 July 2001. Memoirs of Museum Victoria. 2003;60(1):71-77.
9. McCulloch AR. Studies in Australian 1905. Decapodi e Isopodi della Nuova Crustacea. No.3. Records of the Australian Guinea Tedesca raccolti dal Sign. 1. Biro. Museum. 1913;9:321-353, pls. 10-11.
10. McLaughlin PA, Türkay M, Lemaitre R, McLaughlin P, eds. Paguroidea. World Paguroidea & Lomisoidea database. World Register of Marine Species. Retrieved November 25; c2011.
11. McLaughlin PA. A review of the hermit-crab (Decapoda: Anomura: Paguridea) fauna of southern thailand, with particular emphasis on the Andaman Sea, And descriptions of three new species. Phuket Marine Biological Center Special Publication. 2002;23(2):385-460.
12. McLaughlin PA, Holthuis LB. In pursuit of J. F. W. Herbst's species of Diogenes (Anomura: Paguridea: Diogenidae). Journal of Crustacean Biology. 2001;21:249-265.
13. McLaughlin PA, Rahayu dL, Komai T, *et al.* catalog of the hermit crabs (Paguroidea) of Taiwan. National Taiwan Ocean university, Keelung. 2007;7:365.
14. Nirmal T, Jaiswar AK, Chakraborty SK, Pavan Kumar A, Kantharajan G, Nuzaiiba PM. New Records of Hermit Crab (Crustacea: Decapoda: Anomura) From Maharashtra Coast of India Int. J Curr. Microbiol. App. Sci. 2017;6(8):2871-2878.
15. Osawa M, Yoshida R. Two estuarine hermit crab species of the genus Clibanarius (crustacean: Decapoda: Diogenidae) from the Ryuku Islands, Southern Japan. Japanese Society of Systematic Zoology: Species Diversity. 2009;14:267-278.
16. Panikkar NK, Aiver RG. The brackishwater fauna of Madras. Proc. Indian Acad. Sci. 1937;6B:284-337.
17. Palomares MLD, Pauly D. Editors. SealifeBase. World Wide Web electronic publication; c2018. www.sealifebase.org, version (02/2018).
18. Provenzano Jr, Anthony J. The shallow- water hermit crabs of Florida. Bulletin of Marine Science of the Gulf and Caribbean. 1959;9(4):349-420.
19. Rahayu DL. Note on littoral hermit crabs (excluding Coenobitiidae) (Crustacea: Decapoda: Anomura) mainly from Singapore and Peninsula Malaysia. Raffles Bulletin of Zoology. 1996;44(2):335-355.
20. Rahayu DL. Hermit crabs from the South China Sea (Crustacea: Decapoda: Anomura: Diogenidae, Paguridae, Parapaguridae). The Raffles Bulletin of Zoology. 2000;8:377-404.
21. Ray W Ingle. Hermit and stone crabs (Paguroidea). Crayfishes, lobsters, and crabs of Europe: an illustrated guide to common and traded species. Cambridge University Press; c1997. p. 83-98.
22. Siddiqui FA, kazmi QB. A checklist of marine anomurans (Crustacea: Decapoda) of Pakistan, northern Arabian Sea. Memoirs of Museum Victoria. 2003;60:87-89.
23. Southwell T. Actiniaria. Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Mannar Pt. V; c1906. p. 451-451.
24. Sundara Raj B. Order Decapoda. Suborder Anomura (Anomala). In the littoral fauna of Krusadai Island in the Gulf of Mannar with appendices on the vertebrates and plants. Bulletin of the Madras Government Museum, n.s. Natural History Section. 1927;1:129-134.
25. Thomas MM. On a collection of hermit crabs (sic) from the Indian waters. J mar. biol. Ass. India. 1989;31:59-79.
26. Trivedi JN, Soni GM, Trivedi DJ, Purohit BD, Vachhrajani KD. On new records of hermit crabs (Anomura; Paguroidea- Diogenidae) from Gujarat state of India. Electronic J Environmental Sciences. 2015;8:33-42.
27. Wilby D, Riches S, Daly Hise M, Bird A, Wheelwright. M, Foster JJ. Hermit crabs (Pagurus bernhardus) use visual contrast in self-assessment of camouflage. Journal of Experimental Biology. 2018, 221.
28. Yu Yu May. Study on the Anomuran Hermit Crab from Ye coastal area, Mon State. Unpublished MSc Thesis. Department of Marine Science, Mawlamyine University; c2014.
29. Briffa M, Twyman C. Do I stand out or blend in? Conspicuousness awareness and consistent behavioural differences in hermit crabs. Biology letters. 2011 Jun 23;7(3):330-2.