FIRST RECORD OF YELLOWISH-BROWN CRAB *CHARYBDIS* (*CHARYBDIS*) *LUCIFERA* (FABRICIUS, 1798) (CRUSTACEA: DECAPODA: BRACHYURA: PORTUNIDAE) FROM MALAYSIAN WATERS AFTER 127 YEARS, WITH MORPHOLOGICAL AND ECOLOGICAL NOTES[1]

Hadi Hamli[2,6], Abdulla-Al-Asif[2,7,*], Johan Ismail[2,8], Geoffery James Gerusu[3,4] and Sayali Nerurkar[5]

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[2]Department of Animal Science and Fishery, Faculty of Agricultural and Forestry Sciences,
Universiti Putra Malaysia Bintulu Sarawak Campus, Jalan Nyabau 97008, Bintulu, Sarawak, Malaysia.
[3]Department of Forestry Science, Faculty of Agricultural and Forestry Sciences, Universiti Putra Malaysia Bintulu Sarawak Campus,
Jalan Nyabau 97008, Bintulu, Sarawak, Malaysia. Email: geoffery@upm.edu.my
[4]Institut Ekosains Borneo, Universiti Putra Malaysia Bintulu Sarawak Campus, Jalan Nyabau 97008 Bintulu, Sarawak, Malaysia.
[5]Bombay Natural History Society, Hornbill House, S.B. Singh Road, Mumbai 400 001, Maharashtra, India.
Email: sayali.mavalankar@gmail.com
[6]Email: hadihamli@upm.edu.my
[7]Email: jessoreboyhemel@gmail.com
[8]Email: ijohan@upm.edu.my
*Corresponding author

Introduction

Southeast Asia is home to more than 36 species of swimming crabs, especially in Malaysia and Singapore (Ng *et al.* 2008; Wee and Ng 1995). The genus *Charybdis* De Haan, 1833 comprises four subgenera with more than 60 species (Ng *et al.* 2008). Most of the species have been reported as invasives from different parts of the globe (Akash *et al.* 2020; Marchini *et al.* 2015; Wee and Ng 1995). The Yellowish-brown Crab *Charybdis* (*Charybdis*) *lucifera* is one of the well-studied species from the swimming crabs group, belonging to the Family Portunidae.

The nutritional composition of *Charybdis* (*Charybdis*) *lucifera* (Fabricius, 1798) comprises high protein, enriched with polyunsaturated fatty acids and monounsaturated fatty acids, and minerals, compared to its congeners (Ramamoorthy *et al.* 2015; Stella Irin Kumari *et al.* 2015; Yogesh Kumar *et al.* 2019). Potential antimicrobial proteins were detected in the muscle of *C. lucifera,* which might open a new era of antibiotics in medical science (Rameshkumar *et al.* 2009).

Even though the Yellowish-brown Crab is a potential candidate for aquaculture due to its nutritional value and food supplement, in some regions of the world it is considered an invasive species (Katsanevakis *et al.* 2012; Marchini *et al.* 2015; Occhipinti-Ambrogi *et al.* 2010; Zenetos *et al.* 2010). It is also a possible vector of White Spot Syndrome Virus and Rhizocephalan disease in the shrimp industry (Otta *et al.* 1999).

The known records of *Charybdis* (*Charybdis*) *lucifera* from Malaysian waters date back more than 127 years in Sarawak. The first record is from March 1894, from Buntal in Kuching, and the second is from Kedurung (gazetted Kidurong), Bintulu on August 26, 1910. These specimens are deposited at the Sarawak Museum (Leh 1982), however, examining them at present is not possible. Nonetheless, we have examined an unpublished report on collections of crustaceans in the Sarawak Museum (Leh 1982). The report lists specimens of *Charybdis* (*Charybdis*) *lucifera* [Leh 1982, p. 3, wrongly spelt *C.* (*charybdis*) *lucifesa* (Fabricius, 1798)], but no morphological description or image is provided. In this paper, we report the first occurrence of *Charybdis* (*Charybdis*) *lucifera* (Fabricius, 1798) from Sarawak waters after 127 years, with illustrations of morphological characters and ecological notes.

Material and Methods

Sampling methods and data collection: The specimen was collected at the near-shore Bintulu coast, South China Sea, Western Pacific Ocean (3º 20′ 60″ N; 113º 07′ 52″ E). The specimen was collected from water depth of *c*. 4 m. A 100 ft gill net (3-inch mesh size) was fixed parallel to the shoreline, and after one hour, fishes and other marine organisms, including crabs were collected. The samples were placed in an icebox and taken to the laboratory for further analysis. The morphological parameters of the specimen of *Charybdis* (*C.*) *lucifera* were measured through a digital slide caliper (Model: A2583). The specimen was photographed using a Nikon D3100 DSLR camera. The microscopic view of the gonopod was photographed using OPTIKA microscope (Italy) (Model: B 150) (magnification: 4X); with the camera of KOPPACE (China) (Model: FHD V 2.0). The specimen was identified following Wee and Ng (1995), and checked for taxonomic status in Ng *et al.* (2008).

After photography and recording of data, the specimen was deposited at the Department of Animal Science and

Fishery, Faculty of Agricultural and Forestry Sciences, Universiti Putra Malaysia Bintulu Sarawak Campus.

Taxonomy
Order Decapoda Latreille, 1802
Infraorder Brachyura Latreille, 1802
Family Portunidae Rafinesque, 1815
Subfamily Thalamitinae Paul'son, 1875
Genus *Charybdis* De Haan, 1833
Charybdis (*Charybdis*) *lucifera* (Fabricius, 1798)

History of taxonomic works:

1795.	*Portunus lucifer* Weber
1861.	*Goniosoma quadrimaculatum* Milne-Edwards
1893.	*Goniosoma luciferum* Henderson
1899.	*Charybdis* (*Goniosoma*) *quadrimaculata* Alcock
1925.	*Charybdis* (*Goniosoma*) *lucifera* Delsman & de Man
1938.	*Charybdis* (*Charybdis*) *luciferae* Leene
1939.	*Charybdis lucifer* Sakai
1995.	*Charybdis* (*Charybdis*) *lucifera* Wee & Ng
2008.	*Charybdis* (*Charybdis*) *lucifera* Ng *et al.*

Type locality: Indian Ocean, probably Tranquebar (after Chhapgar 1957).

Material Examined: A single adult male specimen measuring 66.71 × 43.06 mm was examined, which was identified as *Charybdis* (*Charybdis*) *lucifera* (Fabricius, 1798) following the description of Wee and Ng (1995) (Deposition code: UPMKB-JSHP-AE-02-2020-01).

We have compared the photograph of our specimen with specimens of the genus *Charybdis* preserved in Naturalis Biodiversity Center, Netherlands, specifically *Charybdis* (*Charybdis*) *lucifera,* which was collected from Pasni (Juddi), Pakistan (Catalogue No. RMNH.CRUS.D.47338 and RMNH. CRUS.D.47337). We also compared our sample specimen with specimens of *Charybdis hellerii* (A. Milne-Edwards, 1867) (Vouchers UF 47040,UF 47050, UF 47099, and UF 47131, all collected from China), preserved in Florida Museum of Natural History.

We also compared our samples with specimens of *Charybdis hellerii* (A. Milne-Edwards, 1867) (Catalogue No. MNHN 2016-4965) preserved in the Museum National d'Histoire Naturelle, France (MNHN). An unpublished catalogue of the Sarawak Museum confirmed the unknown number of specimens of *Charybdis* (*Charybdis*) *lucifera* collected by unknown collectors and enlisted by Leh (1982).

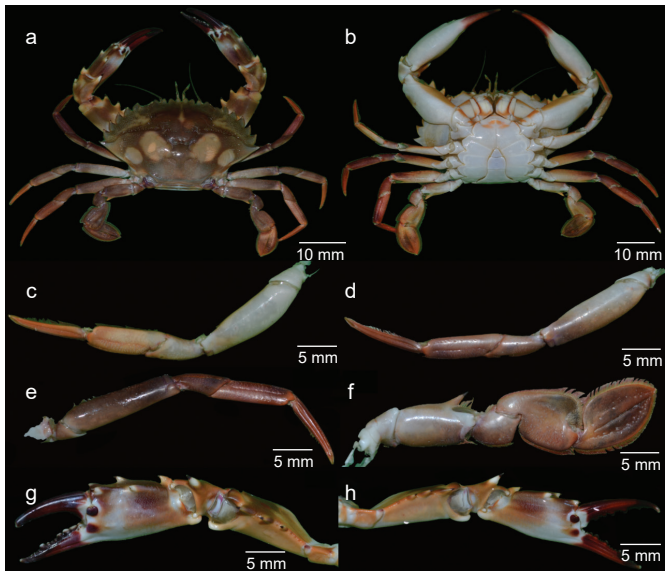

Fig. 1: *Charybdis* (*Charybdis*) *lucifera* (Fabricius, 1798), male (66.71 × 43.06 mm) (UPMKB-JSHP-AE-02-2020-01) Bintulu coast, Sarawak, Malaysia (3º 20′ 60″ N; 113º 07′ 52″ E).
a: habitus, dorsal view; b: ventral view; c: first walking leg (right); d: second walking leg (right); e: third walking leg; f: merus of the fifth pereopod (outer); g: chela; h: claw (left)

Fig. 2: a: first right gonopod, anterior view; b: second gonopod; c: microscopic ventral view of first right gonopod (apex); d: microscopic ventral view of second gonopod

Comparison of these voucher specimens and catalogue referred (Leh 1982), with our sample collected from Bintulu coastal area showed that it is similar to the specimens preserved in Naturalis Biodiversity Center, Netherlands (Catalogue No. RMNH.CRUS.D.47338 and RMNH. CRUS.D.47337).

Description: Antennal flagellum excluded from orbital hiatus; median lobule of lateral part of lower border

of orbit sharply dentiform; frontal teeth rounded; posterior border of cephalothorax curved, forming curved postero-lateral junction; six anterolateral teeth, first anterolateral tooth not truncate, second anterolateral tooth about as large as first; granular ridges on carapace faint, but no distinct cardiac ridges; four pale spots on mesobranchial regions (Fig. 1a); carpus of fifth leg without spine (Fig. 1f); chelipeds not very granular. Carapace yellowish-brown with two large and two small white spots on either of branchial regions (Fig. 1a). First gonopod has subterminal joint with wide base and narrow upper part; terminal joint with upright conical shape sharply curved (Fig. 2a); microscopic view confirmed that apex has spines (Fig. 2c), while second gonopod has open mouth-like V-shape (Fig. 2d) (modified from Wee and Ng (1995). Chelipeds scarlet pink, fingers light brown, extreme tips whitish (Chhapgar 1957).

Leene (1938) examined a male specimen collected by Delsman and de Man (1925) from the Bay of Batavia measuring 95.0 x 61.0 mm; the present specimen has carapace measuring 66.71 x 43.06 mm.

Morphometric parameters: Morphometric measures taken from the specimen are shown in Table 1.

Habitat: The male *Charybdis* (*Charybdis*) *lucifera* was captured from a sandy and rocky substrate area of the Bintulu coast, South China Sea, where water depth was less than 4 m. A previous study from Lem Ngob and Koh Kong (Thailand) suggested that this species could be found in rocky and muddy areas with a depth of not more than 2 m (Rathbun 1910).

Table 1: Morphometric measurements of male *Charybdis* (*Charybdis*) *lucifera* collected from Bintulu coastal area

Parameters	Measurement (mm)
Carapace length	43.06
Carapace width (between tips of posterior antero-lateral teeth)	66.71
Minor (Right) cheliped	
Dactylus length	23.56
Palm length	28.38
Palm depth	12.85
Major (Left) cheliped	
Dactylus length	19.36
Palm length	28.29
Palm depth	15.12
Merus of 5th pereopod	
Length	42.86
Height	10.01
Sixth abdominal segment	
Length	5.98
Height	7.36
Weight of the specimen	47.28 gm

Distribution:

INDIA: Mumbai (Chhapgar 1957), Chennai (Apel and Spiridonov 1998); Gulf of Mannar (Jeyabaskaran *et al.* 2000); Goa (Padate *et al.* 2010); Pondicherry (Satheeshkumar and Khan 2011); Parangipettai (Elumalai *et al*. 2014; Soundarapandian *et al*. 2014); South coast (Krishnamoorthy 2009).

EXTRALIMITAL: MALAYSIA: Buntal, Sarawak, March 1894, Kidurong, Sarawak, 26.x.1910 (Leh 1982) (unpublished); SAUDI ARABIA: Red Sea (Apel and Spiridonov 1998); PAKISTAN: Sindh, Karachi, and Ras Jaddi (Apel and Spiridonov 1998); SRI LANKA: (Apel and Spiridonov 1998); MYANMAR: Mergui Archipelago (Chopra and Das 1937); BANGLADESH: Bay of Bengal (Akash *et al.* 2020); INDONESIA: Aia Bangih, West Sumatra (Apel and Spiridonov 1998); JAPAN: Sagami Bay; TAIWAN (Dai and Yang 1991; Ng *et al.* 2001) Kaohsiung (Lin 1949), Chi-lung (Stephenson 1976), Tai-nan, Yüan-lin Province, and Kaohsiung Province (Huang and Yu 1997); THAILAND (Lundoer 1974); AUSTRALIA: Bernier Island and North West Cape, W.A., from Cairns to Mooloolabah, Queensland (Stephenson *et al.* 1957) west africa (Sudakaran and Fernando 1987), CANADA (Bojko 2017) (invasive), ITALY (Mizzan and Vianello 2009; Occhipinti-Ambrogi *et al.* 2010) (invasive), EGYPT: Coast of the Red Sea (Abo-Hashesh *et al.* 2020) (invasive), Mediterranean Sea (Marchini *et al*. 2015; Zenetos *et al.* 2010) (invasive).

Discussion

Yellowish-brown Crab *Charybdis* (*Charybdis*) *lucifera* has been historically recorded from the Southeast Asian region (Apel and Spiridonov 1998). It was previously recorded in the Indonesian coast of West Sumatra (Apel and Spiridonov 1998), and Thailand (Stephenson *et al.* 1957). According to Rathbun (1910), this species can be found in coastal areas where the water is shallow, and the bottom substrate can be muddy, rocky, sandy, or having hard substrates. The present specimen was found in a sandy, hard bottom habitat on the Bintulu coast. The identification is based on the four pale spots on mesobranchial regions, a key feature of this species.

This species is considered as an invasive species in some European countries, including the Mediterranean

regions, where it was possibly transported through ocean-going vessels (Marchini *et al.* 2015; Occhipinti-Ambrogi *et al.* 2010; Zenetos *et al.* 2010). The European nation has now prepared an alien species network to prevent potential invasion (Katsanevakis *et al.* 2012).

Nutritional studies from India suggest that this species along with other swimming crabs, used to be consumed in some part of India; the observed nutritional values (Ramamoorthy *et al.* 2015; Stella Irin Kumari *et al.* 2015; Yogesh Kumar *et al.* 2019) suggested that the species has huge potential in aquaculture as a solution to malnutrition.

In examining historical and recent specimens of swimming crabs from various museums, Wee and Ng (1995) did not mention a single specimen of *Charybdis* (*Charybdis*) *lucifera* from Singapore and Peninsular Malaysia. Wee and Ng (1995) reported that the only and last observed specimen was recorded from Penang, Malaysia by Balss (1922), who records that *Charybdis* (*Charybdis*) *lucifera* was noticed by Schauinsland in 1906 from an expedition. Balss (1922) did not provide any description or illustrations of the crab species. To the best of our knowledge, the present observation is the first detailed description of *Charybdis* (*Charybdis*) *lucifera* from Malaysian waters, 127 years after the first record. Further investigation can be performed on the ecological impact of this species in the Malaysian ecosystem.

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