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A Red Sea Depth Record of the Coral-Dwelling Crab *Opecarcinus* (Decapoda: Cryptochiridae) in the Mesophotic Zone

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Abstract: Coral-dwelling gall crabs (Cryptochiridae) are obligate symbionts of stony corals and occur on shallow and deep reefs across the tropical belt. The circumtropical genus *Opecarcinus* associates with Agariciidae corals, a dominant component of Mesophotic Coral Ecosystems (MCEs). Here, we report the first Red Sea mesophotic record, with 89 m as the deepest record to date, for *Opecarcinus*—collected from *Leptoseris cf. mycetoseroides*—from the NEOM marine area in Saudi Arabia. This observation reconfirms the depth range flexibility of *Opecarcinus* species and highlights the need for further mesophotic explorations of reef-associated fauna.

Keywords: gall crabs; Crustacea; coral symbionts; Mesophotic Coral Ecosystem (MCE); distribution record



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Coral-dwelling gall crabs ascribed to the family Cryptochiridae Paulson, 1875 are obligate symbionts of a wide range of scleractinian corals [1,2]. Although these crabs inhabit coral reefs, they are often overlooked because of their small size and cryptic lifestyle [3,4]. Moreover, most of the research on this family has focused on shallow-water species, although gall crabs are known to occur as deep as 512 m [5], and crab dwellings have been observed in coral specimens obtained from 620–635 m depths [6]. Strictly deep-sea cryptochirids have been reported in association with the coral families Dendrophylliidae Gray, 1847 from Walvis Ridge in the southern Atlantic Ocean, Mayotte, Walters Shoal (off Madagascar), and New Caledonia [6,7], and Caryophylliidae Dana, 1846 from Madagascar and the Philippines [8]. There are only a few records of gall crabs in the mesophotic zone (~30–150 m depth *sensu* [9]), all associated with zooxanthellate species of the coral family Agariciidae Gray, 1847 [4,8,10,11]. Agariciids can be a dominant component of the Mesophotic Coral Ecosystems (MCEs) worldwide (see [9] for an overview). In the Atlantic Ocean, the gall crab *Opecarcinus hypostegus* (Shaw & Hopkins, 1977) is known to occur in mesophotic waters off Curaçao, where it was recorded from *Agaricia lamarcki* Milne Edwards & Haime, 1951, at approximately a 60 m depth [11]. Van Tienderen and Van der Meij (2016) [4] showed that *O. hypostegus*, associated with Atlantic agariciids, has a higher prevalence at deeper depths, following the vertical distribution of its hosts. In the Pacific

Ocean, the gall crab *Luciades agana* Kropp and Manning, 1996 was recorded on *Leptoseris papyracea* (Dana, 1846) from Guam (128–137 m depth) and Tonga (34 m depth) [8,10]. The genus *Luciades* is likely a junior synonym of *Opecarcinus* Kropp & Manning, 1987, a genus currently under revision (Xu et al. in prep). In the shallow waters of the Indo-Pacific Ocean, *Opecarcinus* is known to inhabit the genus *Leptoseris* Milne Edwards and Haime, 1849 [12] which occurs from the shallow coral reefs to the MCEs [9,13]. However, *Opecarcinus* has never been recorded at mesophotic depths from the Indian Ocean or the Red Sea.

In order to characterize the benthic diversity in the NEOM area, the largest of the Saudi Arabia development projects encompassing the Gulf of Aqaba and Northern Red Sea, Remotely Operated Vehicle (ROV) explorations at mesophotic depths were carried out from October to November 2020 during the Red Sea Deep Blue (RSDB) expedition onboard the M/V OceanXplorer. During a survey with the Argus Mariner XL ROV on the 28th of October 2020, a coral colony of *Leptoseris* cf. *mycetoseroides* Wells, 1954 was observed and collected in the Northern Red Sea (27°42'26.4" N, 35°10'06.0" E) at 89 m depth (Figure 1A). On its surface, two characteristic canopy-like tunnels with a crescent-shaped opening typical for the genus *Opecarcinus* were visible [11,14] (Figure 1B). A male and female crab were extracted from the colony, and based on their overall morphology (vase-shaped carapace longer than broad, widest posterior to mid-length, deflected anteriorly and convex in lateral view, see [2]), the crabs were identified to belong to the genus *Opecarcinus*. At King Abdullah University of Science and Technology (KAUST), high-quality DNA was extracted using a DNAeasy® Blood and Tissue kit (Qiagen Inc., Hilden, Germany), following the manufacturer's protocol, from the muscle tissue of the fifth pereopod. The DNA was amplified with the universal primers LCO1490 and HCO2198 [15] and then sequenced in forward and reverse directions using an ABI 3730xl DNA analyzer (Applied Biosystems, Foster City, CA, USA). Forward and reverse sequences were assembled and edited using Geneious Prime 2019 (Biomatters) and BioEdit Sequence Alignment Editor 7.2.6 [16]. The final nucleotide sequence was blasted against the dataset of Xu et al. (2022) [12] and had 100% identity with *Opecarcinus* SET.04, a species currently under description (Xu et al. in prep).

The circumtropical genus *Opecarcinus* includes ca. 25 species, all associated with the coral family Agariciidae. Depth records span from shallow to mesophotic waters (1–60 m) [3,11,12,17,18]. Nine cryptochirid species, including *Opecarcinus* SET.04, have been recorded to date from the shallow waters (0–30 m) of the Saudi Arabian Red Sea [12]. Hence, our discovery represents a new depth record from the Saudi Arabian Red Sea of the genus *Opecarcinus*, specifically of the soon-to-be-described *Opecarcinus* SET.04, and the deepest record for *Opecarcinus* to date. Our findings further reconfirm the depth range flexibility of *Opecarcinus* species (see also [11]). Moreover, a study in Hawai'i showed that most brachyuran crab assemblages are highly stratified by depth, with deeper reefs hosting different brachyuran communities than the shallower reefs [19]. The depth generalist *Opecarcinus* SET.04 found in this study represents an exception, highlighting that it is likely the gall crabs' host specificity that influences their depth range.

The RSDB expedition allowed us to explore and assess the marine biodiversity at mesophotic depths in the NEOM marine area. The species richness of coral reef taxa changes with depth, shaping distinct assemblages in mesophotic coral ecosystems [20]. Little is known about the effects of depth on reef-affiliated invertebrates, which are some of the most understudied taxa in reef ecosystems. In order to understand the diversity of coral reef assemblages at mesophotic depths and to better protect this low-light environment, further mesophotic explorations, focusing on less studied components of the reef-associated fauna, are required.

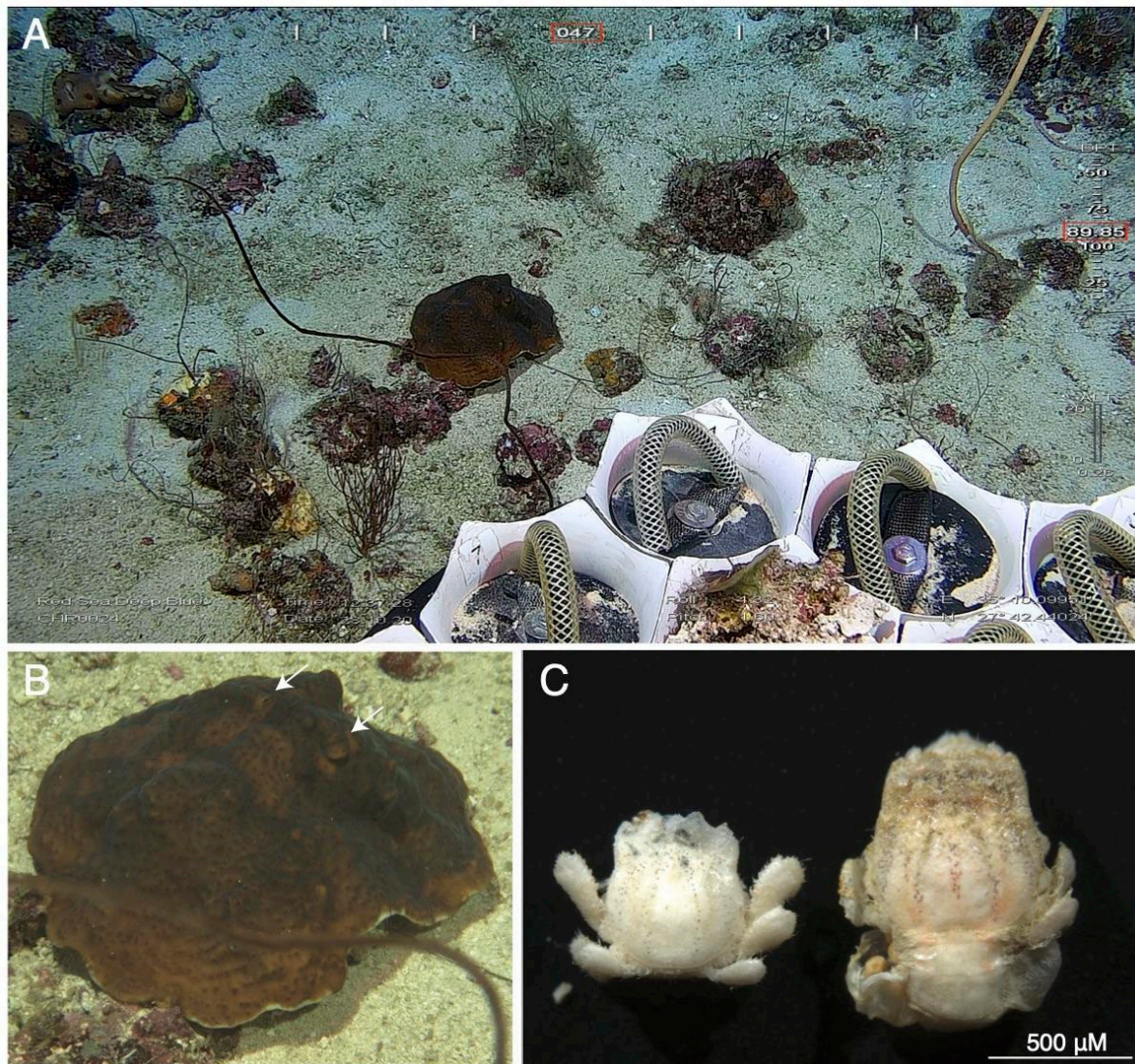


Figure 1. *Opecarcinus* SET.04 in association with *Leptoseris* cf. *mycetoseroides* found at 89 m depth in the NEOM area. (A,B) Coral colony in situ, surrounded by coarse sediment and scattered nodules covered in crustose coralline algae, black corals, and other *Leptoseris* species. Arrows indicate the gall crab dwellings. (C) Dorsal view of male (left) and ovigerous female (right) of *Opecarcinus* SET.04.

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