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RESEARCH ARTICLE

HERMIT CRABS (CRUSTACEA: DECAPODA: ANOMURA) IN ADEN COASTS AT THE GULF OF ADEN WITH A NEW RECORD

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Abstract

The information on the hermit crab diversity on the northern shore of the Gulf of Aden is very limited and almost completely unknown. This study aims to record the hermit crab species in different habitats in Aden coasts at Gulf of Aden. The specimens were collected from 7 sites, by hand, and snorkelling up to 3 m depth, during the period time October 2020- October 2022. In this study, 10 hermit crab species were recorded belonging to 3 families (Coenobitidae, Diogenidae, Parapaguridae) belonging to 6 genera. One of these species represents the first records in the Gulf of Aden (*Dardanus lagopodes* (Forskål, 1775)). The dominant hermit crab on sandy shores was *Coenobita scaevola* (Forskål, 1775), while the dominant hermit crab in rocky shores was *Clibanarius signatus* Heller, 1861.

Keywords: Decapoda; Anomura, Coenobitidae, Diogenidae, Parapaguridae; New record; Gulf of Aden.

1. Introduction

The Red Sea and Gulf of Aden region are globally renowned for their unique and beautiful marine and coastal environments, the diversity of species inhabiting them, the high degree of endemism [1-7].

Yemen has an along coastline at Gulf of Aden with 1690 km includes both 1200 km of mainland coast and 490 km in the Socotra Archipelago [8].

Marine and coastal ecosystems of the Yemeni coastline along at Gulf of Aden consists of rocky cliffs which alternate with long stretches of littoral and sublittoral sand dunes [9], with some wetlands, mangroves, muddy shores, lagoons and coral communities [10-13].

Many biodiversity studies have been conducted in the Yemeni coastal waters at the Red Sea and Socotra Islands by the Strategic Action Program (SAP) and PERSGA in Marine Protected Areas (MPA). The Global Environmental Facility (GEF) and other donors such as the Islamic Development Bank (IsDB) and UNEP funded these initiatives. Still, these studies are rare and lacking in the Gulf of Aden. Studies indicate that too few published studies exist which additionally concentrate on the extreme west with southern shores of the Gulf of Aden in the area of Djibouti and western Somalia [14, 15], but unfortunately, the coasts in the south of the Arabian Peninsula at the Gulf of Aden and the Arabian Sea have not received much attention and studies in marine biodiversity field, leading to a large gap in knowledge on the fauna of marine biodiversity in this region [9, 13, 16-22], and among the marine biodiversity that has not been studied adequately is the diversity of hermit crabs on the northern shore of the Gulf of Aden which the information and data are even more limited and almost completely unknown. Yemeni researchers and foreign researchers have not given the study of hermit crab diversity on the Yemeni coast in the Gulf of Aden and the Red Sea sufficient attention, where hermit crab *Coenobita scaevola* were recorded on the sandy shores of Aden, Bir Ali, and Mukalla on the Gulf of Aden [6, 23]. Ten species of hermit crabs have also been recorded in the sandy and rocky coasts of the intertidal and subtidal areas of the coast of Hodeidah on the Red Sea ,.

Socotra Island has an abundant study on the diversity of hermit crabs, as 17 species were recorded in various coastal environments on Socotra Island [23, 25, 26]. For these reasons, this study aims to:

- Use the data for better knowledge on hermit crabs in the Yemeni coastline along in Aden coasts at the Gulf of Aden as a first step, and fill the gap, and which can make the second step for a survey study including all the Yemeni coastline at Gulf of Aden.

- Provide knowledge on the environments appropriate for the presence of these hermit crabs in the different marine habitats in Aden coasts at the Gulf of Aden.

2. Materials and Methods

In this study, 167 hermit crab specimens were collected by hand, and snorkelling up to 3 m depth, from 7 sites in Aden coasts at Gulf of Aden (Fig. 1& Table. 1). These sites were different habitats such as; sandy shores, rocky shores, mud flats, sponge, and coral committees, including different depth zones such as the supralittoral, intertidal and sublittoral zone up to 3 meters depth. These samples were collected during the period time October 2020- October 2022. All these specimens were transferred to the laboratory of biology department, faculty of Aden education, Aden University and preserved in 70% Ethanol and kept in labeled plastic containers with parameters such as location, date of collection, and coordinates. The specimens were identified by morphological characteristics (characters of carapace, chelipeds, walking legs, pleon segments, and eyestalks) using some keys [27-29]. Shield length (SL) measurements were taken from the rostrum tip to the posterior edge of the shield to denote size by the digital caliper.

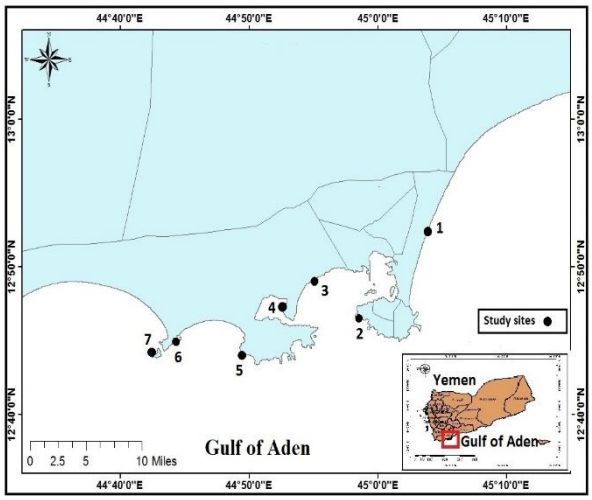

Fig. 1: Sampling sites in Aden coasts.

Table 1: Names of the 7 sites on Aden coasts, coordinates and description the habitats in these sites:

No	Name of site	Coordinates	Habitats	Description
1	Abyan coast	12°48.485 N 45°02.381 E	Sand; sand, rock; rock; subtidal sand.	Exposed shore with sandy shore and rocks.
2	Gold Mohur	12°45.552N 44°59.185 E	Sand; sand, rock; rock; subtidal sand; corals.	Semi sheltered with two rocky headlands and sandy rocky shore.
3	Coast of Al-Bahash	12°49.265 N 44°55.545 E	Sand; sand, rock; rock; subtidal sand.	Exposed shore with sandy rocky habitats.
4	Khor bir Ahmed	12°46.324 N 44°53.281 E	Mud flat; mud, rock; rock; sand; sponge; subtidal sand.	Sheltered site with wide intertidal mud flat up to 3 km in the east side and rocky sandy shore in the west side.
5	Fuqum	12°44.996 N 44°49.301 E	Sand; sand, rock; rock; subtidal sand and rock corals; corals; sponge.	Semi sheltered with two rocky headlands and sandy rocky shore.
6	Imran	12°45.404 N 44°44.569 E	Sand; sand, rock; rock; subtidal sand; corals.	Exposed shore with sandy shore and sheltered shore with sandy rocky habitats.
7	Al-Azizi island	12°44.011 N 44°42.158 E	subtidal rock, corals; corals; sponge.	Island has rocky shore and coral communities.

3. Results

In the present study, 167 specimens of hermit crabs were examined. Their analyses revealed 10 species belong to 3 families and 6 genera (Fig. 2 & Table. 2). Of the 10 species, one species (*Dardanus lagopodes* (Forskål, 1775)) represents the first record for Yemeni coastal waters at the Gulf of Aden.

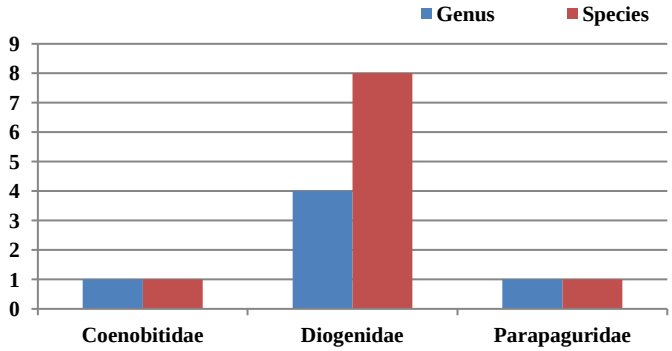

Fig. 2: Comparison between the number of families, genera, and species of hermit crabs in Aden coasts at the Gulf of Aden

Table 2: Hermit crab families and species with their distributions in study area; Present (+), Absent (-), new record in Gulf of Aden (▲)

Family	Taxon	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Coenobitidae	*Coenobita scaevola*	+	+	+	+	+	+	+
Diogenidae	*Calcinus latens*	-	-	-	+	+	+	-
	Clibanarius striolatus	-	+	-	-	+	+	+
	Clibanarius virescens	-	-	-	-	+	+	+
	Clibanarius signatus	-	+	+	+	+	+	+
	Clibanarius longitarsus	-	-	-	+	-	-	-
	Dardanus lagopodes ▲	-	-	-	-	+	-	-
	Dardanus tinctor	-	-	-	+	+	-	-
	Diogenes avarus	+	-	-	-	-	+	+
Parapaguridae	*Sympagurus andersoni*	-	-	-	+	-	-	-

In the following, all the hermit crabs recorded in this study are presented including species names, synonyms, state, material examined, distribution of the species, and some remarks.

Family: Coenobitidae Dana, 1851

Coenobita scaevola (Forskål, 1775)

Plate 1 A

Cancer scaevola Forskål, 1775.
Coenobita compressus var. Jousseaumei Bouvier, 1892.
Coenobita rugosa var. granulata Bouvier, 1890.
Coenobita rugosa var. jousseaumei Bouvier, 1890.

State: Recorded in Aden coasts, sample localities 1, 2, 3, 4, 5, 6, 7; from supralittoral zone of sandy shores.

Remarks: Common and widespread species in all sandy coasts of Aden.

Materials examined: 3♀♀ SL 14.5-16.5 mm **Site 1**. 6♂♂ SL 15-17 mm **Site 1**. 4♂♂ SL 15-16.6 mm **Site 2**. 4♀♀ (2 ovi) SL 15.3-16 mm **Site 3.** 5♂♂ SL 14-17 mm **Site 3.** 3♂♂ SL 16-17.5 mm **Site 4.** 2♀♀ SL 13.6-15.2 mm **Site 5.** 8♂♂ SL 14.8-17.2 mm **Site 5.** 7♂♂ SL 13-16.9 mm **Site 6.** 4♀♀ SL 14.2-15 mm **Site 7.** 6♂♂ SL 14.5-17.6 mm **Site 7.**

Distribution: Red Sea, Gulf of Aden, Socotra, North Coast of Somalia, South Arabian Coast, Gulf of Oman, Arabian Gulf, Pakistan.

Family: Diogenidae Ortmann, 1892

Calcinus latens (Randall, 1840)

Plate 1 B

Calcinus abrolhensis Morgan, 1988.
Calcinus cristimanus (H. Milne Edwards, 1848).
Calcinus intermedius De Man, 1881.
Calcinus terraereginae Haswell, 1882.
Calcinus terrae-reginae Haswell, 1882.
Pagurus cristimanus H. Milne Edwards, 1848.
Pagurus latens Randall, 1840.

State: Recorded in Aden coasts, sample localities 4, 5, 6; from subtidal sand and rock with mud, 0.5-3 m depth.

Materials examined: ♀. ovi. SL 5 mm **Site 4**. 3♀♀ SL 4.7-5.2 mm **Site 5.** 2♂♂ SL 5.1-5.5 mm **Site 5**. 2♂♂ SL 4.5-5.3 mm **Site 6**.

Distribution: Red Sea, Gulf of Aden, Dhofar, Gulf of Oman, Pakistan and the Maldives to Japan, Hawaii and Tuamotu. Mozambique, Kenya, Somalia, Mauritius, the Seychelles, the Chagos Archipelago.

Clibanarius striolatus Dana, 1852
Plate 1 C

Clibanarius striolatus Dana, 1852: 463; 1855: pl. 29, figs. 3a-c; Buitendijk, 1937: 258; Rahayu & Forest, 1992:758.
Clibanarius A Fize & Serène, 1955: 109, fig. 15, pl. 3, fig. 6.

State: Recorded in Aden coasts, sample localities 2, 5, 6, 7 from Intertidal sandy rocky shores.

Materials examined: 4♂♂ SL 9-10.7 mm **Site 2**. 3♀♀ SL 7.2-8.9 mm **Site 5**. 2♂♂ SL 8.4-10.5 mm **Site 5**. 3♂♂ SL 7.9-11.2 mm **Site 6**. 2♀♀ovi. SL 7-8.3 mm **Site 7.** 4♂♂ SL 8-11.8 mm **Site 7.**

Distribution: Red Sea, Gulf of Aden, North Coast of Somalia, Socotra island,Gulf of Oman, Arabian Gulf, Pakistan.

Clibanarius virescens (Krauss, 1843)
Plate 1 D

Pagurus virescens Krauss, 1843.
Clibanarius virescens Dana, 1852.
Pagurus (Clibanarius) virescens Hilgendorf, 1879.
Clibanarius bimaculatus Ortmann, 1892.
Clibanarius philippinensis Estampador, 1937.
Clibanarius sachalinicus Kobjakova, 1955.

State: Recorded in Aden coasts, sample localities 5, 6, 7; from rocky shores, intertidal zone.

Materials examined: ♀ ovi. SL 4.5 mm **Site 5**. 2♂♂ SL 7-7.5 mm **Site 5**. 2♀♀ SL 4.6-5 mm **Site 6.** 4♂♂ SL 4.9-7 mm **Site 6.** 3♂♂ SL 5-7.5 mm **Site 7.**

Distribution: Red Sea, Gulf of Aden, Dhofar, Gulf of Oman, Pakistan, Madagascar, South Africa, East African coast, Seychelles, Indo-Malay Archipelago, Australia, Taiwan, Japan and Fiji.

Clibanarius longitarsus (De Haan, 1849)
Plate 1 E

Clibanarius longitarsus var. trivittata Lanchester, 1902.
Clibanarius longitarsus var. unicolor Buitendijk, 1937.
Pagurus asper H. Milne Edwards, 1848.
Pagurus longitarsus De Haan, 1849.

State: Recorded in Aden coasts, sample locality 4, from Intertidal, mud flats with rocks.

Materials examined: ♀ SL 8.5 mm **Site 4**. 3♂♂ SL 9-12.3 mm **Site 4**.

Distribution: Madagascar, South Africa, East African coast, Seychelles, Socotra, Gulf of Aden, Dhofar, Gulf of Oman, Pakistan, Indo-Malay Archipelago, Australia, Taiwan, Japan and Fiji.

Clibanarius signatus Heller, 1861
Plate 1 F

Clibanarius signatus Heller, 1861a: 23; 1861c: 252.
Clibanarius aequabilis merguiensis: Balss, 1915: 9. Not *Clibanarius aequabilis merguiensis* De Man, 1888.
Cancer ambidexter Forskål, 1775 ·
Clibanarius semistriatus Heller, 1862 ·

State: Recorded in Aden coasts, sample localities 2, 3, 4, 5, 6, 7 from intertidal zone; rocky shores.

Materials examined: 3♀♀ SL 3-3.8 mm **Site 2**. 4♂♂ SL 3.5-4.5 mm **Site 2**. 3♂♂ SL 4-5.6 mm **Site 3**. 2♀♀ (♀ ovi) SL 2.8-4 mm **Site 4.** 4♂♂ SL 3.4-4.5 mm **Site 4.** 6♂♂ SL 4.5-5.9 mm **Site 5.** 4♂♂ SL 3.6-6 mm **Site 6.** 5♀♀ (2 ovi) SL 2.5-5 mm **Site 7.** 6♂♂ SL 3.8-6.6 mm **Site 7.**

Distribution: Red Sea, Gulf of Aden, Socotra Island, Dhofar, Pakistan, Gulf of Oman, Arabian Gulf.

Dardanus lagopodes (Forskål, 1775)
Plate 1 G

Cancer lagopodes Forskål, 1775.
Dardanus helleri Paulson, 1875.
Pagurus affinis H. Milne Edwards, 1836.
Pagurus depressus Heller, 1861.
Pagurus euopsis Dana, 1852.

Type locality: *Cancer lagopodes*: Red Sea.

State: Recorded in Aden coasts, sample locality 5, from subtidal sand and corals, 2 m depth.

Remarks: New records in Gulf of Aden.

Materials examined: ♀ SL 8 mm **Site 5**. 2♂♂ SL 8-10.6 mm **Site 5**.

Distribution: Gulf of Aden, Red Sea, Dhofar, Gulf of Oman, Arabian Gulf, India, Malaysia, New Guinea, Philippines, Australia, Taiwan, Japan, Samoa and French Polynesia, Madagascar, East African Coast, Mauritius and Seychelles.

Dardanus tinctor (Forskål, 1775)
Plate 1 H

Cancer tinctor Forskål, 1775.
Dardanus varipes (Heller, 1861).
Pagurus brevipes Bonnier & Pérez, 1902.
Pagurus tinctor (Forskål, 1775).
Pagurus varipes Heller, 1861.

State: Recorded in Aden coasts, sample localities 4, 5, from subtidal sand and corals, 2 m depth.

Materials examined: ♀ SL 12.3 mm **Site 4**. 2♂♂ SL 13-14.5 mm **Site 4**. ♂ SL 15.4 mm **Site 5**.

Distribution: Red Sea, Gulf of Aden, southern Arabian coast, Gulf of Oman, Arabian Gulf, India, Sri Lanka and South China Sea.

Diogenes avarus Heller, 1865
Plate 1 I

Diogenes avarus Heller, 1865.
Diogenes rectimanus: Lanchester, 1902.
Diogenes pugilator. Bouvier, 1892.
Diogenes pugilator var. *avarus:* Nobili, 1906b:
Clibanarius padavensis: Nateewathana & al., 1981.

State: Recorded in Aden coasts, sample localities 1, 6, 7, from intertidal zone; sandy shores, 0.5-1 m depth.

Materials examined: 3♀♀ SL 2.5-3 mm **Site 1**. 4♂♂ SL 3-4 mm **Site 1**. 5♂♂ SL 3.5-4.3 mm **Site 6**. 3♀♀ SL 3-4.1 mm **Site 7.** 4♂♂ SL 3.8-5 mm **Site 7.**

Distribution: Red Sea, Gulf of Aden, Gulf of Oman, Arabian Gulf, Pakistan, India Singapore, Indonesia, Vietnam, Philippines, Australia, Mozambique and East African coast.

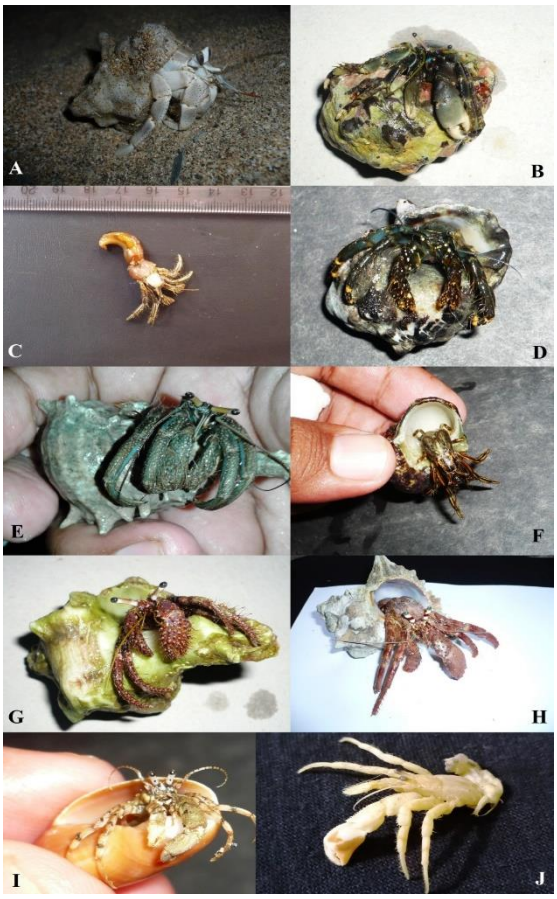

Plate 1: **A**. *Coenobita scaevola*, SL 17.2 mm; **B**. *Calcinus latens*, SL 5.5 mm; **C**. *Clibanarius striolatus*, SL 8.4 mm; **D**. *Clibanarius virescens*, SL 7.5 mm; **E**. *Clibanarius longitarsus*, SL 12.3 mm; **F**. *Clibanarius signatus*, SL 6.6 mm; **G**. *Dardanus lagopodes* , SL 10.6 mm; **H**. *Dardanus tinctor*, SL 15.4 mm; **I**. *Diogenes avarus*, SL 4 mm; **J**. *Sympagurus andersoni*, SL 11.5 mm.

Family: Parapaguridae Smith, 1882

Sympagurus andersoni (Henderson, 1896)
Plate 1 J

Parapagurus andersoni Henderson, 1896.
Parapagurus andersoni var. brevimanus Alcock, 1901.
Parapaguras andersoni-Alcock&rAnderson 1897.
Parapagurus andersoni var. *hrevimanus* -Alcock 1905.
Parapagurus pilosimanus - Balss 1912: 96 (in part not P. *pilosimanus* Smith, 1879).
Sympagurus andersoni - Lemaitre 1994.

State: Recorded in Aden coasts, sample locality 4 from subtidal sand and sponge, 0.5-1 m depth.

Materials examined: 3♀♀ SL 3.7-4.9 mm **Site 4**. 6♂♂ SL 5-11.5 mm **Site 4**.

Distribution: Gulf of Aden, Maldives, Laccadive Sea, off eastern Africa from Somalia to Mozambique, Madagascar, Seychelles and Straits of Malacca.

4. Discussion

The present study recorded 10 hermit crab species belonging to 3 families and 6 genera, from different habitats in Aden coasts at Gulf of Aden, including rocky shores and gravel, sandy shores, mud flats, sponge, and coral committees, and also different depth zones. Such as the supralittoral, intertidal, and sublittoral zone up to 3 meters depth. The dominant hermit crab in this study on sandy shores was *Coenobita scaevola*, and this is the only hermit crab in the supralittoral zone, so; this species is considered a terrestrial hermit crab. This species is also considered prevalent in the sandy coasts of southern Yemen, where it was recorded at Bir Ali, Al-Mukalla, and Socotra Island by [23, 25]. *Coenobita scaevola* is also considered the only one in the family of Coenobitidae Dana, 1851, and is common species on all sandy coasts surrounding the Arabian Peninsula, including the Red Sea, Gulf of Aden, Arabian Sea, Gulf of Oman and Arabian Gulf [1, 23, 24, 25, 30-34].

The dominant hermit crab on the rocky shores of Aden coasts was *Clibanarius signatus*, It was recorded in six rocky sites in this study. This species is also considered the common species in coastal waters around the Arabian Peninsula. It has been recorded in the Red Sea, Gulf of Aden, Socotra Island, Arabian Sea, Gulf of Oman and Arabian Gulf [23, 24, 25, 32, 35, 36].

Some hermit crabs are also common species in coastal waters around the Arabian Peninsula at the Red Sea, Gulf of Aden, Arabian Sea, Gulf of Oman, and Arabian Gulf, these species include; *Calcinus latens*, *Dardanus tinctor*, and *Diogenes avarus*, as indicated by previous studies [1, 23, 24, 25, 30, 32, 35, 36].

Site. 5 (Fuqum) was the site with the highest presence of hermit crabs in this study, as 7 species of hermit crabs were recorded there, and the reason is due to the diversity

of environments and habitats in this site such as; Sand; sand with rock; rock; subtidal sand and rock; corals; sponge. This site is also very rich in marine biodiversity, as mentioned by [19, 21].

Some species were recorded in the Gulf of Aden [23, 25], such as; *Calcinus rosaceus* Heller, 1861; *Diogenes gardineri* Alcock, 1905; *Diogenes jousseaumei* (Bouvier, 1897), but unfortunately they were not recorded in this present study, although the *Diogenes jousseaumei* was recorded as a locality type in the Gulf of Aden. The reason is due to the difference in depths. This study collected samples up to 3 m depth, while these species exist at greater depths (5-20 m).

In this present study, only three families of hermit crabs were recorded: Coenobitidae, Diogenidae, Parapaguridae, and we did not record any hermit crab species of the family Paguridae. A study by [23] indicated that there is a species of the family Paguridae (*Spiropagurus spiriger* (De Haan, 1849)) widespread in the Gulf of Aden.

The hermit crab *Sympagurus andersoni* from the family Parapaguridae Smith, 1882 was recorded in the Gulf of Aden In this study, it was found at 0.5-1 m depth, and this depth is considered shallow water, while this species has been recorded at greater depths in the Gulf of Aden and the western Indian Ocean 80-1800 m as indicated by [37, 38].

There is still a knowledge gap about marine biodiversity in the Yemeni coastal waters on the Gulf of Aden. This study recorded *Dardanus lagopodes* (Forskål, 1775) as a new record in the Gulf of Aden. Although this species is widespread in the Red Sea, Arabian Sea, Gulf of Oman and Arabian Gulf [23, 24, 25, 31, 32, 33, 35].

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مقالة بحثية

السرطانات الناسكة (قشريات- عشريات الارجل- طويلات البطن) في سواحل عدن على خليج عدن مع تسجيل لانتشار نوع جديد

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المُلخّص

المعلومات الخاصة بتنوع السرطانات الناسكة في السواحل الشمالية لخليج عدن محدودة للغاية وغير معلومة، لهذا هدفت هذه الدراسة بتسجيل انواع السرطانات الناسكة في مختلف البيئات الساحلية لعدن. جمعت العينات من 7 مواقع، بواسطة اليد والغوص باستخدام السنوركل حتى عمق 3 م، خلال الفترة اكتوبر 2020م وحتى اكتوبر 2022م. تم تسجيل 10 انواع من السرطانات الناسكة في هذه الدراسة تندرج تحت 3 عائلات (Coenobitidae، Parapaguridae، Diogenidae)، و 6 اجناس، نوع واحد من هذه الانواع يعتبر تسجيل جديد للسرطانات الناسكة في خليج عدن (*Dardanus lagopodes* (Forskål, 1775)). كان النوع السائد من السرطانات الناسكة في السواحل الرملية *Coenobita scaevola* (Forskål, 1775) ، بينما كان النوع السائد في البيئات الصخرية *Clibanarius signatus* Heller, 1861.

الكلمات المفتاحية: عشريات الارجل، طويلات البطن، تسجيل جديد، خليج عدن.

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