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Discovery of an established population of the Arabian goby *Cryptocentroides arabicus* (Gmelin, 1789) in a brackish water environment in Oman

Entdeckung einer etablierten Population der Arabischen Grundel *Cryptocentroides arabicus* (Gmelin, 1789) in einer Brackwasserumgebung im Oman

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Summary: An established population of the Arabian goby *Cryptocentroides arabicus* was discovered in a brackish water habitat located in the inland water bodies of Oman adjacent to the shore of Sea of Oman. Eighty-five specimens ranging in total length between 55 and 95 mm were collected. The present record of *C. arabicus* is considered the first report of this species inhabiting a brackish water environment.

Keywords: New record, range extension, Gobiidae, brackish water, Oman

Zusmmwnfassung: Eine etablierte Population der Arabischen Grundel *Cryptocentroides arabicus* wurde in einem Brackwasserhabitat entdeckt, das sich in den Binnengewässern des Omans nahe der Küste des Omans befindet. Es wurden 85 Exemplare mit einer Gesamtlänge zwischen 55 und 95 mm gesammelt. Der vorliegende Nachweis von *C. arabicus* gilt als der erste Bericht über diese Art in einem Brackwasserhabitat.

Schlüsselwörter: Neuer Nachweis, Arealerweiterung, Gobiidae, Brackwasser, Oman

1. Introduction

Since the works of Boulenger (1887, 1889), which mark the start of the history of fish fauna of Oman, several scientists were involved in ichthyological surveys to study the fish of this part of the world (e.g. White & Barwani 1971; Fischer & Bianchi 1984; Al-Abdessalaam 1995; Randall 1995; Jawad & Al-Mamry 2012; Jawad et al. 2012; Iwatsuki et al. 2012). These activities include comprehensive surveys such as the survey of RV 'Al-Mustaqila 1' that covers the Arabian Sea coasts of Oman (McKoy et al. 2009). This survey was performed between Ra's Al Hadd and the Oman/Yemen border which provided the most comprehensive ichthyofaunal survey of this part of the world since the previous surveys of RV 'Dr Fridtjof Nansen' (Kesteven et al. 1976; Saetersdal et al. 1999; Stromme 1986).

On the other hand, the inland waters of Oman have been less frequently explored by ichthyological explorations in comparison with the Omani marine fish fauna. The freshwater fish fauna has not received enough attention and remained as unsufficiently known field. During the last century, some studies that aimed to study the freshwater fish fauna of the Arabian Peninsula have given a slight attention to the freshwater fish species that inhabit the inland waters of Oman (Banister & Clarke 1977; Krupp 1983). Recently, non-comprehensive studies have dealt with the fish fauna of the inland waters of Oman (Freyhof et al. 2017, 2020).

Cryptocentroides arabicus is a marine species that prefers living at demersal habitats at a depth range of 0 to 1 m (Randall & Goren 1993). Gmelin (1789) described this species as *Gobius arabicus* from the coast of Jeddah, Red Sea. Randall & Goren (1993) reported this species from several localities in the Arabian Gulf region and in Oman, this species was reported from a rock pool area in the Sea of Oman by Randall (1995).

All previous records of this species were obtained from a totally marine environment. The importance of the present study is to report on the discovery of a brackish water habitat that accommodate an established population of the *C. arabicus*. This environment is an addition to the marine environment that this species is known to live in.

2. Materials and Methods

2.1. Description of the sampling area

Wadi Al-Bahayes, where the specimens of *Cryptocentroides arabicus* were collected, is a shallow creek running through mountainous areas located about 35.4 km north of Muscat City (23° 40' 38" N 58° 11' 40" E). The water of this creek is freshwater to brackish water originating from the underground (fig. 1). At Seeb City, this wadi comes in contact with the Sea of Oman in certain times of the years and during heavy rain. The creek is shallow, its depth not exceeding one meter. The banks of the creek are covered fully with vegetation that in some places even covers the bottom. In the mountainous areas, rocks are the main elements of the bottom, while in the flat areas, mixed of rocks and mud is found. Water temperature and pH are generally within the range of 25-28°C and pH 8.0-9.5, and salinity is about 0.05-3%.

2.2. Fish samples

Eightyfive specimens of *Cryptocentroides arabicus* (fig. 2) were collected using hand nets. Fishes attained total lengths ranging from 55 to 95 mm. Samples were preserved in 70% ethanol. Morphometric and meristic characters were recorded according to Randall & Goren (1993). Some of the collected specimens were deposited at Staatliches Museum für Naturkunde in Stuttgart, Rosenstein, Stuttgart, Germany, Catalogue number SMNS 27152.

3. Results and discussion

The morphometric and meristic characters obtained for the specimens of *Cryptocentroides arabicus* were shown in table 1. Their characters are very similar to those from the sea environment.

Specimens of other fish species such as the killifish *Aphaniops stoliczkanus* (Day, 1872), the cyprinid fish *Cyprinion muscatense*, the introduced sailfin molly, *Poecilia latipinna*, and several species of the cyprinid genus *Garra* were present. All these species were observed living in the same spot of the creek and no localisation was expressed by any of those species.

The genus *Cryptocentroides* contains four species, *C. arabicus* in the Arabian Gulf, Sea of Oman and the Red Sea, and *C. insignis* (Seale, 1910) known from the Ryukyu Islands of Indonesia (Randall & Goren 1993), as well as *C. bulbiceps* Whitley, 1953 and *C. gobioides* (Ogilby, 1886) from eastern Australia (Fricke et al. 2021). Comparing with eastern Australian species, *C. arabicus* differs from its congener *C. insignis* in the following set of characters: upper edge of operculum levelled with that of eye (vs upper edge of eye above that of operculum), distance between lower edge of eye and upper jaw long and curved (vs short and straight), posterior edge of preoperculum bent forward (vs straight), soft and spinous parts of dorsal fin slightly separated (vs closely connected), caudal fin pointed (vs rounded), dorsal, pectoral and caudal fins yellowish, head and body with no spots, double dark bands on body, with zigzag shape (vs all fins with blueish colour, different sizes of blue spots distributed over head and body, dark bars on body straight and obliquely located) (Seale 1910). The characters of the specimens of *C. arabicus* collected agree with that given by Randall & Goren (1993) and Randall (1995). The total length range of the

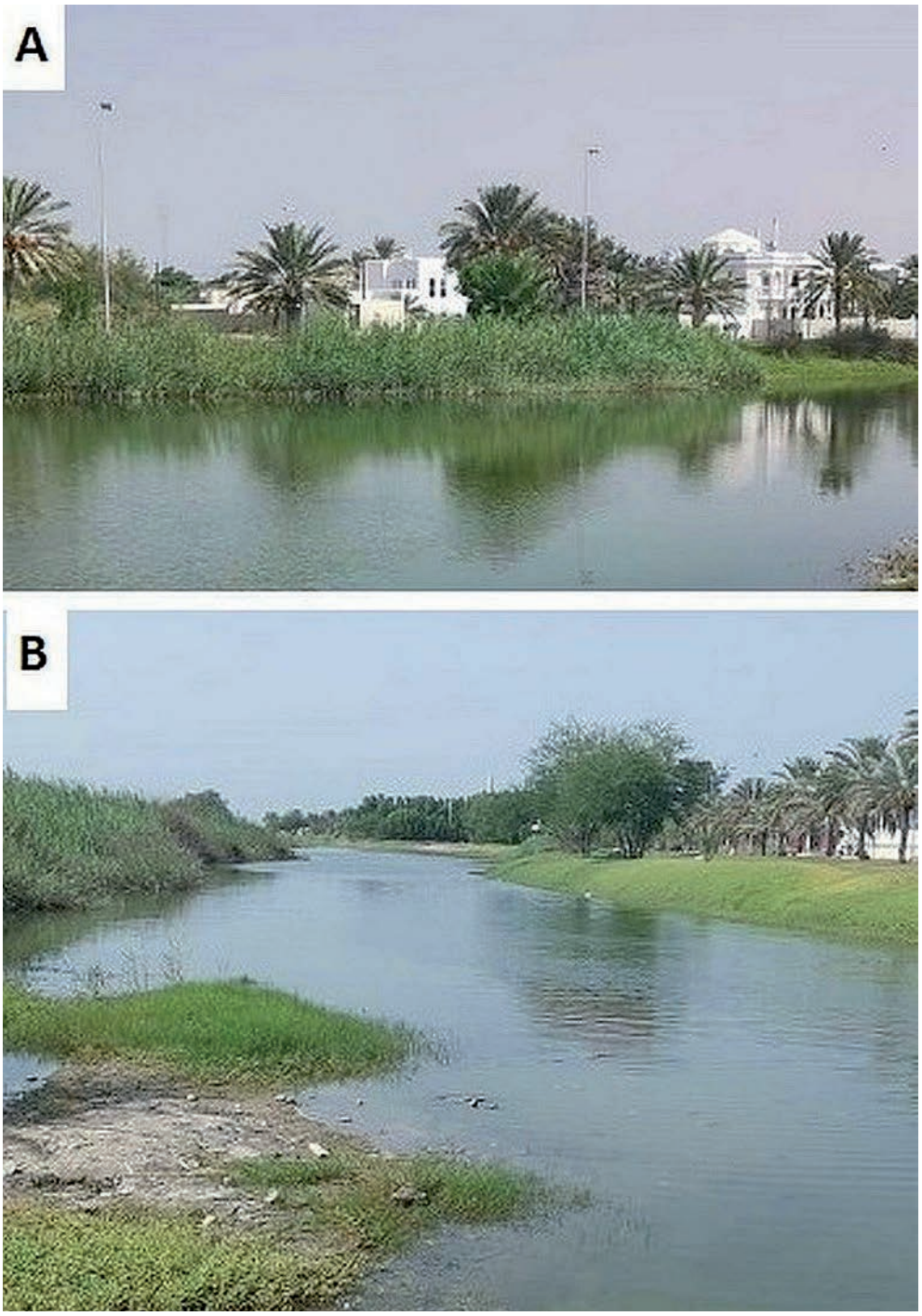

Fig. 1A, B: Images of Wadi Al-Bahayes, a brackish water habitat, where samples of *Cryptocentroides arabicus* were collected (Photos: S. M. Aljufaili).

Abb. 1A, B: Bilder vom Wadi Al-Bahayes, einem Brackwasserhabitat, in dem *Cryptocentroides arabicus* gesammelt wurde (Fotos: S. M. Aljufaili).

Fig. 2: Specimens of *Cryptocentroides arabicus;* 82 mm TL (Photo: S. M. Aljufaili).
Abb. 2: Exemplar von *Cryptocentroides arabicus;* 82 mm TL (Foto: S. M. Aljufaili).

Tab: 1: Morphometric and meristic characters of the Arabian goby *Cryptocentroides arabicus* collected from an inland water in Oman. TL = total length; SL = standard length; HL = head length.
Tab. 1: Morphometrische und meristische Daten von Arabischen Grundeln *Cryptocentroides arabicus* aus einem Binnengewässer im Oman. TL = Gesamtlänge; SL = Standardlänge; HL = Kopflänge.

Morphometric characters/mm	
Total length TL	55-95
Standard length SL (% TL)	43-77.5 (78.281.6)
Head length HL (% SL)	12-20.1 (25.9-27.9)
Snout length SntL (% HL)	1.8-3.8 (15-18.9)
Eye diameter ED (% HL)	1.6-2.5 (12.4-13.3)
Predorsal fin length (% SL)	19-25 (32.3-44.2)
Postdorsal fin length (% SL)	24-76.5 (55.8-98.7)
Prepectoral fin length (% SL)	16-22.5 (29.0-37.2)
Pectoral fin length (% SL)	10.3-14.4 (18.6-23.9)
Prepelvic fin length (% SL)	17-23.1 (29.8-39.5)
Preanal fin length (% SL)	23-45 (53.5-58.1)
Postanal fin length (% SL)	35-68.8 (81.4-88.8)
Maximum body depth (% SL)	10.3-15.6 (20.1-23.9)
Caudal peduncle depth (% SL)	4.3-8.1 (10-10.5)
Meristic characters	
Number of dorsal fin spines	VI-I
Number of dorsal fin rays	12
Number of anal fin spines	I
Number of anal fin rays	11
Number of pectoral fin rays	15-16
Number of gill rakers	12-14

specimens collected falls within that suggested size range for this species (Randall 1995).

The Arabian goby is a marine species and never before being reported from environments other than this. In Omani waters, Randall (1995) collected this species from Barr Al Hikman, which is fairly unspoiled coastal area that offers feeding and nursery grounds for a remarkably diverse community of shorebirds, turtles, fishes, crabs, and other benthic invertebrates (Bom et al. 2018). Therefore, the presence of this species from a brackish water locality reported in this study is considered a new habitat for *C. arabicus* to inhabit.

The short connection of Wadi Al-Bahayes with the sea turns the nature of the water of this creek into an brackish environment. This fact could explain the presence of the Arabian goby in its new environment and it looks that this species has adapted well to the brackish water habitat and forms an established population as seen from the number of individuals collected and various sizes of both males and females found there. This interesting finding may indicate that more ichthyological novelties await their discovery in the inland waters of Oman.

Conflict of Interest and ethical Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article .

The research was done according to ethical standards. The article is the authors' original work which has not been published or under consideration for publication elsewhere.

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