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Original Article

Cocos frillgoby, *Bathygobius cocosensis* (Bleeker, 1854): an additional fish element for the Iranian marine waters (Teleostei: Gobiidae)

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Abstract: Members of the pantropical/subtropical genus *Bathygobius* are small and common gobies in sheltered and exposed shallow rocky or sandy shorelines, reef crests, mangroves, seagrass beds, rock jetties and seawalls in the Atlantic and Indo-Pacific regions. This report documents a significant range extension of Cocos Frillgoby, *Bathygobius cocosensis* into the western parts of Indo-Pacific regions, in the Iranian intertidal coast of Makran Sea. The morphological description of collected individuals and its comparison with morphologically similar related goby species, *B. meggitti* is given and discussed.

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Introduction

Gobiidae is one of the most diverse and species-rich family of marine fishes with more than 1904 valid species (Chakrabarty et al., 2012; Fricke et al., 2019). Members of this family, are found worldwide in freshwater, brackish, and marine, with the majority of these species being associated with shallow tropical and subtropical environments (Agorreta et al., 2013). They are generally small benthic fishes whose paired fins are modified into an adhesive disk that enables them to rest on the bottom (Gill and Mooi, 2012). Some gobies spend most of their time hiding among the cracks, crevices and rocks of coral reefs (Walker and Wood, 2005). Due to their cryptic nature, small size and lack of immediate economic importance, gobies are poorly understood.

Gobies of the genus *Bathygobius* Bleeker, 1878 are a circumtropical fishes that normally found intertidally around coral, rocks, or mangroves that currently comprises about 29 valid species (Smith and Heemstra, 1987; Miller and Stefanni, 2001; Fricke et al., 2019). Due to high diversity and distribution of *Bathygobius*, it has been used as an excellent group to study evolution patterns within the Atlantic

(Rodríguez-Rey et al., 2017) and Indo-Pacific regions.

Bathygobius cocosensis (Bleeker, 1854), commonly referred to as Cocos frillgoby is known from Indo-Pacific, East Africa to Johnston, Marquesas and Tuamotu islands, north to southern Japan, south to the southern Great Barrier Reef and Rapa Islands; Marianas and Marshall Islands in Micronesia (Myers, 1999). Although *B. cocosensis* has been reported from several regions of the Indo-Pacific Ocean, but there has been no record of it from the Iranian marine waters. Hence, in this study, (i) presence of *B. cocosensis* in the Iranian waters is documented, (ii) its detailed morphological characteristics are provided, and (iii) its significant range extension into the western Indo-Pacific Ocean are discussed.

Materials and Methods

The specimens of *B. cocosensis* (Fig. 1) were collected by hand net with mesh size of 1.30 mm in seven trips from October 2016 to May 2018 (Figs. 2, 3) from 10 cm depth of the intertidal rocky pools in two localities of the Iranian intertidal coast of Makran Sea, including Bahal (25°41'N, 57°53'E) and Chabahar (25°16'N, 60°39'E) (Figs. 2-4). After

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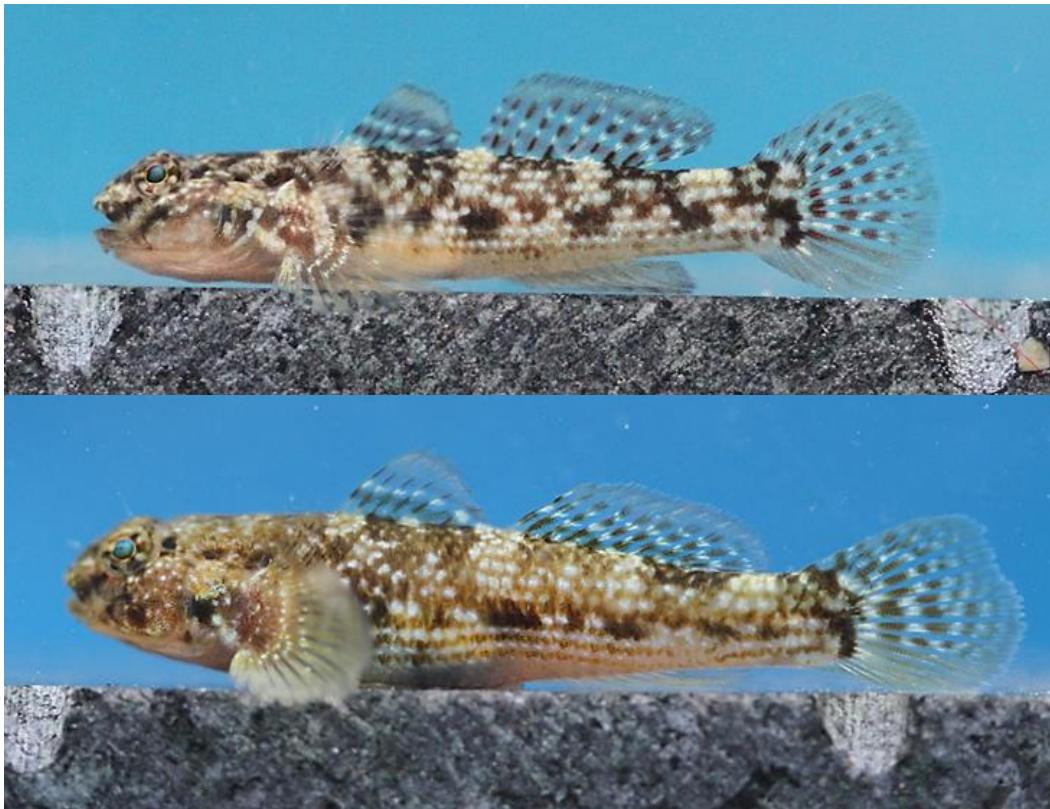


Figure 1. *Bathygobius cocosensis*. (A) Bahal, female, 39.3 mm SL, and (B) Chabahar, female, 45.4 mm SL.

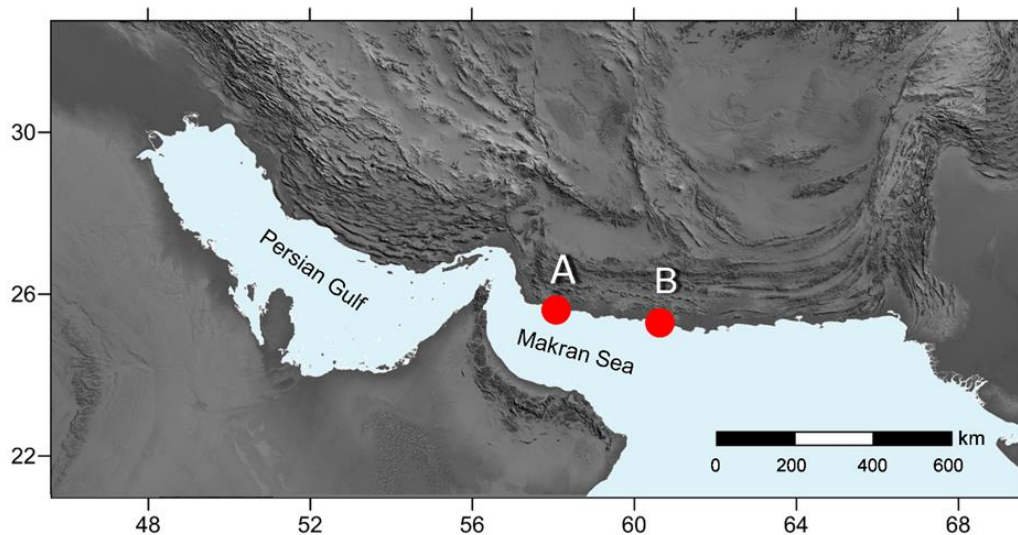


Figure 2. Distribution map of *Bathygobius cocosensis*. The solid red circle are the new record localities. (A) Bahal and (B) Chabahar.

anesthesia with Quinaldine sulphate, the specimens were preserved in 10% neutralized formalin and catalogued in the Zoological Museum of Shiraz University, Collection of Biology Department, Shiraz (ZM-CBSU). The specimens were identified following Smith and Heemstra (1987) and Randall (1995). All morphometric measurements were taken point to point by calipers to an accuracy of 0.1 mm

under the stereomicroscope (Zeiss Stemi sv6). Morphometric characters were given as % standard length (SL) and % head length (HL) in Table 1. Meristic and morphometric methods follow Miller (1988), Chen and Fang (2006) and Chen and Miller (2008). Meristic abbreviations are as follows: D1 = First dorsal fin; D2 = Second dorsal fin; V = Ventral fin; A = Anal fin; P = Pectoral fin; PSD = Predorsal

Table 1. Measurements (in percentage SL) of *Bathygobius meggitti* and *B. cocosensis* from two localities in the Iranian coast of Makran Sea.

Locality	Mean of all localities		Bahal			Chabahar		
Species	<i>B. meggitti</i>	<i>B. cocosensis</i>	<i>B. cocosensis</i>			<i>B. cocosensis</i>		
Number of specimens	Mean of all specimens	Mean of all specimens	Mean of 4 male	Mean of 3 female	Mean	Mean of 3 male	Mean of 5 female	Mean
Standard length (mm)	40.36	34.92	34.43	30.39	32.41	37.79	37.07	37.43
Body depth	17.22	16.53	16.95	16.29	16.61	16.42	16.45	16.42
Body width	23.32	22.08	21.55	22.27	21.93	22.99	21.6	22.27
Head length	30.3	28.25	29.15	28.57	28.9	27.86	27.32	27.62
Snout length	8.55	7.55	8.25	8.25	8.25	6.8	7.11	6.95
Eye diameter	7.53	7.32	7.07	7.07	7.07	7.67	7.48	7.58
Upper jaw length	10.63	10.11	10.04	10.04	10.04	10.72	9.7	10.18
Caudal peduncle depth	11.05	11.21	11.42	11.42	11.42	11.66	10.45	11.01
Caudal peduncle length	23.14	23.75	22.73	22.73	22.73	24.75	24.94	24.88
Predorsal length	36.37	34.25	35.09	35.09	35.09	32.47	34.13	33.33
Preanal length	59.51	57.14	56.82	56.82	56.82	55.25	59.52	57.14
Prepelvic length	28.89	27.55	27.62	27.62	27.62	28.33	26.6	27.47
First dorsal base length	18.19	18.59	18.08	18.08	18.08	18.87	19.42	19.16
Anal base length	15.93	16.67	16.64	16.64	16.64	20.37	14.14	16.69
Caudal fin length	23.98	24.63	23.04	23.64	23.31	25.97	26.25	26.11
Pectoral fin length	26.66	27.1	24.75	24.75	24.75	29.76	30.21	29.94
Pelvic fin length	23.09	24.88	23.64	23.64	23.64	26.6	26.04	26.32

scales; LSS= Longitudinal scales series; and TSS = Transverse scales series.

Results

Bathygobius Bleeker, 1878

Bathygobius Bleeker [P.] 1878:54 [Archives néerlandaises des sciences exactes et naturelles v. 13 3; Masc. *Gobius nebulopunctatus* Valenciennes 1837.

According to Miller and Stefanni (2001) and the genus *Bathygobius* can be diagnosed by the presence of postorbital blotches, body width greater than body length, uppermost pectoral fin rays free from membrane near tips, no barbels on underside of head, no spines on preopercle, chin with curved mental frenum, a small bump below anterior nostril bordered below by a longitudinal groove, cheek papillae pattern longitudinal, gill opening equals pectoral fin base, scales cycloid or ctenoid; no curved canine tooth in each side of lower jaw (Carpenter and Niem, 2001).

Remarks: *Bathygobius* is easily confused with

Drombus and *Palutrus*, which lack free pectoral fin rays, and *Monishia* and *Caffrogobius*, which have a transverse cheek papillae pattern.

Bathygobius cocosensis (Bleeker, 1854)

(Fig. 1)

Gobius cocosensis, Bleeker [P.] 1854:47 [Natuurkundig Tijdschrift voor Nederlandsch Indië v. 7 (no. 1); Indonesia [original locality was Nova Selma, Cocos Island/Cocos-Keeling Islands, eastern Indian Ocean].

Morphological description: D1: VI; D2: I, 9; A: I, 8; P: 17-20; PSD: 12-15; LSS: 33-38; TSS: 17-20.

Some morphometric data of the examined specimens of this species and the similar species, *B. meggitti* are given in Table 1. *Bathygobius cocosensis* is characterized by body width greater than length, body depth 16.53% SL, body width 22.08% SL, Head length 28.25 in SL, upper 3-4 pectoral rays branched to base and free from membrane, rounded

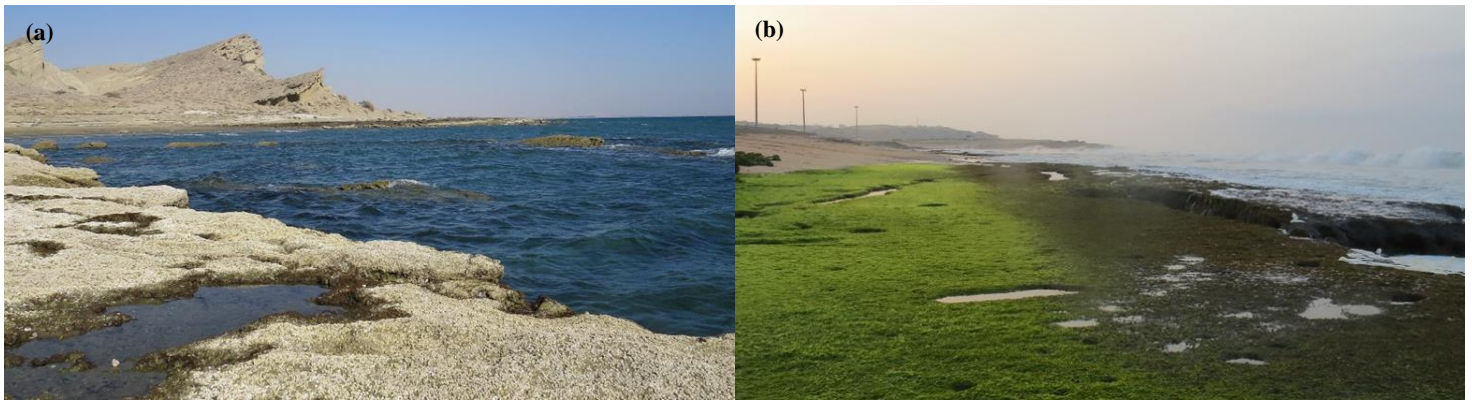


Figure 3. Collecting sites of *Bathygobius cocosensis*. (A) Bahal and (B) Chabahar.

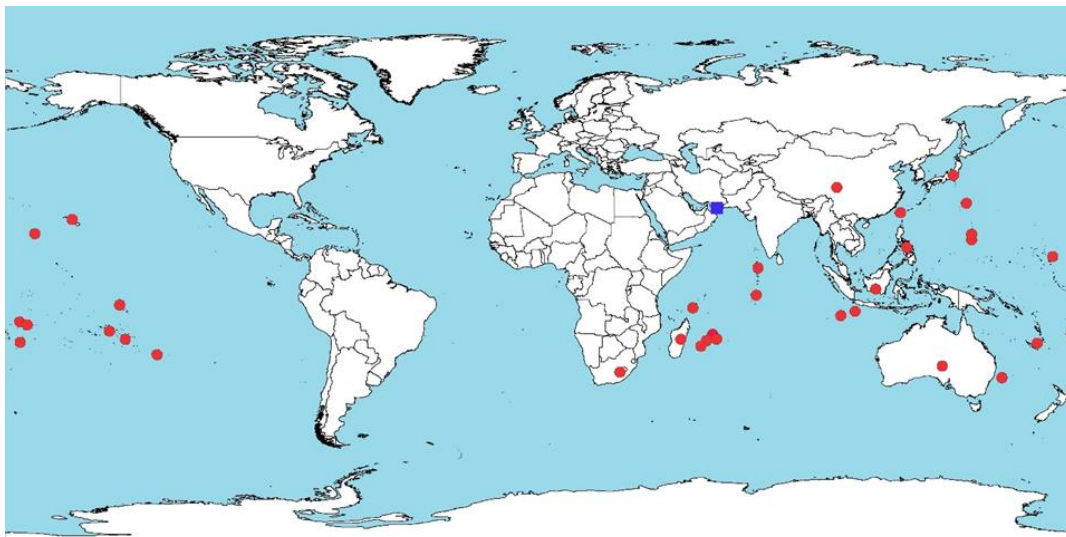


Figure 4. World distribution map of *Bathygobius cocosensis*, including new record (blue solid square) and previous other countries/islands (red solid circle).

caudal fin, predorsal scales nearly reaching to above rear margin of preopercle, scales absent on cheek and operculum, prepelvic area scaled, body scales ctenoid, becoming cycloid on abdomen, breast and nape.

Color: The principal color characters distinguishing this species are: body with mottled brown overall color, with five alternating irregular whitish and brown blotches or saddles dorsally on body, lower half of side with 5-7 rectangular brown blotches, white spots and blotches on cheek and operculum, midsides with about 6-8 elongate black spots, males with numerous longitudinal lines, females mottled, caudal fin spots small, horizontal dark line near base of 1st dorsal fin (Smith and Heemstra, 1987).

Habitat. Marine waters. It is usually found in the rock-pools which are a common feature in the rocky intertidal zone (Fig. 3).

Distribution: East and South Africa, Seychelles, Madagascar and Mascarenes east to Hawaiian Islands and Pitcairn, north to southern Japan, south to Western Australia, Queensland (Australia), New Caledonia and Rapa and now in the Makran Sea (Fig. 4).

Discussions

Recent field investigations in the Persian Gulf, Strait of Hormuz and Makran/Oman Sea have resulted in the discovery or new records of different fish groups (Randall, 1995; Béarez et al., 2008; Uiblein and Heemstra, 2011; Sadeghi et al., 2017; Mehraban and Esmaeili, 2018) including gobies. Nevertheless, work still remains to be done on fish taxonomy and ecology in the area. The Persian Gulf and Oman Sea are included in the Arabian Sea ecosystem whose southern limit is defined by the line between Cape



Figure 5. *Bathygobius meggitti* freshly collected specimen, F28-19, female, 45.96 mm SL, Makran Sea, Chabahar, Daryabozorg.

Guardafui, the Horn of Africa (the north-east point of Somalia) and the Cape Comorin (the southernmost tip of India). Briggs (1974) considers the Oman Sea as a zoogeographic boundary between the Western Indian Ocean and the Indo-Polynesian Provinces. This situation is important from biogeography point of view as it receives fish elements from Indo-Pacific Ocean as presented here by record of Cocos Frillgoby, *B. cocosensis*. Till date, *B. cocosensis* was known from East and South Africa, Seychelles, Madagascar and Mascarenes east to Hawaiian Islands and Pitcairn, north to southern Japan, south to Western Australia, Queensland (Australia), New Caledonia and Rapa, Marianas and Marshall Islands in Micronesia (Randall et al., 1993; Myers, 1999; Fricke et al., 2019). However, it seems that this goby has wider distribution range and now it is found in the Makran Sea.

The specimens of this species in two localities were taken from tide pools with some gravel and sand at depths of 5-20 cm. As, Daryanavard et al. (2015) reported *B. meggitti* (Hora and Mukerji, 1936) and *Bathygobius* sp. from the Kandaloo (in Qeshm Island in the Persian Gulf), it is possible that *Bathygobius* sp. be *B. cocosensis* and therefore, coastal area of the Persian Gulf is also to be considered as suitable habitat for this species.

Bathygobius cocosensis is apparently very similar to *B. meggitti* (Fig. 5), but it can be distinguished from *B. meggitti* by certain characteristics: 33-38 longitudinal scales rows (vs. 38-40 longitudinal scales rows in *B. meggitti*), 12-15 predorsal scales (vs. 14-22

predorsal scales in *B. meggitti*), 17-20 pectoral fin rays with the upper 3 or 4 with rays free of membranes, each with two branches (vs. 20-22 pectoral fin rays with the upper 5 or 6 with rays free of membranes, each with two to four branches in *B. meggitti*), no flaps on nostrils (vs. a small dorsoposterior flap on anterior nostril), no large black spot in the upper base of pectoral fin (vs. present in *B. meggitti*). Also in *B. cocosensis*, predorsal scales are extending forward to above rear preopercle margin and mental frenum distinctly curved with long free lateral lobes.

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Conflict of interest

The authors declare that they have no conflict of interest.

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