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New record of azooxanthellate *Dendrophyllia cribrosa* in the Persian Gulf

(Anthozoa, Scleractinia, Dendrophylliidae)

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There are few studies documenting the azooxanthellate scleractinian coral fauna of the Regional Organization for Protection of the Marine Environment (ROPME) sea area, especially the Persian Gulf, and, therefore, its biodiversity remains poorly known. The occurrence of *Dendrophyllia cribrosa* (Scleractinia, Dendrophylliidae) Milne Edwards & Haime, 1851 was recorded for the first time from the northwestern extension of the Indian Ocean, the Persian Gulf. The specimens were collected off Larak and Farur islands as bycatch in a deep trawl net. The species is described herein based on morphological characters of the colony and skeletal structures. The most distinguishing characters of the species are anastomosed, thick branches, short corallites located perpendicularly on branches, and hexamerally septal arrangements in a complete Pourtalès plan. This record is a range extension to the north-westernmost Indian Ocean from its known range viz. western Pacific Ocean and Africa and also extends its depth range up to the maximum of 70 m.

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Introduction

Dendrophylliidae is a cosmopolitan family of scleractinian corals found in depths down to 2165 m (Cairns 1994). The family comprises both zooxanthellate (meaning that they have a symbiotic relationship with unicellular Symbiodiniaceae algae and thus depend on sunlight as a source of energy; e. g., *Turbinaria*) and azooxanthellate (meaning that they don't have algal symbionts and feed on microorganisms in the surrounding waters; e. g., *Dendrophyllia*) corals. The azooxanthellate *Dendrophyllia* have a three-dimensional structure, making them a great microhabitat for communities in circalittoral zones (Arístegui et al. 1987). Factors distinguishing *Dendrophyllia* from other genera of the family are the treelike growth form and the Pourtalès Plan of septal arrangements (Cairns 2001).

The northwest Indian Ocean is considered as one of the regions with a high diversity of azooxanthellate scleractinians, yet little information is available from its westernmost extensions i. e. the Persian Gulf (Cairns 2007). There are few comprehensive studies on the scleractinian corals in the southern Persian Gulf (e. g., Kuwait, Hodgson & Carpenter 1995; Qatar, Al-Ansi & Al-Khayat 1999) reporting nine azooxanthellate coral species, and a handful of studies describing zooxanthellate scleractinians in the northern Persian Gulf (e. g., Fatemi & Shokri 2001, Maghsoudlou 2008), with no published record

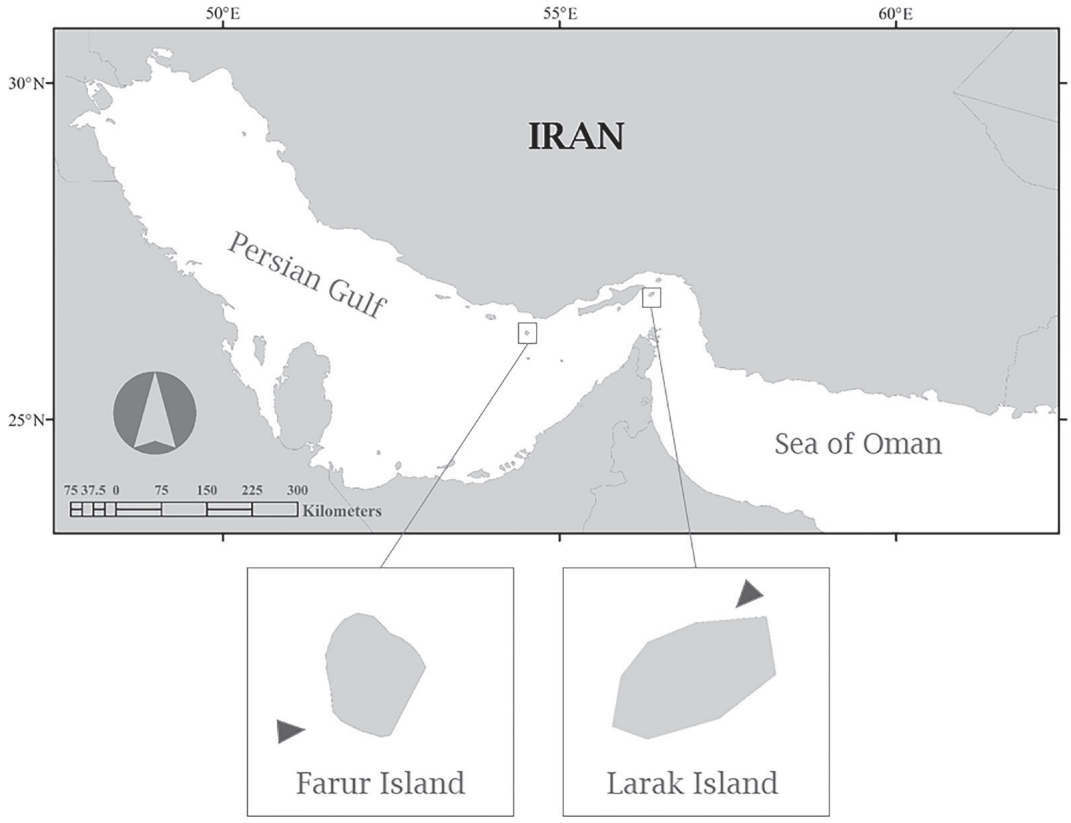

Fig. 1. Map of the sampling area in the northern Persian Gulf. Arrows point to the exact locations from which the samples were collected.

of azooxanthellate Scleractinia from the Iranian waters of the Persian Gulf. However, according to the Global Biodiversity Information Facility (GBIF, https://www.gbif.org/), preserved specimens of *Dendrophyllia* from 1963 were identified to the genus level from Chabahar Bay in the Sea of Oman (Orrell 2019). This paper deals with the morphologic as well as taxonomic characters of a newly recorded species caught in trawl nets taken from the near-shore waters in the northern Persian Gulf.

Materials and methods

The corals were caught as bycatch specimens in deep trawl nets from the depth of 70 m and 67 m off Farur (26°15' N, 54°29' E) and Larak (26°53' N, 56°23' E) islands in the northern Persian Gulf in 2010 (Fig. 1). Specimens were submerged in hydroperoxide for 4 hours, rinsed with fresh water, dried, and thereafter, photographed using a Canon G10 digital camera. Multi-focused photographs were taken in order to obtain clear images of the skeletal structures. Some measurements were made using a vernier caliper with an accuracy of 0.02 mm. Morphometric features measured in axial and lateral corallites were the greater calicular diameter (GCD), lesser calicular diameter (LCD), height, and the number of septa, as well as the GCD and LCD of columella. Skeleton vouchers were deposited in the Marine Ecology Lab at Shahid Beheshti University, Tehran, Iran. Identification was performed using available references (Cairns 1989, 1994, 2004, Ogawa & Takahashi 2000, Cairns & Kitahara 2012).

Results

A scleractinian mesophotic coral, D*endrophyllia cribrosa* Milne Edwards & Haime, 1851 (Scleractinia, Dendrophyllidae), was caught in deep trawl net from the depths of 70 m and 67 m off Farur and Larak islands, respectively. Detailed literature investigations showed that this was a new record for the Persian Gulf.

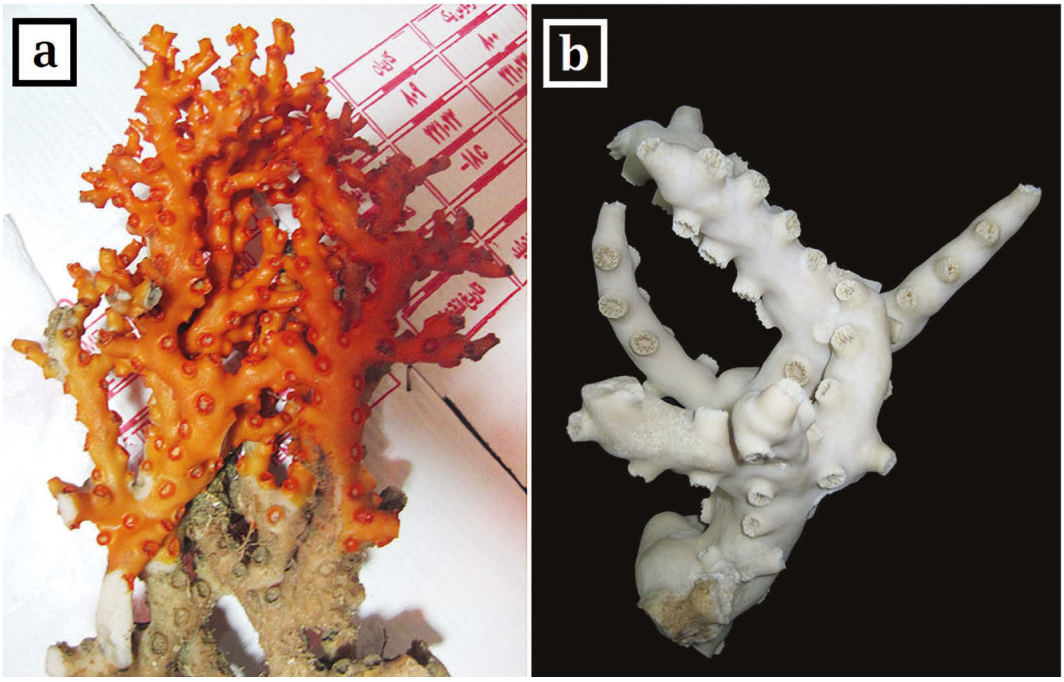

Fig. 2. *Dendrophyllia cribrosa*. **a.** Freshly sampled colony with orange coenosteum. Note the typical branching pattern. **b.** Side view of the skeleton.

Systematics

Order: Scleractinia Bourne, 1900
Suborder: Dendrophylliina Vaughan and Wells, 1943
Family: Dendrophylliidae Gray, 1847
Genus: *Dendrophyllia* de Blainville, 1830

Dendrophyllia cribros
Milne Edwards & Haime, 1851
Fig. 2

Material examined. SBU_MESCOR01, Iran, Larak Island, Persian Gulf, 26°53' N 56°23' E, depth ~ 67 m, 2010; SBU_MESCOR02, Iran, Farur Island, Persian Gulf, 26°15' N 54°29' E, depth ~ 70 m, 2010.

Diagnosis. Colonial, attached; colony with a single basal stem, stout branches budding from the corallum; corallites budding spirally on all sides of the large corallum, almost embedded in corallum; theca porous and rough (synapticulothecate); costae well defined; septa hexamerally arranged in four cycles in a Pourtalès plan; columella spongy (Fig. 3a).

Characteristics. Living colonies surrounded by orange-coloured coenosteum tissues; colony tall, upright with sturdy base, having several large axial corallites with short corallites bud (Fig. 2); corallum bushy; branching extratentacular; some branches fused together; corallites distinctive and oval-shaped, having a greater calicular diameter (GCD) and a lesser calicular diameter (LCD); corallites widely spaced; lateral corallites wider in diameter than axial

Table 1. Summary of morphometric measurements of *Dendrophyllia cribrosa* from the northern Persian Gulf. Abbreviations: GCD, greater calicular diameter; LCD, lesser calicular diameter; SD, standard deviation; n, sample size.

		Min–Max (mm)	Mean ± SD (mm)	n
Axial corallite	GCD	7.5–8.6	8.08 ± 0.45	4
	LCD	6.8–7.86	7.44 ± 0.49	4
	GCD/LCD	1.05–1.1	1.08 ± 0.02	4
	Height	7.4–13.0	9.9 ± 2.57	4
Lateral corallite	GCD	7.96–10.01	8.84 ± 0.60	10
	LCD	6.6–8.28	7.64 ± 0.49	10
	GCD/LCD	0.97–1.24	1.16 ± 0.07	10
	Height	3.19–8.5	5.14 ± 1.84	10
Columella	GCD	2.2–4.58	3.60 ± 0.648	14
	LCD	1.1–2.52	1.79 ± 0.37	14
No. septa		38–50	45.07 ± 4.1	14

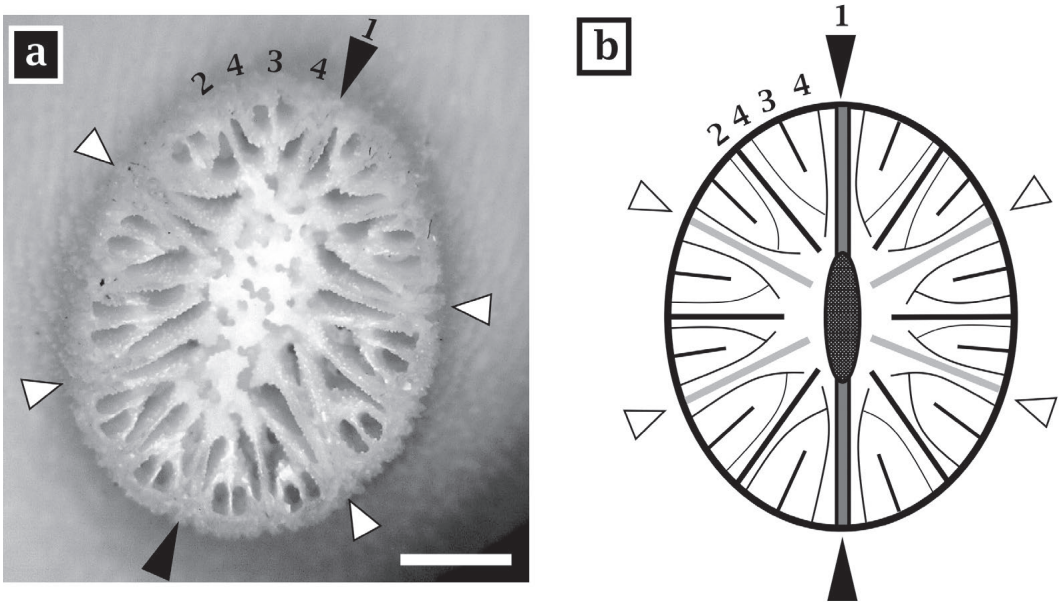

Fig. 3. The calicular view of *Dendrophyllia cribrosa*. **a.** Magnified calical characteristics which show the Pourtalès plan of septal arrangements. Scale bar represents 3 mm. **b.** Schematic construction of (a), illustrating the Pourtalès plan of septa. In both (a) and (b), the two opposite directive septa and the lateral primary septa are shown by black and white arrows, respectively. A half system of septal arrangements is indicated with numbers.

corallites, but shorter (see morphometric details of the specimens in Table 1); septa arranged with 38–50 (regularly 48) in four cycles (Fig. 3).

Distribution. Type locality unknown. Reported from Japan (Cairns 1994), Indonesia (Creuwels 2019), Korea (Song 1988), and Western Africa (Cairns 1994). New record for Iran (Persian Gulf).

Discussion

The genus *Dendrophyllia* is well known in the Red Sea (e. g., Řezanka & Dembitsky 2003, Roder et al. 2013, Röthig et al. 2017), yet species identification is rather rare (e. g., Taviani et al. 2007). Similarly, there are few published records of *Dendrophyllia* in the Arabian Sea (Sheppard & Salm 1988, DeVantier et al. 2004, Ali et al. 2014, 2017), and the Persian Gulf (Hodgson & Carpenter 1995, Al-Ansi & Al-Khayat 1999). In the westernmost Persian Gulf, Hodgson & Carpenter (1995) reported the occurrence of *Dendrophyllia gracilis* (which is currently regarded as *Cladopsammia gracilis*) from Kuwait. The present study confirms the presence of *D. cribrosa* from the Iranian waters of the Persian Gulf. The species is common in the Japanese waters (Cairns 1994) and has been the subject of numerous studies. It has been further recorded from Indonesia (Creuwels 2019), Korea (Song 1988), and Western Africa (Cairns 1994), yet never from the northwestern Indian Ocean. The documented depth range of *D. cribrosa* in northwestern Pacific is 7–40 m (Cairns 1994) and, therefore, our record expands the depth range of the species occurrence up to 70 m.

Morphological features of the diagnosed specimens matched the reported descriptions of the syntype specimen of *D. cribrosa* (Cairns 1994). However, corals in the present study had wider corallites in diameter (GCD: 7.5–10.1 mm; LCD: 6.6–8.28 mm) rather than the syntype specimen (4.5–8 mm). *Dendrophyllia cribrosa* and four other species i. e. *D. ramea*, *D. minuscula*, *D. ijimai*, and *D. indica* belong to the "axial" group in growth forms, meaning that their colonies are arborescent with several large axial corallites (Cairns 1994). Therefore, their discrimination requires detailed analyses of the skeletal features. Nevertheless, *D. cribrosa* is distinguished from *D. ijimai* by its anastomotic branches and flush corallites (Cairns 1994). It is further differentiated from *D. minuscula* by its complete septal Pourtalès plan compared to the incomplete Pourtalès plan in the latter (Ogawa & Takahashi 2000), and from

D. ramea by four cycles in Pourtalès plan rather than six cycles in a complicated plan of Pourtalès (Zibrowius 1973). In the case of *D. indica*, corallites are oriented at different angles to the branches (Pillai 1967), which is in contrast with corallite orientation in *D. cribrosa*.

According to Cairns (2007), the northwestern Indian Ocean (i. e., the Persian Gulf, Arabian Sea, and the Red Sea) has the poorest known deep-water coral fauna since there are only a handful of expeditionary reports on this matter. Therefore, further investigations and scientific explorations are needed to achieve a complete inventory of the extant *Scleractinia* species in the region.

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Conflict of interest. Authors have no conflict of interest to declare.

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