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Research Article

Presence of the Long-fin Goatfish *Upeneus supravittatus* Uiblein & Heemstra, 2010 (Perciformes: Mullidae) in the Oman Sea: Morphological and Molecular Evidence

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Abstract: The long-fin goatfish *Upeneus supravittatus* is recorded from the Iranian coast of the Oman Sea based on morphological and molecular (COI gene) identification. The species was recorded in the area based on two specimens collected from the Chabahar Bay (25° 18' N, 60° 37' E), Northern Oman Sea.

Key words: DNA barcoding, Chabahar Bay, long-fin goatfish

Introduction

The family Mullidae (goatfishes) includes six genera and 86 species inhabiting coastal waters of the Indian, Atlantic and Pacific Oceans; they rarely enter brackish waters. The species of this family possess two long, independently movable hyoid barbells in front of the chin. They are found mostly in shallow waters, on mud and sandy beds as well as in coral reef areas. Goatfish species have pelagic spawning (Kim 2002, Uiblein 2007, Nelson et al. 2016, Froese & Pauly 2021). Barbells have chemical sensory cells used in searching for food (Randall & Kulbicki 2006).

The genus *Upeneus* Cuvier, 1829 includes 37 species. Its members are distinguished by the presence of 28-39 scales in the lateral line and 5-7 scales between the dorsal fins, in addition to having teeth on both jaws, vomer and palatine (Randall 2001, Randall & Kulbicki 2006, Uiblein & Heemstra 2010). The geographical range of *Upeneus supravittatus* Uiblein & Heemstra, 2010 spans across the coastal waters of India, Sri Lanka and Bangladesh. Recently, Uiblein & Gouws (2015) reported it off Karachi, Pakistan, and provided a series of cytochrome c oxidase subunit I (COI) sequences for this species.

In this study, the presence of *U. supravittatus* off the Iranian coast of the Oman Sea is reported based on morphological and molecular evidence.

Materials and Methods

Two specimens of the long-fin goatfish *U. supravittatus* were captured with a beach seine from the Chabahar Bay, Northern Oman Sea, in February 2020 (Fig. 1). Pectoral fin clips were fixed in 96 % ethanol for molecular analysis. Specimens were fixed in 4 % formalin for morphological studies and catalogued in the Aquatic Animal Collection of the Tarbiat Modares University, Collection No. TAC1226F.

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Fig. 1. Long-fin goatfish *Upeneus supravittatus* from the Chabahar Bay, Northern Oman Sea. SL=144 mm. Collection No. TAC1226F.

Morphological studies were based on 38 morphometric characters measured using a calliper with an accuracy of 0.02 mm; three meristic characters were counted using a stereomicroscope (Lagler 1956, Uiblein & Gouws 2015, Alavi-Yeganeh & Bahmani 2018).

DNA was extracted by the phenol-chloroform method (Taggart et al. 1992). PCR reaction was performed using FishF1 and FishR1 primers (FishF1: 5′TCAACCAACCACAAAGACATTGGCAC3′, FishR1-5′TAGACTTCTGGGTGGCCAAAGAATCA3′). PCR products were analysed using Sanger Sequencing. Quality of sequences was controlled visually and trimmed using Chromas software. The two obtained sequences were submitted in GenBank with accession numbers MW800173 and MW800174. The genetic distances between the identified COI haplotype of *U. supravittatus* from the Oman Sea and other previously identified haplotypes from Bangladesh, Pakistan and Sri Lanka were calculated using MEGA6 (Tamura et al. 2013). The phylogenetic relationships of the identified haplotypes from long-fin goatfish with some of its congener species were analysed with Bayesian Likelihood (BL) and Maximum Likelihood (ML) methods, using MrBayes Ver. 3.1.2 and Mega 6 respectively (Ronquist & Huelsenbeck 2003, Tamura et al. 2013).

Results

The 38 morphometric, three meristic and three quantitative colour characters of the two specimens of *U. supravittatus* from the Oman Sea matched with previously reported data (Table 1). Morphologically, *U. supravittatus* was recognised by the eight spines on the first dorsal fin and the nine soft rays on the second dorsal fin, 8-11 oblique bars on the caudal fin. Horizontal lines on the body were orange and extended from the operculum to the caudal fin base. Body colour was silver to grey. Pectoral and ventral fins were both light yellow. Head was silver, with orange spots on operculum. Edges of second dorsal and caudal fins were slightly darker; both fins were yellow to orange. First dorsal fin had black spot with clearly visible horizontal yellow lines. Origin of pectoral fin was also orange, and abdomen was silvery. Scales were relatively large, upper part of head was almost flat and very slightly bulging. Barbells were slightly yellowish at origin and white at end. Dorsal and lateral sides of head were orange.

The two haplotypes of the CO1 sequences from specimens of *U. supravittatus* (628 bp) from the Oman Sea revealed 0.00 k2p distance in comparison with identified haplotypes of this species from Pakistan, Bangladesh and Sri Lanka. The distances between our specimens and other congeneric species appeared in the range of 0.08-0.18 k2p bp. In addition, the new identified haplotypes of *U. supravittatus* from Iranian waters grouped with other COI haplotypes of this species in one clade (Fig. 2). The two haplotypes of *U. suahelicus* were placed as a sister group of the haplotypes of *U. supravittatus*.

All morphological and genetic data confirmed the collected specimens as the long-fin goatfish *U. supravittatus.*

Table 1. Morphometric and meristic characters of two specimens of long-fin goatfish *Upeneus supravittatus* from the Gulf of Oman in comparison with previous data (Uiblein & Gouws 2015).

Source **Characters**	**Uiblein & Gouws (2015)** **(N=55)**	**Present study** **(N=2)**
	Mean (Range)	Mean (Range)
SL (mm)	106.6 (85-144)	93.5 (91.5-95.5)
in % SL		
Body depth at first dorsal-fin origin	27.5 (25-30)	28.6 (27.7-29.6)
Body depth at anal-fin origin	23.7 (22-25)	23.1 (22.2-24.0)
Caudal-peduncle depth	10.5 (9.7-11)	10.6 (10.4-10.8)
Caudal-peduncle width	4.0 (3.4-4.6)	4.2 (4.0-4.3)
Maximum head depth	23.7 (22-26)	24.4 (23.9-25.0)
Head depth through eye	17.7 (16-20)	18.2 (17.0-19.3)
Suborbital depth	10.5 (9.2-12)	9.5 (9.3-9.8)
Interorbital length	8.4 (7.3-9.6)	8.6 (8.4-8.8)
Head length	31.3 (30-33)	28.6 (28.5-28.6)
Snout length	10.6 (9.7-12)	10.0 (9.8-10.3)
Postorbital length	13.7 (12-15)	13.9 (13.6-14.2)
Orbit length	7.6 (6.8-8.4)	6.7 (6.5-6.9)
Orbit depth	6.7 (6.1-7.6)	6.5 (6.4-6.5)
Upper-jaw length	12.6 (12-14)	12.2 (12.0-12.5)
Lower-jaw length	12.0 (11-13)	11.6 (11.4-11.8)
Snout width	9.0 (8.0-11.0)	9.5 (9.4-9.6)
Barbell length	19.8 (17-23)	21.3 (19.7-23.0)
Maximum barbell width	0.9 (0.6-1.0)	0.6 (0.61-0.64)
First pre-dorsal length	40.3 (38.0-43.0)	39.7 (38.8-40.6)
Second pre-dorsal length	67.8 (64-72)	66.9 (66.9-67.0)
Interdorsal distance	15.7 (14-18)	14.5 (14.0-14.9)
Caudal-peduncle length	19.8 (18-22)	20.5 (20.3-20.7)
Pre-anal length	68.6 (64-71)	67.9 (67.8-67.9)
Pre-pelvic length	34.6 (33-37)	35.4 (34.4-36.5)
Pre-pectoral length	32.8 (30-35)	33.1 (32.4-33.8)
Second dorsal-fin depth	24.5 (23-26)	23.8 (23.4-24.1)
Pelvic-fin depth	27.2 (24-30)	25.1 (24.7-25.5)
Pectoral-fin depth	17.9 (16-20)	18.8 (18.0-19.7)
Length of first dorsal-fin base	15.7 (14-17)	15.7 (15.5-15.9)
Length of second dorsal-fin base	13.1 (12-15)	13.3 (13.2-13.4)
Caudal-fin length	29.5 (27-31)	29.7 (29.5-29.9)
Length of anal-fin base	11.0 (9.8-12)	10.2 (10.2-10.3)
Anal-fin height	16.0 (15-17)	15.3 (15.3-15.4)
Pelvic-fin length	19.5 (18-21)	16.8 (16.7-16.8)
Pectoral-fin length	25.2 (23-28)	22.9 (21.9-23.9)
Pectoral-fin width	5.0 (4.1-5.9)	4.9 (4.8-5.0)
First dorsal-fin height	23.8 (22-26)	23.4 (22.6-24.1)
Second dorsal-fin height	16.3 (15-17)	15.1 (15.0-15.1)
Meristic characters		
Pectoral-fin rays	16.4 (16-17)	16.5 (16-17)
Total gill rakers	29.7 (27-32)	29.5 (28-31)
Scales along lateral line	34.6 (34-36)	35.5 (35-36)
Oblique bars on upper caudal-fin lobe	5 (4-6)	4 (4)
Oblique bars on lower caudal-fin lobe	4 (3-5)	4 (4)
Oblique bars on both caudal-fin lobes	9 (8-11)	8 (8)

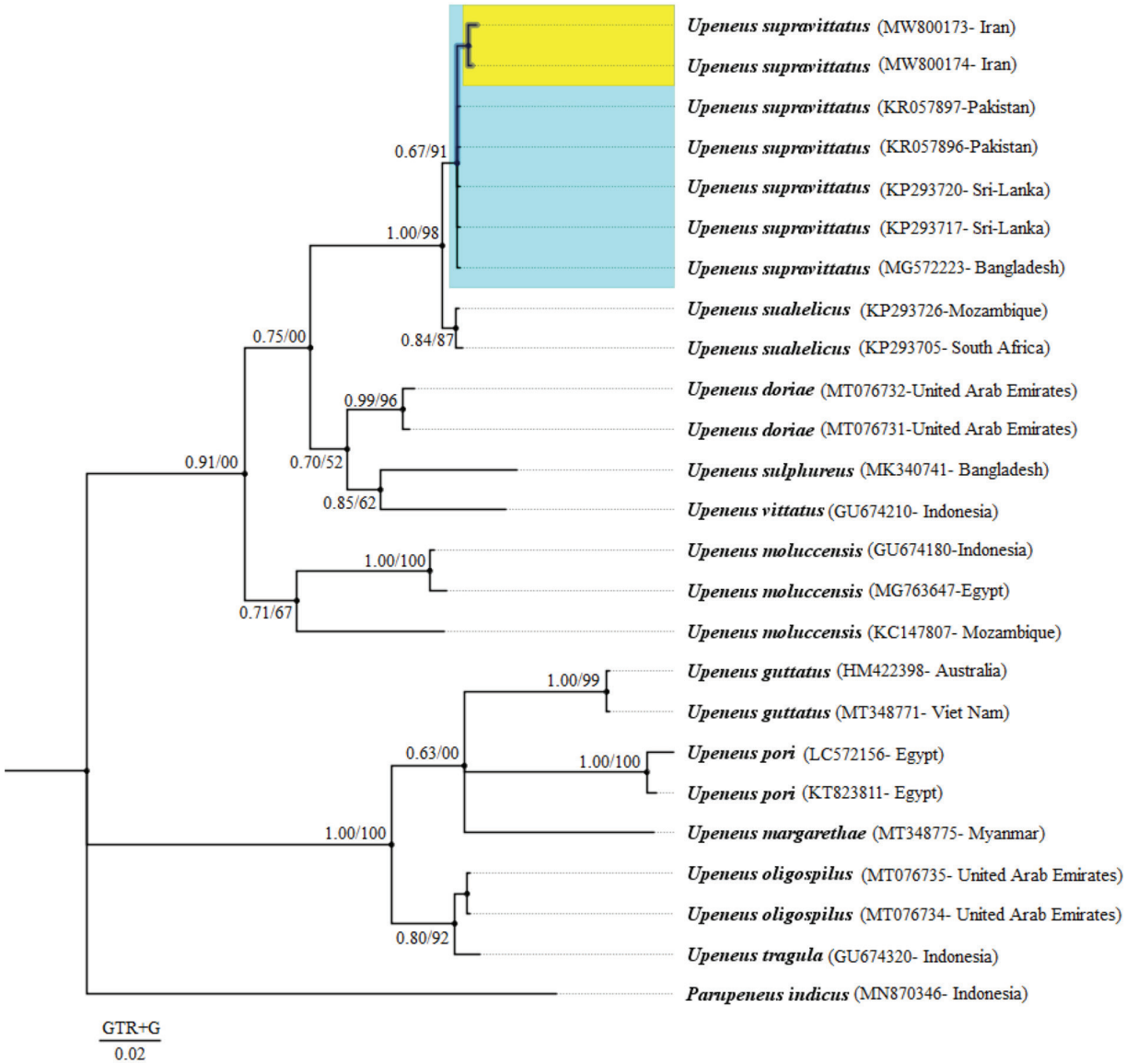

Fig. 2. Bayesian and maximum likelihood estimates of phylogenetic relationships of identified sequences for *Upeneus supravittatus* in the Oman Sea (COI; 628 bp; MW800173 & MW800174, highlighted with yellow colour) with some congener taxa. Nodes are labelled with bootstrap support/posterior probability as certainty indexes.

Discussion

Upeneus supravittatus is similar to three congener species, i.e. *U. indicus*, *U. suahelicus* and *U. vittatus*. *Upeneus indicus* could be identified based on the higher number of lateral-line scales, larger body depth at the anus (26-27 vs. 22-24 %SL) and at the origin of the first dorsal-fin (29-31 vs. 27-29 %SL), as well as its mid-body stripes, which do not connect to the oblique bars on the caudal fin. The differences between *U. suahelicus* and *U. supravittatus* are related to the number of pectoral-fin rays (13-17 vs. 16-17), gill rakers (26-28 vs. 28-29), head length (29-31 vs 30-33 %SL) and slightly shorter barbells (15-21 vs. 19-23; %SL). *Upeneus vittatus* differs from *U. supravittatus* in having irregular width and spacing of the oblique bars on the lower caudal-fin lobe, much wider distal-most bar, larger dark tip on first dorsal fin and mostly shallower body depth at anal-fin origin (Uiblein & Heemstra 2011, Uiblein & Gouws 2015).

Genetically, the most closely related species to *U. supravittatus* was *U. suahelicus*, with an average distance of 4 bp. Haplotypes of two species appeared as sister groups in a monophyletic clade. Our molecular results were concordant with the findings of Uiblein & Gouws (2015).

Regarding several confirmed records of *U. supravittatus* from the coastal waters of Pakistan

based on morphological and molecular evidence, the lack of such records from the coastal waters of the Oman Sea in Iran is probably related to incorrect previous identification and confusing with other congeneric species. There is one specimen from the Oman Sea in the Zoological Museum of the University of Chittagong, Bangladesh (ZMUC P49156), confirmed based on morphological identification. In the present study, the occurrence of *Upeneus supravittatus* in the Oman Sea is confirmed based on morphological and molecular examinations of two specimens sampled from the Chabahar Bay, northern Oman Sea.

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