Thalassas: An International Journal of Marine Sciences (2022) 38:565–571
https://doi.org/10.1007/s41208-022-00394-9

First Report of the Banded Driftfish *Psenes arafurensis* (Gunther, 1889) from the Indian Coast

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Received: 19 December 2020 / Revised: 16 November 2021 / Accepted: 7 January 2022 / Published online: 31 January 2022

Abstract

Driftfishes belonging to the family Nomeidae are distributed circumtropically. Among them, four species of the genus Psenes, namely *Psenes arafurencis, P. cyanophrys, P. maculatus* and *P. pellucidus* are reported from the Indian Ocean. A specimen of *Psenes* sp. collected from a multiday trawler, operated off the southwest coast of India was identified as *Psenes arafurensis* based on morphometric and meristic characteristics which were further confirmed using DNA barcoding and phylogenetic analysis. The earlier doubtful report on the species extending distribution to the Arabian Sea was in 1939 by Norman without a morphological description of the species. The study claims to be the first documentation of the species from the Arabian Sea as well as from Indian waters.

Keywords Driftfish · *Psenes arafurencis* · First report · Arabian Sea · India

Introduction

The family Nomeidae has 16 valid species belonging to 3 genera, distributed worldwide (Nelson 2006). Among them, 11 valid species of genera *Cubipes*, *Nomeus* and *Psenes* are reported from the Indian Ocean (Silas and Prasad 1996; Froese and Pauly 2019). Though four species of the genus *Psenes* viz*., Psenes arafurencis*, *P. cyanophrys*, *P. maculatus* and *P. pellucidus* are known to be reported from the Indian Ocean, the least known of these four species is *P. arafurensis* for which no description exists beyond the description of the holotype given by Gunther (1889) off the coast of Australia, Arafura sea and emended by Regan (1902). The earlier report on the species extending distribution to the Arabian Sea was by Norman, during the John Murray Expedition, 1933–34, but without morphological description (Norman 1939). Therefore, the occurrence of *P. arafurensis* from Indian waters was questionable and the morphological traits remained unknown. During the routine fishery survey, on 14–09-2018 a specimen of *Psenes* sp. measuring 26.4 cm in total length (TL) and weighing 286.5 g was collected from a multiday trawler, operated off the southwest coast of India in a depth range between 100 and 180 m and landed at Puthiyappa Fisheries harbour, Calicut, Kerala. The species was identified as *P. arafurensis* and the morphological traits were described (Fig. 1). Morphological changes with growth, especially between young and sub-adults, are common in nomeid fishes (Haedrich 1967). Nucleotide sequencing of the mitochondrial cytochrome c oxidase subunit I (COI) gene was also carried out to confirm the species occurrence from Indian waters along with the conventional morphological characters.

Materials and Methods

The specimen was brought in an iced condition to Calicut Regional Station of ICAR-Central Marine Fisheries Research Institute for detailed taxonomic investigation. Species identification was initially done based on morphometric and meristic characters, as per the description of Haedrich (1986). The morphometric and meristic characteristics were documented and compared with the reports available from other parts of the world (Gunther 1889; Regan 1902; Nakabo and Doiuchi 2013; Lee et al. 2016). Further to confirm the species by DNA barcode analysis, the tissue sample was collected and stored in 90%

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Fig. 1 *Psenes arafurensis*, 26.4 cm, landed at Puthiyappa FH, Calicut, India

ethanol. Total genomic DNA was extracted from muscle tissue using DNeasy Blood and Tissue Kit (Qiagen, USA) and, partial sequences of the mitochondrial COI gene was amplified by universal primer FishF2/R2 (Ward et al. 2005). The PCR thermal cycling regime consisted of an initial denaturation of 4 min at 94 °C, followed by 30 cycles of denaturation for 30 s at 94 °C, 30 s of annealing at 52 °C, 45 s of extension at 72 °C, with a final extension of 7 min at 72 °C. The PCR product was bidirectionally sequenced, manually assembled and aligned in MEGA 7 (Kumar et al. 2016). The COI sequence (621 bp) generated in the present study was submitted to GenBank (Accession no.: MN746281) and was BLAST against the GenBank database to confirm the identification. Phylogenetic relationship of identified species with barcode data of the same species (Family: Nomeidae) recovered from NCBI was performed using Maximum likelihood (ML) method. ML analysis was executed in MEGA 7 using GTR + G + I nucleotide substitution model with two outgroups (*Psenes pellucidus* and *Psenopsis anomala*).

Results

Systematics

Psenes arafurensis Gunther (1889)
Banded driftfish.
Synonym: *Psenes benardi* Rossignol & Blache (1961).

Materials Examined

One specimen of *P. arafurensis* (TL = 26.4 cm) collected from Calicut, Kerala coast. Other comparative materials include *P. arafurensis* (TL = 29.6 cm) and *P. cyanophrys* (TL = 20.5 cm) collected from Tuticorin coast, Gulf of Mannar.

Description

Medium sized fish with elliptical, deep and compressed body. Dorsal fin rays X-I, 20; pectoral fin rays 19; anal fin rays III, 21; pelvic fin rays I, 5; lateral line scales 48; gill rakers 25; gill filaments 122. Morphometric and meristic traits of the specimen are shown in Tables 1 and 2. Measurements are exhibited as a percentage against SL: Body depth 46.8; body breadth 17.8; head length 37.9; snout length 5.8; eye diameter 12.6; upper jaw length 11;

Table 1 Morphometric measurements of *Psenes arafurensis* collected from Puthiyappa F.H. Calicut

Parameter	Measurements (mm)	% Standard Length (SL)
Total length (TL)	264	138.9
Fork length (FL)	219	115.2
Standard length (SL)	190	-
Head length	72	37.9
Snout	11	5.8
Eye diameter (Same along both axes)	24	12.6
Eye (middle dark portion)	11	5.8
Maxillary length	21	11
Mandibular length	22	11
Width of gill opening	57	30
Snout to insertion of dorsal fin	69	36.3
Length of first dorsal fin	38	20
Length of second dorsal fin	78	41
Snout to insertion of pectoral fin	72	37.9
Length of pectoral fin	72	37.9
Snout to insertion of pelvic fin	72	37.9
Length of pelvic fin	26	13.7
Snout to insertion of anal fin	106	55.8
Length of anal fin	78	41
Length of caudal fin	71	37.4
Snout to vent	100	52.6
Snout to origin of lateral line	61	32.1
Gape	13	6.8
Depth of body in line with eye	54	28.4
Depth of Head	67	35.2
Depth of body at dorsal fin insertion	83	43.7
Depth of body at pectoral fin insertion	88	46.3
Depth of body at pelvic fin insertion	88	46.3
Depth of body at anal fin insertion	83	43.7
Depth of body at mid-length	89	46.8
Depth of body at caudal fin insertion	22	11.6
Inter-orbital distance	23	12.1
Distance between eyes	31	16.3
Breadth of body at dorsal fin insertion	31	16.3
Breadth of body at mid-length	27	14.2
Breadth of Head	34	17.8

Table 2 Comparison of body and meristic characters of *Psenes arafurensis* among authors

Particulars	Present study	Lee et al. (2016)	Nakabo and Doiuchi (2013)	Haedrich (1986)	Regan (1902)	Gunther (1889)
Place/Source of Record	Off Calicut, Arabian Sea	Off Korea, Yellow Sea	Off Japan, Sea of Japan	Off Dassen Id, South Africa	Ann Mag Nat Hist., London	Off Australia, Arafura Sea
Number of specimens	1	4	-	-	1	1
Head length (% SL)	37.9	30.5–33.3	-	-	40.0	37.5
Body depth (% SL)	46.8	41.5–44.8	-	-	60.0	60.0
Eye diameter (% HL)	33.3	28.8–31.2	-	-	37.5	40.0
Snout length (% HL)	15.3	29.5–31.9	-	-	16.7	16.7
Dorsal fin rays	X-I, 20	XI-I, 20–21	X-XI/I-II, 19–21	X-XI/I-II, 18–22	XI-I, 22	XI-I, 22
Anal fin rays	III, 21	III, 21–22	III, 20–21	III, 21–23	III, 22	III, 22
Pelvic fin rays	I, 5	I, 5	I, 5	-	-	-
Pectoral fin rays	19	19–20	18–20	18–20	-	-
Lateral line scales	48	46–48	44–45	55–62	47	47
Gill rakers	25	25–27	-	24–26	-	-
Vertebrae	31	30–31	-	31	31	-

interorbital width 12.1; gape 6.8; predorsal fin length 36.3; prepectoral fin length 37.9; prepelvic fin length 37.9; preanal fin length 55.8; preanus length 52.6; first dorsal fin length 20; second dorsal fin length 41; pectoral fin length 37.9; pelvic fin length 13.7.

Eyes large (33.3% of head length), short and rounded snout, two pairs of nostrils positioned nearer to the tip of snout than to the eye. Mouth with the slanted upper jaw, terminally placed, posterior margin of jaws not embracing to the middle part of the eye, a single row of small and conical teeth. Two dorsal fins, detached from each other by a narrow space, first dorsal fin with 10 spines, much shorter than the second dorsal fin, originating at the base of the pelvic fin and reached till anus, second dorsal fin with a spine, origin at anus and spread to anterior caudal peduncle. Anal fin with 3 weak spines, originating slightly behind the origin of second dorsal fin and spread to anterior caudal peduncle. Large pectoral fin (≃ head length) originating slightly anterior to the origin of the dorsal fin, reaching to the10th ray of the second dorsal fin. Short pelvic fin with a spine, originate at the base of the pectoral fin. Caudal fin large and strongly forked. Marginally arched lateral line, based nearer to the dorsal part of the body with 48 pored scales. Body, head and cheeks shielded with relatively large ctenoid scales.

Colour

Fresh specimen exhibited dark purple colour dorsally and grey on the ventral surface. First dorsal and caudal fin was dark grey. The second dorsal fin, anal fin and pelvic fins were grey. Pectoral fins were translucent.

Discussion

Psenes arafurensis is distributed in the tropical and subtropical seas of the Pacific (Gunther 1889; Kuiter 1993; Chirichigno and Velez 1998; Randall and Lim 2000; Myoung et al. 2002; Nakabo 2002; Allen and Erdmann 2012; Lee et al. 2016), Indian (the Arabian Sea and Bay of Bengal in the present study; Parin and Piotrovsky 2004) and Atlantic Ocean (Bianchi et al. 1993; Menezes et al. 2003; McEachran and Fechhelm 2005) at depths of 150–850 m (Nakabo and Doiuchi 2013). The two species of genus *Psenes* resemble each other in several morphometric attributes. *P. arafurensis* could be distinguished from closely resembling species *P. cyanophrys* by the number of lateral line scales, *i.e.* 47–50 in *P. arafurensis* and 52–62 in *P. cyanophrys*. *P. arafurensis* is also distinguished from the latter by relatively larger eyes and scales on body (Figs. 1 and 4) and extension of predorsal scales maximum to mideye level (Fig. 3). Other two species *P. maculatus* has a firm, moderately elongate silvery body with 55–80 lateral line scales and *P. pellucidus* has a flabby, elongate body with 115–125 lateral line scales. Radiograph of *P. arafurensis* and *P. cyanophrys* collected from Tuticorin coast, Tamil Nadu showed both species had 31 vertebrae (Figs. 2 and 4). Rest of the meristic characteristics of four species of the genus distributed in the Indian Ocean

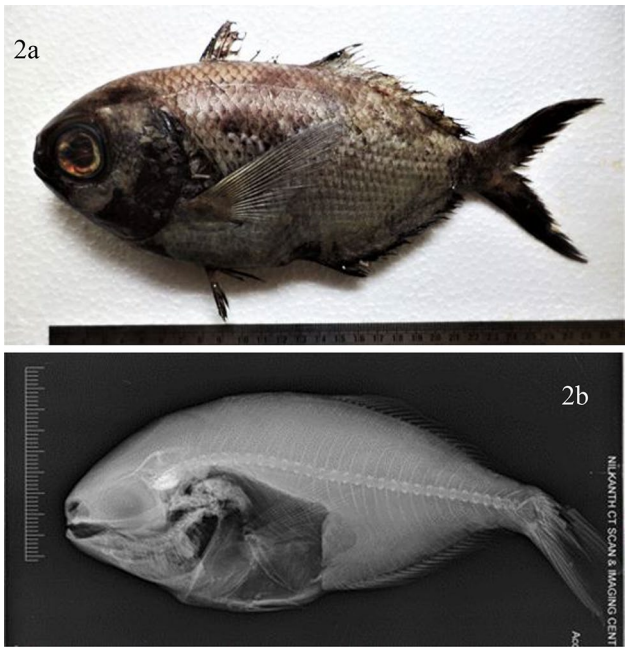

Fig. 2 *Psenes arafurensis*, 29.6 cm (**2a**) collected from Tuticorin coast, Gulf of Mannar and radiograph (**2b**) with 31 vertebrae

are presented in Table 3 (Cuvier and Valenciennes 1833; Lutken 1880; Regan 1902; Kobayashi 1961; Fischer and Bianchi 1984; Haedrich 1986; Last 2001; Myoung et al. 2001; Parin and Piotrovsky 2004; Fahay 2007; Venu 2009; Nakabo and Doiuchi 2013; Lee et al. 2016; Motomura et al. 2017; Froese and Pauly 2019).

The DNA barcode from this study (Accession no.: MN746281), upon comparison with NCBI database, confirmed that the species was *Psenes arafurensis*, which exhibited 100% Query coverage with an identity of 99.84% to *Psenes arafurensis* (Accession: KT167194.1). In phylogenetic analysis, the sequences of *Psenes arafurensis* grouped into one cluster (Fig. 5) revealing the identity of the species. The specimen from Indian waters found to be morphologically different with the Korean specimen of *P. arafurensis* in respect to % of SL: head length (37.9 in the former vs. 30.5–33.3), body depth (46.8 vs. 41.5–44.8), pre-anal length (55.8 vs. 57–59.3), caudal peduncle depth (10.5 vs. 4.5–4.9), eye diameter (12.6 vs.9–10.4) and % of head length: eye diameter (33.3 vs. 28.8–31.2), snout length (15.3 vs. 29.5–31.9), interorbital space (31.9 vs. 37.6–41.9), upper jaw length (29.2 vs. 31.3–34.2). However Regan (1902) opined, the snout is about 16.7% of head length. The caudal peduncle depth and snout length presented by Lee et al. (2016) were way different from the observations made by us. We have digitized the image presented in Lee et al. (2016) of a specimen of 199 mm total length and recalculated the caudal peduncle depth (as percentage of SL) and snout length (as the percentage of HL) which were found to be 10.33% and 17.04%, respectively. The recalculated values were much closer to the values calculated for specimen from India. This shows some mistakes on the part of Lee et al. (2016) either in taking measurements or calculating them. Another possible reason especially in case of snout length would be the misinterpretation of the definition presented in reference literature. Hubbs and Lagler (2004) defined snout length as the distance between most anterior point on the snout or upper lip to the front margin of the orbit, which might have been taken obliquely (by Lee et al. 2016) rather than taking it in straight line (usual practice).

The present study confirms the distribution of *P. arafurensis* in Indian waters (Arabian Sea and Bay of Bengal) through classical morpho-taxonomy as well as DNA barcoding and phylogenetic analysis. It also render the understanding of their specific distributions and range extension in the Indian Ocean. From the biodiversity point of view, it is a piece of vital information which adds another species to Indian ichthyofaunal diversity. Among the four species of *Psenes*, except lateral line scale count, meristic characters do not contribute much towards differentiation of the species. The morphological features like body shape, colour, eye size, pectoral fin shape and proportion may be used for field identification. A field key based on easily observable characters is presented below for all the four species distributed in the region for easy and prompt identification of the species by the field enumerators and researches.

1. (a) Anterior margin of predorsal scales reach to the maximum above mid eye ……..…… 2
   (b) Pre dorsal scales extended to nostrils with the sharp demarcation of small scales above eyes and extended anteriorly, Body firm, deep and compressed; eye com-

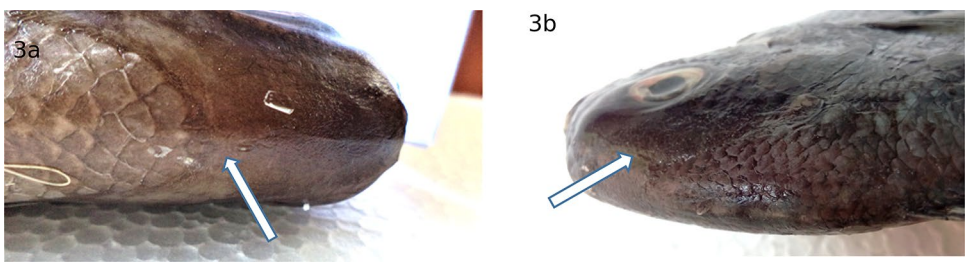

Fig. 3 *Psenes arafurensis* (**3a**) head with pre dorsal scale patch extension limited to mid eye, *Psenes cyanophrys* (**3b**) head with pre dorsal small scale patch extended up to anterior eye margin

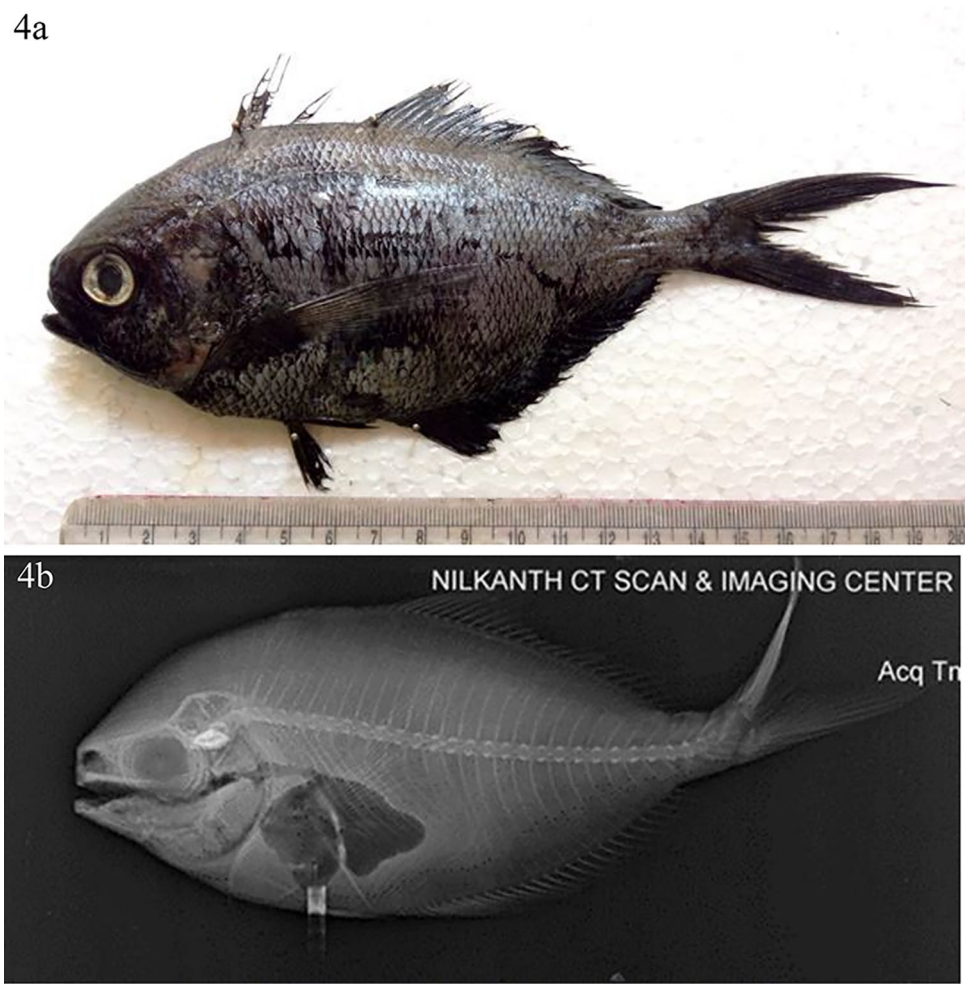

Fig. 4 *Psenes cyanophrys*, 20.5 cm (**2a**), collected from Tuticorin coast, Gulf of Mannar and radiograph (**2b**) with 31 vertebra

paratively small, usually less than snout; Pectoral elongate and equals or less than head; Adults dark grey..... ..... *P. cynophrys*

2. (a) Body firm, moderately deep and compressed; Eye large; Pectoral elongate and equals head; Scales on body large size; Adults dark purple to grey..... *P. arafurensis*

(b) Body firm, moderately elongate and thick; Eye large, greater than snout; Pectoral wing-like and equals head; Adults silvery in colour with bands ..... *P. maculatus*

(c) Body limp and flabby; elongate and tough skin; Eye moderate, less than snout. Pectoral short and rounded; Adults dark brown to deep purple..... *P. pellucidus*

Table 3 Comparison of meristic characters of four species of the genus *Psenes*

Particulars	*P. arafurensis*	*P. cynophrys*	*P. maculatus*	*P. pellucidus*
Dorsal fin rays	X-XI, I-II, 18–22	IX-XI, I, 21–28	IX-XI, I, 22–24	IX-XII, I-II, 26–33
Anal fin rays	III, 20–23	III, 23–28	III, 21–23	III, 26–33
Pelvic fin rays	I, 5	I, 5	I, 5	I,5
Pectoral fin rays	18–20	17–20	20–22	16–20
Lateral line scales	47–50	52–62	55–80	115–125
Gill rakers	8 + 16–18	8 + 18–21	8 + 16–19	8 + 14–16
Vertebrae	30–31	31	33–38	40–44

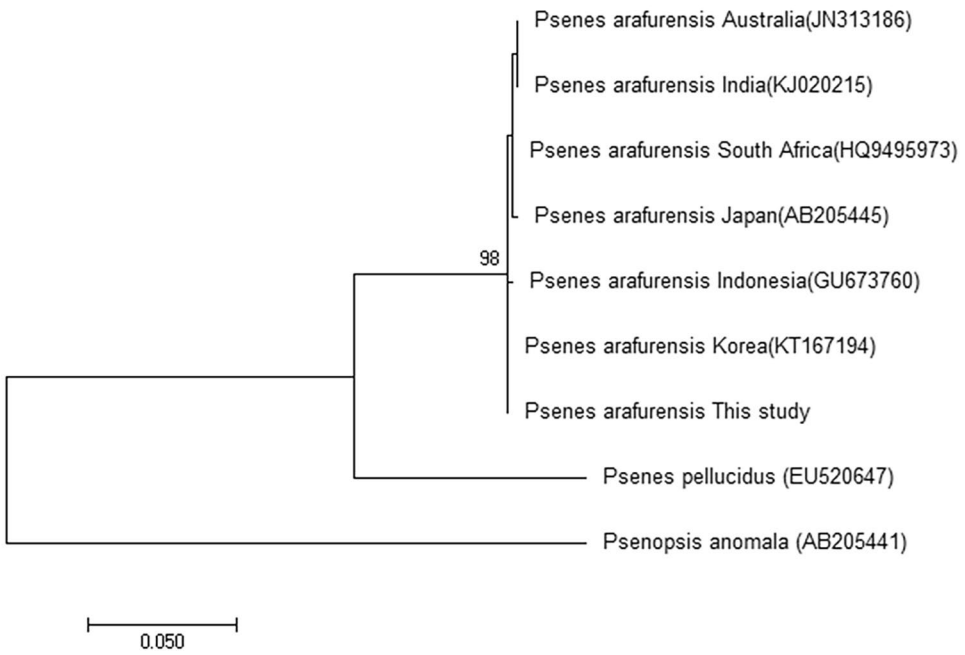

Fig. 5 Maximum likelihood tree generated using partial mDNA COI sequences of *Psenes arafurensis*

Acknowledgements The authors are thankful to the Director, ICAR-CMFRI, Kochi, India for providing facilities and support during the study period.

Declarations

Competing Interest 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 paper.

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