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Note

A taxonomic note on *Crossorhombus azureus* (Alcock 1889) (Family: Bothidae, Order: Pleuronectiformes) from the south-west coast of India

REKHA J. NAIR AND A. GOPALAKRISHNAN

Central Marine Fisheries Research Institute, P. B. No. 1603, Ernakulam North P. O, Kochi - 682 018, Kerala, India
e-mail: rekhacmfri@gmail.com

ABSTRACT

Five species of the bothid genus *Crossorhombus viz.*,*Crossorhombus azureus, C. valderostratus, C. kobensis, C. kanekonis* and *C. howensis* are currently recognised worldwide. Of these, only two species, *C. azureus,* and *C. valderostratus* have been recorded in India. Descriptions of *C. azureus* are mostly based on the first published work of Alcock (1889) and further addition to the knowledge is scanty. Hence an attempt is made here to update the knowledge on the species. Detailed description of the species is presented in this paper based on morphometric and meristic measurements and biological observations on 57 specimens collected from Neendakara on the south-west coast of India. Sexual dimorphism is noticed with males having a series of azure spots on the head. Results of the *t*- test supports the external differences shown by males and females.

Keywords: *Crossorhombus azureus*, Meristics, Morphometrics, Sexual dimorphism

Five species of the bothid genus *Crossorhombus* are currently recognised worldwide: *Crossorhombus azureus* (Alcock, 1889) (Bay of Bengal, north-western Australia, South China Sea, Taiwan and Aru Islands), *C. valderostratus* (Alcock, 1890) (South Africa to India and Sri Lanka, unconfirmed reports from Hong Kong), *C. kobensis* (Jordan and Starks, 1906) (Japan, Formosa Strait and South China Sea), *C. kanekonis* (Tanaka, 1918) (Hong Kong, China, Taiwan and Japan) and *C. howensis* (Hensley and Randall, 1993) (Lord Howe Island and Taiwan). The blue flounder *Crossorhombus azureus* was first described in the Indian waters by Alcock (1889) from Ganjam coast, Bay of Bengal and south-east coast of Ceylon. In the present study, 57 specimens of *C. azureus* were collected from trawl bycatch at Neendakara Fisheries Harbour between December 2000 and April 2010. Review of literature shows that this fish had earlier been reported from the east coast of India along the Ganjam coast, in Odisha and from the Nicobar group of islands, along the east coast of India and also off the south coast of Sri Lanka at Galle, Ceylon, in Poulo Condor Islands, French Indo-China. Although reports of larval forms of *C. azureus* from South African coast, and east coast of Sri Lanka are available (Devi, 1989), records of this species in the fishery along the west coast of India are absent. Descriptions of this species are mostly based on the first published work of Alcock (1889) and further additions to the knowledge are scanty. Hence an attempt is made here to update the knowledge on the species.

Meristic counts and morphometric measurements were made following the methods of Hubbs and Lagler (1949) with the following changes: all ray elements were counted as individual rays because all dorsal and anal fin rays are unbranched. Length of pelvic fin bases was measured from the base of the first ray to the base of the last ray. Head length was measured from the anterior margin of the maxilla to the end of the opercle. Location of the eyes on the ocular side with respect to the front and lateral margins of the fish was determined using snout length by plotting snout length against total length. Snout length was measured from the anterior margin of the maxilla to anterior edge of the upper and lower orbit. Interorbital length was measured as the least depth between the orbits. Relative eye sizes were determined by plotting eye diameter against total length. Body depth was measured as the greatest distance between the dorsal and anal fins at the region below the 38th ray. Head height was the distance from the tip of operculum upright to the dorsal fin base. Scales above the lateral line were counted from the anterior flexion point of the lateral line arch. Teeth count of the lower jaw was taken. Standard length was used throughout. Measurements were made with dial calipers to the nearest 0.01 mm. In small specimens where sex was not obvious using external characters, it was determined by inspection of gonads through a small incision on the right side of the abdominal cavity.

Taxonomic description

Crossorhombus azureus (Alcock 1889) (Fig. 1)

Rhomboidichthys azureus Alcock 1889, p. 283, pl. xvi, Fig. 3; Alcock 1890, p. 435; Alcock 1896, p. 328; Alcock

1898, pl. xxiv, Fig. 3; Johnstone 1904, p. 210; Jenkins 1910, p. 27.

Platophrys microstoma Weber 1913, p. 427, pl. vii, Fig. 3.
Crossorhombus azureus Norman 1927, p. 30; Wu, 1932, p. 93; Norman, 1931, p. 600.

Bothus (Arnoglossus) microstoma Weber and Beaufort, 1929, p. 126.

Bothus microstoma Chabanaud, 1929, p. 379.

(Fig. 2b). Nostrils on the blind side very minute. Fleshy cover seen for the jaws. Palate is also fleshy in nature. Cleft of mouth is nearly vertical. Upper jaw on eyed side carries closely set inward pointing teeth in two rows like a comb; a single row of teeth in lower jaw (Fig. 2c). Origin of dorsal fin on blind side of snout behind mouth. Dorsal fin rays connected with a membrane, scales extend on to rays. A small pore found at the base of each inter-ray membrane (Fig. 2d). Origin of anal fin vertical through hind border

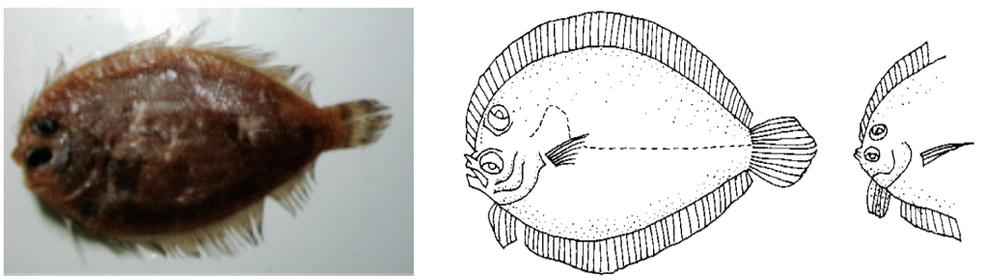
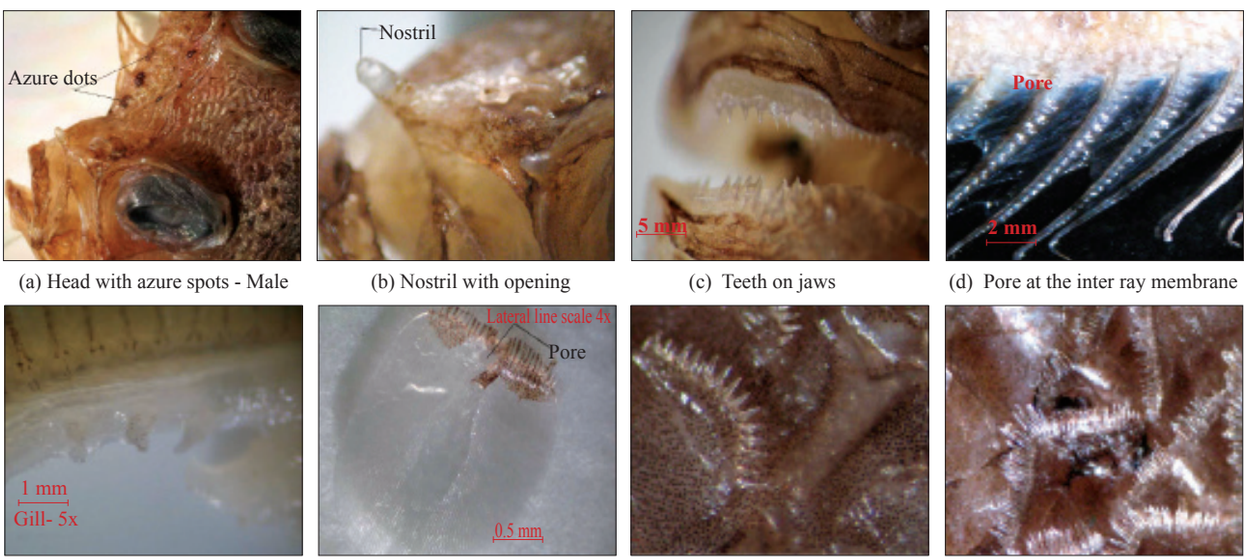


Fig. 1. (a) *Crossorhombus azureus* collected from Neendakara Fishing Harbour; (b) Line drawing of *C. azureus*

Diagnosis: Body oval, its depth being nearly half its length. Head short, deep with anterior profile of head nearly vertical. Head with a series of azure spots above snout in males (Fig. 2a). Upper eye placed half way compared to lower eye. Males present with ocular flaps. Snout projects out and bears a short orbital spine in males; shorter than eye diameter. Bony ridge present in front of orbit, inner margins of orbit very sharp; inter orbital area very concave and wider in males. On eyed side, first nostril is placed above upper jaw, on a fleshy tubercle of operculum, its rays shorter than dorsal. Pectoral fin longer on ocular side; pelvics nearly equal in length. Anal origin little behind base of pelvic fin on blind side. Gill rakers short, fleshy and thick; six present on the first arch (Fig. 2e). Colour light brown, pigmented. Lateral line on ocular side strongly curved at the pectoral fin region; each made up of prominent tubes, the tube opens onto next scale at its split end (Fig. 2f and g). Lateral line on blind side with no supra-pectoral curve, but rises simply to the post-temporal region. Body covered with ctenoid



(a) Head with azure spots - Male (b) Nostril with opening (c) Teeth on jaws (d) Pore at the inter ray membrane

(e) Gill rakers (f) Lateral line scale with pore (g) Lateral line with scale (h) Body scales ctenoid

Fig. 2. Distinguishing features of *Crossorhombus azureus*

scales on ocular side (Fig. 2h), pigmented brownish grey and cycloid scales on blind side. Scales are deciduous. A comparative statement of the morphometric and meristic measurements expressed as percentage of standard length (SL) is given in Table I.

Digestive system: Small coiled tube, intestine short, showing mixed feeding behaviour. Pyloric caeca six in number; whitish in colour, branched in nature.

*Colour***:** In fresh condition head and body on ocular side brownish black; dorsal and anal fins blackish, caudal black with a white band in the centre. Blind side whitish with a conspicuous bluish black colour pattern in males.

Sexual dimorphism: In males, five rows of dark blue azure spots seen on ocular side between eye and snout on the head region (Fig. 2a). Males with a strong rostral spine on snout and with two orbital spines, one on each orbit. Inter orbital space is more in males. Pectoral fin on ocular side is longer than on blind side (Fig. 2b). Males have a characteristic colour pattern on the blind side, the size of which depends on the maturity stage of the animal. A scatter plot of the inter-orbital width of the male and females of *C. azureus* (Fig. 3) shows difference between sexes to be highly significant ($p<0.01$). The same was noticed in the case of pectoral fin length on the ocular side, head length, head height, eye diameter as well as distance from snout to upper eye.

Results of the *t*-test support the external differences shown by males and females. The results of the present study agree with the observations of Hensley and Randall (1993) who stated that species of *Crossorhombus* show sexual dimorphism in several characters and many of the obvious differences between species are in these characters. The dorsal and anal fin counts of the present specimens are similar to that reported by earlier workers. However, there is clear distinction in the ray count of pectoral fin on the blind side and that of the ocular side. The difference in caudal fin count given by Alcock (1890) could be due to the sum total of branched and unbranched rays. A higher value is seen for lateral line scale count in the present samples compared to earlier descriptions. The differences could possibly be due to difference in geographical area studied.

Table 1. Comparison of the morphometric and meristic characters of the blue flounder *C. azureus* from different locations

Characters	Alcock (1889)	Alcock (1890) (S.E coast of Ceylon)	Norman (1927) (S.E India, Burma and Nicobar Islands)	Present study (off Neendakara, S.W. coast of India)**
Fin count				
Dorsal	84	84 – 90	84 – 88	77 – 92 (86)
Anal	64	64 – 70	68 – 73	59 – 77 (66)
Pectoral (O)	10	*	11 – 12	8 – 12 (10)
Pectoral (B)	9	*	11 – 12	7 – 11 (9)
Pelvic	6	*	*	*
Caudal	17	17	*	5 + 11 – 14 (12)
Lateral line count	55	55	53 – 57	50 - 69 (61)
Morphometric measurements (as %SL)				
Head length	3.75 in SL	*	*	23.07 – 26.35 (25) /(3.8 in SL)
Head height	*	*	*	20.99 – 26.55 (23)
Upper eye diameter	*	*	*	7.03 – 10.04 (9)/ 2/8 in Head length
Lower eye diameter	*	*	*	6.09 – 9.26 (8)
Inter orbital	*	*	*	1.75 – 8.07 (5)
Snout to upper eye	½ eye diameter	*	*	4.38 – 13.09 (8) / 3.5 in eye diameter
Snout to lower eye	*	*	*	0.85 – 4.75 (2)
Depth of body	*	*	*	47.3 – 55.2 (51)
Length of pectoral fin on ocular side	*	*	*	14.88 – 19.20 (18)
Length of pectoral fin on blind side	*	*	*	10. 21 – 14.43 (12)
Length of pelvic fin on ocular side	*	*	*	7.3 – 12.9 (10)
Length of pelvic fin on blind side	Longer than pelvic (O)	*	*	3.4 – 15.1 (11)
Length of caudal fin	5.75 in TL	*	*	14.40 – 23 (19)
Dorsal fin base	*	*	*	87.7 – 94.2 (91)
Anal fin base	*	*	*	67.7 – 78.4 (74)
Pectoral base on ocular side	*	*	*	3.1 – 6.0 (4)
Pectoral base on blind side	*	*	*	2.32 - 3.92 (3)
Pelvic base on ocular side	*			7.26 – 12.18 (10)
Pelvic base on blind side	*	Broader than pelvic (O)	*	2.43 – 5.87 (4)
Depth of caudal peduncle	*			10.5 – 12.8 (12)

(* - not available; ** - mean is given in parentheses)

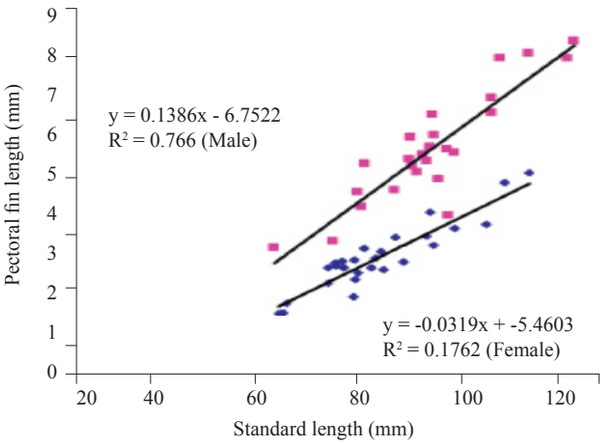


Fig. 3. Relation between interorbital length and standard length in male and female *C. azureus*

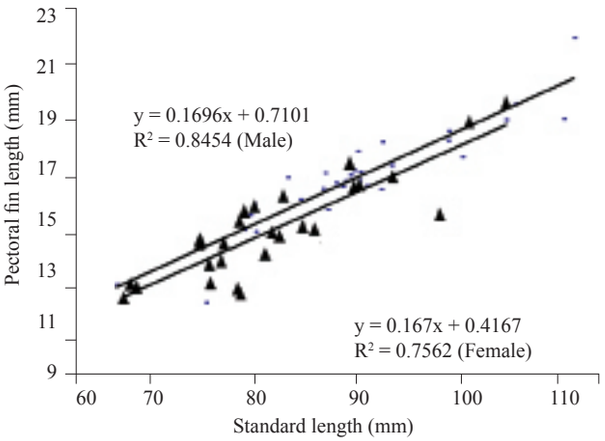


Fig. 4. Relation between pectoral fin length (ocular) and standard length in male and female *C. azureus*

Devi (1989) reported the occurrence of the larval forms of *C. azureus* in the Indian Ocean (Gulf of Thailand and South China Sea). Larval forms of *C. azureus* were found along the coast of South Africa, northern tip of Madagascar, east coast of Sri Lanka, east coast of India and south-west coast of Australia. The depths from where the samples were collected ranged between 110-5504 m (Devi, 1989), which indicates presence of the adult forms in deeper waters. The present study confirms the presence of *C. azureus* in the benthic fauna off Kerala, and records a new distribution area for the fish.

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