

Taxonomy and distributional records of the Indo-Pacific sting fish genus *Minous* (Scorpaeniformes: Synanceiidae) from Indian waters

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Abstract

In this study, we present a taxonomic synthesis and compendium of the diversity and distribution of stonefishes of the genus *Minous* (Scorpaeniformes: Synanceiidae) from Indian waters, including revised species descriptions, diagnoses, and biometric data from specimens off the coast of Visakhapatnam, central eastern India. A total of 342 *Minous* specimens (males, females, and juveniles) from Visakhapatnam waters were examined and identified based on external and internal morphology, resulting in the identification of four *Minous* species: *M. coccineus* Alcock 1890, *M. inermis* Alcock 1889, *M. monodactylus* (Block and Schneider 1801), and *M. trachycephalus* (Bleeker 1855); the last-named recorded for the first time in Indian coastal waters. Furthermore, the study reports the occurrence of *M. inermis* (Alcock's scorpionfish) from coastal waters of Visakhapatnam for the first time. Finally, we present a taxonomic key for the identification of the species of *Minous* present in Indian waters.

KEYWORDS

Indian fishes, new records, sting fishes, taxonomy

1 | INTRODUCTION

Stonefishes (Scorpaeniformes: Synanceiidae), also known as stingfishes, are a diverse group of primarily marine fishes consisting of 38 valid species in nine genera, sometimes classified under subfamilies Synanceiinae and Choridactylinae (Fricke et al., 2021). They have moderately compressed and slightly robust bodies with spiny heads and venom glands at the base of needle-like dorsal fin spines through which they can inject the deadliest of fish neurotoxins (Nelson et al., 2016). Most of the small, bottom-dwelling stonefishes

are found throughout the tropical marine waters of the Pacific and Indian Oceans, from Japan to Australia west to the western Indian Ocean and Red Sea, being usually found near the seashore in shallow waters, but also reaching depths of up to 420 m (Eschmeyer et al., 1979; Amaoka & Kanayama 1981; Mandrytsa 1990, 1993; Nelson et al., 2016; Naranji et al., 2018; Fricke et al., 2021). Stonefishes are mostly found associated to coral reefs, where they live benthically and camouflage as rocks over muddy or sandy substrates, using their pectoral fins for burying and “walking” on the bottom (Nelson et al., 2016).

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Minous Cuvier 1829 is a small and poorly known stonefish genus comprising 15 valid species distributed in the Indo-Pacific region (Fricke et al., 2021), four of which have been reported as occurring in Indian waters, namely: *Minous coccineus* Alcock 1890, *Minous dempsterae* Eschmeyer, Hallacher and Rama-Rao 1979, *Minous inermis* Alcock 1889, and *Minous monodactylus* (Block and Schneider 1801) (de Beaufort & Briggs, 1962; Russell, 1803; Munro, 1955; Eschmeyer et al., 1979; Jones & Kumaran, 1980; Krishnan & Mishra, 1993; Kapoor et al., 2002; Smith & Heemstra, 2012; Matsunuma & Motomura, 2018). *Minous dempsterae*, however, is restricted to the Northwestern Indian Ocean (Fricke et al., 2021). Although the taxonomy of *Minous* has been previously investigated by several authors (Eschmeyer et al., 1979; Amaoka & Kanayama, 1981; Mandrytsa, 1990, 1993; Matsunuma & Motomura, 2018), these studies are mostly regional and without comprehensive consideration of the species occurring in India. Reports on the presence of *Minous* in Indian waters are scarce and include records from Visakhapatnam coastal waters (Russell, 1803), the Indian subcontinent (Day, 1875), Sri Lanka (Munro, 1955), the Laccadive Archipelago (Jones & Kumaran 1980), and the Andaman and Nicobar Island, Bay of Bengal (Rao et al., 2000).

In this study we present a taxonomic synthesis and compendium of the diversity and distribution of stonefishes of the genus *Minous* from Indian waters, including revised species descriptions, diagnoses, and biometric data from specimens and species off the coast of Visakhapatnam, central eastern India. Our work includes the first vouchered and confirmed record of the striped stonefish, *Minous trachycephalus* (Bleeker 1855), from Indian waters, as well as new records of *M. coccineus* and *M. inermis* for the region.

2 | MATERIALS AND METHODS

2.1 | Study area and sampling

Minous specimens were collected fortnightly between December 2010 and December 2020 from the catch landed by commercial fishing boats at Visakhapatnam fish landing center (17.7°N, 83.3°E). Catches were primarily obtained using a variety of fishing nets—including gill, seine, trawl—as well as hooks and lines, operated at variable depths (10–100m). Fishing localities are distributed in waters along the central eastern coast of India, including the major ports and harbors of Paradip, Gopalpur, Baruva, Bhavanapadu, Kalingpatnam, Visakhapatnam, Bhimunipatnam, Pudimadaka, Pentakota, Kakinada, Narsapur, and Machilipatnam (16.98N–20.2 N, 82.19E–86.53E) (Figure 1).

2.2 | Laboratory procedures

Fishes were processed at the Department of Marine Living Resources, Andhra University (DMLRAU), where total length (TL), standard length (SL), and wet weight were measured to the nearest millimeter and gram, respectively. Immediately thereafter, the fishes were preserved in 10% buffered formalin, identified, dissected, sexed, and cataloged.

Specimens were identified as males (♂), females (♀), and juveniles (J). Taxonomic identification followed Eschmeyer et al. (1979), Amaoka & Kanayama (1981), Fischer & Bianchi (1984), Mandrytsa (1990, 1993), and Randall & Eschmeyer (2002). Morphological terminology and abbreviations, including head spines, broadly follows Randall & Eschmeyer (2002) and Eschmeyer (1965). Counts and measurements followed Eschmeyer et al. (1979). Teeth, gill rakers, and pyloric caecae were examined directly. Number of vertebrae was determined using radiographs. All specimens examined in this study are deposited in the DMLRAU fish collection and the Fish Collection of the Estuarine Biology Regional Centre, Zoological Survey of India (EBRC/ZSI/F).

2.3 | Statistical analysis of morphometric data

Comparative morphometric data were tested for static allometry by performing regressions between each body measurement and standard length (SL) on log-transformed data (Table 2), followed by a Student's t-test to examine slope significance for the null hypothesis (isometry). Analysis of covariance (ANCOVA) followed by a Holm-Bonferroni test on the log-transformed and independent size data at varying significance levels (5%, 1%, and 0.1%) were applied to compare the means of morphometric characters among the four sampled species of *Minous*.

3 | RESULTS AND DISCUSSION

A total of 342 *Minous* specimens from the study region (Figure 1) were examined. Taxonomic identification of samples revealed the occurrence of four *Minous* species in the area. In addition to the three species previously recorded for eastern coastal Indian waters (*M. coccineus*, *M. inermis*, and *M. monodactylus*), we identified specimens of *M. trachycephalus* among the comparative material examined, bringing the total of *Minous* species present in the region to four, and overall in Indian waters to five. Meristic, raw morphometric, and log-transformed morphometric data are presented in Tables 1–3, respectively. The slopes of log-transformed regressions were significantly different from 1 (allometric growth) for most morphometric variables measured, indicating that most body proportions change with growth, making raw morphometric data problematic when making comparisons among species. Comparing the allometric coefficients, different combinations of negative and positive allometric growth were observed among the four species of *Minous* (Table 3). Comparable patterns of growth-related proportional changes common to the four species of *Minous* were observed for some characters, mostly displaying positive allometry. ANCOVA results are presented in Appendix S1. These results revealed significant differences in overall body shape among the *Minous* species investigated in this study.

Below we present the systematic accounts based on previous taxonomic treatments of the genus—particularly that of Eschmeyer et al. (1979)—and our own data (except for *M. dempsterae*, which absent from the east coast of India). A taxonomic key to the species of *Minous* found in India is also proposed.

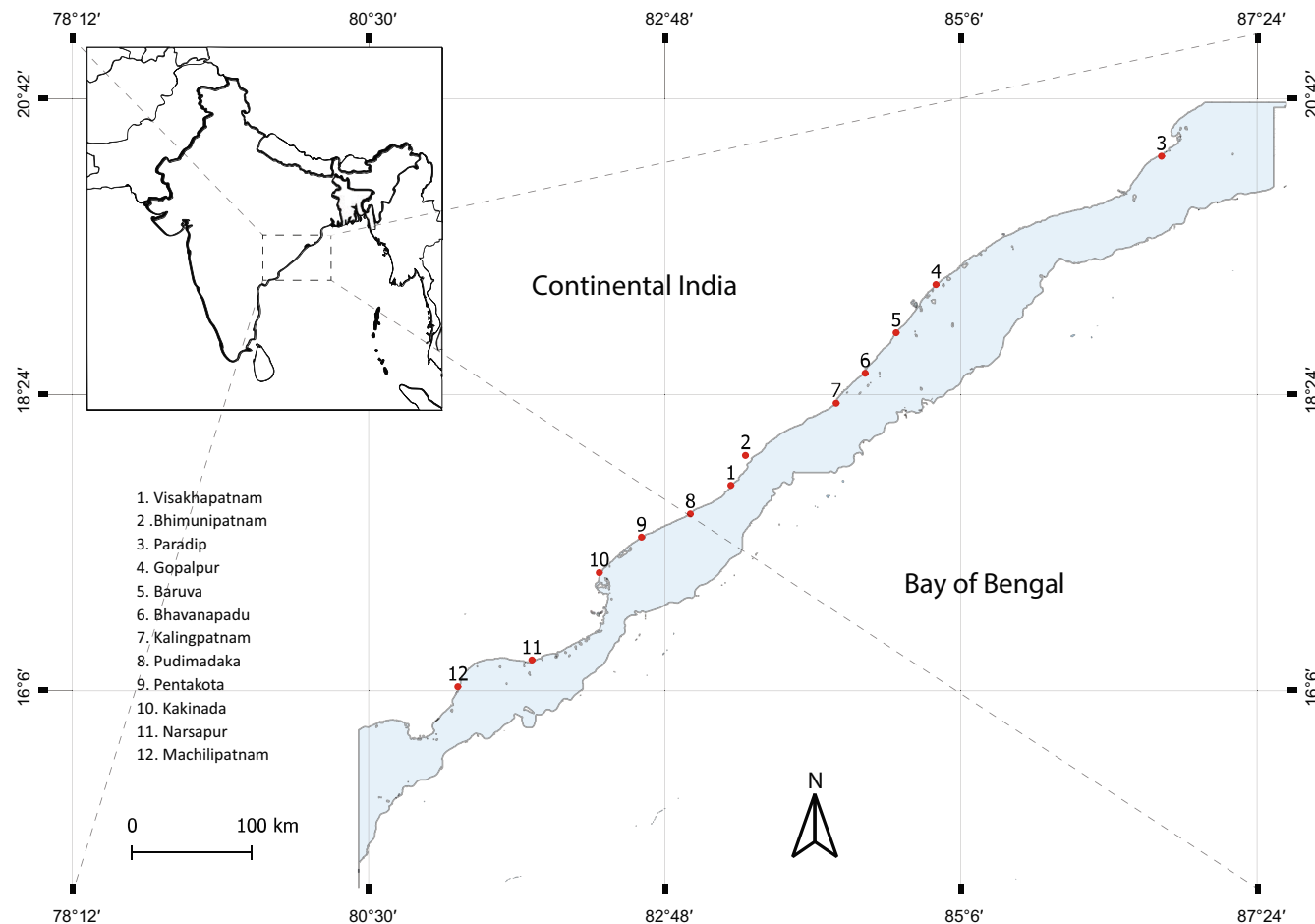


FIGURE 1 Map of the area of study in the coast of central eastern India. Area shaded in blue corresponds to marine waters <1000m deep. Numbers correspond to villages along the central eastern coast of India representing the extent of the sampling area where the fishing boats operated

3.1 | *Minous* Cuvier, 1829

Minous Cuvier in Cuvier and Valenciennes, 1829: 420 (type species: *Scorpaena monodactyla* Bloch and Schneider, 1801, by subsequent designation of Bleeker, 1876).

Corythobatus Cantor, 1849: 1027 (unneeded replacement for *Minous* Cuvier, 1829, not preoccupied by *Minous* Hübner, 1816 in Lepidoptera).

3.1.1 | Diagnosis

The genus *Minous* is distinguished from other synanceiid genera in having the following combination of characters: dorsal-fin rays VIII–XII, 8–14; anal-fin rays II, 7–11; spines almost indistinguishable from soft rays; pectoral-fin rays 12; lowest pectoral ray completely free from rest of fin, slightly enlarged, and fitted at tip with a cuticular “cap”; pelvic-fin rays I, 5; soft rays of all fins unbranched; second suborbital bone wider posteriorly and firmly attached to preopercular bone; scales absent, except for tubes of lateral line; no accessory lateralis

pores on body; a concavity before eyes; no palatine teeth; gill membrane joined to isthmus.

3.1.2 | Distribution

Indo-West Pacific faunal region, from Japan to Australia westward to the western Indian Ocean and Red Sea. Species are mostly coastal and live at depths between about 10 and 420 meters (Smith & Smith, 1963; Eschmeyer et al., 1979; Krishna & Mishra, 1993; Poss, 1999; Smith & Heemstra, 2012; Matsunuma & Motomura, 2018).

3.2 | *Minous coccineus* Alcock, 1890

English name: Onestick stingfish.

Local Telugu name: “Woorah-minoo”.

(Figures 2, 6a, and 7a; Tables 1–3)

Minous coccineus Alcock, 1890: 428. (type locality—off Ganjam coast, 8 miles east-southeast of Kalingapatnam Light, India; Orissa State, India, Bay of Bengal, eastern Indian Ocean; syntypes: ZSI F12924).

TABLE 1 Meristic comparative data of *Minous* specimens from Indian waters off the coast of Visakhapatnam, central eastern India, investigated in this study. Meristic characters and abbreviations: dorsal spines (DS), dorsal rays (DR), anal rays (AR), caudal rays (CR), gill rakers upper arm (GR-UA), gill rakers lower arm (GR-LA), gill rakers total (GRT), lateral line pores (LLP)

Species/character	Counts (frequency)	Mean	SD	SE
<i>M. coccineus</i> (n = 63)				
DS	10 (5), 11 (57), 12 (1)	10.9	0.37	0.04
DR	11 (9), 12 (54)	11.8	0.34	0.04
AR	9 (14), 10 (41), 11 (8)	9.9	0.58	0.07
CR	12 (63)	12	-	-
GR-UA	2 (8), 3 (33), 4 (11), 5 (11)	3.39	0.91	0.11
GR-LA	7 (5), 8 (21), 9 (22), 10 (13), 11 (2)	8.77	0.91	0.11
GRT	10 (2), 11 (3), 12 (19), 13 (22), 14 (4), 15 (1), 16 (12)	13.1	1.62	0.2
LLP	17 (16), 18 (37), 19 (10)	17.9	0.64	0.08
<i>M. inermis</i> (n = 50)				
DS	9 (17), 10 (29), 11 (2), 12 (2)	9.8	0.76	0.1
DR	12 (14), 13 (25), 14 (11)	12.94	0.71	0.1
AR	8 (3), 9 (9), 10 (36), 11 (2)	9.73	0.68	0.09
CR	12 (29), 13 (21)	12.4	0.49	0.06
GR-UA	3 (36), 4 (14)	3.28	0.45	0.06
GR-LA	10 (10), 11 (8), 12 (14), 13 (12), 14 (6)	11.99	0.18	1.92
GRT	14 (7), 15 (8), 16 (15), 17 (7), 18 (13)	16.2	1.3	0.19
LLP	14 (10), 15 (11), 16 (15), 17 (10), 18 (4), 19 (8), 20 (3)	15.7	1.25	0.17
<i>M. monodactylus</i> (n = 70)				
DS	9 (3), 10 (63), 11 (4)	10.1	0.31	0.09
DR	9 (5), 10 (14), 11 (34), 12 (17)	10.8	0.8	0.25
AR	8 (5), 9 (23), 10 (34), 11 (8)	9.63	0.8	0.24
CR	12 (70)	12	-	-
GR-UA	2 (5), 3 (41), 4 (15), 5 (9)	3.4	0.82	0.37
GR-LA	7 (6), 8 (12), 9 (38), 10 (8), 11 (6)	8.94	1.02	0.3
GRT	11 (5), 12 (15), 13 (31), 14 (17), 15 (2)	12.9	0.97	0.25
LLP	17 (8), 18 (27), 19 (17), 20 (10)	18.7	1.17	0.14
<i>M. trachycephalus</i> (n = 23)				
DS	9 (6), 10 (8), 11 (8), 12 (1)	10.17	0.88	0.18
DR	9 (3), 10 (7), 11 (5), 12 (1), 13 (7)	11.08	1.47	0.3
AR	8 (9), 9 (14)	8.6	0.49	0.1
CR	10 (2), 11 (3), 12 (18)	11.69	0.63	0.13
GR-UA	2 (10), 3 (10), 4 (3)	2.69	0.7	0.14
GR-LA	7 (12), 8 (5), 10 (5), 11 (1)	8.69	1.36	0.28
GRT	10 (11), 11 (3), 12 (3), 14 (4), 15 (4)	11.6	1.99	0.41
LLP	18 (12), 19 (8), 20 (3)	18.6	0.72	0.15

3.2.1 | Material examined

EBRC/ZSI/F 13452 (1 specimen) and DMLRAU-00201 (62 specimens), 56 to 136 mm TL (3 J, 45♀ and 15♂), Visakhapatnam, central eastern coast of India (16.98°N–20.2°N, 82.19°E–86.53°E).

3.2.2 | Diagnosis

M. coccineus can be distinguished from its congeners by the following combination of characters: dorsal-fin rays X–XII, 11–12; dorsal spines sharp and moderately strong; first dorsal spine very short, hidden

TABLE 2 Raw morphometric comparative data of Minous specimens from Indian waters off the coast of Visakhapatnam, central eastern India, investigated in this study

	<i>M. coccineus</i> (n = 63)		<i>M. inermis</i> (n = 50)		<i>M. monodactylus</i> (n = 70)		<i>M. trachycephalus</i> (n = 23)	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Total length (TL)	120.6–140.7	133.4 ± 3.71	127.50–140	135.0 ± 2.88	121.90–140.35	131.61 ± 3.96	124.70–136.9	131.8 ± 2.61
Standard length (SL)	73.87–78.76	75.83 ± 1.37	71.42–78.40	74.02 ± 1.48	71.25–82.03	76.03 ± 2.17	73.01–80.18	75.88 ± 1.52
As percentage of standard length								
Body depth (BD)	28.5–37.3	32.8 ± 2.19	25.3–31.4	28.5 ± 1.46	22.35–34.21	30.35 ± 2.83	26.38–33.96	29.72 ± 2.79
Head length (HL)	34.2–46.4	40.8 ± 2.43	36.3–45.3	41.1 ± 2.48	32.83–42.62	38.03 ± 2.91	40.27–51.11	45.09 ± 2.47
Pre-dorsal distance (PreD)	24–32.8	27.0 ± 2.43	23.8–30.4	27.5 ± 1.50	24.00–34.84	31.77 ± 2.04	30.58–39.28	35.34 ± 2.56
Pre-pectoral distance (PreP)	34–45.2	39.0 ± 2.42	32.8–41.4	38.2 ± 1.91	34.21–44.59	39.95 ± 2.67	34.77–45.28	40.85 ± 2.56
Pre-pelvic distance (PreV)	28.5–38.8	34.8 ± 2.54	31.6–40.7	36.9 ± 2.42	31.42–40.81	37.40 ± 2.83	33.92–44.64	39.98 ± 2.64
Pre-anal distance (PreA)	57.1–67.7	63.6 ± 2.76	60–68.5	64.9 ± 2.32	57.53–67.85	63.92 ± 2.72	62.5–69.73	66.03 ± 2.20
Dorsal-fin base length (DB)	67.8–79.6	75.6 ± 2.72	66.1–78.7	72.0 ± 2.93	64.78–76.31	71.06 ± 2.86	62.22–72	68.45 ± 2.80
Pectoral-fin base length (PB)	9.7–17.6	13.5 ± 1.7	7.7–16.3	12.0 ± 1.83	8.3–17.3	11.7 ± 1.9	9.61–17.85	13.19 ± 2.15
Anal-fin base length (AB)	31.4–41.5	37.7 ± 2.49	30.9–40.9	36.0 ± 2.65	31.7–42.8	37.1 ± 2.8	23.07–33.96	31.88 ± 2.55
Dorsal spine length (DSL)	12.0–20.5	16.9 ± 2.02	11.9–18.8	15.0 ± 1.73	10.5–18.3	13.4 ± 1.70	9.85–19.67	13.85 ± 2.19
Dorsal-fin soft ray length (DFL)	16.4–28.5	21.0 ± 2.59	20.3–30.3	23.9 ± 2.58	14.6–24.6	17.5 ± 2.3	16.90–25.71	20.80 ± 2.50
Pectoral-fin length (PFL)	32.1–41.0	36.9 ± 2.52	40–50.7	45.6 ± 2.86	34.3–43.8	38.1 ± 2.6	36.53–46.05	42.37 ± 2.76
Pelvic-fin spine length (VSL)	12.8–23.2	18.5 ± 2.75	16.4–24.6	21.0 ± 2.83	10.2–19.7	13.8 ± 2.5	12.5–17.77	14.60 ± 1.55
Pelvic-fin soft ray length (VFL)	21.1–31.4	26.5 ± 2.73	23.0–32.1	27.4 ± 2.02	22.2–32.3	26.8 ± 2.6	19.67–26.66	23.14 ± 2.11
Anal-fin spine length (ASL)	6.5–12.5	9.4 ± 1.65	6.5–12.7	9.5 ± 1.60	6.4–14.7	9.0 ± 1.8	6.52–13.11	9.82 ± 1.39
Anal-fin soft ray length (AFL)	10.7–22.5	16.7 ± 2.72	14.2–23.2	18.1 ± 2.68	12.2–21.1	16.2 ± 2.3	12.5–20	16.23 ± 1.78
As percentage of head length								
Head depth (HD)	59.4–72.5	67.3 ± 2.61	54.2–64.2	60.0 ± 2.91	61.2–72.7	66.1 ± 2.9	54.05–62.5	58.32 ± 2.63
Head width (HW)	57.1–69.4	63.4 ± 2.88	48.2–58.3	53.3 ± 2.60	51.4–61.9	53.7 ± 2.3	45.94–56.52	49.58 ± 2.88
Eye diameter (ED)	26.6–37.0	30.8 ± 2.72	25–33.3	28.5 ± 1.92	20.5–30.7	25.1 ± 2.9	20–30.76	24.94 ± 2.90
Pre-orbital distance (PrO)	18.1–27.7	22.7 ± 2.38	20–30.7	24.9 ± 2.40	22.5–32.5	26.9 ± 2.8	25–36.66	32.90 ± 2.64
Post-orbital distance (PoL)	37.8–48.3	42.2 ± 2.60	38.2–48.4	43.9 ± 2.60	38.4–48.2	43.9 ± 2.7	30.43–40.54	36.26 ± 2.78
Inter orbital (IO)	20–28.1	23.6 ± 2.21	12.9–21.4	17.4 ± 2.32	14.8–24.1	20.4 ± 2.7	14.70–23.07	17.58 ± 2.59
Upper jaw length (UJL)	38.2–48.4	43.1 ± 2.75	39.3–48.3	43.2 ± 2.70	36.3–46.1	42.4 ± 2.8	30.77–42.30	38.11 ± 2.67
Lower jaw length (LJL)	37.1–46.8	43.1 ± 2.75	42.4–51.7	47.6 ± 2.92	42.1–52.3	48.4 ± 2.9	30.43–40	37.22 ± 2.42
Maxillary width (MD)	11.4–22.2	15.6 ± 2.67	13.3–20.6	16.9 ± 1.97	12.5–22.7	19.1 ± 2.7	14.28–23.07	18.32 ± 2.57
Snout length (SNL)	25.6–35.7	29.0 ± 2.28	25.7–35.4	29.9 ± 2.63	25.9–37.9	32.7 ± 2.9	21.73–30.76	27.12 ± 2.59
Caudal peduncle depth (CPD)	5.5–14.5	10.3 ± 1.70	5.7–10.6	8.0 ± 1.32	6.6–14.8	10.1 ± 1.6	14.28–25	20.61 ± 2.81

TABLE 3 Regression parameters and correlation between standard length (SL) and morphometric variables in the Minoan specimens from Indian waters off the coast of Visakhapatnam, central eastern India, investigated in this study

	<i>M.monodactylus</i>			<i>M.coccineus</i>			<i>M.inermis</i>			<i>M.trachycephalus</i>		
	Slope	Intercept	r ²	Slope	Intercept	r ²	Slope	Intercept	r ²	Slope	Intercept	r ²
In SL-In TL	0.922	0.6071	0.9556	1.0096	0.2475	0.9824	0.9768	0.3987	0.976	0.9628	0.4311	0.9906
In SL-In BD	0.9138	-0.8288	0.6349	1.0264	-1.2288	0.8973	0.837	-0.5688	0.8585	0.8336	-0.1039	0.9342
In SL-In HL	1.1034	-1.3846	0.7942	0.9436	-0.6535	0.9114	1.1248	-1.4138	0.8716	0.8336	-0.1039	0.9342
In SL-In HD	1.0581	-1.6059	0.7472	0.9615	-1.1264	0.9116	0.9488	-1.1845	0.7706	0.6273	0.2167	0.8979
In SL-In HW	0.9716	-1.4462	0.7552	0.9823	-1.2768	0.8972	0.9835	-1.4478	0.7542	0.6358	0.018	0.8486
In SL-In PreD	0.9486	-0.9295	0.7841	0.8036	-0.4627	0.7974	0.9523	-1.0878	0.8554	0.9324	-0.7607	0.867
In SL-In PreA	0.8796	0.0671	0.9034	1.1001	-0.8839	0.9661	1.0632	-0.6984	0.9435	1.0052	-0.4374	0.9726
In SL-In PreP	0.8817	-0.4148	0.779	0.8557	-0.3186	0.9056	0.9791	-0.8744	0.881	0.8362	-0.2141	0.9008
In SL-In PreV	0.859	-0.3849	0.699	0.9295	-0.7507	0.8568	0.9923	-0.9632	0.8023	0.8371	-0.2392	0.8866
In SL-In PFL	1.1095	-1.4351	0.8405	0.8562	-0.3749	0.8686	1.0201	-0.8707	0.8242	1.1059	-1.3024	0.9235
In SL-In VFL	0.9274	-1.0112	0.6322	0.9181	-0.9764	0.7394	0.9168	-0.9434	0.7517	0.6831	-0.146	0.8037
In SL-In DSL	0.6329	-0.4496	0.3773	0.9611	-1.6138	0.6952	0.9562	-1.7171	0.5525	1.142	-2.5808	0.6857
In SL-In DFL	1.0227	-1.8447	0.5757	0.972	-1.4452	0.7199	0.8199	-0.6806	0.5365	0.9374	-1.3158	0.7043
In SL-In ASL	0.4301	0.0046	0.1127	0.8073	-1.5473	0.4308	0.5819	-0.6005	0.193	1.0476	-2.5292	0.6677
In SL-In AFL	0.8014	-0.9796	0.3775	0.8898	-1.3249	0.5149	0.7249	-0.5603	0.3062	0.969	-1.6948	0.7567
In SL-In VSL	0.639	-0.4551	0.2095	1.2577	-2.8092	0.7316	0.4773	0.6328	0.21	0.6862	-0.6204	0.7207
In SL-In DB	0.9316	-0.0509	0.9097	1.0227	-0.3772	0.9687	0.9172	0.02	0.9131	0.9451	-0.1507	0.9562
In SL-In AB	0.9445	-0.7563	0.7497	0.9872	-0.919	0.8914	0.9331	-0.742	0.7457	1.2238	-2.0799	0.9069
In SL-In PB	0.7405	-1.0519	0.309	0.9396	-1.7445	0.6632	1.1599	-2.7947	0.5291	0.743	-0.9653	0.499
In SL-In CPD	0.6702	-0.8978	0.2716	0.7521	-1.2105	0.4341	0.8152	-1.7544	0.2994	0.7372	-1.5969	0.8179
In SL-In PrO	0.9588	-2.0868	0.619	0.9788	-2.2906	0.7726	1.113	-2.7584	0.6795	1.0325	-2.0482	0.8442
In SL-In PoL	1.0284	-1.8877	0.7431	0.9019	-1.3364	0.8653	1.0929	-2.1032	0.8238	1.0402	-1.9827	0.8846
In SL-In ED	0.857	-1.7207	0.4938	0.961	-1.9084	0.8413	0.9022	-1.7332	0.812	0.618	-0.5995	0.6572
In SL-In IO	0.8711	-1.9874	0.3396	0.7884	-1.4289	0.6369	1.1567	-3.3013	0.4851	0.9628	-2.8449	0.6632
In SL-In SNL	1.1555	-2.7277	0.6684	0.958	-1.9562	0.8418	1.1195	-2.601	0.789	0.9639	-1.9563	0.8085
In SL-In UJL	0.9849	-1.7361	0.7423	0.9009	-1.3119	0.8438	1.1226	-2.2458	0.8902	0.851	-1.1433	0.8393
In SL-In LJL	0.9737	-1.5573	0.7146	0.9239	-1.4168	0.837	0.9906	-1.5924	0.8167	0.8491	-1.1585	0.8545
In SL-In MW	0.9054	-2.2015	0.3889	0.5956	-1.0204	0.3789	0.7898	-1.7826	0.4867	0.7242	-1.3537	0.5041

under the skin; anal-fin rays II-III, 9-11; gill rakers total 10-16; gas bladder present; head spines moderately developed; maxillary bone with two sharp spines.

3.2.3 | Meristic characters

D X-XII, 11-12; A II-III 9-11; P 11+1; C 12; Llp 17-19; GR 2-5+1+7-11 = 10-16; pyloric caeca 2-5; vertebrae 24-26.

3.2.4 | Colouration

Ground color of body brown, becoming paler ventrally; upper portion of flanks with alternating white bars, bordered with narrower dark brown lines. Small, scattered dark spots present on body except on lower flanks. Upper part of head brown, area below suborbital grey to silvery; edges of both jaws with pale brown pigmentation. Dorsal fin brown, anterior spinous dorsal fin membranes blackish distally; posterior spinous dorsal fin membranes and soft dorsal fin with pale bands extends obliquely from fins to upper surface of body, soft dorsal margin blackish. Pectoral-fin base pale brown, darker at distal half; inner surface of pectoral fin with dark brown irregular spots of different sizes on tan background; spots loosely arranged near base and becoming closer to each other towards tip; free pectoral-fin ray cap yellow. Base of pelvic with brown pigmentation; pelvic and anal fins pale brown proximally, tips dark brown. Caudal fin pale brown with scattered black pigmentation.

3.2.5 | Distribution

Coastal waters of South Africa, the Red Sea, Arabian Sea, Bay of Bengal, Burma, Gulf of Thailand, Jawa, and Taiwan in depths ranging from 23 to 81 m (Smith & Smith, 1963; Eschmeyer et al., 1979; Krishnan & Mishra, 1993; Poss, 1999; Randall & Van Egmond, 1994). Until now, the species had been reported in Indian waters from Ganjam coast (Alcock, 1890) and from the Bay of Bengal (Eschmeyer et al., 1979). This represents the first record from Visakhapatnam waters, which is considerably far south from the Ganjam locality.

3.2.6 | Remarks

The description, meristic counts, and morphometric variation (Tables 1 and 2) reported herein conform with those of Alcock (1890), Eschmeyer et al. (1979), Chen (1981), and Smith & Heemstra (1986) for *M. coccineus*. The presence of yellow spots on the medial side of the pectoral-fin base is the most striking character promptly allowing the identification of this species. In the catches of Visakhapatnam, *M. coccineus* was mainly represented in bottom trawl catches throughout the year, rarely in shore seines. The maximum total length was previously recorded at 100 mm TL

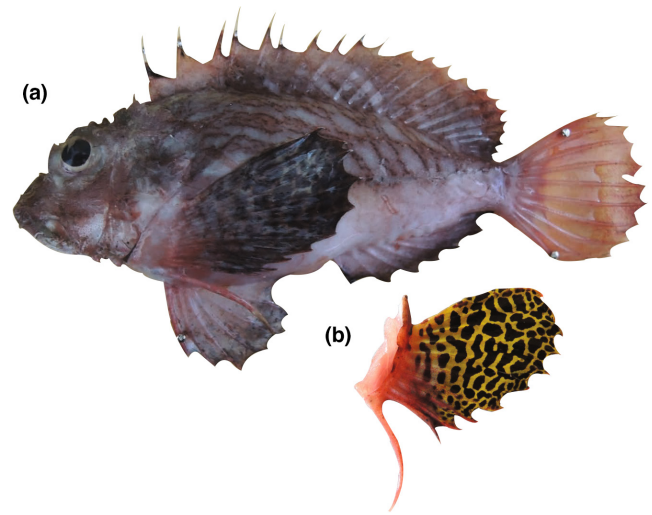


FIGURE 2 Fresh specimen of *Minous coccineus* (DMLRAU-00201, 124 mm TL) (a); medial side of pectoral fin (b)

(Smith & Heemstra, 1986), while the largest specimen examined herein was 136 mm TL, which significantly increases the known maximum size of the species.

3.3 | *Minous dempsterae* Eschmeyer, Hallcher, and Rama-Rao, 1979

English name: Oblique banded stingfish.

Minous dempsterae Eschmeyer, Hallcher, and Rama-Rao, 1979: 469. (type locality—off western India, 21°11'-08'N, 69°16'-13'E, depth 70-72 meters; holotype: USNM 218417).

3.3.1 | Diagnosis

M. dempsterae can be distinguished from its congeners by the following combination of characters: dorsal fin with X-XI (usually XI), 11-13; all dorsal fin spines sharp, thin and moderately strong; first dorsal spine less than half of second and close to its base of second; anal fin with II, 9-11; anal spine difficult to distinguish from soft rays; vertebrae 25-28. Gill rakers total 11-15 on outside of first arch, 3-5 on upper arch, 8-10 on lower arch; lateral line pores 18-20; gas bladder present; long pectoral fin reaching at most to above middle of anal fin; body oblong, compressed, dorsal profile slightly equal to ventral; dorsal profile slightly equal to ventral; head spines moderately well developed with ridges; lacrimal bone with two sharp spines; its lacrimal spines extend over maxilla and anterior one points down and forward; second spine points out and to rear; first lacrimal spine about half of the posterior one; preopercle with six to seven spines; first and second short; third ridge like, serrated with pointed tip, equal to third lacrimal spine; fourth one short, pointed; fifth, sixth and seventh spines broad, blunt, last spine with serrations (Eschmeyer et al., 1979; Matsunuma & Motomura, 2018).

3.3.2 | Meristic characters

D X-XII, 11-13; A II-III 9-11; P 11+1; C 12; Llp 18-20; GR 3-5+1+8-10 = 11-15; pyloric caeca 2-5; vertebrae 25-28 (Eschmeyer et al. 1979).

3.3.3 | Colouration

Body brown, paler ventrally; anterior spinous dorsal fin membranes blackish distally; upper portion with alternating pale and brown bands; pale bands bordered with inner dark lines. Ventral portion of the body pale, without markings; head brown; area below sub-orbital gray to pale; edges both jaws pale white with pigmentation; pectoral fins black, becoming pale on base; inner surface with small irregular pale spots on a dark background; free pectoral ray cap white; base of pelvic with brown pigmentation; Pelvic and anal fins dusky brown proximally, tips dark brown. Caudal fin pale brown with scattered black pigmentation (Eschmeyer et al., 1979; Matsunuma & Motomura, 2018).

3.3.4 | Distribution

Northwestern Indian Ocean: Persian Gulf east to India (Fricke et al., 2021). Reports from Indian waters from Mumbai coast, off western India (Eschmeyer et al., 1979).

3.4 | *Minous inermis* Alcock, 1889

English name: Alcock's scorpionfish.

Local Telugu name: "Murri-moyya".

(Figures 3, 6b, and 7b; Tables 1-3)

Minous inermis Alcock, 1889: 299-300 (type locality: Bay of Bengal east of Sacramento shoals on Godavari coast, India; syntypes: ZSI F12444-45).

3.4.1 | Material examined

EBRC/ZSI/F 13450 (2 specimens) and DMLRAU-00202 (48 specimens), 65 to 113mm TL (1 J, 39♀ and 10♂), Visakhapatnam, central eastern coast of India (16.98°N-20.2°N, 82.19°E-86.53°E).

3.4.2 | Diagnosis

M. inermis can be distinguished from its congeners by the following combination of characters: dorsal-fin rays IX-XII, 12-14; all dorsal-fin spines thin and flexible; first dorsal spine very short, close to the second dorsal spine; anal-fin rays II, 8-11; gill rakers total 14-18; vertebrae 26; lateral-line pores 16-18; gas bladder present; long

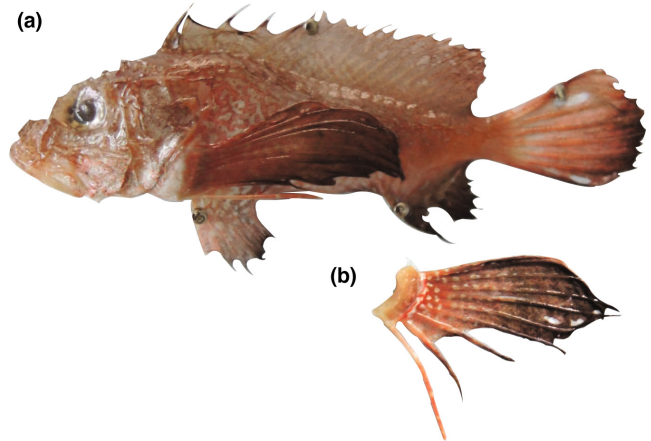


FIGURE 3 Fresh specimen of *Minous inermis* (DMLRAU-00202, 96 mm TL) (a); medial side of pectoral fin (b)

pectoral fin, reaching over end of anal fin; head spines moderately developed; two sharp spines over maxillary; smooth exposed bony surface of head; down and backward posterior lacrimal spine; uppermost preopercular spine not beyond opercular margin; large opercle; free pectoral fin ray beyond pelvic fin.

3.4.3 | Meristic characters

D IX- XII, 12-14; A II, 8-11; P 11+1; C 12-13; V I,5; GR 3-4+1+8-14 = 14-18; Llp 16-18; pyloric caeca: 2-3; vertebrae 26.

3.4.4 | Colouration

Variable, upper flanks rosy or red brown with short grey irregular linings, lower flanks pale, area before pelvics pale grey; area behind pelvics and ventral side pale red. Upper part of head grey with reddish tinge, cheeks, maxilla pale red brown, proximal half of pectoral fin pale red brown with increasing in darkness distally; inside of pectoral fin light grey, axil and proximal half with irregular white linings, distal half dark grey or black; free pectoral ray banded with pale grey and red brown. Proximal half of pelvics pale red brown with pale grey or white irregular lines, distal half grey. Anal-fin proximal half pale red, distal half grey. Caudal fin red, with grey edge; throat and barbel white.

3.4.5 | Distribution

Northern Indian Ocean in coastal areas from the Bay of Bengal west to the Gulf of Oman, Somalia, and from the Saya de Malha Bank (Smith & Smith, 1963; Eschmeyer et al., 1979; Krishnan & Mishra, 1993). Previous records from Indian waters include those of Alcock (1889) and Krishnan & Mishra (1993) for the Bay of Bengal, Alcock (1899) for the Coromandel and Malabar coasts, and

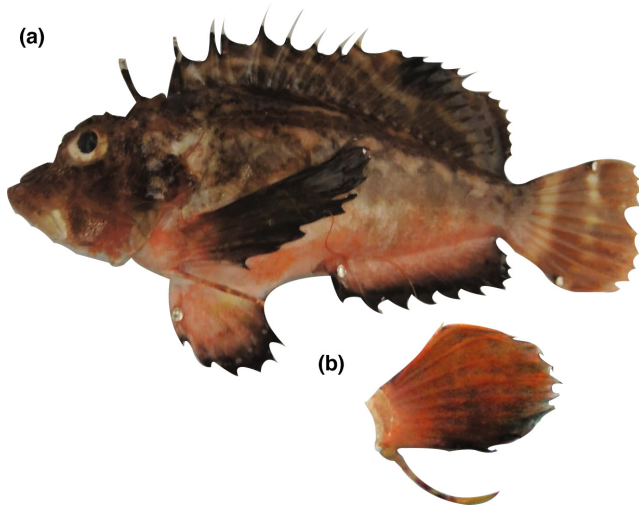


FIGURE 4 Fresh specimen of *Minous monodactylus* (DMLRAU-00203, 114 mm TL) (a); medial side of pectoral fin (b)

Eschmeyer et al. (1979) for the mouth of Hooghly River. This is the first record from Visakhapatnam waters.

3.4.6 | Remarks

The description, meristic counts, and morphometric variation (Tables 1 and 2) reported herein conform with those of Alcock (1890), Eschmeyer et al. (1979), and Smith & Heemstra (1986) for the species. In the catches of Visakhapatnam, *M. inermis* was mainly represented in bottom trawl catches at depths of 35–420 m and was caught along with members of the families Priacanthidae, Mullidae and Triglidae. *M. inermis* mostly prefers deeper waters with muddy bottom. The spines are venomous. The species is reported to grow up to 113 mm TL (Eschmeyer et al., 1979).

3.5 | *Minous monodactylus* (Block and Schneider, 1801)

English name: Grey stingfish.

Local Telugu name: “Worrah Minoo”.

(Figures 4, 6c, and 7c; Tables 1–3)

Scorpaena monodactyla Bloch and Schneider, 1801: 194. (type locality: not stated; holotype (unique): ZMB (apparently lost)).

3.5.1 | Material examined

EBRC/ZSI/F 13449 (2 specimens) and DMLRAU-00203 (68 specimens), 66 to 128 mm TL (31 J, 27 ♀ and 12 ♂), Visakhapatnam, central eastern coast of India (16.98°N–20.2°N, 82.19°E–86.53°E).

3.5.2 | Diagnosis

Minous monodactylus can be distinguished from its congeners by the following combination of characters: dorsal-fin rays IX–XI, 9–12, total dorsal-fin elements (spines plus soft rays) usually 21, dorsal spines sharp and strong; anal-fin rays II, 8–11; gill rakers total 11–15; vertebrae 25–26; lateral-line pores 17–20; head nearly as broad as the body, scabrous, and armed with many spines; the front declivous, grooved; a long curved spine on each side of the rostrum, two or three small prickles in front; mouth large; protrusible jaws; nearly equal; teeth small; tongue short, smooth; eyes close to the crown in a deep prickly orbit; dorsal fin single; pectoral fin broad; caudal fin truncate; colour of belly pale to dark brown, paler on lower flanks, dusky silvery on ventral side.

3.5.3 | Meristic characters

D IX–XI, 9–12; A II, 8–11; P 11 + 1; V I, 5; C 12; GR 2–5 + 1 + 7–11 = 11–15; Llp 17–20; pyloric caeca 5; vertebrae 25–26.

3.5.4 | Colouration

Variable, body pale to dark brown, paler on lower flanks, dusky silvery on ventral side. Upper flanks with two narrow white, wavy bars, first one ending on base of soft dorsal, second one extending to caudal peduncle. Head pale below; maxilla, lower jaw white; edges of both jaws have brown pigmentation. Dorsal fin pale brown, tips of dorsal spines dark brown; edge of soft dorsal dark, with blotch in upper half from first to fifth rays; dorsal fin with irregular white streaks. Base of pectoral fin pale brown, outer surface dark brown, inner surface pale; free pectoral ray with reddish-brown and white bands, a yellow cap at tip. Pelvics and anal bases pale brown, darker at edge. Caudal peduncle crossed by dark brown; caudal fin with two broad dark brown vertical bars.

3.5.5 | Distribution

Minous monodactylus is a shallow water species occurring from near shore to about 55 m. It is the most geographically widespread of the genus (Eschmeyer et al., 1979), distributed from the western Indian Ocean and Red Sea to Indonesia and Japan (Poss & Rama Rao, 1984). This species has been recorded in Indian waters from Vizagapatam (Visakhapatnam) (Russell, 1803), from Madras (Günther, 1860), from the Malabar coast (Day, 1875), from the Ganjam coast (Eschmeyer et al., 1979), from Pondicherry and Karaikal (Mishra & Krishnan, 2003), and from Andhra Pradesh (Barman et al., 2004).

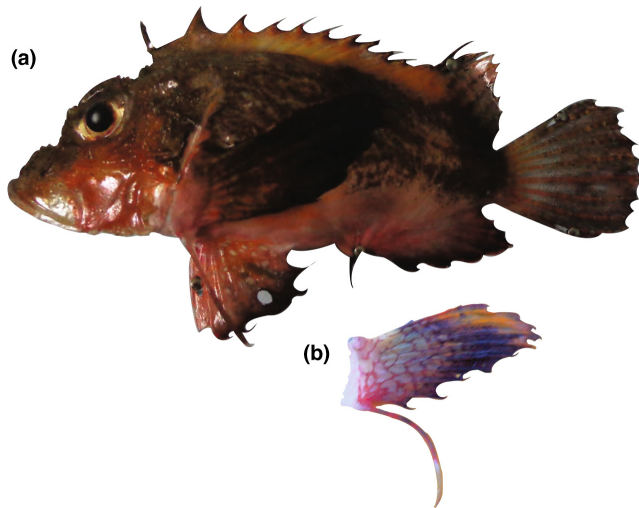


FIGURE 5 Fresh specimen of *Minous trachycephalus* (DMLRAU-00201, 92 mm TL) (a); medial side of pectoral fin (b)

3.5.6 | Remarks

The description, meristic counts and morphometric variation (Tables 1 and 2) reported herein conform with those of Cuvier & Valenciennes (1829), Richardson (1846), Cantor (1849), Günther (1860), Day (1875), Munro (1955), de Beaufort & Briggs (1962), Carcasson (1977), Eschmeyer et al. (1979), Chen (1981), Fischer & Bianchi (1984), Smith & Heemstra (1986), and Carpenter & Niem (1999) for the species. This species is reported to reach up to 101 mm SL (de Beaufort & Briggs, 1962). Meanwhile, we report here a maximum SL of 78.4 mm. In the catches of Visakhapatnam, *M. monodactylus* was mainly represented in bottom trawl catches, rarely in shore seines.

3.6 | *Minous trachycephalus* (Bleeker, 1855)

English name: Striped stingfish.

Local Telugu name: "Murri-moyya".

(Figures 5, 6d, and 7d; Tables 1–3)

Aploactis trachycephalus Bleeker, 1855: 451 (type locality: Manado, Sulawesi, Indonesia; Holotype (unique): RMNH.PISC 5901).

Corythobatus trachycephalus: Bleeker, 1865: 282.

Minous trachycephalus: Eschmeyer et al., 1979 (northeastern Indian Ocean and northwestern Pacific oceans; Allen and Erdmann, 2012 from East Indies; Motomura, 2013 from Gulf of Thailand; Matsunuma et al., 2017 (Red Sea).

3.6.1 | Material examined

EBRC/ZSI/F 13451 (1 specimen) and DMLRU-00204 (22 specimens), 59–110 mm TL (18♀ and 5♂), Visakhapatnam, central eastern coast of India (16.98°N–20.2°N, 82.19°E–86.53°E).

3.6.2 | Diagnosis

Minous trachycephalus can be distinguished from its congeners by the following combination of characters: dorsal-fin rays IX–XII, 9–13, total dorsal-fin elements (spines plus soft rays) usually 20–21, dorsal spines moderately strong, thin, and flexible, first dorsal spine short; anal-fin rays II, 8–9; gill rakers total 10–15; vertebrae 24–25; lateral-line pores 18–20; gas bladder absent; pectoral fin reaching up to middle of anal fin; head spines poorly developed.

3.6.3 | Meristic characters

DIX–XII, 9–13; AII, 8–9; VI, 5; C 10–12; P 11 + 1 = 12; GR 2–4 + 1 + 7–11 = 10–15; LI tubes 18–20; pyloric caeca 2–3; vertebrae 24–25.

3.6.4 | Colouration

Body coloration variable; alternating dark brown with black; pale pinkish on lower flanks, milk white on ventral side. Upper flanks with dark oblique bands extend obliquely back from under the posterior portion of the spinous dorsal fin and a black blotch between anterior dorsal spines; soft dorsal yellowish with black, tips of dorsal spines dark brown; edge of dorsal dark, with blotch in upper portion of soft dorsal rays. Base of pectoral fin pale brown; distal part of pectoral fin blackish; inner side of pectoral fin variable, axil light brown or pale with stripes or rows of spots radiating outward along pectoral rays. Anal fin pale pink with outer margin tinged with black. Pelvic fin brown with white markings and darker distally. The observed coloration of medial side of pectoral fin conforms to that reported by Eschmeyer et al. (1979).

3.6.5 | Distribution

This species was recorded by de Beaufort & Briggs (1962) from Indonesia and up until this study its distribution was restricted to the Indo-West Pacific (Madagascar and Red Sea east to New Caledonia, and northern Australia north to Taiwan) (Matsunuma & Motomura, 2018). This is the first record of this species in Indian waters. The species appears to be one of the shallower-living species. Few depths of capture records are available between 11 and 46 m. An authentication of the widespread range of this species based on voucher specimen data is necessary, owing to the previous taxonomic confusion with congeners.

3.6.6 | Remarks

The description, meristic counts and morphometric variation (Tables 1 and 2) reported herein conform with those of de Beaufort & Briggs (1962) and Eschmeyer et al. (1979), but not entirely with

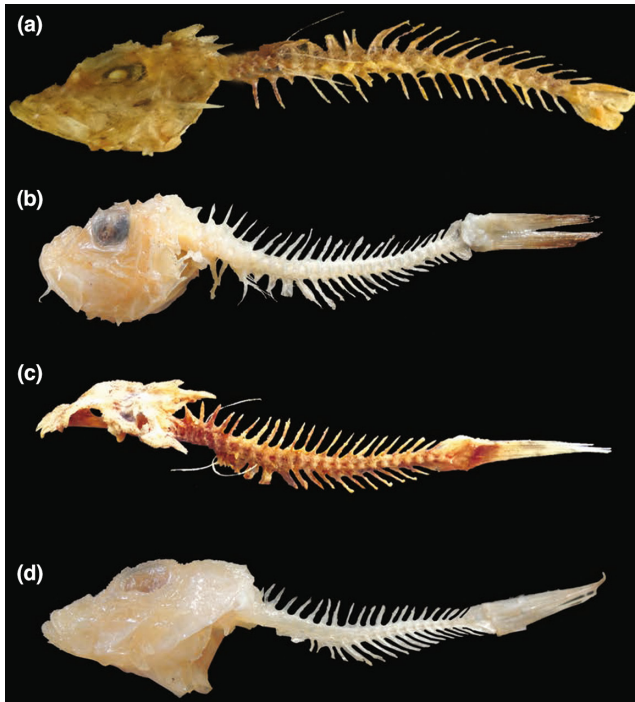


FIGURE 6 Skeletonized specimens of *Minous* species present in eastern coastal Indian waters: *M. coccineus* (a), *M. inermis* (b), *M. monodactylus* (c), and *M. trachycephalus* (d)

meristic data—particularly gill-raker counts—reported Matsunuma & Motomura (2018), which might be attributed to regional variation. In the catches of Visakhapatnam, *M. trachycephalus* was represented in bottom trawl catches and caught along with deep water fishes such as Mullidae or Priacanthidae at depths of 27–90 m. The species, however, is relatively rare in Visakhapatnam waters. Unlike other *Minous* species, *M. trachycephalus* was not found throughout the year, missing from catches during the months of January, May, and September to November. Prior to this study, the species was known to grow up to 105 mm TL (de Beaufort & Briggs 1962) (vs. 136.9 mm TL reported herein).

4 | KEY TO THE SPECIES OF *Minous* PRESENT IN INDIAN WATERS

1a. First dorsal spine slightly longer than second and well separated from base of second spine; dark blotch between first and fifth dorsal rays; caudal fin with two broad dark brown vertical bars; second preopercular spine longer ... *Minous monodactylus* (Bloch and Schneider, 1801).

1b. First dorsal spine weak, shorter than second, its base close to that of second; second preopercular spine relatively short.... 2.

2a. Three lacrimal spines, second spine sharp, longer than first; inner surface of pectoral fin with dark brown irregular spots of different sizes on yellow background; free pectoral ray not banded ... *Minous coccineus* Alcock, 1890.

2b. Two lacrimal spines ... 3.

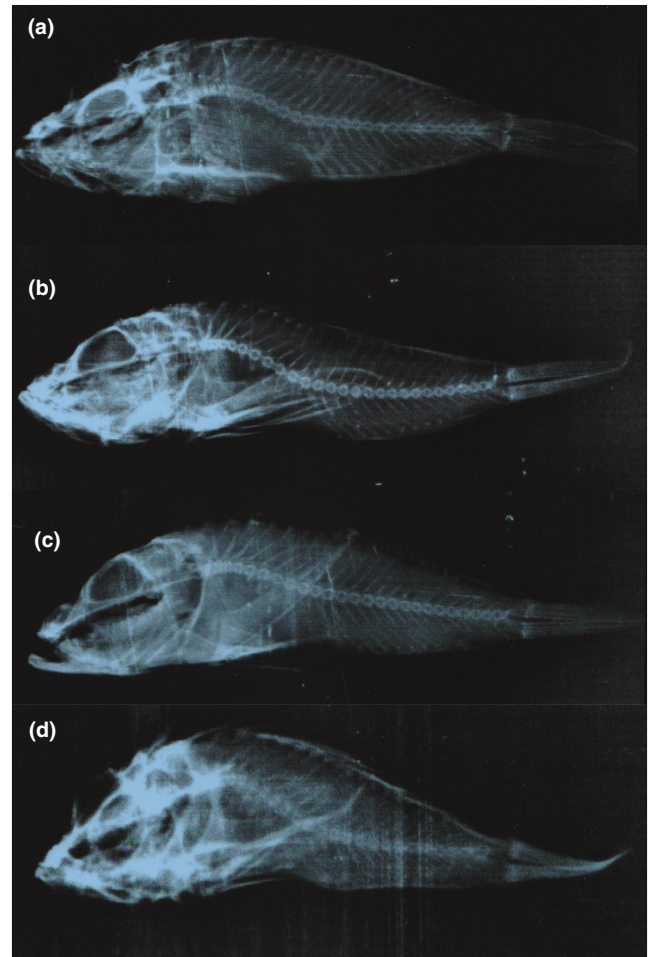


FIGURE 7 Radiographs from specimens of *Minous* species present in eastern coastal Indian waters: *M. coccineus* (a), *M. inermis* (b), *M. monodactylus* (c), and *M. trachycephalus* (d)

3a. First lacrimal spine about the same length or 2/3 of second spine; axil and proximal half of pectoral with irregular white linings; distal half dark grey or black; free pectoral ray banded with pale grey and red brown; head length 41% of standard length ... *Minous inermis* Alcock, 1889.

3b. First lacrimal spine about half the length of second spine ... 4.

4a. Base of pectoral fin pale brown; distal part of pectoral fin blackish; inner side of pectoral fin variable, axil light brown or pale with stripes or rows of spots radiating outward along pectoral rays; free pectoral ray banded with white and red, distally white; head length 45% of standard length ... *Minous trachycephalus* (Bleeker, 1855).

4b. First lacrimal spine points down and forward; body with irregular oblique dark and light stripes; medial side of the pectoral fin dark with small pale spots on a dark background; pelvic fin without hexagonal markings ... *M. dempsterae* Eschmeyer, Hallacher and Rama-Rao, 1979.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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