



Distribution and diversity of Goatfishes, (Mullidae, Teleostei, Syngnathiformes), along the Indian Coast

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Short communication

Abstract

Goatfishes (Family Mullidae) are widely spread across different tropical and temperate coastal habitats. Mullidae diversity was studied from different sampling locations from both the west and east coast of India including Lakshadweep. During the period 2019-2021, the study revealed the presence of 14 species under three genera, *Mulloidichthys*, *Parupeneus* and *Upeneus*. The distribution pattern of the species was noticeable with the genus *Mulloidichthys* reported only from the Lakshadweep islands. This study throws light on a lesser-studied group which is ornamental and also serves as an ecological indicator.

Keywords: Diversity, mullidae, goatfish, mulloidichthys, upeneus, India, distribution

Introduction

Goatfishes belonging to the family Mullidae consists of 99 species under six genera (Froese and Pauly, 2022). They are important marine food fishes of the world. Though many species of goatfish are brightly coloured (Vivekanandan *et al.*, 2003), they are not very popular as aquarium fish. Goatfishes are widely distributed in tropical, subtropical and temperate habitats; in shallow water, open, sandy (Uiblein, 2007) or muddy bottoms (Lachner, 1954; Fischer and Bianchi, 1984; Kim, 2002; Randall, 2004); brackish and marine habitat while some species are also associated with coral reefs (Ben-Tuvia and Kissil, 1988) and hard bottoms; others separate mainly by depth (Uiblein and Causse, 2013). These fishes are characterized by a pair of whisker-like sensory barbels on the lower jaw which is used to trace food hidden in sand or reef crevices (Gosline, 1984; Randall and Kulbicki, 2006). Goatfishes can change their colouration depending on their current activity (Rajan *et al.*,

2012). Goatfishes serve as an important ecological indicator (Uiblein, 2007) and respond to human activities, such as modification of their habitat by changing their distributional range. Of the six genera (*Mulloidichthys*, *Mullus*, *Parupeneus*, *Pseudupeneus*, *Upeneichthys*, *Upeneus*) in the family Mullidae, *Mulloidichthys* is the only genus represented in all tropical and subtropical seas (Uiblein, 2011), while *Parupeneus* is found only in the Indo-Pacific region (Ben-Tuvia and Kissil, 1988); *Upeneus* is found worldwide except in eastern Pacific region (Randall and King, 2009).

In India, 21731 t of goatfishes were landed during the year 2020 (CMFRI, 2021). An analysis of the fishery showed that the landings of goatfish decreased from 34575 t in 2010 (1.12% of the total landings) (CMFRI, 2011) to 21731 t in 2020 (0.79 % of the total landings). The higher abundance, availability and occurrence of goatfish have been noticed in Tamil Nadu, Andhra Pradesh and Kerala coast. However, goatfishes do not form a fishery as such in southwestern India but occur along with nemipterid fishes. Goatfishes are mainly caught as bycatch of the trawls rather than targeted fishing (Vivekanandan *et al.*, 2003).

The western Indian Ocean goatfish of the genus *Upeneus* was reviewed by Uiblein and Heemstra (2010); 36 valid species of the genus *Upeneus* have been recognized (Uiblein and McGrouther, 2012). Presently, the genus *Upeneus* is the most diverse with 42 valid species (Uiblein *et al.*, 2020) while *Parupeneus* has 32 valid species (Uiblein *et al.*, 2018). The genus *Mulloidichthys* from the western Indian Ocean was reviewed by Uiblein (2011), who recognized seven valid species. Though numerous studies have been conducted worldwide recently, not much detailed work has been done in India except by Thomas (1969).

Material and methods

A rapid survey on the family Mullidae was done across maritime states during 2019-2021 and collections were made from different sampling locations on both the west and east coast of India including Lakshadweep (Fig. 1), using different gears across seasons. Fresh samples were collected from the harbour and taken to the laboratory at ICAR- Central Marine Fisheries Research Institute (CMFRI), where the specimens were sorted, cleaned and photographed in fresh condition. Goatfish species were identified according to the classical taxonomic methods *viz.*, meristics, morphometrics, colours, body stripes and caudal fin bars patterns using standard literature (Uiblein *et al.*, 2020). Diagnostic characteristics of the specimens were measured following Uiblein (2011) for *Mulloidichthys* species, Randall and Heemstra (2009) for *Parupeneus* and Uiblein *et al.* (2020) for *Upeneus*. Measurements were made using a digital calliper (Insize 1108-150) and recorded to the nearest 0.01mm. Nomenclature and taxonomical details were referred from Eschmeyer's Catalog of Fishes (Fricke *et al.*, 2022).

Results and discussion

Sampling was conducted at two centres on the northwest coastline of India, seven centres on the southwest coastline, three centres on the southeast coastline and one on the northwest coastline. The highest diversity was observed in the genus *Upeneus* with six species followed by the genus *Parupeneus* with five species and *Mulloidichthys* with three species. Examining the coastline diversity, the west coast showed diversity with 13 species followed by the east coast with eight species. Seven species were common to both coasts.

Genus Mulloidichthys Whitley 1929

The genus is characterized by two or more rows of teeth on the jaws; vomer and palatines lack teeth. First dorsal fin

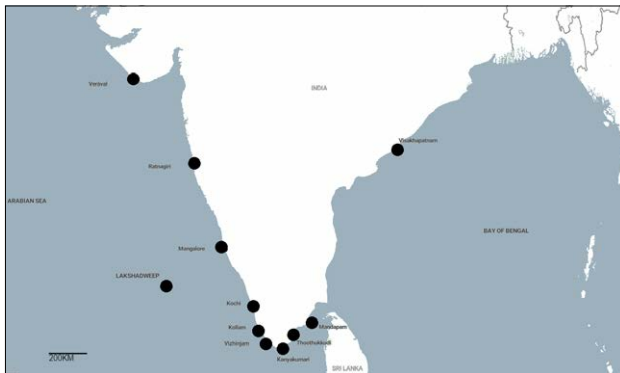


Fig. 1. Map showing sampling locations.

with eight spines; lateral line complete; body oblong and slightly compressed. Fresh specimens of most species contain body stripes.

Genus *Mulloidichthys* is reported to be widely distributed across the tropical reef waters of the Atlantic, Indian and Pacific Oceans (Bray *et al.*, 2007). Of the seven valid species only four are known to the Indo-Pacific region; *M. ayliffe*, *M. flavolineatus*, *M. pfluegeri* and *M. vanicolensis* (Uiblein, 2011; Keita *et al.*, 2016). All four species reported are common to Indian waters (Thomas, 1969; Koya, 2007; Uiblein, 2011; Rajan *et al.*, 2012; Nair and Kuriakose, 2014). In the present study, three species of *Mulloidichthys* *i.e.* *M. ayliffe* (Fig. 2), *M. flavolineatus* (Fig. 3) and *M. vanicolensis* (Fig. 4) were collected from Lakshadweep Island (Table 1).

Mulloidichthys ayliffe Uiblein, 2011: Body yellowish to orange; fins yellow; body and head with two to five bluish lateral



Fig. 2. *Mulloidichthys ayliffe* Uiblein, 2011



Fig. 3. *Mulloidichthys flavolineatus* (Lacepède, 1801)



Fig. 4. *Mulloidichthys vanicolensis* (Valenciennes, 1831)

Table 1. List of goatfishes recorded from the west and east coast of India

Genus	Species	West coast /(State)	East coast/(State)
<i>Mulloidichthys</i>	<i>Mulloidichthys ayilffe</i> Uiblein, 2011		
	<i>Mulloidichthys flavolineatus</i> (Lacepède 1801)	Lakshadweep	-
	<i>Mulloidichthys vanicolensis</i> (Valenciennes, 1831)		
<i>Parupeneus</i>	<i>Parupeneus barberinus</i> (Lacepède, 1801)	Lakshadweep	-
	<i>Parupeneus cyclostomus</i> (Lacepède 1801)	Mangalore (Karnataka)	-
	<i>Parupeneus heptacanthus</i> (Lacepède, 1802)	Kochi, Kollam (Kerala); Thengapattanam (Tamilnadu)	Kanyakumari, (Tamil Nadu)
	<i>Parupeneus indicus</i> (Shaw, 1803)	Kochi (Kerala); Lakshadweep	Kanyakumari, Mandapam, Tuticorin (Tamil Nadu); Visakhapatnam (Andhra Pradesh)
	<i>Parupeneus macronemus</i> (Lacepède 1801)	-	Tuticorin (Tamil Nadu)
<i>Upeneus</i>	<i>Upeneus guttatus</i> (Day, 1868)	Kochi, Kollam (Kerala); Mangalore (Karnataka); Thengapattanam, (Tamilnadu)	Kanyakumari, Mandapam, Tuticorin (Tamil Nadu)
	<i>Upeneus margarethae</i> Uiblein and Heemstra, 2010	Kochi (Kerala)	Kanyakumari, Mandapam, Tuticorin (Tamil Nadu)
	<i>Upeneus moluccensis</i> (Bleeker, 1855)	Kochi, Kollam (Kerala); Mangalore (Karnataka); Ratnagiri (Maharashtra); Veraval (Gujarat)	Tuticorin (Tamil Nadu); Visakhapatnam (Andhra Pradesh)
	<i>Upeneus sulphureus</i> Cuvier, 1829	Kochi, Kollam, Vizhinjam (Kerala)	Mandapam, Tuticorin (Tamil Nadu)
	<i>Upeneus tragula</i> Richardson, 1846	Kochi (Kerala); Colachel (Tamilnadu)	Kanyakumari, Mandapam, Tuticorin (Tamil Nadu)
	<i>Upeneus vittatus</i> (Forsskal, 1775)	Kochi, Vizhinjam (Kerala)	-

body stripes extending to the posterior part of second dorsal fin; two to three yellow stripes between blue stripes; ventral body and barbels white; pectoral fin with 16 -17 rays; lateral line scales 35-37.

Mulloidichthys flavolineatus (Lacepède 1801): Body silvery white, head silvery white sometimes yellowish; a yellow mid-lateral body stripe from upper lip to through eye to below caudal origin; below first dorsal fin base, a black oval to rectangular blotch sometime not clearly visible at yellow mid-lateral body stripe; barbels white; fins white to yellowish; anal and pelvic fin transparent; pectoral fin with 15-18 rays; lateral line with 34-38 scales.

Mulloidichthys vanicolensis (Valenciennes, 1831): Body with a single straight yellow mid-lateral body stripe from eye to caudal-fin base; body silvery-white dorsally; white coloured barbels; yellow coloured caudal and dorsal fins; pectoral fin

with 15-17 rays; lateral line with 36-38 scales. This species was collected from Lakshadweep.

Genus Parupeneus Bleeker 1863

The genus *Parupeneus* is characterized by a toothless palate with a single layer of prominent bluntly conical teeth on the jaws. Body brightly coloured; caudal fin usually without bars or dark-coloured markings; first dorsal fin with eight rays; pectoral fin rays 14-18; lateral line scales 27-28. *Parupeneus* (Uiblein and Causse, 2013) is usually seen below 100 m depth. *Parupeneus* is the second largest genus of Family Mullidae of Indian waters. They are known only from the Indo- Pacific region (Randall and King, 2009) with 35 valid species (Froese and Pauly, 2022). Ten species: *P. barberinus* (Lacepède 1801), *P. ciliatus* (Lacepède 1802), *P. cyclostomus* (Lacepède 1801), *P. heptacanthus* (Lacepède 1801), *P. indicus*

(Shaw 1803), *P. macronemus* (Lacepède 1801), *P. minys* Randall and Heemstra 2009, *P. multifasciatus* (Quoy and Gaimard 1825), *P. pleurostigma* (Bennett 1831), *P. trifasciatus* (Lacepède 1801) have been reported from the Indian waters (Day (1889); Thomas (1969); Randall (2004); Randall and Heemstra (2009); Rajan *et al.* (2012).

In the present study five *Parupeneus* species have been recorded from different sampling locations (Table 1) includes *Parupeneus barberinus* (Lacepède, 1801) (Fig. 5), *P. cyclostomus* (Lacepède 1801) (Fig. 6), *P. heptacanthus* (Lacepède, 1802) (Fig. 7), *P. indicus* (Shaw, 1803) (Fig. 8) and *P. macronemus* (Lacepède 1801) (Fig. 9).

***Parupeneus barberinus* (Lacepède, 1801):** Whitish body with a black stripe from upper lip through eye towards the posterior part of the second dorsal fin, stripe darker in dorsal fin region; a black spot on the mid-base of caudal fin;



Fig. 5. *Parupeneus barberinus* (Lacepède, 1801)



Fig. 6. *Parupeneus cyclostomus* (Lacepède 1801)



Fig. 7. *Parupeneus heptacanthus* (Lacepède, 1802)

body ventrally whitish; dorsally yellowish; barbels whitish; pectoral rays 17.

***Parupeneus cyclostomus* (Lacepède 1801):** Yellowish grey body; upper caudal peduncle with yellow spot covering; caudal, second dorsal and anal fin with an alternate yellow and blue band; barbels: very long and white and; pectoral rays 16.

***Parupeneus heptacanthus* (Lacepède, 1802):** Brownish yellow to light red coloured body dorsally and silvery white ventrally; adults have a small reddish spot on the body below the first dorsal fin and lateral line scale. Barbels white; pectoral fin 16; lateral line scales 27-28.

***Parupeneus indicus* (Shaw, 1803):** Body with a round black spot on the side of caudal peduncle; a large elongated yellow/white spot along the lateral line below inter-dorsal space; barbels white in colour. Pectoral rays 16; lateral line scales 28.

***Parupeneus macronemus* (Lacepède 1801):** Body red coloured; a black body stripe starts from the eye through the lateral line and moves towards the caudal peduncle; round black spot on the side of caudal peduncle; barbels white; first dorsal fin reddish; second dorsal fin with black colour on the one- half of base which extends to last ray tip. Pectoral rays 16.

Genus *Upeneus* Cuvier 1829

Most of the species of the genus *Upeneus* occur in shallow depths of less than 100 m (Uiblein and Heemstra, 2010).



Fig. 8. *Parupeneus indicus* (Shaw, 1803)



Fig. 9. *Parupeneus macronemus* (Lacepède 1801)

Upeneus can be distinguished from other genera by having teeth on jaws, vomer and palatine (Lachner, 1954; Thomas, 1969; Golani, 2001). Teeth form a triangular patch on the vomer and an elongated band on the palatine. The body is brightly coloured with stripes; caudal fins with bars in most of the species. First dorsal fin with 7-8 spines; pectoral fin rays 12-17; lateral line complete; scales on lateral line 28-39. Forty-two valid species (Uiblein *et al.*, 2017, 2019, 2020) have been reported worldwide; In India, around 14 species have been reported; *U. guttatus* (Day 1868); *U. heemstra* Uiblein and Gouws 2014; *U. indicus* Uiblein and Heemstra 2010; *U. japonicus* (Houttuyn 1782); *U. luzonius* Jordan and Seale 1907; *U. margarethae* Uiblein and Heemstra 2010; *U. moluccensis* (Bleeker 1855); *U. oligospilus* Lachner 1954; *U. sulphureus* Cuvier 1829; *U. sundaicus* (Bleeker 1855); *U. supravittatus* Uiblein and Heemstra 2010; *U. taeniopterus* Cuvier 1829; *U. tragula* Richardson 1846; *U. vittatus* (Forsskål 1775) (Thomas, 1969; Kumaran and Randall,

1984; Vivekanandan *et al.*, 2003; Uiblein and Heemstra, 2010; Rajan *et al.*, 2012; Uiblein and Gouws, 2014; Uiblein *et al.*, 2019).

In the present study, six species were collected from the east and west coasts of India (Table 1): *U. guttatus* (Fig. 10); *U. margarethae* (Fig. 11); *U. moluccensis* (Fig. 12); *U. sulphureus* (Fig. 13); *U. tragula* (Fig. 14); *U. vittatus* (Fig. 15).

***Upeneus guttatus* (Day, 1868):** Body white laterally and ventrally; small red pigmentation above lateral line; caudal fin with reddish bars; barbels usually yellow; pectoral fin rays 13. Lateral line scales 28-31.

***Upeneus margarethae* Uiblein and Heemstra, 2010:** Body with red colour above the lateral line and white ventrally; lateral body with small red dots; red bars on caudal fin; barbels white; pectoral fin rays 14; lateral line scales 28-30.



Fig. 10. *Upeneus guttatus* (Day, 1868)



Fig. 13. *Upeneus sulphureus* Cuvier, 1829



Fig. 11. *Upeneus margarethae* Uiblein & Heemstra, 2010



Fig. 14. *Upeneus tragula* Richardson, 1846



Fig. 12. *Upeneus moluccensis* (Bleeker, 1855)



Fig. 15. *Upeneus vittatus* (Forsskål 1775)

***Upeneus moluccensis* (Bleeker, 1855):** Body with a prominent yellow mid-lateral body stripe; bars present on upper caudal fin lobe and lacks on lower lobe; barbels white; body white ventrally; pectoral fin rays 14-16; lateral line scale 33-36.

***Upeneus sulphureus* Cuvier, 1829:** Body with two yellow lateral body stripes; body white ventrally; caudal fin without bars; tip of the first dorsal fin pigmented black; barbels white. Pectoral fin rays 15-17; lateral line scales 33-37.

***Upeneus tragula* Richardson, 1846:** Body with a brown mid-lateral body stripe; irregular dark spots are seen below body stripe; barbels yellow; caudal fin with dark brown or black bars. Pectoral fin rays 13; lateral line scale 28-30.

***Upeneus vittatus* (Forsskål 1775):** Body dorsally with two prominent yellow or pale brown mid-lateral body stripes; white ventrally; the tip of first dorsal fin black; caudal fin bars with pale brown or black; the distal-most lobe of the lower fin has the widest black bar. Pectoral fin rays 15-16; lateral line scales 36-38.

The specimens collected were analyzed and their morphometric and meristic data were recorded. The details and locations of the fish collected are provided in Table (1).

In the present study, 14 species in three genera were collected compared to Thomas (1969) who reported 19 species in three genera. Diversity studies of goatfishes across the maritime states revealed a higher abundance of genus *Upeneus* along both coasts of India. *Upeneus sulphureus* and *U. moluccensis* were available throughout the coast, while *U. guttatus* was more common along the southwest coast. Of the species recorded in the genus *Parupeneus*, *P. indicus* and *P. heptacanthus* dominated from both coasts of India. Genus *Mulloidichthys* was collected only from Lakshadweep.

Conclusion

This study conducted within a limited period shows that 14 species in three genera were recorded during the study along the Indian coast. Of this 13 species were recorded on the west coast and eight species were recorded on the east coast. Of the 13 species on the west coast, three genera with one genus and one species were recorded from the northwest and 13 species in three genera from southwest coast. Of the eight species in two genera recorded from the east coast, three species were from two genera from the northeast coast and eight species from two genera from southeast coast (Table 2). Seven species in two genera (*Upeneus* and *Parupeneus*) were common to both coasts. The common species were *Parupeneus heptacanthus*, *P. indicus*, *P. macronemus*, *Upeneus guttatus*, *U. margarethae*,

Table 2. Number of species recorded from different Coastal regions of India

Coastal regions	Total no. of Species	No. of species recorded from each genus		
		<i>Mulloidichthys</i>	<i>Parupeneus</i>	<i>Upeneus</i>
Northwest	1	1	-	-
Southwest	13	3	4	6
Northeast	3	-	1	2
Southeast	8	-	3	5

U. moluccensis, *U. sulphureus* and *U. tragula*. Thomas (1969) has also reported these species from both the coast. The goatfishes are suitable habitat indicators and can be used in the monitoring and management of the ecosystem (Uiblein, 2007; Rajan *et al.*, 2012). This study was of a limited time and is a preliminary study showing that there is a need to further explore the mullid diversity across Indian waters and to study taxonomy, distribution pattern, abundance and biology and ecology.

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