

Diversity record of family mugilidae (cuvier, 1829) from estuary of Sabarmati river, Gujarat, India

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Abstract

Mulletts are the fishes of family Mugilidae belong to order Actinopterygii, which lives in coastal and marine habitats. These fishes are also found in coastal lagoons, rivers, and estuaries. Mulletts occupy a comparatively low position in the food web and are thus relatively efficient secondary producers of protein. They are situated at the base of the food pyramid due to their nature of consumption on particulate organic matter, detritus, and benthic microalgae. They are able to make high-quality fish protein available to top predators. Mulletts are highly consumable fish in coastal regions of Gujarat. The taxonomy and systematics of the mullet requires much attention due to its ecological and commercial importance. Mulletts have two widely separated dorsal fins, which is the prominent morphological identification character. They are medium to large-sized fishes, with the sub-cylindrical body; head often broad and flattened dorsally. Present study revealed vital information on the taxonomy and diversity of the mulletts from Sabarmati estuary, Gujarat. The identification of fresh specimens was carried out and three species were identified as *Mugil cephalus*, *Chelon planiceps*, and *Rhinomugil corsula*. This paper also records the range extension of *R. corsula* from the western coast of India. The paper emphasizes the importance of further research in family Mugilidae for a better understanding of its distribution, ecology, and physiology for aquaculture point of view as species of this family are highly consumable due to its nutritive values.

Keywords: Mullet, *Rhinomugil corsula*, Range extension, Nutritive value, Taxonomy, Morphology

1 Introduction

The Mulletts - members of Family Mugilidae (Class: Actinopterygii) are one of the most ubiquitous teleost families in coastal waters of most temperate, sub-tropical and tropical waters in both

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hemispheres of the globe. They are found in coastal marine waters, hypersaline to brackish-water lagoons, estuaries and freshwater (Crosetti and Blaber 2015), where the benthos is enriched with organic matter (Blaber and Whitfield 1977; Odum, 1970; Cardona, 2006). Mulletts have extraordinary adaptabilities which help them to survive in pristine waters of coral reefs to highly turbid estuarine and fresh waters. Some species can even survive in some of the most polluted waters in the world, e.g. in the harbour at Visakhapatnam in India (Blaber, 2000). In the world, first known reference of the grey mullet comes from the Mediterranean, since the people of the Ancient Greek and Rome used as an important nutritional resource (Thompson, 1947). Aristotle had described the life history of different species of grey mullets in his work 'The history of Animals' (second half of the 4th century BC). He used the name '*kefalos*' which means 'head' for *Mugil cephalus*, '*kestrefs*' for *Liza ramada*, '*myxinos*' for *L. aurata* and '*chelon*', focusing on the big lips, for *Chelon labrosus* (Thompson, 1947; Koutrakis, 1999). After that, Linnaeus had described *M. cephalus* in his 'Systema Naturae' in 1758.

Different species of mulletts consists some common morphological features, however they adapted some specialized features. The mouth is terminal or sub-terminal in most mullet species (Thomson, 1966; Drake et al., 1984), but in the genera *Agonostomus*, *Rhinomugil* and *Joturus* - it is inferior, being overhung by a fleshy snout (Thomson, 1966). The premaxilla is protrusible in all species due to the internal hook of the maxilla which forces the premaxilla outwards (Thomson, 1954). In mulletts, usually the adult females are greater than the males, however, they do not show sexual dimorphism. Sexes can be distinguishing in the breeding season as females carry eggs thus the portion of the abdominal region become bulgy. An extensive revision of the genera of Mugilidae done by Schultz (1946) in which he paid attention to the taxonomic importance of mouth parts, position of the mouth (inferior or terminal), the relative thickness of the lips, the nature of the upper attachment of the maxilla and the curvature and degree of exposure of the posterior angle of the maxilla (Figure 5). Shen and Durand (2016) reported 71 species belonging to 20 genera in Indo-Pacific and Australian waters. They also reported a total of 31 species and 10 genera are present in the India and South-East Asia.

In India, common species of southern Indian mulletts were recorded by Day (1865, 1888) and a more detailed report was made by Whitehouse (1922). Joshi et al., (2018) reported 18 species belonging to the seven genera from the Indian coastal waters. Studies on the taxonomy and diversity of the mulletts from the western coast of India are very insufficient specially from Gujarat (Ansar et al., 2017; Bijukumar et al., 2000; Barve et al., 2003; John, 1955). It is extensively used for feeding purpose in India and having nutritional values (Brahmane et al., 2014; Joshi et al., 2018; Saravanakumar et al., 2009). There are no such observations on mulletts found from the Gulf of Cambay which is having major and diverse estuarine ecosystems except Narmada Estuary (Bhakta, 2019). Therefore, present study was conducted to understand the taxonomic and diversity status of the mulletts from the estuary of Sabarmati River, Gujarat.

2 Materials and Methods

Sabarmati River is one of the four major rivers of Gujarat consists one of the 13 noteworthy rivers basins of India with catchment zone of more than of 20,000 km² which is nearly 0.66% of the total geographical area of the India (Jain et al., 2007). It originates from the Aravalli hills and enters into the Arabian sea through Gulf of Cambay. It consists around 35 km long stretch of the estuarine zone from the mouth of Sabarmati river. Samples were collected from the seven on-shore villages of the Sabarmati estuary with the cooperation of local fishermen (Figure.1). Fresh specimens were

preserved in 10% formaldehyde and transported to the laboratory at the Department of Zoology, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara.

Morphological identification was carried out and meristic characters were recorded. The shape of the mouth parts, position of the eye, nature of the maxilla and presence or absence of adipose eyelids and degree of its intrusion over the eyes were recorded (Thomson, 1997). Apart from these, count of lateral and transverse line scales, number of total fin rays and spines of all fins, position of the nostrils, numbers of the branchiostegal rays were recorded. The number of scales of the lateral line has been counted from behind the head and immediately above the insertion of the pectoral fin to the caudal fork (Day, 1888; Thomson, 1997). Seventeen morphometric characters (Table. 1) viz. total length (TL), standard length (SL), fork length (FL), eye diameter (ED), pre-orbital length (POL), head length (HL), body depth (BD), pre-dorsal length (PDL), pre-pectoral length (PPL), pre-ventral length (PVL), pre-anal length (PAL), peduncle length/distance between caudal and anal fins (PL/DCA), caudal peduncle height (CPH), distance between dorsal and caudal (DDC), distance between dorsal and anal (DDA), length of pectoral fin (LPF), basal length of anal fin (BLAF). Standard length was measured from the tip of the snout to the caudal fork (Crosetti and Blaber 2015). The measurements were taken by using normal centimetre scale, fine pointed divider and forceps to the nearest cm. Roman numerical indicates the number of spines and Arabic numerical indicates number of rays in fins. To observe the changes in morphometric characters, specimen of all three species were selected almost equal in size from the collection.

Abbreviations: BR: Branchiostegal Rays, D1: First dorsal, D2: Second dorsal C: Caudal, A: Anal, V: Ventral, P: Pectoral, L: Lateral line, tr: Transverse line.

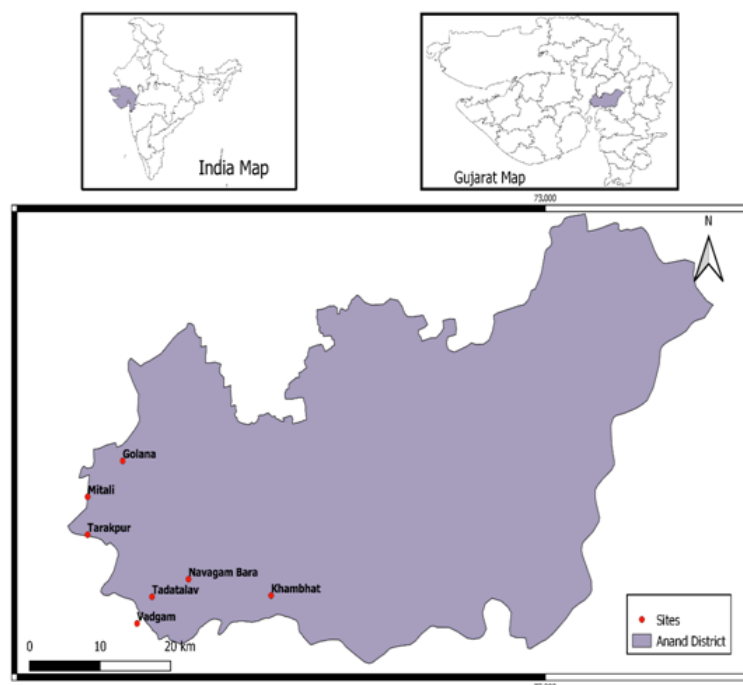


Figure 1. Study site map: India, Gujarat state, Anand district, Sabarmati Estuary: Villages viz. 1) Golana 2) Mitali 3) Tarakpur 4) Tadatalav 5) Vadgam 6) Navagam Bara 7) Khambhat..

3 Results

The present study reports three species of family Mugilidae from Sabarmati estuary viz. (I) *Mugil cephalus* (Figure.2) (II) *Rhinomugil corsula* (Figure.3) (III) *Chelon planiceps* (Figure.4). Present study also revealed the range extension of the *R. corsula* species as it was only reported from the Narmada estuary earlier (Bhakta, 2019).

Syatematics:

Class: Actinopterygii

Division: Teleostei

Sub-Division: Euteleostei

Super-Order: Acanthopterygii

Order: Mugiliformes

Family: Mugilidae (Cuvier,1829)

(I) *Mugil cephalus* (Linnaeus, 1758)

Diagnosis. BR 6, D1 iv, D2 i/8, C 15, A iii/9, V i/5, P 16, L 42-44, tr 14. Body slender, cylindrical, compressed at posterior; head with no scales in front of anterior nostrils; scales cycloid type; interorbital region flattened; eye diameter larger than pre-orbital length; adipose eyelid covering entire eye; upper lip comparatively thin; anterior nostril situated below and nearer to the upper lip, posterior nostril situated above the level of the upper rim of the eye; maxilla straight; pad at mouth corner; posterior tip not curved; inferior mouth; anal fin longer than the second dorsal fin; body depth comparatively less; caudal peduncle height comparatively small.

Colouration. Light olive colour at dorsal side, ventral and lateral side silvery, lateral side consists stripes, pelvic fins pale yellowish and rest fins dusky.

IUCN category: Least concern (LC).

Common name: Flathead grey mullet.

Vernacular name: Boi, Gandhiyo (in Gujarati).

Habitat. Saltwater and Brackish water. Sometimes enters into freshwater body.

Distribution. Cosmopolitan in distribution from warm temperate to tropical seas (Crosetti and Blaber (2015).

(II) *Rhinomugil corsula* (Hamilton, 1822)

Diagnosis. BR 6, D1 iv, D2 i/8, C 17, A iii/9, V i/5, P 13, L 48-45, tr 16. Body slender, elongated; blunt pointed head; ctenoid scales; V-shaped mouth, upper lip overhang; interorbital slightly longer than eye diameter, eye diameter and snout almost equal; mouth corner extended up to mid-eye; both nostrils below level of lower edge of eye, anterior nostril almost 1/3 distance from eye to snout tip, posterior nostril vertically parallel to anterior edge of eye; posterior nostril comparatively nearer to eye than anterior nostril to lip; prominent raised cutaneous rim around anterior nostril; pectoral fin reaching up to mid eye when extended anterior side; second dorsal arises comparatively far behind the origin of the anal fin, anal and second dorsal fins equal in size.

Colouration. Anterior dorsal side light olive, whitish at abdomen and caudal area grey in colour. Pectoral fin pale yellow while rest fins dusky in colour.

IUCN category: Least concern (LC).

Common name: Corsula.

Vernacular name: Boi, Dokari (in Gujarati).

Habitat. Freshwater inhabitant mainly and brackish water.

Distribution. India, Bangladesh, Myanmar, Nepal (Rahman 1989).

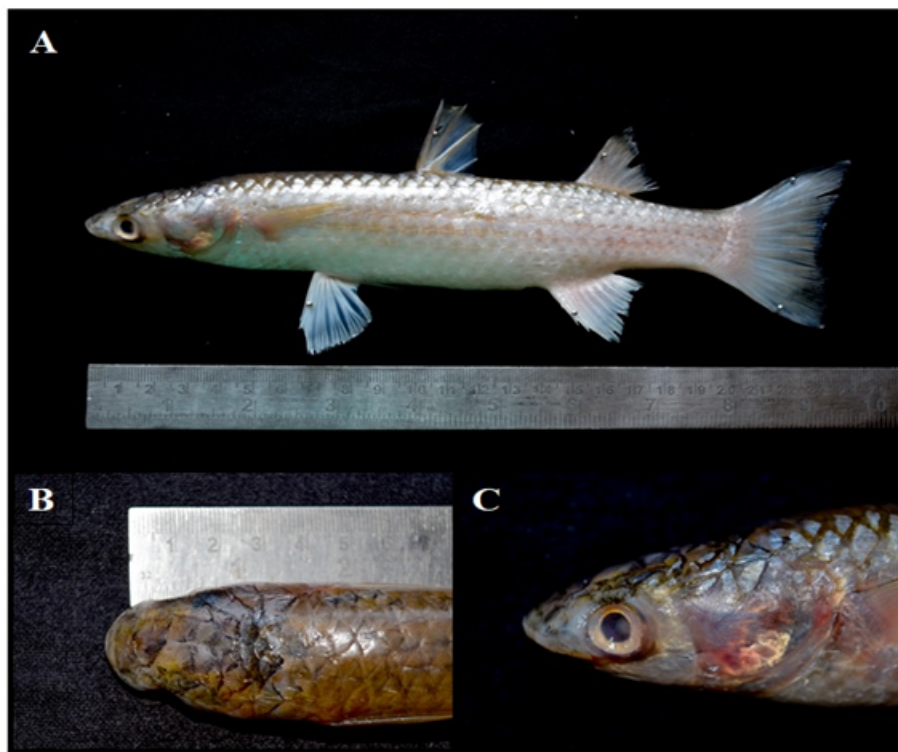


Figure 1. *Mugil cephalus*: (A) Specimen examined in laboratory, (B) Head dorsal view, (C) Head lateral view.

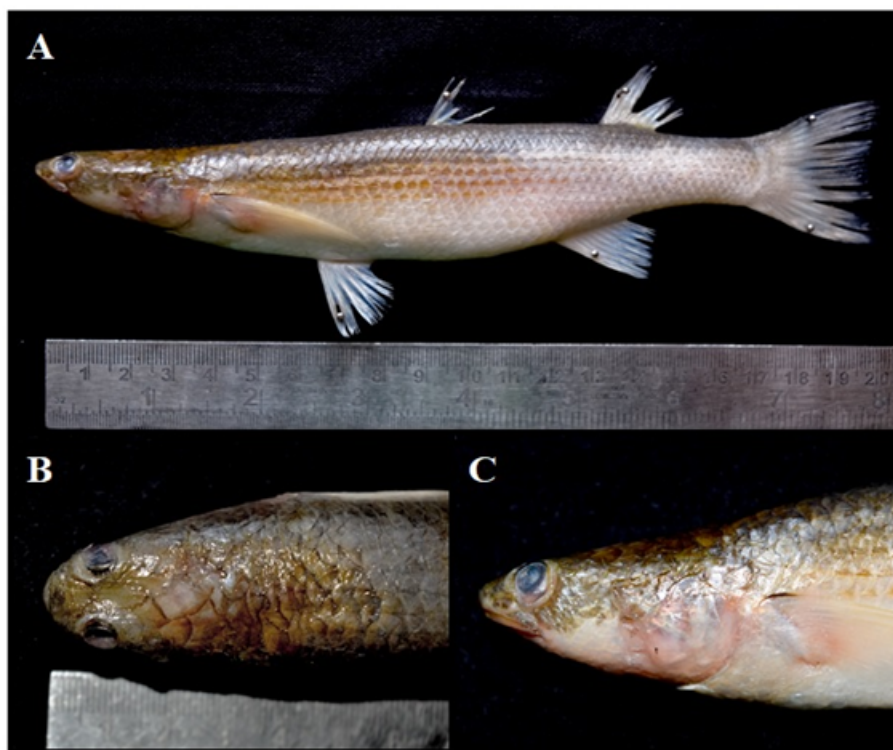


Figure 1. *Rhinomugil corsula*: (A) Specimen examined in laboratory, (B) Head dorsal view, (C) Head lateral view - maxillary tip extended up to middle of the eye.

(III) *Chelon planiceps* (Valenciennes, 1836)

Diagnosis: BR 6, D1 iv, D2 i/9, C 17, A iii/9, V i/5, P 15, L 36-38, tr 12. Body subcylindrical, elongated; body depth comparatively much more; pointed head, depressed upper profile; ctenoid scales; interorbital flat and twice to eye diameter; adipose tissue obsolescent; mouth corner vertically parallel to posterior nostril and slightly curved downwards; terminal mouth; tip of the upper jaw reaching vertical between posterior nostril and anterior edge of eye; nostrils equidistance from each other and from eye and lip; dorsal and anal fins almost equal in size; body depth much longer; first dorsal fin origin nearer to snout tip than to caudal fin base.

Colouration. Pale yellow on dorsal side with dark olive on head, ventral side silvery and fins dusky, presence of dark stripes.

IUCN category: Data deficient

Common name: Tade grey mullet

Vernacular name: Boi (in Gujarati).

Habitat. Saltwater and brackish water.

Distribution. Indian ocean to West Pacific, Red sea to Australia, Philippines, China, the Marianas and Guam (Thomson, 1997).



Figure 4. *Chelon planiceps*: (A) Specimen examined in laboratory, (B) Head dorsal view, (C) Head lateral view - curved maxillary tip.

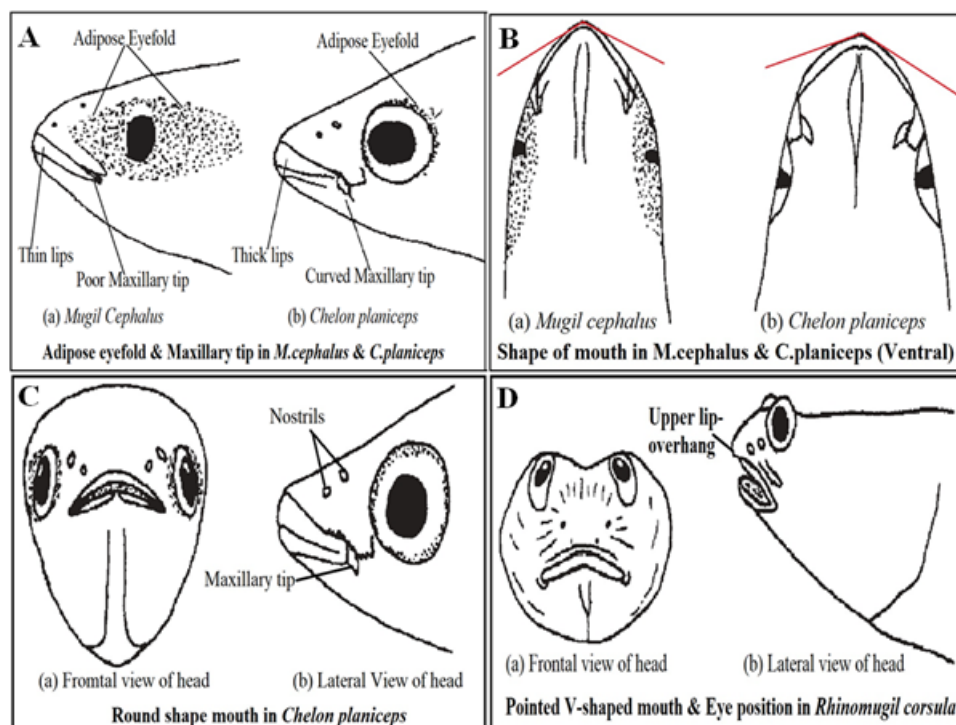


Figure 5. (A) *Mugil cephalus* and *Chelon planiceps* - Adipose eyelid, (B) *Mugil cephalus* and *Chelon planiceps* - Mouth Shape, (C) *Chelon planiceps* - Shape of Mouth, (D) *Rhinomugil corsula* - Structure of Head (Barve et al., 2003).

Table 1. Morphometric analysis (cm) of mullets recorded from Sabarmati estuary, Gujarat.

| Characters | <i>Mugil cephalus</i> | <i>Chelon planiceps</i> | <i>Rhinomugil corsula</i> |
|------------|-----------------------|-------------------------|---------------------------|
| TL | 24.6 | 20.6 | 22.1 |
| SL | 20.2 | 16.5 | 18.7 |
| FL | 3.7 | 3 | 2.6 |
| ED | 2.1 | 0.9 | 0.4 |
| POL | 1.2 | 1.1 | 0.8 |
| HL | 4.7 | 4.2 | 4.1 |
| BD | 4.6 | 4.4 | 4.7 |
| PDL | 10.5 | 8.7 | 9.2 |
| PPL | 4.8 | 4.2 | 4.5 |
| PVL | 7.3 | 6.2 | 7 |
| PAL | 14.2 | 11.8 | 12.3 |
| PL/DCA | 4.1 | 3.2 | 3.8 |
| CPH | 2.2 | 2.3 | 2.2 |
| DDC | 10.1 | 6.5 | 2.6 |
| DDA | 6.3 | 5.2 | 5.5 |
| LPF | 3.2 | 2.7 | 4.1 |
| BLAF | 2.3 | 2 | 2.1 |

4 Discussion

In the present study, it was observed that all three species having distinguish morphological features with major changes in head region. In *Mugil cephalus*, head is broad and flattened from orbital gap to upper lip (Fig. 2B) while in *Chelon planiceps*, it was flattened at interorbital space and bent after anterior nostril to upper lip and depressed (Fig. 4B). In *Rhinomugil corsula*, interorbital gap is small and snout is somewhat upwards with overhang upper lip which creates slightly convex surface of the snout (Fig. 3B). Crosetti and Blaber (2015) proposed that the head as a whole is an informative organ from the taxonomic point of view. They further added that the wide variation in shape and relative size can be observed amongst the species of Mugilidae such as head is often broad and flattened or gently convex dorsally. The positional relationship and form (shape, size) generates a variety of head shapes such as eye diameter, position of nostrils, and distance from respective body parts (Fig. 5).

The presence of adipose membrane was considered as a good taxonomic character and commonly used to differentiate between genera (Fig. 5) (Jordan and Swain, 1884; Whitehouse, 1922; Oshima, 1922; Smith, 1948; Thomson, 1954). Present study suggests that in *M. cephalus* adipose eyelid is present with broad elongated anterior and posterior adipose lids (Fig. 2C) while *C. planiceps* consists obsolescent eyelid covering up to the iris (Fig. 4C). In *R. corsula* adipose eyelids are present, eyes elevated and their upper margin being above the level of the inter-orbital space (Fig. 3C). The position of lips has been considered as a useful character by Pillay (1962) in separating *Rhinomugil* from *Mugil*. Present study reported that the upper lip of *M. cephalus* is thin and without papillae whereas (Fig. 2A) in *C. planiceps* the upper lip forms the end of the snout and it has moderate thickness (Fig. 4A). *R. corsula* consist angular mouth with thick upper lip and overhang to scratch algae from rocky substratum (Fig. 3A).

In present study, it was found that the premaxilla is straight but shorter, not extending below corner of mouth in the species *M. cephalus* (Fig. 2C). In *C. planiceps*, it is curved, longer and distinctly extends below the corner of mouth (Fig. 4C) while in *R. corsula* it reaches up the middle of the eye vertically (Fig. 3C). The visibility or otherwise of the end of maxilla when mouth is closed has been used as an important character in the description of grey mullets (Fig. 5) (Schultz, 1946; Thomson, 1997; Fischer and Bainchi, 1984). Present study shows that the maxillary tip is distinctly exposed and posterior tip is slightly curved only in species of *C. planiceps* where in it can be seen easily even in lateral view (Fig. 5A). Its visibility is poorest and posterior tip not curved down in *M. cephalus* while in *R. corsula* it reaches to below the middle of eye (Fig. 5D) (Table-3, Fig.3C).

5 Conclusion

This study reveals the complexity of the mullets found in this region and provided a baseline authenticated data on Mugilidae taxonomy. As per literary sources, Mugils are being utilized tremendously as a part of estuarine aquaculture fisheries in many parts of the world and in India specially in Kerala, Tamilnadu and West-Bengal due to their nutritional values. However, such an aquaculture practice for the same has not been developed in Gujarat and most part of the West Coast of India. Also, Sabarmati estuary is dealing with pollution (Haldar et al., 2014; Kumar, 2011; Kumar et al., 2013). Thus, it affects the fishery business as local fishermen are not getting enough catch. Taxonomic study will be useful in exploring the area of further research on individual species regarding their aquaculture potential which can be beneficial for the science and human

being.

Conflict of interests

The authors declare that they have no conflicts of interest.

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