



Research Article

Present status and distribution of the family Syngnathidae at the Hooghly-Matlah estuarine system with some conservation aspects

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The Syngnathidae family, comprising of pipefishes, seahorses, and seadragons, frequently occurs in marine, estuarine, and occasionally in freshwater environments. The Hooghly-Matlah estuary in West Bengal, India, is characterised by tidal dynamics, a salinity gradient, and rich biodiversity, making it an ideal habitat for many fish species, including multiple syngnathid species adapted to brackish water environment. Sampling in the Hooghly-Matlah estuary system was carried out between 2021 and 2023, which encountered altogether three syngnathid species. Pipefishes are designated as Least Concern, while seahorses are listed as Vulnerable (VU) in the IUCN Red List. Syngnathids are largely used in trade, and because of their rapidly declining populations, several countries have prohibited their exports. Among the three species (*Hippichthys spicifer*, *Hippocampus trimaculatus*, and *Microphis cunocalus*), only one species (*Microphis cunocalus*) was barcoded, and the sequence is submitted to the GenBank with accession number OP090589.1. Even though some syngnathids live only in marine habitats, the Hooghly-Matlah estuary supports a few of these species; consequently, proper conservation plans and management measures should be implemented to ensure their long-term sustainability.

[**Keywords:** Conservation aspects, Distributional status, Hooghly-Matlah estuary, Natural habitat, Syngnathidae]

Introduction

Syngnathid fishes exhibit a global distribution, inhabiting coasts across the world, except for polar regions. They thrive in a range of environments, including estuaries, mangroves, seagrasses, coral and rocky reefs, as well as streams, lakes, and rivers. Seahorses and their relatives are fascinating fish that have captured human interest and admiration for centuries, making them valuable allies in modern conservation initiatives aimed at protecting aquatic ecosystems¹. A more comprehensive understanding of the conservation status of this group will facilitate the implementation of targeted conservation actions for diverse ecosystems. Successful conservation of syngnathid fishes requires a variety of actions in coastal regions, many of which face significant human influence¹.

The life cycle and behaviour of syngnathid fishes (pipefishes, seadragons, and pipehorses) make them sensitive to population decline², owing to their limited capacity for reproduction and specific environmental needs. The pipefishes are slender, elongated fishes that are distinguished by their fused jaws that form a tubular snout and, in certain species, the prehensile tail. Except for pipefishes, which vary between genera

in the form of their brood structure, the family Syngnathidae includes roughly 307 species from 54 genera of pipefishes, pipehorses, and seadragons having nearly identical life cycles^{3,4}. From India, altogether 22 syngnathid species from 11 genera are reported³, majority of which inhabit marine reefs. This group's distinguishing characteristics of male pregnancy, along with extended snouts, fused jaws, lack of pelvic fins, being encircled in bony rings, and being covered in thick plates of bony armour, have made them important model organisms for the study of sexual selection^{5,6}.

Syngnathids are bottom-dwelling predators that live on corals, macroalgae, mangroves, seagrasses, estuaries, lagoons, and open-bottom habitats⁷. Syngnathids are culturally, ecologically, economically, and therapeutically significant species⁸. They are well known for their extremely specialised morphology as well as their unusual reproductive practices, as 14 of the 54 reported taxa are monotypic in nature⁹. Male pregnancy is a distinct reproductive process that all these species share.

The pipefishes *Hippichthys spicifer* and *Microphis cunocalus* are categorised as Least Concern species on the IUCN Red List, while the seahorse *Hippocampus*

trimaculatus is listed as Vulnerable¹⁰. They are mainly captured as by-catch from trawlers and other similar gear in marine waters. Exports of syngnathids are limited to sustainable levels under the Convention on International Trade in Endangered Species (CITES) of wild fauna and flora because they are predominantly traded, and their populations are dwindling fast. Even though some syngnathid species only inhabit marine environments, the Hooghly-Matlah estuary supports a few of them; therefore, effective conservation plans and management techniques should be adopted to maintain these species' populations in estuarine systems.

Materials and Methods

Seasonal sampling (pre-monsoon, monsoon, and post-monsoon) of the fish assemblage pattern was conducted at ten separate stations in the Hooghly-Matlah estuary for two years from April 2021 to March 2023, namely Nabadwip, Balagarh, Birlapur,

Roychak, Kakdwip, Bakkhali, Sandeshkhali, Jharkhali, Gosaba, and Pathar Pratima. Only three of the ten designated sample sites, namely Balagarh, Kakdwip, and Jatirampur (Gosaba), all of which were characterised as having appropriate algae and mangrove habitats, yielded syngnathid specimens (Fig. 1). Fish samples have been collected from the various operational fishing gears. For experimental fishing, bag nets (5 – 10 mm code end mesh size), gill nets (20 – 40 mm mesh size), set-barrier nets (10 – 30 mm mesh size), shore seines (10 – 40 mm mesh size), and lift nets (10 – 40 mm mesh size) were utilised. The fish specimens were recognised as having the lowest taxonomic rank (species) based on the published literature and traditional taxonomic keys^{4,11-12}. Total genomic DNA was obtained using the procedure of Sambrook *et al.*¹³ and the phenol-chloroform-isoamylalcohol method. All the specimens were kept as voucher specimens at the ICAR-CIFRI museum. Water quality parameters were analysed

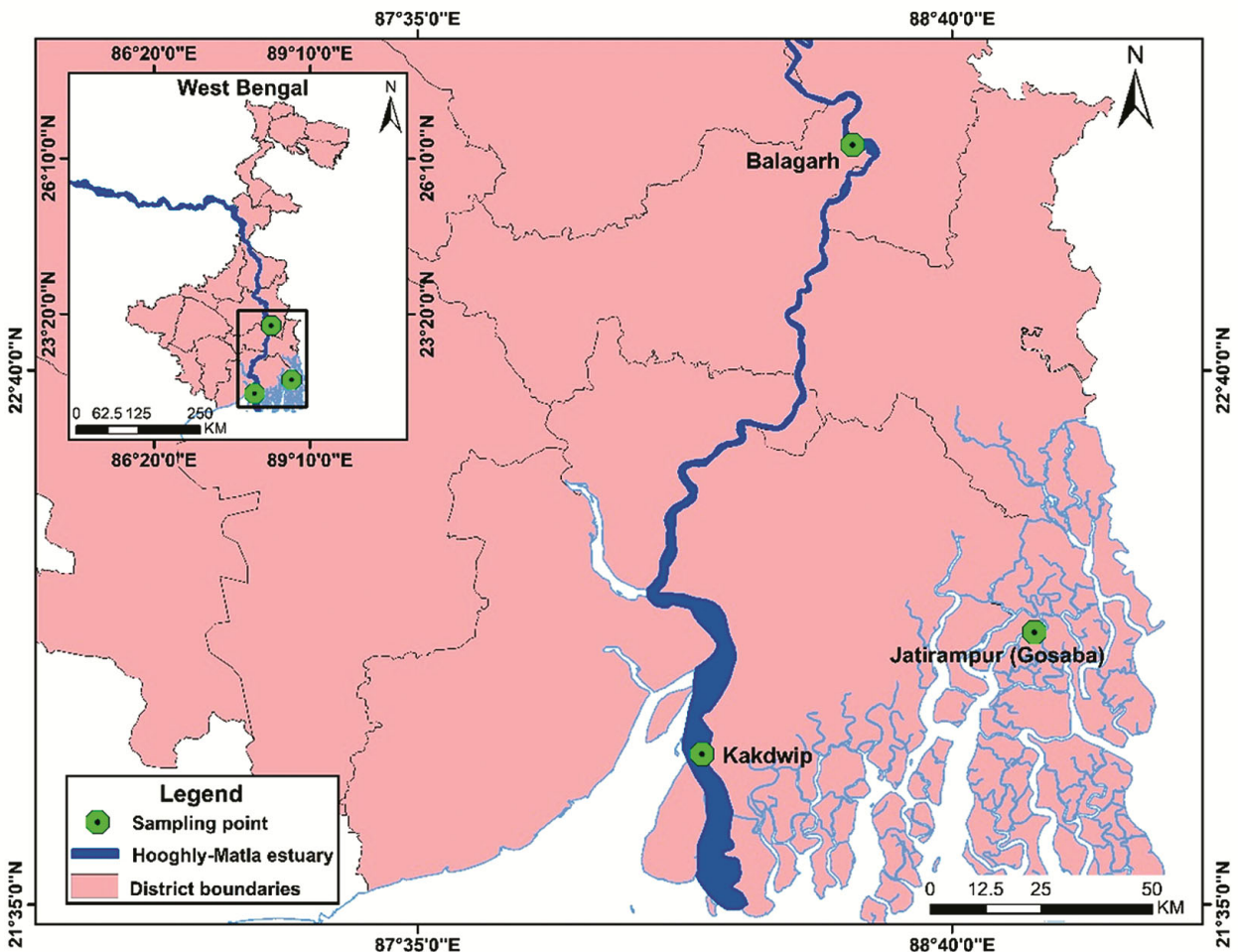


Fig. 1 — Map showing the collection sites of syngnathids from the Hooghly-Matlah estuarine system during 2021-2023

using known methods¹⁴ at the collection sites of the syngnathids. Parameters like water temperature, turbidity, pH, and salinity were measured using the multi-parameter analysis equipment AQUAREAD 7000. The digital depth sounder HONDEX PS-7 was used to measure the depth. Transparency was measured using a Secchi disc and DO was measured using titrimetric methods.

Results and Discussion

Three collected syngnathids were among the 217 finfish species reported during the three years of sampling at ten designated locations of the Hooghly-Matlah estuarine system. Stations such as Balagarh, Kakdwip, and Jatirampur (Gosaba) were found to be the habitats for these syngnathids. The detailed morphological features of syngnathids are provided below.

Hippichthys spicifer (Ruppell, 1838)

The genus *Hippichthys* belongs to the Syngnathinae (Herald, 1959) subfamily and is defined by the position of the brood pouch under the tail (tail-brooders). The lateral snout ridge, dorsal fin origin on or posterior to the second tail ring, and head length that is 6.9 to 10.3 times the standard length (8.0 times in the reported specimen) distinguish *Hippichthys spicifer*. The live specimen is brownish, mottled, or has prominent dark stripes that cross the lower half of the trunk's side and venter. The dorsal and pectoral fins are hyaline or brown-flecked and not heavily spotted; the caudal fin is brown with a short, light edge (Fig. 2b).

Hippichthys spicifer, also known as the bellybarred pipefish, is a tropical euryhaline demersal species found at depths ranging from 0 to 3 meters in marine, brackish, and freshwater. It can be found from the Red Sea and East Africa to Sri Lanka and Samoa in the Indo-Pacific area¹⁵. Adults of the species are frequently found in shallow coastal and estuarine waters, occasionally among mangroves, and in freshwater in the lower reaches of rivers¹⁶. A total of 3 specimens were collected at Kakdwip and Jatirampur with salinities ranging from 10.83 ± 0.16 to 31.50 ± 0.50 ppt, and depth from 6.9 ± 0.79 to 13.0 ± 0.5 m. Both locations were characterised by the presence of mangroves and could be good habitats for the bellybarred pipefish.

Microphis cunocalus (Hamilton, 1822)

The pipefish genus *Microphis* is found in both estuarine and freshwater environments and is a

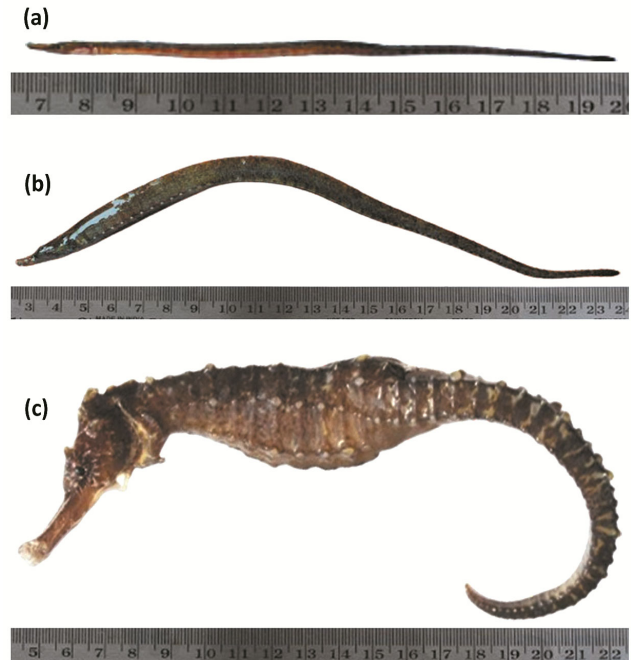


Fig. 2 — a) *Microphis cunocalus*, b) *Hippichthys spicifer*, and c) *Hippocampus trimaculatus* reported from the Hooghly-Matlah estuarine system

member of the Syngnathidae family. The genus is identified by the intersection of the lateral trunk ridge and the inferior tail ridge, the presence of nine caudal fin rays, and the presence of a brood pouch beneath the trunk¹⁷. *Microphis cunocalus*, often known as the Crocodile-tooth pipefish, is a potamodromous tropical demersal species widespread in Asia, including India, Bangladesh, and Sri Lanka¹⁸. *Microphis cunocalus* has an elongate, sub-cylindrical body with a tiny, terminal mouth (Fig. 2a). The head is 7.3 – 8.8 times longer than the standard length, and the snout is relatively deep, measuring 4.7 – 7 times the standard length. Dorsal fin rays 47 – 56, tail rings 24 – 27. The species live colouring is greenish above, filthy white below, with silvery eyes, a silvery opercle, and a reddish caudal fin. The species is widespread in the Indian states of West Bengal, Odisha, Tamil Nadu, Maharashtra, Goa, and Kerala¹¹. *Microphis cunocalus* is somewhat common in the Hooghly-Matlah estuary, although it has no commercial value. The DNA barcode was also generated, and the sequence has been deposited in GenBank under the accession number OP090589.1.

In the current investigation, two specimens were obtained from Balagarh sampling sites in a set-barrier net catch with a mean salinity of 0.04 ± 0.00 ppt, and depth of 6.9 ± 1.95 m. The collection sites were highly

macrophyte-vegetated areas that could safeguard the Crocodile-tooth pipefish.

***Hippocampus trimaculatus* Leach, 1814**

Hook-like cheek and eye spines, a low coronet, a thin skull, and the absence of a nose spine characterise *Hippocampus trimaculatus*¹⁹⁻²⁰. This species has 11 trunk rings, 39 tail rings, 19 – 20 soft dorsal rays, 4 soft anal rays, and no caudal fin. *Hippocampus trimaculatus* is a non-migratory, reef-associated marine species found at depths ranging from 0 to 100 meters². It is sold in the following countries: India, Cambodia, China (Hong Kong and Taiwan), Indonesia, Japan, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam^{4,21}.

Hippocampus fuscus, *Hippocampus histrix*, *Hippocampus kelloggi*, *Hippocampus kuda*, *Hippocampus trimaculatus*, and *Hippocampus mohnikei* have all been discovered in Indian waters²¹. *Hippocampus trimaculatus* is found on cluttered

gravel or sand bottoms near shallow reefs, muddy estuaries, and mangroves²². A list of syngnathid species available in Indian waters with their respective habitats and IUCN Red List status is provided in Table 1.

Two specimens of *H. trimaculatus* were collected from Kakdwip sampling sites from a bagnet catch with a mean salinity of 10.83±0.16 ppt, and at depth of 6.9±1.95 m. The collection sites were partly surrounded by mangroves, which are highly favourable for seahorse habitats.

The family Syngnathidae, which includes pipefishes and seahorses, contain around 307 marine, brackish, and freshwater species. All these species share the odd reproductive strategy of male pregnancy. The family Syngnathidae has 22 species spread across 11 genera in India, the bulk of which are associated with marine reefs. Most of the species in this family are vulnerable and in decline due to overfishing, habitat loss and degradation due to

Table 1 — List of Syngnathidae available in Indian waters with their respective habitats and IUCN Red List status (as per Froese & Pauly³)

Species name	Common name	Habitat	IUCN Red List Category	Max size recorded
<i>Bhanotia fasciolata</i> (Duméril, 1870)	Corrugated pipefish	Marine	LC	9.0 cm SL
<i>Choeroichthys brachysoma</i> (Bleeker, 1855)	Short-bodied pipefish	Marine	LC	7.0 cm TL
<i>Choeroichthys sculptus</i> (Günther, 1870)	Sculptured pipefish	Marine	LC	8.5 cm TL
<i>Corythoichthys intestinalis</i> (Ramsay, 1881)	Scribbled pipefish	Marine	LC	16.0 cm SL
<i>Doryrhamphus excisus</i> Kaup, 1856	Bluestripe pipefish	Marine	LC	7.0 cm TL
<i>Hippichthys cyanospilos</i> (Bleeker, 1854)	Blue-spotted pipefish	Marine, brackish, freshwater	LC	16.0 cm SL
<i>Hippichthys heptagonus</i> Bleeker, 1849	Belly pipefish	brackish, freshwater	LC	15.0 cm SL
<i>Hippichthys penicillus</i> (Cantor, 1849)	Beady pipefish	Marine, brackish, freshwater	LC	18.0 cm SL
<i>Hippichthys spicifer</i> (Rüppell, 1838)	Bellybarred pipefish	Marine, brackish, freshwater	LC	18.0 cm TL
<i>Hippocampus fuscus</i> Rüppell, 1838	Sea pony	Marine	NE	14.4 cm OT
<i>Hippocampus histrix</i> Kaup, 1856	Thorny seahorse	Marine	VU	17.0 cm TL
<i>Hippocampus kelloggi</i> Jordan & Snyder, 1901	Great seahorse	Marine	VU	22.0 cm OT
<i>Hippocampus kuda</i> Bleeker, 1852	Spotted seahorse	Marine, brackish	VU	30.0 cm TL
<i>Hippocampus trimaculatus</i> Leach, 1814	Longnose seahorse	Marine	VU	22.0 cm TL
<i>Ichthyocampus carce</i> (Hamilton, 1822)		Marine, brackish, freshwater	LC	15.0 cm (male)
<i>Microphis brachyurus</i> (Bleeker, 1854)	Short-tailed pipefish	Marine, brackish, freshwater	LC	22.0 cm SL
<i>Microphis cuncalus</i> (Hamilton, 1822)	Crocodile-tooth pipefish	brackish, freshwater	LC	17.5 cm SL
<i>Microphis deocata</i> (Hamilton, 1822)	Deocata pipefish	freshwater	NT	15.0 cm SL
<i>Oostethus insularis</i> (Hora, 1925)	Andaman pipefish	freshwater	VU	
<i>Phoxocampus belcheri</i> (Kaup, 1856)	Rock pipefish	Marine	LC	7.2 cm SL
<i>Syngnathoides biaculeatus</i> (Bloch, 1785)	Alligator pipefish	Marine	LC	29.0 cm TL
<i>Trachyrhamphus serratus</i> (Temminck & Schlegel, 1850)		Marine	DD	30.0 cm TL

coastal development.

Syngnathid species are typically found in vegetated or other complex habitats^{19,23}. Syngnathids are frequently found on seagrass meadows²⁴. According to Lourie *et al.*¹⁹, species like *H. trimaculatus* are found in deeper water (> 50 feet) and associate with sponges, soft corals, and sandy bottoms. The current study further demonstrated that syngnathids are found in the Hooghly-Matlah estuary systems, together with associated macro-vegetation and mangrove habitats.

Overexploitation of Indian seahorses has been linked to population declines²⁵, so the Government of India designated all species of the family Syngnathidae as protected species under Schedule I (Part 2A) of the Indian Wildlife Protection Act, 1972, affecting the trade of Indian seahorses. Table 2 depicts the distribution of *Hippichthys spicifer*, *Hippocampus trimaculatus*, and *Microphis cunocalus* in the Indian waters.

Water quality parameters

Analysis of water quality data revealed that the average water parameters at the specimen collection sites were water temperature of 29.57±0.32 to 33.60±0.10 °C and a salinity of 0.040±0.00 to 31.50±0.50 ppt. Water was relatively less transparent (transparency 15.00±2.00 to 48.67±3.21 cm; turbidity 18.88±14.26 to 262.00±39.58 NTU), with higher transparency at upper freshwater areas and lesser values at lower estuarine areas. Sufficient dissolved oxygen (5.20±0.02 to 5.73±0.12 mg/l) and a suitable pH (8.12±0.10 to 8.43±0.04) were recorded at the sites, which indicated a congenial estuarine environment for the species. The depth of the water at the collection sites was recorded at 6.9±1.95 m at Balagarh, 6.9±0.79 m at Kakdwip, and 13.0±0.5 m at Jatirampur (Table 3).

The Hooghly-Matlah estuarine system is a home to a wide variety of flora and wildlife. There are several studies on fish and fisheries from the Hooghly-Matlah estuary system²⁶⁻³⁰, but none on the abundance and distribution of syngnathids. Recent research has revealed a decline of fish fauna in the Ganga River, particularly in the Hooghly-Matlah estuarine system³¹.

The reduction in the overall number of fish species listed as threatened and the percentage of fish on the IUCN Red Lists poses a danger to fish diversity in the Hooghly-Matlah estuarine system³². According to the current study, IUCN-listed endangered fish species in the Hooghly-Matlah estuarine system require conservation measures. Estuaries, which serve as transitional zones between freshwater and marine habitats, are biodiversity hotspots for a diverse range of ichthyofaunal species, including ecologically important species such as syngnathids³³. These species are critical for preserving ecological balance because of their sensitivity to environmental changes, allowing them to serve as markers of habitat health. Across food webs, syngnathids play an important role

Table 3 — Important water quality parameters at collection sites of syngnathids at Hooghly-Matlah estuarine system

Water parameters	Collection sites		
	Balagarh (May 2022)	Jatirampur (Gosaba) (May 2022)	Kakdwip (September 2022)
Water temperature (°C)	31.6±0.1	29.57±0.32	33.6±0.0.1
Depth (m)	6.9±1.95	13.0±0.5	6.9±0.79
Transparency (cm)	34.67±4.16	48.67±3.21	15.00±2.00
Turbidity (NTU)	39.50±2.14	18.88±14.26	262.00±39.58
pH	8.43±0.04	8.12±0.10	8.24±0.01
DO (mg/l)	5.20±0.02	5.73±0.12	5.60±0.02
Salinity (ppt)	0.04±0.00	31.50±0.50	10.83±0.16

Table 2 — Distribution of *Hippichthys spicifer*, *Hippocampus trimaculatus*, and *Microphis cunocalus* from Indian waters

Species	Distribution	Habitat	Reference
<i>Microphis cunocalus</i>	Hooghly estuary, West Bengal	Freshwater, estuary	Talwar & Jhingran ¹¹
<i>Hippichthys spicifer</i>	Gulf of Mannar	Marine	Sethunarayanan & Rajagopal ³⁶
<i>H. spicifer</i>	Cochin estuary, Kerala	Estuary	Parvathy <i>et al.</i> ³⁷
<i>H. spicifer</i>	Palk Bay	Marine	Jeyabaskaran <i>et al.</i> ³⁸
<i>Hippocampus trimaculatus</i>	Gulf of Mannar region	Marine	Murugan <i>et al.</i> ³⁹
<i>H. trimaculatus</i>	Coromandel coast	Marine	Balasubramanian ⁴⁰
<i>H. trimaculatus</i>	Mumbai waters	Marine	Anonymous ⁴¹
<i>H. trimaculatus</i>	Kerala coast	Marine	Lipton & Thangaraj ⁴²
<i>H. trimaculatus</i>	Palk Bay	Marine	Lipton & Thangaraj ⁴²
<i>H. trimaculatus</i>	Vizhinjam in south Malabar	Marine	Thangaraj <i>et al.</i> ⁴³
<i>H. trimaculatus</i>	Kollam (Kerala) and Mandapam (Tamil Nadu)	Marine	Goswami <i>et al.</i> ⁴⁴

in nutrient cycling, supporting higher trophic levels³⁴. Furthermore, their distinct biological characteristics, such as parental care, make them valuable for evolutionary research. The syngnathids must be conserved due to their vulnerability to habitat deterioration, overfishing, and climate change, all of which threaten estuarine ecosystems worldwide.

It is recommended that actions such as establishing fish-protected areas for in-situ breeding, building migratory fish passageways, and ex-situ fish breeding be implemented in the Hooghly-Matlah estuarine system. It is necessary to conduct significant environmental studies before implementing any hydro-related efforts in the Hooghly-Matlah estuarine system. Maintaining riverine connectivity with related bodies of water, such as wetlands, that allow fish species to transit for feeding, spawning, and rearing is vital as it supports the species community.

Conclusion

The study's goal was to provide a clear picture of syngnathid abundance and distribution patterns in the Hooghly-Matlah estuarine system. Many syngnathids have charisma that makes them suitable flagship species for problems and solutions in marine conservation. Issues such as overexploitation, by-catch, and habitat degradation have been the major concerns faced by syngnathids in recent years. Thus, there is a need to involve the relevant stakeholders in securing the syngnathid populations. Recent attempts in India to breed and grow seahorses in captivity have been successful³⁵. Such efforts need to be quantified, and threats must be mitigated before any translocations or stocking take place.

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Conflict of Interest

The authors declare no conflict of interest.

Ethical Statement

All authors have read, understood, and agreed to publish the manuscript in IJMS. Research is carried out in accordance with the applicable ethical guidelines and required permissions.

Author Contribution

DB: Primary data collection, data entry and analysis, and manuscript writing; RKM: Field data collection and manuscript editing; BKD: Conceptualisation of the manuscript; SMN: Data entry and analysis; TK: Study map preparation; and SS: Manuscript editing.

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