

FISH DIVERSITY OF ASHTAMUDI LAKE

*Dissertation submitted to the University of Kerala
in partial fulfillment of the requirements
for the award of the degree of*

**BACHELOR OF SCIENCE
IN
ZOOLOGY
(2018 - 2021)**

Submitted by

Candidate Name	Candidate Code
AYISHA S	25018142005
MEENU M S	25018142009
NEENU NELSON	25018142012
SWETHA SUSEELAN	25018142016
AZIYA B KARIM	25018142021
SAHIL T	25018142029
VARSHA KENNADY	25018142033
FATHIMA BEEVI	25018142036
S AMINA	25018142042
SAJID N R	25018142043



**DEPARTMENT OF ZOOLOGY
TKM COLLEGE OF ARTS AND SCIENCE
KOLLAM-5**

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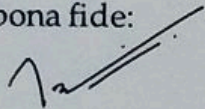
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2018-2021

CERTIFICATE

This is to certify that the dissertation entitled "Fish diversity of Ashtamudi Lake" is an authentic record of the work done by.....VARSHA KENNADY..... under my supervision as partial fulfillment of the requirements for the Degree of *Bachelor of Science* in *Zoology* and this report has not been submitted earlier for the award of any degree or diploma or any other similar titles anywhere.

Certified bona fide:



Dr. Jasin Rahman V K
Asst. Professor & Head
Dept. of Zoology



ROHINI KRISHNA M V

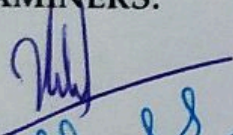
(Supervisor)

Asst. Professor

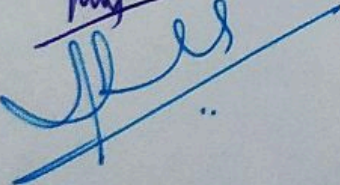
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EXAMINERS:

1.



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DECLARATION

I do hereby declare that this dissertation "Fish diversity of Ashtamudi Lake" is a bona fide report of the project work carried out by me, under the supervision and guidance of Rohini Krishna MV, Asst. Professor, Department of Zoology, TKM College of Arts and Science, Kollam as partial fulfillment of the requirements for the award of the Degree of *Bachelor of Science* in Zoology.

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31.3.2021

VARSHA KENNADY

Varsha Kennady
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ACKNOWLEDGEMENT

I express my sincere gratitude to my research supervisor Mrs. Rohini Krishna.M.V, Assistant Professor, Department of Zoology, T.K.M. college of Arts and Science for the valuable guidance and encouragement given throughout the period of work. She had helped us to identify the fishes and also checked the draft in no time.

I am indebted to Dr. MK Anil, Principal Scientist and Head, Vizhinjam Regional Centre of CMFRJ and Mr.Praveen Prasannan, Aquaculture Expert Service, NFDDB-Aqua One Centre, Thrikkunapuzha for the help rendered in doing the work.

I am grateful to Dr. Jasin Rahman V.K., Assistant professor and Head of the Department of Zoology for the necessary facilities provided to carry out the work successfully

I extend my sincere thanks to all the teachers of Dept. of Zoology for their advice and encouragement.

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INTRODUCTION

The coastal region of Kerala is unique due to the fact that it contains an extensive network of estuaries and backwater lakes lying parallel to the Arabian Sea. These water bodies popularly known as 'Kayals' which exist in different sizes and shapes have their bed level at about 1.5 to 1.8 m below mean sea level. Kerala has 44 rivers of which 41 are west flowing and 3 are east flowing. The waters of a majority of the rivers in Kerala drain into the Kayals before they empty into the sea through a large number of perennial and seasonal openings and the Ashtamudi Lake is one of the most important estuarine/backwater systems in Kerala.

Ashtamudi Lake (Ashtamudi Kayal) is situated in the Kollam District of Kerala. It is located at $8^{\circ}53' - 9^{\circ}2' N$; $76^{\circ}31' - 76^{\circ}41' E$ and it is the second largest estuary in Kerala and consists of 8 palm shaped lakes covering an area of over 32 sq km. The wetland ecosystem of Ashtamudi is unique and it was also declared as a Ramsar site in 19 August 2002. It is an international treaty for the conservation and sustainable utilization of wetlands, the Convention was signed in 1971 in the city of Ramsar in Iran. The lake has many major tributaries of which Kallada River is the major one. The Kallada river originates near Ponmudi in Western Ghats and it is formed by the confluence of three rivers viz., Kulathupuzha, Chenthurnipuzha, and Kalthuruthipuzha. The Kallada river empties itself into the Ashtamudi Lake at Neendakara as it enters the Arabian sea and forms Kerala's deepest estuary. Ashtamudi Lake has many branches like

Thevally, Kandachira, Kureepuzha Thekkumbhagam, Kallada, Perumon, Kumbalathu, Kanjirottu, Vellimon, Chavara. Munroe Island (Munroethuruth), Chavara South and Thekkumbhagam Island are the major islands situated on Ashtamudi Lake.

The biodiversity of Ashtamudi Lake is unique as it has both marine and estuarine organisms. At and near the mouth of the river, where it meets the sea, a special and distinctive environment prevails. This ecotone, or "buffer zone", between freshwater of the stream and salt water of the sea is called an estuary.

Estuaries may be classified according to their geomorphology in coastal plain, fjord, bar built and tectonic (Pritchard, 1952). Coastal plain estuaries, also called drowned river valleys, are those that were formed as a result of the Pleistocene increase in sea level, starting ~15,000 years ago. Originally rivers, these estuaries formed during flooding over several millennia by rising sea levels. Their shape resembles that of present-day rivers, although much wider. They are typically wide (order of several kilometers) and shallow (order 10 m) with large width/depth aspect ratios. Fjords are associated with high latitudes where glacial activity is intense. They are characterized by an elongated, deep channel with a sill. The sill is related to a moraine of either a currently active glacier or an extinct glacier. Riverine fjords are related to extinct glaciers and their main source of buoyancy comes from river inputs. They are usually found equator ward of glacial fjords. Glacial fjords are found in high latitudes, poleward of riverine fjords. They are related to active glaciers and their main source of

buoyancy is derived from melting of the glacier and of snow and ice in mountains nearby. Fjords are deep (several hundred meters) and narrow (several hundreds of meters) and have low width/depth aspect ratios with steep side walls. Fjords are found in Greenland, Alaska, British Columbia, Norway, New Zealand, Antarctica and Chile. Bar-built estuaries, originally embayments, became semi-enclosed because of littoral drift causing the formation of a sand bar or spit between the coast and the ocean. Some of these bars are joined to one of the headlands of a former embayment and display one small inlet (few hundreds of meters) where the estuary communicates with the ocean. Some other sand bars may be detached from the coast and represent islands that result in two or more inlets that allow communication between the estuary and the ocean. In some additional cases, sand bars were formed by rising sea level. Tectonic estuaries were formed by earthquakes or by Earth's crust fractures and creases that generated faults in regions adjacent to the ocean. Faults cause part of the crust to sink, forming then a hollow basin. An estuary is formed when the basin is filled in by the ocean.

REVIEW OF LITERATURE

Ashtamudi Lake harbours great diversity of both vertebrate and invertebrate faunal elements. The previous studies conducted revealed great diversity of fin fishes and also a few species of crabs, clams, prawns and mussels. The lake also supports diversity of avian fauna like Tailor bird, Indian white-breasted kingfisher, Common sandpiper, Cattle egret.

The brackish waters are areas of confluences of fresh water and sea water and the salinity ranges from 5 to 27 ppt. They contain unique brackish water species and also some marine species who invade brackish areas depending upon the salinity. One of the most commonly occurring and commercially important brackish water fish in Kerala is *Etroplus suratensis* also known as pearl spot (Karimeen in Malayalam). In 2010 it was also announced as the official state fish of Kerala. Ashtamudi Lake possess a dense population of this species. *Etroplus* is included in the least concerned category of the IUCN red list of marine species. Another abundant species found in Ashtamudi Lake is *Paphia malabarica*, also known as short necked clam which is an edible bivalve and is commercially very important as it contributes to 90% of India's clam meat export. The short-neck clam fishery of Ashtamudi Lake was awarded the Marine Stewardship Council (MSC) certification during 2014. The Marine Stewardship Council is an independent non-profit organization that sets standards for sustainable fishing around the world. The Central Marine Fisheries Research Institute (CMFRI), Kochi, the Kerala State Fisheries

Department and the World Wildlife Fund, had joined hands with the local fishing community to achieve the certification. It was for the first time that a fishery in India has been awarded the certification.

Fish have been adapting to changes in their living environments throughout evolutionary history. Those that are unable to adapt, eventually die out (Vostradovsky, 1973). Over the years, humans have contributed to the extinction of many species. On a smaller scale, we have continually tested the adaptability of species by disturbing their living environments (Gulland, 1977). So the documentation of the fish fauna of important backwater systems like Ashtamudi Lake is very important.

Fish is one of the most important sources of protein in human diet. It contains lysine and sulphur containing amino acids. Most fishes contain 15-25% protein and 1-5% fat. Fish is a good source of vitamins A, D and B. Fish proteins are characterized by high digestibility, biological value and growth promoting value.

The present project focuses on the fish diversity of Ashtamudi Lake. Most of the studies carried in Ashtamudi Lake are restricted to the mouth of the estuary and adjoining areas. The diversity or other parameters of interior areas of Ashtamudi Lake has not been studied before. So the present study will help to reveal the unexplored fish diversity of Ashtamudi Lake. The region is unique in possessing high population density of a species of black clam *Villorita cyprinoides* it is endemic to India and it is sparsely seen in high salinity conditions. It is locally known as

Kakka. Many people harvest it for their lively hood and the clam meat serves as a basic source of protein and its shell as a source of lime.

3 regions were selected for collection Chavara, Thevally and Perayam. The Chavara sector is highly polluted due the presence of high concentration of minerals such as titanium in the soil and the factories such as KMMML operating there discharge their effluents into the lake. Thevally sector of the lake is polluted due to various anthropogenic activities due to the presence of high population density around the lake and also due to the presence of various tourist activities such as resorts and house-boating in the lake, so monitoring the fish diversity of these regions is of utmost importance.

Many studies focussing on the hydrobiological parameters and fish diversity of various estuarine systems in India have been carried out. Hydrobiological observations of the Hoogly- Matalah estuary have been made by Dutta *et al.* (1954), Bose (1954), Shetty *et al.*(1961) and Basu and Ghosh(1970). The ichthio-fauna of the estuary has been reported upon by Hora and Nair (1940) and David (1954). A brief hydrobiological survey of parts of the Mahanadi estuary was conducted by INS *Investigator* during 1952 and the fish disposal status of the estuary was studied by (Shetty *et al.*,1965). A stretch of Godavari estuary covering an area of about 45 sqkm were studied by scientists of Andhra University, Waltair.(Anon.,1965). Hydrobiological and fisheries observations on the relatively less known Vellar estuaries discharging into the Bay of Bengal were made by Chacko *et al.* (1954).The hydrobiology, flora ,fauna and fisheries of the Adayar

estuary were studied by Panikkar and Aiyar (1937) and Jones (1937). The fish diversity of the Adyar estuary was described by Evangeline (1967). Hydrobiological observations relevant to fisheries of Zuari and Mandovi estuaries discharging into the Arabian Sea were made by Dehadrai (1970).

Bottom salinity characters of the entire Cochin backwaters were studied by Josanto (1975). The fish diversity of the Vembanad Lake were documented by Shetty, 1965; Kurup, 1982; Kurup and Samuel, 1983, 1985, Kurup *et al.* 1989. Fishery diversity of Ashtamudi Lake was studied by Nair *et al.* (1983), Kurup and Thomas (2001), Binushma Raju (2011), Saumya (2012) and Vimal Raj *et al.*, (2014). The total faunal diversity of Ashtamudi Lake was studied by Raghunathan (2007).

MATERIALS AND METHODS

3 different locations of the Ashtamudi Lake was selected for the purpose of the study (Fig 1). The fishes were caught from Chavara sector of Ashtamudi Lake with the help of cast nets (Fig 2). Fishes were also obtained from Perayam fish market (Fig 4) and also from Thevally fish landing centre. In Thevally the fishes were collected with the help of cast net and Chinese fishing net (Fig 5). The method of operation is described below.

Cast net- This is the simplest type of net which can be operated by a single man throwing it over the water surface. It is a long circular umbrella like net (Fig 3) with lead sinkers attached along the periphery which helps in throwing open the net covering a large circular area and helps in sinking the net over the fishes faster than the fishes swimming away from the area to escape. Cast nets are operated from the shore or from a boat. At the time of fishing the net is swung over the head and dropped to the distance reachable by attached rope. After sometime it was slowly dragged out of water with the rope. The fishes which entered the net were caught and collected.

Chinese fishing nets (Cheena vala)- They are a type of stationary lift net. They are fishing nets that are fixed land installations for fishing (Fig 5). While commonly known as 'Chinese fishing nets' in India, the more formal name for such nets is 'shore operated lift nets'. Huge mechanical contrivances hold out horizontal nets of 20 m or more across. Each

structure is at least 10 m high and comprises a cantilever with an outstretched net suspended over the sea and large stones suspended from ropes as counterweights at the other end. Each installation is operated by a team of up to six fishermen.

The system is sufficiently balanced that the weight of a man walking along the main beam is sufficient to cause the net to descend into the sea. The net is left for a short time, possibly just a few minutes, before it is raised by pulling on ropes. The catch is usually modest: a few fish and crustaceans, which may be sold to passers-by within minutes. Rocks, each 30 cm or so in diameter, are suspended from ropes of different lengths. As the net is raised, some of the rocks one-by-one come to rest on a platform thereby keeping everything in balance. Each installation has a limited operating depth. Consequently, an individual net cannot be continually operated in tidal waters. Different installations will be operated depending on the state of the tide.

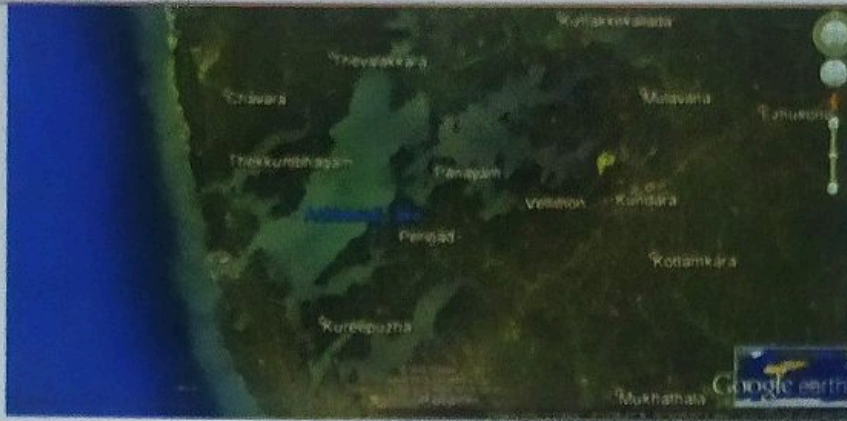


Fig.1. Map showing the position of Ashtamudi Lake

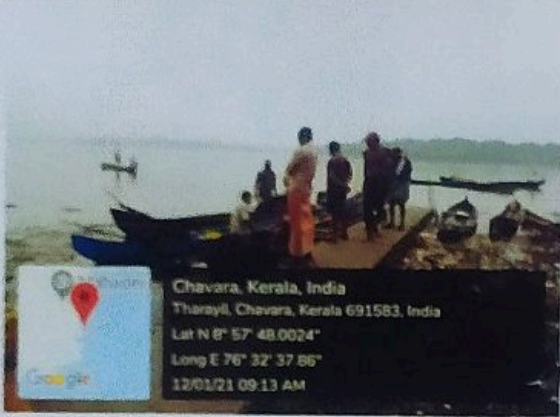


Fig 2. Fish landing centre at Chavara



Fig 3. Fisherman operating a cast net



Fig 4. Students at Perayam fish market



Fig 5. Chinese fishing net at Thevally

The fishes were collected with the help of local fishermen and the collection was carried out during the morning from 6.00 to 10.30 AM. The collections were carried out during a time period of January to March. Monthly visits were conducted to the site during the time span of 3 months. The specimens collected were preserved in 10% formalin for systematic studies. The body colouration was noted in fresh condition and photographed in digital camera. For identification of fishes the important taxonomic treatise of Day (1967), Jayaram (1999), Talwar and Jhingran (1991) were consulted in addition to FAO sheet and Fishbase.

For identifying the fishes various morphometric and meristic characters such as - dorsal rays, anal rays; pectoral rays, lateral-line scales; gill rakers and body depth were measured according to Allen and Erdmann (2009)

RESULTS

21 species of fishes belonging to 17 Families and 11 Orders were recorded during the study period. Identity of the species, salient morphological and biological characters and economic importance of each species is described below.

1. *Rastrelliger kanagurta* (Cuvier, 1816)

Common name: Indian mackerel

Order: Scombriformes

Family: Scombridae

Description: Head longer than body depth. Maxilla partly concealed, covered by lachrymal bone but extending to about hind margin of eye. Interpelvic process small and single. Swim bladder present. Anal spine rudimentary. The body of the Indian mackerel is moderately deep, and the head is longer than the body depth. The maxilla are partly concealed, covered by the lacrimal bone, but extend till around the hind margin of the eye. These fish have thin dark longitudinal bands on the upper part of the body, which may be golden on fresh specimens. There is also a black spot on the body near the lower margin of the pectoral fin. Dorsal fins are yellowish with black tips, while the caudal and pectoral fins are yellowish. The remaining fins are dusky.

Biology: Adults occur in coastal bays, harbors and deep lagoons, usually in some turbid plankton-rich waters. Form schools. Feed on phytoplankton

(diatoms) and small zooplankton (cladocerans, ostracods, larval polychaetes, etc.) . Small groups were seen eating eggs of *Cheilio inermis* straight after spawning. Adult individuals feed on macroplankton such as larval shrimps and fish. Eggs and larvae are pelagic.

Uses: Generally marketed fresh, frozen, canned, dried-salted, and smoked; also made into fish sauce.

2. *Hyporhamphus limbatus* (Valenciennes, 1847)

Common name: Congaturi halfbeak

Order: Hemiramphidae

Family: Beloniformes

Description: The body shows typical halfbeak shape with an elongated lower jaw and cylindrical elongated body. They have no spines on fins, but do have 13-16 rays of their dorsal fins and 13-16 rays on their anal fins. The longest recorded Jumping halfbeak was 35 cm long, but most of them are 13 cm long commonly. Body is greenish above, and a silvery lateral stripe widening posteriorly. Ventrally white in color. Fleshy tip of the beak is reddish colored. Greatly prolonged, beak-like lower jaw, equal to, or longer than head length; upper jaw short, triangular and scaly, its width 0.6-0.8 times in its length. Preorbital distance 1.3-2.1 times in diameter of orbit and 0.75-1.2 times in length of upper jaw. Total number of gill rakers on first gill arch 23-37. Anal fin rays 13-16; caudal fin emarginate, not strongly forked.

Biology: Coastal species. Found at surface levels of tidal freshwaters and brackish estuaries. Feed mainly on insects.

Uses: Marketed fresh and dried salted.

3. *Chanos chanos* (Forsskål, 1775)

Common name: Milkfish

Order: Gonorynchiformes

Family: Chanidae

Description: Colour of the body olive green dorsally; flanks silvery; unpaired fins with dark margins. They can reach a weight of about 14 kg and an age of 15 years. They have an elongated and almost compressed body, with a generally symmetrical and streamlined appearance, one dorsal fin, falcate pectoral fins and a sizable forked caudal fin. Mouth is small and toothless. They have 13-17 dorsal soft rays, 8-10 anal soft rays and 31 caudal fin rays.

Biology: Adults are found in offshore marine waters and shallow coastal embayments, but also frequently enter estuaries and occasionally penetrate freshwater streams. They occur in small to large schools near the coasts or around islands where reefs are well developed. Eggs and larvae are pelagic up to 2-3 weeks. Older larvae migrate onshore and settle in coastal wetlands (mangroves, estuaries) during the juvenile stage, or occasionally enter freshwater lakes. Juveniles and sub-adults return to sea where they mature sexually. Mature adults spawn only in fully saline water. Larvae eat zooplankton; juveniles and adults eat cyanobacteria, soft algae, small

benthic invertebrates, and even pelagic fish eggs and larvae. This species can thrive and grow in water as hot as 32° C. Spawns in clear shallow waters above a bottom of sand or coral and at a distance of not more than 30 km from the shore. Females spawn up to 5 million eggs which hatch in about 24 hr. Spawning and fertilization take place at night.

Uses: Larvae are collected from rivers and are grown in culture ponds into juveniles which are marketed fresh, smoked, canned or frozen.

4. *Oreochromis mossambicus* (Peters, 1852)

Common name: Mozambique tilapia

Order: Cichliformes

Family: Cichlidae

Description: Snout long; forehead with relatively large scales, starting with 2 scales between the eyes followed by 9 scales up to the dorsal fin. Adult males develop a pointed, duckbill-like snout due to enlarged jaws, often causing the upper profile to become concave, but upper profile convex in smaller specimens. Pharyngeal teeth very fine, caudal fin not densely scaled; female and non-breeding male silvery with 2-5 mid-lateral blotches and some of a more dorsal series; breeding male black with white lower parts of head and red margins to dorsal and caudal fins.

Biology: Adults thrive in standing waters. Inhabits reservoirs, rivers, creeks, drains, swamps and tidal creeks; commonly over mud bottoms, often in well-vegetated areas. Normally not found at high altitudes. Able to survive extreme reduction of temporary water bodies. Highly euryhaline.

Grows and reproduces in fresh, brackish and seawater. Can be reared under hyper-saline conditions. Tolerates low dissolved oxygen levels and can utilise atmospheric oxygen when water oxygen levels drop. Mainly diurnal. May form schools. Omnivorous, feeds mainly on algae and phytoplankton but also takes some zooplankton, small insects and their larvae, shrimps, earthworms and aquatic macrophytes. Juveniles carnivorous/omnivorous, adults tend to be herbivorous or detritus feeders. Large individuals have been reported to prey on small fishes, and occasionally cannibalise their own young. Exhibits considerable plasticity in feeding habits as well as in reproductive biology. Polygamous, maternal mouthbrooder. Reaches sexual maturity at 15 centimeter length, but stunted fish may breed at 6-7 centimeters and at an age of just over 2 months.

Uses: Marketed fresh and frozen. Excellent palatability. Used extensively in biological, physiological and behavioural research. Translocated and introduced for aquaculture, sport fishing, stocking man-made lakes and biological control of nuisance plants and animals.

5. *Systemus sarana* (Hamilton, 1822)

Common name: Olive barb

Order: Cypriniformes

Family: Cyprinidae

Description: The body of olive barb is deep and moderately compressed; dorsal profile elevated. Eyes are large and situated in the anterior half of

the head and snout is rounded. Two pairs of nostrils are present and each nostril of each pair separated by a muscular flap. Mouth is wide, pores absent on the snout. Two pairs of barbels are present, rostral barbels are slightly shorter than the maxillary pair. Last unbranched ray of dorsal is strongly osseous and finely serrated along its posterior edge. Pelvics originate below the origin of dorsal fin. The colour is silvery in the back; opercle shot with gold and yellowish white in the abdomen. Body oblong, head, small, barbels 2 pairs. Maxillary pair longer than orbit, rostral pair shorter.

Biology: Adults occur in rivers, streams, lakes and backwaters. Tolerant of salinity. They form schools in groups of four or five to several dozens. Spawn in running waters among submerged boulders and vegetation. It can live in sandy bed mixed with mud and in fairly swift current. It normally forms groups of four or five to several dozen. The species is omnivorous and feeds on aquatic insects, fish, algae and small prawns. Photoperiod plays a major role in controlling the reproductive activity of this fish. It attains the sexual maturity in the first year of its life and prefers shallow water of floodplain areas for the breeding.

Uses: This species can also be used as an ornamental species due to its attractive silver-coloured body and hardy nature. This species is considered as the "biological control" in aquacultural practices.

6. *Elops machnata* (Forsskål, 1775)

Common name: Tenpounder

Order: Elopiformes

Family: Elopidae

Description: Back blue/grey, sides silvery with a yellow tinge; fins faint yellow. Body elongate, fusiform. Mouth terminal, the upper jaw reaching well behind eye; a gular plate present between arms of lower jaw; branchiostegal rays very numerous (23 to 25). No spines in fins; dorsal fin origin a little behind mid-point of body; anal fin short, with 14 to 17 rays, its origin well behind dorsal fin base; pelvic fins a little in front of dorsal fin origin. Scales very small upper jaw reaching well behind eye; teeth on jaws villiform.

Biology: *E. machnata* is a eurythermic tropical species found widely in subtropical and warm temperate regions. This is also a euryhaline species having a wide salinity tolerance i.e., 0 to 90 ppt and mostly found in turbid waters. Juveniles are common in warm, turbid coastal waters, but enters lagoons and estuaries. Young and adults feed on small fishes and crustaceans. Probably spawn at sea, but the transparent larvae migrate to inshore areas and are often found in brackish water. Are voracious carnivores that take fish, squid and shrimp bait. A total length of 126 cm for this species has been reported from Knysna, South Africa. Pelagic in coastal waters, entering lagoons and estuaries. Spawning probably occurs in the sea, the transparent larvae (leptocephali) migrating to inshore

nursery areas. Feeds on small fishes and crustaceans. Caught with seines, gillnets and handlines.

Uses: Edible, but not tasty and full of bones. No special fishery; commonly taken in sport fishing. Marketed fresh or frozen.

7. *Caranx ignobilis* (Forsskål, 1775)

Common name: Giant trevally

Order: Carangiformes

Family: Carangidae

Description: Silvery-grey fish, with the head and upper body slightly darker in both sexes. Fish greater than 50 cm show sexual dimorphism in their colouration, with males having dusky to jet-black bodies, while females are a much lighter coloured silvery-grey. Individuals with darker dorsal colouration often also display striking silvery striations and markings on the upper part of their bodies, particularly their backs. Black dots of a few millimetres in diameter may also be found scattered all over the body, although the coverage of these dots varies between widespread to none at all. All the fins are generally light grey to black, although fish taken from turbid waters often have yellowish fins, with the anal fin being the brightest. The leading edges and tips of the anal and dorsal fins are generally lighter in colour than the main part of the fins. There is no black spot on the operculum. Traces of broad cross-bands on the fish's sides are occasionally seen after death. Gill rakers 20-24; breast naked ventrally, typically with a small to large patch of prepelvic scales; head and body

silvery grey to black above, usually paler below; fins usually uniformly grey to black, fish from turbid coastal waters often with yellow fins, the anal fin usually brightest.

Biology: Adults are pelagic over sand and rock. They occur singly and inhabit clear lagoon and seaward reefs. They feed on crustaceans (like crabs and spiny lobsters) and fishes at night. Juveniles are found in estuaries. Large individuals may be ciguatoxic. The largest trevally reaches 1.7 m in length and a weight of over 60 kg. Spawning occurs on shallow seaward reefs and offshore banks

Uses: It is sold at market fresh, frozen, salted, and smoked, and as fishmeal and oil.

8. *Gerres filamentosus* (Cuvier, 1829)

Common name: Whipfin silver-biddy

Order: Perciformes


Family: Gerreidae

Description: They inhabit marine or brackish habitat. Depth 1.9 to 2.3 times in standard length. Base of first dorsal-fin spine, ascending at an angle of about 45° to the horizontal. Dorsal- and anal-fin spines strong, particularly second anal-fin spine; second dorsal-fin spine longer than head minus snout, fewer than 38 lateral-line scales to base of caudal fin. Body silvery, indistinct, fine, dark stripes following scale rows in older fish, caudal fin dusky, anal and pelvic fins yellowish.

Biology: Adults are coastal inhabitants found on soft bottoms, over sandy substrate. Juveniles are found in brackish mangrove estuaries, sometimes enter fresh water, lakes, tidal creeks and lower freshwater reaches of rivers. Feed on small crustaceans, polychaetes and forams on sand or muddy-sand bottoms, worms and insect larvae. Length at first reproduction was reported to be around 12 cm SL, for a population in a South African estuary. Juveniles enter estuaries and mangrove areas at 1 cm SL and stay until they reach maturity, at which stage they move out to sea. They are mainly benthic feeders with highly protrusible mouths and have been observed foraging for infaunal invertebrates.

Uses: Salted or made into fish sauce.

9. *Monodactylus argenteus* (Linnaeus, 1758)

Common name: Silver moony 

Order: Perciformes

Family: Monodactylidae

Description: Adults bright silver with yellow and dusky dorsal fin tip. Small juveniles more colorful with yellow over most of the dorsal fin and two vertical black bands over the head. Fins yellow except pectoral translucent. Eyes large, mouth small. This species reaches a maximum length of about 27 centimeters. It is bright shiny silver with yellowish edges to the fins. The dorsal and anal fins have black tips. Juveniles have more yellow coloration.

Biology: Feeds on plankton and detritus. Commonly seen in schools; small juveniles either solitary or in small aggregations. Highly territorial. Caught with throw nets. This species occurs in a wide variety of habitat types, including the open ocean, brackish waters, and the freshwater habitat of rivers. In Australia it can be found in harbors and estuaries around piers. Its ability to survive in a wide range of salinities makes it a model organism in the study of salinity tolerance. Juveniles are especially tolerant to salinity changes, easily maintaining homeostasis in variable environments such as estuaries. Although the silver moony displays territorial behavior, the species can be kept in saltwater aquaria and is easy to rear in captivity. It can remain solitary or form schools. It is a detritivore and planktivore. The myxozoan parasite *Kudoa monodactyli* was first described from and named after this fish.

10. *Leiognathus equulus* (Forsskål, 1775)

Common name: Common ponyfish

Order: Perciformes

Family: Leiognathidae

Description: Body very deep, compressed, with a strongly humped back; body depth 1.7-1.9 times in standard length; mouth pointing downward when protracted; gill rakers short and fleshy, head and breast scaleless. Colour of adults, back greyish, belly silvery and many parallel close-set faint bars on back; usually a dark brown saddle on caudal peduncle; axil of pectoral fins grey to black; margin of soft dorsal fin black; both caudal-fin lobes with broad dusky margins; pectoral, pelvic, and anal fins colourless

to yellowish. In juveniles (5-7 cm TL), thin, closely arranged, grey vertical lines descending from back to about midheight; membrane between anal-fin spines conspicuously yellow; posterior margin of caudal-fin lobes pale yellow and dusky; other fins hyaline; snout dotted black.

Biology: Found in river mouths and muddy inshore areas, often in mangrove areas. Adults are coastal inhabitants found on soft bottoms, usually between depths of 10-70 meters. Juveniles are commonly found in mangrove estuaries and tidal creeks, sometimes entering the lower reaches of freshwater streams. Adults move in schools. Frequently ascend into freshwater reaches of rivers. Active by day. Feed on polychaetes, small crustaceans, small fishes and worms. Important food fish in the tropics. Caught near the bottom with bottom trawls, set nets, push nets, dip nets, and beach seines. In Indian waters, schools near the surface during April-May when caught with drift gill nets.

Uses: Larger specimens sorted for human consumption and marketed fresh or dried-salted, but surplus fish used to feed ducks, converted to fishmeal, or discarded.

11. *Oxyurichthys tentacularis* (Valenciennes, 1837)

Common name: Tentacled goby

Order: Perciformes

Family: Gobiidae

Description: Body is very elongate, compressed, and the body profile is convex. Snout is obtuse, a little longer than the eye or shorter than eye, tip

before margin of eye. Anterior nostril is in a short tube. Mouth is oblique and the lower jaw prominent. Maxillary extends to below posterior part of eye. On each side 20 curved teeth are present in the upper jaw. Some longitudinal mucous canals are present on the cheek. The fish has a dull greenish colour. The sexes of *O. tentacularis* can be distinguished by differences in the urogenital papilla, which is in the ventral region between the anal orifice and the anal fin origin. The urogenital papilla is short, blunt, and pinkish in females, while in males it is thin, pointed, pale, and smooth. In both sexes, the urogenital papillae are covered only by epithelium and not by scales. In most cases, male fishes are larger, head rather long, compressed, a darker olive green body, and longer fin rays than female fishes of similar length.

Biology: They are omnivorous bottom-dwelling fishes. Occurs inshore, enters rivers and lagoons. Exclusively in brackish habitat, is known as 'kuravali' in Malayalam. A modified gill net, "koozhalivala" is used for its fishing. The easiness to catch the fish and low price has made this fish a favourite of the locals. Though its abundance and distributions is noted in other estuaries and backwaters of India, perhaps this is the only estuary in India where there is a commercial fishery for a Goboid species.

Uses: They are relatively inactive, hence, function as food of larger fishes and are also used as food fish locally.

12. *Epinephelus tauvina* (Forsskål, 1775)

Common name: Greasy grouper.

Order: Perciformes

Family: Serranidae

Description: Color of head and body pale greenish grey or brown with round dark spots that vary from dull orange-red to dark brown, centers darker than the edges. A large black blotch (or group of black spots) often visible on body at the base of last 4 dorsal-fin spines. Five sub vertical dark bars may be present on body. Dark spots on soft dorsal, caudal and anal fins of juveniles are so close that the pale interspaces form a white reticulum. 95-112 scales in longitudinal series. Scales on body ctenoid in juveniles, becoming cycloid in adults except the area beneath and posterior to pectoral fins. Pyloric caeca 16-18.; broadly rounded preopercle, serrae at angle of preopercle slightly enlarged; upper edge of operculum almost straight; posterior nostrils distinctly larger than anterior nostrils; maxilla reaching well past eye, greatest width about twice suborbital depth, Differs from *E. howlandi* by its more elongate body and closer-set spots .

Biology: Adults prefer clear water areas on coral reefs; juveniles have been taken from reef flats and in tide pools, adults found in deeper waters. Solitary and common in lightly fished areas. Adults from Oceania almost exclusively feed on fishes (holocentrids, mullid, and pomacentrid); and occasionally, crustaceans. Present in the Hong Kong live fish markets. Occasionally ciguatoxic . Reports of sizes in excess of 80 cm total length for *E. tauvina* are probably based on misidentifications of *E. coioides*, *E.*

malabaricus, and *E. lanceolatus*; these species grow much bigger than *E. tauvina*.

13. *Lutjanus argentimaculatus* (Forsskål, 1775)

Common name: Mangrove red snapper

Order: Perciformes

Family: Lutjanidae

Description: Body moderately deep, greatest depth 2.3 - 2.7 in SL; preopercular notch poorly developed; vomerine tooth patch crescentic; gill rakers of first gill arch 16-20 (including rudiments); scale rows on back more or less parallel to lateral line, or parallel below spinous part of dorsal fin and sometimes rising obliquely posteriorly, or rarely with entirely oblique rows. Colour of the body generally greenish brown on back, grading to reddish; belly silvery or whitish (deep water specimens usually overall reddish); juveniles with a series of about 8 white and streaks 2 blue across cheeks.

Biology: A euryhaline species. Juveniles and young adults occur in mangrove estuaries, the lower reaches of freshwater streams and tidal creeks. Adults are often found in groups around coral reefs. Eventually migrate offshore to deeper reef areas, sometimes penetrating to depths in excess of 100 m. Mainly nocturnal, this species feeds mostly on fishes and crustaceans. Found in Hong Kong live fish markets. Caught mainly with handlines, bottom longlines, and trawls; marketed mostly fresh and dried-

salted. Maximum length is 104 cm, max weight 14.5 kg and max age 39 years for specimens from the east coast of Australia.

Uses: Excellent food fish. An important market species throughout the Indo-Pacific region, but never found in large quantities. A good aquaculture species because it doesn't get rancid easily when frozen. It commands a good export market price with no limit on body size. No reported damaging diseases.

14. *Crenimugil buechanani* (Bleeker, 1853)

Common name: Bluetail mullet

Order: Mugiliformes

Family: Mugilidae

Description: Mulletts are distinguished by the presence of two separate dorsal fins, small triangular mouths, and the absence of a lateral line organ. They feed on detritus, and most species have unusually muscular stomachs and a complex pharynx to help in digestion. This species is greenish dorsally; flanks and abdomen are silvery; small gold patch on upper operculum and iris; caudal fin bright blue and pectoral fins yellow with dark blue spot dorsally at origin.

Biology: Inhabit coastal waters, including estuaries and rivers. Young fish frequent estuaries and also ascend rivers and coastal creeks. Feed on algae, diatoms, detritus, and crustaceans. Oviparous, eggs are pelagic and non-adhesive. Caught during the spawning period. Other methods include the use of stakenets, pouch nets, and barrier nets. A common noticeable

behavior in mullet is the tendency to leap out of the water. There are two distinguishable types of leaps: a straight, clean slice out of the water to escape predators and a slower, lower jump while turning to its side that results in a larger, more distinguishable, splash. The reasons for this lower jump are disputed, but have been hypothesized to be in order to gain oxygen rich air for gas exchange in a small organ above the pharynx.

15. *Thryssa mystax* (Bloch & Schneider, 1801)

Common name: Moustached thryssa

Order: Clupeiformes

Family: Engraulidae

Description: It is a small schooling fish found in depth of 0-50m. Maximum length does not exceed 15.5 cm. The fish has 11 to 12 dorsal soft rays and only present 29 to 37 anal soft rays. There are 24 to 32 keeled scutes from isthmus to anus on belly region. Lower gill rakers are serrated. Body is silver, darker dorsally. There is a distinctive dark blotch behind upper part of gill opening, which can easily identify the species from other *Thryssa* species. Caudal fin is yellowish. Tip of snout on a level with eye center. Maxilla long, reaching to or almost to base of first pectoral fin ray; first supra-maxilla oval, minute. Lower gill rakers with serrae on the inner edge even and not clumped. A dark blotch behind upper part of gill opening.

Biology: Found in coastal pelagic waters and often observed as entering mangroves and adjacent brackish waters. Juveniles and adults may penetrate the upper reaches where mixohaline-mesohaline conditions

prevail. Eggs and larvae are found in the lower reaches of the mangroves. A schooling species found mostly inshore. Feed on planktonic organisms in coastal waters. Juveniles in mangroves feed on larvae of shrimps and fish. Confusions in identification make all previous biological studies unreliable. One of the commonest species of *Thryssa*. It feeds on planktons, fish larva, and small crustaceans like shrimp larva.

16. *Arius maculatus* (Thunberg, 1792),

Common name: Spotted catfish

Order: Siluriformes

Family: Ariidae

Description: *Arius maculatus* can be distinguished from the other members of this genus by the presence of a single dorsal spine, 7 soft dorsal rays, 16 - 30 soft anal rays, rugose head shield and deep and long median fontanelle groove. They can reach a maximum length of about 80cm. The fish inhabits Marine, freshwater and brackish water habitat. It is demersal exhibiting potamodromous migration and usually occurs at a depth of about depth range 50 - 100 m. Arius species have three pairs of barbels, including the fleshy and cylindrical maxillary barbels and two pairs of mental barbels. The base of the adipose fin is moderately long, about half the length of the base of the anal fin.

Biology: The eggs are incubated in the mouth of the male. *Arius maculatus* or other catfish species that are commonly found in the mangrove waters are benthic feeders. They can locate their prey efficiently in the muddy

waters through their well-developed sense of smell and vision. The presence of maxillary barbels serves as an important sensory organ in search for embedded prey in the muddy sediment of the mangrove area. *Arius maculatus* is dioecious. The mature female and male gonads develop in separate individuals and fertilisation of the gametes take place externally. The ova are large and yolky or small and non-yolky, this non-functional ova are also extruded at the time of spawning. After retaining the large functional ova in the mouth, the non-functional ova are probably eaten by the male parent to maintain basal metabolism.

Uses: The fish is of commercial interest to fisheries. It is primarily marketed fresh.

17. *Nematalosa nasus* (Bloch, 1795)

Common name: Bloch's gizzard shad

Order: Perciforms

Family: Clupidae

Description: It occurs in marine, freshwater and brackish water. The body is dark bluish dorsally and silvery below. The sardines are known to swim at a maximum depth of 30 metres. The largest known standard length for the species is 22 cm. The fish can be separated from its sister species by the presence of a dark spot behind gill opening. Belly consists with 17 to 20 and 9 to 13 scutes. It has 15 to 19 dorsal soft rays and 17 to 26 anal dorsal soft rays. Anterior arm of pre-operculum with the third infra-orbital bone immediately above it, no fleshy gap between; lower jaw strongly flared

outward. Pectoral axillary scale present; hind edge of scales distinctly toothed.

Biology: It is a filter feeder and feeds on planktons. *N. nasus* is a microplankton feeder with dominant and seasonally specialized feeding habit on benthic foraminiferans (*Ammonia beccarii*) during breeding season and generalized feeding habit on other microplankton groups of bacillariophyceae, chlorophyceae, cyanophyceae and copepods, nematodes in other seasons

Uses: Widely used as a food fish, it can be made in to fish balls and can eat both as fresh and dried forms. It can be marketed fresh, dried-salted or boiled and also can be made into fish balls. This fish is very bony in nature.

18. *Gerrus oyena* (Forsskål, 1775)

Common name: Blacktip silver biddy

Order: Perciforms

Family: Gerreidae

Description: It occurs in the marine and brackish waters of coastal waters of the Indian Ocean and the western Pacific Ocean. It inhabits estuaries, coastal waters and lagoons. This species can reach a length of 30 cm (12 in), though most do not exceed 20 cm (7.9 in). Body laterally compressed, mouth terminal, strongly protractile, pointing downward when extended. Bands of minute, acute teeth in both jaws; no incisors, canines, or molars. Dorsal fin long, single. Caudal fin markedly to very deeply forked. Scales

large, obvious but deciduous, cycloid or finely ctenoid, extending over sides of head. Brilliant silver in colouration.

Biology: For both sexes, the maximal development occurs during April and May. Based on the seasonal reproductive cycle of the species, ovary development of the females occurs from March to September, while the testes development of the males occurs between March and August. For both sexes, the maximal development occurs during April and May. Using the gonadosomatic index, the minimum standard length (SL) at sexual maturity was 89.7 mm for the females and 81.4 mm for males. The size at which 50% of individuals were sexually mature was 104 mm SL in females and 92 mm SL in males.

Uses: This species is important to local commercial fisheries.

19. *Pseudotroplus maculatus* (Bloch, 1785)

Common name: Orange chromid

Order: Perciforms

Family: Cichlidae

Description: It is known as 'pallathi' in Malayalam. Body disc shaped, deep and strongly compressed. Eyes are large. The fishes are in general peaceful. The fishes are highly sensitive to sudden changes in the water chemistry. Orange Chromid has an oval shaped and highly compressed body. The body color can vary, but should generally be orange in colour, this can range from quite pale orange to red. Wild fish are rather olive-green in color with 1-3 dark blotches just above midbody. When frightened

or stressed short bars may appear in the upper portion of the body with a solid dark posteroventral patch. The majority of body scales having an orange-red centre, and these numerous horizontal lines of deep golden spots giving the spotted pattern of the fish. The belly is light orange while the fins are transparent with an orange tint. Males sometimes have greyish pelvic and black anal fins.

Biology: The fish will deposit 200 to 300 eggs on any suitable surface. It can withstand pH between 6.0 to 7.5. Females are smaller and less colourful, they lack the red region in the fins. The species co-occurs throughout its range with *Etroplus suratensis*. Orange chromides prey on the eggs and larvae of *E. suratensis* and also act as a "cleaner fish" removing parasites from the larger green chromides in a cleaning symbiosis. The species also feeds on zooplankton and algae. *Pseudetroplus maculatus* juveniles feed on mucous coating of their parents; this is essential for the small fry survival.

Uses: This small species attains a length of 8 cm and is used as a food fish though of low value. Wild caught fish are rarely-seen in the aquarium hobby although selectively-bred ornamental strains are widely-available, which have a solid yellow-orange colour pattern with no dark elements.

20. *Etroplus suratensis* (Bloch, 1785)

Common name: Pearl spot

Order: Perciforms

Family: Cichlidae

Description: It is a popular and delicious table fish popularly called karimeen in Malayalam. Though their natural habitat is the brackish waters; they enter rivers and canals adjoining backwaters. It is called pearl spot due to the presence white spots which resemble pearls. The body is laterally compressed. The dorsal fin has numerous spines and the anal fin has only 3 or 4 spines. The colour is greenish or deep purple with eight vertical bands across the body. It can attain a maximum length of about 30 cm and a weight of 1.4 kg.

Biology: It is omnivorous; feeding on aquatic vegetation, planktonic organisms, worms, shrimps and small insect larvae. *Etroplus* breeds throughout the year with two peak periods during December - February and another during May - June months. Adults engage in altruistic multiple parental care where several adults care for a single brood that presumably were spawned by only two of the adults. After spawning, about 500 eggs are laid and attached to a submerged log, rock or sometimes roots and weeds, in still or slow flowing water. Parents guard and fan the eggs until hatching, usually about 4 days. The fry shoal around their parents during the first weeks of growth. Parents refrain from feeding from the time of spawning until the fry become independent. One kg of grown fish can cost about Rs.300-350. *Etroplus suratensis* and *E. maculatus* form the main species and the former is dominant among pearl spots in reservoirs of India. They mainly feed on detritus and occupy the same niche as that of *Oreochromis mossambicus*.

Uses: This fish is very valuable and has very high demand, hence it is being cultured ponds, pens and cages. These fishes are very popular food fishes but their biomass is very low in reservoirs compared to other cichlids. In 2010 this species was named the official state fish of Kerala.

21. *Stolephorus indicus* (van Hasselt, 1823)

Common name: Indian anchovy

Order: Perciforms

Family: Engraulidae

Description: Marine and brackish, pelagic-neritic, oceanodromous and commonly occurs at a depth range 20 - 50 m. Belly with 2 to 6 small needle-like pre-pelvic scutes. Maxilla tip pointed, reaching to or only just beyond front border of pre-operculum; hind border of pre-operculum convex, rounded. Isthmus muscle tapering evenly forward to hind border of branchial membrane. Body light transparent fleshy brown, with silver stripe down flank; no dark pigment lines on back between head and dorsal fin. Maximum length do not exceed 15.5 cm. It has 15 to 17 dorsal soft rays and 18 to 21 anal soft rays. Maxilla tip is pointed, reaching front border of pre-operculum. Body slender, elongate, rather round in cross-section, belly rounded; lower gillrakers 20-28; pelvic fin tips not reaching to below dorsal fin origin; anal fin short, with usually 3 unbranched and 16-18 branched finrays, its origin below centre of dorsal fin base.

Biology: A schooling species occurring in coastal waters and which appears to enter at least the estuarine parts of rivers and tolerate brackish

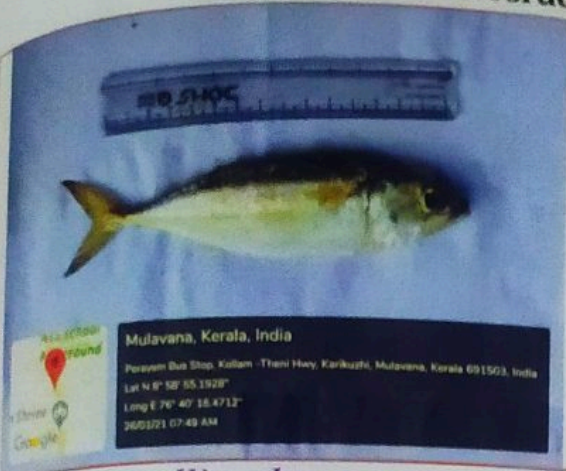
water. Feeds most likely on zooplankton .Used for human consumption and as a bait in the tuna fishery. Migrates out into deeper and more saline water to breed, returning inshore immediately thereafter.

Uses: Used as bait in the tuna fishery although said to be fragile. This fish is part of the cuisine of the Indian and Southeast Asian marine regions. It can be crisp-fried, used to make fish-based culinary products like fish sauce or in curries. In Sri Lanka, this variety of fish is made into a tasty snack by dipping in a batter of flour, then rolled in bread crumbs and deep fried in oil. It is also popular as a 'white curry', i.e., a curry made with coconut milk. A spicier variant is made with dry chilli gravy and served with scraped fresh coconut to offset the hotness of the gravy.

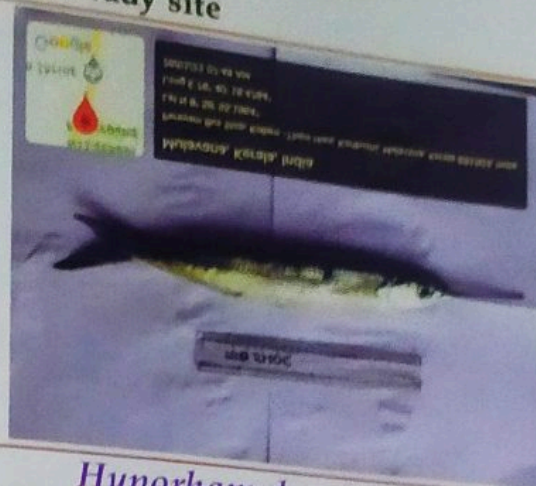
Table 1: List of fishes obtained from Ashtamudi Lake

Sl No	Species	Order	Family
1	<i>Rastrelliger kanagurta</i>	Scombriformes	Scombridae
2	<i>Hyporhamphus limbatus</i>	Beloniformes	Hemiramphidae
3	<i>Chanos chanos</i>	Gonorynchiformes	Chanidae
4	<i>Oreochromis mossambicus</i>	Cichliformes	Cichlidae
5	<i>Systemus sarana</i>	Cypriniformes	Cyprinidae
6	<i>Elops machnata</i>	Elopiformes	Elopidae
7	<i>Caranx ignobilis</i>	Carangiformes	Carangidae
8	<i>Gerres filamentosus</i>	Perciformes	Gerreidae
9	<i>Monodactylus argenteus</i>	Perciformes	Monodactylidae
10	<i>Leiognathus equulus</i>	Perciformes	Leiognathidae
11	<i>Oxyurichthys tentacularis</i>	Perciformes	Gobiidae
12	<i>Epinephelus tauvina</i>	Perciformes	Serranidae
13	<i>Lutjanus argentimaculatus</i>	Perciformes	Lutjanidae
14	<i>Crenimugil buechanani</i>	Mugiliformes	Mugilidae
15	<i>Thryssa mystax</i>	Clupeiformes	Engraulidae
16	<i>Arius maculatus</i>	Siluriformes	Ariidae
17	<i>Nematalosa nasus</i>	Perciforms	Clupidae
18	<i>Gerrus oyena</i>	Perciforms	Gerreidae
19	<i>Pseudetroplus maculatus</i>	Cichliformes	Cichlidae
20	<i>Etroplus suratensis</i>	Cichliformes	Cichlidae
21	<i>Stolephorus indicus</i>	Clupeiformes	Engraulidae

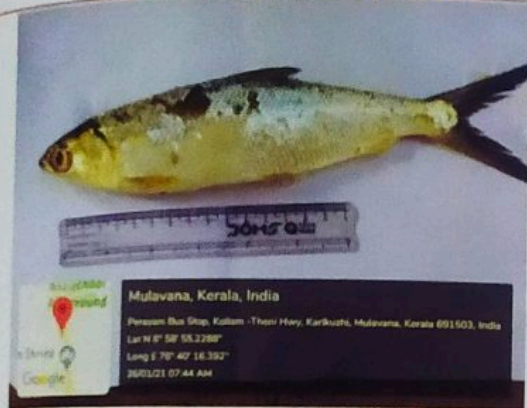
Fishes recorded from study site



Rastrelliger kanagurta



Hyporhamphus limbatus



Chanos chanos



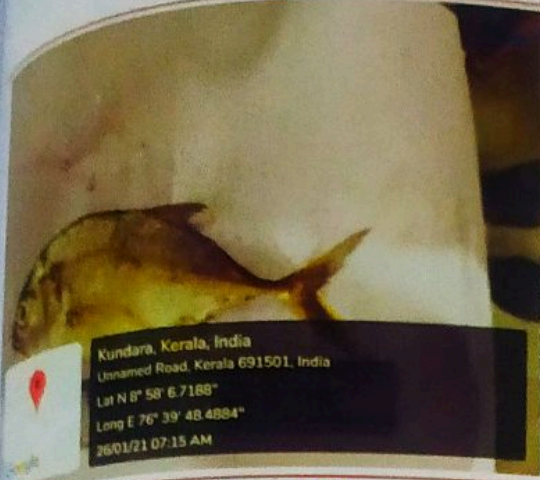
Oreochromis mossambicus



Systomus sarana

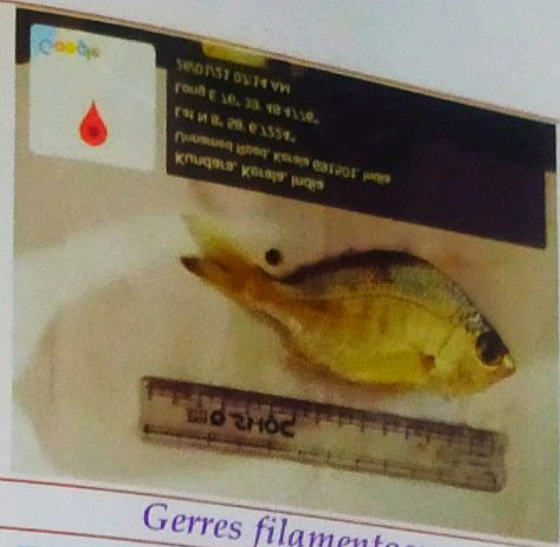


Elops machnata



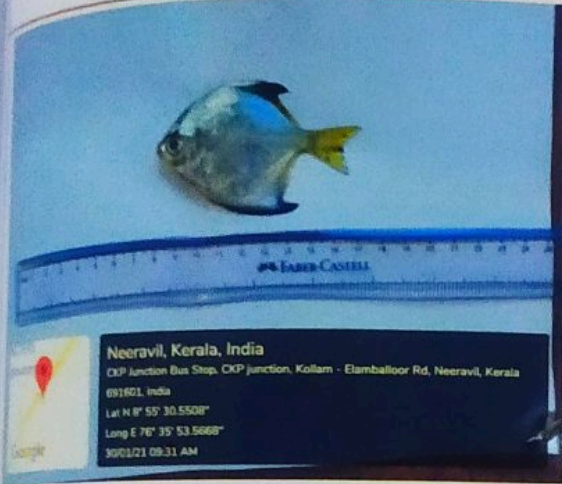
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 Unnamed Road, Kerala 691501, India
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 Long E 76° 39' 48.4884"
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Caranx ignobilis



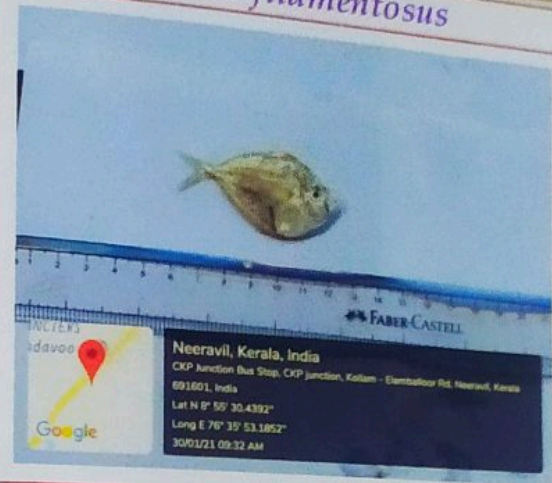
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Gerres filamentosus



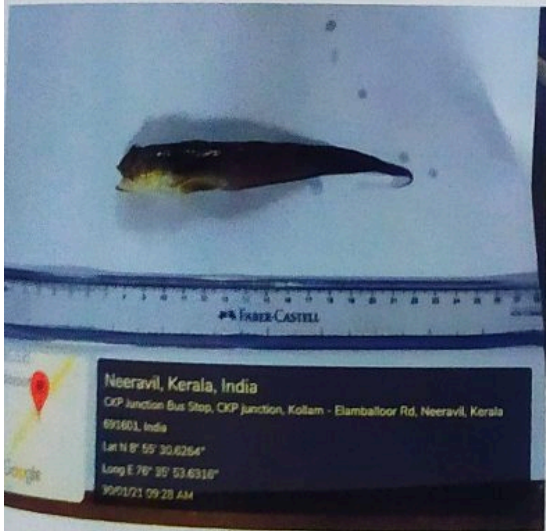
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Monodactylus argenteus



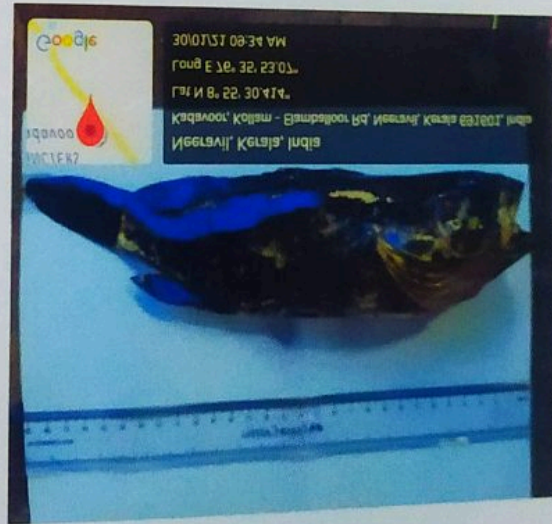
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 CKP Junction Bus Stop, CKP junction, Kollam - Elamballoor Rd, Neeravil, Kerala 691601, India
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 Long E 76° 35' 53.1852"
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Leiognathus equulus



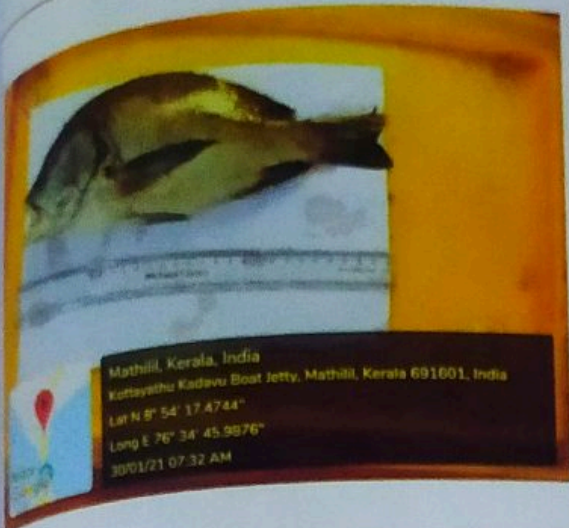
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Oxyurichthys tentacularis



Neeravil, Kerala, India
 CKP Junction Bus Stop, CKP junction, Kollam - Elamballoor Rd, Neeravil, Kerala 691601, India
 Lat N 8° 55' 30.4392"
 Long E 76° 35' 53.1852"
 30/01/21 09:32 AM

Epinephelus tauvina



Mathill, Kerala, India
 Kottayathu Kadavu Boat Jetty, Mathill, Kerala 691601, India
 Lat N 8° 54' 17.4744"
 Long E 76° 34' 45.9876"
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Lutjanus argentimaculatus



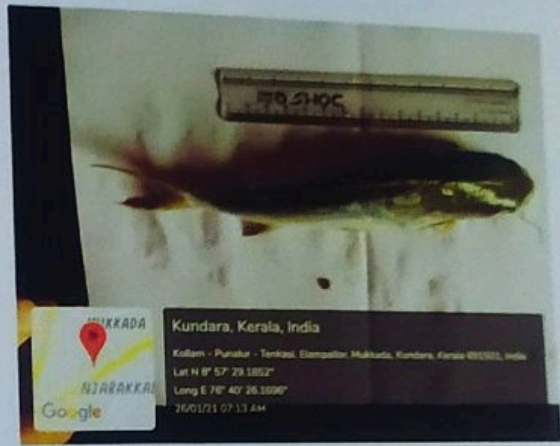
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Crenimugil buchanani



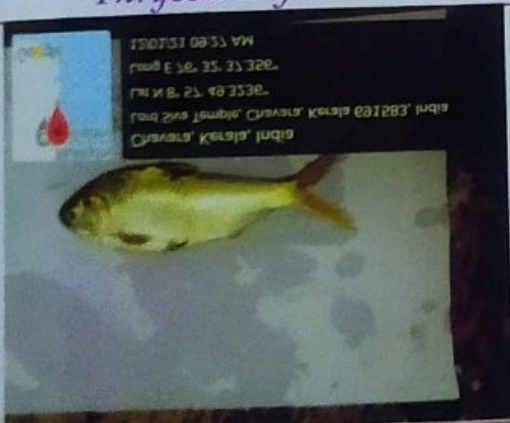
Chavara, Kerala, India
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 Long E 76° 32' 37.3560"
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Thyryssa mystax



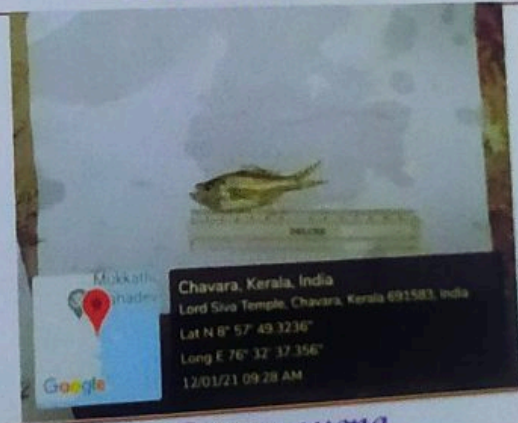
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 16/01/21 07:13 AM

Arius maculatus



Chavara, Kerala, India
 Lord Siva Temple, Chavara, Kerala 691583, India
 Lat N 8° 57' 49.3236"
 Long E 76° 32' 37.3560"
 12/01/21 09:28 AM

Nematalosa nasus



Chavara, Kerala, India
 Lord Siva Temple, Chavara, Kerala 691583, India
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 Long E 76° 32' 37.3560"
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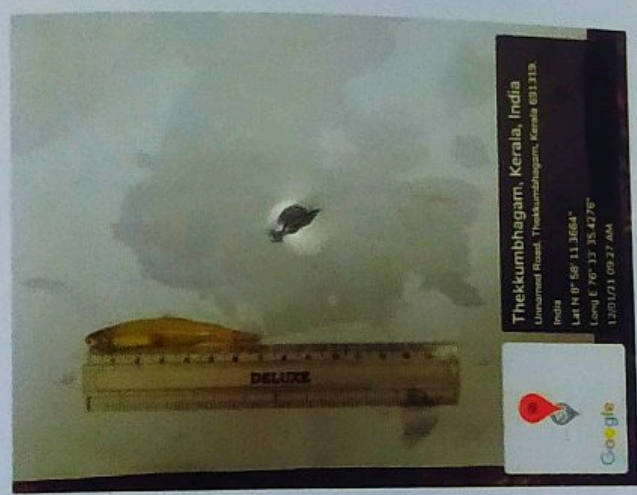
Gerrus oyena



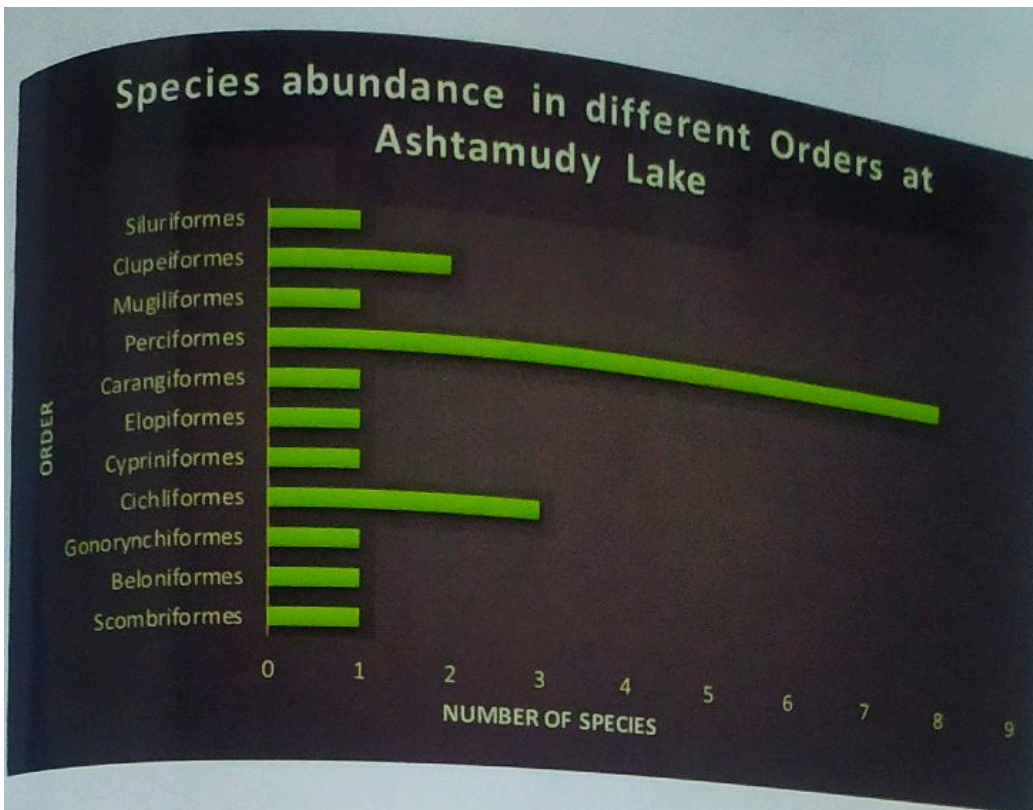
Pseudotroplus maculatus



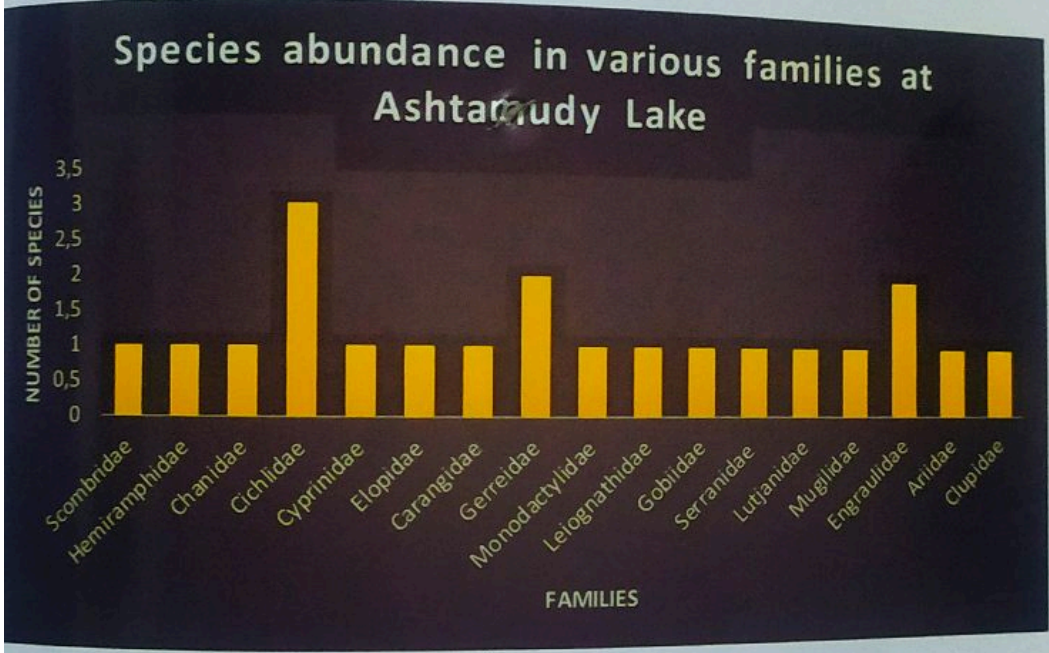
Etroplus suratensis



Stolephorus indicus



Species abundance in various orders from Ashtamudi Lake.



Species abundance in various Families landed from Ashtamudi Lake

DISCUSSION

About 21 species belonging to 17 families and 11 orders were recorded from the present study and of this 3 species was recorded from the family Cichlidae and 1 species each from Cyprinidae, Carangidae, Gerreidae, Engraulidae etc. The order which contained the most number of species was Perciformes with 8 species followed by Cichliformes with 3 species and Clupeiformes with 2 species.

Asha *et al* (2014) had conducted studies in the Vembanad estuary and some of the fishes which are commonly observed in both the estuaries are *Pseudetroplus maculatus*, *Eetroplus suratensis*, *Nematolosa nasus*, *Stolephorus indicus*, *Oxyurichthys tentacularis*, *Chanos chanos*, *Oreochromis mossambicus*, *Puntius sarana*, *Leiognathus equulus* and *Arius maculatus*.

Fish diversity of Vattakayal, which is a part of the Ashtamudi Lake was studied by Sheetal *et al* (2013) and the fishes common to both studies include *Oreochromis mossambicus*, *Eetroplus maculatus*, *E. suratensis*, *Chanos chanos* and *Puntius sarana*.

Some of the fishes recorded during the present study were also observed by Vimal Raj *et al* (2014) in the studies conducted on the Ashtamudi Lake. The common species recorded during both the studies were *Arius maculatus*, *Caranx ignobilis*, *Eetroplus suratensis*, *P. maculatus*, *Oxyurichthys tentacularis*, *Chanos chanos*, *Puntius sarana*, *Thryssa mystax*.

Leiognathus equulus, *Lutjanus argentimaculatus*, *Crenimugil buehanani* and *Stoliphorous indicus*.

Fish assemblages are influenced by the size and tidal influence of the estuary, habitat diversity, biological productivity, water quality and human activities. The abundance and diversity of estuarine fish are therefore a reflection of ecological conditions of that estuary. Estuarine fishes exhibit a number of unique adaptations and they are euryhaline in nature i.e., they can tolerate a wide range of salinity variations. Estuarine fish have adapted to use both mechanisms - in high saline water they excrete salts and retain water, and when the water gets fresher, they excrete water and retain salts. This remarkable physiological adaptation allows these species to exploit both marine and freshwater (or semi-freshwater) environments. The estuaries consist of a unique mixture of distinct habitats and these habitats do not exist in isolation. Estuaries are important as they function as spawning grounds, nursery areas, feeding grounds and as pathways in diadromous (catadromous or anadromous) migrations. Estuaries are very important habitat for resident fish and other aquatic animals in addition to marine fishes and shrimps, as some of the very important fish and prawn species use estuaries as their nursery ground and must be protected. In addition to this estuaries are of great commercial importance as seeds of prawns and economically important fishes are easily available in estuaries. The estuaries can also be used for commercial farming of food fishes such as Pearl spot (*Etroplus*), scads (*Caranx* and *Alepes*), mullet (*Valamugil*) and groupers (*Epinephelus*) through techniques such as cage and pen culture as juveniles of these commercially important species are observed during the

present study. So the study and conservation of estuarine fishes are very important.

CONCLUSION

Ashtamudi estuary and its sustainable management would affect a million people living on its shores and the large species of rare birds and animals which provide equally important biodiversity to the environment. So the following recommendations can be noted for maintaining the fish diversity and fish stocks and also the lively hood of people living in its vicinity.

- Identifying and phasing out of the sources of pollution.
- Providing better sanitation, control of industrial growth and disposal of urban waste to ensure maintainable level of water quality in the estuary.
- Monitoring the declining stock of fish production in the estuary through concerted efforts in a sustainable manner and with community participation.
- Encouraging product diversification of coir to ensure better economic returns to people with the coordination of self-help groups.
- Improved shore protection through mangrove afforestation for ecosystem development on the banks of the estuary.
- Mining to be allowed selectively at village level, away from the banks of the lake.
- Discontinuing estuary reclamation.
- Earmarking navigation routes undisturbed by fishing nets.

- Neendakara port should be provided with improved sanitation facilities, enhanced boat-fuelling terminals and drainage terminals.
- Promoting ecotourism with better facilities of inland navigation.
- Developing of marine bio-reserve, nature is land and mangrove conservation area.
- Promoting visits to nearby temples and other places of cultural and archeological importance.
- Promoting visits to coir-producing villages, rubber producing villages, rice fields, fish hatcheries and other biodiversity hot spots.

Pollution of the estuary from oil spills from thousands of fishing boats, discharge of pollutants from paper mills, aluminum industries and ceramics; retting of coconut husk, disposal of huge quantities of untreated sewage from Kollam city, direct disposal of human excreta from hanging latrines and natural habitat contribute to serious degradation including reclamation of the estuary and are the major concerns for the survival of the estuary. The failure of an estuarine eco-system can inhibit the initiatives for protection of India's coastal environment and it can totally deter the leap back to sustainable development.

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