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Ichthyofaunal Diversity in the Freshwater Tidal Stretch Along the Kalingapatnam Estuary, Srikakulam, Andhra Pradesh, India

V. Harathi[1], K. Rama Rao[2]

[1]*AU TDR-HUB, Andhra University, Visakhapatnam, India.*
[2]*Department of Zoology, Govt. Degree College for Men, Srikakulam, A. P, India.*
[32]*Department of Zoology, Dr. V. S. Krishna Government Degree & PG College (A), Visakhapatnam, A. P, India.*

**Corresponding author's: V. Harathi*

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Abstract

The present study elucidates the ichthyofaunal diversity of Kalingapatnam estuary in the North- east coast of Andhra Pradesh, India. A detailed analysis of piscine diversity revealed a total of 97 species of fresh water, estuary and marine fish belonging to 26 orders, 53 families, and 85 genera, collected three landing locations for the first time. In the present investigation, recorded genera out of 85, the homogeneous percentage was observed of Perciformes and Siluriformes had the highest with 11.76%, followed by Acanthuriformes, Cypriniformes 9.41%, Clupeiformes 8.23%, Carangiformes 4.70%, Beloniformes, Canthuriformes, Cichliformes, Spariformes, Tetraodontiformes 3.52%, Carcharhiniformes, Anabantiformes, Centrarchiformes, Gobiiformes, Mugiliformes, Mulliformes, Scombriformes, Synbranchiformes each with 2.35%. Anguilliformes, Cyprinodontiformes, Elopiformes, Gonorynchiformes, Istiophoriformes, Kurtiformes and Osteoglossiformes each with 1.17%. The habitation of fishes was primarily benthic/ demersal, with contributing to 40.20%, followed by benthopelagic 28.86%, pelagic and reef-associated fish 15.46% in this estuary. The omnivores have a highest percentage of 50.98%, followed by the carnivorous 25.49%, and the herbivorous18.36%. According to IUCN (2023) status the ichthyofaunal diversity was recorded in the current investigation.

Keywords: *Ichthyofauna, Habitation, Pelagic, Benthopelagic, Omnivores, IUCN*

1. Introduction

India has extensive estuarine and brackish water resources along its east and west coasts. According to the Government of India (2000), India's total brackish water resources are projected to be 1.44 million hectares. Orissa, Gujarat, Kerala, and West Bengal all have substantial brackish water resources. Andhra Pradesh, with a long coastline of 974 km2 and a continental shelf area of 33,227 km2, is spread over nine districts. The state has approximately 2.0 lakh hectares of brackish water and 27,500 ha of mangrove swamp. Pulicat Lake, with a total size of 77,000 hectares, is a highly important brackish water lake in the region. The Godavari estuarine system covers 330 km2. Estuaries sustain freshwater life forms, marine life forms, and ultimately brackish water forms, which may live in water with varying salinity. Furthermore, in the higher reaches, this habitat will sustain pure freshwater forms, euryhaline forms in the intermediate sections, and stenohaline forms near the mouth. (www.wikipedia.com).

According to the National Bureau of Fish Genetic Resources (NBFGR) database in Lucknow, 2,508 native finfish species have been documented, with 1,518 from the marine environment, 113 from brackish water, and 877 from freshwater environments. Fishing reduces the abundance of a top consumer (Consumer 4), raises the quantity of its prey (Consumer 3), and decreases the abundance of Consumer 3's prey. Depending on the intricacy of the food web, species in a food chain are classified into three or more trophic levels. A trophic level in a food chain refers to an organism's position in its environment. Primary producers, consumers, and detritivores are examples of these functions. The most obvious link between body size and food web structure is the trophic interaction hierarchy and the projected rise in a predator's trophic position with size (Woodward et al., 2005). Georgios Vagenas et al., (2022) explored the trophic patterns of the Balkan biodiversity hotspot's freshwater fish fauna and

compared the nutritional needs of freshwater fish species. The trophic level of the examined fish species ranged from 2.0 to 4.5, which is within the predicted range for freshwater ecosystems, indicating the existence of top predators as well as primary consumers. The fish species in the current study are classified as herbivorous (2.0-2.5), omnivore (2.5-3.5), and carnivorous (3.5-4.5) based on their trophic level.

The various contributions of dominating species in each environment caused variations in assemblage structures. The fish assemblage in the freshwater zone was dominated by common freshwater species, whereas marine juveniles were strongly connected with the estuary ecosystem. Estuary weirs have a special influence on fish assemblages because they disrupt the relationship between freshwater and estuarine fish populations and migratory success for regional fish fauna. (Joo Myun et al., 2020). The estuary may be divided into three separate hydrogeomorphic zones based on the time of year it is inundated by tidal fluctuations: subtidal, intertidal, and supratidal (Twilley et al., 2019). The tidal freshwater region differs from riverine regions primarily because of tidally produced physical phenomena such as longer water residence time, fluctuating water levels, and shifting current velocities and directions. changes from a mixohaline scenario are caused mostly by changes in salinity and particle suspended matter content. The tidal freshwater reaches are a critical site for physical, chemical, and biological processes that can significantly modify riverine intake before it reaches the freshwater-seawater interface (Schuchardt et al. 1993). This study considerably documented the total number of fish ecologically associated with the Kalingapatnam estuary's fresh and brackish waters. The first-hand information on the ichthyofaunal diversity is provided in this paper.

Fig: 1. Kalingapatnam estuary

2. Materials And Methods

Fish samples were collected from three sites, Kalingapatnam (18.343629N), 84.116297E, Rajarampuram (18.354871N), 84.118357E, and Gara (18.348191N), 84.103766E from December 2021 to November 2023 (Fig 1). The samples collected with the help of fishermen by using Seine net, bag net, cast net, gill net, scoop net, drag net, stake net, trap net of varying mesh size, hooks and line were used for fishing. Freshly collected fish were carefully cleansed and photographed. These fish were taken to the lab and fixed in glass jars before being preserved in a 9–10% formalin solution (Jayaram, K. C, 1999). The fish were recognized to the species level using keys for Indian subcontinent fish. The species were identified primarily based on morphometric and meristematic characteristics. Talwar, P. K. & Kacker, R. (1984), Barman, R.P. (1993), Day, F (1994), Jayaram K.C. (1999, 2011), Munro, I. S. R (2000), Nath, P. and Dey, S.C (2000), Talwar P.K. and Jhingran A.G. (1991), Froese, R. and D. Pauly (2023). Fischer, W. and G. Bianchi (1984). The IUCN (2023) conservation status of the fish species has been listed.

3. Results and Discussion

The current study identified the presence of 97 fish species belonging of 26 orders, 53 families, and 85 genera were collected three landing stations from December 2021 to November 2023. A list of fishes was compiled in the current study, including their order, family, genus, species, Environment, trophic level, and IUCN status. Table 1 shows the species that have been listed. The illustrate number and percentage composition of families, genera, and species under different orders in the current study. The homogeneous percentage was observed of order Perciformes and Siluriformes was dominant with 13 species, which contributed to 13.39% of the total species, followed by Cypriniformes 9 (9.27%), Acanthuriformes and Clupeiformes 8 (8.24%), Anabantiformes and Carangiformes 4 (4.12%), Canthuriformes, Beloniformes, Cichliformes, Mugiliformes, Spariformes 3 (3.09%), Carcharhiniformes, Anguilliformes, Centrarchiformes, Gobiiformes, Mulliformes, Synbranchiformes each with 2 (2.06%) and Cyprinodontiformes, Elopiformes, Gonorynchiformes, Istiophoriformes,

Kurtiformes, Osteoglossiformes each with I (1.03%) Fig 2. The estuary, which has high-saline water almost throughout year, was dominated by marine species. The similar observations were recorded by Bijukumar, & Sushama (2000) reported the ichthyofauna was represented by 112 species belonging of 14 orders, 53 families and 80 genera in Ponnani Estuary,Kerala. Abhishek Bharadwaj and Devi Prasad (2021) undertook a comprehensive investigation of piscine diversity and found 63 freshwater, estuarine, and marine fish belonging to 13 orders and 37 families. Perciformes was shown to be the largest order in the Dakshina Kannada Sasihithlu Estuary. Ray et al., (2022) observed that a total of 231 species of finfish belonging to 27 orders, 81 families, and 167 genera were recorded. In this Order Perciformes was the highest with 41 species, 22 genera, and 10families.

It was followed by Carangiformes, and Clupeiformes in Gowtami-Godavari estuary. Fullontona et al., (2019) identified a total of 87fish species belonging to 51 families inside the estuarine part of the Panchupada River during the survey period. Mukherjee et al., (2013) investigated a total of 64 brackish water species were belonging to 38families showing tropical and subtropical affinities. Fish distribution in relation to environmental varia- bles was investigated in the Matla River of Sundarban estuarine system. Chicharo et al., (2006) reported 56 fish species in the Guadiana River for two distinct hydrological years. Mohanty et al., (2015) documented 317 species belonging to 207 genera, in 88 families and 23 orders of Ichthyofaunal diversity in Chilika Lake.

In the present investigation recorded genera out of 85, the homogeneous percentage was observed of Perciformes and Siluriformes had the highest with 10 (11.76%), followed by Acanthuriformes, Cypriniformes 8 (9.41%), Clupeiformes 7 (8.23%), Carangiformes 4 (4.70%), Beloniformes, Canthuriformes, Cichliformes, Spariformes, Tetraodontiformes 3 (3.52%), Carcharhiniformes, Anabantiformes, Centrarchiformes, Gobiiformes, Mugiliformes, Mulliformes, Scombriformes, Synbranchiformes each with 2 (2.35%). Anguilliformes, Cyprinodontiformes, Elopiformes, Gonorynchiformes, Istiophoriformes, Kurtiformes and Osteoglossiformes each with 1 (1.17%) Fig 2.

In the similar observation the homogeneous percentage was observed of order Cypriniformes contributed to 42.86% of the total species observed in freshwater at river Narayana puram anicut and Madduvalasa reservoir of Vamsadhara River (Rama Rao, and Ramachandra Rao. (2021), Ramachandra Rao and Rama Rao (2023). Out of 34 recorded genera, Cypiniformes contributed 38.24% of species, followed by Siluriformes (23.21%), Perciformes (16.07%), Osteoglossiformes, Cyprinodontiformes, Ostariophysi, Anguilliformes, Beloiniformes, and Channiformes, each with 2.94%. Recorded families out of 53, the homogeneous percentage was observed of Perciformes and Siluriformes highest with 7 (13.20%), Cypriniformes 4 (7.54%), Acanthuriformes, Clupeiformes, Spariformes 3 (5.66%), Anabantiformes, Beloniformes, Carangiformes, Centrarchiformes, Gobiiformes, Tetraodontiformes each with 2 (3.77%) and archarhiniformes, Anguilliformes, Canthuriformes, Cichliformes, Cyprinodontiformes, Elopiformes, Gonorynchiformes, Istiophoriformes, Kurtiformes, Mugiliformes, Mulliformes, Osteoglossiformes, Scombriformes, Synbranchiformes each with 1 (1.88%) in Kalingapatnam estuary (Fig 2). Ghosh et al., (2011) evaluated 140 species of fish from 18 orders and 55 families of estuarine and marine species, with 59.29% moving upstream to freshwater zones. Perciformes accounted for more than 45% of all fish species reported in Subarnarekha Estuary.

In the present study ichthyofaunal diversity are classified as herbivorous (2.0-2.5), omnivore (2.5-3.5), and carnivorous (3.5-4.5) based on their trophic level. The omnivores have a highest percentage of 49 (50.51%), followed by the carnivorous 38 (39.17%), and the herbivorous 10 (10.30%) (Fig. 3). A similar study was observed by Rama Rao (2023) reported the highest number of omnivores (51.02%, followed by carnivores (26.53% and herbivores (18.36%) in `freshwater stretch Gotta Barrage at Hiramandalam and Narayana puram auict. According to Haojie Su (2021), the trophic level community structure of recorded fish species revealed the dominance of top-level carnivores (39%), followed by mid-level carnivores (28%), predators (17%), omnivores (14%), and herbivores or planktivores (2%). Various fish species have trophic levels as low as 2.0 or as high as 4.5 (Woodward et al., 2005).

In the present investigation recorded to species environment and dominance of habitation places. During the study period Marine and Brackish water fish species and Brackish water and freshwater are occupied similar numer, its contributed to 33 (34.02%) and Marine, Brackish water and freshwater 30 (30.92%) Fig 4. According to Ramanujam et al., (2014), 101 species were encountered during the investigation. 66 species were reported in the estuarine reach's brackish, saline, and marginal waters, with 47 found within the estuary itself, 34 at the place of confluence with the Bay of Bengal, and 20 in the creek's backwater.

In the present study, the habitation of fishes was primarily benthic/ demersal, with 39 contributing to 40.20%, followed by benthopelagic (28.86%), pelagic and reef-associated fish (15.46%) in this estuary.

The omnivores have a highest percentage of 26 (50.98%), followed by the carnivorous 13 (25.49%), and the herbivorous 10 (18.36%). A similar study was observed by Rama Rao (2023) reported the highest number of omnivores (51.02%, followed by carnivores (26.53% and herbivores (18.36%) in `freshwater stretch Gotta Barrage at Hiramandalam. According to IUCN (2023) status in the current investigation, 67 species contributed to 69.07% are least concern (LC), 16 species contributed to 16.49% are not evaluated (NE), 6 species contributed to 6.18% near threaten (NT), 5 species contributed to 5.15% are vulnerable (VU), and 3 species contributed to 3.09% are data deficient (DD) (Table 4; Fig.). Abhishek Bharadwaj & Devi Prasad (2021) documnted 48 species belonged to Least Concern (LC) category, two Near Threatened species (NT), two species Data Deficient (DD) and 10 species Not Evaluated (NE) category in Sasihithlu Estuary of Dakshina Kannada, Karnataka.

Table: 1. Ichthyofaunal check list of Kalingapatnam estuary

Class: Chondrichthyes/Elasmobranchii						
Order/Family		***Fish Scientific Name***	**Common Name**	**Trophic Level**	**Environment**	**Iucn Status**
I. Carcharhiniformes						
Carcharhinidae	1	*Carcharhinus Sorrah (Müller & Henle, 1839)*	Spot-Tail Shark	4.2 ±0.5	Marine; Brackish; Reef-Associated	Nt
	2	*Rhizoprionodon Acutus (Rüppell, 1837)*	Milk Shark	4.3 ±0.4	Marine; Freshwater; Brackish; Benthopelagic	Vu
Class: Osteichthyes/Actinopterygii						
II. Acanthuriformes						
Drepaneidae	3	*Drepane Longimana (Bloch&Schneider, 1801)*	Banded Sicklefish	3.5 ±0.37	Marine; Brackish; Reef-Associated; Amphidromous	Nt
Leiognathidae	4	*Deveximentum Insidiator (Bloch, 1787)*	Pugnose Ponyfish	2.8 ±0.27	Marine; Brackish; Demersal; Amphidromous	Ne
	5	*Eubleekeria Splendens (Cuvier, 1829)*	Splendid Ponyfish	2.9 ±0.38	Marine; Brackish; Demersal; Amphidromous	Lc
	6	*Gazza Minuta (Bloch, 1795)*	Toothpony Fish	4.2 ±0.0	Marine; Brackish; Demersal;	Lc
	7	*Karalla Dussumieri (Valenciennes, 1835)*	Dussumier's Ponyfish	3.2 ±0.38	Marine; Brackish; Demersal	Ne
	8	*Leiognathus Equulus (Forsskål, 1775)*	Common Ponyfish	3.0 ±0.40	Marine; Freshwater; Brackish; Demersal; Amphidromous	Lc
	9	*Nuchequula Nuchalis (Temminck & Schlegel, 1845)*	Spotnape Ponyfish	3.0 ±0.25	Marine; Brackish; Pelagic-Neritic	Ne
Scatophagidae	10	*Scatophagus Argus (Linnaeus, 1766)*	Spotted Scat	3.0 ±0.35	Marine; Freshwater; Brackish; Demersal; Amphidromous	Lc
III. Anguilliformes						
Anguillidae	11	*Anguilla Bengalensis* (Gray, 1830)	Indian Long Fin Eel	3.8 ±0.7	Marine; Freshwater; Brackish; Benthopelagic; Catadromous	Nt

	12	*Anguilla Bicolour* (Mcclelland, 1844)	Indian Short Fin Eel	3.6 ±0.50	Marine; Freshwater; Brackish; Demersal; Catadromous	Nt
IV. Anabantiformes						
Anabantidae	13	*Anabas Testudines* (Bloch, 1792)	Climbing Perch	3.0 ±0.4	Freshwater; Brackish; Demersal; Potamodromous	Lc
Channidae	14	*Channa Orientalis* (Bloch & Schneider, 1801)	Walking Snakehead	3.8 ±0.59	Freshwater; Brackish; Benthopelagic	Vu
	15	*Channa Punctata* (Bloch, 1793)	Spotted Snakehead	3.8 ±0.70	Freshwater; Brackish; Benthopelagic; Potamodromous	Lc
	16	*Channa Striata* (Bloch, 1793)	Striped Snakehead	3.6 ±0.47	Freshwater; Brackish; Benthopelagic	Lc
V. Beloniformes						
Belonidae	17	*Strongylura Strongylura (Vanhasselt, 1823)*	Spottail Needlefish	4.2 ±0.73	Marine; Brackish; Pelagic-Neritic	Ne
	18	*Xenentodon Cancila* (Hamilton, 1822)	Freshwater Garfish	3.9 ±0.62	Freshwater; Brackish; Pelagic-Neritic	Lc
Hemiramphidae	19	*Hyporhamphus Limbatus* (Valencienues, 1847)	Congaturi Halfbeak	3.1 ±0.1	Marine; Freshwater; Brackish; Pelagic-Neritic; Potamodromous	Lc
VI. Canthuriformes						
Sciaenidae	20	*Leiostomus Xanthurus (Lacépède, 1802)*	Spot Croaker	3.2 ±0.1	Marine; Brackish; Demersal; Oceanodromous	Lc
	21	*Sciaenops Ocellatus (Linnaeus, 1766)*	Red Drum	3.7 ±0.57	Marine; Brackish; Demersal; Oceanodromous	Lc
	22	*Pennahia Argentata(Houttuyn, 1782)*	Silver Croaker	4.1 ±0.7	Marine; Benthopelagic; Oceanodromous	Lc
VII. Carangiformes						
Carangidae	23	*Caranx Ignobilis (Forsskål, 1775)*	Giant Trevally	4.2 ±0.4	Marine; Brackish; Reef-Associated	Lc
	24	*Trachinotus Carolinus (Linnaeus, 1766)*	Florida Pampino	3.5 ±0.6	Marine; Brackish; Benthopelagic; Oceanodromous	Lc
	25	*Carangoides Ferdau (Forsskal, 1775)*	Yellowspotted Crevelle	4.3 ±0.5	Marine; Brackish; Reef-Associated;	Lc
Rachycentridae	26	*Rachycentron Canadum (Linnaeus, 1766)*	Cobia	4.0 ±0.0	Marine; Brackish; Reef-Associated; Oceanodromous	Lc
VIII. Centrarchiformes						
Terapontidae	27	*Terapon Jarbua (Fabricius, 1775)*	Jarbua Terapon	3.9 ±0.5	Marine; Freshwater; Brackish; Demersal; Catadromous	Lc

Percalatidae	28	*Percalates Colonorum (Gunther,1863)*	Brackish Water Perch	3.5 ±0.4	Freshwater; Brackish; Demersal; Catadromous	Lc
IX. Cichliformes						
Cichlidae	29	*Oreochromis Mossambicus* (Peters, 1852)	Mozambique Tilapia	2.2 ±0.0	Freshwater; Brackish; Benthopelagic; Amphidromous	Vu
	30	*Etroplus Sureness* (Bloch, 1790)	Pearl Spot	2.9 ±0.26	Freshwater; Brackish; Benthopelagic	Lc
	31	*Pseudetroplus Maculates* (Bloch, 1795)	Ornage Chromid	2.7 ±0.1	Freshwater; Brackish; Benthopelagic	Lc
X. Clupeiformes						
Dorosomatidae	32	*Konosirus Punctatus (Temmink & Schlegei,1846)*	Dotted Gizzard Shad	2.9 ±0.24	Marine; Brackish; Pelagic-Neritic; Oceanodromous	Lc
	33	*Hilsa Kelee (Cuvier, 1829)*	Kelee Shad	2.9 ±0.33	Marine; Freshwater; Brackish; Pelagic-Neritic; Anadromous	Lc
	34	*Sardinella Fimbriata (Valenciennes, 1847)*	Fringescale Sardinella	2.7 ±0.30	Marine; Brackish; Pelagic-Neritic	Lc
	35	*Tenualosa Ilisha (Hamilton, 1822)*	Hilsa Shad	2.9 ±0.29	Marine; Freshwater; Brackish; Pelagic-Neritic; Anadromous	Ne
	36	*Nematalosa Nasus (Bloch, 1849)*	Bloch's Gizzard Shad	2.2 ±0.09	Marine; Freshwater; Brackish; Pelagic-Neritic; Anadromous	Lc
Engraulidae	37	*Stolephorus Indicus (Van Hasselt, 1823)*	Indian Anchovy	3.6 ±0.0	Marine; Brackish; Pelagic-Neritic; Oceanodromous	Lc
	38	*Stolephorus Commersonnii Lacepède, 1803*	Commerson's Anchovy	3.1 ±0.20	Marine; Brackish; Pelagic-Neritic; Anadromous	Lc
Pristigasteridae	39	*Opisthopterus Tardo Ore* (Cuvier, 1829)	Tardoore, Long Finned Herring	3.4 ±0.46	Marine; Brackish; Pelagic-Neritic; Amphidromous	Lc
XI. Cypriniformes						
Cyprinidae	40	*Cyprinus Carpio* (Linnaeus, 1758)	Common Carp	3.1 ±0.0	Freshwater; Brackish; Benthopelagic	Vu
	41	*Labeo Calbasu* (Hamilton-Buchanan, 1822)	Black Rohu	2.0 ±0.00	Freshwater; Brackish; Demersal; Potamodromous	Lc
	42	*Puntius Sophore (F.Hamilton, 1822)*	Pool Barb	2.6 ±0.1	Freshwater; Brackish; Benthopelagic	Lc
	43	*Puntius Ticto* (Hamilton, 1822)	Ticto Barb	2.2 ±0.0	Freshwater; Brackish; Benthopelagic	Lc

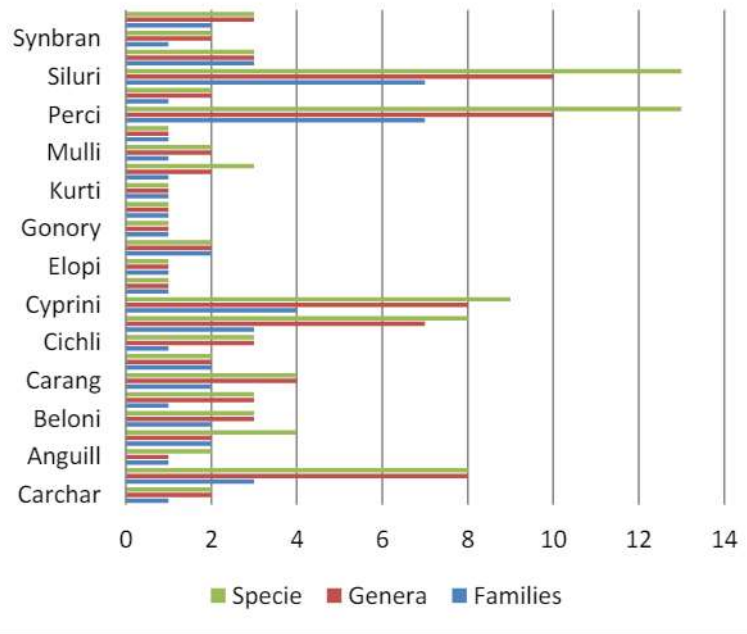
	44	*Systomus Sarana* (Hamilton, 1822)	Olive Barb	2.9 ±0.2	Freshwater; Brackish; Benthopelagic; Potamodromous	Lc
Danionidae	45	*Rasbora Daniconius* (Hamilton, 1822)	Slender Rasbora	3.1 ±0.1	Freshwater; Brackish; Benthopelagic	Lc
	46	*Salmostoma Bacaila* (Hamilton, 1822)	Large Razorbelly Minnow	3.2 ±0.40	Freshwater; Brackish; Benthopelagic; Potamodromous	Lc
Xenocyprididae	47	*Ctenopharyngodon Idella* (Valencienues, 1844)	Grass Carp	2.0 ±0.00	Freshwater; Brackish; Benthopelagic; Potamodromous	Lc
	48	*Hypophthalmichthys Molitrix* (Valencienues,1844)	Silver Carp	2.0 ±0.00	Freshwater; Brackish; Benthopelagic; Potamodromous	Nt
Cyprinodontiformes						
Aplocheilidae	49	*Aplocheilus Panchax (Hamilton, 1822)*	Blue Panchax	3.2 ±0.40	Freshwater; Brackish; Benthopelagic	Lc
XII. Elopiformes						
Megalopidae	50	*Megalops Cyprinoides (Broussonet 1782)*	Indo-Pacific Tarpon	3.5 ±0.1	Marine; Freshwater; Brackish; Benthopelagic; Amphidromous	Dd
XIII. Gobiiformes						
Eleotridae	51	*Eleotris Fusca (Forster, 1801)*	Dusky Sleeper	3.8 ±0.3	Marine; Freshwater; Brackish; Demersal; Amphidromous	Lc
Gobiidae	52	*Glossogobius Giuris* (Hamilton, 1822)	Tank/Bar-Eyed Goby	3.7 ±0.2	Marine; Freshwater; Brackish; Benthopelagic	Lc
Xiv. Gonorynchiformes						
Chanidae	53	*Chanos Chanos* (Forsskal, 1775)	Milkfish	2.4 ±0.20	Marine; Freshwater; Brackish; Benthopelagic; Amphidromous	Lc
XV. Istiophoriformes						
Sphyraenidae	54	*Sphyraena Obtusata (Cuvier, 1829)*	Barracuda	4.5 ±0.4	Marine; Brackish; Reef-Associated	Ne
XVI. Kurtiformes						
Apogonidae	55	*Ostorhinchus Semilineatus (Temminck & Schlegel, 1842)*	Half-Lined Cardinal	3.5 ±0.0	Marine; Brackish; Reef-Associated	Dd
XVII. Mugiliformes						
Mugilidae	56	*Mugil Cephalus (Linnaeus, 1758)*	Flathead Grey Mullet	2.5 ±0.17	Marine; Freshwater; Brackish; Benthopelagic; Catadromous	Lc
	57	*\Planiliza Parsia (Hamilton, 1822)*	Goldspot Mullet	2.0 ±0.00	Marine; Freshwater; Brackish; Demersal; Catadromous	Ne

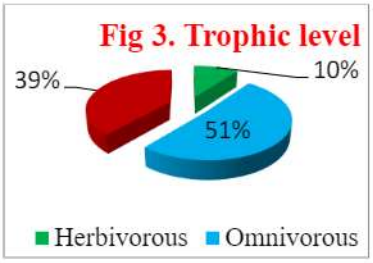
	58	*Planiliza Macrolepis* (Smith, 1846)	Largescale Mullet	2.4 ±0.2	Marine; Freshwater; Brackish; Demersal. Subtropical	Lc
XVIII. Mulliformes						
Mullidae	59	*Parupeneus Indicus (Shaw, 1803)*	Indian Goatfish	3.5 ±0.37	Marine; Brackish; Reef-Associated	Lc
	60	*Upeneus Vittatus (Forsskål, 1775)*	Yellow Striped Goatfish	3.6 ±0.0	Marine; Brackish; Reef-Associated	Lc
XIX. Osteoglossiformes						
Notopteridae	61	*Notopterus Notopterus* (Pallas, 1769)	Grey Feather Back	3.5 ±0.0	Freshwater; Brackish; Demersal	Lc
XX. Perciformes						
Ambassidae	62	*Ambassis Nalua (Hamilton, 1822)*	Scalloped Perchlet	3.4 ±0.4	Marine; Freshwater; Brackish; Demersal; Amphidromous	Lc
	63	*Chanda Nama (Hamilton, 1822)*	Elongate Glass-Perchlet	3.6 ±0.54	Freshwater; Brackish; Benthopelagic; Potamodromous	Lc
	64	*Parambassis Ranga* (Hamilton, 1822)	Indian Glassy Fish	**3.5 ±0.32**	Freshwater; Brackish; Demersal	Lc
Gerreidae	65	*Gerres Filamentosus (Cuvier, 1829)*	Whipfin Silver-Biddy	3.3 ±0.2	Marine; Freshwater; Brackish; Demersal; Amphidromous	Lc
	66	*Gerres Subfasciatus (Cuvier, 1830)*	Common Silver Belley	3.3 ±0.3	Marine; Brackish; Demersal	Lc
Latidae	67	*Lates Calcarifer (Bloch, 1790)*	Barramundi	3·8	Marine; Freshwater; Brackish; Demersal; Catadromous	Lc
Lutjanidae	68	*Lutjanus Argentimaculatus (Forsskål, 1775)*	Mangrove Red Snapper	3.6 ±0.5	Marine; Freshwater; Brackish; Reef-Associated; Oceanodromous	Lc
	69	*Lutjanus Johnii (Bloch, 1792)*	John's Snapper	4.2 ±0.6	Marine; Brackish; Reef-Associated; Oceanodromous	Ne
	70	*Lutjanus Indicus (Allen, White&Erdmann, 2013)*	Snapper Fish	3.8 ±0.6	Marine; Freshwater; Brackish; Reef-Associated	Lc
Monodactylidae	71	*Monodactylus Argenteus (Linnaeus, 1758)*	Silver Moony	3.0 ±0.33	Marine; Freshwater; Brackish; Pelagic-Neritic	Lc
Polynemidae	72	*Eleutheronema Tetradactylum (Shaw, 1804)*	Fourfinger Threadfin	4.1 ±0.5	Marine; Freshwater; Brackish; Pelagic-Neritic; Amphidromous	Ne

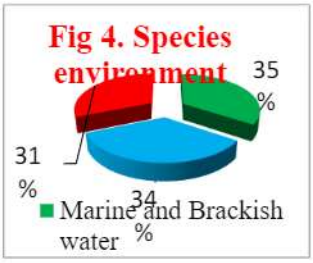
	73	*Leptomelanosoma Indicum (Shaw, 1804)*	Indian Threadfin	3.9 ±0.67	Marine; Brackish; Demersal; Amphidromous	Ne
Sciaenidae	74	*Johnius Coitor* (Hamilton, 1822)	Coitor Croaker	3.4 ±0.5	Marine; Freshwater; Brackish; Demersal; Amphidromous	Lc
XXI. Scombriformes						
Trichiuridae	75	*Trichiurus Lepturus (Linnaeus, 1758)*	Largehead Hairtail	4.20	Marine; Brackish; Benthopelagic; Amphidromous	Lc
	76	*Lepturacanthus Savala (Cuvier, 1829)*	Savalai Hairtail	4.3 ±0.76	Marine; Brackish; Benthopelagic	Ne
XXII. Siluriformes						
Ariidae	77	*Arius Arius (Hamilton, 1822)*	Threadfin Sea Catfish	3.5 ±0.37	Marine; Brackish; Demersal; Amphidromous	Ne
	78	*Arius Jella (Day, 1877)*	Blackfin Sea Catfish	3.5 ±0.37	Marine; Brackish; Demersal; Amphidromous	Ne
	79	*Arius Maculatus (Thunberg, 1792)*	Spotted Catfish	3.4 ±0.46	Marine; Freshwater; Brackish; Demersal; Potamodromous	Ne
	80	*Nemapteryx Caelata (Valenciennes, 1840)*	Engraved Catfish	4.0 ±0.64	Marine; Brackish; Demersal; Potamodromous	Ne
	81	*Plicofollis Dussumieri (Valenciennes, 1840)*	Blacktip Sea Catfish	4.0 ±0.62	Marine; Freshwater; Brackish; Demersal	Lc
Bagridae	82	*Mystus Cavasius* (Hamilton, 1822)	Gangetic Mystus	3.4 ±0.4	Freshwater; Brackish; Demersal; Amphidromous	Lc
	83	*Mystus Vittatus* (Bloch, 1794)	Striped Dwarf Catfish	3.1 ±0.1	Freshwater; Brackish; Demersal	Lc
Clariidae	84	*Clarias Batrachus* (Linnaeus, 1758)	Air Breathing Catfishes/ Magur	3.4 ±0.50	Freshwater; Brackish; Demersal; Potamodromous	Lc
Heteropneustidae	85	*Heteropneustes Fossilis* (Bloch, 1794)	Stinging Catfish	3.6 ±0.3	Freshwater; Brackish; Demersal;	Lc
Pangasiidae	86	*Pangasius Pangasiu* (Hamilton, 1822)	Pangas Catfish	3.4 ±0.51	Freshwater; Brackish; Benthopelagic	Lc
Schilbeidae	87	*Eutropiichthys Vacha* (Hamilton, 1822)	Batchwa Vacha	3.9 ±0.63	Freshwater; Brackish; Pelagic; Potamodromous	Lc
Siluridae	88	*Ompok Bimaculatu* (Bloch, 1794)	Butter Catfish	3.9 ±0.4	Freshwater; Brackish; Demersal;	Nt

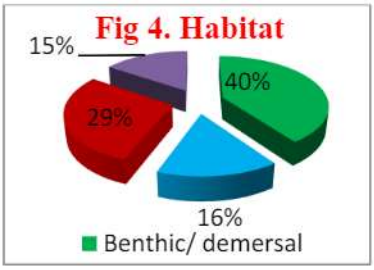
	89	*Wallago Attu* (Bloch & Schneider, 1801)	Wallago	3.7 ±0.56	Freshwater; Brackish; Demersal; Potamodromous	Vu
XXIII. Spariformes						
Lethrinidae	90	*Lethrinus Nebulosus (Forsskal, 1775)*	Spangled Emperor	3.8 ±0.2	Marine; Brackish; Reef-Associated; Non-Migratory	Lc
Sparidae	91	*Acanthopagrus Latus (Houttuyn, 1782)*	Yellowfin Seabream	3.8 ±0.43	Marine; Freshwater; Brackish; Demersal.	Dd
Sillaginidae	92	*Sillago Sihama (Fabricius, 1775)*	Silver Sillago	3.3 ±0.1	Marine; Brackish; Reef-Associated; Amphidromous	Lc
XXIV. Synbranchiformes						
Mastacembelidae	93	*Mastacembelus Armatus* (Lacepède, 1800))	Zig Zag Eel	2.8 ±0.27	Freshwater; Brackish; Demersal	Lc
	94	*Macrognathus Pancalus* (Hamilton, 1822)	Barred Spiny Eel	3.5 ±0.51	Freshwater; Brackish; Benthopelagic	Lc
XXV. Tetraodontiformes						
Tetraodontidae	95	*Chelonodontops Patoca (Hamilton, 1822)*	Milkspotted Puffer	3.1 ±0.40	Marine; Freshwater; Brackish; Reef-Associated; Anadromous	Lc
	96	*Leiodon Cutcutia Hamilton, 1822*	Ocellated Pufferfish	3.3 ±0.2	Freshwater; Brackish; Demersal	Lc
Triacanthidae	97	*Triacanthus Biaculeatus (Bloch, 1786)*	Short-Nosed Tripodfish	2.8 ±0.29	Marine; Brackish; Demersal	Ne

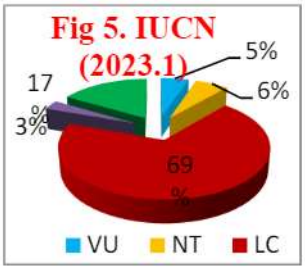
Fig: 2. Number and percentage composition of under various orders











4. Conclusion

The present study has unveiled a relatively rich ichthyofaunal diversity in Kalingapatnam estuary During the study period Marine and Brackish water fish species and Brackish water and freshwater are occupied similar number, its contributed to 33 and Marine, Brackish water and freshwater 30, Habitation of fishes were primarily benthic/ demersal, contributed to highest, followed by benthopelagic, pelagic and reef-associated fish in this estuary. The omnivores have a highest percentage, followed by the carnivorous and the herbivorous. The estuary, which has high-saline water almost throughout year, was dominated by marine species. The present study can be used as baseline data to assess the status of ichthyofauna and to formulate conservation strategies.

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Declaration

The methodology was collaboration between both authors, KRR and VH, who contributed to the completion of this work and also carried out the morphometric, meristic, trophic level, and IUCN status analyses of the wild fish. The final manuscript was read and approved by both writers.

Ethical Approval

This study was conducted according to international ethical standards set by the Institutional Animal Care and Use Committee

Consent to participate

Not applicable as commercial gear operating estuary, the local fishermen were involved in the sampling study.

Data availability statement

The authors confirm that the data used to support the findings of this study are available within the manuscript.

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