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Study on the Ornamental Fin Fish of Indian Sundarbans with Special Reference to Few Floral Sources for Carotenoid Pigmentation

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Abstract: Marine aquarium trade is rapidly expanding and there is a growing demand for tropical marine aquarium fishes in the international market. This paper provides an initial assessment of a new venture, the mangrove ornamental fish resources in Indian Sundarbans. A total of 67 species of finfish were identified of which the representatives from the order Perciformes are dominant. Mangrove plants association is one of the great sources of pigmentation for the estuarine fishes. Different types of carotenoid pigments were recorded from 22 estuarine fin fish species, among which many are common with the pigments isolated from the ripen leaves of 8 mangrove plant species.

Key words: Perciformes % Mangrove% Estuarine, Ripen Leaves.

INTRODUCTION

Ornamental fishes are characterized by a wide diversity of colors and color patterns and success in the ornamental fish trade is very much dependent on the vibrant color of the fish [1]. Marine aquarium trade is rapidly expanding and there is a growing demand for tropical marine aquarium fishes in the international market. Globally, the aquarium industry is valued at 4-15 billion USA dollars. In USA, 89 million fresh water fishes are being maintained in 12.1 million tanks while 5.6 million tropical marine fishes, in 1.1 million tanks [2]. In India, the scientific and technological advancements have led to an increased demand for tropical marine aquarium fishes in the recent years and this has opened a new avenue for developing a lucrative and money spinning. It has been estimated that 1.5-2 million people worldwide keep marine aquaria [3]. Estimated value of marine ornamental trade is 200-330 million US $ per year [4, 5].The largest suppliers of marine ornamental fishes are Indonesia and the Philippines. Brazil is one of the leading exporters of freshwater ornamental fishes, but also appears as a consistent supplier of marine species [6]. Unlike freshwater aquaria species, where 90% of fish species are currently farmed, the majority of marine aquaria are stocked from wild caught species [7]. According to data held in Global Marine Aquarium Database a total of 1,471 species of marine ornamental fishes are traded globally. Most of the species are associated with coral reefs although relatively a high number of species are associated with mangrove habitats and mudflats. About 400 species of ornamental fishes belonging to 175 genera and 50 families are reported in Indian waters. But this figure is on the rise as more numbers of surveys are made in different coral locations of the country [8]. Generally the ornamental fishes found in mangroves represent estuarine species along with inclusion of some marine species. Nyanti *et al*. [9] reported that the fish population found in the river especially the larger-sized individuals are sporadic visitors to the area. During the rainy season, the increased flow of freshwater results in the appearance of freshwater species. Mangroves are valuable ecosystems that act as nurseries and feeding grounds for many fish species including non- resident fish that enter the mangroves to feed at high tide [10]. These brackish waters are home to an amazingly diverse and unique group of fishes, some of which are commonly available to keep in the home aquarium. A number of surveys have

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been made for the estimation of finfish diversity in Indian mangrove ecosystem [11-19], but till now no research work has been attempted related to the diversity of ornamental fish resources of the Indian Sundarbans. The present study aims to explore a new horizon of utility of mangroves bioresources by icthyofaunal species in mangrove based Sundarban Biosphere Reserve.

MATERIALS AND METHODS

Collection and Identification of Samples: The ornamental fishes were collected by bag nets, scoop nets and cast net between the periods of April, 2009- March, 2010. The fishes were sampled from some main rivers of Indian Sundarbans like Muriganga, Hetania-Doania, Saptamukhi, Thakuran and Matla from few of their tidal estuarine creeks (Fig. 1). The collected fishes were transported by the help of buckets with battery aerator. They were initially acclimatized to the ambient environment of artificial aquaria. Some of the fishes which were euryhaline in nature were acclimatized successfully to live even in freshwater by gradual reduction of the salinity of the aquarium. The fishes were identified following by Talwar *et al*. Talwar & Kacker, Talwar & Jhingran and Fish Base [14, 20-22]. The mangroves leaves were identified following Naskar & Naskar and Guha Bakshi [12, 19].

Estimation of Carotenoids from Mangrove Leaves and Fish Species: Estimation of total carotenoid from different organs (like scale, fins etc) of 22 finfish species and from ripen leaves of 8 mangrove plant were carried out according to the procedure of BioAstin/ Naturose [23].

Analysis of UV-Viz study: The optical absorbance spectra of the ripen leaves of 8 mangroves and samples from 22 fishes were recorded in the wavelength range of 300-700 nm using a spectrophotometer (Shimadzu UV-3101PC) at room temperature.

RESULTS

The total numbers of 67 fish species were recorded during our study period from the Indian Sundarban Biosphere Reserve (Table 1). It was also found that the Order Perciformes emerge as most dominant groups among these diverse colored fish community (Fig. 2). The maximum to minimum varieties of estuarine ornamental fin fishes were recorded during monsoon, post monsoon and pre monsoon respectively, in all five rivers (Fig. 3). It was found that the Matla River harbors the highest colored finfish species throughout the year i.e. monsoon, post monsoon and pre monsoon (Fig. 3). Out of 8 species of selected mangrove plants, we found Retinyl acetate;

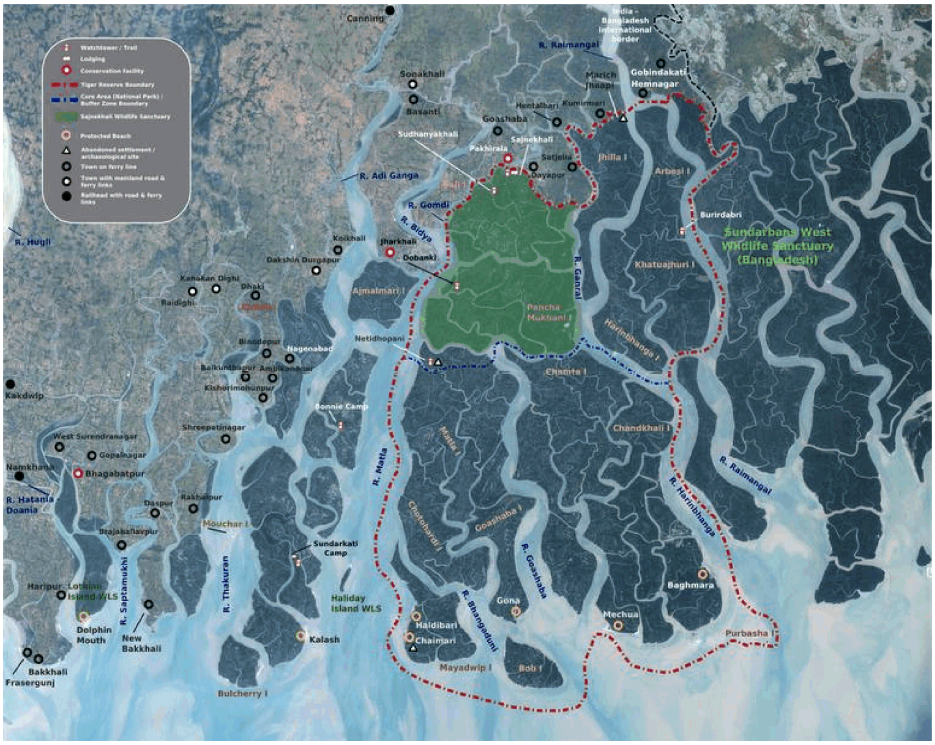

Fig. 1: Map of Sundarban

Table 1: List of ornamental fish species documented from the study sites of Sundarban Mangroves.

No.	Scientific name	Local name	Order	Family
1	*Scatophagus argus* (Linnaeus)	Pairatoli/Paira Chanda	Perciformes	Scatophagidae
2	*Monodactylus argenteus* (Linnaeus)	Chanda	Perciformes	Monodactylidae
3	*Hemiramphus far* (Forsskal)	Bak	Atheriniformes	Hemiramphidae
4	*Therapon jarbua* (Forsskal)	Kath koi	Perciformes	Teraponidae
5	*Leiognathus splendens* (Cuvier)	Bhola	Perciformes	Leognathidae
6	*Periophthalmus weberi* Eggert	Daku macch	Perciformes	Gobiidae
7	*Chelanodon patoca* (Hamilton- Buchanan)	Patoka	Tetraodontiformes	Tetraodontidae
8	*Chelanodon fluviatilis* (Hamilton- Buchanan)	Patoka	Tetraodontiformes	Tetraodontidae
9	*Tetraodon cutcutia* Hamilton- Buchanan	Tapa	Tetraodontiformes	Tetraodontidae
10	*Mystus gulio* (Hamilton- Buchanan)	Nona tangra	Siluriformes	Bagridae
11	*Toxotes chataeus* (Hamilton- Buchanan)	Rucho/uchoo	Perciformes	Toxotidae
12	*Brachygobius nunus* (Hamilton- Buchanan)	Nona Bele	Perciformes	Gobiidae
13	*Triacanthus biacculeatus* (Bloch)	Helicopter	Tetraodontiformes	Triacanthidae
14	Glossogobius guiris (Hamilton- Buchanan)	Bele	Perciformes	Gobiidae
15	*Etropus macculeatus* (Bloch)	Bele	Perciformes	Cichlidae
16	*Etropus suratensis* (Bloch)	Bele	Perciformes	Cichlidae
17	*Drepane punctatus* (Linnaeus)	Baul Pomfret	Perciformes	Ephippidae
18	*Pisodonophis boro* (Hamilton- Buchanan)	Sona Bam	Anguilliformes	Ophichthidae
19	*Arius dussumieri* Valenciennes	Med kanta	Siluriformes	Ariidae
20	*Lutjanus johni* (Bloch)	Koi bhola/Chanda koi	Perciformes	Lutjanidae
21	*Pterotolithus macculatus*	Madhu bhola	Perciformes	Sciaenidae
22	*Leognathus blochii* (Valenciennes)	Chhoto Chanda	Perciformes	Leognathidae
23	*Secotor ruconius* (Hamilton- Buchanan)	Baro Chanda	Perciformes	Leognathidae
24	*Sillaginopsis panijus* (Hamilton)	Tul bele	Perciformes	Sillaginidae
25	*Bregmaceros maccleandi* Thompson	Rule	Gadiformes	Bregmacerotidae
26	*Dasciaena albida* (Cuvier)	Surungi Bhola	Perciformes	Sciaenidae
27	*Stigmatogobius javanicus* (Bleeker)	Sabuj chhap Bele	Perciformes	Gobiidae
28	*Stigmatogobius sadanundio* (Hamilton- Buchanan)	Kalo chhapBele	Perciformes	Gobiidae
29	*Odontamplyophus rubicondus* (Hamilton- Buchanan)	Pithuli	Perciformes	Gobioidae
30	*Taeniodae anguillaris* (Linnaeus)	Cheoa	Perciformes	Gobioidae
31	T. *buchanani* (Dey)	Lal Cheoa	Perciformes	Gobioidae
32	*Megalops cyprinoids* (Broussonet)	Omlet	Elopiformes	Megalopidae
33	*Boleopthalmus boddarti* (Pallas)	Menu machh	Perciformes	Gobiidae
34	*Gobiopterus chuno* (Hamilton- Buchanan)	Gang chuno	Perciformes	Gobiidae
35	*Polymenus paradiseus* Linnaeus	Topse	Perciformes	Polymenidae
36	*Coilia ramcarti* (Hamilton- Buchanan)	Jat Amude	Clupeiformes	Engraulidae
37	C. *reynaldi* Valnciennes	Rupoli Amude	Clupeiformes	Engraulidae
38	C. *dussumieri* Valnciennes	Amude	Clupeiformes	Engraulidae
39	*Pampus chinensis* (Euphrasen)	Pomphret	Perciformes	Stromateidae
40	*Anguilla bengalensis* (Gray and Hardwicke)	Bam	Anguilliformes	Anguillidae
41	*Mene maculate* (Bloch)	Chanda	Perciformes	Menidae
42	*Pseudorhombus arsius* (Hamilton- Buchanan)	Bhoot pata	Perciformes	Bothidae
43	*Cynoglossus lingua* Hamilton - Buchanan	Salfish	Pleuronectiformes	Cynoglossidae
44	*Platycephalus indicus* (Linnaeus)	Chota bele	Scorpaeniformes	Platicephalidae
45	*Protonibea diacanthus* (Lacepede)	Kat Bhola	Perciformes	Lutjanidae
46	*Mystus bleekeri* (Day)	Gang tangra	Siluriformes	Bagridae
47	*Paraplagusia bilineata* (Bloch)	Pata machh	Pleuronectiformes	Cynoglossidae
48	*Mugil cephalus* Linnaeus	Parse	Perciformes	Mugilidae
49	*Alepes djedaba*	Kane Poka	Perciformes	Carangidae
50	*Hilsa toli*	Kokila	Clupeiformes	Clupeidse
51	*Pterotolithus maculatus*	Tika Bhola	Perciformes	Sciaenidae
52	*Periopthalmus variabilis*	Menu	Perciformes	Gobiidae
53	*Periopthalmodon schlosseri*	Menu	Perciformes	Gobiidae
54	*Eleutheronema tetradactylym*	Gurjali	Perciformes	Polynemidae
55	*Lutjanus johni*	Pankhai	Perciformes	Lutjanidae
56	*Protonibea diacanthus*	Kalo Bhola	Perciformes	Sciaenidae
57	*Johnius coitor*	Lal Bhola	Perciformes	Sciaenidae
58	*Muraenosox talaban*	Nona bam	Anguilliformes	Muraenesocidae
59	*Zenarchopterus ectunio*	Bak	Cyprinodontiformes	Hemiramphidae
60	*Strongylura strongylura*	Bak	Atheriniformes	Belonidae
61	*Brachygobius nunas*	Nona Bele	Perciformes	Gobiidae
62	*Atropus atropus*	Taka	Perciformes	Carangidae
63	*Bregmaceros maccleandii*	Rule	Gadiformes	Bregmacerotidae
64	*Toxotes chatereus*	Baishnab chuno	Perciformes	Toxotidae
65	*Butis butis*	Bhut Bele	Perciformes	Eleotrididae
66	*Panna microdon*	Surungi Bhola	Perciformes	Sciaenidae
67	*Moringua raitaborua*	Nona Bam	Anguilliformes	Moringuanidae

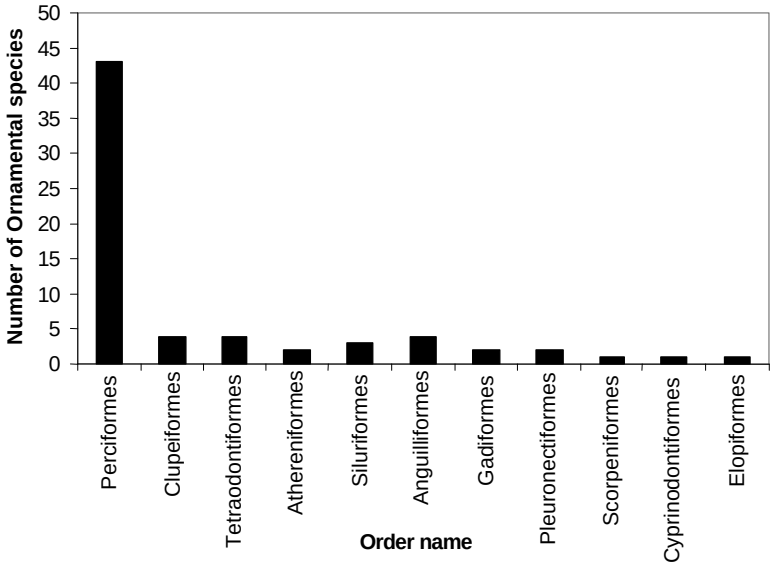

Fig. 2: Diversity of Order of different ornamental fish species of Indian Sundarbans.

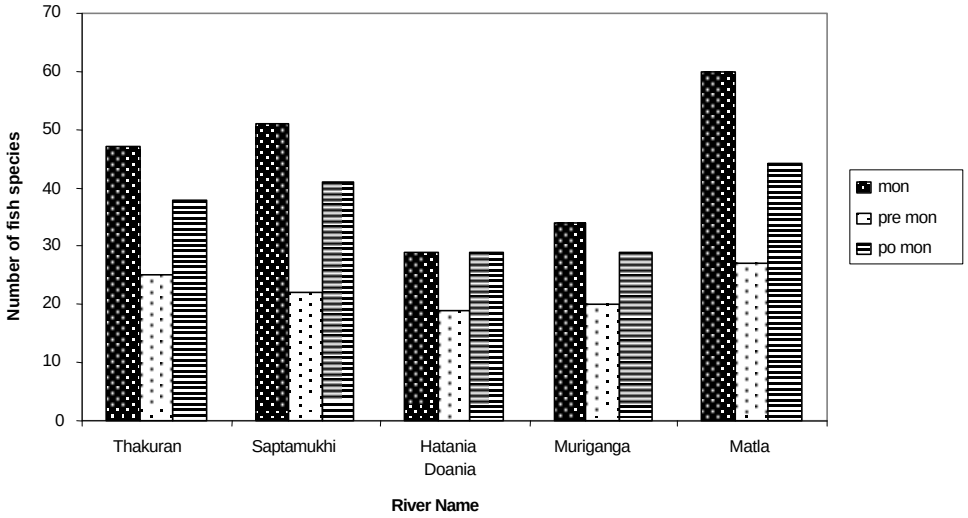

Fig. 3: Seasonal variation in ornamental fish diversity in different rivers of Indian Sundarbans.

Table 2: Concentration of carotenoid pigment extracted from different organs

Sl No.	Scientific name	Organ of carotenoid extraction	Extracted carotenoid amount (ppm)	UV-Viz Graph	Absorption Maxima (nm)	Type of pigment
1	*Ceriops decandra*	Ripen Leaves	634.33 ± 4.59	Fig 4	416, 668	Isocryptoxanthin, chl-a
2	*Xylocarpus granatum*	Ripen Leaves	103.87 ± 3.085	Fig 5	331, 420, 478	Retinyl acetate, Retinyl propionate, Retinyl palmitate, Isocryptoxanthin
3	*Rhizophora epiculata*	Ripen Leaves	221.6 ± 3.28	Fig 6	335, 404	Retinyl acetate, Retinyl propionate, Retinyl palmitate, $Retinal_2$
4	*Exocaria agallocha*	Ripen Leaves	564.67 ± 3.96	Fig 7	336, 480	Retinyl acetate, Retinyl propionate, Retinyl palmitate, Astaxanthin
5	*Ceriops tagal*	Ripen Leaves	751.5 ± 5.28	Fig 8	335	Retinyl acetate, Retinyl propionate, Retinyl palmitate

Table 2: Continued

Sl No.	Scientific name	Organ of carotenoid extraction	Extracted carotenoid amount (ppm)	UV-Viz Graph	Absorption Maxima (nm)	Type of pigment
6	*Avicennia officinalis*	Ripen Leaves	201.6 ± 2.15	Fig 9	331, 422	Retinyl acetate, Retinyl propionate, Retinyl palmitate, Isocryptoxanthin
7	*Bruguiera gymnorhiza*	Ripen Leaves	197.4 ± 2.99	Fig 10	420, 668	Isocryptoxanthin, chl-a
8.	*Heretiera fomes*	Ripen Leaves	284.067 ± 3.26	Fig 11	335, 419, 448, 479	Retinyl acetate, Retinyl propionate, Retinyl palmitate, Isocryptoxanthin, Lutein, Astaxanthin
9	*Coilia neglecta*	Fin	266 ± 8.19	Fig 12	--	--
10	*Hilsa toli*	Scale	6.53 ± 0.9	Fig 13	334	Retinyl acetate, Retinyl propionate, Retinyl palmitate
11	*Thryssa hamiltoni*	Dorsal & caudal fin	174 ± 1.962	Fig 14	333, 478	Retinyl acetate, Retinyl propionate, Retinyl palmitate, Isozeaxanthin
12	*Polynemus parasdiseus*	Dorsal, pelvic & caudal fin	162.17 ± 1.73	Fig 15	454, 485	Beta carotene, Cryptoxanthin, Crustaxanthin
13	*Gadusia chapra*	Pectoral & caudal fin	180.8 ± 1.351	Fig 16	350	$Retinol_2$
14	*Pellona ditchella*	Fins	63.3 ± 2.56	Fig 17	332, 420, 445, 478	Retinyl acetate, Retinyl propionate, Retinyl palmitate, Isocryptoxanthin, CAEE, Isozeaxanthin
15	*Chrysochir aureus*	Pelvic and Pectoral fin	170.39 ± 1.97	Fig 18	462,488	Echinenone, Crustaxanthin
16	*Stigmatogobius sadanandio*	Scale	42.73 ± 2.61	Fig 19	398, 450, 480	$Retinal_2$ Isocryptoxanthin, Astaxanthin
17	*Sillaginopsis panijus*	Pelvic and Pectoral fin	23.07 ± 0.745	Fig 20	482	Zeaxanthin
18	*Coilia reynaldi*	Pectoral fin	150.67 ± 1.862	Fig 21	336, 426, 454	Retinyl acetate, Retinyl propionate, Retinyl palmitate, isocryptoxanthin, Beta catene, Cryptoxanthin
19	*Terapon jerbua*		172.6 ± 1.117	Fig 22	445, 480	CAEE, Astaxanthin
20	*Polydactylus indicus*		141.73 ± 3.165	Fig 23	475	Phoenicoxanthin
21	*Drepane punctata*	Fins	53.73	Fig 24	450, 478	Isocryptoxanthin, Isozeaxanthin
22	*Coilia dussumieri*	Pectoral fin	56 ± 3.28	Fig 25	340, 454,482	$Retinol_2$, Zeaxanthin, Beta carotene,
23	*Setipinna phansa*	Pectoral & caudal fin	23.67 ± 0.683	Fig 26	450, 481	Isocryptoxanthin, Astaxanthin, Zeaxanthin
24	*Pomadassys hasta*	Pectoral fin	301.2 ± 1.61	Fig 27	350, 454, 482	$Retinol_2$, Zeaxanthin, Beta carotene
25	*Setipinna taty*	Fins	167.3 ± 1.22	Fig 28	458, 490	Crustaxanthin,
26	*Strongylura strongylura*	Fins	68.77 ± 0.85	Fig 29	418, 445, 480	Isocryptoxantin, CAEE, Astaxanthin
27	*Otolithoides pama*	Fins	23.6 ± 0.82	Fig 30	454	Beta catene, Cryptoxanthin
28	*Alepes djedaba*	Caudal & Pectoral fin	44.8 ± 0.655	Fig 31	445, 480	CAEE, Astaxanthin
29	*Scomberomorus commerson*	Caudal fin	25.7 ± 0.942	Fig 32	332, 416, 445, 476	Retinyl acetate, Retinyl propionate, Retinyl palmitate, Isocryptoxanthin, CAEE, Lutein

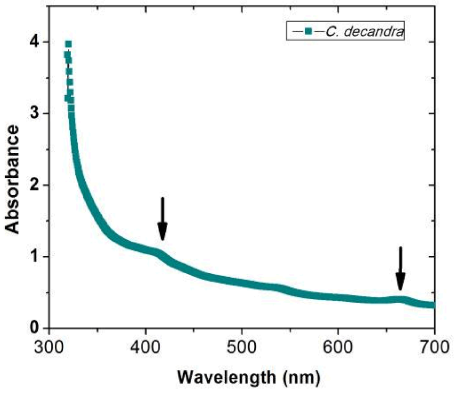

Fig. 4: UV-Vis study of *Ceriops decandra*

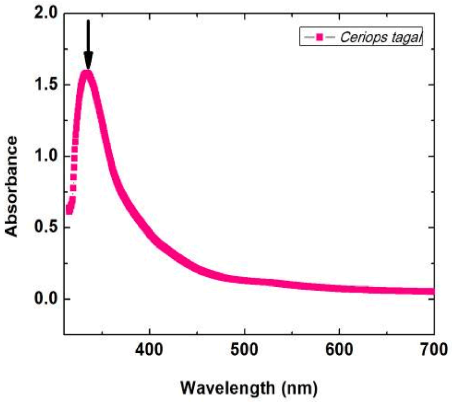

Fig. 8: UV-Vis study of *Ceriops tagal*

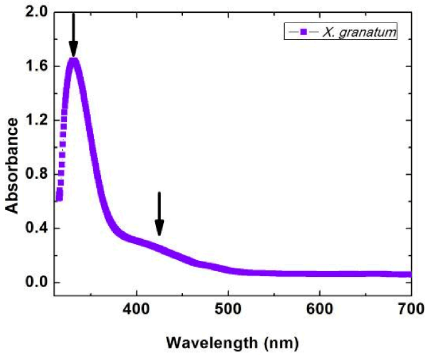

Fig. 5: UV-Vis study of *Xylocarpus granatum*

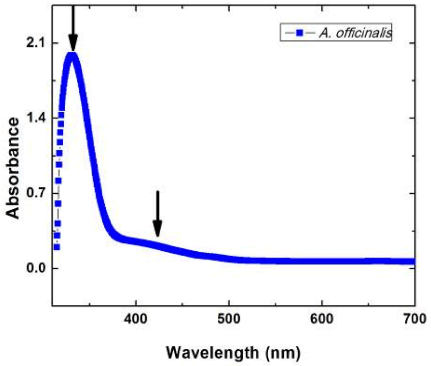

Fig. 9: UV-Vis study of *Avicennia officinalis*

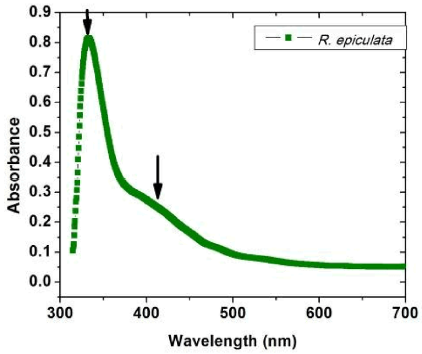

Fig. 6: UV-Vis study of *Rhizophora epiculata*

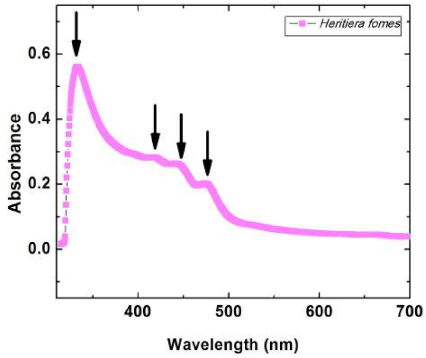

Fig. 10: UV-Vis study of *Heretiera fomes*

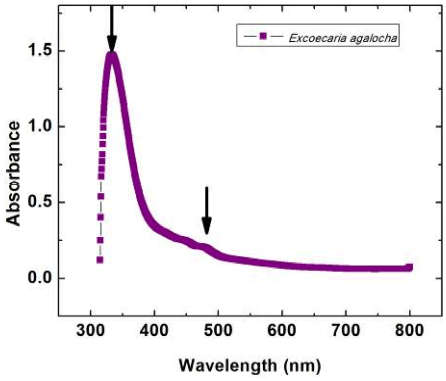

Fig. 7: UV-Vis study of *Excoecaria agalocha*

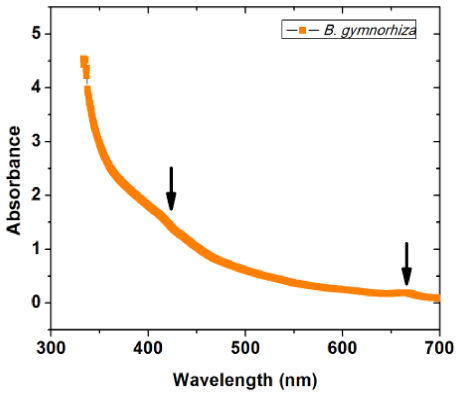

Fig. 11: UV-Vis study of *Brugeira gymnorhiza*

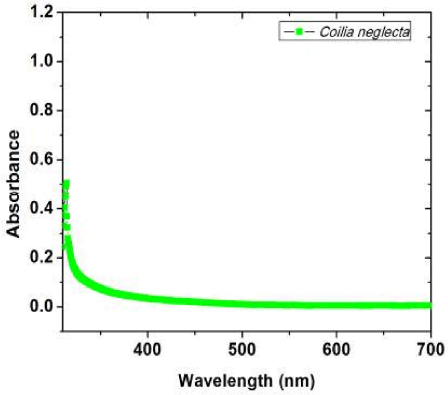

Fig. 12: UV-Vis study of *Coilia neglecta*

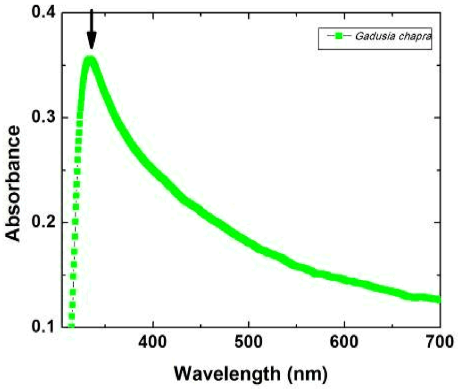

Fig. 16: UV-Vis study of *Gadusia chapra*

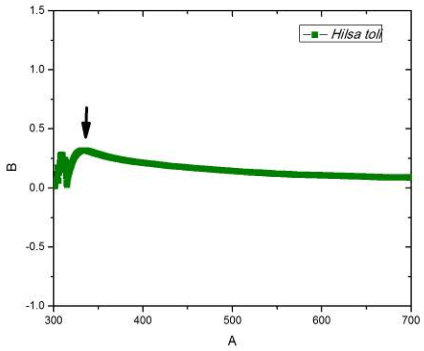

Fig. 13: UV-Vis study of *Hilsatoli*

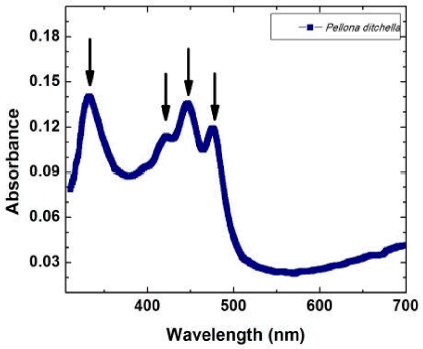

Fig. 17: UV-Vis study of *Pellona ditchella*

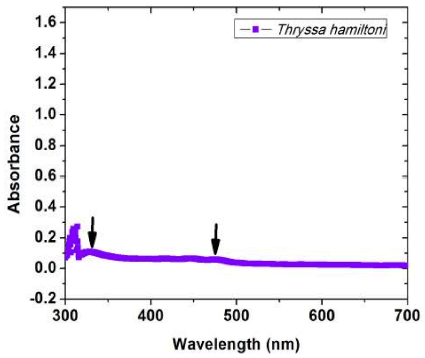

Fig. 14: UV-Vis study of *Thryssa hamiltoni*

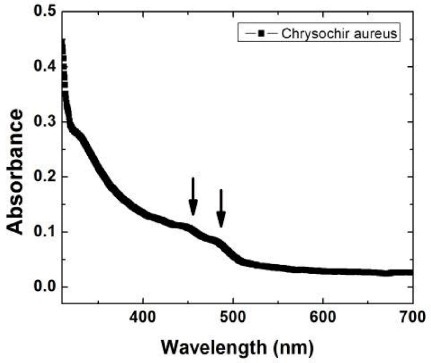

Fig. 18: UV-Vis study of *Chrysochir aureus*

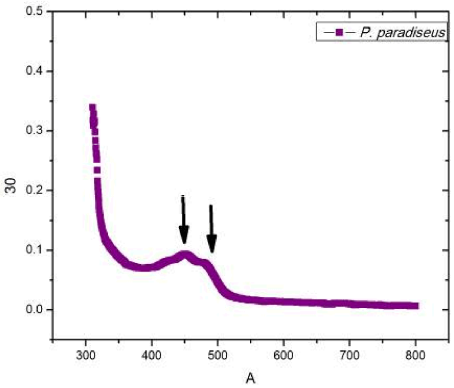

Fig. 15: UV-Vis study of *Polynemus paradiseus*

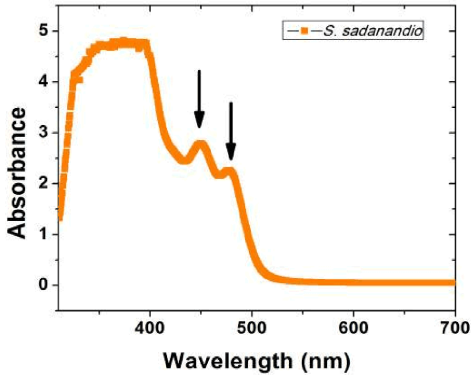

Fig. 19: UV-Vis study of *Stigmatogobius sadanandio*

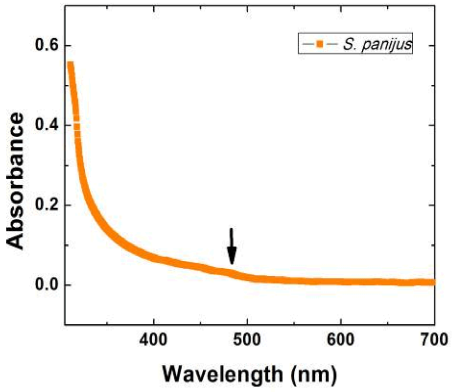

Fig. 20: UV-Vis study of *Sillaginopsis panijus*

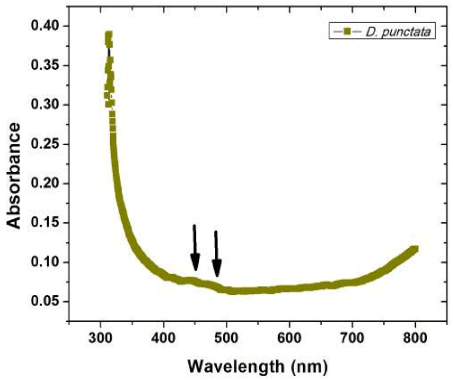

Fig. 24: UV-Vis study of *Drepane punctata*

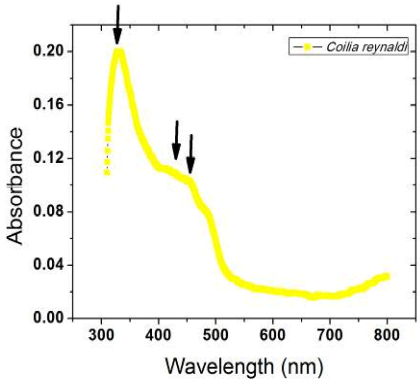

Fig. 21: UV-Vis study of *Coilia reynaldi*

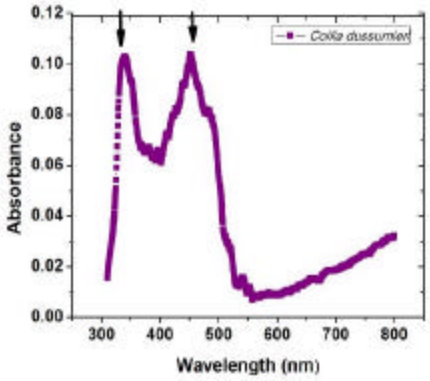

Fig. 25: UV-Vis study of *Coilia dussumieri*

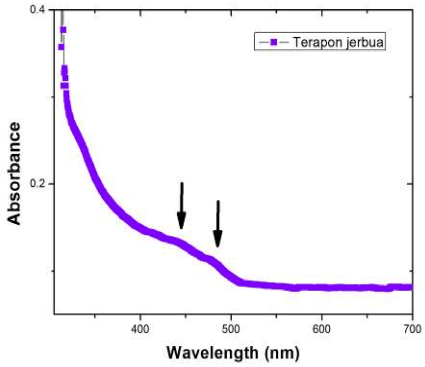

Fig. 22: UV-Vis study of *Terapon jerboa*

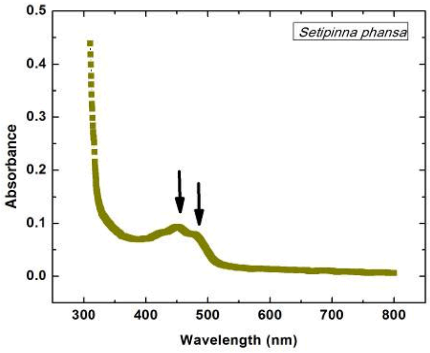

Fig. 26: UV-Vis study of *Setipinna phansa*

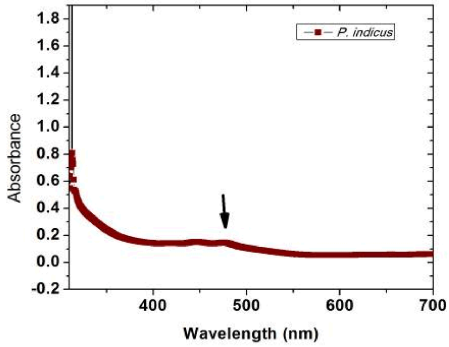

Fig. 23: UV-Vis study of *polydactylus indicus*

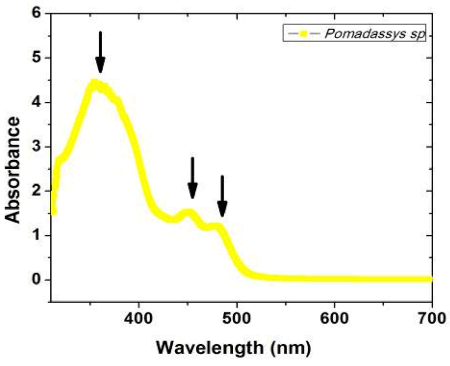

Fig. 27: UV-Vis study of *Pomadassys sp*

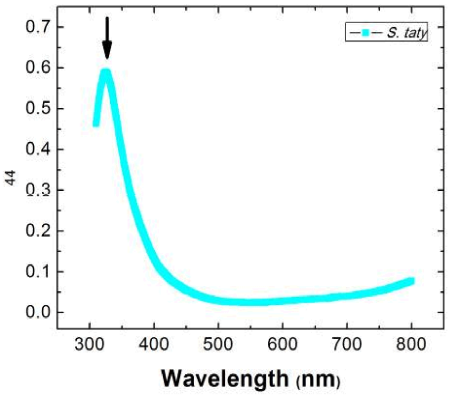

Fig. 28: UV-Vis study of *Setipinna taty*

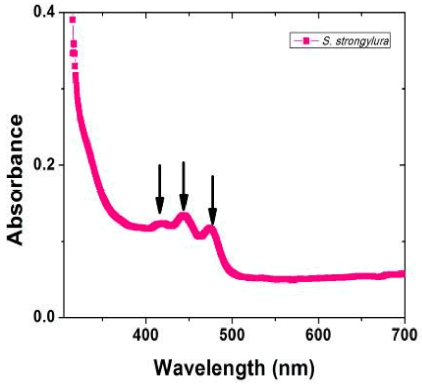

Fig. 29: UV-Vis study of *Strongylura strongylura*

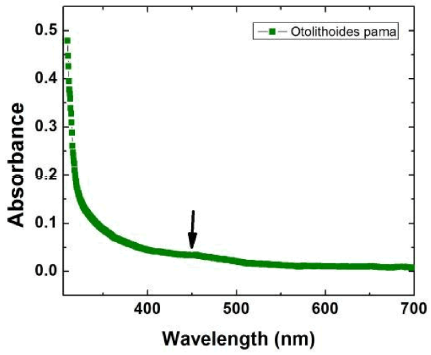

Fig. 30: UV-Vis study of *Otolithoides pama*

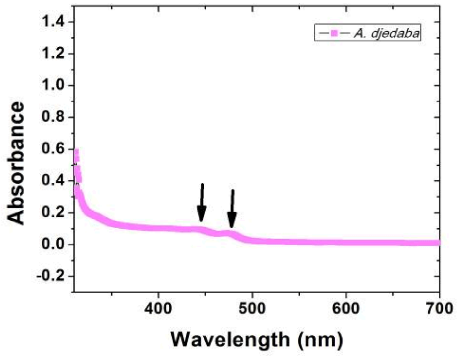

Fig. 31: UV-Vis study of *Alepes djedaba*

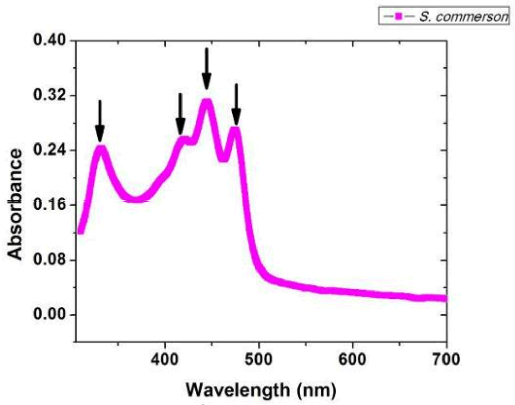

Fig. 32: UV-Vis study of *Scomberomorus commerson*

Table 3: ANOVA analysis of ornamental fish diversity of different rivers of Sundarbans

	Sun of Square	df	Mean square	F value	Sig
Between groups	1192.533	2	596.267	8.179	0.00574
Within groups	874.8	12	72.9		
Total	2067.3331	4			

Retinyl propionate and Retinyl palmitate from ripen leaves of 6 species. Isocryptoxanthin were found from 5 species. Astaxanthin and Lutein were extracted from 2 species and 1 species of mangrove plant, respectively (Table 2). A great variety of carotenoid pigments were also recorded from 22 ornamental fin fish species (Table 2). Except the above mentioned mangrove ripen leave based carotenoids, ornamental fin fishes show many other types like Retinol$_2$, Zeaxanthin, Beta carotene, CAEE, Phoenicoxanthin, Cryptoxanthin, Isozeaxanthin, Echinenone and Crustaxanthin (Table 2). ANOVA indicates that the ornamental fish diversity among the five different rivers of Indian Sundarbans varied significantly (Table 3).

DISCUSSION

Among all the groups of animal species available in Sundarbans, fishes are one of the most important species because of their abundance and diversity. Mangrove forests are among the world's most productive sites, producing organic carbon well in excess of the ecosystem requirements and thus contributing significantly to the global carbon cycle. The complexity of mangrove forest habitat increases the residence time which assists in the assimilation of inorganic nutrients and trapping the suspended particulate matter [10]. The pelagic system around the coastal zone is highly productive due to

considerable concentration of nutrients derived from anthropogenic origin, surface run-off, litters and detritus of mangrove vegetation [24]. Among the 34 mangrove species and several associated species occurring in Indian Sundarbans, few dominant mangrove species and few associated flora have been reported as rich in carotenoids especially in astaxanthin [25].

The distribution of carotenoids in fin fishes differs with the species, habitat and their food habit. Commonly found carotenoids are tunaxanthin in yellow fish, astaxanthin in red fish, zeaxanthin in anchovies, flatfish and shark, tunaxanthin, leutien and zeaxanthin in brackish water fish [26]. The fishes in the family clupidae were found to contain tunaxanthin along with zeaxanthin, astaxantin and doradoxanthin [27]. Baek *et al*. [28] observed that zeaxanthin content decreases with the concomitant increase of cryptoxanthin and cynthiaxantin after spawning. The most common types of carotenoids are astaxanthin, $-carotene, metabolites of $-carotene, "-crotene, echinenone, cryptoxanthin, lutein, tunaxanthin and zeaxanthin etc which are available in algae, aquatic plants, higher angiospermic plants and different animal species (coelenterated, mollusks, echinoderms and fish). However, carotenoids cannot be synthesized by most animals, including fishes and must be obtained from dietary sources [29]. It was described that after entering the feed materials containing carotenoids into the intestinal lumen more or less 50% is degraded into different forms of vitamin A and the rest is transported to different body parts. The concentrated accumulation of pigments to the specified organ/organs is regulated by the carotenoid binding protein present there [30-33].

Maximum estuarine fin fish species usually stay in primary and secondary consumer level in their ecological food chain and their feeding list contains various objects like phytoplanktons zooplanktons, crustaceans, mollusca, detritus matter, decomposed and undecomposed mangrove plant products, organic waste material etc. Mangrove forest based estuarine ecosystem harbors diverse kind of nutrients for the better growth and development of its own floral and faunal components. Among these nutritive elements carotenoids are significant one. Carotenoids not only impart the body color of species, it also boosts up the immune power of species and helps them to fight against different oxidative stresses [33].

CONCLUSION

From the present study it can be concluded that the mangrove leaves are one of the important source of different types of carotenoid pigments. It is clear from the study that the various fin fishes share the carotenoid pigments like Retinyl acetate, Retinyl propionate, Retinyl palmitate, Astaxanthin, Isocryptoxanthin, Lutein and $Retinal_2$ with the selected mangrove plant species. Besides these, the pigments like Zeaxanthin, Isozeaxanthin, Cryptoxanthin, Crustaxanthin, Phoenicoxanthin and Beta carotene were also found from the fish samples and many of them are the metabolic derivatives or optical isomers of Astaxanthin and Isocryptoxanthin. The estuarine fin fishes also collect their body pigments from many other food sources like algae, crustaceans and molluscs. More research works are needed to evaluate the other details regarding this arena but from the above study it can be said that the mangrove dominated estuarine habitats plays very significant roles for essential ornamentation of estuarine and coastal fin fishes.

REFERENCES

1. Ramamoorthy, K., S. Bhuvaneswari, G. Sankar and K. Sakkaravarthi, 2010. Proximate composition and carotenoid content of natural carotenoid sources and its color enhancement on marine ornamental fish *Amphiprion ocellaris* (Cuveir 1880). World Journal of Fish and Marine Sciences, 2(6): 545-550.
2. Hoff, F.H., 1996. Marine ornamental fish culture. In: From Discovery to Commercialization (M. Carrillo, L. Dahie, J. Morales, P. Sorgelous, N. Svennevig and J. Wyban, Eds.). Oostende Belgium European Aquaculture Society, 19: 1-298.
3. Lewbart, G., M. Stoskopf, T. Losordo, J. Geyer, J. Owen, D. White Smith, M. Law and C. Altier, 1999. Safety and efficacy of the environmental products group master flow aquarium management system with Aegis Microbe Shield TM. Aquaculture Engineering, 19: 93-98.
4. Chapman, F and S. Fitz-Coy, 1997. United States of America trade in ornamental fish. Journal of the World Aquaculture Society, 28: 1-10.
5. Larkin, S. and R. Degner, 2001. The US wholesale market for marine ornamentals. Aquarium Sciences and Conservation, 3(1-3): 13-24.
6. Wood, E., 2001. Collection of coral reef fish for aquaria: global trade, conservation issues and management strategies. Marine Conservation Society, UK, pp: 1-56.

7. Andrews, C., 1990. The ornamental fish trade and fish conservation. Journal of Fish Biology, 37 (Supplement A): 53-59.
8. Satheesh, J.M., 2002. Biology of the clown fish, *Amphiprion sebae* (Bleeker) from Gulf of Mannar (Southeast coast of India). Ph.D. Thesis, Annamalai University, India, pp: 1-159.
9. Nyanti, L.T., Y. Ling and G. Jongkar, 2012. Fish and Crustacean Communities and Fish Length-Weight Relationship of Lutong River, Miri, Sarawak, Malaysia. World Journal of Fish and Marine Sciences, 4(1): 102-110.
10. Mitra, A., K. Banerjee and D.P. Bhattacharyya, 2004. The other Faces of Mangrovs. Published by Department of Environment, Government of West Bengal, pp: 1-132.
11. Sen, T.K., 1975. Fish and fisheries aspects of the Sundarbans, West Bengal. Sci & Cult., 41(10): 500-502.
12. Naskar, K.R. and D.N. Guha Bakshi, 1987. Mangrove swamps of the Sundarbans. Naya Prokash, Calcutta, pp: 1-263.
13. Mandal, A.K. and N.C. Nandi, 1989. Fauna of Sundarban Mangrove Ecosystem, West Bengal, India. *Fauna of Conservation Areas*, Zoological Survey of India, pp: 1-116.
14. Talwar, P.K., P. Mukherjee, D. Saha, S.N. Pal and S. Kar, 1992. Marine and estuarine fishes. In: State Fauna Series 3: Fauna of West Bengal, Part 2. Zoological Survey of India, Calcutta, pp: 243-342.
15. Chaudhuri, A.B. and A. Choudhury, 1994. Mangroves of the Sundarbans, India. Volume 1; In: M Zahir Hussain, G Acharya (eds): IUCN, The World Conservation Union, Bangkok, Thailand.
16. Bose, T., T.K. Baguli, A.K. Ghosh and K.R. Naskar, 1999. A review of shell fish and finfish species from the brackish water fisheries of the Sundarbans and their impact on the mangrove ecology. In: Sundarbans Mangal (eds D.N. Guha Bakshi, P Sanyal and K. R. Naskar). Naya Prokash. Calcutta, pp: 539-547.
17. Sanyal, P., 1983. Mangrove tiger land- the Sundarbans of India. Tiger paper, 10(3): 1-4.
18. Khan, R.A., 2003. Fish faunal resources of Sundarban estuarine system with special reference to the biology of some commercially important species. Records of the Zoological Survey of India. Occasional Paper: 209: 1- 150.
19. Naskar, K.R., 2004. Manual of Indian Sundarbans. Daya Publishing House, New Delhi, pp: 1-220.
20. Talwar, P.K. and K.K. Kacker, 1984. Commercial sea fishes of India. Handbook, Zoological Survey of India, pp: 1-977.
21. Talwar, P.K. and A.G. Jhingran, 1991. Inland fishes of India and adjacent countries. Vol 1& 2. Oxford and IBH Publishing Co. Pvt. Ltd, pp: 1-1158.
22. Fish Base, 2003. World Wide Web electronic publication (R. Froese and D. Pauly, Eds.).http://www.fishbase.org.
23. BioAstin/ Naturose™ Technical Bulletin- 020, Revision Date: November 9, 2001.
24. Chakrabarty, K., 1991. Man, animal and plant. Darbari Prokashan. Calcutta, pp: 1-173.
25. Mitra, A., K. Banerjee. and A. Banerjee, 2006. Screening mangroves in search of astaxanthin. Seshaiyana, 14(1): 1-2.
26. Matsuno, T. and S. Hirao, 1989. Animal carotenoids. Marine biogenic lipids, fats and oils, vol. (1) (ed) Ackmen RG, CRC Press, Boca Raton.
27. Matsuno, T. and M. Katsuyama, 1976. Comparative biochemical studies of carotenoids in fishes XII. On the 9 species of fishes in the order clupeidae. Bull Jap. Soc. Sci. Fish, 42: 765-768.
28. Baek, S.H., S.Y. Kim, K.I. Geong, M.J. Kweon, D.S. Choi, J.H. Kim, H.S. Kim and B.S. Ha, 1999. Comparison of carotenoid pigments in Korean bittering, *Cheilognathus signifier* and bride bittering, *Rhodeus ukekii* in the subfamily Ciprinidae, J. Korean Soc. Food Sci. Nutr., 28: 1220-1225.
29. Storebakken, T. and H.K. No, 1992. Pigmentation of rainbow trout. Aquaculture, 100: 209-229.
30. Barua, A.B. and U.C. Goswami, 1977. Formation of vitamin A in a freshwater fish. Biochem. J., 164: 133-136.
31. Goswami, U.C. and A.B. Barua, 1981. Origin of retinol in freshwater fish. Curr. Sci., 50: 150-151.
32. Goswami, U.C. and S. Bhattarcharjee, 1982. Biosynthesis of 3-dehydroretinol: Metabolism of lutein ($-_-carotene-3,3' diol) in *Clarius batrachus* and *Ompok pabo*. Biochem. Internat. 5(4): 545-552.
33. Goswami, U.C. and N. Sharma, 2005. Efficiency of a few retinoids and carotenoids in vivo in controlling benzo (a) pyrene-induced forestomach tumour in female Swiss mice. Br. J. Nutr., 94: 540-543.