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Growth performances, feeding ecology and prey preferences of tade mullet, *Liza tade* (Forsskål, 1775) in extensive brackishwater farming system

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Abstract
Present study was conducted to assess growth performances, feeding ecology and prey preferences of tade mullet (*Liza tade*) in extensive polyculture for 9 months during February to November, 2015. Impoundments were filled with unfiltered estuarine water (17.2ppt) containing seeds of various crustacean and fish species and water was exchanged (20-30%) every lunar cycle through bamboo screens. No feed or fertilizer was applied following common practice. Tade mullet fingerlings (4.24±0.76g) added with auto stocked fishes @ 2000 fish/ ha attained 260.41±10.50 g. They showed negative allometric growth ($W=0.007\ TL^{2.951}$) indicating shortage of food materials in extensive farming system. Feeding intensity in terms of stomach fullness increased with increasing fish weight. Feeding ecology study indicated tade mullet as herbivorous fish grazing on phytoplankton and organic matter from the bottom sediment. Although tade mullet fed on Bacillariophyceae, Myxophyceae and Chlorophyceae according to the order of dominance, they actively selected Chlorophyceae followed by Myxophyceae and Bacillariophyceae according to order of preference indicating their ability to select preferred food items.

Keywords: *Liza tade,* Extensive system, polyculture, growth, feeding ecology, prey selection

Introduction
Fish species belonging to the family Mugilidae, commonly referred to as mullets, comprises mainly of coastal marine species that are widely distributed in all tropical, subtropical and temperate seas. Mullets are generally considered to be ecologically important and forms major food resource for human populations in certain parts of the world [1]. Tade mullet (*Liza tade* Forsskål 1775) is one of the most important mullet species widely cultured in both brackish and freshwater mono and poly-culture fish ponds [2]. Owing to its good consumer preference and market price, non-carnivorous food habit and abundant availability of seeds, tade mullet is a good candidate for polyculture with other species including shrimps [3]. It has a high quality flesh, superior growth, large maximum size and wide salinity and temperature tolerance power [4].

Growth potential of a fish species is one of the most important criteria for selection as a candidate species. Available reports regarding growth of tade mullet is highly variable from farming trials. Tade mullet fingerlings (5g) were grown to 215-265 g in 18 months with *Liza parsia* at ratios of 1: 2 and 1: 4 at overall stocking density of 25000/ ha in West Bengal coast [5]. Growth of tade mullet fingerlings (6.16±0.49 g) up to 203.24 g at stocking density of 3300/ ha in 148 days culture with *Penaeus monodon* at stocking density of 50000/ ha was reported [6]. Much lower growth was also reported where tade mullet fingerlings (7.60±0.24g) attained 80.40±4.02g at stocking density of 1500/ha in 180 days polyculture with *Mugil cephalus* (4500/ ha), *L. parsia* (2000/ha) and *P. monodon* (20000/ha) [3]. For efficient culture and management of fish resource, knowledge on food and feeding habits of fishes is of immense importance [7]. Food and feeding habits of a species of fish is intimately associated with the ecological niche that they occupy in the natural environment [8] and knowledge on this aspect is advantageous in their proper management and exploitation [9].

Mullets are generally considered as herbivorous, omnivorous, plankton feeders, or even micro crustacean predators [10].

Tropic behavior of mullets has been reported by different authors using extensive terminology which categorized feeding patterns of these species [9]. Some examples include algae feeders [11], micro and meio-benthos feeders [12], interface-feeders [13], deposit feeders [14], benthic microphagous omnivores [15] and limno-benthofagous [16]. Food and feeding habits of the fish vary with time of the day, season of the year, size of the fish, environmental condition and with different food substances present in the water body. Changes in feeding habits of a fish species are a function of the interactions among several environmental factors that influence the selection of food item [17]. Stomach content analysis and features of the alimentary system provide information on food, feeding behavior and selective feeding if any [18]. Feeding behaviour at the level of prey selection can have implications at the individual [19], population [20] and community levels [21].

In India *Liza tade* occurs in marine, shallow coastal waters, coastal lakes and estuarine environments and is cultured in brackishwater farms [22], freshwater tanks [23] and experimentally in salt water ponds [24]. In West Bengal, the low-lying lands near estuaries and deltaic areas enclosed by embankments called "Bheries" are used for traditional finfish cultivation mostly for mullets, especially during rains [25] where tade mullet is considered as most preferred fish due to its superior taste and market value. In bheries, large numbers of fish and shrimp seeds brought in through tidal water and partial stocking are reared for a period of 6–7 months [26].

In spite of being widely cultured as an important component in traditionally practiced extensive polyfarming, information on tade mullet growth performances and feeding ecology in such systems are scarce. The present study was designed to assess growth performances and feeding ecology with special emphasis on prey preferences of tade mullet in extensive polyculture system to strengthen the ecosystem approach for brackishwater polyculture management.

Materials and methods

Present experiment was carried out during February to November, 2015 at Gopalnagar Dakshin village (21.8029-21.8073°N, 88.2962-88.2985°E) of Pathapratima block in South 24 Parganas district of West Bengal, India. This area lies within the Hooghly-Matla estuarine complex popularly known as 'Sundarbans'. Three tide-fed brackishwater impoundments (0.7 to 0.9ha) locally called as 'Bhery' located at the bank of a creek of Hatania-Doania river were selected. The impoundments were dewatered and sundried at the beginning. Lime stone powder was applied to the dried pond bottom at 500 kg ha^{-1}during first week of January. Unfiltered saline tidal water (11.2ppt) from the adjacent creek was allowed to let in the impoundments during second week of January through bamboo screen fitted inlet system and each pond was filled up to a depth of 110cm. Traditional bamboo screen used in 'Bhery' allows entry of small fry of different species but restricts exit of bigger fishes. Entry of tade mullet fry along with other species was not anticipated as seeds of *L. tade* remain available in south-east and south-west coasts during November–April and north-east coast during July–October [27]. Tade mullet fry collected during October were nursery reared in a different pond for stocking in the impoundments. Seeds of other fishes entered in the impoundments along with tidal water were allowed to grow for one month and pre-nursed fingerlings of tade mullet (4.24±0.76g, 9.72±0.59cm) were released @ 2000 ha^{-1} during February. About 20-30% water was exchanged every lunar cycle depending on the tidal amplitude throughout the rearing period following common practice. Water and fish samples were collected from three ponds to eliminate any possible biasness. Both fish and water samples were frizzed in ice before those were carried to laboratory for subsequent analysis.

From each three ponds, 10 fish were collected during middle of each month i.e. 30 fish in a month and total 300 fish were collected and analyzed throughout 9 months study period. Gravimetric data of fishes were collected monthly throughout the experimental period. The total length (TL, cm) was recorded with a slide caliper, while body weight (W, g) was measured using a digital electronic balance.

Daily weight gain (*DWG*) is a function of weight and time and was estimated for each replicate pond with the formula:

$$DWG = \frac{W_f - W_i}{t}$$

Where W_f and W_i are the average final and initial weight in time *t*.

Specific growth rate (*SGR*) was calculated using the conventional equation:

$$SGR = \frac{\ln w_f - \ln w_i}{t} \times 100$$

Where W_f and W_i are the average final and initial weight in time *t*.

The mathematical relationship between length and weight was calculated using the conventional formula [28].

$$W = a.TL^b$$

Where *W* is fish weight (g), *TL* is total length (cm), *a* is the proportionality constant and *b* is the isometric exponent. The parameters *a* and *b* were estimated by non-linear regression analysis.

Fulton's condition equation was used to find out the condition factor [29]:

$$K = \frac{\overline{w}}{(\overline{TL})^3} \times 10^2$$

Where *K* is the condition factor, $\overline{w}$ is the average weight (g) and $\overline{TL}$ is the average total length (cm)

After gravimetric measurements, the stomachs were removed intact by cutting above the cardiac and below the pyloric sphincters and preserved in a vial with 4% formalin. The stomach fullness degree was assessed by visual estimation and classified as gorged, full, 3/4 full, 1/2 full, 1/4 full little and empty [30]. The stomach contents were placed into fixed volume of 4% formalin. From each vial one ml stomach contents were then transferred to Sedgwick-Rafter counting cell and phytoplankton constituents were identified and counted [31-32]. Planktonic constituents of stomachs were categorized as Bacillariophyceae (diatoms), Chlorophyceae (green algae), Myxophyceae (blue-green algae), copepods, and dinflagellates and fish parts. Numeric percentages of each category were determinated. The major constituents as organic matter and sand particles in stomach were also evaluated.

Water samples were collected from surface of the study ponds between 09:00 and 10:00 hours at monthly intervals. Water quality parameters such as water temperature, pH, dissolved oxygen (DO), alkalinity, nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N), ammonia-nitrogen (NH_3-N) and phosphate-phosphorus (PO_4-P) were measured following standard methods [33]. Salinity was assessed using a refractometer (ATAGO, Japan).Plankton samples were collected monthly by filtering 100 L of water through bolting silk plankton net (mesh size 64 µm). Plankton concentrates were immediately preserved in 4% buffered formalin for further qualitative and quantitative analysis.

The percentage compositions of food items in the stomach falling under different groups were then compared with that of fish ponds to evaluate prey preferences. Prey preferences were determined by the Ivlev Electivity Index [34] using the following formula:

$$E = \frac{r - p}{r + p}$$

Where, r = Percentage of dietary item in ingested food, p = Percentage of prey in the environment.

Differences in final length, final weight, daily weight gain (DWG), specific growth rate (SGR), survival and exponential value of length-weight relationship (LWR) were determined by analysis of variance with the General Linear Model procedure using SPSS for Windows v.17.0 programme (SPSS Inc. Chicago IL USA). Duncan's Multiple Range Test [35] was used for comparison of treatments. All data were expressed as mean ± standard error (S.E.).

Results

Fish growth in terms of final length (cm) and weight (g) is presented in Figure 1. Fishes were grown from 4.20±3.20 g (9.72±0.59 cm) to 260.41±10.50 g (34.00±1.60 cm) after 270 days of rearing. Average daily weight gain (DWG) recorded was 0.92±0.12 g day^{-1} which ranged between 1.49 (July) and 0.37g (February). Specific growth rate (SGR) varied between 4.32 (February) and 0.41 % day^{-1} (September) while mean value recordedto be 1.52±0.41% day^{-1}.

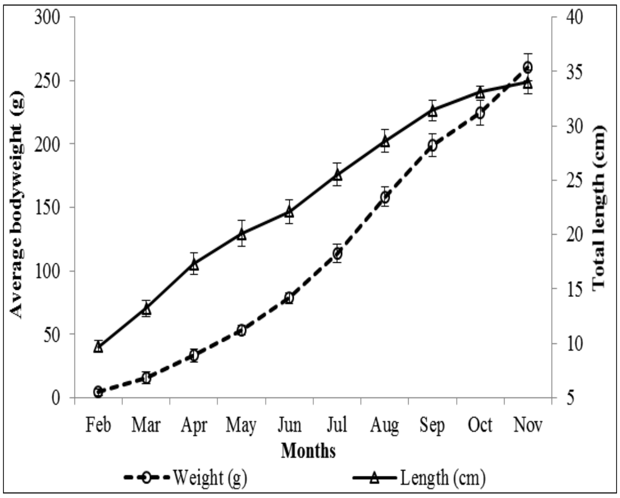

Fig 1: Growth of tade mullet (*Liza tade*) reared in extensive farming system

Fultons condition factor (K) of fish was 1.25±0.06 considering the whole rearing period. Length Weight Relationship (LWR) showed curvilinear growth pattern and exponential value (b) of LWR was recorded to be 2.951 indicating negative allometric growth (Figure 2).

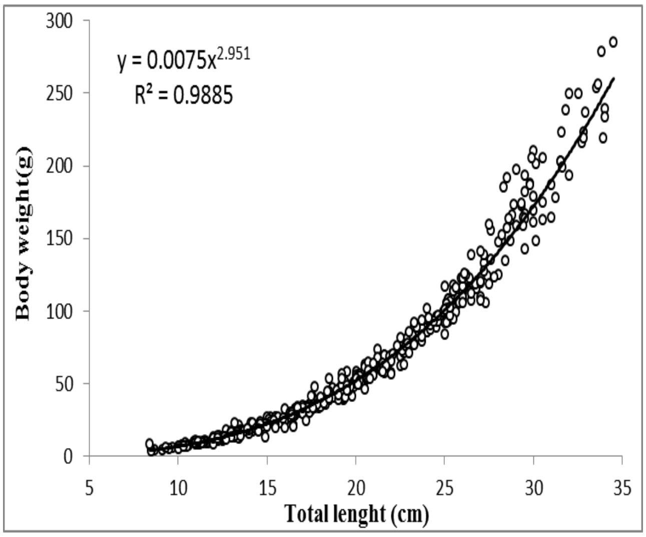

Fig 2: Length weight relationship of tade mullet (*Liza tade*) reared in extensive farming system

Table 1: Feeding intensity of tade mullet (*Liza tade*) in extensive brackish water farming impoundments during the rearing period

Months	Gorged	Full	3/4 Full	1/2 Full	1/4 Full	Little	Empty
Feb	0	65	11.5	6.66	1.5	0	15
Mar	3.3	5	5	25.5	36.2	15	10.2
Apr	4.7	6.8	6.9	17.5	25	25	14.5
May	3.3	10.9	10	20.5	26.6	26	2.4
Jun	22.2	16.7	11.1	16.7	21.2	11.1	1
Jul	6.66	9.99	13	16.35	26	25.5	3
Aug	11.7	13.32	13.8	26.7	27.8	0	6.7
Sep	29.4	24.5	10	11.8	11.3	11.7	1.2
Oct	15	10	24	20	20	11	0
Nov	13.32	13.32	16.65	23.31	26.64	6.66	0
	n= 30 for each month, 10 fishes were collected monthly from three ponds under study.						

Feeding intensity of tade mullet indicated by the extent of stomach fullness is depicted in Table 1. Lower feeding intensity was observed during the initial months of rearing characterized with higher number of empty stomachs. Feeding intensity was observed to increase gradually indicated by increasing number of gorged and full stomachs as rearing proceeded. Highest feeding intensity was observed during the final month. Percentage occurrences of food materials observed in the tade mullet stomachs are presented in figure 3. According to the order of dominance, the most abundant phytoplankton groups in three study ponds were Bacillariophyceae (23.04–40.10%), Chlorophyceae (9.59-20.39%) and Myxophyceae (4.45-14.36%). The dominant zooplankton groups in the stomach was dinflagellates (1.84-5.11) followed by copepods (0.20-2.97%). Fish and shrimp parts (0.12-9.98%) as non-planktonic suspended material were also present. Percentage occurrence of decayed organic matter such as rotted parts of macrophytes, unidentified organic particles, cladoceran appendages and foraminifera shell was 9-15%. Sand particles and mud constituted 21.65-46.45% of stomach content.

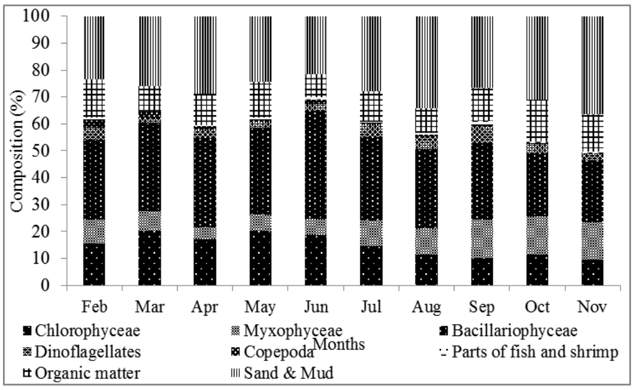

Fig 3: Percentage occurrences of food materials in tade mullet (*Liza tade*) stomach reared in extensive farming system

The variations of water quality parameters in three experimental ponds are presented in Table 2.Water temperature showed wide range and fluctuated between 18.7 and 33.1 ºC. Maximum temperature was recorded during April (34.1 ºC) and minimum during November (19.5 ºC). Dissolved oxygen (DO) and pH value were almost similar throughout the culture period and ranged between 5.81 to 9.00 ppm and 7.92 to 8.72 respectively. Salinity showed wide variation in three experimental ponds throughout the study duration and was maximum (18.8ppt) during summer (May) and minimum (3.4ppt) during rainy season (August). This is the usual seasonal salinity variation of the tidal water in the Sundarban region (Moriarty 1976). Nitrogenous metabolites such as nitrite-nitrogen (NO_2-N) and total ammonia nitrogen (NH_3-N) varied between 9.33-24.47 and 21.83-44.08µg/ l, respectively in three ponds. Concentration of total ammonia nitrogen was significantly ($p < 0.05$) higher in pond 3 than other two ponds. Nitrate-nitrogen (NO_3-N) and phosphate-phosphorous (PO_4-P) concentration ranged between 69.62-111.04 and 21.58-43.27 µg/ l, respectively while there were no significant (P>0.05) difference among three experimental ponds. Significantly (p < 0.05) rich planktonic concentration was observed in pond 1 and poor in pond 3.

Table 2: Water quality parameters of three extensive brackishwater impoundments used for tade mullet (*Liza tade*) rearing

Water quality parameters	Pond 1	Pond 2	Pond 3
Temperature (ºC)	29.9±1.7	29.9±1.7	29.7±1.9
pH	8.04±0.23[a]	7.96±0.25[a]	7.78±0.31[b]
DO (mg L^{-1})	6.06±0.42[a]	5.99±0.52[a]	5.69±0.52[b]
Salinity (ppt)	12.87±5.34	12.74±5.32	12.89±5.19
NO_2-N (µg L^{-1})	16.35±5.83	15.91±5.62	16.11±6.63
NO_3-N (µg L^{-1})	93.12±15.41	92.66±11.14	92.97±8.94
NH_4-N (µg L^{-1})	30.96±5.61[b]	31.19±7.91[b]	34.89±6.27[a]
PO_4-P (µg L^{-1})	32.07±13.43	31.91±11.98	31.89±12.74
Phytoplankton (numbers/L^{-1} ×10^3)	15.38±1.62[a]	15.12±1.94[b]	14.95±1.73[c]
Zooplankton (numbers/L^{-1}×10^3)	3.05±0.25[a]	2.91±0.23[b]	2.83±0.17[c]
Means bearing different superscripts indicate statistically significant differences in a row (p<0.05); Values are expressed as mean ± SE (n=10 for each impoundments every month)			

Percentage occurrences of planktonic and other suspended food components in pond water are presented in Figure 4. According to order of dominance, the most abundant phytoplankton groups in three earthen ponds were Bacillariophyceae, Chlorophyceae, and Myxophyceae. The dominant zooplankton group in three ponds was dinflagellates followed by copepods, fish and shrimp parts were also present in the water body. Most abundant genera observed under Bacillariophyceae according to the order of dominance were *Navicula, Nitzschia, Cyclotella, Gyrosigma* and *Melosira. Cymbella, Synedra, Coscinodiscus and Pleurosigma* were among the other less abundant genera under Bacillariophyceae. Genera observed under Chlorophyceae according to the order of dominance were *Pediastrum, Chlorella, Scenedesmus* and *Tetraedron.* In addition, *Ankistrodesmus, Coelastrum, Crucigenia*, *Scenedesmus* and *Pandorina* were also encountered as less abundant genera. *Anabaena* and *Oscillatoria* were the most dominant genera under Myxophyceae. Other genera such as *Chroococcus, Gloeocapsa,* and *Merismopedia* also represented Myxophyceae with comparatively less abundance. Myxophyceae constituted 4.21-8.52% of planktonic forms. Common Dinoflagelletes such as *Ceratium* and *Peridinium* and Copepods like *Calanus* spp were most plentiful genera among zooplankton groups. Rotifers and cladocera existed as less abundant zooplankton groups. Highest percentage occurrence of dinoflagelletes and copepods were observed during April (47.56%) and July (24.88%) while lowest percentage occurrence were found during May (31.06%) and August (2.04%), respectively.

Electivity index (E) of different food constituents is presented in Figure 5. Electivity index (E) for Chlorophyceae varied from 0.37 to 0.81 (0.61±0.04) with highest value recorded during May. Preference for Chlorophyceae gradually increased as rearing proceeded till May and the trend was maintained till august followed by decreasing trend afterwards. Electivity index (E) for Bacillariophyceae ranged between 0.01and 0.40 (0.10±0.03) with higher values during early months of rearing which gradually decreased as the fishes were grown with an abnormal peak during July. On other hand E for Myxophyceae varied from 0.22 to 0.59 (0.38±0.04) with maximum value during November. Preference for Myxophyceae was low during early months of rearing and showed increasing trend afterwards. E for Dinoflagelletes, copepods and fish or shrimp parts ranged between –0.66 to –0.92 (–0.82±0.03), 0.13 to –0.92 (–0.44±0.13), and –0.23 to–0.97(–0.71±0.07) respectively throughout the culture period indicating non-preference. Decayed organic matter and sand particles were not considered for electivity analysis.

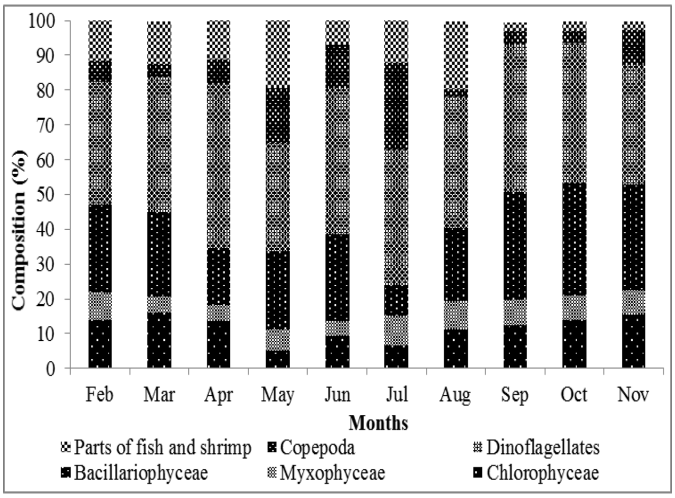

Fig 4: Percentage occurrences of suspended food materials in ambient water of tade mullet (*Liza tade*) extensive farming impoundments

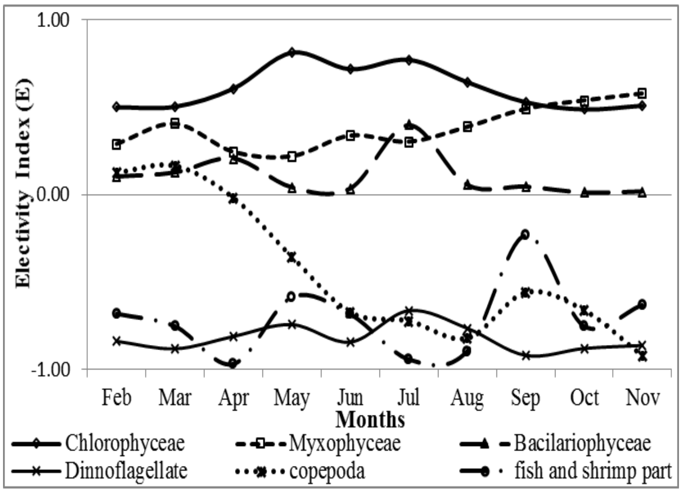

Fig 5: Prey electivity index of suspended food materials consumed by tade mullet (*Liza tade*) in extensive farming system

Discussion

Growth and metabolism of euryhaline species is often affected by salinity because the energy used for osmoregulation is not available for growth [36]. Tade mullet (*L. tade*) is reported to require minimum energy for osmoregulation at 15 ppt and isosmotic salinity for this species is 10 ppt [37]. Existence of ambient salinity close to isosmotic in the studied impoundments might have helped tade mullet to grow without salinity stress. Other factors such as food availability and stocking density might have affected growth in the present study. Much higher growth rate in shrimp-tade mullet polyculture in fed ponds compared to the present study has been reported where 6.16±0.49g tade mullet fingerlings attained 203.24 g with ADG of 1.33g/ day in 148 days at tade mullet stocking density of 0.33 individual/m^2 with tiger shrimp stocking density of 5 individuals/ m^2 [6]. Lower growth rate of tade mullet was reported from Sundarbans [5] where tade mullet fingerlings (5g) were grown to 265 g (ADG: 0.48g/day) in 18 months with *Liza parsia* at ratio of 1: 4 at overall stocking density of 25000/ ha in West Bengal coast. These observations indicate viability of tade mullet-tiger shrimp polyculture. However, tade mullet fingerlings (7.60±0.24g) attained 80.40±4.02g (ADG: 0.40g/day) at stocking density of 1500/ ha in 180 days polyculture with *Mugil cephalus* (4500/ ha), *L. parsia* (2000/ha) and *P. monodon* (20000/ ha) [3]. Higher growth rate of tade mullet in tade mullet-tiger shrimp polyculture may be attributed to no feeding competition among organisms of different trophic levels. Lower growth rate of tade mullet in culture with parsia and in mullets-tiger shrimp poly culture may be attributed to feeding competition with other mullets belonging to the same trophic level. Lower stocking density of other mullets as those entered naturally in the present study might be the reason behind better growth of tade mullet in spite of being non-fed mullets-shrimp polyculture. The isometric exponent (b=2.951) of length weight relationship in the present study indicated negative allometric growth of tade mullet. When the b parameter is equal to 3, growth is isometric and when it is less than or greater than 3, it is allometric [38]. More specifically, growth is positive allometric when organism weight increases more than length (b>3), and negative allometric when length increases more than weight (b<3) [39]. Negative allometric growth and low condition factor (K= 0.64±0.02) of tade mullet in the present study indicates shortage of food materials in the farming system as competition for space is not likely in such low density and low production systems. Exponent value of LWR in the present study corroborated with those reported from tropical lagoon of Sri Lanka [40].

Higher feeding frequency in bigger fishes than smaller ones may be attributed to the fear of potential predators by the smaller fishes while feeding as they are more vulnerable and would rather feed more cautiously than their bigger counterpart [41]. In tide fed extensive farming systems, tade mullets coexists with other herbivorous and some carnivorous fishes such as *Lates calcarifer*, *Megalops cyprinoides*, *Eleutheronema tetradactylum*, *Therapon jarbua*, *Glossogobius giuris* etc. which gains entry during the process of tidal water exchange and lowers production [3]. Larger fish may require more food to obtain the necessary energy for reproductive activity than smaller ones require for growth. Moreover, a wider mouth opening in larger fish helps to ingest relatively larger quantity food items at a time [42].

Reports on tade mullet feeding ecology is rare, however, food and feeding habits of other mullets have been studied by many authors [10, 15, 40, 43-47]. Mullets are well suited for farming since they feed on algae, diatoms, small crustaceans, decayed organic matter and mud; hence there is a little need to feed [48]. Mullets has been expressed that they were chiefly plankton feeders [49, 50]. Bacillariophyceae followed by myxophyceae and Chlorophyceae as most dominant food constituents of *M. cephalus* in brackishwater environments has been reported from various parts of Indian subcontinent [7, 51, 52] and other parts of the world [53-56]. Planktonic algae were reported to be the dominant food item of gold spot mullet, *Liza parsia* and planktonic groups according to the order dominance was Chlorophyceae, Bacillariophyceae and Myxophyceae [57]. Phytoplankton groups in stomach content of tade mullet according to the order of dominance in the present study were Bacillariophyceae, Chlorophyceae, and Myxophyceae. Differences in the order of dominance of different planktonic groups in the stomach content of mostly available mullet species in the studied region; *M. cephalus*, *L. parsia* and *L. tade* indicate some short of sharing strategy of the trophic level which they belong.

Maintenance of good water quality is essential for optimum growth and survival of aquatic organisms under culture. Recorded water quality parameters in the present study were within optimum ranges for brackishwater aquaculture [58] and differed significantly ($P < 0.05$) with time. Concentrations of toxic gases like nitrite-nitrogen (NO_2-N) and ammonia-nitrogen (NH_4-N) remained lower than the critical level and concentrations of nutrients like nitrate-nitrogen (NO_3-N) and phosphate-phosphorous (PO_4-P) was much lower than fertilized ponds from Sundarban [3, 59]. Lower nutrient concentrations in the studied extensive system may be attributed to complete dependence on natural productivity without any additional input. Order of dominance of the planktonic groups in the ambient water in the present study was corroborated with that reported from the Hooghly estuary [60]. As the extensive farming system depends only on the natural productivity and no feed or fertilizer is applied, such farming system can be considered as representative of the natural environment and existence of planktonic community structure resembling the natural environment is expected.

Viewing the complex nature of fish feeding ecology, electivity index (E) analysis is essential to throw some light on food preferences. As per Ivlev's equation, E ranges from -1 to +1, where -1 to 0 stands for negative selection, while values 0 to +1 can be interpreted as positive selection of that prey item. Subsequent investigation suggested that a true positive or negative prey selection can be interpreted only at values > 0.3 or < -0.3[61]. Chlorophyceae was found to be the most preferred planktonic group by tade mullet in spite of ranking second in the order of dominance in the stomach content, whereas, Bacillariophyceae being dominant planktonic constituent in the stomach and water column ranked third according to the prey electivity analysis (Fig 5). Myxophyceae was the second preferred food constituent although ranking third in order of dominance in the stomach content. Among zooplanktonic groups, copepoda were selected for initial two months but cannot be attributed as true selection. Other zooplanktonic (dinoflagellates) and suspended particles derived from animal origin like fish or shrimp parts were not at all selected and were probably swallowed mechanically during intake of other food stuffs. On the basis of these observations, it may be suggested that tade mullet does not intake food at random but have the ability to select particular food items. It has been suggested that the organization of the alimentary system of a particular species, as for example in the relative concentrations of its digestive enzymes, may be such as to obtain maximum advantage for only a limited part of the range of material which the animal is actually capable of ingesting [53]. Order of preference of phytoplanktonic food by tade mullet as Chlorophyceae>Myxophyceae>Bacillariophyceae is different from coexisting species, *M. cephalus* as Bacillariophyceae> Myxophyceae>Chlorophyceae [52] in the same environment further indicates feeding strategy to reduce competition within the same trophic level.

Conclusion

Present investigations suggests that tade mullet has good growth potential and can be considered for intensified farming, however, protocols for intensified mono and polyculture has to be standardized. Feeding ecology study indicates that tade mullet is mainly a herbivorous fish which grazes on phytoplankton in the water column and consumes organic matter from the bottom sediment. Although tade mullet fed on Bacillariophyceae, Myxophyceae and Chlorophyceae according to the order of dominance, they showed preference towards Chlorophyceae followed by Myxophyceae and Bacillariophyceae. Further research is needed to unveil feeding strategies of other coexisting species in the studied environment having aquaculture importance. This will enable establishment of optimum species combination for improved brackishwater polyculture based on optimum food sharing and resource utilization as a step forward towards sustainable aquaculture development.

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