STUDY ON THE DIETARY OVERLAP AND GUT CONTENT ANALYSIS OF ETROPLUS SURATENSIS AND ETROPLUS MACULATUS FROM KADINAMKULAM LAKE, THIRUVANANTHAPURAM DISTRICT, KERALA.

DISSERTATION SUBMITTED TO ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM IN PARTIAL FULFILMENT OF THE REQUIREMENT

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SUBMITTED BY,

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682011. **2020 – 2022**

CERTIFICATE

This is to certify that the dissertation entitled **'Study on the Dietary overlap and Gut content analysis of *Etroplus suratensis* and *Etroplus maculatus* from Kandinamkulam Lake, Thiruvananthapuram district, Kerala'**, submitted to St. Teresa's College (Autonomous), Ernakulam, in partial fulfilment of the requirement of award of degree of Master of Science in Zoology is an authentic work carried out by **Ms. ATHIRA CHANDRAN** (**SM20ZOO001**) in the academic year 2020 – 2022 under the guidance and supervision of FEED SOLUTIONZ, Student Startup working under the mentorship of Dr. Pramod Kiran R.B., Assistant Professor, Department of Aquatic Biology and Fisheries, University of Kerala, Karyavattom Campus, Thiruvananthapuram and Mrs.Tiya K J (Internal Guide), Assistant Professor, Department of Zoology, St. Teresa's College, Ernakulam.

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This is to certify that, the project entitled, **"Study on the Dietary overlap and Gut content analysis of *Etroplus suratensis* and *Etroplus maculatus* from Kandinamkulam Lake, Thiruvananthapuram district, Kerala"** is an authentic record of the project carried out by Ms. ATHIRA CHANDRAN of St. Teresa's College, Ernakulam, Kerala, under the guidance of Feed Solutionz, Student startup at the Department of Aquatic Biology and Fisheries, University of Kerala, Kariavattom Campus, Thiravanathapuram during the period from 01/04/2022 to 30/04/2022 in partial fulfillment of requirements for the degree of Master of Science in Zoology.

We further certify that, she has completed all the works and duties to our complete satisfaction.

Place : Thiruvanathapuram

Date : 01/06/2022

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DECLARATION

I hereby declare that the dissertation entitled '**Study on the Dietary overlap and Gut content analysis of *Etroplus suratensis* and *Etroplus maculatus* from Kandinamkulam Lake, Thiruvananthapuram district, Kerala**'submitted to St. Teresa's College (Autonomous), Ernakulam in partial fulfilment of the requirements, for the award of the Degree of Master of Science in Zoology is a record of original research work done by me under the supervision and guidance of FEED SOLUTIONZ, Student Startup working under the mentorship of Dr. Pramod Kiran R.B., Assistant Professor, Department of Aquatic Biology and Fisheries, University of Kerala, Karyavattom Campus, Thiruvananthapuram, during the period from 01-04-2022 to 30-04-2022 and Mrs. Tiya K J (Internal Guide), Assistant Professor, Department of Zoology, St. Teresa's College, Ernakulam, to the best of my knowledge and belief, this project contains no material previously published or written by another person, except where due reference is made.

ATHIRA CHANDRAN

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ATHIRA CHANDRAN

LIST OF ABBREVIATIONS

SL. NO.	ABBREVIATION	EXPLANATION
1.	cm	Centimetre
2.	TL	Total length
3.	%	Percentage
4.	pH	Potential of Hydrogen
5.	GSR	Gastro somatic ratio
6.	RLG	Relative gut length
7.	EBFM	Ecosystem Based Fisheries Management
8.	g	Gram
9.	mm	Millimetre
10.	W	Weight
11.	FI	Fullness index
12.	FP	Feed preference index
13.	cm	Centimetre
14.	g	Gram
15.	IT IS	Integrated Taxonomic Information System- Report
16.	GSI	Gastro-somatic Index
17.	Ji	Number of fish containing prey
18.	P	The number of fish with food in their stomach
19.	f	Frequency of occurence
20.	SD	Standard deviation

LIST OF TABLES

SL.NO	TITLE	PAGE NO.
1.	Average Relative gut length (RGL) & Average Gastro somatic index (GSI) along with their Standard deviation (SD) of both fish species.	20
2.	Observed Food items & their Frequency of occurrence(f), percentage frequency of occurence(f %) of *Etroplus suratensis*	20
3.	Observed Food items & their Frequency of occurrence(f), percentage frequency of occurence(f %) of *Etroplus maculatus*	22

LIST OF FIGURES

SL. NO.	TITLE	EXPLANATION
1.	Kadinamkulam Lake	12
2.	Site Map	12
3.	Collected pearlspot	12
4.	Orange chromide	12
5.	Measuring *Etroplus suratensis*	12
6.	Measuring *Etroplus maculatus*	12
7.	Dissected *Etroplus maculatus*	13
8.	Dissecting *Etroplus suratensis*	13
9.	Gut content taken in petridish	13
10.	Relative gut length (RGL) of *Etroplus suratensis*	18
11.	Relative gut length (RGL) of *Etroplus maculatus*	18
12.	Gastro somatic index (GSI) of *Etroplus suratensis*	19
13.	Gastro somatic Index of *Etrolpus maculatus*	19
14.	Percentage composition of prey/ items observed through gut content analysis of *Etroplus suratensis*	21
15.	Percentage composition of prey/food items observed through gut content analysis of *Etroplus maculatus*	22
16.	Crustacean larvae	23
17.	Nematode	23
18.	Copepods	23
19.	Arthropod parts	23
20.	Gastropod shell	23
21.	Fish egg obtained from the gut of *Etroplus maculatus*	23

22.	Miscellaneous items	23
23.	Fish scales	23
24.	Zooplanktons	23
25.	Arthropod body part	23
26.	Cruatacean appendage	23

CONTENTS

SL.NO	CONTENTS	PAGE NO
1	ABSTRACT	1
2	INTRODUCTION	2-3
3	AIM AND OBJECTIVE	4
4	REVIEW OF LITERATURE	5-10
5	MATERIALS AND METHODS	11-17
6	PLATE 1: SAMPLING	12
7	PLATE 2: GUT CONTENT ANALYSIS	13
8	RESULT AND DISCUSSION	18-25
9	PLATE 3: OBSERVED PREY ITEMS	23
10	CONCLUSION	26
11	REFERENCE	27-32

ABSTRACT

The study investigate the differences and similarities in the diet composition among two species of the genus *Etroplus* which can inhabit in both fresh and brackish water. A total number of 30 stomachs were analyzed for data collection of each species; *Etroplus suratensis* ranging from 2.3 to 16.2 cm TL and *Etroplus maculatus* ranging from 5.8 to 9.4cm TL collected from Kadinamkulam Lake, Trivandrum. The selected species *Etroplus suratensis* and *Etroplus maculatus* feed on a common base of food resources and therefore, some niche overlap is present in terms of general diet composition. However, changes in the trophic niche with size and differences in some morphological traits among the species explain the observed differences in diet. Results indicate that the diets of the two species were dominated by plant parts and filamentous algae.

INTRODUCTION

Analysis of gut content is widely used to ascertain the food and feeding habit of fish species. Diets of fishes represent an integration of many important ecological components that included behavior, condition, habitat use, energy intake and inter/intra specific interactions. Accurate description of diets and feeding habits provides the basis for understanding the trophic interactions in aquatic food webs. Investigation on the food and feeding habits will throw more light on the migratory and shoaling habits of pelagic fish species and it is particularly important for a species of high commercial value (Zanden *et al*., 2000).

The feeding habits of most fishes are roughly grouped in to the following three major trophic categories: Carnivorous, Omnivorous and Herbivorous (Seaburg, 1957). Most studies on fish diets rely on examination of stomach content to quantify prey abundance usually to a coarse taxonomic resolution where the main aim of the study is ecology-based (Robichaud *et al*., 1991).The diet of fishes changes with a number of factors which are extrinsic (biotope, region) or intrinsic (species, size, behavior) and thus information on diet of fishes is important to understand the basic functioning of fish assemblages which are important for developing Ecosystem Based Fisheries Management (EBFM) models (Hanson *et al*., 2002). Studying feeding habit of fishes does have great importance both in fisheries and aquaculture. n fisheries, it provides information on distribution pattern and the feeding ground of both local and regional and also has direct implication for fishing gear such as long line and fish trap which used it as bait. Study on the food and feeding habits of fish is a crucial requirement for the success of aquaculture practices which has great possibilities in a developing country like India. The gut content indicates what the fish would feed on and also provides information on the trophic interactions in aquatic food webs (Melby *et al*., (2019). For the selection of suitable culture species for successful fish farming, study of food and feeding habits of fishes is of much importance (Manon and Hossain, 2011).In aquaculture, the knowledge of food item is crucial for rearing the larvae in order to provide different live food at different life stages, while providing a critical appraisal of the existing knowledge of food and feeding habits of marine fishes in Indian waters, emphasized the importance of chemical analyses of food of fishes as it is of crucial importance in understanding dynamics of energy and its channeling to various trophic levels (Qasim, 1972).

Direct examination of stomach content has become a standard practice for studying feeding habits of fish and other animals for many years (Hyslop, 1980). Currently, many other methodologies such as radioisotopes, stable isotope analysis, direct species observations & fatty acid analysis are used (Braga *et al*., 2012). However, the easiest and most used method is direct gut content analysis carried out through dissection or evacuation and examination of stomach contents. This method has great potential and is good enough for most biological as well as ecological studies (Manko, 2016). For a better understanding of diet data and for accurate interpretation of fish feeding habits, factors such as sampling location, time of day, prey availability and even the type of gear used to collect the fishes need to be considered (Zacharia, 2017).

The length of the gut determines the feeding nature of a fish, that is; herbivorous fishes have longer gut as compared to the carnivorous fishes. In different fishes as well as in same fish of different length groups food selection varies (Ribble and Smith, 1983; Sibley and Calow, 1986;Horn, 1989;Starck, 2005). The pearl spot (Etroplus suratensis), belonging to the family cichlidae and an endemic cichlid species to Asia, are widely distributed in the India and Sri Lanka. Importantly, this fish forms important fishery in the brackish water lakes of India. Its abundance in the Chilka lake, Pulicat lake and Vembanad Lake has been reported previously This species show wide salinity tolerance. It is essentially a brackish water fish that has become naturally acclimatized to freshwaters. Euryhaline nature and omnivorous feeding habit make the fish compatible to be farmed in polyculture with both brackish water and freshwater fish and prawns. In spite of their economic importance, the feeding ecology of this fish is poorly known. (Priya *et al*.2020).

In the present study, diet composition and gut content of pearlspot and orange chromide collected from Kadinamkulam Lake, Thiruvanathapuram was analysed.*Etroplus suratensis* in different habitats have been studied by several authors (Jhingran and Natarajan, 1969; Devaraj *et al*., 1975; De Silva *et al*., 1984; Jayaprakash and Padmanabhan, 1985; Keshava *et al*., 1988; Keenleyside, 1991) while that of *Etroplus maculatus* is comparatively less. The present work focuses on the study of dietary overlap and gut content analysis of *Etroplus suratensis* and *Etroplus maculatus* and this will provide an insight into the food preferences of both species as well as it enables to determine their commonness in feeding.

AIM AND OBJECTIVES

AIM

To study the dietary overlap and gut content analysis of *Etroplus suratensis* and *Etroplus maculatus* collected from Kadinamkulam lake, Thiruvananthapuram district, Kerala.

OBJECTIVES

- To understand the diet composition of *Etroplus suratensis Etroplus maculatus* in Kadinamkulam lake, Thiruvanathapuram.

- To compare the food preferences of *Etroplus suratensis* and *Etroplus maculatus* from kadinamkulam lake, Trivandrum for potential dietary overlap.

REVIEW OF LITERATURE

Ever since trophic ecology theory was introduced in the early1940s (Lindeman, 1942), much attention has been paid to the development of suitable methods to enable scientific progress in this field (e.g. Baker *et al*., 2014; Hynes, 1950; Hyslop, 1980 for fish; Pierce & Boyle, 1991 for marine mammals; Birkhofer *et al*., 2017 for invertebrates). In the studies of aquatic animals such as fish, the possibilities for direct observation of feeding behaviour and prey choices are limited. Stomach content analysis is therefore an important and universal means for detailed exploration of diet composition and feeding ecology. Fishes are particularly benign organisms for dietary studies from stomach contents analysis as they canoften be sampled in high numbers, usually swallow their prey as whole and mostly have a well-defined stomach. Fish typically have key roles as consumers and top predators in the trophic network of aquatic ecosystems and their tropic ecology is an important parameter in most species descriptions (Froese &Pauly, 2017).

Studies of the feeding ecology of animals are essential for understanding trophic interrelations, population and community dynamics within an ecosystem and for comparisons among systems. Stomach contents analysis are instrumental in this respect. Consequently, a vast number of publications exist for addressing the aspects of fish feeding ecology through the analysis of stomach contents data (Braga *et al*., 2012; Simenstad &Cailliet, 2017) and many methods have been adopted in this respect (Baker *et al*., 2014; Hyslop, 1980; Manko, 2016). Over time, anumber of publications have addressed methodical approaches used in fish feeding studies (e.g. Ahlbeck *et al*., 2012; Baker *et al*., 2014; Berg,1979; Buckland*et al*., 2017; Cortés, 1997; Hynes, 1950; Manko, 2016;Windell& Bowen, 1978), including a few method reviews that have become key references for stomach contents studies, in particular Hyslop (1980). However, despite these efforts, a consensus for as standardised methodology for stomach contents analysis has yet not been reached.

The lack of methodical consensus may chiefly be ascribed to the existence of several problems and challenges associated with the available methods for stomach contents analysis, which eventually may bias the outcome of such studies. An inherent problem with any method is that the contribution of slowly digested prey taxa will tend to be overestimated. More specifically, differential gastric evacuation rates of prey taxa due to, for example, differences in fat contents (Amundsen & Klemetsen, 1988; Elliott, 1972, 1991; Persson,

1979,1981), energy levels (Jobling, 1980, 1987), or food particle sizes(Jobling, 1987; Legler*et al*., 2010) will lead to an overestimation of slowly digested prey, since these will tend to remain in the stomach for an extended time period (Baker*et al*., 2014; Hyslop, 1980). Furthermore, some indigestible remains, in particular hard body parts such as fish otoliths, crayfish gastroliths, chitinous head capsules of insects, mollusc shells and other exoskeleton or skeleton parts, are much easier to identify than the remains of softer prey types. Such indigestible remains may be preferentially retained in the stomach for prolonged periods of several weeks (dos Santos &Jobling, 1991;Jørgensen &Jobling, 1988) and their dietary role will inevitably tend to be overestimated in stomach contents analysis. On the other hand, digestion and fragmentation of prey, often combined with extensive mucus formation, can make the taxonomical identification difficult (Buckland *et al*., 2017). For the same reasons, it is usually difficult and highly time consuming to separate and handle prey items for mass or volume measurements, for example (Baker *et al*., 2014; Buckland *et al*., 2017), which are required by some methods (Hyslop,1980). Typically, the potential problems and challenges for stomach contents analysis are of different importance among the various methodological approaches that are available, an aspect that needs careful consideration in the evaluation of different methods. Some methods are also far more time consuming than others, imposing important cost–benefit trade-offs that need to be considered in any method assessment.

The diet of five freshwater fish species of Lake Trichonis, the largest natural lake of Greece, was studied by Stoumboudi *et al*. (2022). Specifically, the studied species were *Atherina boyeri*, *Luciobarbus albanicus*, *Leuco spanosi*, *Scardinius acarnanicus* and *Tropidophoxinellus hellenicus*. Diet analysis was based on stomach content analysis of seasonal samples collected and trophic indices were estimated (Shannon-Wiener, Levins', Schoener, Trophic level) so as to investigate each species' feeding diversity, trophic niche breadth, trophic level as well as their trophic competition and overlap. Moreover, the annual and the seasonal relative condition factor were estimated. The diet analysis indicated a tendency of the studied species to omnivorous feeding strategy and a seasonal fluctuation in their diet composition. In addition, the estimated trophic indices revealed similar feeding behavior and significant diet overlap between species, suggesting narrow partitioning of the food resources. However, the relative condition factor ranged between 0.973 and 1.041, indicating a state of wellbeing for the fish species and possibly sufficient food availability.

Comparative gut content analysis of invasive mosquitofish from Italy and Spain was studied by Jourdan *et al*. (2021). Eastern mosquitofish, *Gambusia holbrooki*, among the most widely

introduced freshwater species globally. According to his findings, mosquito fishes are omnivores with a preference for detritus and cladocerans; they display size- and population-specific differences in gut morphologies and diet, with larger fish feeding more intensively over a wider range of prey items and some of the variation would be associated with differences in local environmental and climatic factors. Not a single diet item was shared among all populations. When further identified size- and population-specific differences in the occurrence of some diet items and gut morphologies. However, observed patterns in dietary habits did not seem to be driven by the environmental and climatic variables. The fairly variable diet likely aids invasion success and helps explain the ubiquity of invasive mosquitofish across Italy and Spain, as mosquitofish seem to be able to rely on whatever a local habitat provides. With further identification that size-specific differences likely capture the substantial sexual size dimorphism (males are smaller than females), while population-specific differences are likely the result of differences in local prey abundance. The lack of an influence of temperature on dietary habits suggests that mosquitofish feeding ecology may be less impacted by rising temperatures than other freshwater fish species.

Food habit studies provide a better understanding about the interspecific and intraspecific interactions between different members of an ecological community and also enables to map the flow of energy nutrients and pollutants (Cailliet *et al*. 1986). A study conducted by Bindu and Padmakumar(2008) gave insight on the food of pearlspot, *Etroplus suratensis* in the Vembanad Lake and it was dominated by filamentous algae (43%) followed by detritus (35%), aquatic plants (12%), diatoms (9%) and molluscan shells (1%). Filamentous algae were the major food throughout the year. Feeding intensity was higher during pre-monsoon months. Well developed dentition, long intestine and other characteristics were related to dietary habits. Relative length of gut varies between 1.12 and 6.81 indicating omnivorous feeding.

Percentage of feeding varies among different size groups of fishes and according to the study by Lydia (2016), the percentage of feeding was higher among the younger fishes as compared to the bigger fishes. Dasgupta (1988, 1990 & 1991) also came up with similar reports based on his study. Priya *et al*.(2020) investigated on food and feeding analysis of *Etroplus suratensis* from Sarvepalli Reservoir. The composition of the food varied from season to season depending upon the fluctuations in the occurrence of food items in the environment. This is because in flood-pulse systems, water level oscillations directly influence the connectivity to floodplain habitats for fish (Kong *et al*., 2018). Feeding chronology based on

diurnal surveys indicate that it feeds mainly during the daylight hours. Distinct differences in the mean relative intestinal length between populations from the coastal lagoon and inland reservoirs were evident and these differences are correlated to their respective feeding habits. Diurnal changes in feeding activity are associated with changes in the stomach pH (De Silva *et al*., 1984). Study conducted by Melby *et al*.(2019)on the food and feeding habits of *Etroplus suratensis*, in Vellayani lake of Kerala; the gut content analysis based on the frequency of occurrence and points method revealed that the gut was predominant with macrophytic aquatic plant (33%) and filamentous algae (31%) and the above investigation on *E. suratensis* was an indicative of predominant herbivoric food preference of the species in Vellayani Lake. Kong *et al*. (2018) during his study on seasonal variations in diet composition, diet breadth and dietary overlap between three commercially important fish species within a flood pulse system suggest that the flood-pulse may play a role in mediating the competitive interactions between the three species by making it possible for species to shift their diet as the availability of resources changes over time. This may ultimately promote biodiversity by providing opportunities for species to avoid competition and live in harmony with other species displaying similar dietary requirements during some periods of the year.

A study conducted by Maisnam and Sunkam(2017), on the diet of Threatened Fish *Pethia shalynius* (Yazdani and Talukdar 1975) in which the relative length of gut, gastro somatic index, index of preponderance and gut contents were analaysed and determined. The feeding habit of *Pethia shalynius*, an endemic and threatened hill stream fish of Northeast India was observed, and it revealed *P. shalynius* feeds on a few types of food and therefore can be categorised as stenophagic. Similar stenophagic feeding habit of spiny eel, *Macrognathus pancalus* Hamilton 1822 and *M. aral* (Bloch and Schneider 1801) feeding on earthworms, insects, micro-crustaceans and the larvae of other aquatic invertebrates has been reported by Abujam and Biswas (2010).

Study conducted by Bindu and Padmakumar (2008)on the feeding of the pearlspot,*Etroplus suratensis* in the Vembanad Lake, Kerala gave insight on feeding intensity during seasons and also accounted on dentition, long intestine and other characteristics related to dietary habits indicating omnivorous feeding.Two types of fishing practices viz., gillnetting in night hours and scareline fishing during day time. It was believed that in scareline fishing, brooding and nesting fishes are the ones that are generally caught. However, in the present study, an analysis of the fullness of the guts showed that all fishes caught in scarelining were not

brooders. Being omnivorous, the fish fed predominantly on filamentous algae (43%), detritus (35%) and other items such as aquatic plants, diatoms, molluscan shells etc. Detritus play a significant role in the diet of fishes in freshwater systems. An account on empty stomach and intensive feeding indicated lowest food intake during monsoon months (June-July) coinciding with the breeding season (Jayaprakash and Nair, 1981) and intense feeding during pre monsoon months (Bindu and Padmakumar, 2008) Variation in Relative Length of Gut (RLG) in *E. suratensis* that is long coiled gut indicates its adaptation for better digestion and absorption of the plant and phytoplanktonic matter (Desai, 2003; Serajuddin and Rustam Ali, 2005). Hence observed that the RLG value increased with the increase of vegetable matter as food and decreased with the increase of animal matter. Accounting for the dentition of *E. suratensis* the frontal incisiform sharp teeth are adapted for feeding on higher plants (Fryer and Iles, 1972). The pharyngeal teeth are equipped for grinding and crushing molluscan shells similar to those of the cichlid, *Haplochromis placodon.* The semi - circular nature of the mouth and minimum protractibility of the lips indicates the complex food capturing mechanism by nibbling or scrapping algae from a hard substrate (Greenwood, 1952).

In a study conducted by Nipen *et al*. (2020) on feeding biology and food selection in Rainbow snakehead, *Channa bleheri*, a total of 103 specimens were collected from different sampling site of Assam and after the precise method of removing the gut and carefully observing its contents different method like occurrence method, numeric method dominance method, volume and weight method, fullness method and point method were chosen for the percentage composition of each item in the sample. With a thorough analysis of relative length of gut (RLG) value and GSR (gastro somatic ratio) value species is found to be highly insectivorous in nature in its juvenile and adult phase. However in the growing phase from juvenile to adult it feeds equally on insects and zooplankton. With the total feed component analysed the percentage composition of insect is found to be highest and followed by zooplankton etc. Thus the fish is considered primarily as insectivorous fish.

A study conducted on the feeding habits of pearlspot in the Nethravati Gurpur Estuary by Keshava *et al*.(1998) revealed the feeding pattern of *E. suratensis* on each month. Analysis of stomach content both quantitatively and qualitatively showed several variation in feeding which was related to relative abundance of food, age and diurnal variation in feeding. Qualitative analysis was carried out by using both occurrence and point volumetric method. Qualitative analysis indicated dominance of filamentous algae and decayed organic matter in

food content. The data showed a relation to size of fish with food composition along with variation in feeding intensity in each month. The above study on *E. suratensis* gave an insight to the most consumed matter by the species which is decayed organic matter. And also a size dependent preference to certain food items was noticed in present study. One among the interesting phenomenon observed in the study was dominance of empty stomach during most of months. The work states that the feeding intensity might be related to maturation of gonads and spawning activity besides food availability.

The food selection varies in different fishes as well as in same fish of different length groups. The food selection by the fish will reflect the trophic index and position in the food chain (Nayak *et al*., 2020). According to Chakraborty *et al*., (2017) on length-weight relationship, relative condition factor, food and feeding habits of *Channa striata*. Total length of the fish sample ranged from 130-400 mm and weight 65-955g the species was categorized into two group's viz., Group I (< 200 mm) and Group II (200 mm) for convenience of interpretation. The length weight relationship was recorded as W = 0.0072 L 3.104 for the Group I and W = 0.0068 L 3.060 for Group II. Food and feeding habits revealed fishes were the main food items followed by insects and crustaceans indicating *Channa striata* is a carnivore, predatory and bottom dwelling fish. Similar work was conducted by Nayak *et al.*, (2020) on the Feeding biology and food selection in Rainbow Snakehaed (*Channa bleheri, Vierke 1991*). *Channa bleheri* is found to be highly carnivorous in its juvenile stage as indicated by its very low relative gut length (RLG) value. The Gastro-Somatic Ratio (GSR) is found to be highest (1.29±0.27) in 60-80 mm group. Gut content analysis shows that they primarily feed on mostly on plankton and insect larvae, in their juvenile stage and mostly insects in their adult stage. Ecologically a tropic score of 3 can be assigned to the fish and it can be placed as a secondary consumer on the basis of feed constituent.

A study conducted by (Daghooghi *et al.*, 2018)on the feeding habits of *Rastrelliger kanagurta* (Cuvier, 1817) in the Persian Gulf (Hormozgan Province) in which the feed preference index (FP), fullness index (FI), and stomach contents of *Rastrelliger kanagurta* were evaluated to assess the quantity and type of feed habits. Results of stomach contents study showed that Indian mackerel fed on Phytoplankton, Zooplankton and fish. The food preference (FP) were calculated for Copepods (FP=75.45) and then bivalve (FP=37.81), Coscinodiscus (FP=35.55), Tintinnids (FP=29.59), Peridinium (FP=25.46), Ceratium (FP=23.39), Pyrophacus (FP=20.87), Dinophisis (FP=16.97),

Pleurosigma(FP=16.28), Noctiluca (FP=15.82) and Oscillatoria (FP=11.47) were second hand feed items and *Encrasicholina punctifer* (FP=8.02), thalassiothrix (FP=8.02), Naupli (FP=6.65) and also other feed items with FP lower than 10 were random foods identified for this species. Similar work on Food and Feeding Habits of *Amblypharyngodon mola* (Hamilton) from Kaptai Reservoir, Bangladesh was conducted by (Mamun *et al*., 2004). For the analysis of gut contents two methods were followed namely occurrence and points methods. *A. mola* was found to be planktivorous which feed mainly on Chlorophyceae (78.77%), Bacillariophycea (11.85%), and Debris with mud (3.09%). These food items clearly indicated that the fish preferred phytoplanktonic food. The fish incidentally took the animal nature plankton foods of Rotifera and Crustacea in negligible amount, 1.58 and 0.24% respectively.

Shift in diet have been reported in *Piaractus brachypomus* introduced to sepik- Ramu River Basin, Papua New Guinea (Correa, 2014). The feeding habits of *P. mesopotamicus* larvae revealed that phytoplankton, preferably chlorophytes and rotifers, form their food (sipauba-Tavares and Braga, 1999). *P.brachypomus* can also utilize carbohydrates and lipids in a same manner in the maximization of protein consumption (Abimorad and Carnerio, 2007). The analysis of the stomach contents during the study revealed that African catfish, *Clarias gariepinus* is a euryphagus omnivore with feeds on a wide spectrum of organisms according to Bruton (1979). *Clarias gariepinus* is omnivorous, exhibiting both scavenging and predatory behavior. He also added that these fishes didn't rely completely on offshore fishes and benthic invertebrates at high lake level, but could readily switch their feeding on littoral fishes and invertebrates when these became abundant. These fishes had the ability to utilize a broad range of prey in different habitats which suggest its dietary plasticity, one of the important factors responsible for establishing themselves in a wide range of environment (Gorenewald, 1964).

MATERIALS AND METHODS

COLLECTION

The fishes were collected randomly from Kadinamkulam lake of Thiruvanathapuram district, Kerala, during the month (pre-monsoon period) of April, 2022. Kadinamkulam Lake (lat. 8c35'-8°40'N and long. 76°45'-76°52'E) opens into the sea at Perumathura by a temporary bar mouth. The Vamanapuram River flows into the sea through this opening. It is connectedto the Anchuthengu Backwater on the north and the Veli Lake on the south.

SAMPLING AND ANALYSIS

Samples of *Etroplus suratensis* and *Etroplus maculatus* were collected randomly. For this fishes were caught using cast nets and 9 castings were employed for getting the desired species. A total of 30 *E.suratensis* and *E. maculatus,* each of which were collected and examined for gut content analysis. Immediately after collection, fishes were preserved in 10 per cent buffered formalin and taken to lab. The specimens were measured for total length to the nearest 0.1 cm using a scale and body weight to the nearest 0.1 g using an electronic balance and the gut along with contents were removed and preserved in 5% formalin. After noting the total length and weight of the fishes, their stomach were taken out, and measured the length and weight. The contents of the gut were preserved in 5% neutralized formalin for further analysis. For the analysis, a longitudinal cut was made across the stomach and the contents were transferred into a petridish. The contents were kept for five minutes to remove excess formalin and then examined under a stereomicroscope as well as compound microscope. The total length-weight and fullness of the gut were recorded by following the procedures suggested by Windell and Bowen (1978).

Fig 1 : Kadinamkulam Lake

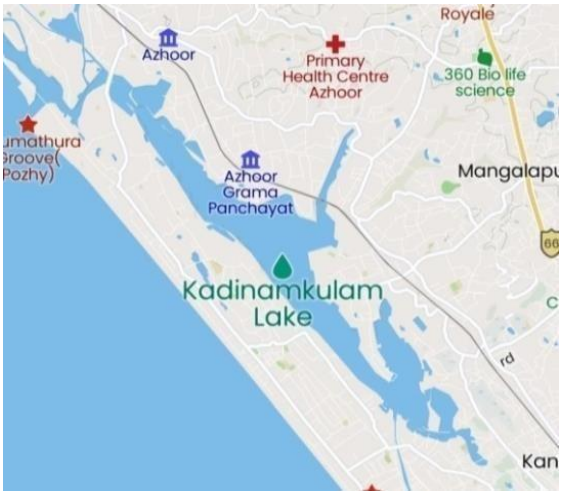

Fig 2: Site Map

(Source : https://mapcarta.com/W383753872/Map)

Fig 3: Collected pearlspot

Fig 4: Orange chromide

Fig 5: Measuring *Etroplus suratensis*

Fig 6: Measuring *Etroplus maculatus*

Fig 7: Dissected *Etroplus maculatus*

Fig 8: Dissecting *Etroplus suratensis*

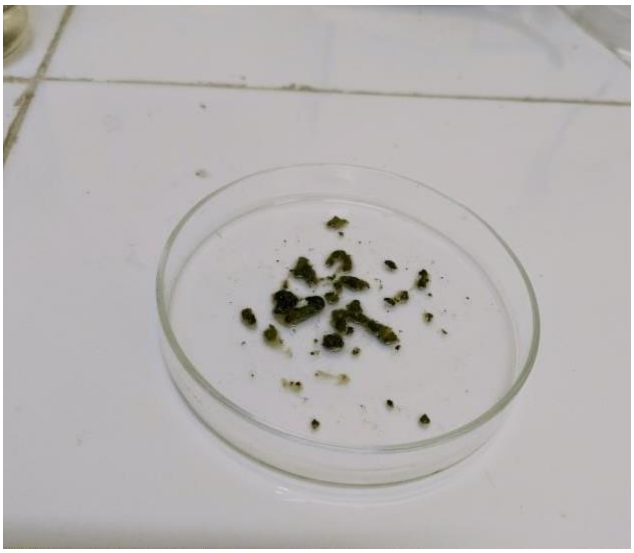

Fig 9: Gut content taken in petridish

Taxonomic Classification

1. ***Etroplus suratensis (Bloch, 1790)***

Kingdom	:	**Animalia**
Subkingdom	:	**Bilateria**
Infrakingdom	:	**Deuterostoma**
Phylum	:	**Chordata**
Subphylum	:	**Vertebrata**
Infraphylum	:	**Gnathostomata**
Superclass	:	**Actinoptergii**
Class	:	**Teleostei**
Superorder	:	**Acanthoptergii**
Order	:	**Perciformes**
Suborder	:	**Labroidei**
Family	:	**Cichlidae**
Genus	:	**Etroplus**
Species	:	***Etroplus suratensis* (Bloch, 1790)**

Source : IT IS (Integrated Taxonomic Information System- Report)-https://www.itis.gov

The green chromide, *Etroplus suratensis* is a species of cichlid fish that is native to fresh and brackish water habitats in some parts of India. It mainly feeds on aquatic plants, including filamentous algae and diatoms, but it consumes the occasional mollusk and other animal matter. The adult appears to be oval in shape with a short snout. It is grey green with dark barring and a dark spot at the base of the pectoral fin (Abraham, R. 2011). With common length : 20.0 cm TL male/unsexed and Max length : 40.0 cm TL male/unsexed. This species

is a bi-parental substrate spawner which forms temporary pair bonds when reproductively active.After spawning, about 500 eggs are laid and attached to a submerged log, rock or sometimes roots and weeds, in still or slow flowing water. Parents guard and fan the eggs until hatching .Parents refrain from feeding from the time of spawning until the fry become independent (FAO, 2010).

2. ***Etroplus maculatus (Bloch, 1795)***

Kingdom	**:**	**Animalia**
Subkingdom	**:**	**Bilateria**
Infrakingdom	**:**	**Deuterostoma**
Phylum	**:**	**Chordata**
Subphylum	**:**	**Vertebrata**
Infraphylum	**:**	**Gnathostomata**
Superclass	**:**	**Actinoptergii**
Class	**:**	**Teleostei**
Superorder	**:**	**Acanthoptergii**
Order	**:**	**Perciformes**
Suborder	**:**	**Labroidei**
Family	**:**	**Cichlidae**
Genus	**:**	**Etroplus**
Species	**:**	***Etroplus maculatus* (Bloch, 1795)**

Source :WoRMS- , http://www.marinespecies.org version(08/2021).

The orange chromide, *Etroplus maculatus* is a species of cichlid fish that is endemic to freshwater and brackish streams, lagoons and estuaries in southern India and Sri Lanka (Loiselle, P.V. 1995). It is locally known as 'Pallathi'. It reaches a length up to 8cm. This species is popular with fishkeeping hobbyists, and is kept frequently in aquariums. The

species co-occurs throughout its range with the green chromide (*Etroplus suratensis*). Orange chromides prey on the eggs and larvae of the green chromide and also act as a "cleaner fish" removing parasites from the larger green chromides in a cleaning symbiosis. The species also feeds on zooplankton and algae (Fish base, 2017). They spawns in shallow water, on a soft depression excavated by both parents. About 200 eggs are laid and hatch after 5 days, during which time the parents tend, and if necessary fan them.

ANALYSIS OF GUT CONTENT

The method employed for the gut content analysis was purely qualitative. For this, the gut was examined and based upon the degree of distension, points were allotted. And the points were; gorged, full, good, moderate, poor and empty; while points were assigned separately for each food item as swarm, plenty, few, little and rare through eye estimation method and the feeding intensity was estimated. The following outline of methods is based mainly on the reviews by Hynes (1950), Pillay (1952), Windell (1968), Hyslop (1980) and Chipps *et al*., (2002).

POINTS (NUMERICAL) METHOD

The points method is an improvement on the numerical method where consideration is given to the bulk of the food items. The simple form of points method is the one in which the counts are computed falling a certain organisms as the unit. Depending upon the fullness of the stomach and based on eye estimation, points such as 50, 40, 30, 20, 10 and 0 were given for gorged, full, good, moderate and empty stomachs respectively (Windel and Bowen, 1974). Points such as 50, 40, 30, 20, 10 and 5 were given for the swarm, plenty, common, few, little and rare were allotted for each food or prey item respectively (Kow, 1950). Percentage composition of the food items in the stomach for each prey item of fish was thus obtained.

GASTRO-SOMATIC INDEX (GSI)

The gastro-somatic index (GSI) is a relationship between weight of alimentary canal and weight of fish, which helps in determining the feeding condition in different months and

seasons. Gastro-somatic Index is calculated as the percentage of gut- weight to the total weight of the fish (Khan *et al*., 1998).

GSI = WEIGHT OF GUT / WEIGHT OF FISH X 100

RELATIVE GUT LENGTH (RGL)

Relative gut length is calculated as the ratio of full un-stretched gut length (mm) to the total length of the fish (mm). The RGL of the fish was determined by using the formula

RGL=TOTAL LENGTH OF GUT/TOTAL LENGTH OF THE FISH

FREQUENCY OF OCCURRENCE METHOD

The number of stomachs in which each item occurs is recorded and expressed as a percentage of the total number of stomachs studied. Frequency of Occurrence= Ji / P; where, Ji = number of fish containing prey i, P = the number of fish with food in their stomach. (Hyslop, 1980)

RESULTS

The gut content analysis of *Etroplus suratensis* and *Etroplus maculatus* showed various food oraganisms. Prey items were identified and points were allotted. The total number of analyzed stomachs was 30 for *Etroplus suratensis* having a total length(TL) ranging from 2.3 to 16.2 cm and 30 for *Etroplus maculatus* from TL 5.8 to 9.4cm. Analysis of Relative gut length (RGL), Gastro somatic Index(GSI) and Frequency of occurrence(f) of prey items showed the following data.

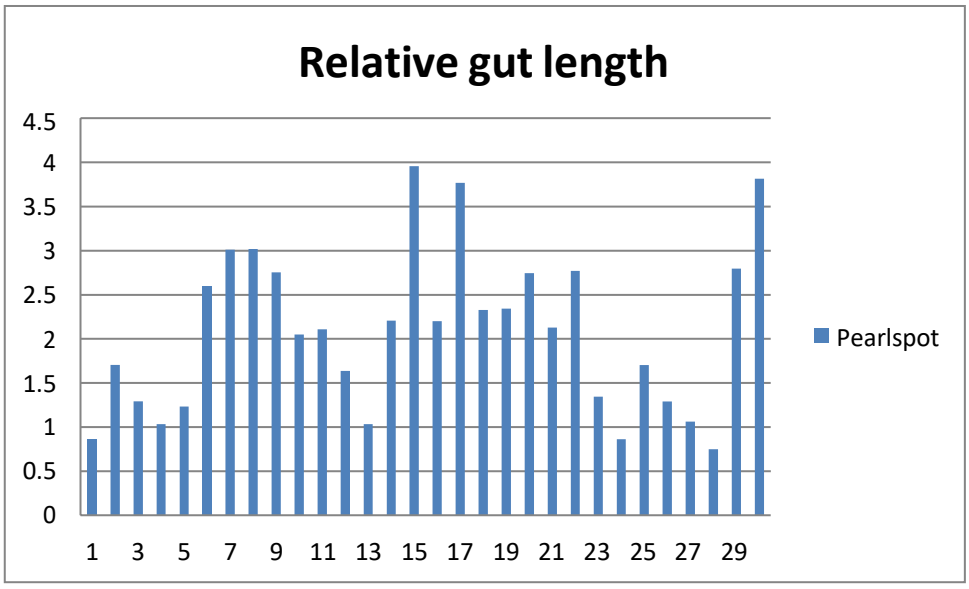

Figure 10: Relative gut length (RGL) of *Etroplus suratensis*

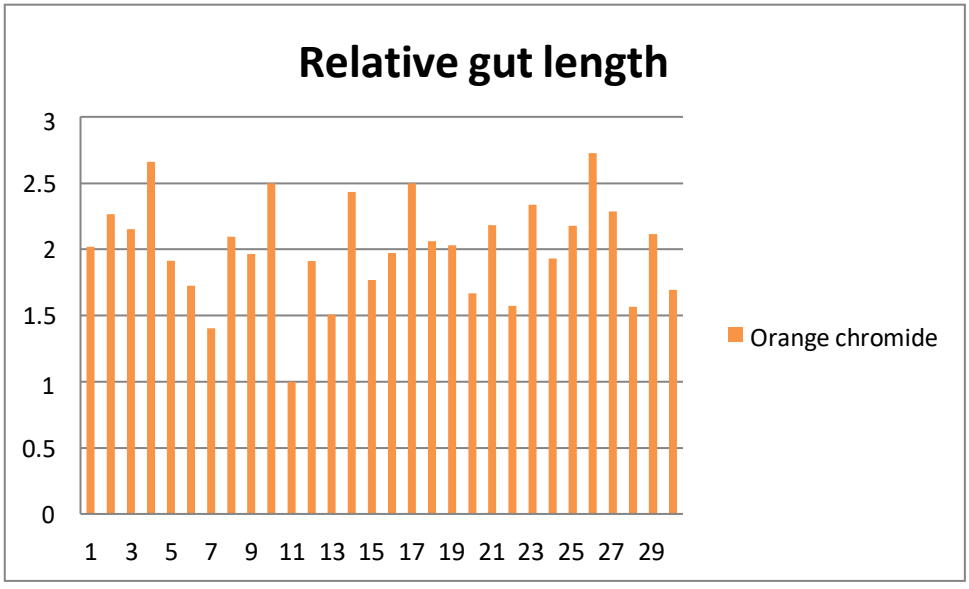

Figure 11: Relative gut length (RGL) of *Etroplus maculatus*

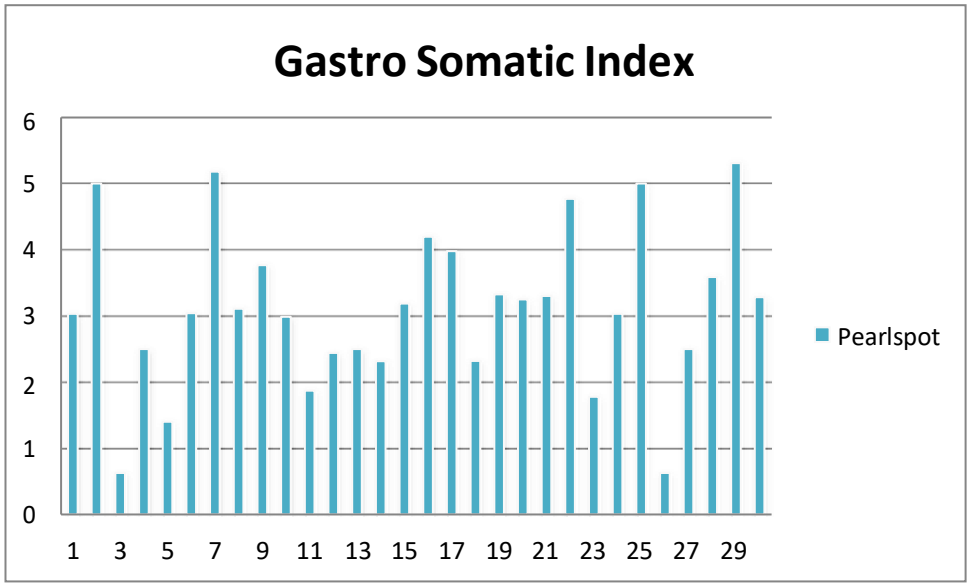

Figure 12: Gastro somatic index (GSI) of *Etroplus suratensis*

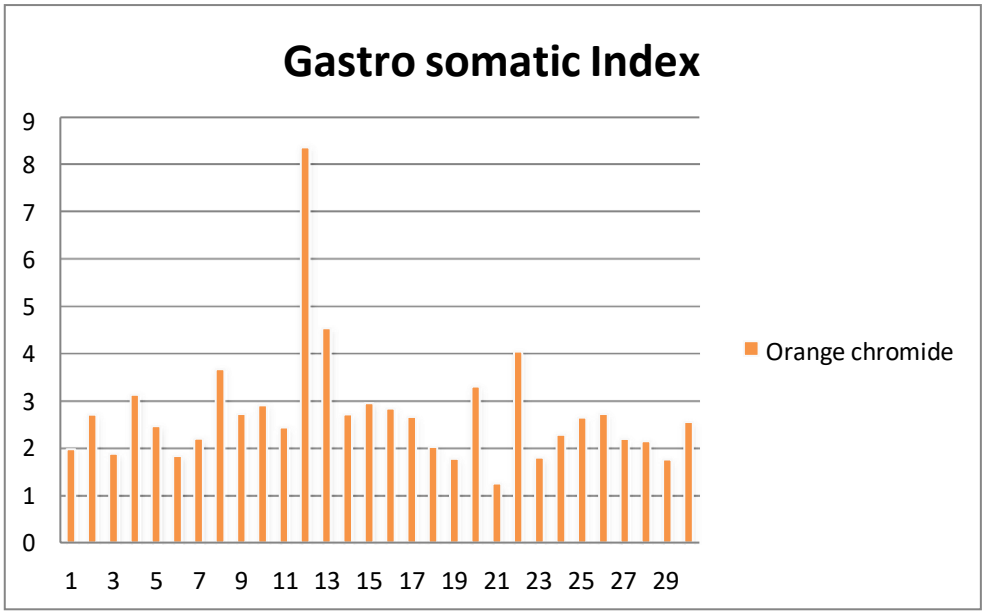

Figure 13: Gastro somatic Index of *Etrolpus maculatus*

Fish species	RGL	GSI
Etroplus maculatus	2.004417	2.748765
	SD 0.387709	SD 1.273796
Etroplus suratensis	2.080015	3.107316
	SD 0.916971	SD 1.219327

Table 1: Average Relative gut length(RGL) & Average Gastro somatic index(GSI) along with their Standard deviation (SD) of both fish species

The Relative gut length of *Etroplus suratensis* showed an average value of 2.080 with a standard deviation of 0.916 while that of *Etroplus maculatus* showed an average value of 2.004 with a standard deviation 0.387 (Table 1). Gastro somatic index (GSI) is a relationship between weight of alimentary canal and weight of fish, which helps in determining the feeding condition in different months and seasons. The average Gastro somatic index value was 2.748 for *E. maculatus* while that of *E. suratensis* was 3.1073 with standard deviation 1.273 and 1.219 respectively.

Sl. No.	Food items	Ji	f(Ji/P)	f %
1	Plant parts	28	0.965	96.5
2	Filamentous algae	27	0.931	93.1
3	Zooplankton	4	0.137	13.7
4	Silt	2	0.068	6.89
5	Digested food	29	1	100
6	Miscellaneous items	2	0.068	6.89
7	Detritus	9	0.31	31
8	Arthropods	2	0.068	6.89

Table 2: Observed Food items & their Frequency of occurrence(f), percentage frequency of occurence(f%) of *Etroplus suratensis*

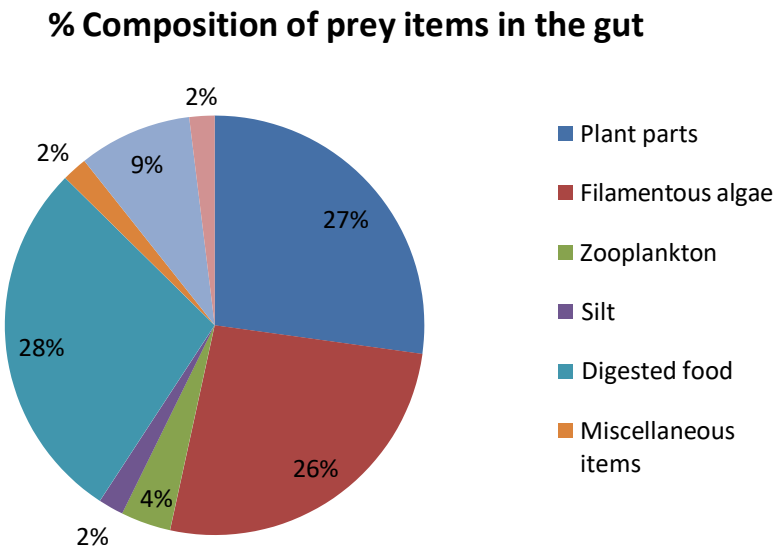

Figure 14: Percentage composition of prey/ items observed through gut content analysis of *Etroplus suratensis*

The stomach content of *Etroplus suratensis* observed was composed mainly of digested food (28%) plant parts (27%) followed by filamentous algae(26%). Other food items include zooplankton (4%), detritus (9%) along with silt (2%), arthropods(2%) and miscellaneous items (2%) in equal proportion. A slightly different result was observed in *Etroplus maculatus* in which various prey items were estimated. Their gut composed mainly of zooplanktons, especially the copepods (22%) followed by plant parts (20%), filamentous algae (18%), miscellaneous items (10%), digested food (9%), detritus (8%), crustacean larvae (7%), silt (4%). Gastropod shell and fish egg were also observed (1%). A nematode was also found in the gut of one the dissected fishes.

Sl. No.	Food items	Ji	f(Ji/P)	f %
1	Plant parts	28	0.933333	93.33333
2	Filamentous algae	25	0.833333	83.33333
3	Copepods	30	1	100
4	Detritus	11	0.366667	36.66667
5	Digested food	13	0.433333	43.33333
6	Crustacean larvae	9	0.3	30
8	Silt	6	0.2	20
9	Miscellaneous items	14	0.466667	46.66667
10	Gastropod	1	0.033333	3.333333
11	Fish egg	1	0.033333	3.333333

Table 3: Observed Food items & their Frequency of occurrence(f), percentage frequency of occurence(f%) of *Etroplus maculatus*

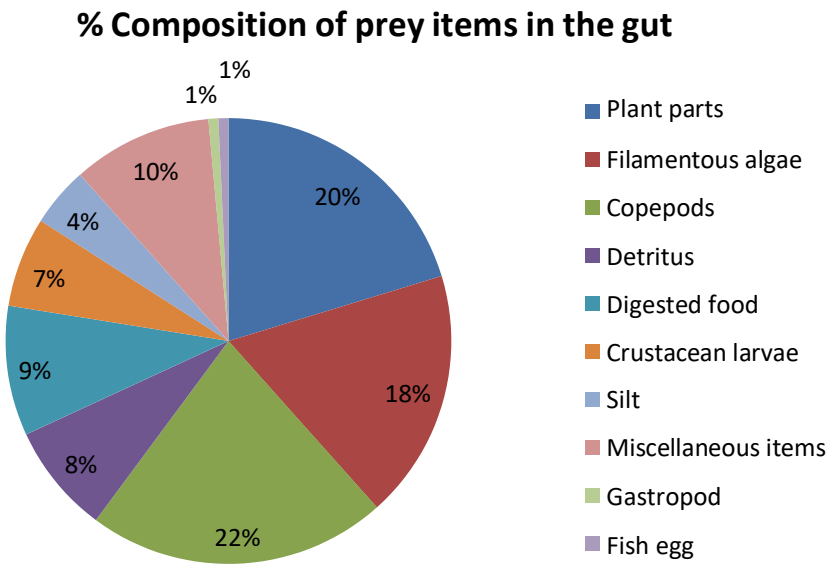

Figure 15: Percentage composition of prey/food items observed through gut content analysis of *Etroplus maculatus*

Fig 16: Crustacean larvae

Fig 17: Nematode

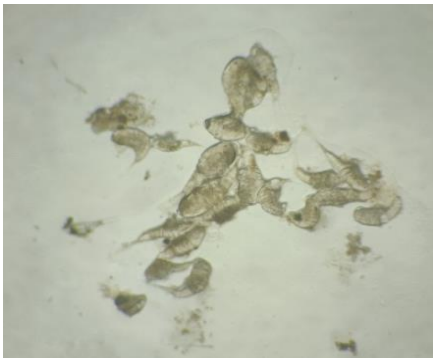

Fig 18: Copepods

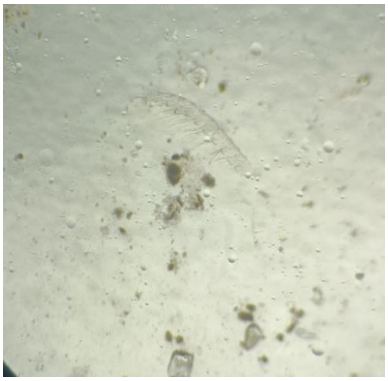

Fig 19: Arthropod parts

Fig 20: Gastropod shell

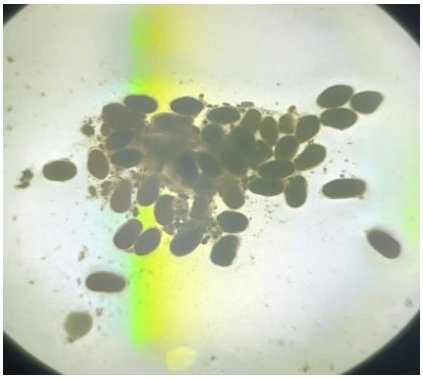

Fig 21: Fish egg obtained from the gut of *Etroplus maculatus*

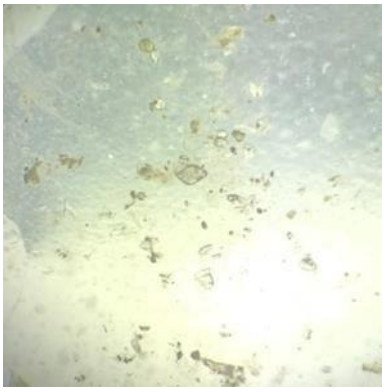

Fig 22: Miscellaneous items

Fig 23: Fish scales

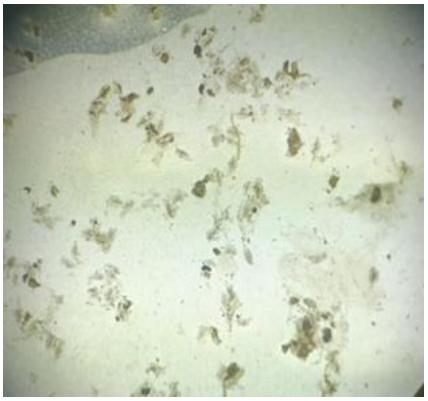

Fig 24: Zooplanktons

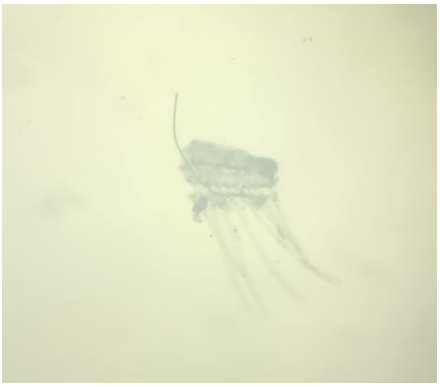

Fig 25: Arthropod body part

Fig 26: Crustacean appendage

DISCUSSION

The results showed an inclination of both the fish species towards a herbivores diet even though they are omnivorous species. A major part of the observed fishes were composed of plant parts and filamentous algae. Similar results were found in the study conducted by Bindu and Padmakumar (2008) and it gave insight on the food of pearlspot, *Etroplus suratensis* in the Vembanad Lake and it was dominated by filamentous algae (43%) followed by detritus (35%), aquatic plants (12%), diatoms (9%) and molluscan shells (1%). Filamentous algae were the major food throughout the year. The study conducted on the feeding habits of pearlspot in the Nethravati Gurpur Estuary by Keshava *et al*.(1998)also revealed the feeding pattern of *E. suratensis* on each month. Analysis of stomach content both quantitatively and qualitatively showed several variation in feeding which was related to relative abundance of food, age and diurnal variation in feeding. Similar work by Priya *et al*. (2020), on food and feeding habits of *Etroplus suratensis* (Bloch, 1790) from Sarvepalli reservoir of Nellore district, Andhra Pradesh also reveals the same. The proportions of major food items of *E. suratensis* predominantly on filamentous algae (57%), diatoms (10. 84%), higher aquatic plants (14. 62%), detritus (17. 61%), molluscans (6. 64%), crustaceans (4. 34%), rotifers (3. 49%), copepods (1. 65%) and fish scales (1. 63%) were present in the gut contents. Filamentous algae, detritus, aquatic plants and diatoms were present as major food constituents throughout the study.

Study conducted by (Melby *et al*., 2019) on food and feeding habits of *Etroplus suratensis* (bloch, 1790) in Vellayani lake, Kerala. The frequency of occurrence data was dominated by diatoms (78%), macrophytes (77%), filamentous algae (76%) and detritus (72%) followed by miscellaneous items (58%), zooplanktons (36%) and molluscs (11%). The frequency of occurrence of different food components such as macrophytic plants, filamentous algae, diatoms, and detritus showed similar trend in different length groups and seasons. Percentage of food composition: The fish is predominantly herbivorous in feeding habit in the Lake with incidental occurrence of small amount of animal matter and the gut contents showed a general dominance of both macrophytic plant parts (33%) and filamentous algae (31%) followed by detritus and digested matter (12%), diatoms (11%), miscellaneous items (7%), zooplankton (5%) and molluscs (1%). Work by Keshava *et al*.(1998). Feeding habits of the pearlspot, *Etroplus suratensis* (Bloch) in the Nethravati - Gurpur Estuary showed results of qualitative analysis and it indicated the dominance of filamentous algae and decayed organic matter in the food content. Sand grains, crustacean and miscellaneous items such as fish, fish

Scales and otolith diatoms. Oscillatoria, tintinicls, bivalves, insects, and unidentifiable matter also occurred in considerable quantity. The proportions of major food items were: filamentous algae (29.15%), decayed organic matter (38.61%), crustaceans (2.66%), semidigested matter (16.35%), sand and mud (3.89%) and miscellaneous items (9.34%). In the present study, all the prey items discussed above were also found in both the fish species. As the sampling was done during the pre-monsoon period, dietary overlap was observed to a certain extend and theomnivorous nature of both the species reflected throughout the study. The GSI sometimes indirectly indicates the spawning season in certain species of fin fishes. This index is verylow during the peak spawning season because of the more number of empty stomachs. The rise and fall of GSI always show an inverse relationship with the gonadosomatic index. The average Gastro somatic index value was 2.748 for *E. maculatus* while that of *E. suratensis* was 3.1073. The concentrations of detritus in the diet of *E. suratensis* as well as in *E. maculatus* observed in the present work, is indicative of its preference for detritus. Detritus play a significant role in the diet of fishes in both freshwater and brackish water systems.

CONCLUSION

Study on the food and feeding habits of fish is a crucial requirement for the success of aquaculture practices which has great possibilities in a developing country like India. The gut content indicates what the fish would feed on and also provides information on the trophic interactions in aquatic food webs. The length of the gut determines the feeding nature of a fish, that is; herbivorous fishes have longer gut as compared to the carnivorous fishes. In different fishes as well as in same fish of different length groups food selection varies. The current study concentrates on finding the diet composition and preferences of two species, *E. suratensis* and *E. maculatus* sampled from a brackish water body. The Relative gut length of *Etroplus suratensis* showed an average value of 2.080 while that of *Etroplus maculatus* showed an average value of 2.004 . Gastro somatic index (GSI) is a relationship between weight of alimentary canal and weight of fish, which helps in determining the feeding condition in different months and seasons. The average Gastro somatic index value was 2.748 for E. maculatus while that of E. suratensis was 3.1073 with standard deviation 1.273 and 1.219 respectively. he results showed an inclination of both the fish species towards a herbivores diet and dietary overlap was observed up to a certain extend.

REFERENCE

1. Abujam, S.,K.,S., and S.,P., Biswas. 2010. Notes on the biology of spiny eel. Sincoltejo 5:87-91.
2. Ahlbeck, I., Hansson, S., &Hjerne, O. 2012. Evaluating fish diet analysis methods by individual-based modelling. Canadian Journal of Fisheries and Aquatic Sciences, 69, 1184– 1201.
3. Amundsen, P.-A., &Klemetsen, A. 1988.Diet, gastric evacuation rates and food consumption in a stunted population of Arctic charr (Salvelinusalpinus L.) in Takvatn, northern Norway.Journal of Fish Biology, 33, 697– 709.
4. Baker, R., Buckland, A., & Sheaves, M. 2014. Fish gut content analysis:robust measures of diet composition.Fish and Fisheries,15, 170–177.
5. Baker, R., Buckland, A., & Sheaves, M. 2014. Fish gut content analysis: robust measures of diet composition. Fish and Fisheries, 15, 170– 177.
6. Berg, J. 1979. Discussion of methods of investigating the food of fishes with reference to a preliminary study of the prey of *Gobiusculus flavescens*.Marine Biology, 50, 263– 273.
7. Bindu, L., and K.,G.,Padmakumar. 2008. Food of the pearlspot *Etroplus suratensis* (Bloch) in the Vembanad Lake, Kerala. Journal of Marine Biology Association, India. 50:156-160.
8. Birkhofer, K., Bylund, H., Dalin, P., Ferlian, O., Gagic, V.,Hambäck, P. A.,...Jonsson, M. 2017. Methods to identify the prey of invertebrate pred-ators in terrestrial field studies.Ecology and Evolution,7, 1942–1953.
9. Braga, R. R., Bornatowski, H., &Vitule, J. R. 2012.Feeding ecology of fishes: an overview of worldwide publications.Reviews in Fish Biology and Fisheries, 22, 915– 929.
10. Buckland, A., Baker, R., Loneragan, L., & Sheaves, M. 2017.Standardising fish stomach content analysis: The importance of prey condition. Fisheries Research, 196, 126– 140.
11. Chakraborty, Rupali, Sudhir, Kumar, Das, Bhakta, Dibakar. 2017. Length-weight relationship, relative condition factor, food and feeding habits of *Channa striata* from wetlands of nadia district, west Bengal.J. Inland Fish. Soc. India, 49 (2) : 22-26.
12. Cortés, E. 1997. A critical review of methods of studying fish feeding based on analysis of stomach contents: Application to elasmobranch fishes. Canadian Journal of Fisheries and Aquatic Sciences, 54, 726– 738.

13. De Silva, S., S.,P. Maitipe and R.,T.,Cumaranatunge. 1984. Aspects of biology of euryhaline Asian cichlid, *Etroplus suratensis*. Env. Biol. Fish., 10(1/2): 77-87.

14. Desai, V., R., 2003.Synopsis of biological data on the tor mahseer, *Tor tor* (Hamilton, 1822).FAO Fisheries Synopsis, 158: 36 pp.

15. Devaraj, K.,V., B.,Santharam and H., P., C.,Shetty. 1975. A comparative study of food of juveniles of the pearlspot, *Etroplus suratensis* (Bloch) collected from estuarine and freshwaters. Mysore J. Agri. Sci., 9: 479-486

16. Elliott, J. M. (1972). Rates of gastric evacuation in brown trout Salmotrutta L. Freshwater Biology, 2, 1– 18.

17. Elliott, J. M. (1991). Rates of gastric evacuation of piscivorous brown trout Salmotrutta L. Freshwater Biology, 25, 297– 305.

18. Froese, R., &Pauly, D. (2017).FishBase.World Wide Web Electronic Publi-cation.Retrieved from www.fishbase.org.version (10/2017).

19. Froese, Rainer and Pauly, Daniel. 2011."*Etroplus suratensis*" in FishBase.July 2011 version.

20. Fryer, G., and T., D., Iles. 1972. The Cichlid Fishes of the Great Lakes of Africa : their Biology and Evolution. Oliver & Boyd, Edinburgh, 532 pp.

21. Georgios,Vagenas, Maria, T., H., Stoumboudi, Olga,Petriki, Argyro, Andriopoulou. 2022. Dietary patterns of five freshwater fish species in a large Mediterranean lake. Journal of Freshwater Ecology, 37,203-220.

22. Greenwood, P., H., 1952. A revision of the Lake Victoria Haplochromis species (Pisces: Cichlidae). Part. 2. Bull. Brit. Mus. Nat. Hist. Zool., 5: 76-97.

23. Griffiths, S.,P., Fry, G., C., Manson, F., J. 2007.Feeding dynamics, consumption rates and daily ration of long tail tuna,*Thunnus tonggol* in Australian waters, with emphasis on the consumption of commercially important prawns. Mar Freshw Res.;58(4):376–397.

24. Hovde, S., C., Albert O., T., Nilssen E., M. 2002.Spatial, seasonal and ontogenetic variation in diet of northeast Arctic Greenland halibut (*Reinhardtius hippoglossoides*). ICES J Mar Sci.;59:421–437.

25. Hynes, H. B. N. 1950. The food of fresh-water sticklebacks (Gasterosteusaculeatus and Pygosteuspungitius), with a review of methods used in studies of the food of fishes.Journal of Animal Ecology, 19, 36– 58.

26. Hyslop, E., J., 1980. Stomach contents analysis - a reviewof methods and their application. J. Fish Biol., 17(4):411-429.

27. Jayaprakas, V., and N., B., Nair. 1981. Maturation and spawning in pearlspot, *Etroplus suratensis* (Bloch). Proc. Natl. Inst. Sci. India, B47 (6): 828-836.

28. Jobling, M. 1980. Gastric evacuation in plaice, *Pleuronectes platessa* L.: effects of dietary energy level and food composition. Journal of Fish Biology, 17, 197– 196.

29. Jobling, M. 1987. Influences of food particle size and dietary energy content on patterns of gastric evacuation in fish: test of a physiological model of gastric emptying. Journal of Fish Biology, 30, 299– 314.

30. Jørgensen, E. H., &Jobling, M. 1988. Use of radiographic methods in feeding studies: a cautionary note. Journal of Fish Biology, 32, 487– 488.

31. Keshava, Joseph, P., S.,and M., M., Joseph. 1988. Feeding habits of the pearlspot, *Etroplus suratensis*(Bloch) in the Nethravati-Gurpur estuary, Mangalore. In: M.Mohan Joseph (Ed). Proc. The First Indian Fisheries Forum, Asian Fisheries Society, Indian Branch, Mangalore,

32. L.Bindu , K., G.,Padmakumar. 2008. Food of the pearlspot*Etroplus suratensis* (Bloch) in the Vembanad Lake, Kerala. Journal of the Marine Biological Association of India, 50 (2) : 156 – 160.

33. Legler, N. D., Johnson, T. B., Heath, D. D., &Ludsin, S. A. 2010.Water temperature and prey size effects on the rate of digestion of larval and early juvenile fish.Transactions of the American Fisheries Society, 139, 868– 875.

34. Levins R., 1968. Evolution in changing environments: some theoretical explorations (No. 2). Princeton(NJ): Princeton University Press

35. Liao, H., Pierce C., L., Larscheid, J., G. 2001.Empirical assessment of indices of prey importance in the diets of predacious fish. Trans Am Fish Soc.;130(4):583–591.

36. Lindeman, R., L., (1942). The trophic-dynamic aspect of ecology.Ecology,23, 399–418p. 203-206.

37. Loiselle, P.,V., (1995). The Cichlid Aquarium. Germany: Tetra Press. ISBN 1-56465-146-0.

38. Manko, P. (2016). Stomach content analysis in freshwater fish feeding ecology. Slovakia: University of Prešov.

39. Melby, Emmanuel, Neethu, G.,P.,1., Sreekanth, G.,B., and Pramod, Kiran, R.,B. 2020. Food and feeding habits of *Etroplus suratensis* (Bloch, 1790) in Vellayanilake, Kerala. Journal of Aquatic Biology & Fisheries | Vol. 7 | : 120 - 126

40. Natarajan A.,V., Jhingran A.,G.,1961. Index of Preponderance – a method of grading the food elements in the stomach analysis of fishes.Indian J Fish.;8(1):54–59.

41. Nath, S., R., Beraki, T., Abraha, A.2015. Gut content analysis of indian mackerel (*Rastrelliger kanagurta)*. J Aquac Mar Biol.;3(1):268–272.

42. NipenNayak ,Jyotirmoysonowal , shyama Prasad Biswas. 2020. Feeding Biology and food selection in Rainbow Snakehead (*Channa bleheri* ,Vierke 1991). NeBIO ,11(1): 51-55.

43. Persson, L. 1979. The effects of temperature and different food organisms on the rate of gastric evacuation in perch (*Perca fluviatilis*).Freshwater Biology, 9, 99– 104.

44. Persson, L. 1981. The effects of temperature and meal size on the rate of gastric evacuation in perch (*Perca fluviatilis*) fed on fish larvae. Freshwater Biology, 11, 131– 138.

45. Priya, P.,S., P., V., Ramalingaiah D., R., Ram, Mohan, R.,R ., Anupama and G., Ganesh. 2020. Journal of Entomology and Zoology Studies .8(4): 2349-2351.

46. Qasim, S.,Z., 1972. The dynamics of the food and feeding habits of some marine fishes.Indian J Fish.;19(1&2):11–21.

47. Robichaud, D., A.,Walner, R., W., Bailey, R., F., J.1991.Differential selection of crab *Chironectes opilio* andHyas spp. as prey by sympatric cod *Gadus morhua* and thorny skate *Raja radiata*. Fish Bull.;89(4):669–680.

48. Schoener T., W., 1970.Nonsynchronous spatial overlap of lizards in patchy habitats.Ecology. 51(3):408–418.

49. Seaburg, K., G., 1957. A stomach sampler for live fish.J Fish Biology;16(4):441–444.

50. Shannon, C., Weaver W., 1949. The mathematical theory of communication. Urbana (IL): University ofIllinoisPres; p. 14.

51. Simenstad, C. A., &Cailliet, G. M. 2017.Retrospective on the origin, intent and impact of the Gutshops and some directions for the future.Environmental Biology of Fishes, 100, 299– 308.

52. Windell, J. T., & Bowen, S. H. 1978. Methods for study of fish diets based on analysis of stomach contents. In T. B. Bagenal (Ed.), Methods for the assessment of fish production in fresh waters (3rd ed., pp. 219– 226). Oxford: Blackwell Scientific Publications.

53. Zanden, Vander, M., J., Rasmunssen, J., B. 2000. Variation in N and C trophic fractionation: Implications for aquatic food web studies. LimnolOceanogr.;46(8):2061–2066.