FOOD SELECTIVITY OF POND REARED AND WILD *ETROPLUS SURATENSIS* (BLOCH) AND EFFECT OF SUPPLEMENTARY FEEDING ON ITS GROWTH

By

SATHIAVATHY C. R.

THESIS

Submitted in partial fulfilment of the requirement for the degree

MASTER OF FISHERIES SCIENCE

Faculty of Fisheries,
Kerala Agricultural University

Department of Aquaculture
COLLEGE OF FISHERIES
Panangad — Cochin
1989

Dedicated to
My beloved Parents and Brothers

DECLARATION

I hereby declare that this thesis entitled " FOOD SELECTIVITY OF POND REARED AND WILD ETROPLUS SURATENSIS (BLOCH) AND EFFECT OF SUPPLEMENTARY FEEDING ON ITS GROWTH" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title, of any other University or Society.

Panangad
20.02.1989

(SATHIAVATHY. C.R.)

CERTIFICATE

Certified that this thesis, entitled "FOOD SELECTIVITY OF POND REARED AND WILD ETROPLUS SURATENSIS (BLOCH) AND EFFECT OF SUPPLEMENTARY FEEDING ON ITS GROWTH" is a record of research work done independently by Kumari Sathiavathy. C.R. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to her.

Dr. SUSHEELA JOSE
(Chairperson, Advisory Board)
Associate Professor
Dept. of Aquaculture
College of Fisheries
Panangad.

Panangad

20.02.1989

ACKNOWLEDGEMENTS

I wish to express my deep sense of gratitude to Dr. Susheela Jose, Associate Professor of Aquaculture, for her invaluable guidance and constant encouragement throughout the course of this investigation.

My sincere thanks are also due to Dr. K. Jayasree Vadhyar, Associate Professor of Aquaculture, Dr. Thresiamma James, Assistant Professor of Algology and Sri. P.M. Sherief, Assistant Professor of Biochemistry, members of my advisory committee for their helpful suggestions during the study. The valuable help rendered by Sri. P.M. Sherief both in the design and conduct of the feeding experiments is gratefully acknowledged.

I am grateful to Dr. M.J. Sebastian, Dean, College of Fisheries, Panangad for providing necessary facilities for carrying out my work. I am greatly indebted to Dr. D.M. Thampy, Professor of Aquaculture who evinced a keen interest in my work. My sincere thanks are also due to all other members of the staff of the Department of Aquaculture for their sincere co-operation during the course of the study.

I take this opportunity to thank Sri. T.M. Sankaran, Associate Professor and Head of Department of Management Studies and Smt. Alphy Korath, Junior Assistant Professor (Statistics), for helping me in the statistical analysis of the data.

I also wish to record my thanks to Dr. M.K. Mukundan, Head of Department of Processing Technology and Sri. K.K. Varma, Head of Department of Fishery Hydrography for providing the necessary facilities to carry out the various analyses in the study.

Dr. C.J. Cherian, Associate Professor of Biological Oceanography, Sri. P.S. Mrithunjayan, Assistant Professor of Chemistry, Smt. Lizy Behanan, Assistant Professor of Food and Nutrition, Dr. Rosamma Bright Singh, Post Doctoral Fellow, and Dr. D. Sudharma., Assistant Professor of Microbiology deserve my special thanks for the many and varied help they rendered during the course of my study.

My sincere thanks are also due to Dr. S.S. De Silva, and Dr. Samarakoon, of Sri Lanka for the generous gift of their publications on Etroplus suratensis.

I wish to thank the staff of the Libraries of the College of Fisheries Panangad, Central Marine Fisheries Research Institute, Cochin and the School of Marine Sciences, University of Cochin for their timely help in obtaining important references for my study.

A host of friends have generously helped me in various ways during the course of my study. I take this opportunity to express my unfeigned gratitude to all of them.

My parents, brothers and sisters in law deserve my sincere thanks, since they have been a source of great inspiration to me in my work.

I also thank the Kerala Agricultural University for providing me a fellowship during the tenure of my study.

Panangad
20.02.1989

(SATHIAVATHY. C.R.)

CONTENTS

PAGE NO.

-0-

LIST OF TABLES

PAGE NO.

-0-

LIST OF FIGURES

PAGE NO.

LIST OF PHOTOGRAPHS

I. INTRODUCTION

I. INTRODUCTION

The green chromid, *Etroplus suratensis* (Bloch) commonly known as the pearl spot is an important cichlid, occurring along the eastern and western coastal tracts of peninsular India, Sri Lanka and Pakistan. It is found in both fresh and brackish water habitats such as swamps, ponds, paddy fields, rivers, backwaters and estuaries, attaining a maximum length of 300 mm. It can tolerate wide fluctuations in salinity, and hence it is cultured in the brackish water farms as well as in the fresh water reservoirs, in peninsular India. In Kerala, the capture fishery of the species from the rivers and lakes contributed to 2891 tonnes in 1986, which formed 9% of the total inland fish landings in the State (Anon 1987).

A closely allied species *E. maculatus* occurs in the same habitats as that of *E. suratensis*. But since the size of this species is very small, growing only upto 76 mm, it is not considered suitable for culture, though it is caught from the wild and sold as an aquarium fish. *E. canarensis* is yet another species of the genus found in South Canara which attains a maximum length of 114 mm.

It has been reported that in its natural environment adult *E. suratensis* is essentially a vegetable feeder but that the young individuals prefer zooplankton (Alikunhi, 1957; Prasadam, 1971; Jayaprakas, 1980). The fish attains maturity at the age of 8-9 months and the fecundity is in the range of 1300-6000. It breeds throughout the year, but two peaks have been noticed, one from December to February and the other from July to August (Jayaprakas 1980). The fish exhibits parental care and has the habit of nest building to protect the fry.

E. suratensis is considered as one of the tastiest fishes in Kerala and claims a high market demand. But, inspite of its delicious taste, high market demand, easy availability, amenability to culture, non predacious nature, adaptability to wide fluctuations in salinity and breeding habits in captivity, the main drawback in its culture is the poor rate of growth in comparison to other brackishwater species like Chanos chanos and Mugil cephalus. Thampy et al. (1987) have reported an average monthly increment of 8.08 mm and 7.78 g for E. suratensis from the brackish water farm at Vytilla, Kerala. Considerable attention has been given in recent years to research and development programmes relating to the culture of this fish and various measures have been adapted to enhance its growth in captivity under intensive management practices and stocking density manipulations. But no worthwhile results have so far been obtained and production of E. suratensis still remains low, ranging from 900 to 1000 kg/ha/year (Anon 1981).

The aim of the present study is to find out the nature of food items and feeding habits of E. surantensis fry, fingerlings, subadults and adults categorised under four different length groups in captive and wild environments viz., a brackishwater culture pond and Cochin backwaters respectively.

The data of the relative length of the gut in different length groups from the two environments provides information on the nature of food consumed and the extent of feeding in the two environments. The study of salient ecological parameters in the cultured and wild habitats of the species throws light on the abundance and variation of the food items in relation to the biotic and abiotic factors. Formulation of a suitable supplementary feed incorporating the natural food items for E. suratensis is highly warranted in enhancing the growth rate and production of the species in culture ponds. However if the preferential food items of the species can be established in the culture ponds, supplementary feed can be dispensed with in the aquaculture practice of E. suratensis.

-0-

II. REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

2.1 Food and Feeding habits

The green chromid E. suratensis belongs to family Cichlidae, comprising of over 700 species, the members of which are found in the brackish and fresh water habitats of Africa, South America, parts of North America, and parts of Asia. It is one of the important species of Asian cichlids, the other species of the genus being E. maculatus and E. canarensis.

The African cichlids on the other hand are numerically a large group including tilapias, Pelmatochromis sp., Nannachromis sp. etc. It has been reported that the larger African lakes of Malawi, Victoria, and Tanganika contain about 500 endemic species of cichlids (Fryer and Iles 1972). The inland fish production of African continent itself is based on the capture and culture of these species. The American cichlids contain mainly species of ornamental importance and are found from Texas along the eastern and southern coasts of Mexico to central and most of south America and some Caribean islands.

E. surantensis is distributed widely in India, in the brackish water and freshwater environments from Goa on the west coast to Chilka lake on the east coast. It also occurs in Sri Lanka and Pakistan. It has been introduced into the different interior watersheds like reservoirs and freshwater lakes during 1940's where it has established itself. Though several early workers dealt with the biology, reproduction, behaviour, food and feeding and ecology of the species in their natural environment, much more remains to be known about the growth, behaviour, food selectivity, reproductive habits etc., of the species in captivity.

The earliest studies on the different species of Etroplus in India was on their systamatics and distribution. Important among these are that of Day, (1888). Several authors who studied the biology of the species have dealt with the food and feeding habits briefly. Raj Sundara (1916) in his studies on freshwater fishes of Madras have briefly dealt with the food and feeding habits of E. suratensis. In 1942, Sebastian studied the role of E. suratensis and E. maculatus in the control of mosquitoes. Bhaskaran (1946) studied the food habits of young ones of E. suratensis from freshwater tanks and reported that they feed mainly on filamentous algae, marginal plants and detritus. Job et al. in 1947 studied the biology of the species from freshwater tanks wherein they have described the food and feeding habits briefly. The weed destroying habit of E. suratensis was elucidated by Gopinath in 1948. In 1949, Chacko studied the food and feeding of the fry and fingerlings and reported that they feed rarely on higher marginal plants, insect larvae and filamentous algae. Alikunhi in 1957, described the food of E. suratensis and reported that, from 19 mm length onwards they feed mainly on zooplankton, but as growth is in progress they shift to filamentous algae such as spirogyra and vegetable matter. In 1962, Hora and Pillay have observed that adults of E. suratensis are herbivores, feeding on chlorophyceae, cyanophyceae and decaying organic matter. Prasadam in his studies on the biology of E. suratensis in Pulicat lake in 1971, reported that the fish is mainly a vegetable feeder with seasonal variation in feeding activity. According to him the smaller size groups predominantly feed on microvegetation and the larger size groups utilise mainly macrophytes. Gopalakrishnan (1973) while describing the taxonomy and biology of the species, has dealt with the food and feeding habits too. A comparative study of the food of juveniles of E. suratensis collected from estuaries and freshwaters at Mangalore was done by Devaraj et al., (1975). They found that filamentous algae and detritus formed the dominant food items in the stomachs of fishes collected from estuarine waters, while in the fishes collected from freshwaters, insect larvae and detritus were found to dominate. Varghese (1975), has briefly dealt with the food and feeding habits of E. suratensis in his studies on the biology, morphology and development of cichlids in India. He has reported that this species is omnivorous, showing a certain degree of specificity with regard to the food items it consumes and that it displays definite variations in the diet in some months. He has also reported that there is no change in food between males and females and between 'zero' year groups and adults. Jayaprakas in 1980 in his work on the biology of E. suratensis has studied the food and feeding habits of different size groups of the species, collected from Veli lake in Trivandrum. He found that, there is a gradual change in the preference from diatoms and zooplankton to filamentous algae and then to higher aquatic plants, as growth proceeds. The digestability of aquatic macrophytes by E. suratensis and the relative merits of three indegenous components as markers with daily changes in protein digestability were studied by De Silva and Perera (1983). Costa (1983) made biological studies of the pearl spot from three different habitats in Sri Lanka. In 1984, De Silva et al. studied some aspects of the biology of this species, where its food and feeding habits from brackish waters and freshwater reservoirs in Sri Lanka have been described. Mahobia (1987) in his studies on Indian cichlids has evaluated the biochemical composition of E. suratensis and E. maculatus. He has reported that the protein, lipid and carbohydrate is found to decrease in muscle and liver with advancement of maturation followed by an increase after the spawning in both E. suratensis and E. maculatus.

Studies on E. maculatus, the organge chromid, which is a closely allied species has also been done by selected workers. But since the size of this species is very small, growing only upto 76 mm, it has no relevance in aquaculture and is of little importance in the present study. Panicker as early as 1920, described briefly the biology of the species along with E. suratensis. Rao (1972) has studied the compensatory metabolic regulation to seasonal thermal stress on this species and the metabolic compensation during thermal acclimation in the tissue of the fish. In 1973, Wyman and Ward described the development behaviour in this species. Histomorphological studies of the alimentary canal of the species was done by Thomas (1975). Jayaprakas et al. (1979) have described the food and feeding habits and breeding biology of the species. The biology of E. maculatus was studied by Amaranth in 1979.

Studies on African cichlids are much more numerous, wide and varied than those of their Asian counterparts. But only those which are directly related to the food and feeding habits of these species and pertinent to the present study have been dealt with in this review. Fish (1955) studied the food of tilapias in general from East Africa. In 1956, Le Roux studied the feeding habits of the young of four species of Tilapia. Fryer (1961) studied the biology of Tilapia variabilis in the northern waters of Lake Victoria. He found that this species seems to be a specialised feeder with a strong tendency for fine benthic sediments. Food and feeding habits of Tilapia guineensis, T. melanotheron and T. mariae inhabiting the Lagos lagoon in Nigeria were studied by Fagade (1971). He has reported that the important items in the stomachs include filamentous algae, diatoms, sand grains and unidentified organic matter. In 1972, Malek reported that both sexes of T. zilli feed on plant material as well as food of animal origin. In the same year Alkholy and Malek, examined the relative proportion of food components of T. zilli in different localities. They found that, T. zilli is omnivorous, eating both vegetable and animal matter, having a tendency to take more plant matter than animal matter. Moriarty and Moriarty (1973) studied the quantitative estimation of the daily ingestion of phytoplankton by T. nilotica and Haplochromis nigripinnis in Lake George. They reported that T. nilotica can assimilate 70-80% of the carbon ingested in the form of plankton (Microcystis, Anabaena, Nitzchia). Preliminary observations on the feeding habits of T. nilotica in Lake Rudolf was done by Harbot (1975). Lauzenne and Iltis (1975) studied the food selection in T. galilaea. They found that this fish is phytoplanktivorous feeding on bottom deposits composed of benthic algae. In 1976, Spataru and Zorn studied the food and feeding habits of T. galilae and T. aurea inhabiting the lake Kinneret in Israel. They have reported that T. galilae is a phytophage and feeds mainly on Peridinium cisctum and Pyrophyte, whereas T. aurea utilises a variety of phytoplankton, zooplankton and zoobenthos. Bowen (1976a) studied the feeding ecology of the Sarotherodon mossambicus in Lake Sibaya, Kwazulu. Spataru (1978) analysed the food of T. zilli inhabiting the lake Kinneret in Israel. He found seasonal changes in the food composition with abundance of chironomid pupae in winter and spring and zooplankton in summer and autumn. Saha and Dewan (1978) studied the gut contents of T. nilotica and reported that this fish is an omnivore with higher feeding preference for detritus and plant food. In 1979, Dewan and Saha have described the feeding pattern of T. nilotica inhabiting the Bangladesh waters and found increased feeding activity from noon to midnight with peak activity immediately after dusk and reduced feeding activity after midnight Aravindan in 1980, studied the food selection of T. mossambica from three natural environments viz, river, estuary and pond. He has reported that the fish feeds mainly on aquatic plant material in pond, filamentous algae in river, while in estuary its main diet consists of ostracods and copepods. Gophen (1980), studied the food sources, feeding behaviour and growth rates of Sarotherodon galilaeum fingerlings. Bowen in 1982, studied the feeding, digestion and growth of tilapias, and reported that they are mostly herbivores and detritivores. Moreau et al. (1986) have studied the possibility of utilising natural pond productivity for feeding young tilapias from the larval to the fingerling stage. They have tried three types of food viz; higher aquatic plants such as Lemna sp. phytoplankton such as Chlorella sp and zooplankton mainly Daphnia sp for feeding Tilapias.

2.2 Culture Aspects

Studies on different aspects of culture of E. suratensis are limited. Jayaprakas (1980) studied the culture possibilities of E. suratensis in Kerala. The culture of E. suratensis in mono and poly species combinations was done by Thampy et al. (1978) in Vytilla and Gopinathan (1981) in Goa, under the All India Co-ordinated Research project on Brackishwater fish farming. As a part of the above project E. suratensis was cultured in experimental ponds under different stocking densities and fertilization rates. Supplementary feeding with conventional feeds of ground nut oil cake and wheat bran was also done in some experiments. Sumitra et al. (1981) have conducted an experiment on the culture of E. suratensis in brackish water ponds in Goa. The growth, survival and production of the species in the brackish water culture ponds has been described by Thampy et al. (1987).

2.3 Supplementary Feeding

The various aspects of the practice of artificial feeding in pisciculture has been reviewed by Ling (1967), Shell (1967) and Chervinski et al. (1968). In India, supplementary feeding in fish culture has already gained some recognition (Alikunhi, 1956; Das, 1967; Singh and Bhanot, 1970; Chakraborty et al., 1971; Lakshman, 1974; Prasadam and Gopinath, 1976; HaripradaDas, 1976; Jeyachandran and Paul Raj, 1976 and 1977).

Information on supplementary feeding of E. suratensis is very scant. Sumitra et al. in 1978 studied the food conversion efficiency of E. suratensis in the brackishwater culture ponds in Goa, with four different feeds. Studies on the food conversion of E. suratensis in laboratory conditions were carried out by KrishnaKumari et al. (1979). They have reported that the conversion efficiency was low with all the three test diets containing 40-60% protein. The food preference and the effect of supplementary feeding on the growth and survival of E. suratensis have been studied by Jayaprakas and Nair (1981). Caloric values of ingested food of E. suratensis grown in culture pond have been studied by Sumitra et al. (1981). In 1982, Sumitra et al. worked out the energetics and food conversion efficiency of the species in relation to different feeding levels.

Several studies have been conducted on the feasibility of incorporating vegetable matter in the supplementary feed of many other species of herbivorous fishes. The inclusion of higher aquatic plants in the diet of fishes which are herbivorous in the adult have been suggested by Huet (1960). The importance of incorporating natural food items in the feed has been well illustrated by Yashouv and Ben Sehaachar (1967) in experiments conducted with

Mugil capito. Singh (1970) has found that fresh water algae Oedogonium is a nutritive source for Cirrhinus mrigala. Alikunhi et al. (1971), have conducted feeding experiments of Ctenopharyngodon idella and Catla catla with aquatic weeds such as Hydrilla, Vallisneria and Najas. Liang and Lovell (1971) showed that the addition of 5-10% water hyacinth meal in Vitamin free diets increased growth and reduced mortality of channel catfish fingerlings. Caulton (1976), conducted feeding experiments of T. rendelli with Ceratophyllum demersum and reported that an assimilation efficiency ranging from 47.8% to 58.7% may be regarded as being very good for primary macrophagous herbivore. Cruz and Laudencia (1978) reported better growth of tilapia on feed supplemented with mulbery leaf meal. Fresh leaves of Alocasia macroliza were used for feeding tilapia in cage culture with promising results (Pompa 1978). Pantastico and Baldia (1980) showed that incorporation of ipil-ipil leaf meal in the diets of Tilapia nilotica resulted faster growth rates as compared to control, fed on the rice bran alone. Venugopal (1980) has reported the possibility of incorporating the leaf powder of Colocasia esculenta in supplementary feeds of Indian major carps. The digestion of an aquatic macrophyte by Tilapia zilli has been studied by Buddington (1979). Devaraj et al. (1981) evaluated the performance of the plant sources like duckweed and cabbage leaves in the formulation of fish feeds. Gaigher (1984) reported that when tilapia was fed with combination of duckweed and commercial pelleted feeds, growth rate of fish doubled with increased food conversion. Edwards et al. (1985) described the incorporation of composted and dried water hyacinth in pelletted feeds for Oreochromis niloticus.

-0-

III. MATERIALS AND METHODS

III. MATERIALS AND METHODS

3.1 Captive and Wild Environments

A culture pond in the campus of College of Fisheries (09^{o} 58'N and 76^{o} 28E) formed the captive environment and the Vembanad Lake lying adjacent to the campus (09^{o} 58'N and 76^{o} 28'E) formed the wild environment from which specimens of E. suratensis for the present study were collected.

The pond was a closed one with earthen bundhs and having an area of 120 M^2. The average water depth of the pond was 70 cm. The pond was dewatered and the weed and predatory fishes were removed by the application of mahua oil cake at the rate of 250 ppm. Lime was applied in the pond, after assessing the pH, at the rate of 500 kg/ha. Water was then let into the pond by siphoning from the adjacent feeder canal of the farm. Fertilization was done with urea (100 kg/ha), superphosphate (250 kg/ha) and cow dung (5000 kg/ha) in monthly doses.

The Vembanad lake is a shallow semi enclosed body of water of the tropical zone with the characteristics of a tropical estuary. A narrow gut, about 450 m wide form its main connection with the Arabian sea and this region is subjected to regular tidal influence. It is a catchment basin for several important rivers which empty large quantity of flood waters during the monsoon season, enriched with nutrients and considerable quantity of silt. The site of collection of specimens for the present study was about 8 km from the bar mouth adjacent to some prawn filteration fields.

Open Backwaters

3.2 Analysis of ecological parameters

For determining the pH, salinity &alkalinity, the water samples were collected from the pond and backwaters. For the dissolved oxygen and primary production water samples were collected in 250 ml dissolved oxygen bottles, without trapping any air bubbles before closing them with stoppers.. These samples were fixed immediately in the field itself, with manganous sulphate and potassium iodide. The ecological parameters were analysed at monthly intervals.

3.2.1 Water Temperature.

The temperature of surface water was recorded using a mercury thermometer having a range from 0 to 50°C and graduations of 0.1°C.

3.2.2 Water pH.

The pH was determined by electrometric method using a digital pH meter (Elico model U-I-122). The instrument was calibrated using buffer solutions having pH 4.2, 7 and 9.2.

3.2.3 Salinity.

Standard argentometric method as described by Strickland and Parsons (1972) was followed for the estimation of water salinity.

3.2.4 Total alkalinity.

Total alkalinity of the collected water samples was estimated using acidimetric titration method described in APHA et al. (1981).

3.2.5 Dissolved Oxygen

Dissolved oxygen was determined following Winkler's method as detailed by Strickland and Parsons (1972).

3.2.6 Phytoplankton Primary Production.

The phytoplankton primary production was determined using light and dark bottle technique as detailed in Strickland & Parsons (1972). Surface water was taken from pond and backwater in two light bottles and one dark bottle each. From one set of light bottles initial estimation of oxygen was done. The other two sets (one light and one dark bottle) were incubated for 6 hrs, (10.a.m. - 4.p.m.). After incubation the bottles were taken out and the dissolved oxygen was fixed in the field, and estimated by the Winkler's method, in duplicate. All oxygen values were converted to carbon values by multiplying with factor 0.375 and productivity values were expressed as $mgC/m^3/$ 6 hrs.

3.2.7 Zooplankton.

Plankton samples were collected from the culture pond and the backwaters by filtering 50 l of water using a plankton net made of No.25 bolting silk (63 µ mesh size) and were preserved in 5% formalin. Quantitative estimation of items in number per litre was made for the zooplankton.

3.2.8 Zoobenthos.

For the zoobenthos estimation the bottom mud samples from the pond and the backwaters were collected using a Van Veen Grab having a biting area of 625 cm^2 (25x25 cm). While collecting the samples, it was ensured that the grab was full and the top layer was undisturbed. The contents of the grab were transfered to enamel trays and sieved through a 500 µm mesh standard test sieve for separating the zoobenthos from the sediment particles, using filtered pond water. The contents of the sieve were transfered to polythene containers and preserved in 5% formalin for further analysis.

The zoobenthos were sorted out using a fine needle and fine pipette They were identified upto group level, counted and wet weight was determined for each group in an electric monopan balance. Before weighing, the samples were washed with distilled water, dried until no more wet spots appeared on the filter paper following Ulomski's method as described by Edmondson and Winberg (1971).

3.3 Collection and Analysis of E. suratensis

3.3.1 Collection of E. suratensis from Culture Pond.

The study pond was stocked with 68 Nos. of E. suratensis which works out to 5,600 nos/ha with four length groups, fry (30-49 mm), fingerlings (50-69 mm), subadults (70-89 mm) and adults (90-120 mm), in 1:1:1:1 ratio. During each month six numbers of specimens belonging to each length groups were removed from the pond. The stocking density in the pond was retained by restocking the pond with same number of fishes of the same size groups.

3.3.2 Collection of E. suratensis from backwaters.

E. suratensis of the four different length groups as mentioned earlier were collected from the marginal areas by the operation of cast nets during monthly intervals. Six numbers of specimens from each length group were chosen and brought to the laboratory for detailed studies. The specimens were collected from same area during each month.

3.3.3 Analysis of E. suratensis.

Feeding intensity, RLG factor, food preference and selectivity index of specimens of four length groups from culture pond and backwaters were studied.

E. suratensis of length group I

E. suratensis of length group I

E. suratensis of length group II

E. suratensis of length group III

E. suratensis of length group IV

3.3.3.1 Feeding Intensity.

The collected fishes were immediately brought to the laboratory. Salient morphometric measurements of the fishes viz; standard length, total length and weight were taken and then grouped into four length groups. The fishes were dissected out, and the digestive tract of each specimen was then carefully removed to note the intensity of feeding, based on the state of distension of the stomach and the amount of food contained therein. The fishes were grouped into five following groups.

(1) E - Empty - when the stomach was empty.

(2) P - Poor - when the stomach contained little food and was not distended.

(3) M - Medium - when the stomach was half full and slightly distended.

(4) G - Good - when the stomach was full and distended.

(5) H - Heavy - when the stomach was gorged with food and was fully distended.

Feeding index was calculated using the following formula:

$$\text{Feeding index} = \frac{\text{No. of fishes with good and heavy stomachs}}{\text{No. of fishes examined}} \times 100$$

3.3.3.2 R.L.G. Factor.

To find out if there is relative difference in the diet of fish during different stages in the two environments, the RLG factor was worked out as described by Al Hussaini (1949) and Das & Srivasthava (1979). RLG is the relative length of gut to the total length of fish. The total length of each fish was noted. Length of gut of each fish was measured carefully. The RLG factor is calculated by the following formula.

$$\text{RLG} = \frac{\text{Length of gut}}{\text{Total length of fish}} \times 100$$

3.3.3.3 Food Preference.

Various investigators have adopted different methods for analysing the gut contents. While the methods available differ considerably in most studies, the same comparative results are obtained with all of them (Windell, 1970). Pearse (1915) used the 'Volumetric method' for analysis of food of some shore fishes of Wiscosin. Hynes (1950) employed the 'points method' in the quantitative estimation of different food items of the fresh water sticklebacks.

Because of the presence of diatoms, micro and macro materials as well as detritus in the stomach contents of E. suratensis, the volumetric or gravimetric estimation could not be satisfactorily adopted for the present study. Therefore, for evaluating the different food organisms the points method of Swynnerton and Worthington (1940) as reviewed by Venketaraman (1960) was found to be quite suitable and convenient over the other methods.

The stomach contents were carefully removed and examined immediately in the fresh condition as far as possible. Otherwise they were preserved in 5% formalin for subsequent examination. Stomach contents of all the specimens were examined separately in petridishes. The larger elements were isolated and identified with the help of a handlens, while the smaller organisms were identified using a microscope as far as possible upto genus level or the family, depending upon the completeness of the organisms and extend of digestion.

For evaluating the preference of food consumed, points were alloted to the different food items. The points gained by each food item were then summed up and scaled down to percentage. This gives the percentage composition of food items of different length groups in various months, in culture pond and backwaters. This method gives both qualitative and quantitative data without the need for very detailed counts (Venketaraman, 1960).

3.3.3.4 Selectivity Index.

The percentage occurrence of various food items in stomach contents were compared to the percentage of the same items in the environment for calculating the selectivity index. Plankton samples were collected from both environments during the same day and the relative percentage of each items were observed. Selectivity index was calculated by the formula described by Ivelev in 1961 and also followed by Aravindan in 1980. The formula is given below:

$$E = \frac{ri - pi}{ri + pi} \quad \text{where,}$$

E = Selectivity index

ri and pi = The percentage of food items in stomach and in the environment respectively.

Selectivity index of the various food items for the different length groups from the pond and the backwaters was calculated during the month of October at the initial month of the study when the salinity was low due to the north east monsoon and during the final month of March, when the salinity was high in the pond and backwaters.

3.4 Feeding Experiment

3.4.1 Preparation of cisterns.

Feeding experiment was done in cement cisterns having a capacity of 500 litres. Filtered pond water having a salinity of 5 ppt was used in the cisterns. The cisterns were filled with 375 litres of water for the experiment.

Fresh Hydrilla verticillata

Fresh Enteromorpha intestinalis

Fresh Enteromorpha intestinalis

3.4.2 Preparation of feeds.

Conventional feed used in the experiment was made using rice bran, groundnut oil cake and wheat flour at 5:5:1 ratio. The ingredients were powdered and then mixed thoroughly with required amount of water to make a dough. It was then autoclaved at ambient pressure for 30 minutes. The feed was pelletised and dried at 60°C in a hot air oven.

3.4.3 Procedure of Feeding Experiment.

Four numbers of *E. suratensis* fingerlings were introduced into each cistern after 10 days period of acclimatisation. Initial weight of each specimen was noted. The fishes in different cisterns were fed with different feeds at the rate of 10% of their body weights. Each feed was given in duplication. The different feeds used were,

1. Conventional feed alone (100%) - (Ricebran + groundnut oilcake + wheat flour)
2. Conventional feed 50% + Fresh *Hydrilla verticillata* 50%
3. Fresh *Hydrilla verticillata* alone (100%).
4. Conventional feed 50% + Fresh *Enteromorpha intestinalis* 50%
5. Fresh *Enteromorpha intestinalis* alone (100%).

Feeds were given in the morning and in the next morning the excreta and the unutilised feed if any were removed by siphoning. Feeding was continued for 30 days. Water exchange was done daily when 10 litres of water was removed from each cisterns and fresh filtered water was added. After 30 days feeding the fishes were removed and the final weight of each individual was noted.

3.4.3.1 Specific growth rate.

Considering that the smaller fish attained a lower weight and larger fish attained a higher weight, the specific growth rate (expressed as percentage wet body weight d^{-1}) of individual fishes were estimated using the initial and final weight measurements. The specific growth rate was determined using the formula, given below:

$$\text{Specific growth rate} = \frac{\ln W_2 - \ln W_1}{d} \times 100$$

Where,

W_1 = Initial weight

W_2 = Final weight

d = Number of days of feeding

3.4.3.2 Percentage gain in body weight.

Average initial weight and average increase in weight on each replication was noted. Then the percentage gain in body weight was calculated using the following formula:

$$\text{Percentage gain in body weight} = \frac{\text{Average increase in weight}}{\text{Average initial weight}} \times 100$$

3.4.3.3 Statistical Analysis.

The difference in the mean growth performance of E. suratensis in response to conventional feed and feeds containing natural food items viz; Hydrilla verticillata and Enteromorpha intestinalis was statistically tested by the application of variance technique (Snedecor and Cochran, 1968). The pair of treatments which differed significantly were further analysed by the method of least significant difference based on 't' test.

-0-

IV. RESULTS

IV. RESULTS

4.1 Ecological parameters of the Captive and Wild environments

Ecological parameters of the culture pond (captive environment) and the backwaters (wild environment) were analysed at monthly intervals during the period of study, from October 1986 to March 1987.

4.1.1 Water Temperature.

Temperature of the culture pond and backwaters is given in Table 1 and Fig.1.

The minimum temperature observed in the culture pond was 28°C in December, while the maximum of 31°C was recorded in February and March.

Water temperature of the backwaters was generally higher than that of the pond except in February. In the backwaters the temperature ranged from 30°C in December and January and 33°C in October.

4.1.2 Water pH.

The water pH of the culture pond and backwaters during the period is represented in the Table 1 and Fig.2.

At the commencement of the investigation in October, the pH of the pond water was 8.5 from which it went down to 6 in November. But this was rectified by adding lime at the rate of 500 kg/ha, and thereafter the pH was constantly 8 from December to March.

The pH of the backwaters ranged between 7.5 and 9. From the initial pH of 7.5 in October, it went upto 9.0 in November and then declined to 8.5 in December and 8.0 in January, rising again to 9 in February. In March it dropped to 8.5.

Table 1 Physico-chemical parameters of the culture pond (P) and backwater (B) during the study period

Months	Temperature °C		pH		Salinity (ppt)		'Al'kalinity (ppm)		Dissolved oxygen(ppm)		Primary Productivity gC/m^3			
											Gross		Net	
	P	B	P	B	P	B	P	B	P	B	P	B	P	B
October 1986	30.0	33.0	8.5	7.5	3.5	5.3	35.3	45.3	4.4	6.6	1560	2880	1200	2500
November 1986	30.5	31.0	6.0	9.0	9.0	11.0	46.7	66.7	4.8	11.2	1020	1920	750	1500
December 1986	28.0	30.0	8.0	8.5	12.9	23.0	63.7	103.7	6.0	6.4	720	1200	600	720
January 1987	30.0	30.0	8.0	8.0	15.0	23.0	55.3	95.3	6.7	7.5	4440	4680	2300	2680
February 1987	31.0	30.5	8.0	9.0	19.5	31.5	60.5	68.3	8.0	9.5	1800	2860	1500	1640
March 1987	31.0	31.5	8.0	8.5	18.0	29.5	65.0	66.5	5.9	6.5	1200	2640	840	1800

Plate I

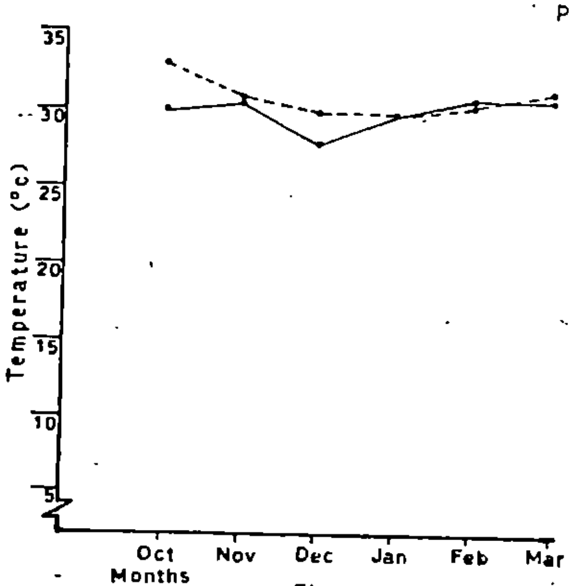

Fig. 1

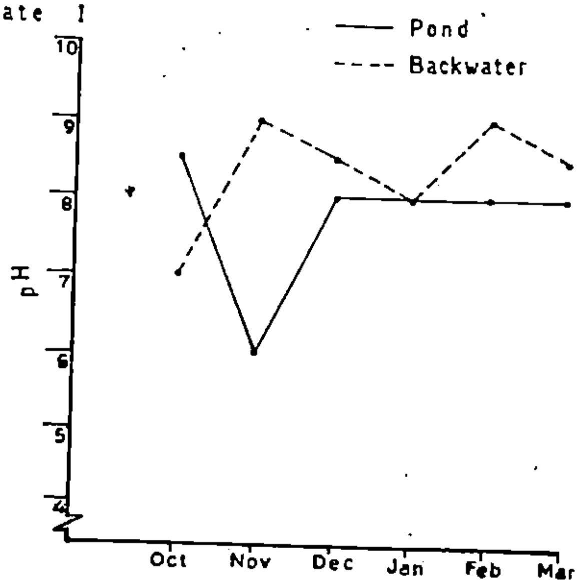

Fig. 2

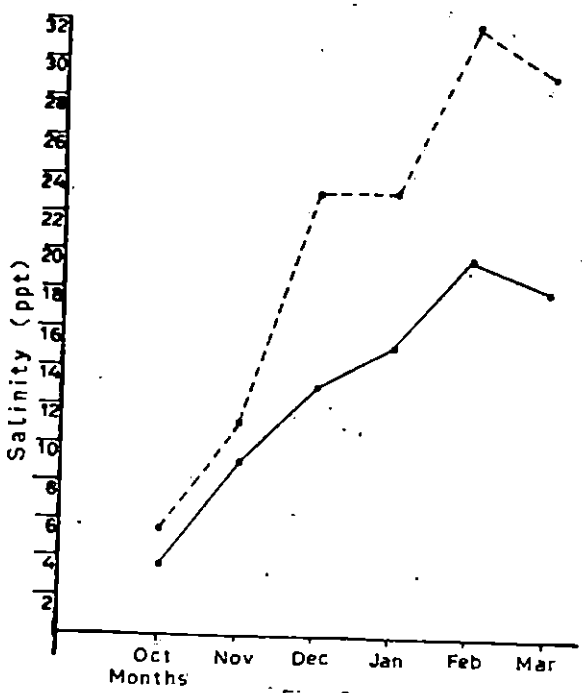

Fig. 3

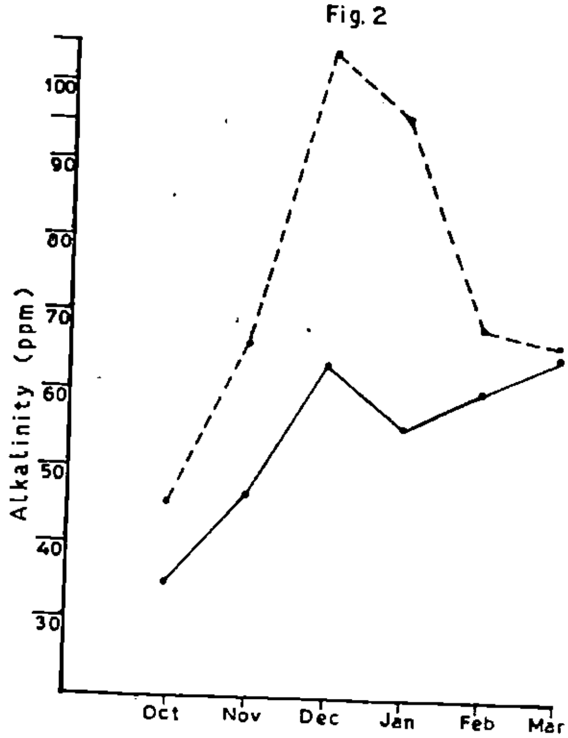

Fig. 4

Plate II

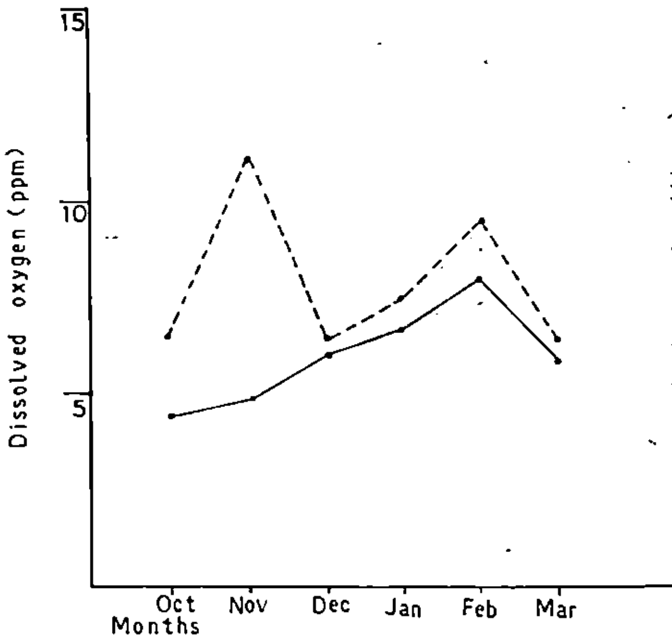

Fig. 5

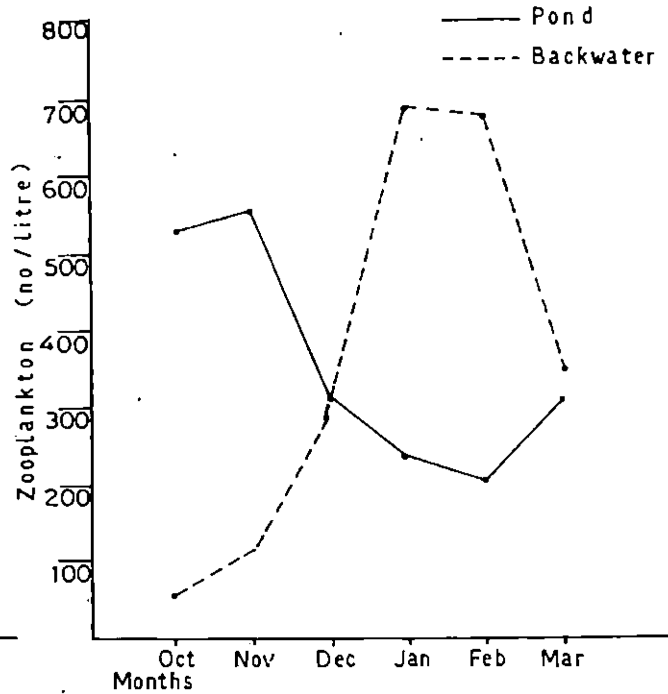

Fig. 6

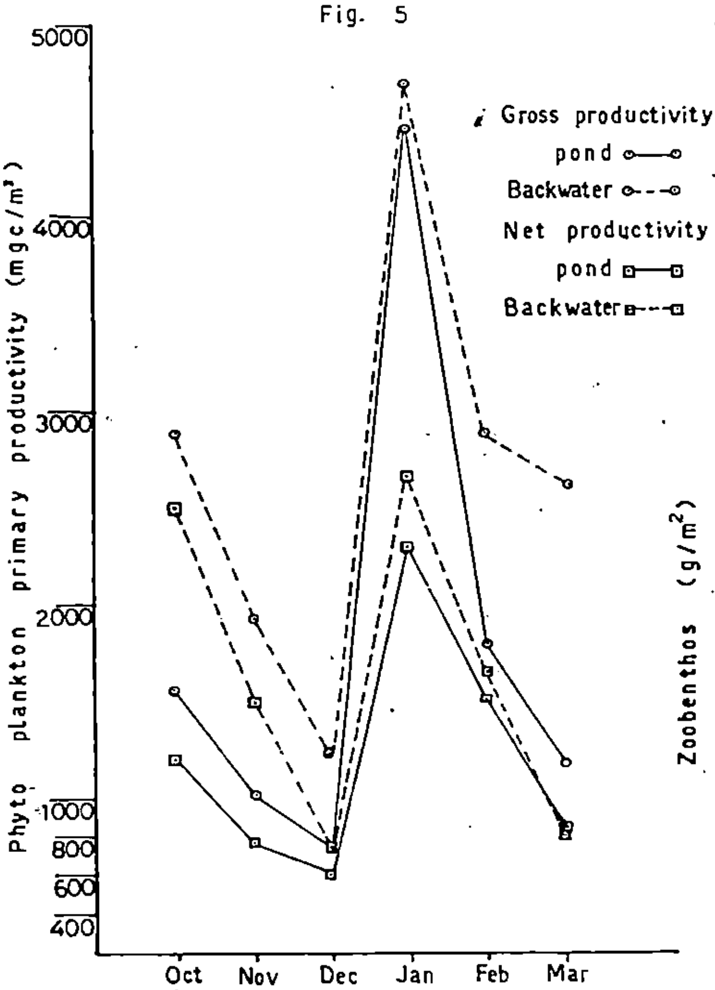

Fig. 7

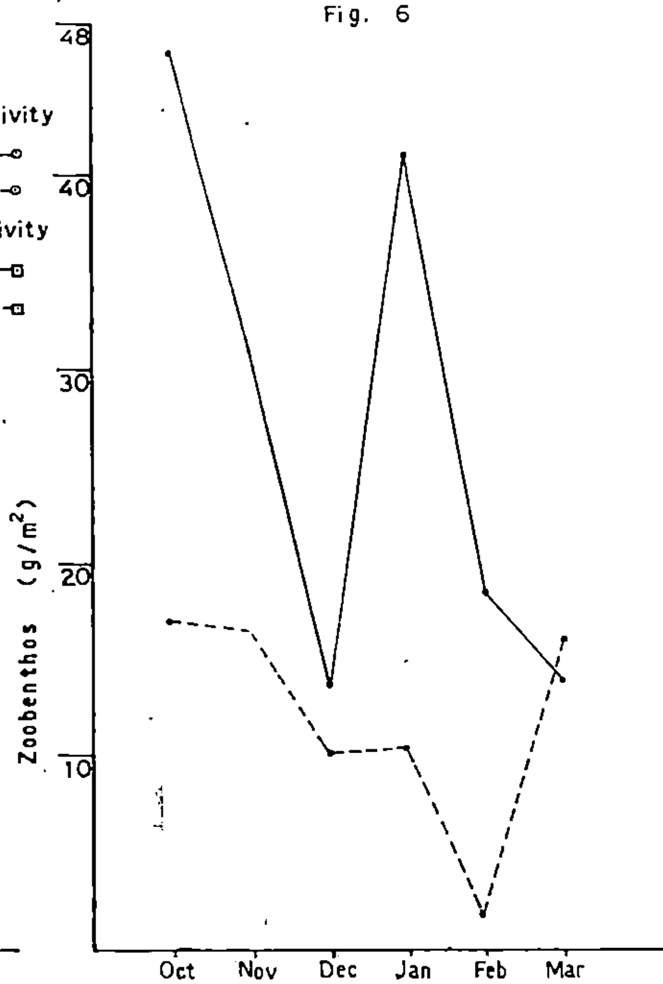

Fig. 8

4.1.3 Salinity.

Salinity of the pond water and backwaters during the period is given in Table 1 and Fig.3.

Salinity in the pond at the beginning of the study was 3.5 ppt from which it steadily increased to a maxium of 19.5 ppt in February. In March it dropped to 18 ppt. In the backwaters the salinity values ranged between 5.3 ppt in October and 31.5 ppt in February.

4.1.4 Total Alkalinity.

The total alkalinity values of the pond and backwaters are given in Table 1 and Fig. 4

Total alkalinity of the pond water was 35.3 ppm in October. Thereafter it steadily increased and reached 65.0 ppm in March.

In the backwaters the alkalinity value in October was 45.3 ppm. From this it was rising steadily and reached 103.7 ppm during December. Then it steadily declined to 66.5 ppm during March.

4.1.5 Dissolved Oxygen.

Dissolved oxygen content of pond water and the backwaters is represented in Table 1 and Fig.5.

Dissolved oxygen content of pond water ranged between 4.4 ppm in October and 8 ppm in February. There was a steady increase in dissolved oxygen content of the pond water from October to February. The dissolved oxygen content then dropped to 5.9 ppm in March. The dissolved oxygen content of the backwater samples was higher than that of the pond samples throughout the period of study, and reached a value of 11.2 ppm in

November. There were ups and downs in the dissolved oxygen content throughout the period of study. Thus from the initial reading of 6.6 ppm in October, dissolved oxygen content rose to 11.2 ppm in November. Then it went down to 6.4 ppm in December, rose to 7.5 ppm in January, still rising to 9.5 ppm in February and then decreased to 6.5 ppm in March.

4.1.6 Phytoplankton primary production.

Phytoplankton primary production (gross and net) of the pond and backwaters is given in the Table 1 and Fig.7.

In the pond the lowest net and gross production were noted in December as 600 mgC/m^3/6hrs, and 720 mgC/m^3/hrs respectively. The highest values observed were 2300 mgC/m^3/hrs and 4440 mgC/m^3/6hrs respectively during January.

In the backwaters the lowest values of net and gross production 720 mgC/m^3/6hrs and 1200 mgC/m^3/6hrs respectively were observed during December. The highest values observed were 2680 mgC/m^3/6hrs and 4680mgC/m^3/6hrs in January.

4.1.7 Zooplankton.

The quantity of zooplankton is expressed in numbers per litre from both the environments during the period from October 1986 to March 1987 and are given in Table 2 and Fig.6.

The important groups of zooplankton observed in the culture pond were crustacean nauplii, copepods, rotifers, and cladocerans. In the backwaters all the above groups were present and added to these, fish eggs and larvae were encountered.

Calanoid and cyclopoid copepods were the predominant groups among the copepods, both in culture pond and backwaters. The copepods in the pond ranged from 89 No/l in February to 305 No/l in October and contributed to 50.43% of the total zooplankton during the entire period of study. In the backwaters the copepods ranged from 8 No/l in October and 305 No/l in February which contributed to 41.18% of total zooplankton.

Among the rotifers, Brachionus sp. were most important in both environments. Their peak from culture pond was noted during November when 177 No/l were collected whereas the minimum numbers were collected in January (26 No/l). Their contribution to the total plankton of the pond was 23.54%, while in the backwaters they contributed to 17.03% of the total plankton, with their number ranging from 7 No/l in October to 136 No/l in January.

Crustacean nauplii were also seen in considerable numbers from both the pond and the backwaters. Their contribution being 19.94% of the total zooplankton in the culture pond and 15.38% in the backwaters. The peak period of abundance of nauplii in the culture pond was during the month of November (91 No/l) whereas in the backwaters it was during February (165 No/l).

Among the cladocerans Moina sp. was dominant in the two environments. In the culture pond it was always seen to be below 30 No/l whereas in the backwaters it ranged between 5 No/l in October and 162 No/l in January. The percentage of this species was only 6.086% in the culture pond whereas it was 19.56% in the backwaters.

In the backwaters, fish eggs and larvae were also found in the plankton sample during all months except in December. The maximum number was

Table 2 Abundance of zooplankton groups in culture pond (P) and backwater (B) during the study period

	Copepods		Rotifers		Crustacean nauplii		Cladocerans		Fish eggs and larvae		Total	
Months	P	B	P	B	P	B	P	B	P	B	P	B
October 1986	305	8	115	7	77	31	29	5	-	5	526	56
November 1986	271	18	177	18	91	68	18	17	-	4	557	125
December 1986	166	131	61	54	66	28	20	75	-	-	313	288
January 1987	131	300	26	136	59	70	17	162	-	17	233	685
February 1987	89	305	33	90	61	165	21	100	-	18	204	678
March 1987	115	135	91	66	72	60	25	67	-	18	303	346
Percentage Contribution	50.43	41.18	23.54	17.03	19.94	15.38	6.086	19.56	-	2.85	-	-

recorded in February and March with 18 No/l, whereas the minimum number was noted during November (4 No/l). Its contribution to the total zooplankton of the backwaters was 2.85%.

4.1.8 Zoobenthos.

The abundance (wet weight in g/m^2), percentage dominance and frequency of occurrence of zoobenthic groups in culture pond and backwaters during the study period are given in Tables 3 & 4 and Fig.8.

The zoobenthic groups present in the culture pond were mainly amphipods, chironomids, polychaetes, tanaids and gastropods, whereas the important groups in the backwaters were amphipods, chironomids, polychaetes and tanaids.

The important item among the amphipods was Corophium sp. in the culture pond with a frequency of 66.660, while its frequency in the backwaters was 50.000. The peak period of dominance of amphipods was during the month of November in the pond where it contributed to 53.205% of zoobenthos. In backwaters, the corresponding value was 35.149% during March. The peak abundance of amphipods in the culture pond was 16.400 g/m^2 in November while in backwaters, the peak value was 6.400 g/m^2 in March.

Chironomid larvae were present in the benthic samples of both the culture pond and the backwaters. In culture pond its frequency of occurrence was 50.000, while in backwaters it was 66.667. The abundance of the chironomids in the culture pond was highest during October (5.696 g/m^2), while in the backwaters it was during December (9.040 g/m^2). The peak dominance of chironomids in the pond and backwaters was 28.456% and 89.540% during February and December respectively.

Table 3 Abundance (a) in g/m^2, Dominance (d) in %, and Frequency of occurrence of zoobenthos in culture pond during the study period

Months	Amphipods		Chironomids		Polychaetes		Tanaids		Gastropods		Total abundance
	a	d	a	d	a	d	a	d	a	d	
October 1986	11.115	23.826	5.696	12.210	-	-	4.539	9.729	25.300	54.233	46.65
November 1986	16.400	53.205	-	-	8.312	26.966	6.112	19.828	-	-	30.824
December 1986	-	-	-	-	11.552	85.469	1.964	14.530	-	-	13.516
January 1987	2.640	6.374	4.539	10.959	-	-	3.137	7.574	31.100	75.091	41.416
February 1987	-	-	5.310	28.456	13.350	71.543	-	-	-	-	18.660
March 1987	5.569	40.662	-	-	8.312	59.337	-	-	-	-	14.000
Frequency of Occurrence	66.660		50.000		66.667		66.667		33.333		

Table 4. Abundance (a) in g/m^2, dominance (d) in % and frequency of occurrence of zoobenthos in backwaters during the study period.

Months	Amphipods		Chironomids		Polychetes		Tanaids		Total abundance
	a	d	a	d	a	d	a	d	
October 1986	2.640	15.449	7.568	44.288	6.880	40.262	-	-	17.088
November 1986	-	-	-	-	13.559	81.332	3.112	18.667	16.671
December 1986	-	-	9.040	89.540	-	-	1.056	10.459	10.096
January 1987	3.179	30.576	5.090	48.956	0.688	6.617	1.440	13.850	10.397
February 1987	-	-	-	-	1.115	55.889	0.880	44.110	1.995
March 1987	6.400	35.149	5.696	31.282	6.112	33.567	-	-	18.208
Frequency of occurrence	50.000		66.667		83.333		66.667		

The polychaetes commonly present were Nereis sp., Dendronereis sp. etc. The frequency of occurrence of polychaetes in the culture pond and backwaters were 66.667 and 83.330 respectively. The peak abundance of polychaetes occurred in pond during February (13.350 g/m^2) and in the backwaters during November (13.559 g/m^2). The dominance of polychaetes was highest in the pond during December when it contributed to 85.469% of the total zoobenthic fauna. The corresponding value in the backwaters occurred during November when it was 81.332%.

Tanaids, mainly Apseudes sp. was present in the pond as well as in the backwaters. The frequency of occurrence of tanaids was 66.667 both in the pond and backwaters. The peak abundance of this group in pond was 6.112 g/m^2 in November, while in the backwaters it was 3.112 g/m^2 during the same month. The peak dominance of tanaids in pond occurred during November (19.828%) and in the backwaters during February (44.110%).

Melania sp. was the dominant gastropod in the benthic samples from the culture pond while it was not encountered in the samples from the backwaters. In the pond, its frequency of occurrence was 33.330 and it was restricted to October and January. The peak abundance of gastropods was 31.100 g/m^2 and their peak dominance was 75.091%, both of which were observed during January.

4.2 Feeding Intensity

Feeding intensity of E. suratensis of the four different length groups in the two environments are given in Table 5 & 6 and feeding index in Table 7 and Fig.9.

Table 5 Feeding intensity of *E. suratensis* of four different length groups in the culture pond during the study period (percentage given in brackets)

Length group	No. of fishes examined	No. of fishes with empty stomach	No. of fishes with poor stomach	No. of fishes with medium stomach	No. of fishes with good stomach	No. of fishes with heavy stomach
First length group (30-49 mm)	36	9 (25.00)	13 (36.11)	9 (25.00)	3 (8.33)	2 (5.55)
Second length group (50-69 mm)	36	9 (25.00)	13 (36.11)	7 (19.44)	5 (13.88)	2 (5.55)
Third length group (70-89 mm)	36	10 (27.77)	9 (25.00)	5 (13.55)	9 (25.00)	3 (8.33)
Fourth length group (90-120 mm)	36	7 (19.44)	7 (19.44)	6 (16.666)	7 (19.44)	9 (25.00)
Total	144	35	42	27	24	16
Percentage Contribution		24.3055	29.166	18.75	16.566	11.111

Table 6. Feeding intensity of E. suratensis of four different length groups in the culture pond during the backwaters during the study period (percentage given in brackets)

	Length group	No. of fishes examined	No. of fishes with empty stomach	No. of fishes with poor stomach	No. of fishes with medium stomach	No. of fishes with good stomach	No. of fishes with heavy stomach
First	Length group (30-49mm)	36	3 (8.33)	7 (19.44)	6 (16.66)	10 (27.77)	10 (27.77)
Second	Length (50-69mm)	36	2 (5.55)	5 (13.88)	5 (13.88)	12 (33.333)	11 (30.55)
Third	Length group (70.89mm)	36	3 (8.33)	2 (8.33)	5 (13.88)	13 (30.55)	13 (36.11)
Fourth	Length (90-120mm)	36	2 (5.55)	3 (8.33)	3 (8.33)	15 (41.666)	13 (36.11)
	Total	144	10	18	20	49	47
	Percentage contribution		6.94	12.50	13.88	34.03	32.63

Table 7 Feeding index of E. suratensis belonging to four different length groups from Culture pond and Backwaters during the study period

	First length group (30-49mm)	Second length group (50-69mm)	Third length group (70-89mm)	Fourth length group (90-120mm)
Culture Pond	13.89	19.45	33.33	44.44
Backwater	55.56	66.67	72.22	77.78

Fig. 9 Average feeding index of E. suratensis of four different length groups, in the pond and backwaters during the study period.

Fig. 10 Average RLG of E. suratensis of four different length groups in the pond and backwaters during the study period.

Plate III

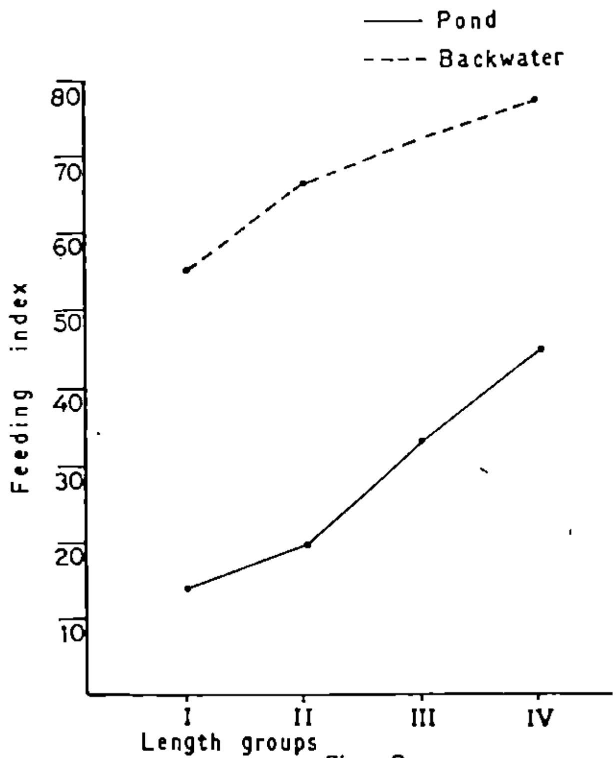

Fig. 9

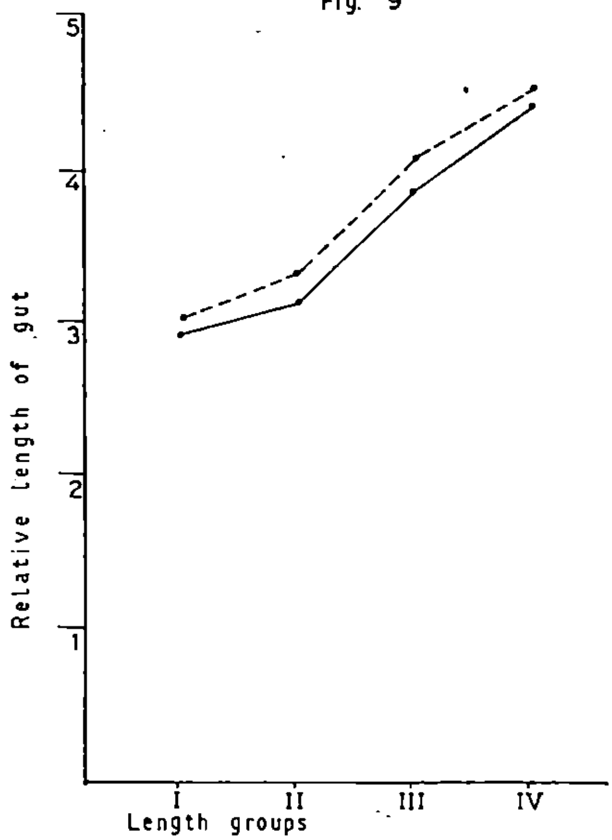

Fig. 10

So far as the feeding intensity of fishes from the pond is concerned, it is seen that the percentage of empty stomachs and poor stomachs were decreasing from first to fourth length groups. In the length group I the percentage of empty and poor stomachs were 25.00 and 36.11 respectively, whereas in the length group IV the percentage of empty as well as poor stomachs were 19.44 The percentage of specimens with good and heavy stomachs were seen to be increasing from first to fourth length group. Thus in the length group I the percentage of good and heavy stomachs were 8.33 and 5.55 respectively, while in the length group IV their values went upto 19.44% and 25.00%.

Feeding intensity of fishes collected from the backwaters were relatively greater than those from the pond. In this case also, there was a declining trend in percentage of empty and poor stomachs (8.33 and 19.44% to 5.55 and 8.33%) from first to fourth length group, whereas an increase in the percentage of good stomachs (27.77 to 41.67%), and heavy stomachs (27.77 to 36.11%) from first to fourth length group.

Considering the feeding index of E. suratensis belonging to four different length groups collected from culture pond and backwaters, higher feeding indices were found in the fishes collected from the backwaters in all the length groups. Thus the feeding indices of E. suratensis belonging to first length group from the culture pond were 13.89 and 55.56 in the backwaters. For the second length group, the feeding indices in the culture pond and backwaters were 19.45 and 66.67 respectively. For the fishes belonging to third length group, the feeding indices were 33.33 and 72.22 respectively. The feeding indices of fourth length group in culture pond and backwaters were 44.44 and 77.78 respectively.

Table 8 Relative length of gut (RLG) of E. suratensis of four different length groups from Culture pond during the study period.

No.	Length group	Average total length (mm)	Average length of gut (mm)	(RLG)
1.	First length group (30-49 mm)	45	131	2.911
2.	Second length group (50-69 mm)	61	190	3.111
3.	Third length group (70-89 mm)	89	343	3.850
4.	Fourth length group (90-120mm)	105	465	4.420

Table 9 Relative length of gut (RLG) of E. suratensis of four different length groups from Backwater during the study period

No.	Length group	Average total length (mm)	Average length of gut (mm)	(RLG)
1.	First length group (30-49 mm)	47.5	143	3.011
2.	Second length group (50-69 mm)	59.5	198	3.331
3.	Third length group (70-89 mm)	83.3	334	4.010
4.	Fourth length group (90-120 mm)	106.5	483	4.535

4.3 Variation in the Gut length of four Length groups of *E. suratensis* in Captive and Wild environments

RLG factor of *E. suratensis* belonging to four length groups from the two environments are represented in Tables 8 & 9 and Fig.10.

The average RLG of the specimens from the pond of length group I (30-49 mm) was 2.911 & that of length group II (50-69 mm) was 3.111. It was 3.850 for length group III (70-89 mm) & 4.420 for length group IV (90 mm to 120 mm).

In the backwaters, the RLG of the four length groups of fishes was greater than their corresponding values in the pond. Thus it was seen that the RLG of length group I (30-49 mm) was 3.011 and that of length group II (50-69 mm) was 3.331. The RLG of length group III (70-89 mm) and length group IV (90-120 mm) was 4.011 and 4.535 respectively.

4.4 Items observed in the stomach contents of *E. suratensis* collected from Captive and Wild environments

The data of the stomach content analysis revealed, that the main food items of *E. suratensis* from the captive environment of a culture pond in general, consisted of diatoms, filamentous algae, detritus, rotifers, copepods, other crustaceans, insect larvae and gastropods, whereas in the specimens collected from the wild in backwaters the main food items observed were filamentous algae, diatoms, higher aquatic plants, detritus, rotifers, copepods, other crustaceans and insect larvae.

4.4.1 Diatoms.

The most commonly observed diatoms in the stomach contents were *Pleurosigma sp.*, *Navicula sp.*, *Nitzchia sp.*, *Fragillaria sp.*, etc., Diatoms were observed in the stomach contents of specimens from both the pond and the backwaters. Pleurosigma sp. and Navicula sp. were more common than Nitzchia sp. and Fragillaria sp.

4.4.2 Filamentous algae.

Important filamentous algae in the stomach contents were Spirogyra sp. Anabaena sp. and Oscillatoria sp. Of these Spirogyra sp and Anabaena sp. were abundant and formed one of the major items of food in the stomach contents of the specimens from the culture pond, whereas the Oscillatoria sp. and Spirogyra sp. were abundant in the stomach contents of specimens from backwaters.

4.4.3 Higher Aquatic plants.

Undigested and semidigested leaves of the plants viz; Hydrilla sp., Enteromorpha sp., Najas sp., Ceratopteris sp., etc. were observed in the stomach contents of all the three length groups above 50 mm in the backwaters. These aquatic plants were completely absent from the stomach contents of specimens from the culture pond since the higher aquatic plants were absent in the culture pond.

4.4.4 Detritus.

Decaying organic matter mixed with sand and mud was usually noticed in the stomach contents of the specimens of all the four length groups in varying amounts, from both the culture pond and the backwaters.

4.4.5 Rotifers.

Brachionus sp. were the important rotifers present in the stomach contents of E. suratensis. Although, rotifers were not an important food item, they were present in small numbers in the stomach contents of all the specimens in both the environments throughout the period of study.

4.4.6 Copepods.

Copepods were present in small numbers in the stomach contents of E. suratensis from both the environments. Since most of them were found as bits and fragments, they could not be identified.

4.4.7 Other Crustaceans

Among the other crustaceans the important groups encountered in the stomach contents were cladocerans, gammarids, tanaids, decapod larvae etc. Since they were mostly seen as exoskeletal remnants and bits of appendages, they also could not be identified.

4.4.8 Molluscs.

Small gastropod of the genus Melania was present in small quantities occasionally, in the stomach of specimens from the culture pond.

4.4.9 Insect Larvae.

Insect larvae chiefly of chironomids were recorded occasionally in small numbers from the stomach contents of the individuals from both the environments.

4.5 Food variations in the stomach of E. suratensis of four different length groups in Captive and Wild environments

The percentage composition and the monthly variation of the different food items in the stomach contents of fishes of the four different length groups from the pond and the backwaters is given in Tables 10 to 17 and Figs.11 to 34.

4.5.1 Food of E. suratensis of length group I (30-49 mm).

The major food items in the stomach contents of E. suratensis of length group I from the pond were diatoms, filamentous algae, detritus, copepods, rotifers, other crustaceans, insect larvae and gastropods.

In October, diatoms constituted 41.171% of the stomach contents of this length group. It decreased to 11.996% during November and then increased to 39.582% during January. In February it constituted only 25.962% of the stomach contents while in March it was 44.354%. In the stomach contents of fishes from backwaters the percentage contribution by diatoms was varying throughout the study period. In October, it constituted 71.666% of the stomach contents while in November it declined to 23.550%. Again in December, it rose to 79.047% and then declined to 23.147% in January, rising up to 73.573% in March.

The percentage of filamentous algae in the stomach contents of E. suratensis from the culture pond ranged between 11.311% during November and 40.277% during February. Variations in its quantity was observed throughout the study period. In the case of individuals collected from backwaters the contribution of filamentous algae in the diet ranged between 3.174% in December and 45.000% in February. During the remaining months, its contribution was as 10.661% in October, 15.942% in November, 44.330% in January and 7.20[illegible]% in March.

Maximum percentage of detritus (74.856%) in the stomach of the pond reared E. suratensis was noted during November and minimum (19.545%) during the month of February. In the case of specimens from the backwaters, the contribution of detritus ranged between 6.172% in October and 45.579%

Table 10. Percentage composition of food items in the stomach contents of *E. suratensis* of length group I from culture pond during the study period.

Months	Diatoms	Filamentous algae	Higher aquatic plants	FOOD ITEMS Detritus	Rotifers	Copepods	Other crust-aceans	Gastropods	Insect larvae
October 1986	41.171	23.150	-	31.565	-	1.745	2.372	-	-
November 1986	11.996	11.311	-	74.856	0.899	-	0.897	-	-
December 1986	30.206	19.091	-	44.252	2.724	-	3.724	-	-
January 1987	39.582	27.472	-	22.527	2.500	1.648	-	2.123	4.148
February 1987	25.962	40.277	-	19.545	5.164	2.388	3.888	2.776	-
March 1987	44.354	26.742	-	22.869	2.345	2.345	-	-	1.345

Table 11. Percentage composition of food items in the stomach contents of E. suratensis of length group I from open backwaters during the study period.

Months	Diatoms	Filamentous algae	Higher aquatic plants	FOOD ITEMS			Other crustaceans	Gastropods	Insect larvae
				Detritus	Rotifers	Copepods			
October 1986	71.666	10.661	-	6.172	3.700	5.200	2.600	-	-
November 1986	23.550	15.942	-	45.579	3.005	5.752	6.172	-	-
December 1986	79.047	3.174	-	7.301	1.571	3.945	5.004	-	-
January 1987	23.147	44.333	-	10.079	6.192	6.945	9.300	-	-
February 1987	30.173	45.000	-	9.305	5.230	5.615	4.696	-	-
March 1987	73.573	7.207	-	7.516	-	3.900	7.800	-	-

in November. The contribution of detritus was low in the stomach contents of specimens from the backwaters except during November.

The other items encountered in the stomach contents were rotifers, copepods, other crustaceans, insect larvae and gastropods. The percentage of rotifers in the stomach contents of the pond reared fishes ranged between 0.899% in November and 5.164% during February. In the backwater samples, the rotifers ranged between 1.571% during December and 6.192% during January. Copepods were also occasionally present in small numbers and its highest contribution in the stomach contents of pond reared fishes occurred during February (2.388%). In the stomach contents of specimens from backwaters, its highest percentage contribution was in January when it contributed to 6.945% of the stomach contents. The maximum percentage of other crustaceans in the stomach contents of the fishes from pond was 3.888% in February. The corresponding value in the backwater samples was 9.300% during January. Insect larvae were present only in the stomach contents of E. suratensis from pond and that too only during the month of January (4.148%) and March (1.345%). Remains of aquatic plants were altogether absent from the stomach contents of samples collected from the pond as well as from the backwaters. Small gastropods were noted in the stomach contents of fishes collected from the culture pond only. It was present only during January (2.123%) and February (2.776%).

4.5.2 Food of E. suratensis of length group II (50-69 mm).

Diatoms constituted 15.145% of the stomach contents of the pond reared fishes during October. From November to March its contribution was steadily declining from 36.333% to 21.000%. In the stomach contents of fishes collected from backwaters, the contribution of diatoms in total diet increased

Table 12. Percentage composition of food items in the stomach contents of E. suratensis of length group II from culture pond during the study period.

Months	Diatoms	Filamentous algae	Higher aquatic plants	FOOD ITEMS Detritus	Rotifers	Copepods	Other crusta-ceans	Gastropods	Insect larvae
October 1986	15.145	36.00	-	38.068	3.408	3.771	1.904	1.704	-
November 1986	36.333	26.561	-	29.227	3.508	-	2.016	2.352	-
December 1986	36.135	25.318	-	25.791	3.135	3.689	2.742	1.450	1.730
January 1987	33.830	17.282	-	38.905	3.009	3.487	3.487	-	-
February 1987	25.777	18.444	-	48.444	2.333	1.333	3.669	-	-
March 1987	21.000	52.941	-	19.196	2.176	1.764	1.744	-	1.176

Table 13. Percentage composition of food items in the stomach contents of *E. suratensis* of length group II from open backwaters during the study period.

Months	Diatoms	Filamentous algae	Higher aquatic plants	FOOD ITEMS Detritus	Rotifers	Copepods	Other crusta-ceans	Gastropods	Insect larvae
October 1986	18.850	67.957	5.006	5.654	-	1.641	0.892	-	-
November 1986	37.000	33.000	8.000	18.000	3.000	-	1.000	-	-
December 1986	81.967	8.524	3.278	3.278	0.983	-	1.966	-	-
January 1987	14.035	54.385	13.333	15.087	-	1.052	2.104	-	-
February 1987	8.376	78.534	4.973	5.759	0.785	1.57	-	-	-
March 1987	30.909	53.830	6.969	5.454	0.909	-	1.820	-	-

from 18.850% in October to 81.967% in December. There was an abrupt decline in its contribution to 14.035% in January and 8.376% in February rising again to 30.909% in March.

The contribution by filamentous algae ranged from 17.282% (January) to 52.941% (March) in the diet of the pond reared E. suratensis. From October to February its contribution declined from 36.000% to 18.444% in the stomach contents. During March it again rose to 52.941%. In the stomach contents of fishes from backwaters the contribution by filamentous algae was showing wide fluctuations. Thus it was 67.95[illegible]% of the diet in October, but declined to 8.524% in December. Thereafter the percentage rose to 78.534% in February, declining again to 53.830% in March.

Percentage of detritus in the stomach contents of the pond reared fishes also showed wide fluctuations throughout the study period. It ranged from 19.196% in March to 48.444% in February. In the stomach contents of the backwater samples, detritus ranged from 3.278% in December to 18.000% in November.

Contribution of higher aquatic plants which was present only in the stomach contents of fishes collected from backwaters ranged from 3.278% during December to 13.333% in January. The percentage of the rotifers in the stomach contents of the pond reared fishes varied from 3.508% in November and 2.176% in March. Its corresponding variation for the fishes collected from backwaters was from 3.000% during November and 0.785% during February.

The maximum contribution by copepods (3.771%) to the stomach contents of fishes from culture pond was noted during October, while in the backwaters the corresponding value was 1.641% during the same month. In the case of other crustaceans, the highest contribution was 3.669% to the diet of the pond reared E. suratensis during the month of February. For the fishes collected from backwaters it was 2.104% during January. Gastropods and insect larvae were present in the stomach contents of only pond reared fishes and that too occasionally. Maximum percentage of gastropods was noted during November as 2.352%, while the corresponding value for the insect larvae was 1.730% during December.

4.5.3 Food of E. suratensis of length group III (70-89 mm).

The contribution of diatoms in the diet of pond reared fishes ranged from 20.650% in October to 71.919% in November. In January it was 29.130% and in March it was 30.902%. In the case of the fishes from backwaters the contribution of diatoms to the diet was very low compared to the pond reared fishes. It contributed to 17.100% of the diet during October, 3.225% during December and 3.257% in January. In March it formed 6.147% of the diet.

The percentage of filamentous algae in the stomach of pond reared E. suratensis ranged between 7.075% in November and 43.478% in January while in the samples from the backwaters, the contribution of the filamentous algae ranged between 9.120% during January and 80.695% during December. Fluctuations were noted in the contribution of filamentous algae to the diet, throughout the study period.

The contribution of detritus in stomach contents of pond reared fishes was 34.040% during October. During the month of November it was 16.787%, while in December it went upto 29.000%, then decreased to 16.521% in January, rising again to 47.980% in February. In March, it contributed to 43.950% of the stomach contents. In this length group also, the contribution of detritus in the stomach contents of fishes collected from the backwaters

Table 14. Percentage composition of food items in the stomach contents of E. suratensis of length group III from culture pond during the study period.

Months	Diatoms	Filamentous algae	Higher aquatic plants	FOOD ITEMS Detritus	Rotifers	Copepods	Other crusta-ceans	Gastropods	Insect larvae
October 1986	20.650	31.000	-	34.040	4.417	3.492	2.117	2.492	1.792
November 1986	71.919	7.075	-	16.787	1.393	1.736	1.136	-	-
December 1986	24.852	35.000	-	29.000	2.544	2.227	3.765	2.650	-
January 1987	29.130	43.478	-	16.521	1.304	2.171	6.086	1.304	-
February 1987	21.407	13.207	-	47.980	4.716	4.304	6.086	2.304	-
March 1987	30.902	15.000	-	43.950	2.395	1.404	2.743	2.208	1.395

Table 15. Percentage composition of food items in the stomach contents of *E. suratensis* of length group III from open backwaters during the study period.

Months	FOOD ITEMS								
	Diatoms	Filamentous algae	Higher aquatic plants	Detritus	Rotifers	Copepods	Other crusta-ceans	Gastropods	Insect larvae
October 1986	17.100	31.000	29.360	14.000	-	2.230	3.099	-	3.200
November 1986	12.612	44.594	24.324	15.000	-	1.351	2.116	-	-
December 1986	3.225	80.695	6.774	6.100	1.914	-	1.303	-	-
January 1987	3.357	9.120	76.221	8.061	1.954	1.278	-	-	-
February 1987	6.947	20.595	58.560	11.100	-	1.306	1.488	-	-
March 1987	6.147	68.032	13.934	9.000	1.654	-	1.229	-	-

was lesser than that in the pond reared fishes. Thus it ranged between 6.100% in December and 15.000% in November.

The higher aquatic plants was present only in the stomach contents of fishes collected from the backwaters. Its contribution to the total diet was seen to be 29.360% during October while it declined to 6.774% during December, rising upto 76.221% in January, declining again to 13.934% in March.

The maximum contribution of rotifers, to the stomach contents of pond reared fishes was 4.716% during February, while the corresponding value for the fishes collected from backwaters was 1.954% in January. The maximum contribution of copepods in the stomach contents of the pond reared fishes was 4.304% during February. For the fishes collected from the backwaters the corresponding value was 2.230% during October. The maximum contribution of other crustaceans in the stomach contents of the pond reared and backwater samples were 6.086% (January and February) and 3.099% (October) respectively. In the case of gastropods, which were present in stomach contents of only the pond reared fishes, a maximum contribution of 2.650% was observed during December. Insect larvae were noted only rarely, when they contributed to 1.792% (October) of the diet of the pond reared fishes, whereas for the samples collected from backwaters, it was present only during October when they contributed to 3.200% of the diet.

4.5.4 Food of *E. suratensis* of length group IV (90-120 mm).

The contribution of diatoms in the diet of pond reared *E. suratensis* was 45.150% during October and 52.550% during November from which it declined to 24.523% in January and then increased to 42.202% in March.

Table 16. Percentage composition of food items in the stomach contents of *E. suratensis* of length group IV, from culture pond during the study period.

Months	FOOD ITEMS								
	Diatoms	Filamentous algae	Higher aquatic plants	Detritus	Rotifers	Copepods	Other crusta-ceans	Gastropods	Insect larvae
October 1986	45.150	17.800	-	28.600	2.750	3.800	-	1.900	-
November 1986	52.550	33.710	-	10.709	1.052	0.806	1.182	-	-
December 1986	26.578	38.633	-	26.191	2.003	2.021	1.882	-	2.692
January 1987	24.523	39.276	-	30.423	1.267	1.728	1.382	1.382	-
February 1987	31.935	36.129	-	22.258	3.935	1.870	3.870	-	-
March 1987	42.202	29.276	-	25.394	1.746	-	1.382	-	-

Table 17. Percentage composition of food items in the stomach contents of E. suratensis of length group IV, from culture pond during the study period.

Months	FOOD ITEMS								
	Diatoms	Filamentous algae	Higher aquatic plants	Detritus	Rotifers	Copepods	Other crusta-ceans	Gastropods	Insect larvae
October 1986	50.493	9.788	32.555	5.840	-	1.322	-	-	-
November 1986	21.212	21.919	29.090	21.232	-	3.030	1.515	-	2.000
December 1986	12.345	50.123	25.493	7.159	0.925	1.850	2.100	-	-
January 1987	14.093	36.751	28.187	21.000	-	-	-	-	-
February 1987	17.093	15.151	35.157	28.046	1.006	2.600	0.910	-	-
March 1987	14.934	37.032	36.147	7.196	2.229	2.458	-	-	-

Figs. 11 to 14 Percentage composition of food items in the stomach contents of E. suratensis of length group I (Fig.11), length group II (Fig.12), length group III (Fig.13) and length group IV (Fig.14) in the pond and backwaters during October 1986.

Denotation of the histogram:

diatoms - shaded, filamentous algae - oblique lines,
detritus - triangles; rotifers - vertical lines,
copepods - crosses, higher aquatic plants - broken lines,
other crustaceans - large dots, grastropods - squares,
insect larvae - small dots.

Plate IV

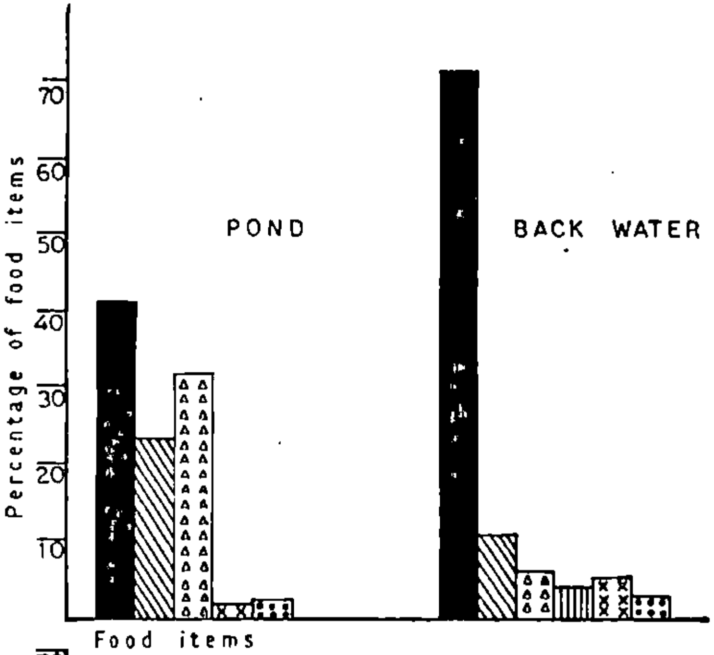

Fig 11

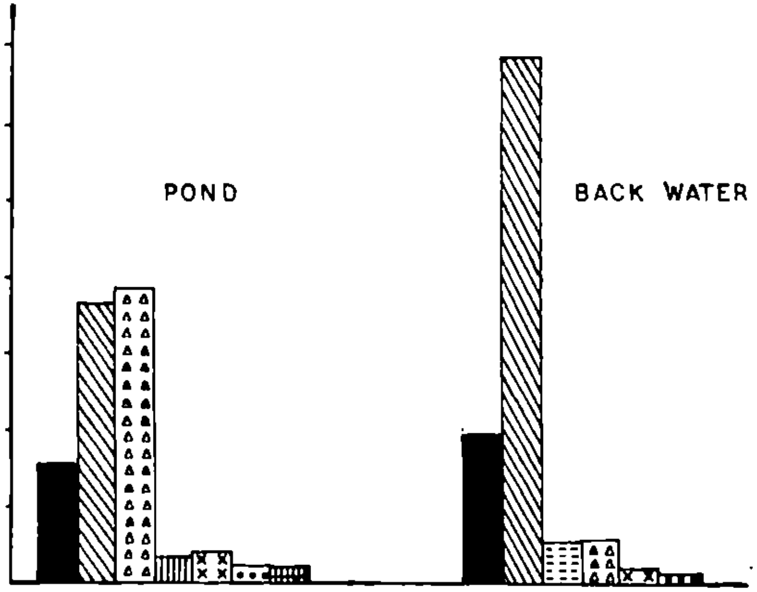

Fig 12

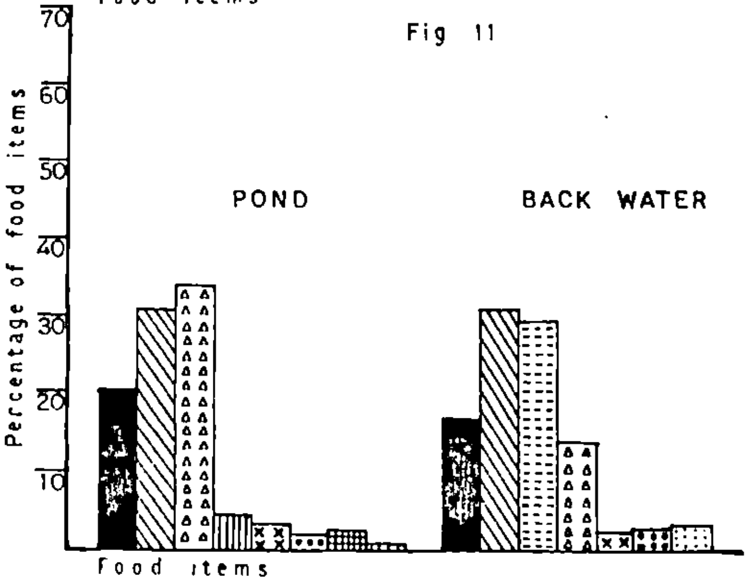

Fig 13

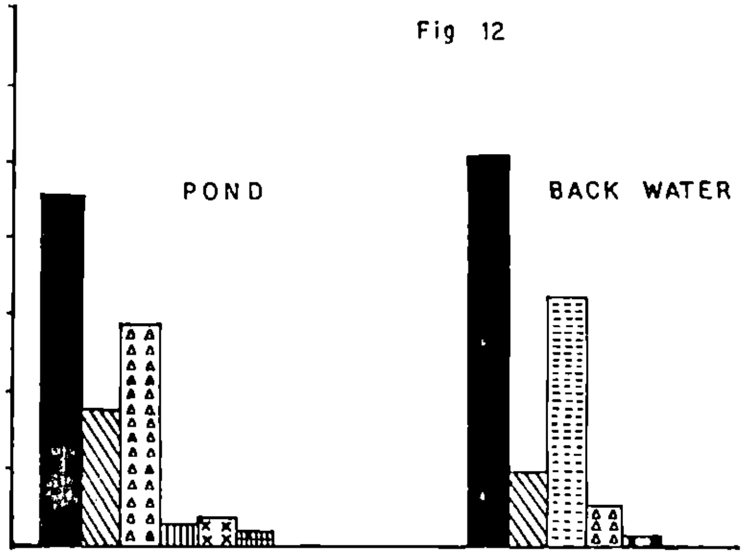

Fig 14

Figs. 15 to 18 Percentage composition of food items in the stomach contents of *E. suratensis* of length group I (Fig.15), length group II (Fig.16), length group III (Fig.17) and length group IV (Fig.18) in the pond and backwaters during November 1986.

Denotation of the histogram:

diatoms - shaded, filamentous algae - oblique lines,
detritus - triangles; rotifers - vertical lines,
copepods - crosses, higher aquatic plants - broken lines,
other crustaceans - large dots, grastropods - squares,
insect larvae - small dots.

Plate V

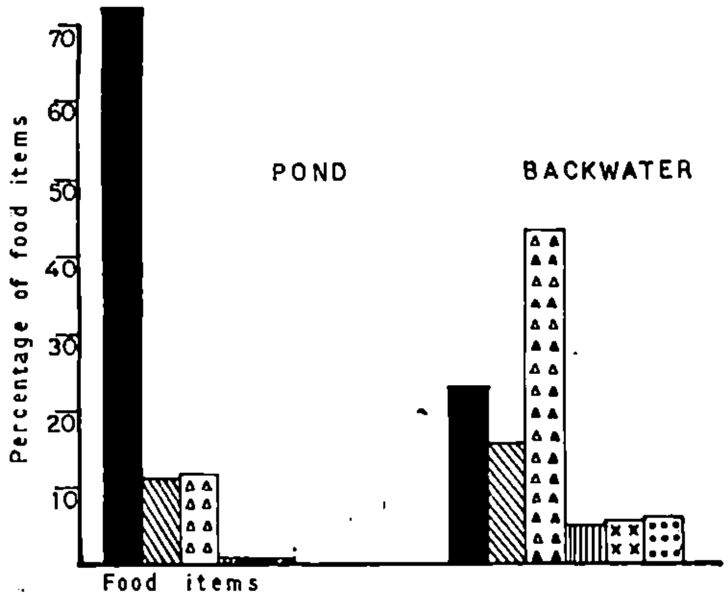

Fig. 15

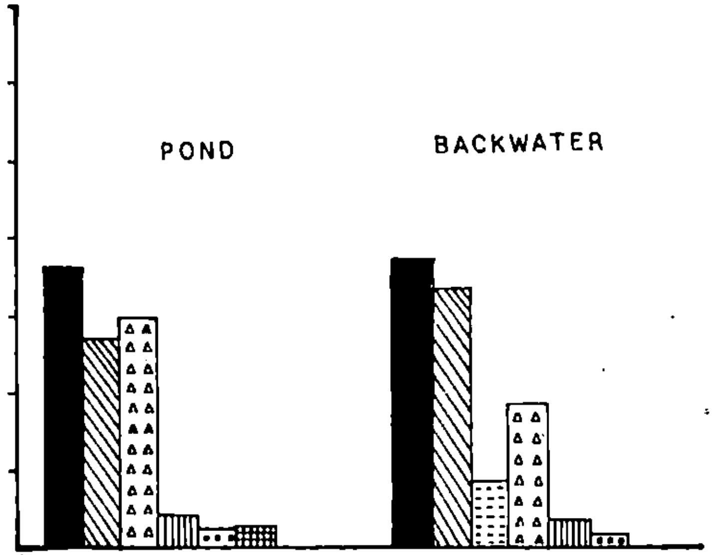

Fig. 16

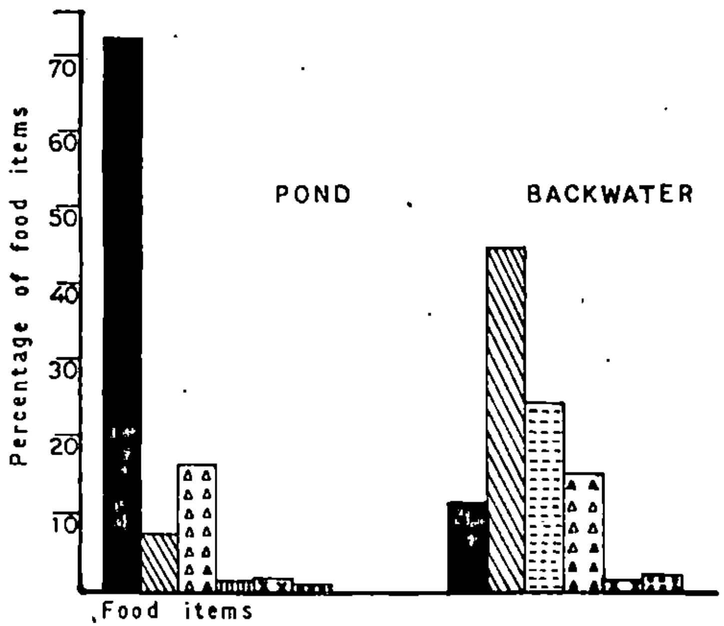

Fig. 17

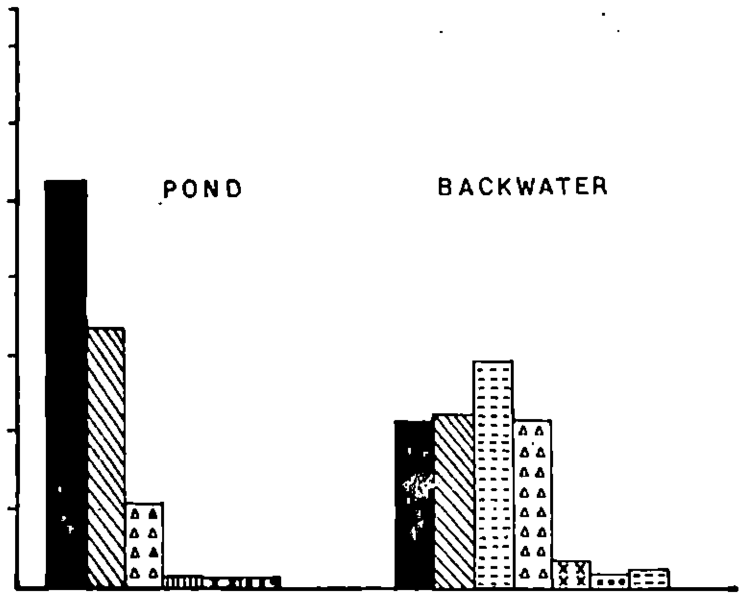

Fig. 18

Figs. 19 to 22 Percentage composition of food items in the stomach contents of E. suratensis of length group I (Fig.19), length group II (Fig.20), length group III (Fig.21) and length group IV (Fig.22) in the pond and backwaters during December 1986.

Denotation of the histogram:

diatoms - shaded, filamentous algae - oblique lines,
detritus - triangles; rotifers - vertical lines,
copepods - crosses, higher aquatic plants - broken lines,
other crustaceans - large dots, grastropods - squares,
insect larvae - small dots.

Plate VI

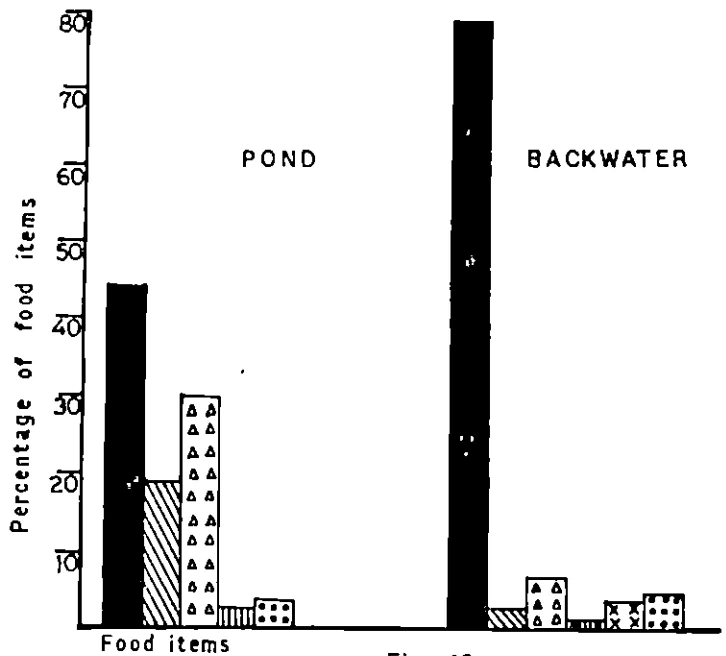

Fig. 19

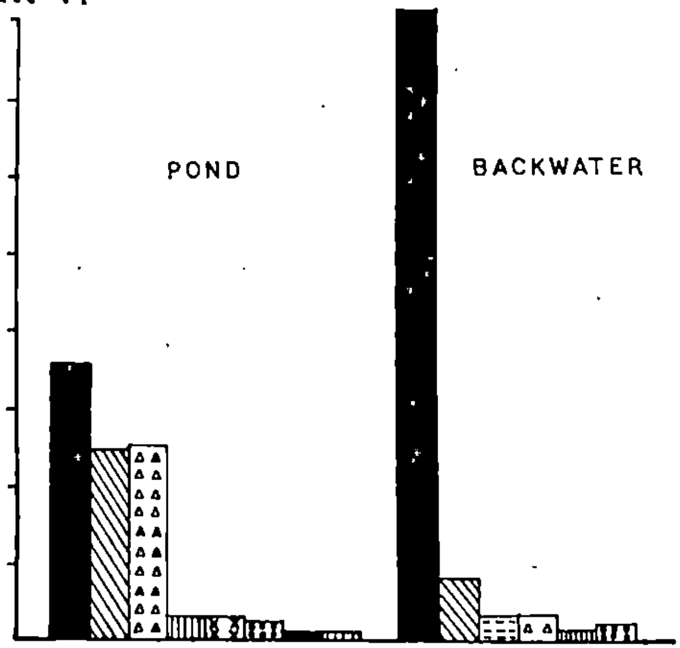

Fig. 20

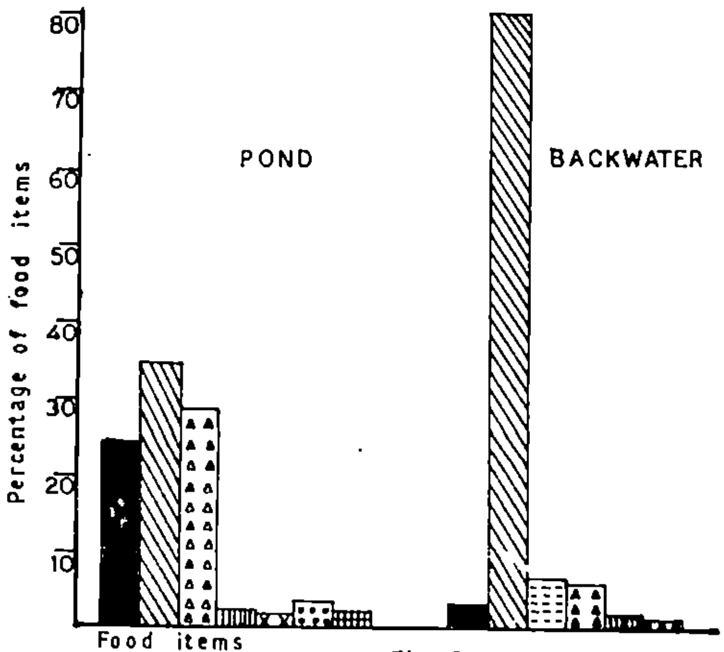

Fig. 21

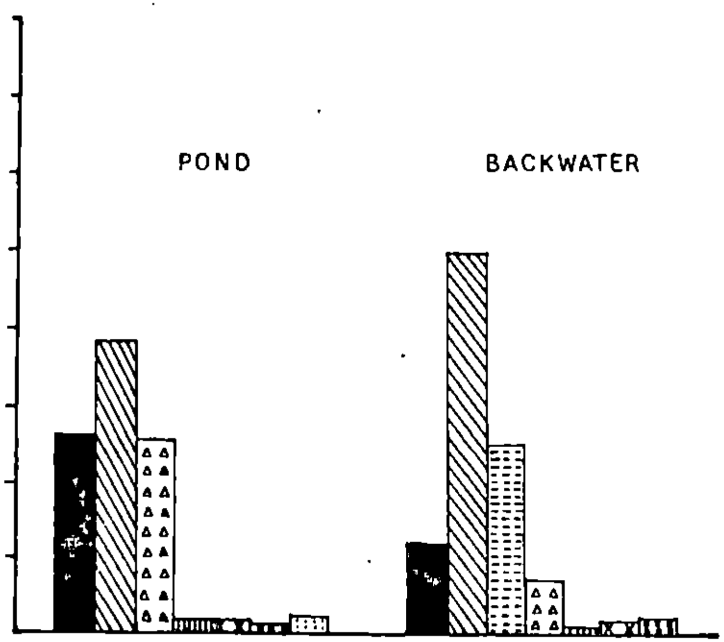

Fig. 22

Figs. 23 to 26 Percentage composition of food items in the stomach contents of E. suratensis of length group I (Fig.23), length group II (Fig.24), length group III (Fig.25) and length group IV (Fig.26) in the pond and backwaters during January 1987.

Denotation of the histogram:

diatoms - shaded, filamentous algae - oblique lines,
detritus - triangles; rotifers - vertical lines,
copepods - crosses, higher aquatic plants - broken lines,
other crustaceans - large dots, grastropods - squares,
insect larvae - small dots.

Plate VII

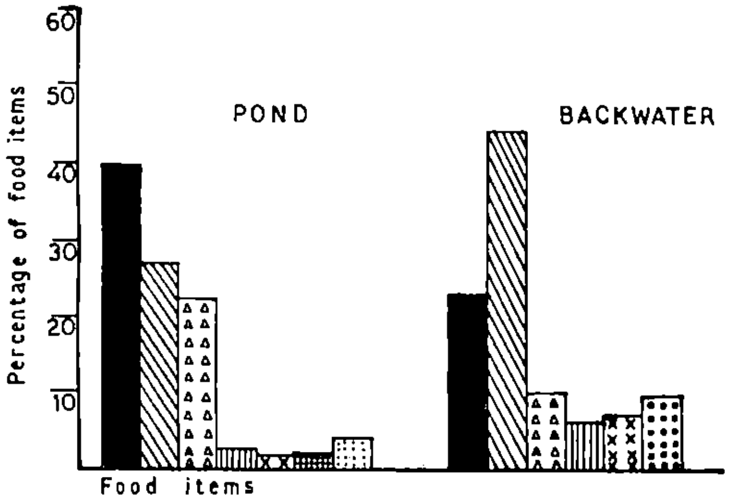

Fig. 23

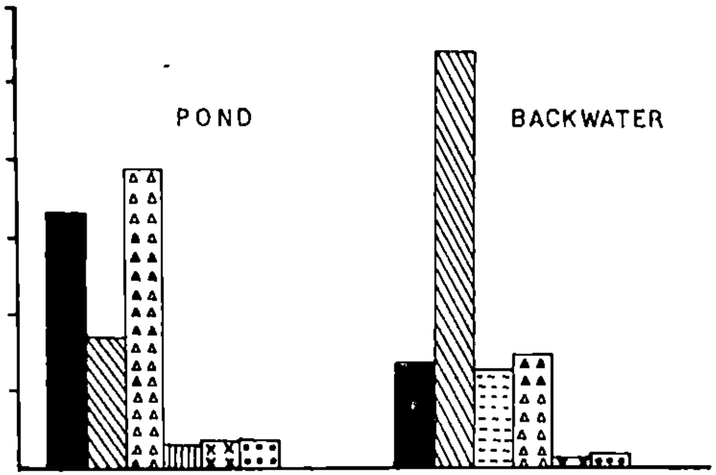

Fig. 24

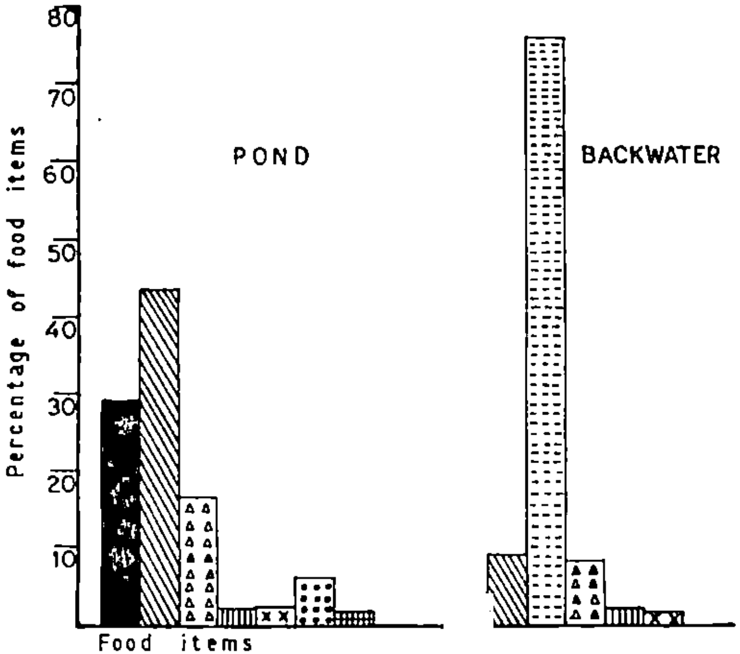

Fig. 25

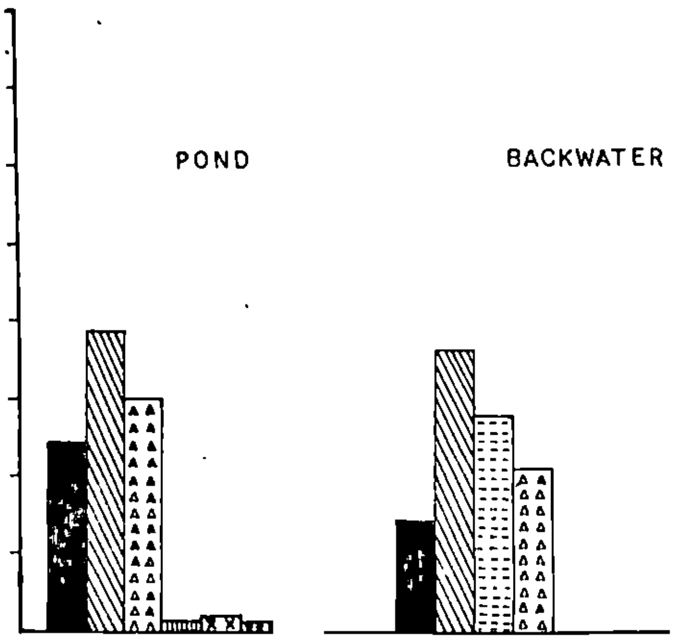

Fig. 26

Figs. 27 to 30) Percentage composition of food items in the stomach contents of E. suratensis of length group I (Fig.27), length group II (Fig.28), length group III (Fig.29) and length group IV (Fig.30) in the pond and backwaters during February 1987.

Denotation of the histogram:

diatoms - shaded, filamentous algae - oblique lines,
detritus - triangles; rotifers - vertical lines,
copepods - crosses, higher aquatic plants - broken lines,
other crustaceans - large dots, grastropods - squares,
insect larvae - small dots.

Plate VIII

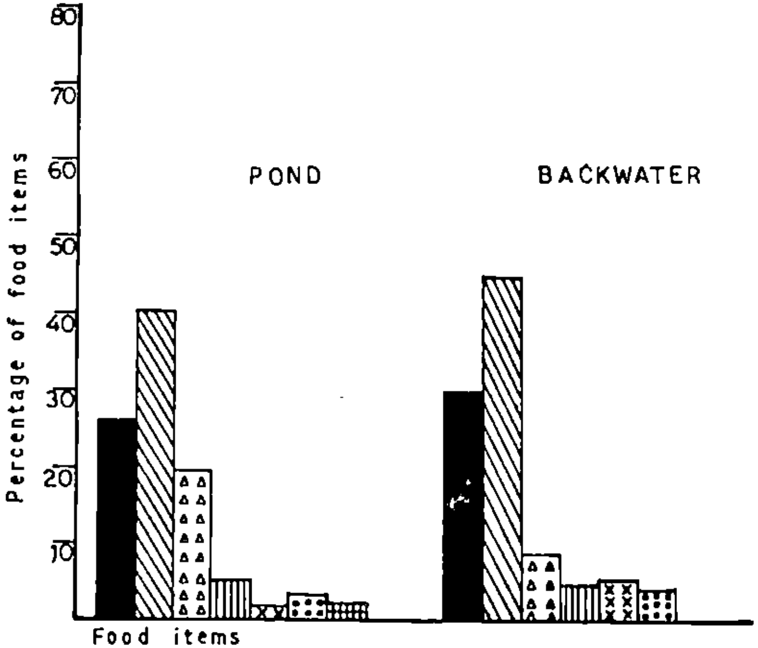

Fig. 27

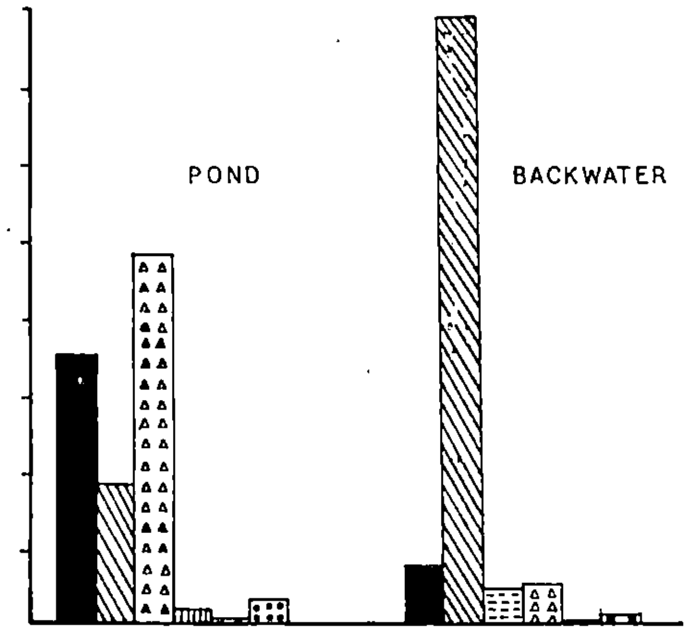

Fig. 28

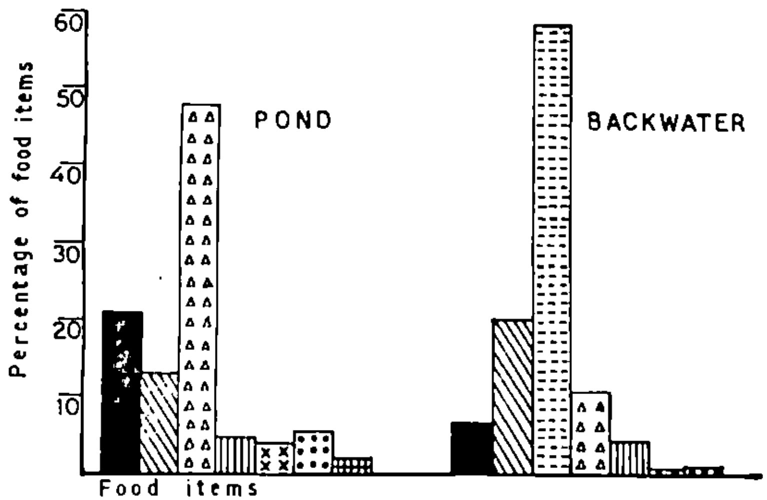

Fig. 29

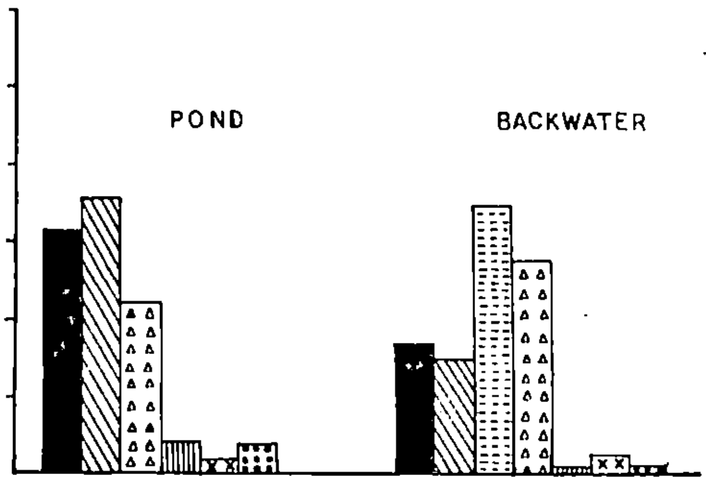

Fig. 30

Figs. 31 to 34) Percentage composition of food items in the stomach contents of E. suratensis of length group I (Fig.31), length group II (Fig.32), length group III (Fig.33) and length group IV (Fig.34) in the pond and backwaters during March 1987.

Denotation of the histogram:

diatoms - shaded, filamentous algae - oblique lines,
detritus - triangles; rotifers - vertical lines,
copepods - crosses, higher aquatic plants - broken lines,
other crustaceans - large dots, grastropods - squares,
insect larvae - small dots.

Plate IX

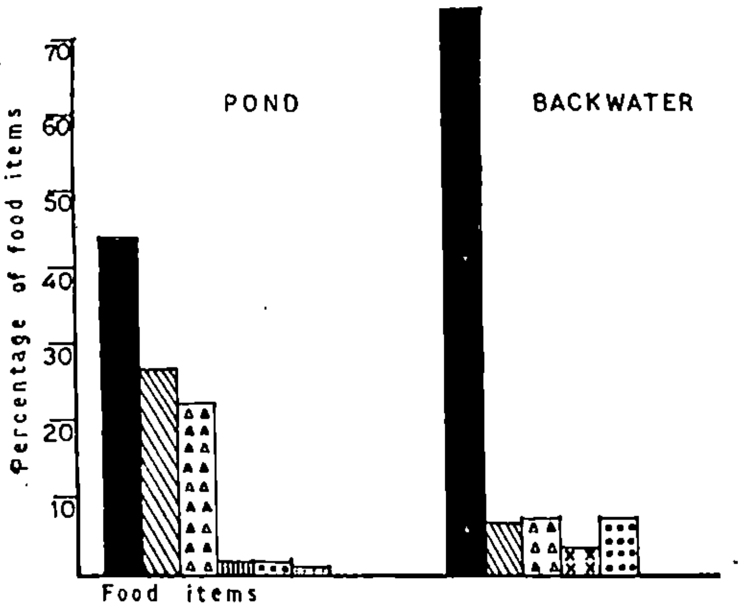

Fig. 31

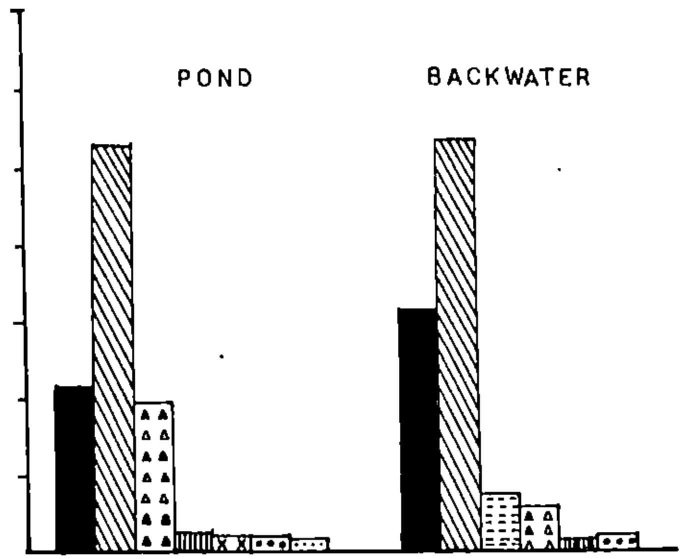

Fig. 32

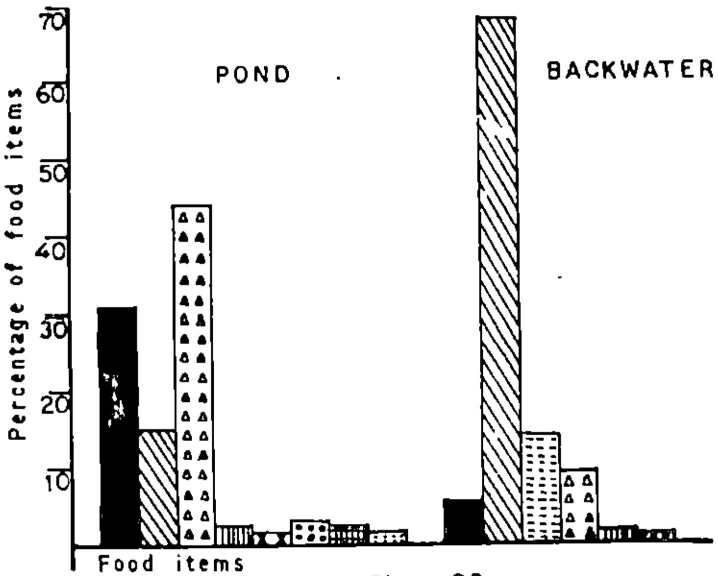

Fig. 33

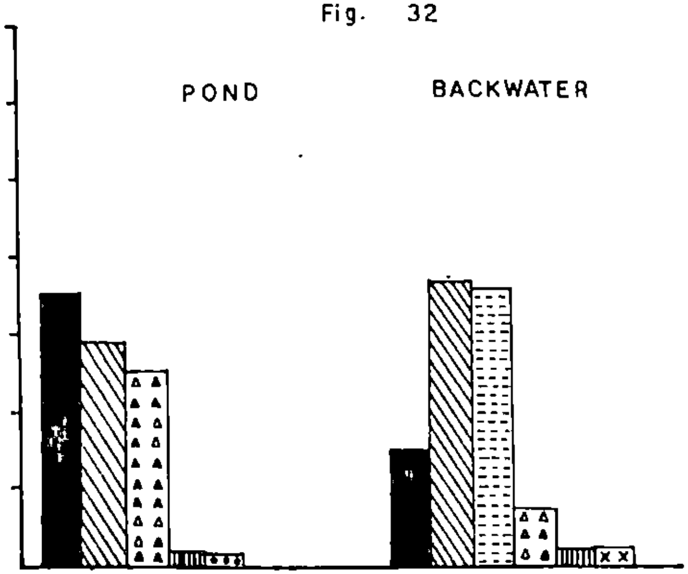

Fig. 34

In the stomach contents of specimens from the backwaters the contribution of diatoms was 50.493% in October. In December it declined to 12.345%, while in January it was 14.093%, but increased to 17.093% in February falling to 14.934% in March.

The contribution of filamentous algae in the stomach contents of pond reared E. suratensis ranged between 17.800% during October and 39.276% during January. In the case of fishes from the backwaters the range was between 9.788% during October and 50.123% during December.

The contribution of detritus to the diet of pond reared samples was showing variations during the different months under study. In October it contributed to 28.600% of the diet while in November it formed 10.709%. In January it rose to 30.423% then declined to 22.258% during February and increased to 25.394% in March. The contribution of detritus was relatively low in the stomach contents of specimens collected from backwaters and it was found to range between 5.840% during October and 28.046% during February.

Higher aquatic plants contributed to 32.550% of the stomach contents of fishes from backwaters during October. It declined to 25.493% in December then steadily rose upto 36.147% in March. The aquatic macrophytes were entirely absent from the stomach contents of fishes from the culture pond.

Among other minor items, rotifers contributed upto 3.935% (February) of the stomach contents of pond reared E. suratensis while in the fishes collected from the backwaters the corresponding value was 2.229% in March. The highest contribution of copepods to the stomach contents of the pond reared fishes was 3.800% during October, while the corresponding value for the fishes collected from backwaters was 3.030% during November. The maximum contribution of other crustaceans in the stomach contents of pond reared and the backwater samples were 3.870% (February) and 2.100% (December) respectively. Gastropods were present in the stomach contents of E. suratensis collected from culture pond only. Their contribution was 1.900% of the stomach contents during October and 1.382% in January. They were absent from the stomach contents during the other months. Insect larvae were present in the stomach contents of pond reared fishes during December alone when they contributed 2.692% of the food. In the samples from backwaters they were present only in November with a contribution of 2.00%.

4.6 Preferred Food items of E. suratensis in Captive and Wild environments

The average percentage composition of food items consumed by E. suratensis belonging to four different length groups, during the entire study period from the culture pond and backwaters are presented in the Tables 18 & 19 and Figs. 35-38.

4.6.1 Preferred Food items of four different Length groups in Culture pond.

According to the data collected it was found that in the culture pond the most important food items were diatoms, detritus and filamentous algae.

Considering the food preference of the each length group, in culture pond it was found that the first length group feeds mainly on detritus (35.936%) and diatoms (32.212%) followed by filamentous algae, which contributed to 24.674%. Rotifers (2.272%), copepods (1.354%), insect larvae (0.916%) and gastropods (0.817%) were other items of minor importance.

In the case of the second length group, detritus again formed the most preferred food item contributing to 33.272% of the total diet followed by

Table 18

Average percentage composition of food items consumed by *E. suratensis* of different length groups in the culture pond from October 1986 to March 1987.

Food items	Length Groups			
	I (30-49 mm)	II (50-69 mm)	III (70-89 mm)	IV (90-120 mm)
Diatoms	32.212	28.037	33.143	37.156
Filamentous algae	24.674	29.424	24.127	32.471
Higher aquatic plants	-	-	-	-
Detritus	35.936	33.272	31.380	23.929
Rotifers	2.272	2.923	2.795	2.126
Copepods	1.354	2.341	2.556	1.704
Other Crustaceans	1.815	2.594	3.656	1.616
Gastropods	0.817	0.918	1.826	0.564
Insect larvae	0.916	0.484	0.531	0.449

filamentous algae (29.424%) and diatoms (28.037%). The other food items of minor importance were rotifers (2.923%), other crustaceans (2.594%), copepods (2.341%), gastropods (0.918%) and insect larvae (0.484%).

Diatoms were the major food item of the third length group contributing to 33.143% followed by detritus 31.380% and filamentous algae (24.127%). Other crustaceans (3.656%), rotifers (2.795%), copepods (2.556%), gastropods (1.826%) and insect larvae (0.531%) formed food items of minor importance.

In the case of fishes of the fourth length group, diatoms again constituted the major food item (37.156%), followed by the filamentous algae (32.471%) and detritus (23.929%). Other items of minor importance in the stomach contents were rotifers (2.126%), copepods (1.704%), other crustaceans (1.616%), gastropods (0.564%) and insect larvae (0.449%).

4.6.2 Preferred Food items of four different Length groups in Backwaters.

The important food items consumed by *E. suratensis* in the backwaters during the period of study were filamentous algae, higher aquatic plants, diatoms and detritus.

Data on various items in the stomach contents of *E. suratensis* of the first length group from the backwaters shows that diatoms were the dominant food item with a contribution of 50.193%. Filamentous algae (21.053%) formed the next dominant food item, followed by detritus (14.325%). Other crustaceans (6.711%) copepods (4.069%) and rotifers (3.283%) formed other food items of minor importance.

Filamentous algae provided 49.372% of total food, forming the major food item of the fishes belonging to the second length group. Diatoms (31.856%) were the next important item succeeded by detritus (8.872%). Higher aquatic plants

Table 19

Average percentage composition of food items consumed by E. suratensis of different length groups in the open backwaters from October 1986 to March 1987.

Food items	Length Groups			
	I (30-49 mm)	II (50-69 mm)	III (70-89 mm)	IV (90-120 mm)
Diatoms	50.193	31.856	8.231	21.695
Filamentous algae	21.053	49.372	42.339	28.461
Higher aquatic plants	-	6.927	34.862	31.105
Detritus	14.325	8.872	10.544	15.079
Rotifers	3.283	0.946	0.920	0.693
Copepods	4.069	0.711	1.028	1.874
Other Crustaceans	6.711	1.297	1.539	1.878
Gastropods	-	-	-	-
Insect larvae	-	-	0.542	0.333

Figs. 35 to 38 Average percentage composition of food items in the stomach contents of *E. suratensis* of length group I (Fig.35), length group II (Fig.36), length group III (Fig.37) and length group IV (Fig. 38) in the pond and backwaters during the study period (October 1986 to March 1987).

Denotation of the histogram:

diatoms - shaded, filamentous algae - oblique lines,
detritus - triangles; rotifers - vertical lines,
copepods - crosses, higher aquatic plants - broken lines,
other crustaceans - large dots, grastropods - squares,
insect larvae - small dots.

Plate X

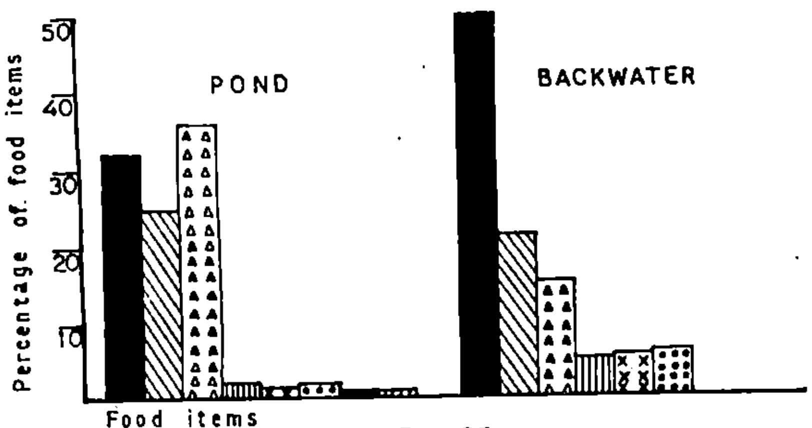

Fig. 35

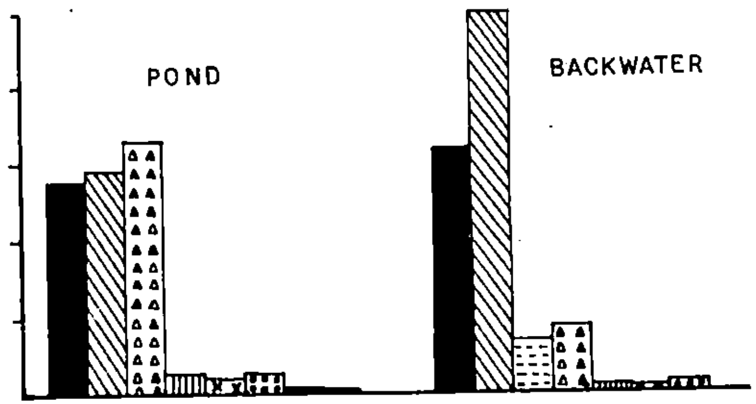

Fig. 36

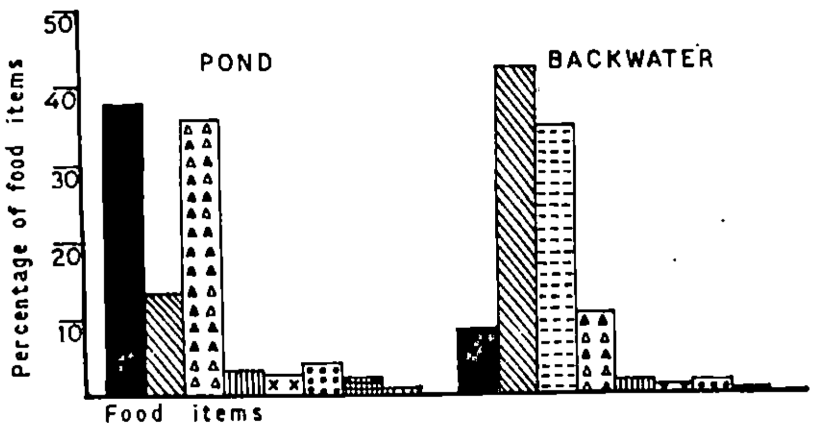

Fig. 37

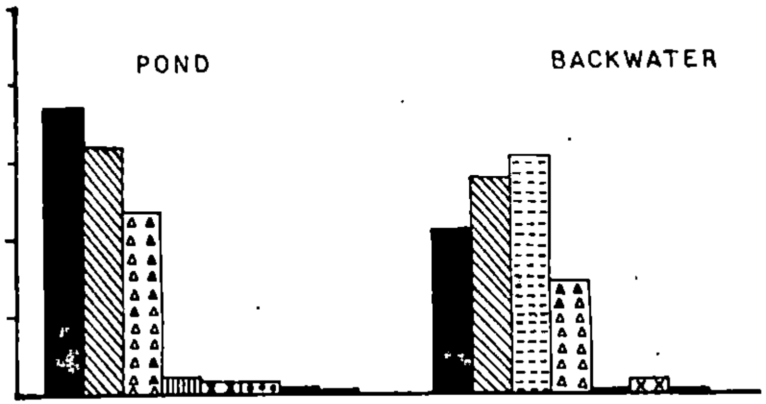

Fig. 38

formed 6.927% of the total stomach contents. Other crustaceans (1.297%), rotifers (0.946%) and copepods (0.711%) were the food items of minor importance.

Filamentous algae formed the most significant food item of the stomach contents (42.339%) of third length group. Higher aquatic plants formed next important food item with a contribution of 34.862%. Detritus (10.544%) and diatoms (8.231%) were the other notable food items. Items of minor importance were rotifers (0.920%), other crustaceans (1.539%), copepods (1.028%) and insect larvae (0.542%).

The predominant food item of E. suratensis belonging to the fourth length group was higher aquatic plants with contribution of 31.105% of the total stomach contents. Filamentous algae (28.461%) formed the next important food item, followed by diatoms (21.695%). Detritus contributed to 15.079% of the total food. Copepods (1.874%), other crustaceans (1.878%), rotifers (0.693%) and insect larvae (0.333%) were the other food items.

4.7 Selectivity Index

Selectivity index of different food items, which were observed in the stomach contents of the E. suratensis of four different length groups in the culture pond and backwaters during the first and last months of the study is given in Tables 20 to 23.

During October the selectivity index of diatoms in the culture pond for the first length group was -0.246, & that of second length group was -0.636. The corresponding values for the third and fourth length groups were -0.534 and -0.202 respectively. In the backwaters the selectivity indices of diatoms for the four different length groups in October were, +0.325, -0.313, -0.356 and +0.168

Table 20. Percentage occurrence of various food items in the stomach of E. suratensis (ri) and in the environment (pi) with, selectivity index (E) in the culture pond during October, 1986.

	Length groups											
	First length group (30-49 mm)			Second length group (50-69 mm)			Third length group (70-89 mm)			Fourth length group (90-120 mm)		
Food items	ri	pi	E	ri	pi	E	ri	pi	E	ri	pi	E
Diatoms	41.171	68.000	- 0.246	15.145	68.000	- 0.635	20.650	68.000	- 0.534	45.150	68.000	- 0.202
Filamentous algae	23.750	6.500	+ 0.570	36.000	6.500	+ 0.694	31.000	6.53	+ 0.653	17.800	6.500	+ 0.454
Higher aquatic plants	-	-	-	-	-	-	-	-	-	-	-	-
Detritus	31.565	-	+ 1	38.068	-	+ 1	34.040	-	+ 1	28.600	-	+ 1
Rotifers	-	5.000	- 1	3.408	5.000	- 0.189	4.417	5.000	- 0.062	2.800	5	- 0.282
Copepods and other crustaceans	4.117	20.500	0.666	5.675	20.500	- 0.566	5.609	20.500	- 0.570	3.8	20.5	- 0.687
Gastropods	-	-	-	1.704	-	+ 1	2.492	-	+ 1	1.900	-	+ 1
Insect larvae	-	-	-	-	-	-	1.792	-	+ 1	-	-	-

Table 21. Percentage occurrence of various food items in the stomach of E. suratensis and in the environment (pi) with selectivity index (E) in the backwaters during October, 1986.

	Length Groups											
	First length group (30-49 mm)			Second length group (50-69 mm)			Third length group (70-89 mm)			Fourth length group (90-120 mm)		
Food items	ri	pi	E	ri	pi	E	ri	pi	E	ri	pi	E
Diatoms	70.666	36.000	+0.325	18.850	36.000	- 0.313	17.100	36.000	- 0.356	50.493	36.000	+0.168
Filamentous algae	10.661	10.000	+0.032	67.957	10.000	+ 0.743	31.000	10.000	+ 0.512	9.788	10.000	-0.011
Higher aquatic plants	-	-	-	5.006	-	+ 1	29.360	-	+ 1	32.555	-	+1
Detritus	6.172	-	+ 1	5.654	-	+ 1	14.000	-	+ 1	5.840	-	+1
Rotifers	3.700	6.000	- 0.237	-	6.000	- 1	2.230	6.000	- 0.458	-	6.000	-1
Copepods and other crustaceans	7.800	48.000	- 0.720	2.533	48.000	- 0.900	3.099	48.000	- 0.880	1.322	48.000	-0.946
Gastropods	-	-	-	-	-	-	-	-	-	-	-	-
Insect larvae	-	-	-	-	-	-	3.200	-	+ 1	-	-	

Table 22. Percentage occurrence of various food items in the stomach of E. suratensis (ri) and in the environment (pi) with selectivity index (E) in the culture pond during March, 1986.

	Length groups											
	First length group (30-49 mm)			Second length group (50-69 mm)			Third length group (70-89 mm)			Four length group (90-120 mm)		
Food items	ri	pi	E	ri	pi	E	ri	pi	E	ri	pi	E
Diatoms	44.354	60.000	- 0.150	21.000	60.000	- 0.481	30.902	60.000	- 0.320	42.282	60.000	- 0.173
Filamentous algae	26.742	10.500	+ 0.436	52.941	10.500	+ 0.669	15.000	10.500	+ 0.176	29.276	10.500	+ 0.472
Higher aquatic plants	-	-	-	-	-	-	-	-	-	-	-	-
Detritus	22.889	-	+ 1	19.198	-	+ 1	43.950	-	+ 1	25.394	-	+ 1
Rotifers	2.345	9.500	- 0.604	2.176	9.500	- 0.627	2.395	9.500	- 0.597	1.746	9.500	- 0.689
Copepods and other crustaceans	2.345	20.00	- 0.790	3.508	20.000	- 0.702	4.147	20.000	- 0.657	1.382	20.000	- 0.871
Gastropods	-	-	-	-	-	-	2.208	-	+ 1	-	-	-
Insect larvae	1.345	-	+ 1	1.176	-	+ 1	1.395	-	+ 1	-	-	-

Table 23. Percentage occurrence of various food items in the stomach of E. suratensis (ri) and in the environment (pi) with selectively index (E) in the backwaters during March, 1987.

	Length groups											
	First length group (30-49 mm)			Second length group (50-69 mm)			Third length group (70-89 mm)			Fourth length group (90-120 mm)		
Food items	ri	pi	E	ri	pi	E	ri	pi	E	ri	pi	E
Diatoms	73.573	33.000	+ 0.381	30.909	33.000	- 0.333	6.147	33.000	-0.686	14.934	33.000	-0.377
Filamentous algae	7.207	6.500	+ 0.052	53.030	6.500	+ 0.782	68.032	6.500	+0.826	37.032	6.500	+0.701
Higher aquatic plants	-	-	-	6.969	-	+ 1	13.934	-	+1	36.147	-	+1
Detritus	7.516	-	+ 1	5.454	-	+ 1	9.000	-	+1	7.196	-	+1
Rotifers	-	9.000	- 1	0.909	9.000	- 0.812	1.654	9.000	-0.690	2.229	9.000	- 0.603
Copepods and other crustaceans	11.700	51.500	- 0.630	1.818	51.500	- 0.932	1.229	51.500	-0.953	2.458	51.500	- 0.909
Gastropods	-	-	-	-	-	-	-	-	-	-	-	-
Insect larvae	-	-	-	-	-	-	-	-	-	-	-	-

respectively. During March selectivity index of diatoms in the pond for the four length groups were -0.150, -0.482, -0.320 and -0.174 respectively, while the corresponding values in the backwaters were +0.381, -0. 33, -0.686 and -0.377.

Selectivity indices of filamentous algae in culture pond during October for the four different length groups were, +0.570, +0.694, +0.653 and +0.465 respectively. In the backwaters the corresponding values were +0.032, +0.743, +0.512 and +0.011. During March the selectivity indices of filamentous algae for four different length groups in the culture pond were +0.436, +0.669, +0.176 and +0.472. The corresponding values in the backwaters were +0.052, +0.782, +0.826 and +0.701.

The selectivity index of aquatic plants was +1 in backwaters for length groups II, III and IV. But in the fishes belonging to length group I, higher aquatic plants were neither observed in the stomach contents nor encountered in plankton sample. Higher aquatic plants were not observed in the stomach contents of any of the length groups from culture pond during both the months under study, since no aquatic plants were present in the culture pond.

As far as the detritus is concerned, the selectivity index was +1 for all the four length groups in both the environments during two months under study, since detritus was seen in the stomach contents, but was not observed in plankton samples.

Selectivity index of rotifers was maximum (-0.062) for fishes of length group III during October in culture pond, whereas it was minimum (-1) for the specimens of length group I. In the backwaters the minimum value of -1 was observed for the length groups II and IV and the maximum value of -0.237 was noted for the length group I. The highest selectivity index of rotifers was -0.597 for the length group III during March in the culture pond, whereas the minimum value was -0.690 for the length group IV. In the backwaters the corresponding values were -0.603 for the length group IV, and -1 for the length group I respectively.

In the case of copepods and other crustaceans, highest selectivity index observed was -0.566 for length group II in the culture pond during October, while the minimum was -0.687 for the length group IV. In the backwaters the corresponding values for copepods and other crustaceans were, -0.720 for the length group I and -0.946 for the length group IV. During March, the highest selectivity index of copepods and other crustaceans was -0.657 for the length group III and the lowest value was -0.871 for the length group IV in the culture pond, while in the backwaters highest and lowest values were -0.630 (length group I) and -0.953 (length group III) respectively.

The selectivity index of gastropods was +1 for length groups II, III & IV in culture pond during October, since gastropods were not observed in the plankton samples. But for the fishes of length group I, it was neither present in the stomach contents nor in the plankton samples. During March, the selectivity index of gastropods was +1 for length group III, but for the remaining three length groups it was not observed as a food item in the stomach contents. In the backwaters, gastropods were absent in the stomach contents of all the length groups during both the months under study. They were not encountered in the plankton samples too. Hence there seem to be no selectivity index for gastropods in backwaters.

So far as the insect larvae are concerned, their selectivity index was +1 for length group III alone in the culture pond during October. In the case of other length groups they were noted in the stomach contents. In the backwaters also, selectivity index was +1 for length group III alone whereas they were not observed in the stomach contents and plankton samples for all other three length groups. During March, the selectivity index of the insect larvae in the culture pond was +1 for length group I, II & III. While in the length group IV, they were absent from both the stomach contents and plankton samples. In the case of fishes from the backwaters, since no insect larvae were observed in either stomach contents or in the plankton samples during this month no selectivity index exists.

4.8 Results of Feeding Experiment

The growth increments, specific growth rate (as percentage wet body weight d^{-1}), percentage gain in body weight and food conversion factor of E. suratensis obtained in the feeding experiment are presented in Table 24.

The percentage of crude protein in the different sets of feeds were analysed and found as follows. For the feed I, containing groundnut oil cake and rice bran, the percentage of crude protein was 31.500%. For feed II, which contain 50% groundnut oil cake + rice bran mixture and 50% fresh Hydrilla verticillata, the crude protein was 24.550%. For the feed III, with fresh Hydrilla verticillata alone, the value of protein was 17.600%. In the case of feed IV, comprising of 50% groundnut oil cake + rice bran mixture and 50% fresh Enteromorpha intestinalis the percentage of crude protein was 23.300% and for the feed V, with fresh Enteromorpha intestinalis alone, the percentage of crude protein was 15.100%.

Out of the five different feeds given, the best conversion factor, specific growth rate and percentage gain in weight was obtained for feed V, where the fishes had grown from an initial average size of 103 mm/20.500 g to 106 mm/ 23.500 g, registering an average daily growth rate of 0.100 g. In this case, the specific growth rate obtained was 0.455 and percentage gain in body weight was 14.634. Food conversion factor obtained for this feed was 18.

For the feed IV, the fishes had grown from an initial average size of 103 mm/21.750 g to a final average size of 107 mm/24.125 g, within 30 days registering a monthly increment of 2.375 g and a daily increment of 0.079 g. Specific growth rate obtained with this feed was 0.345 and percentage gain in body weight was 10.920%. Conversion factor obtained was 24.

Fishes fed with the feed III had grown from an initial size of 93 mm/ 15.562 g to a final size of 107 mm/17.250 g, registering a monthly increment of 1.688 g and daily increment of 0.056 g. The specific growth rate obtained with this feed was 0.343, whereas the percentage gain in body weight was 10.847. The conversion factor obtained with this feed was 24.

With feed II, the fishes have grown from an average initial size of 109 mm/25.312 g to an average final size of 111 mm/26.812 g registering a daily growth rate of 0.050 g. The specific growth rate obtained with this feed was 0.192 and the percentage gain in body weight was 5.926%. The food conversion rate of this feed was 44.

A comparison of the growth increment, specific growth rate,and percentage gain in body weight of the fishes fed on the five feeds show that, it was least in the case of fishes fed with feed I. Here, the fishes have grown from an initial average size of 103 mm/21.375 g to 104 mm/22.376g and a corresponding daily increment of 0.033 g. Specific growth rate was 0.153 and percentage gain

Table 24. Details of the feeding experiment of *E. suratensis* with five different feeds

		Feed I	Feed II	Feed III	Feed IV	Feed V
1.	No. of days	30	30	30	30	30
2.	No. of fingerlings stocked	8	8	8	8	8
3.	Initial individual weight (Average g)	21.375	25.312	15.562	21.750	20.500
4.	No. of fish harvested	8	8	8	8	8
5.	Individual weight at harvest (Average g)	22.376	26.812	17.250	24.125	23.500
6.	Total weight at harvest (g)	179.000	214.496	138.000	193.000	188.000
7.	Weight increment per fish during the test (g)	1.00	1.50	1.688	2.375	3.000
8.	Daily individual growth increment (g)	0.033	0.05	0.056	0.079	0.100
9.	Amount of feed (g)	444.60	526.48	323.68	452.40	426.40
10.	Conversion factor	56	44	24	24	18
11.	Percentage gain in body weight	4.683	5.926	10.847	10.920	14.634
12.	Specific growth rate	0.153	0.192	0.343	0.345	0.455

in the body weight was 4. 683%. Food conversion factor for this feed was 56.

4.8.1 Statistical Analysis.

The efficiency of the five different feeds given were compared using analysis of variance technique, the results of which are presented in the Table 25 and 26

Considering the growth rate of individual fish and assuming that the smaller fish attained a lower weight and larger fish attained a higher weight, the specific growth rate values of individual fishes were estimated using the initial and final weight measurements. These values were compared using Analysis of variance technique, in order to find out the effect of various feeds given. The analysis showed significant variation between feeds (Table 26). Hence pair-wise comparison was also done, using the standard technique of least significant difference method. The critical difference at 5% level was obtained as 0.1011. On comparison of this value, with the mean specific growth values, feeds I and II showed no significant difference. Similarly, those between feeds III & IV, and IV & V and III & V were also not significant. But feed I showed significant difference with feeds III, IV and V. Similarly, feed II also showed significant difference with feeds III, IV and V. Hence the feeds can be grouped into two. First group of feed I & II and the second group comprising feeds III, IV and V. The growth rate obtained by feeds III, IV and V were comparatively higher than the growth rate obtained by feeds I & II.

-0-

Table 25. Specific growth rate obtained by individual fishes in the feeding experiment.

	Fishes							
	1	2	3	4	5	6	7	8
<u>Feeds:</u>								
I	0.133	0.073	0.073	0.080	0.170	0.243	0.243	0.243
II	0.310	0.230	0.393	0.230	0.106	0.220	0.106	0.053
III	0.253	0.170	0.253	0.326	0.606	0.416	0.480	0.466
IV	0.196	0.344	0.297	0.344	0.466	0.200	0.490	0.350
V	0.410	0.343	0.473	0.473	0.200	0.540	0.570	0.38

TABLE 26

ANOVA TABLE

Source of variation	Sum of squares	Degrees of freedom	Means sum of square	F. Ratio	Table value
Between Feeds	0.4070	4	0.10174	* 7.1958	2.714
Between Replication	0.0651	7	0.0093	1.520	3.23
Error	0.39592	28	0.01414		
Total	0.86802	39			

V. DISCUSSION

V. DISCUSSION

5.1 Ecological parameters of the Captive and Wild environments

The life activities of any aquatic animal are influenced by several biotic and abiotic factors prevailing in its surroundings. As a general rule, the distributional limit of an animal in any particular environment is determined by the degree of influence exerted by each of these factors, either singly or in combination with others. Further, food utilisation is also known to be affected by the water quality.

The parameters considered in the present study are the most important criteria in fish culture ponds, which exert direct bearing on the growth and food intake of cultivable fish. Hence analyses of these factors were found necessary in the present study to find their influence on the food intake of the fish.

5.1.1 Water Temperature.

Temperature has a pronounced effect on chemical and biological processes. Boyd (1982) reported that warm water fishes grow best at temperature between 25°C and 32°C. Philippart and Ruwet (1982) reported that cichlids especially Sarotherodon mossambicus, S. niloticus, S. aureus can tolerate a temperature range of 8°C to 42°C. Sumitra et al. (1981) in an experiment on culture of pearl spot in brackish water ponds at Goa have noted a temperature variation between 26.5°C and 33.0°C. In the present study, the temperature observed in the culture pond and backwaters fall well within the tolerance range of the cichlids and hence did not seem to affect the food intake of the fish in both the environments.

5.1.2 Water pH.

Swingle (1961) reported that acidic and alkaline death points for fishes are at pH 4 and 11 respectively. According to him if water is more acidic than pH 6.5 or more alkaline than pH 9.5 for long periods, reproduction and growth will diminish. Sumitra et al. (1981) reported a change of pH from 6.5 to 8 in brackish water culture ponds at Goa, where culture experiments of E. suratensis were conducted. The range of pH in the experimental ponds of the brackishwater fish farm at Vytilla in Kerala has been reported as between 5.5 and 9.3 (Mrithunjayan et al., 1987). Hora and Pillay (1962) reported that feebly alkaline pH of 7.8 is characteristic of good water suitable for the fish culture. Reite et al. (1974) have shown experimentally that cichlids especially S. aureus can withstand a pH range of 5 to 11. In the present study a drop in pH to 6 was noted in the culture pond during November. But it was corrected by adding lime at the rate of 500 kg/ha and thereafter pH remained steady, till the end of the study. In the backwaters the range of pH was between 7.5 and 9 which falls within the tolerance limit of cichlids.

5.1.3 Water Salinity.

The osmotic pressue of solutions increases with increase in salinity. Fish species differ in their osmotic pressure requirements. So the optimum salinity for fish culture differs to some extent with species. Whitefield and Blaber (1979) have reported that T. zilli and S. mossambicus can adapt to a wide range of salinity from 0.16 to 44 ppt in the former and 0 to 120 ppt in the latter. In the present investigation, the salinity ranged from 3.5 ppt in October to 19.5 ppt in February in culture pond, while in the backwaters, it was between 5.3 ppt in October and 31.5 in February. The fishes did not seem to be affected by this variation.

5.1.4 Total Alkalinity.

Water with total alkalinity of 20-150 ppm contain suitable quantities of carbondioxide to permit the plankton production for fish culture (Boyd 1982). In the fertilized fish ponds the total alkalinity values were in the range of 20-120 ppm, which did not affect fish production (Boyd and Walley, 1975). Therefore it is desirable to have alkalinity values above 20 ppm in fertilized ponds. The total alkalinity in the brackish water culture ponds at Vytilla as reported by Jose et al, (1988) ranged from 45 to 240 ppm. In the present study the range of total alkalinity in the culture pond was between 35.3 and 65.0 ppm, whereas in the backwaters it ranged from 45.3 to 103.7 ppm. These alkalinity values seem suitable for normal life activities of the fishes.

5.1.5 Dissolved Oxygen.

The solubility of oxygen in water depends mainly on temperature and pressure. The rates of respiration (oxygen consumption) by fish varies with species, size, temperature, activity, nutritional status and other factors. Swingle (1969) has made a practical assessment of the dissolved oxygen requirements of warm water fishes. According to him if dissolved oxygen is below 1 ppm for more than few hours the cultured fishes die. If dissolved oxygen content of water is between 1 and 5 ppm, fishes may survive but their reproduction slows down and growth is retarded on continuous exposure. If dissolved oxygen content is more than 5 ppm fishes reproduce and grow normally. Mechanik (1957) noticed a direct relation between low oxygen level of water and poor protein digestability. Any reduction in dissolved oxygen even to 50 percent air saturation value can depress food consumption and growth rate of fish. Sumitra et al. (1981) in their experiments on culture of pearl spot in the brackish water culture pond in Goa, observed a variation in dissolved oxygen from 1.54 ml/litre to 9.44 ml/litre, while the range of dissolved oxygen in the experimental ponds at Vyttila was from 3.5 ppm to supersaturation (Mrithunjayan et al. 1987). In the present study, the dissolved oxygen content of pond and backwaters was above 4.00 ppm throughout the period of study. It ranged from 4 to 8 ppm in culture pond and 6.4 to 11.2 ppm in backwaters and hence it did not seem to affect the life activities of the fishes.

5.1.6 Phytoplankton Primary Production.

Investigations on the primary production related to fish production in open waters in India are well documented. But similar studies in culture ponds are scanty. Quasim et al. (1969), Quasim (1973 & 1979) and Gopinathan et al. (1984) observed that in Cochin backwaters the gross primary production ranged from 0.35 to 1.50 gC/m^2/day. Sumitra et al. (1981) have stated that, the primary production in brackishwater ponds in Goa, where experiments on culture of pearl spot were conducted, ranged from 104 mgC/m^3/day to 8823 mgC/m^3/day. Jose et al. (1988) have recorded a range of primary production values from 1.1 to 8.1 gC/m^3/day in the brackish water culture ponds at Vytilla. In the present study, the gross primary production values of backwaters as well as culture pond were higher than the previously reported values. Thus in the culture ponds the gross primary production ranged from 720 mgC/m^3/6hrs to 4440 mgC/m^3/6hrs, while in the backwaters it was between 1200 mgC/m^3/6hrs and 4680 mgC/m^3/6hrs.

5.1.7 Zooplankton.

Fifteen major zooplankton groups have been recorded from the Cochin backwaters (Pillai et al., 1973). Jose et al. (1988) have reported that in the brackish water culture ponds at Vytilla, the important groups of zooplankton were limited to copepods, cladocerans, rotifers, ostracods, mysidaceae & polychaetes. Madhupratap and Haridas (1977) observed a close association between salinity changes in the environment and zooplankton composition. In the present study the important zooplanktonic groups in the culture pond were copepods, rotifers, crustacean nauplii, caldocerans etc, while in the backwaters, the important groups were copepods, rotifers, crustacean nauplii, cladocerans, fish eggs and fish larvae. In the culture pond under study, because of the effect of manuring, the abundance of zooplankton population was showing a regular pattern throughout the period of study, the range being 204 No/l and 557 No/l. The addition of fertilizers and manures may serve to increase the fertility of the culture pond, thereby leading to increased plankton production (Boyd 1982). In the backwaters, change in plankton quantity and composition were noted throughout the period of study. Thus a maximum abundance of zooplankton was noted during January, when the salinity was 23.0 ppt. The abundance of copepods increased with the rise in salinity. The rotifers also were found in good numbers during the high saline period. The occurrence of crustacean nauplii and the cladocerans was more or less uniform throughout the period of study. Fish eggs and larvae also were distributed in small numbers throughout the period of study.

5.1.8 Zoobenthos.

According to Jhingran (1975), the important groups of the macrobenthic fauna in brackish water ponds of Sundarbans are molluscs, polychaete worms and smaller crustaceans like copepods, amphipods, isopods, tanaids etc. According to Kurian et al. (1975), the quantity and quality of benthic organisms are dependent upon the prevailing salinity, temperature, and nature of substratum. He has reported that the bottom fauna of the Cochin backwaters are composed mainly of polychaetes and molluscs. Benthic organisms found in the brackish water ponds at Vytilla, are represented by polychaetes, amphipods, tanaids, insect larvae, bivalves and gastropods (Jose et al., 1988). In the present study, the important groups of zoobenthic organisms were amphipods, polychaetes, chironomids, tanaids etc, both in culture pond and backwaters. The gastropod Melania sp. was found in fairly good numbers during October and January in the culture pond. The effect of manuring in the culture pond seemed to influence the abundance of benthic organisms also. Thus their values ranged from 14.000 g/m^2 to 46.689 g/m^2 in culture pond while the corresponding values in the backwaters were between 10.096 g/m^2 and 18.208 g/m^2.

5.2 Food and feeding habits of E. suratensis in Captive and Wild environments

The observations in the present study reveal several interesting aspects in the feeding habits of E. suratensis of different length groups in captive environment of a culture pond and in wild environment of the open backwaters.

5.2.1 Feeding Intensity.

In the present study maximum feeding intensity was observed for specimens of fourth length group (90-120 mm), both in the culture pond and open backwaters. Jayaprakas (1981), while studying the feeding habits of _E. suratensis_ of different size groups from Veli lake, has reported that maximum feeding intensity was shown by the specimens in the length group of 105-140 mm, which corresponds to the fourth length group in the present study. According to him, feeding intensity is maximum in fishes which are about to attain sexual maturity. Prasadam (1971) also, has suggested that adults of _E. suratensis_ were more actively feeding than juveniles. Similarly in _Gasterosteus aculeatus_ maximum feeding intensity was noted for the specimens about to attain maturity (Hynes 1950). The maximum feeding intensity of maturing fishes may be due to the increased requirements of the biochemical constituents needed for gonad development.

Devaraj _et al._ (1975) in their studies on the food and feeding habits of _E. suratensis_ from fresh water tanks and the estuaries in Mangalore have reported, that the intensity of feeding was higher in juveniles of _E. suratensis_ in estuarine environments than in fresh water tanks. They have also reported that, in estuarine environment feeding intensity was higher in juveniles, whereas the feeding intensity appeared to be somewhat similar in all the length groups of fishes collected from the fresh water tanks.

In the present study also, the feeding intensity of the species was higher in backwaters than for the fishes collected from the culture ponds. The higher feeding intensity of _E. suratensis_ in backwaters in the present study may be due to the availability of the preferred food items in this environment.

5.2.2 Variation in the gut length of different length groups in two environments.

Relative lengths of gut for different fishes with diverse feeding habits have been estimated by Das and Srivasthava (1979). They have reported that, there is an increase in RLG for herbivorous fishes from early larval stages to adult. Thus they have observed an increase in the RLG of Cirrhinus reba from 3.06 to 8.94 as it grows from fingerling to adult. Similarly in Cirrhinus mrigala, RLG increased from 6.05 to 11.6, from fingerling to juvenile stage.

Quantitative data for Tilapia rendelli, Sarotherodon melanothera and S. mossambicus, show that ratio of intestinal length to fish standard length is between 7:1 and 10:1 (Caulton, 1976; Pauly, 1976). In the present study RLG of E. suratensis was found to increase from fry to adult in both the environments. This indicates, that the species gradually turns to vegetative feeding habit from the omnivorous habit in the earlier stages. In the culture pond also, the morphology of the gut seem to be adapted for herbivorous feeding habit in adult stages, since it was seen to increase from 2.911 in first length group to 4.420 in the fourth length group. In the backwaters RLG increased from 3.011 in the first length group to 4.535 in the fourth length group.

De Silva and Perera (1983) have reported that m.r.i.l. (mean relative intestinal length) of E. suratensis was less than that of a typical herbivorous fish and varies between 1.6:1 to 3.7:1. In 1984, De Silva et al. reported that the mean relative intestinal length of E. suratensis is higher in fresh water reservoir, where it is primarily adapted to feed on macrophytes than that in euryhaline lagoon where its food was mainly molluscs. In the present study, the RLG of the adult E. suratensis was slightly higher in the backwaters, where it was found to be feeding on macrophytes, while the corresponding value in the culture pond is lesser where it feeds predominantly on detritus and diatoms. Jayaprakas et al. (1979) have reported that the general layout of the alimentary canal as evidenced by RLG for E. maculatus is 2.2 which clearly confirms to that of omnivorous fishes (Al Hussaini, 1947). According to Al Hussaini (1949), the length of intestine for omnivorous fishes varies from 0.7 to 4 times the length of animal. In the present study, it can be seen that E. suratensis has an omnivorous feeding habit during the early stages coming under first to third length groups in the culture pond, where the RLG increased from 2.911 to 3.850. In fourth length group RLG was 4.420. In the fishes collected from backwaters, the RLG was below 4 in first two length groups, while in the remaining two length groups it was above 4. Hence it can be assumed that E. suratensis in its matural habitat is more inclined to a herbivorous diet from 70 mm size onwards.

5.2.3 Food Variations in different Length groups.

Food and feeding habits of E. suratensis have been studied by several previous workers (Raj, 1939; Bhaskaran, 1946; Job et al., 1947; Alikunhi, 1957; Hora and Pillay, 1962; Jhingran and Natarajan, 1969; Prasadam, 1971; Devaraj et al., 1975; Varghese, 1975; Jayaprakas, 1980; Costa, 1983; Desilva et al., 1984).

Feeding habits of the species during different stages of its life cycle have also been discussed by some workers (Alikunhi, 1957; Hora and Pillay, 1962; Prasadam, 1971; Jayaprakas, 1980).

The results of the present study indicate that there is variation in feeding habits during different stages of life cycle of E. suratensis, and the observations agree in certain aspects with those of the previous workers, while show variations in certain others.

Alikunhi (1957), while discussing the feeding habits of E. suratensis during different stages in the life cycle has reported that larvae feed mainly on zooplankton but switch over to filamentous algae (Spirogyra) and vegetable matter from 19 mm size onwards. Prasadam (1971), in his studies on the biology of the pearl spot from Pulicat lake has reported that there is difference in food habits between the smaller and larger length groups. He found that smaller size groups predominantly feed on microvegetation while the larger groups mostly feed on the macrophytes and other hard items. Jayaprakas (1980) has studied the feeding habits of the species of four different length groups in Veli lake and found that there is a distinct change in preference from diatoms and zooplankton in the earlier stages, to filamentous algae in the juveniles to higher aquatic plants in the adults. Hora and Pillay (1962) have reported tht adults of E. suratensis mainly feed on blue green algae and decaying organic matter. They have reported that besides vegetable matter, this species also takes zooplanktonic organisms such as copepods, daphnids, other crustaceans, insect larvae and worms. In Chilka lake, it has been found to feed on weeds, algae, detritus, gastropods and other miscellaneous items like bivalves, insects, mysids etc. (Jhingran and Natarajan, 1969). In the present study, mysids and worms were absent from both environments, while the aquatic macrophytes were absent in the culture pond and hence they were not found in the stomach contents of specimens collected from the culture pond.

Varghese (1975) has reported that the species is omnivorous with no change in food items among the different stages. Sumithra et al. (1981) while studying the caloric value of ingested food of E. suratensis grown in culture pond, have observed no change in the feeding habits of the species during the different stages and reported that the species is principally a phytoplankton - detritus feeder. The observations made by Varghese (1975) and Sumithra et al. (1981), indicating an omnivorous feeding habit for the species with no change in the food selection during the different stages may be due to the fact, that they may have made observations in enclosed environments, where there is no scope for wide food selection. In the present study also, the specimens from culture pond showed more or less omnivorous diet with minimum variations in food selection during the different stages, and detritus diatoms and filamentous algae formed the major food items.

Detritus which formed an important food of pond reared E. suratensis has been reported to play a significant role in the diet of certain freshwater cichlids according to Bowen (1981). Devaraj et al. (1975) in a comparative study of the food of juveniles of E. suratensis collected from estuarine and freshwaters of Mangalore, have observed that detritus formed a significant portion of the stomach contents of fishes collected from both estuarine and freshwater environments. It has been pointed out by Halver (1972), that when plant material and other food are lacking, tilapias will eat bottom detritus, muck and decaying vegetation.

E. suratensis which has been reported to be predominantly macrophytic feeder in adult stage proves to be so in the open backwaters as per the data obtained in the present study. The main species of aquatic macrophytes in the present study were Enteromorpha sp., Najas sp., Ceratophyllum sp. etc, while Hydrilla, Elodea, Chara etc were reported to be present in the stomach contents of E. suratensis from the Veli lake (Jayaprakas, 1981). Hora and Pillay (1962) reported the presence of Blyxa and Utricularia in the gut contents of the fishes from Chilka lake.

De Silva et al. (1984) reported that the dentition and the position of mouth of E. suratensis shows mixed characteristics. The frontal incisiform sharp teeth are similar to those found in cichlid fishes such as Tilapia rendelli, T. zilli and Haplochromis similis, that feed on higher aquatic plants (Fryer and Iles, 1972).

5.2.4 Feeding habits in different environments.

Comparative studies of food habits of E. suratensis in different environments are few in number. (Devaraj et al., 1975; Costa, 1983; De Silva et al., 1984). Many of the previous studies in feeding habits were done in their natural habitat either in freshwater or in brackish water. Devaraj et al. (1975) in a comparative study of the juveniles of E. suratensis from estuarine environment and freshwater tanks of Mangalore, have reported that the filamentous algae and detritus formed the dominant food items in the stomach contents of fishes from estuarine waters, while insect larvae and detritus were found as dominant food items in the stomach contents of fishes collected from freshwater tanks. De Silva et al. (1984), who studied the food and feeding habits of E. suratensis from euryhaline Koggala lagoon and a freshwater reservoir in Sri Lanka have found that, in freshwater reservoir macrophytes formed the major food item in the gut.

In 1975, Bruton and Bolt have reported that in Lake Sibaya, South Africa, S. mossambicus adults captured in the marginal vegetation zones feed on diatoms, vegetable debris and mud. But those captured in open waters of limnetic zone feed on aerial insects (Coleoptera and Hemiptera). The adults of African cichlids of the genus Tilapia especially T. rendelli, T. zilli, T. sparrmani and T. tholloni which feed preferentially on the filamentous algae, aquatic macrophytes and vegetable matter of terrestrial origin (leaves and plants etc), take animal food and blue green algae in waters with poor aquatic vegetation. It has been reported by Phillipart and Rwet (1982), that within a given water body the feeding regime of the species is extremely variable depending upon the size and the microhabitats occupied by the fish and time of the year.

The food items in closed brackishwater culture pond are relatively constant due to the limited interaction with the open backwaters. The organisms in a culture pond were less diverse where a steady rise and decline of these occur due to the effect of manuring (Jose et al. 1988). This may be the reason for finding little difference in the food selection in the various length groups in brackish water culture pond.

In the backwaters there seems to be clear cut demarkation in the selection of food items. Thus, fishes of the first length group were seem to prefer filamentous algae and diatoms, for individuals of the second length group the preference were for filamentous algae, diatoms and detritus. The prefered diet of fishes of third length group was filamentous algae and higher aquatic plants. Finally in the fourth length group, marked preference for macrophytes followed by filamentous algae was noticeable.

The gastropod (Melania sp), found in the stomach contents of the pond reared fishes was one item that was not observed in fishes from backwaters. De Silva et al. (1984), has pointed out that pharyngeal teeth of E. suratensis are similar to those found in the cichlids Haplochromis placodon which is a typical mollusc eater. According to Barnes (1980), the dentition of E. suratensis is suited for exploitation of the food resources generally abundant in the typical coastal lagoon.

5.2.5 Selectivity Index.

Selectivity index of different food items by Tilapia mossambica in three different habitats were estimated by Aravindan (1980). According to his observations, the African cichlid T. mossambica which has well established in the different fresh and brackish water environments in Kerala, is found to be selective in its feeding habits in different environments of a temple tank, a river and a brackish water lake. Thus in the temple tank, eventhough filamentous algae, unicellular algae, copepods and detritus were abundant, the fish showed marked preference for aquatic plant materials while in river, though unicellular algae were available in fair amounts, the fish showed a noticeable preference for the filamentous algae. In the brackish water lake the fish was found to eat plankton supplemented with fish eggs and larvae and mysids. De Silva et al. (1984) found relatively high proportion of detritus in the diet of E. suratensis in the reservoirs, while complete absence of detritus in those from the coastal lagoon, and according to him this may be indicative of the selective feeding on detritus.

The results of the present study in the two environments show that in the pond, little selectivity was seen between different length groups of E. suratensis. Thus during October, when the plankton sample from culture pond contained mainly diatoms, copepods and other crustaceans, filamentous algae rotifers etc, the main items observed in the stomach contents of the fishes belonging to the four length group were, detritus, diatoms, filamentous algae etc with slight variations in their preference among the different length groups. The corresponding food selectivity of fishes collected from the backwaters were much wider and hence selectivity during different stages were obvious. The main groups of plankton encountered in the open backwaters were copepods and other crustaceans, diatoms filamentous algae, rotifers etc. The stomach contents of fishes belonging to first two length groups contained diatoms, filamentous algae, detritus etc. But from the second length group onwards presence of aquatic macrophytes were also observed in the stomach contents. Fishes of the third and fourth length groups were found to feed mainly on filamentous algae, higher aquatic plants, diatoms etc. During March also, the groups of planktonic organisms in the culture pond remained the same, though their numerical abundance changed. During this month, the main items observed in the stomach contents of pond reared fishes belonging to the four length groups were detritus, filamentous algae, diatoms etc. But for the fishes collected from the backwaters, the selectivity was more marked during different stages. The important groups of plankton during this month from the backwaters were copepods and other crustaceans, diatoms and rotifers. But the main food items observed in the stomach contents of fishes of the first length group were diatoms, copepods & other crustaceans and detritus. Filamentous algae, diatoms and higher aquatic plants were the major food items in the stomach contents of fishes of the second length group. In the case of the fishes of the third length group, the main food items were filamentous algae, higher aquatic plants and detritus and of the fourth length group the major constituents of stomach contents were filamentous algae, higher aquatic plants and diatoms.

5.3 Feeding Experiment

The quality and quantity of food can affect the growth rate of the cultured fishes to a considerable extent. (Gerking, 1955; Warren and Davis, 1967). But the feed should be acceptable to the fish or else it will act indirectly as a fertilizer and may serve to increase the natural productivity of the pond, which in turn may be utilised by the fish (Halver; 1972). The importance of incorporating natural food items in artificial feed has been well illustrated by Yashouv and Ben Schachar (1967) in experiments conducted with Mugil capito in Israel, where a percentage increase of body weight of 115.50 was observed with plankton feed alone, 127.0 with pellets alone composed of wheat, fish meal, soya flour containing 21% protein, and 183 with pellets and plankton feed together. The natural pond productivity alone has been used for feeding young tilapias from larval stages to fingerlings. Three types of feeds have been used; higher aquatic plants such as Lemna minor (duck weed), phytoplankton especially chlorella zooplankton mainly Daphnia (Moreau et al., 1986). The inclusion of higher aquatic plants in the diets of fishes which are herbivorous in the adult have been suggested by Huet 1960; Halver, 1972; Gaigher, 1984; Edwards et al. 1985. Huet (1960) has pointed out that chopped grasses, water plants, algae, papaw, banana leaves, mill scrappings, bran, broken rice grain and oil cakes can be used for feeding tilapias.

The feeds usually given to cultivated fishes in India include various cereal bran like rice bran and wheat bran and oil cakes of ground nut, mustard, coconut etc. (Alikunhi, 1957; Sinha, 1981). The important published literature on the use of supplementary feed for E. suratensis both in laboratory and field conditions are those of Jayaprakas (1980), Sumitra et al. (1978), Krishnakumari et al. (1979), Anon (1981), De Silva and Perera (1983) etc.

In the present study pelletised conventional feed containing 31.500% crude protein, Hydrilla verticillata and conventional feed containing 24.600% crude protein, Hydrilla verticillata containing 17.600% crude protein Enteromorpha intestinalis and conventional feed with 23.35% crude protein and Enteromorpha intestinalis containing 15.100% crude protein were used for feeding E. suratensis. Among these feeds, maximum specific growth rate (expressed as percentage wet body weight d^{-1}) of 0.455 with percentage gain in body weight of 14.634%, and a monthly increment in weight of 3.000 g was observed for fishes fed on Enteromorpha intesinalis alone. The minimum values for these factors were observed for the fishes fed on conventional feed. In this case, the specific growth rate was 0.153 the percentage gain in body weight was 4.683% and monthly increment was 1.00 g.

Sumitra et al. (1982) reported a high specific growth rate for the species when fed on feed containing 53.62% protein. Haripradadas (1976), reported good growth rate in fingerlings of grey mullet Mugil cephalus when fed with groundnut oil cake mixed with rice bran. But in the present study, highest specific growth rate (0.455), was obtained for Enteromorpha intestinalis containing 15.100% crude protein, while the lowest specific growth rate of 0.153 was obtained for the fishes fed on the feed containing rice bran and groundnut oil cake.

Jayaprakas (1980) conducted feeding experiments of E. suratensis with four different feeds. He has reported, that the feed incorporating rice bran, groundnut oil cake, tapioca flour Eichhornea and clam meal was found to be most efficacious feed. When the fishes were fed with this feed, it gave a percentage gain in the body weight of 101.6%, and survival of 100% for 60 days experiment. In the present study, where the duration of the experiment was 30 days survival was 100% with all the five feeds but percentage gain in body weight was only 14.634 obtained for the fishes fed with Enteromorpha intestinalis alone. The minimum value (4.683%) was noted for the fishes fed on groundnut oil cake and rice bran.

Sumitra et al. (1981), obtained a monthly increment of 2.25 mm and 0.98 g for E. suratensis when fed on groundnut oil cake and wheat bran with 35% protein level. Jayaprakas (1980), obtained a monthly increment of 4.36 g in his feeding experiments of E. suratensis with the feed incorporating rice bran, groundnut oil cake, tapioca flour, Eichhornia and clam meal. Thampy et al. (1987) have conducted a series of experiments with E. suratensis in brackish water culture ponds at Vytilla with a view to increase the growth rate and production of the species. In one set of experiment, where supplementary feeding with rice bran and groundnut oil cake was provided at the rate of 5% of the body weight, monthly increment of 7.78 g was obtained while the corresponding value for the fishes without supplementary feed was 5.80 g. The comparatively better growth rate in culture ponds may be due to an indirect effect of the feed than its actual consumption by the fishes. The feeds rich in groundnut oil cake, rice bran and tapioca flour acted as manure in the natural systems thereby promoting algal and zooplankton growth which in turn are consumed by the fishes. In the present feeding experiment, the fishes were entirely dependant on the supplementary feed, and left over food since it was removed on the next morning itself, could not act as a fertilizer in the experimental cisterns. Among the five feeds used a maximum monthly increment of 3.00 g was obtained by feeding with Enteromorpha intestinalis alone.

The conversion efficiency of E. suratensis has been worked out by Sumitra et al. (1978) in their feeding experiments of E. suratensis using different levels of protein diets and they have concluded that maximum conversion efficiency was obtained at 60-80% protein level. Krishnakumari et al. (1979) in a laboratory experiment on the food conversion efficiency of the species has suggested that with the test diets they used the conversion efficiency was very low compared to the reported values for other fishes (Kevern, 1966; Pandian, 1967a & b; De Silva and Balfontin, 1974; Mathavan, et al., 1978). The test diets were, group I containing silkworm pupae, rice bran and tapioca flour, group II, containing groundnut oil cake, rice bran and tapioca flour, and group III, containing groundnut oil cake, rice bran, cowdung and tapioca flour.

Although E. suratensis is reported as a herbivore, feeding experiments incorporating aquatic weeds were done only by few workers. Jayaprakas (1980) conducted feeding experiments of E. suratensis and stated that feed incorporating Eichhornia, along with groundnut oil cake, rice bran, tapioca flour and clam meal was found to be most efficacious feed. Digestability of aquatic macrophyte Hydrilla by E. suratensis was reported by De Silva and Perera (1983). They have reported that the total digestability varied between 34.60% and 51.90%. Daily variation in protein digestability ranged from 51.20% to 81.80%.

The incorporation of vegetative matter in the feed of other species has been done by a number of workers. Aquatic macrophytes have been used as feed for Tilapia zilli by Buddington (1979). Singh (1970), has found that freshwater algae Oedogonium sp is a nutritive source for Cirrhinus mrigala. Cruz and Laudencia (1978) reported better growth of tilapia on feed supplemented with mulbery leaf meal. Pompa (1978) has reported an average daily growth rate of 0.55 g and a food conversion ratio of 10-13 when T. rendelli cultured in cages were fed on the leaves of Alocasia macrorhiza and ipil ipil leaf (24.5% dry weight of protein) in combination with wheat bran or rice bran. In the Philippines, Pantastico and Baldia (1980) have used a feed combining 20% ipil ipil leaf meal (Leucaena leucocephala, Leguminoseae), 20% fish meal, and 60% rice bran for S. mossambicus in cage culture. The feed contained 27.3% dry weight of protein and gave a food conversion ratio of 1:4.0. Gaigher et al. (1984) who have conducted feeding experiments of hybrid Oreochromis niloticus X O. aureus, with duck weed Lemna gibba and commercial pellets, have reported that when fed on duckweed alone, intake rate was low, feed conversion ratio good (1:1) and relative growth rate poor. When the fishes were fed on pellets in addition to duckweed, the rate of duck weed consumption decreased and growth rate of fishes doubled with feed conversion ratio between 1.20 and 1.80. The growth performance of the fish for both the diets were similar. Caulton (1978) conducted feeding experiments of T. rendelli with the aquatic plant Ceratophylum demersum and reported that an assimilation efficiency ranging from 47.8% to 58.7% may be regarded as being very good for the primary macrophagous herbivores. This efficient utilisation of food can be attributed largely to successful trituration and efficient pre-assimilatory processing of food (Caulton, 1976).

Edwards et al. (1985), described incorporation of composted dried water hyacinth in pelleted feeds for tilapia, Oreochromis niloticus. According to them, good growth and feeding efficiency was obtained with diets containing up to 75% composted water hyacinth, with no significant reduction in fish performance compared to the control diet. Further, composted water hyacinth was found to be better than dried water hyacinth.

Venugopal (1980) has reported the possibility of incorporating the leaf powder of Colocasia esculenta in supplementary feeds of Indian major carps. Devaraj et al. (1981), have evaluated the utilisation of duck weed and waste cabbage leaves in the formulation of fish feed. The relative efficiency of aquatic weeds such as Hydrilla, Vallisneria and Najas by Ctenopharyngodon idella was worked out by Alikunhi et al. (1971). They have reported a monthly growth rate of 3.75 g for grass carp and the conversion factor for the various aquatic weeds were found to be 1:20-29 for Vallisneria, 1:10 to 1:22 for Najas and 1:11-1:26 for Hydrilla.

In the present study, two common aquatic weeds viz., Enteromorpha intestinalis and Hydrilla verticillata were selected for feeding trials and the conversion ratio (not corrected for the unconsumed food) for these were 1:18 for Enteromorpha intestinalis, 1:24 for Hydrilla verticillata whereas in the mixed diets with Enteromorpha intestinalis and conventional feed the conversion ratio was found to be 1:24 and with Hydrilla verticillata and conventional feed was of the order of 1:44 The conversion ratio for conventional feed was 1:56. The fishes seemed to relish fresh Enteromorpha and consumed it completely; whereas in the case of fresh Hydrilla, only the leaves were eaten, while the harder stem parts were not taken.

-0-

VI. SUMMARY

VI SUMMARY

The growth and production of E. suratensis in brackish water culture ponds remain low even with intensive management practices. The poor rate of growth of the species in the captivity may be attributed to the non-availability of preferred food items in this environment and hence an attempt has been made in the present study to evaluate the food selectivity and feeding habits of the species in the captive environment of a culture pond and in the wild from the Cochin backwaters. A feeding experiment of E. suratensis was conducted to formulate a suitable supplementary feed for the species by incorporation of some of its natural food items.

The present study was done from October 1986 to March 1987. Salient ecological parameters viz; temperature, pH, salinity, alkalinity, dissolved oxygen, phytoplankton primary production, zooplankton and zoobenthos of the culture pond and the backwaters were analysed at monthly intervals. E. suratensis of four different length groups viz; (1) fry (30-40 mm)-first length group, (2) fingerlings (50-69 mm)-second length group, (3) subadults (70-89 mm)-third length group, (4) adults (90-120 mm)-fourth length group, were stocked in a culture pond in the College of Fisheries Farm, after preliminary preparations and manuring. From the end of first month onwards, six specimens each, of four different length groups were collected from the culture pond, as well as from the backwaters. Each month the number that were removed from culture pond were restocked with the same number of specimens of the various length groups. The feeding intensity of the species in the captive and wild environments, relative length of gut during different stages, food items consumed by different length groups, in the culture pond and in backwaters and selectivity index of the various food items were studied in detail.

A feeding experiment with fingerlings of E. suratensis was conducted with five different feeds in duplicate. The feeds were (1) conventional feed made of groundnut oil cake and rice bran (1:1) having 31.5% crude protein, (II) 50% conventional feed + 50% fresh Hydrilla verticillata having 24.55% crude protein, (III) Fresh Hydrilla verticillata alone having 17.60% crude protein, (IV) 50% conventional feed + 50% fresh Enteromorpha intestinalis having 23.30% crude protein (V) Fresh Enteromorpha intestinalis alone having 15.10% crude protein. The experiment was conducted in cement cisterns of 500 litres capacity filled with 375 litres of pond water of 5 ppt salinity. 50 litre of water from each cistern was exchanged daily. Four numbers of fingerlings of E. suratensis were introduced into each cistern and daily feeding was done at the rate of 10% of their body weight with each of the feeds in duplicate.

Analysis of physico-chemical parameters of culture pond and backwaters show, that their range was tolerable for the normal life activities of fishes and did not seem to affect the food intake of the species. Numerical abundance of zooplankton and net weight of zoobenthos were showing more or less regular pattern in the culture pond while in the backwaters their abundance showed wide variations during each month of study period.

The feeding intensity of E. suratensis were found to increase from first length group to fourth length group in both the environments. Thus, in the culture pond, percentage of empty stomachs were found to decrease from 25% in the first length group to 19.44% in the fourth length group, while the percentage of heavy stomach increased from 5.55% in first length group to 25%

in the fourth length group. In the backwaters the percentage of empty stomachs in the first and fourth length groups were 8.33% and 5.55% respectively; whereas the percentage of heavy stomachs in these two length groups were 27.77% and 36.11%, respectively. The feeding indices of four different length groups in the brackish water culture pond were 13.89, 19.45, 33.33 and 44.44, while the corresponding values in the backwaters were 55.55, 66.67, 72.22 and 77.78. Hence it is seen that the feeding intensity of E. suratensis is higher in the backwaters than in the culture pond. Among the different length groups the feeding intensity seems to increase from first to fourth length groups in both the environments.

The RLG of E. suratensis from first to the fourth length group in the culture pond were, 2.911, 3.111, 3.850 and 4.420 while the corresponding values for the fishes from the backwaters were 3.011, 3.331, 4.010 and 4.535. Thus both in culture pond and in the backwaters, there seems to be an increasing trend in the RLG from first to fourth length group, indicating a herbivorous diet in the subadult and adult stages. A comparison of RLG of pond reared E. suratensis and the backwater samples show, that the RLG was slightly higher in the individuals of all the length groups in the latter environment, than their corresponding value in the former environment. This might be due to the predominantly herbivorous diet in this environment made possible by abundance of aquatic macrophytes in the backwaters.

The food items of the four length groups in culture pond were detritus, diatoms, filamentous algae, rotifers, copepods, other crustaceans, insect larvae and gastropods, with some variations in their order of preference among different length groups. Thus in the first length group, the most important food items were, detritus (35.936%), diatoms (32.212%) and filamentous algae (24.674%), while in the second length group, it was diatoms (33.272%), filamentous algae (29.424%) and diatoms (28.037%). In the third length group, the order of preference was diatoms (33.143%), detritus (31.380%), filamentous algae (24.127%), other crustaceans (3.656%) and rotifers (2.795%). The order of preference of food items in the fourth length group was diatoms (37.156%), filamentous algae, (32.471%), detritus (23.929%), rotifers (2.126%), copepods (1.704%) and other crustaceans (1.616%).

In the backwaters the major food items of E. suratensis were filamentous algae, diatoms, higher aquatic plants, detritus, rotifers, copepods, other crustaceans and insect larvae. The stomach contents of first length group contained mainly, diatoms (50.193%), filamentous algae (21.053%) detritus (14.325%), other crustaceans (6.711%), copepods (4.069%) and rotifers (3.283%). In the second length group the important items were filamentous algae (49.372%), diatoms (31.856%), detritus (8.872%) and higher aquatic plants (6.927%). In the third length group, filamentous algae (42.339%), higher aquatic plants (34.862%), and detritus (10.544%) formed the important food items. In the fourth length group, the major food items were higher aquatic plants (31.105%), filamentous algae (28.461%), diatoms (21.695%), detritus (15.079%), copepods (1.874%) and other crustaceans (1.878%).

Selectivity index of the important food items in the culture pond and backwaters during October 1986 and March 1987 is as follows:

During October, the selectivity indices of diatoms in the culture pond for the four length groups from I to IV were -0.246, -0.636, -0.534 and -0.202 respectively. The corresponding values in the backwaters were +0.325, -0.313, -0.356 and +0.168. During March selectivity indices of diatoms in the pond for the four length groups were -0.150, -0.481, -0.320 and -0.173 respectively, while in the backwaters the corresponding values were, +0.381, -0.[illegible]33, -0.686 and -0.377. Selectivity indices of filamentous algae for the four length groups in the culture pond during October were +0.570, +0.694, +0.653 and +0.465 respectively. In the backwaters the corresponding values were +0.032, +0.743, +0.512 and +0.011. During March the values of selectivity indices in the culture pond for the four different length groups were +0.436, +0.669, +0.176 and +0.472, while the corresponding values in the backwaters were +0.052, +0.782, +0.826 and +0.701.

As far as detritus is concerned, the selectivity index was +1 for all the four length groups in both the environments, during the two months under study since detritus was seen in the stomach contents, but was not observed in the plankton samples.

Selectivity index of higher aquatic plants was +1 in backwaters for the length groups II, III and IV. But for the fishes belonging to length group I, since higher aquatic plants were neither observed in the stomach contents nor encountered in the plankton sample, no selectivity index exists. Higher aquatic plants were also not observed in the stomach contents of any of the length groups from culture pond during both the months under study since no aquatic plants were present in the culture pond and hence no selectivity index exists for this item.

The results of the feeding experiment indicate that maximum values for average specific growth rate (as percentage wet body weight d^{-1}) (0.455), average monthly increment (3g), percentage gain in the body weight (14.634%) and best food conversion factor (18) were obtained for feed V, viz; fresh Enteromorpha intestinalis alone. The specific growth rate for the remaining four feeds from feed I to IV were in the order of 0.153, 0.192, 0.343 and 0.345 respectively. The average monthly increment in weight obtained from the three feeds were 1.00 g, 1.500 g, 1.688 g and 2.375 g respectively. Percentage gain in body weight obtained by these feeds were 4.683%, 5.926%, 10.847%, and 10.920% respectively while the food conversion factor obtained by these feeds were 56, 44, 24 and 24.

Statistical analysis using analysis of variance technique showed that there was no significant variation due to the effect of replication. But variation was seen due to the effect of feeds. Analysis of least square method indicates that these five feeds can be grouped into two. The first group containing feeds I and II, where there was no significant difference between the feeds. The second group contains feeds III, IV and V in which no significant difference were seen among the feeds themselves, but all these feeds show significant difference with the feed I and II.

The results of the study give an indication of the variations in the food items of the species at different length groups in the two environments. The introduction of preferred food items clearly helps to enhance the growth rate of the species under experimental conditions. This study provides scope for trying these items in ponds which in turn may augment the production of the species.

-0-

VII. REFERENCES

REFERENCES

Al Hussaini, A.H. (1947) Feeding habits and the morphology of alimentary tract of some teleosts, living in the neighbourhood of the Marine Biological Station, Ghardequa, Red sea. Fond I. Univ. Publications of the Marine Biological Station. Ghardaqua 5 : 4-61.

Al Hussaini, A.H. (1949) On the functional morphology of the alimentary tract of some fishes in relation to differences in their feeding habits. Quart. J. Micr. Sci. 90 (2) : 190-240.

Alikunhi, K.H. (1956) Fish culture techniques in India. Progr. Fish. Devlpt. India : 66-77.

Alikunhi, K.H. (1957) Fish culture in India. Fm. Bull. Indian Coun. Agric. Res. 20 : 144 pp.

Alikunhi, K.H., Sukumaran, K.K. and Parameswaran, S. (1971) Studies on composite fish culture: production by compatible combinations of Indian and Chinese carps. J. Indian. Fish. Assoc. 1 (1) : 26-57.

Alkholy, A.A. and Malek Abdel, S.A. (1972) Food and feeding habits of some Egyptian Fishes in Lake Quarun. part. I. Tilapia zilli (Grev). A. According to localities. Bull. Inst. Oceanogr. Fish. Cairo. 2 : 185-201.

*Amaranth, Y. (1979) Preliminary studies on the biology of cichlid fish Etroplus maculatus (Bloch). Research Report B.Sc. (special science) Degree. University of Kelaniya. 52 pp.

American Public Health Association, American water works association and water pollution Control Federation (1981) Standard methods for the examination of water and waste water. 15th Edition APHA. 1015. DC.20005: Fifteenth street. N.W. Washington.

Anonymous, (1981) Proc. Fourth Workshop of All India Co-ordinated Research Project Brackish water Prawn and Fish Farming. Centr. Inland Fish. Res. Inst. I.C.A.R. Kakinada 1981 : 25 pp.

Anonymous, (1987) Kerala Fisheries an Overview. Department of Fisheries, Government of Kerala : 92 pp.

Aravindan, C.M. (1980) Food selection and feeding habits of Tilapia mossambica in different ecological habitats. Proc. Indian Natn. Sci. Acad. B 46 (1) : 54-57.

Barnes, R.S.K. (1980) Coastal lagoons. The natural history of a neglected habitat. Cambridge University press. Cambridge : 106 pp.

Bhaskaran, V.K. (1946) Bionomics and life history of Etroplus suratensis (Bloch) with special reference to stocking tanks. Proc. 33rd. Indian Sci. Congr. Part III. Abst. No.42 : 128 pp.

*Bowen, S.H. (1976) Feeding ecology of cichlid fish Sarotherodon mossambicus in Lake Sibaya, Kwazulu. Rhodes University, Grahams town. Ph D. dissertation : 135 pp.

*Bowen, S.H. (1981) Digestion and assimilation of periphytic detrital aggregate by Tilapia mossambica. Trans. American Fish. Soc. 110 : 241-247.

Bowen, S.H. (1982) Feeding, Digestion and Growth - Qualitative considerations. Biology and culture of Tilapias. ICLARM Conference Proceedings. Edited by R.S.V. Pullin and R.H. Lowe Mc. Connel : 141-156.

Boyd, C.E. (1982) Water quality management for pond fish culture. Elsevier Sci. Publ. Co. Amsterdam : 318 pp.

Boyd, C.E. and Walley, W.W. (1975) Total alkalinity and hardness of surface waters in Albama and Mississippi. Auburn University Agricultural Experiment Station Auburn, Albama, Bull. 465 : 16 pp.

Bruton, M.N. and Boltt, R.E. (1975) Aspects of biology of Tilapia mossambica Peters (pisces : Cichlidae) in a natural fresh water lake (Lake Sibaya, South Africa). J. Fish. Biol. 7 : 423-446.

*Buddington, R.K. (1979). Digestion of an aquatic macrophyte by Tilapia zilli. J. Fish. Biol. 15 (3) : 449-456.

Caulton, M.S. (1976) The importance of pre digestive food preparation of Tilapia rendelli Boulenger, when feeding on aquatic macrophytes. Trans. Rhod. Scient. Asso. 57 : 22-28.

Caulton, M.S. (1978). Tissue depletion and energy utilisation during routine metabolism by sub adult Tilapia rendelli Boulenger. J. Fish. Biol. 13 : 1-6.

Chacko, P.I. (1949) Fish and Fisheries of the Muthupet saline swamp, Tanjore district. Proc. 36th Indian Sci. Congr. (Allahabad), Pt. 3. Abstracts: 163-164.

Chakraborty, R.D., Murthy, D.S., Sen P.R., and Chatterjee, D.K. (1971). Preliminary observations on the usefulness of silkworm pupae as feed for fingerlings of Indian major carps and common carp. J. Inland Fish. Soc. India. 3 : 117-118.

Chervinski, J., Hepner B. and Tagari, H. (1968) Studies on carp nutrition. 2. Effect of a protein rich diet on fish yields in farm ponds. Bamidgeh. 20 : 6-15.

*Costa, H.H. (1983) Biological studies of the pearl spot Etroplus suratensis (pisces : Cichlidae) from three different habitats in Sri Lanka. Int. Rev. Gesamt. Hydrobiol. 68 (4) : 565-580.

Cruz, E.M. and Laudencia, I.L. (1977). Protein requirements of Tilapia mossambica fingerlings. Phillip. J. Biol. 6 : 177-182.

*Cruz, E.M. and Laudencia, I.L. (1978) Screening of feeding stuffs as ingredients in the rations of Nile Tilapia : Kalikasan. 7 : 159-164.

Das, B.C. (1967). Effects of micronutrients on the survival and growth of Indian carp fry. FAO. Fish. Rep. (44), 3 : 241-256.

* Das, S.M. and Moilana, S.K. (1958) Variations in the alimentary canal in relations to food. J. lent. 20 : 29-40.

Das, S.M. and Srivasthava, A.K. (1979) On relative length of gut (RLG) in some food fishes of Utharpradesh with changes from fingerlings to adult stage. J. Inland Fish. Soc. India. 2 (1) : 6-11.

Day, F. (1878-88) The fishes of India : a natural history of the fishes of India, Burma and Ceylon, text including supplement - London, 1 pp 1-20, 1-816; 2, 197 pls.

Day, F. (1889) The fauna of British India, including Ceylon and Burma Fishes - London, 1, pp :- xviii, 1-548, 164 figs. 2, pp. i-xiv, 1-509, 177 Figs.

*De Silva, S. Sena and Balfotin. F (1974) Laboratory studies on food intake growth and food conversion of young herring, Clupea herrangus (L).

De Silva, S. Sena., Parakum, M., Ruchira, T. and Cumaranatunge (1984) Aspects of the biology of euryhaline Asian cichlid, Etroplus suratensis Env. Biol. Fish. 10 (1-2) : 77-87.

De Silva, S. Sena. and Perera, N.K. (1983) Digestability of an aquatic macrophyte by cichlid Etroplus suratensis with observations on the relative merits of three indegenous compounds as markers and daily changes in protein digestability. J. Fish. Biol. 23 : 675-684.

Devaraj, K.V., Krishna Rao, D.S. and Kesavappa, G.Y. (1981) Utilisation of duck weed and waste cabbage leaves in the formulation of fish feed. Mysore J. Agric. Sci. 15: 131-135.

Devaraj, K.V. Santharam, B. and Shetty, H.P.C. (1975) A comparative study of the food of juveniles of the pearl spot Etroplus suratensis (Bloch) collected from Estuarine and Fresh waters. Mysore J. Agric. Sci. 9 : 479-486.

Dewan, S. and Saha, S.N. (1979) Food and feeding habits of Tilapia nilotica 2. Diel seasonal patterns of feeding. Bangladesh J. Zool. 7 (2) : 75-80.

Edmondson, W.T. and Winberg, G.G. (1971) A manual on the methods for the assessment of secondary productivity in freshwater. IBP. Hand Book. No.17. Blockwell Scientific publications. Oxford. 358 pp.

*Edwards, P., Kamal, M. and Wee, K.L. (1985) Incorporation of composted and dried water hyacinth in pelleted feeds for the tilapia Oreochromis nilotica. Aquacul. and Fish. Manage. 16: 233-248.

Fagade, S.O. (1971) The food and feeding of Tilapia species in the Lagos lagoon. J. Fish. Biol. 3 (2) : 151-156.

*Fish, G.R. (1955). The food of Tilapia, in East Africa. Uganda J. 19 : 85-89.

Fryer, G. (1961) Observations on the biology of the cichlid fish Tilapia variabilis Boulenger in the northern waters of lake Victoria (East Africa). Rev. Zool. Bot. Africa. 64 : 1-33.

Fryer, G. and Iles, T.D. (1972) The cichlid fishes of great lakes of Africa, their biology and evolution. Publ. by Oliver and Boyd. Edinburgh: 641 pp.

Gaigher, I.G., Porath, D. and Granoth, G, (1984) Evaluation of duck weed (Lemna gibba) as feed for tilapia (Oreochromis niloticus O. aureus) in a recirculating unit. Aquaculture. 41 : 235-244.

*Gerking, S.D. (1955) Influence of rate of feeding and body composition on protein metabolism of blue gill sun fish. Physiol. Zool. 28 : 267-282.

Gopalakrishnan, V. (1973). Taxonomy and Biology of tropical fin fish for coastal aquaculture in the Indopacific Region. Ed. T.V.R. Pillay. Fishing News (Books) Ltd. London. : 119-215.

*Gophen, M. (1980) Food sources, feeding behaviour and growth rates of Sarotherodon galilaeum (Linnaeus) fingerlings. Aquaculture. 20 (2) : 101-115.

Gopinathan, C.P., Nair, P.V.R. and Nair, A.K.K. (1984) Quantitative ecology of Phytoplankton in the Cochin backwaters. Indian J. Fish. 3 : 325-346.

Gopinathan, V.G. (1981) Culture of Etroplus suratensis in Panaji Center Goa. Proceedings IVth workshop All India Co-ordinated Research project on Brackish water prawn and fish farming Indian Counc. Agr. Res. CIFRI, Kakinada, A.P. 25 pp.

Gopinath, K. (1948) Weed distroying habits of Etroplus suratensis (Bloch). Department of Research Report for the septennium 1939-1946. University of Travancore. Division, Marine Biology and Fisheries, 1948 : 268 pp.

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

Halver, J.E. (1972) Fish Nutrition. Ed. J.E. Halver. Academic Press Newyork. 1972.

Harbot, B.J. (1975) Preliminary observations on the feeding of Tilapia nilotica in L. Rudolf. African J. Trop. Hydrobiol. Fish. 4 (1) : 27-37.

Haridas, P., Madhu pratap, M. and Rao, T.S.S. (1973) Salinity, temperature and zooplankton biomass of the backwater from Cochin to Alleppey. Indian J. Mar. Sci. 2 : 194-202.

Haripradadas. (1976) Feeding experiments on Mugil cephalus (L) Mahasagar Bull. Nat. Inst. Ocean, 9 : 79-81.

Hora, S.L. and Pillay, T.V.R. (1962) Handbook on the fish culture in the Indo pacific region F.A.O. Fish. Biol. Tech. Pap. 14 : 124 pp.

Huet, Marcel. (1960) Textbook of fish culture - breeding and cultivation of fish. Fishing News (Books) Ltd, England.

Hynes, H.B.N. (1950) The food of fresh water sticklebacks (Gasterosteus acculeatus and Pyqosteus pingilim with a review of methods used in studies of the food of fishes. J. Anim. Ecol. 19 (1) : 36-38.

*Ivlev, V.S. (1961) Experimental ecology of feeeding of fish. (Yale University).

Jayaprakas, V. (1980) Culture possibilities of pearl spot, Etroplus suratensis (Bloch) in Kerala. Sea Food Export J. 12 (11) : 51-52.

Jayaprakas, V. (1980) The biology of Etroplus suratensis. PhD thesis University of Kerala : 435 pp.

Jayaprakas, V. and Nair, N.B. (1981; Maturation and spawning in the pearl spot Etroplus suratensis (Bloch). Proc. Indian Natn. Sci. Acad. 47 B (6) 828-836.

Jayaprakas, V. and Nair, N.B. (1981 Food preference and effect of supplementary feeding on the growth of Etroplus suratensis (Bloch). Memoir of the Salem Institute of Experimental Biology, No.I : 177-185.

Jayaprakas, V., Padmanabhan, K.G. and Balasubramaniam, N.K. (1979). Food, feeding habits and breeding biology of the orange chromid Etroplus maculatus (Bloch). J. Aq. Biol. 4 : 9-21.

Jeyachandran, P. and Paulraj, S.J. (1976) Experiments with artificial feeds on Cyprinus carpio fingerlings. J. Inland Fish. Soc. India. 8 : 33-37.

Jeyachandran, P. and Paulraj, S. (1977) Formulation of pelleted feeds and feeding trials with connon carp. J. Inland. Fish. Soc. India. 9 : 46-52.

Jhingran, V.G. (1975) Fish and fisheries of India. Hindustan publishing Corporation., Delhi, 954 pp.

Jhingran, V.G. and Natarajan, A.V. (1969) A study of the fisheries and fish population of Chilka lake during the period 1957-1965. J. Inland Fish. Soci. India. 1 : 49-126.

Job, T.J., Alikunhi, K.H. and Choodamani. (1947) On the biology of the pearl spot Etroplus suratensis (Bloch) Proc. 34th Indian Sci. Congr. (Delhi) pt. 3. Abstract : 183 pp

Jose, Susheela., Mathew, P.M., Jose, M.M., and Mrithyunjayan, P.S. (1988). Zooplankton and macrobenthos in a brackish water fish farm in the south west coast of India. Proc. First Indian Fish. Forum Mangalore. 1988 : 146-150.

*Kevern, N.R. (1966). Feeding rate of carp estimated by radio isotopic method. Trans. American Fish. Soc. 95 (4) : 363-371.

Krishnakumari, L., Sumitra Vijayaraghavan., Royan, J.P. and Wafar, M.V.M. (1979) Laboratory studies on the food conversion in Etroplus suratensis Mahasagar. 12 (1) : 41-44.

Kurian, C.V., Damodaran, R. and Antony. A. (1975) Bottom fauna of Vembanad lake. Bull. Dept. Mar. Sci. University of Cochin. 4 : 987-994.

Lakshman, M.A.V. (1974) Fatten the fish in your ponds. Indian Farming. April 1974.

Lakshman, M.A.V., Murthy, D.S., Pillai, K.K. and Banerjee, S.C. (1967). On a new artificial feed for carp fry. F.A.O. Fish. Rep. 44 : 373-387.

Lauzanne, L. and Iltis, A, (1975) La selection de la nourriture chez I. T. galilaea (Pisces - cichlidae) du lac Tchad can. O.R.S.T.O.M. Ser Hydrobiol. 9 (3) : 193-199.

Le Roux, P.J. (1956) Feeding habits of young four species of Tilapia S. African J. Sci. 53 (2) : 33-37.

* Liang, J.K. and Lovell, R.T. (1971) Nutritional value of water hyacinth in channel catfish feeds. Hyacinth Control J 9 : 40-44.

Ling, S.W. (1967) Feeds and feeding of warm water fishes in ponds in Asia and the Far East. F.A.O. Fish. Rep. 3 (4) : 291-309.

Madhupratap, M, and Haridas, P. (1977) Secondary production in the Cochin Backwaters, a tropical monsoonal estuary, Proc. Sym. on warm water zooplankton spl. publn. Natn. Inst. Ocean : 515-519.

Mahobia, Gopal Prasad (1987) Studies on Indian Cichlids. Ph D. thesis Centre of Advanced studies in mariculture. Central Marine Fisheries Research Institute, Cochin : 213 pp.

* Malek, Abdel (1972) Food and feeding habits of some Egyptian fishes in lake Quarun. Part I. Tilapia zilli B. According to different length groups. Bull. Inst. Ocean. Fish. U.A.R. 2 : 203-213.

Mathavan, S., Vivekanandan, E. and Pandian, T.J. (1978) Food utilisation in the fish T. mossambica fed on plant and animal foods. Helgolander, Wiss, Meeresunters. 28 : 66-70.

*Mechanik, F.J. (1957) O Vlijanii konzentracii kialoreda vode na rost i ozotisyi obmen malkov reduznoi forcli Ryb. choz. 33 : 75-76.

Moreau, C., Orachungwong., Segura, G, et Tanthipwon, O. (1986). Alimentation du jeune Tilapia, Application au Development de son elevage intensif. Aquaculture Research in the African Region. Proc. African Seminar Aquaculture organised by the I F S. 7-11. October, 1985. (Ed) E. Huisman : 60-96.

Moriarty, C.M. and Moriarty., D.J.W. (1973) Quantitative estimation of the daily ingestion of phytoplankton by T. nilotica and Haplochromis nigripinnis. J. Zool. 171 : 41-56.

Moriarty, D.J.W. (1973) The physiology of digestion of blue green algae in the cichlid fish Tilapia nilotica. J. Zool. London 171 : 25-39.

Mrithunjayan, P.S., Mathew, P.M., Jose, Susheela and Jose, M.M. (1987). Ecology of a brackish water fish farm with respect to chemical parameters. Seminar on Fish. Res. and Devpt. in Kerala. Tech. Session III. Department of Aquatic biology and fisheries, University of Kerala 1987. Trivandrum, April 28-29.

Pandian, T.J. (1967a) Intake, digestion absorption and conversion of food in the fishes, M. cyprinoides and O. striatus J. Mar. Biol. 1 : 16-32.

Pandian, T.J. (1967b) Food intake, absorption, and conversion in the fish O. striatus. Helgolander. Wisenschaflliche meeres. unter Suchungen, 15 : 637-647.

Paniker, N.P. (1920) Notes on two cichlid fishes of Malabar, Etroplus suratensis and Etroplus maculatus. Madras Fish. Bull. 12 (5) : 157-166.

*Pantastico, J.B. and Baldia, J.P.G. (1980) Ipil - ipil meal as supplemental feed for Tilapia nilotica in cages. Fish. Res. J. Phillippines. 5 : 13-16.

Pauly, D (1976) The biology, fishery and potential for aquaculture of Tilapia melanotheron in a small west African lagoon. Aquaculture. 7 (1) : 33-49.

*Pearse, A.S. (1915) On the food of small shore fishes in the waters near Madison, Wisconsin. Bull. Wis. Nat. Hist. Soc. 13 : 7-22.

Philippart, J-cl. and Ruwet, J-cl. (1982) Ecology and distribution of Tilapias. The biology and culture of Tilapias. Edited by R.S.V. Pullin and R.H. Lowe - Mc. Connell. ICLARM Conference proceedings: 432 pp.

Pillai, V.K., Joseph, K.J. and Nair, A.K. (1973) The plankton production in the Vembanad lake and adjacent waters in relation to the environmental parameters. Bull. Mar. Sci. Univ. Cochin. 8 : 137-150.

*Pompa, J.J. (1978) Experiments on the growth of Tilapia rendelli Boulenger, cultured in cage and fed with fresh leaves of Alocasia macroliza. Inf. Tee. Cart. Piscic. Exp. Univ. Caldas : 2 : 43-50.

Prasadam, R.D. (1971) Observations on the biology of pearl spot Etroplus suratensis (Bloch) from the Pulicat lake, Madras. J. Inland Fish. Soc. India. 3 : 72-78.

Prasadam, R.D. and Gopinathan, K. (1976) Experimental studies on the food preference and the effect of supplementary feeds on the growth and survival of grey mullet, Mugil macrolepis. J. Inland Fish. Res. Soc. 8 : 172-178.

Quasim, S.Z. (1973) Experimental ecology of tropical marine phytoplankton. Mar. Biol. Asscn. India Spl. Publ. 80-86.

Quasim, S.Z. (1979). Primary production in some tropical environments. Marine Production mechanisms IBP. Handbook. No. 20 : 31-69.

Quasim, S.Z., Wellershaw, S.P., Bhattathiri, P.M.A. and Abidi, S.A.H. (1969) Organic production in a tropical estuary. Proc. Indian Acad. Sci. 69 (B) : 51-94.

Raj, B.S. (1939b) Etroplus suratensis. Service Bulletin, Madras Fisheries Department, Madras, 4 : 86 pp.

+ Raj, B. Sundara. (1916) Notes on the freshwater fishes of Madras Rec. Indian Mus. 12 (6) : 249-294.

Rao, P. (1972). Metabolic compensation during the thermal acclimation in the tissue of a tropical freshwater fish Etroplus maculatus (Teleostei) Biol. Zentralbl 91 (6) : 681-693.

*Reite, O.B., Maloiy, G.M.O., and Aasenaug, B. (1974) pH, salinity and temperature tolerance of Lake Magadi Tilapia Nature. (London). 247-315.

Saha, S.N. and Dewan, S. (1979) Food and feeding habits of Tilapia nilotica (Linnaeus). Types and amounts of food taken by the fish, its size and pattern of feeding. Bangladesh J. Zool. 7(1) : 53-60.

Sebastian, V.O. (1942) On the role of Etroplus maculatus (Bloch) and Etroplus suratensis (Bloch) in the control of mosquitoes. J. Bombay Nat. Hist. Soc. 43 (2) : 271-273.

Shell, E.W. (1967) Feeds and feeding of warm water fish in North America. F.A.O Fish. Rep. 44 : 310-325.

Singh, C.S. (1970) Freshwater algae Oedogonium obtruncatum Wittrock as a nutritive source to Cirrhinus mrigala (Ham). Indian J. Exp. Biol. 8 (2) : 153-154.

Singh, C.S. and Bhanot, K.K. (1970) Nutritive value of algal feeds for common carp, Cyprinus carpio L. J. Inland Fish. Soc. India. 2 : 121-127.

Sinha, V.R.P and Ramachandran, V. (1981). Freshwater fish culture. Publications and Information division, Indian Council of Agricultural Research, New Delhi 80 pp.

Snedecor, G.W. and Cochran, W.G. (1968) Statistical methods. Oxford and IBH. publ. Co. Calcutta : 593 pp.

Spataru, P. (1978) Food and feeding habits of Tilapia zilli (Cichlidae) in Lake Kinneret (Israel). Aquaculture, 14 : 327-338.

Spataru, P. and Zorn, M. (1976). Some aspects of natural food and feeding habits of Tilapia galilae and T. aurea in Lake Kinneret Bamidegh. 28 : 12-17.

Strickland, J.D.H. and Parsons, T.R. (1972). A practical handbook of sea water analysis Bull. Fish. Res. Bd. Canada. 167. 2nd Edition: 311 pp.

Sumithra, Vijayaraghavan, Wafar, M.V.M. and Royan, J.P. (1978) Food conversion in Etroplus suratensis. Mahasagar 11 (1-2) : 95-99.

Sumithra, Vijayaraghavan, Krishnakumari, L, Dhawan, R.M. and Royan, J.P. (1981). Caloric values of ingested food of E. suratensis in culture pond. Indian J. Mar. Sci. 10 : 205-207.

Sumithra, Vijayaraghavan., Royan, J.P. and Rao, T.S.S. (1982) Growth and food conversion efficiency in the fish Etroplus suratensis in relation to different feeding levels. Indian J. Mar. Sci. 11 (4) : 350-352.

Swingle, H.S. (1961) 'Relationships of pH of pond water to their suitability for fish culture. Proc. Pacific. Sci. Congr. 1957, 10 : 72-75.

Swingle, H.S. (1969) Methods of Analysis for water, organic matter and pond bottom soils used in Fisheries Research. Auburn University, Auburn, Albama. 119 pp.

Swynnerton, G.H. and Worthington, E.B. (1940) Note on the food of fish in Hawes water (Westembor land). J. Anim. Ecol. 9 : 183-187.

Tal, S. (1967) Economic aspects of fish feeding in the East. FAO. Fish. Rep. 3 (44) : 285-290.

Thampy, D.M., Rajendran, C.G. and Mrithunjayan, P.S. (1978) Culture of Etroplus suratensis in Vytilla fish farm of Kerala Agri. University, Cochin IIIrd Workshop of AICRP. Brackish water prawn and Fish Farming Cochin, 9 & 10 Nov. 1978.

Thampy, D.M., Jose, Susheela, Rajendran, C.G., Mrithunjayan, P.S. and Jose, M.M. (1987) The growth, survival and production of pearl spot Etroplus suratensis (Bloch) in brackish water culture ponds. Natn. Seminar on Estuarine Management. Science and Technology. Abst. EB 12.

Thomas, P.J. (1975) Studies on the alimentary canal of Etroplus maculatus (Bloch) Bull. Dept. Mar. Sci., University of Cochin., 7 (3) : 511-521.

Varghese, P.P. (1975) Studies on the biology, morphology and development of Cichlidae (Pisces) of Kerala, India, PhD. Thesis Cochin University. 215 pp.

Venkataraman, G. (1960) Studies on the food and feeding relationship of the inshore fishes of Calicut on the Malabar Coast. Indian J. Fish. 7 : 275-306.

Venugopal, M.N. (1980) Studies on the growth response of Catla catla (Ham), Cirrhinus mrigala (Ham) and Cyprinus carpio (Linn) to protein of different sources in the pelleted feeds. Masters degree thesis submitted to the University of Agricultural Science, Bangalore, 144 pp.

*Warren, C.E. and Davis, G.E. (1967) The laboratory studies on the feeding, bioenergetics and growth of fish. The Biological Basis of Freshwater Fish Production. Ed. Shelbyn, Gerking. Blackwell Oxford : 175 pp.

*Whitefield, A.K. and Blaber, S.J.M. (1979) The distribution of the freshwater cichlid Sarotherodon mossambicus in estuarine systems. Env. Biol. Fishes. 4 (1) : 77-81.

Windell, J.T. (1970) Food analysis and rate of digestion. Methods for assessment of fish production in freshwaters. (Ed) Ricker, IBP. Hand book No.3 Blackwell oxford publications : 197-203.

* Wyman, R.L. and Ward, J.A. (1973) The development of behaviour in the cichlid fish Etroplus maculatus. Z. Trier Psychol. 3 : 461-491.

Yashouv, A. and Ben Schachar, (1967) Breeding and growth of Mugilidae. II. Feeding experiments under laboratory conditions with Mugil cephalus L. and Mugil capito Cuvier. Bamidgeh. 19 (2-3) : 50-66.

* Not referred to in the original.

ABSTRACT

Food and feeding habits of E. suratensis during fry (30-49 mm), fingerlings (50-69 mm), subadult (70-89 mm) and adult (90-120 mm) stages in the captive environment of a culture pond and wild environment viz; Cochin backwaters were studied. The study was conducted from October 1986 to March 1987.

A culture pond in the College of Fisheries, Panangad was stocked with E. suratensis of the above four length groups in 1:1:1:1 ratio, at a stocking density of 5600 Nos/ha, after preliminary preparations. Samples were collected from both these environments from the end of first month onwards. Each month, the numbers that were removed from the culture pond were restocked with same numbers of specimens of various length groups.

Salient ecological parameters viz; temperature, pH, salinity, alkalinity, dissolved oxygen, phytoplankton primary productivity, zooplankton and zoobenthos of the culture pond and the backwaters were analysed at monthly intervals.

The feeding intensity of the specimens in the captive and wild environment, relative lengths of gut during different stages, food items consumed in the culture pond and in the backwaters and selectivity index of various food items were studied.

A feeding experiment was also conducted with fingerlings of E. suratensis where five feeds were used in duplicate. The feeds used were (I) conventional feed made of groundnut oil cake and rice bran (1:1) having 31.50% crude protein (II) 50% conventional feed + 50% fresh Hydrilla verticillata having 24.55% crude protein (III) Fresh Hydrilla verticillata alone having 17.60% crude protein (IV) 50% conventional feed + 50% fresh Enteromorpha intestinalis having 23.30% crude protein (V) Fresh Enteromorpha intestinalis alone having 15.1% crude protein.

Analyses of the physico-chemical parameters of the captive and wild environments show that their range was tolerable for the normal life activities of fishes and did not affect the food intake of the species.

The feeding intensity of E. suratensis was found to increase from the first length group to the fourth length group in both the environments. The feeding indices of the four different length groups in the brackish water culture pond were 13.89, 19.45, 33.33 and 44.44 while the corresponding values in the backwaters were 55.56, 66.67, 72.72 and 77.78. Feeding intensity of E. suratensis was higher in the backwaters than in the culture pond.

The RLG of E. suratensis from first to fourth length groups in the culture pond were 2.911, 3.111, 3.850 and 4.420 while the corresponding values for the fishes from the backwaters were 3.011, 3.331, 4.010 and 4.535.

The food items in general of the four length groups in culture pond were detritus, diatoms, filamentous algae, rotifers, copepods, other curstaceans, insect larvae and gastropods, with some variations in their order of preference among different length groups. In the backwaters the major food items in general were diatoms, higher aquatic plants, detritus, rotifers, copepods, other crustaceans and insect larvae.

Selectivity index of the important food items in the culture pond and backwaters during October 1986 and March 1987 were studied for all the length groups. Selectivity index values were obtained for diatoms, filamentous algae, rotifers, copepods, other crustaceans and insect larvae for all the for length groups in pond and backwater. The selectivity index of detritus was +1 for all the four length groups in culture pond and backwaters, during both the months under study. For the higher aquatic plants, the selectivity index was +1 for the length groups II, III and IV in the backwater. But for the length group I, in the backwaters and for all the four length groups in culture pond, no selectivity index exist for higher aquatic plants.

In the feeding experiment, maximum values for average specific growth rate expressed as percentage wet body weight d^{-1} (0.455), average monthly increment (3g), percentage gain in the body weight (14.634%) and best food conversion factor (18) were obtained for feed V, viz; fresh Enteromorpha intestinalis alone.

Statistical analysis using analysis of variance technique showed that there was significant variation due to the effect of feeds. Analysis of least square method indicate that these five feeds can be grouped into two. In the first group, with feeds I and II, there was no significant difference between the feeds. In the second group with feeds III, IV and V, no significant difference were seen among themselves, but all these feeds show significant difference with the feeds I and II. The growth performance obtained by these feeds in the second group were superior than the feeds I and II.

-0-