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STUDIES ON THE NATURAL FOOD OF MAJOR, COMMON AND SOME CHINESE CARPS AS INFLUNCED BY FERTILIZATION IN COMPOSITE CULTURE PRACTICES

SUMMARY

Natural food components were analyzed for *Catla catla, Labeo rohita, Cirrhinus mrigala, Cyprinus carpio, Hypophthalmichthys molitrix* and *Ctenopharyngodon idella* in 6 composite culture ponds, which were fertilized with broiler manure. The natural food examined and defined was collected both from guts of fish sampled and from pond water. The proportional amount of phytoplankton found in guts of *Catla catla, Labeo rohita, Cirrhinus mrigala, Cyprinus carpio, Hypophthalmichthys molitrix* and *Ctenopharyngodon idella* was 80-90 %, 70-80 %, 60-70 %, 60-80 %, 35-90%, 28-75%, respectively. The parallel zooplankton values were 10-15 %, 25-30 %, 30-40 %, 20-40 %, 20-30%, 25-45 %, respectively. In ponds stocked with these 6 fish species, the proportional amount of phytoplankton in the pond water was 10-20 %, 25-35 %, 30-40 %, 45-55 %, 15-25 %, 10-20 %, respectively. This demonstrates empirically the inverse relationship between the type of plankton preferentially consumed by a given fish and the predominant plankton type present in ponds stocked with that fish. The mechanism of this preferential feeding is presumably associated with the diameter of the filtering net meshes of the gills of these fishes.

INTRODUCTION

Aquaculture in Pakistan is still in infancy, consisting mainly in polyculture of major carps. Composite culture of major, common and some Chinese carps has been developed by increasing major carps stocking rates and through the introduction of planktophagous Chinese carps to increase production in order to meet the demand of animal protein (Mahboob, 1992). The aim of introducing the planktophagous Chinese carps and a common carp was to increase the production through utilization of the phytoplankton and zooplankton (Cremer and Smitherman, 1980). Semi-intensive carp polyculture is an age-old popular practice in south Asia, especially in Pakistan, Bangladesh and India, where it is the main aquaculture production system (Miah *et al*., 1997, FAO, 1997 and Reddy *et al*., 2002). In south Asian polyculture, a wide variety of fish species are cultured. Among those species, rohu *Labeo rohita* (Hamilton), catla *Catla catla* (Hamilton) and mrigal *Cirrhinus cirrhosus* (Bloch) are very popular (Uddin *et al*., 1994, FAO, 1997, Miah *et al*., 1997; Kanak *et al*., 1999). Between 1980 and July 1990, these 3 species contributed 75% of the total inland aquaculture production in Pakistan (Mahboob, 1992). In fish ponds, the production of fish has often been significantly influenced by the quality and quantity of phytoplankton. Nutrient enrichment by the addition of fertilizers, supplementary feeds and other eutrophication processes are said to cause proliferation of algae (Padmavathi and Veeraiah, 2009) In addition, polyculture is preferred, based on the assumption that each species stocked has its own feeding niche that does not completely overlap with the feeding niche of other species. In consequence, a larger fraction of the natural food available in the pond is used in multi-species systems. In some cases, one species enhances the food available for other species, thus increasing further the total fish yield per unit area (Swingle, 1966; Hepher *et al*., 1989; Miah *et al*., 1993). The dynamics of plankton are described in order to determine the relations between the biomass of plankton present in the pond and that in the guts of fishes and the relative utilization of different plankton component by different fish species.

Nevertheless, production systems are continuously changing. Nowadays, farmers prefer to stock *rohu* because it enjoys a higher consumer preference and market value. The farmers also prefer to stock common carp *Cyprinus carpio* (L.) as a bottom feeder instead of *mrigal* because common carp grows faster than *mrigal* and the overall production is higher when combined with *rohu* and *catla* in polyculture ponds (Dewan *et al*., 1985; Wahab *et al*., 1995; and Milstein *et al*., 2002). Wahab *et al*. (2002) conducted an experiment with *rohu*, *catla*, *punti Puntius sophore* (Hamilton), common carp, and *mrigal*, in semi-intensive polyculture and achieved a 60% higher yield of *rohu* with common carp as bottom feeder compared to *mrigal*. *Rohu* is known as a water column feeder mainly feeding on plankton (Das and Moitra, 1955; Dewan et al., 1977; Jhingran and Pullin, 1985; Wahab *et al*., 1994) and common carp is a bottom feeder mainly feeding on benthic macroinvertebrates and zooplankton (Tang, 1970; Spataru *et al.,* 1980; Hepher and Pruginin, 1981; Spataru *et al.,* 1983). When artificial feed is applied, common carp readily accepts artificial food (Yashouv and Halevy, 1972; Spataru *et al*., 1980; Schroeder, 1983; Milstein and Hulata, 1993). The food and feeding habits of *rohu* and common carp might differ according to the overall food and feed availability. Stirring effect of common carp may enhance nutrient availability, which in turn increase natural food availability in the ponds (Yashouv, 1971; Milstein *et al*., 1988; 2002).

Considering the above issues, the goal of the present study was to analyze the effect of addition of *Cyprinus carpio* (common carp), *Hypophthalmichthys moilitrix, Ctenopharyngodon idella* along with major carps on natural food availability, food preference, food intake, growth and fish production.

MATERIALS AND METHODS

Study site and pond preparation

The investigation was carried out in 15 earthen fish ponds of dimension 20m x 10m x 2.5m (length x width x depth) at located at the Fisheries Seed Hatchery, Faisalabad. The area has somewhat salty ground water. Each treatment was replicated three times in a factorial experiment. The ponds were supplied by groundwater from an adjacent deep tube-well. Prior to the experiment, ponds were drained, renovated, aquatic vegetation was removed and fishes and macrofauna were eradicated. All ponds were treated with agricultural lime ($CaCO_3$) at a rate of 250 kg ha^{-1} and filled with water 7 days prior to fertilization.

Fish stocking and management

After preliminary preparation of ponds, approximately about 4 month-old (Table 1) fingerlings of *Catla catla, Labeo rohita, Cirrhinus mrigala, Hypophthalmichthys molitrix, Ctenopharyngodon idella* and *Cyprinus carpio* were stocked randomly in each of the ponds in the ratios of 10:30:12.5:25:10:12.5, respectively with the stocking density of 2.87 m^3/fish (Javed, 1988). The interspecies ratios were adopted according to Lakshamanan *et al*. (1971).

Table 1 - Interspecies ratios

SPECIES	N.	RATIO	WEIGHT(g)	FORK LENGTH(mm)	TOTAL LENGTH(mm)	FINAL WT(g)
C. catla	20	10	12.87±0.08	53.23±0.05	59.33±0.09	610.25±0.99
L. rohita	64	30	11.93±0.05	50.84±0.08	57.62±0.07	706.83±1.24
C. mrigala	26	12.5	16.80±0.02	53.68±0.06	61.22±0.07	595.44±1.02
H. molitrix	52	25	22.14±0.07	124.18±0.09	143.74±0.16	867.55±2.64
C. idella	20	10	19.57±0.09	93.36±0.07	97.82±0.08	938.89±3.37
C. carpio	26	12.5	18.49±0.10	81.32±0.07	1o1.43±0.2	905.94±2.66

Table 2 - Nitrogen and Phosphorus percentages of treatment material

Treatment	Treatment material	% Nitrogen	% Phosphorus
T_1	Artificial feed (Vegetable sources)	5.60 ±0.03	2.05 ±0.06
	Broiler manure	4.62 ± 0.12	1.66 ±0.14
T_2	Control (no additive)		

The percentage of N, P and K of the 4 treatment materials in this study were obtained by AOAC (1984) methods (Table 2). During the experimental period the ponds (T_1) received the broiler manure and artificial food on alternate days at the rate of 0.15 g Nitrogen/100g of fish/day

Assessment of plankton and benthic macroinvertebrates

Water samples for plankton analysis were collected fortnightly taking 1-litre samples at 10 randomly selected locations in each pond with a Niskin bottle. Each composite 10-l sample was then passed through a 10-μm mesh plankton net. Each concentrated plankton sample was then transferred to a plastic bottle and diluted to 100 ml with formalin and distilled water to obtain a 5% buffered formalin solution. Plankton numbers were estimated in a Sedgewick–Rafter (S–R) cell. A 1 ml sample was put in the S–R cell and was left 10 min to allow plankton to settle. The plankton in 10 randomly selected fields in the S–R cell was identified up to genus level and counted. As determination keys were used Ward and Whipple (1959), Prescott (1962), Belcher and Swale (1976), and Bellinger (1992). The number of individuals of a given species per litre of pond water (N) was estimated by multiplying the mean plate count (n) by the coefficient 3538 derived from the following formula:

$$N = 100 \times 530.66\ n / 20 \times 0.75 = 3538\ n$$

Analysis of gut content

Two specimens per fish species per pond were collected each month for gut content analysis. Each fish was weighed individually and killed in ice water. The body cavity of the fish was carefully opened and 5 cm of the anterior gut was cut and preserved immediately in a jar containing 10% buffered formalin. The content from each 5 cm gut was carefully washed into a Petri dish and diluted to 50 ml with water. A 1 ml sub-sample was transferred by a pipette to a S–R cell containing 1000 1-mm^3 fields and left for 10 min to allow the solid particles to settle. The S–R cell was set up under a microscope and identification of food items was done in 10 square fields. The different food items collected from the gut were qualified and quantified up to the genus level. The calculations were done using the formula

$$N=P\times C\times 100$$

with N = number of a specific food item available in 5 cm gut, P = total number of specific food observed in 10 fields, and C = volume (ml) of sample in the Petri dish. The biomass of each plankton *taxon* in the pond water, and the reconstituted weight of ingested food organisms, was calculated by the method of standard weight.

RESULTS

Abundance of phytoplankton and zooplankton in the ponds

The relative abundance of phytoplankton and zooplankton in the different species throughout the experimental period is presented in Tables 3-6. A total of 26 phytoplankton species, 9 Rotatoria, and 9 Crustacea were identified. The number of identified species was relatively small, consisting of eurytopic species only, possibly as a result of the heavy activity these ponds suffered. Microcrustaceans, being valuable food organism for many fish species, were represented by genera *Daphnia, Cyclops, Moina, Bosmina* and *Scapholeberis*. The density (number of individuals per litre) of phytoplankton and zooplankton in the different ponds is shown in Table 7 and 8. The density of both types of plankton tended to increase from July to October. The decrease in their density was noticed in November and December. The phytoplankton density was similar in ponds during the given period except the last month of study. The density of zooplankton components was higher under T_1 where silver carp gained more weight during the months of July and August. The total biomass varied between 1.5 mg l^{-1} to 16.9 mg l^{-1}. The comparatively low plankton biomass is probably due to the grazing effect exerted by the fish. The low plankton values in July may be due to the ponds being filled with fresh water and immediately stocked with fish. Larger quantities of rotifers and micro-crustaceans in the months of October and November (Table 5 and 6) may be a response to the lower temperatures.

The highest biomass value was recorded in August and September, and gradually decreased thereafter. The phytoplankton biomass was considerably higher under T_1, varying between 1.5 mg l^{-1} and 18.9 mg l^{-1}. The zooplankton biomass ranged between 3.7 to 14.8 mg l^{-1} in treated pond and was negligible during July under T_3, but increased dramatically during September and October. However, the response of T_2 (control) for both phytoplankton and zooplankton was very poor throughout the experimental period.

Natural Food component found in the guts of different fish species

Thala (*Catla catla*)

The most frequent items of natural food in the guts of thala (Indian major carp) examined under all the 5 treatments are presented in Table 9. The *Catla catla* gut contained mainly phytoplankton comprising Chlorophyta (*Volvox*, *Chlamydomonas*, *Spirogyra*, *Oedogonium*, *Eudorina*, *Coelastrum*, *Microspora*, *Haematococcus*), Euglenophyta (*Euglena* and *Phacus*), Myxophyceae (*Anabaena*, *Nostoc*, *Spirulina*, *Microcystis*, *Aphanocaspa*, *Aphanizomen* and *Schizothrix*), and Bacillariophyceae (*Denticula*, *Synedra* and *Cyclotella*). The frequency of zooplankton was much lower than that of phytoplankton. Crustacea (*Cyclops*, *Moina*, *Latona* and *Diaptomus*) were found in 15% and Rotatoria (*Brachionus*, *Keratella*, *Filinia*, *Adineta* and *Floscularia*) in about 12% of the fish. The maximum number of individuals (1.5×10^{11}) and their reconstituted biomass (31g) in a single fish were higher for Chlorophyta than for any other type of phytoplankton.

Rohu (*Labeo rohita*)

The main food in the guts of *Labeo rohita* consisted of different types of zooplankton: Crustacea (*Moina*, *Daphnia, Bosmina, Alonella, Polyphemus* and *Simocephalus*) and Rotatoria (*Filinia, Asplanchna,* and *Keratella*) (Table 5). Phytoplankton was also found in the intestine of *rohu*, with detritus and, rarely zoobenthos. Some of the phytoplankton groups e.g. Chlorophyta, Myxophyta and Euglenophyta were found in the most of the fish abundantly. The maximum reconstituted biomass of zooplankton was higher as compared to phytoplankton.

Mori (*Cirrhinus mrigala*)

The most frequent items of natural food recorded in the gut of this fish species consisted of zooplankton and insect larvae (Table 5). The major contributors, among the Crustacea were *Diaptomus, Branchinella, Polyphemus, Simocephalus* and *Cyclops*. Among Rotifera, *Branchionus, Mytilina, Euchlanis* and *Acylus* were found. The detritus constituted over 20% of the total wet weight of the gut contents in some cases.

Silver carp (*Hypophthalmichthys molitrix*)

The gut contents of all the fishes consisted of mainly phytoplankton comprising Chlorophyta (*Volvox, Chlamydomonas, Spirogyra, Oedogonium, Characium*, *Ulotrix, Microspora* and *Pedastrium*). Euglenophyta (*Euglena*, *Trachelomonas* and *Phacus*) and Myxophyceae (*Anabaena*, *Spirulina, Microcystis, Chara* and *Nitella*), found in about 80% of silver carp in the treated ponds. The frequency of zooplankton was much lower than that of phytoplankton, Cladocera being found in 10% and Rotatoria and Copepoda in about 9% of the fish. The maximum number of individuals (1.5 x 10^{12}) and their reconstituted biomass (34g) in a single fish were higher for Chlorophyta than for any other type of phytoplankton, and several orders of size greater than for any type of zooplankton (less than 1mg).

Common carp (*Cyprinus carpio*)

The most frequent items of natural food in the guts of common carp consisted of insect larvae and pupae, oligochaetes and some zooplankton species (Table 6). The largest weight of natural food consisted of Chironomidae larvae, may fly nymphs and pupae, Crustacea (*Moina* and *Cyclops*) and Olygochaeta (*Tubifex*). Detritus constituted over 35% of the total wet weight of the gut contents in some cases.

Grass carp (*Ctenopharyngodon idella*)

All the grass carp examined under all the 5 treatment in the present study had plant remains in their guts, and also small amounts of detritus and zooplankton (6% of the total weight of food in the intestine).

DISCUSSION

The interaction between fish and food organisms is of utmost importance in polyculture systems (Milstein *et al.*, 1988). Species with different feeding niches stocked at different densities can influence the natural food availability positively (e.g. by releasing nutrients from the pond bottom) or negatively (e.g. by direct ingestion) (Milstein, 1992; Milstein and Svirsky, 1996; Paerl and Tucker, 2007). According to Hepher *et al*. (1989) and Milstein and Svirsky (1996), stirring of sediments by common carp increases natural food availability by enhancing nutrient flows through the food web. The silver carp (*Hypophthalmichthys molitrix*) and thala (*Catla catla*) both are surface feeders equipped with very fine filtering apparatus (Cremer and Smitherman, 1980). They consumed mainly small unicellular algae. The gut contents of these two fish species included *Chlamydomonas* whose cell diameter is ca. 10 µm. The ability of silver carp to filter organisms smaller than its filtering net meshes (36 µm) is not understood. Rohu (*Labeo rohita*), having comparatively bigger pores in its filtering apparatus, retained mainly large sized rotifers, crustaceans and colonial algae.

Plankton occurrence in these ponds correlates negatively with the preferences of the different fishes. The decrease in phytoplankton abundance from October onward was probably due to decrease in temperature which resulted in the increase of the zooplankton.

The most frequent items of natural food contents in the guts of mori (*Cirrhinus mrigala*) and common carp (*Cyprinus carpio*) consisted of crustacean, insect larvae, pupae and oligochaetes (Table 6). This close resemblance

Table 3 - Phytoplankton and their relative abundance in *Catla catla* , *Labeo rohita* and *Cirrihina mrigala*. Relative abundance expressed by the symbols: O = not present; A = < 1 % ; B = 1-5% ; D =10-15% ; E = > 50%; j, a, s, o, n, d, months

	Catla catla						*Labeo rohita*						*Cirrihna mrigala*					
	j	a	s	o	n	d	j	a	s	o	n	d	j	a	s	o	n	d
CHLOROPHYTA																		
Volvox	B	B	A	O	O	A	O	O	O	A	O	A	O	O	O	A	A	O
Chlamydomonas	A	A	A	O	O	B	O	O	A	A	B	B	A	A	A	O	O	O
Spirogyra	B	B	D	D	B	B	A	A	O	O	O	O	O	O	O	O	O	A
Oedogonium	A	A	O	O	D	C	C	C	B	B	D	D	C	C	O	A	B	D
Eudorina	C	C	D	E	E	D	O	O	O	O	O	O	O	O	O	O	O	O
Coelstrum	B	B	D	D	O	A	C	C	B	B	A	A	O	O	B	B	O	O
Microspora	A	A	D	E	E	E	O	O	O	A	A	O	B	B	O	O	O	O
Haemotocoocus	O	O	O	B	B	C	B	B	O	O	O	O	O	O	O	O	O	O
Characium	C	C	C	C	E	E	O	O	O	O	O	O	O	O	O	O	O	A
Ulotrix	D	D	D	E	E	A	B	B	B	C	C	O	A	A	B	B	B	O
Pediastrum	O	O	O	O	O	O	B	C	C	C	E	D	C	C	C	D	O	O
EUGLENOPHYTA																		
Euglena	B	B	B	D	D	E	D	D	D	E	E	O	D	D	C	O	O	O
Phacus	O	O	O	C	C	C	O	O	O	O	O	A	B	A	O	O	O	O
Trachelomonas	O	O	O	O	O	O	O	O	O	O	O	O	B	C	C	O	O	O
MYXOPHYCEAE																		
Anabaena	B	B	B	D	D	D	A	A	E	E	C	O	O	O	O	O	O	O
Nostoc	O	O	A	A	E	E	B	B	B	D	D	O	O	O	O	A	A	O
Spirulina	D	D	E	E	B	B	C	C	A	O	A	A	A	A	A	A	A	A
Microcystis	A	A	C	B	C	D	O	O	C	C	B	B	O	O	O	O	O	O
Asphanocaspa	B	B	B	B	O	O	O	O	O	O	O	O	A	A	B	D	A	O
Aphanizomen	D	D	E	B	A	A	B	B	B	B	B	B	O	O	O	O	O	O
Schizothrix	B	A	O	O	C	O	O	O	O	A	O	O	O	O	O	O	O	O
Chara	O	O	O	O	O	O	A	A	C	C	O	O	O	O	O	A	A	A
Nitella	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
BACILLARIOPHYCEAE																		
Denticula	C	C	E	E	E	D	B	B	B	O	O	O	A	A	A	A	A	O
Synedra	A	O	O	C	C	B	O	O	O	B	B	B	O	O	O	O	O	O
Cyclotella	O	O	O	B	B	A	O	O	O	O	O	O	A	A	A	O	O	O

Table 4 - pytoplankton abundance and their relative abundance in *Hypophthalmicthys molitrix, Ctenopharyngodon idella* and *Cyprinus carpio.* Relative abundance expressed by the symbols: O = not present; A = < 1%; B = 1-5; D =10-15% ; E > 50%; j, a, s, o, n, d, months

	SILVER CARP						GRASS CARP						COMMON CARPIO					
	j	a	s	o	n	d	j	a	s	o	n	d	j	a	s	o	n	d
CHLOROPHYTA																		
Volvox	C	C	D	D	D	B	O	O	O	O	O	O	A	A	A	O	O	A
Chlamydomonas	A	A	A	A	B	B	B	B	D	E	B	A	O	O	O	O	O	O
Spirogyra	C	C	C	E	E	D	O	O	O	A	A	O	O	O	B	B	O	O
Oedogonium	B	B	O	D	D	D	B	B	C	O	O	O	A	B	C	C	B	B
Eudorina	O	O	O	O	O	O	O	O	O	O	O	O	A	O	O	O	B	O
Coelstrum	A	A	O	O	O	O	O	B	B	B	B	O	O	O	O	O	O	O
Microspora	C	D	E	E	E	D	C	C	C	E	B	B	O	O	O	O	O	O
Haemotocoocus	O	O	O	O	O	O	O	O	O	O	O	O	O	O	B	C	B	O
Characium	B	O	D	D	E	E	D	E	E	C	C	O	A	A	C	C	B	O
Ulotrix	D	D	O	O	E	B	O	O	O	O	O	O	B	C	C	O	A	A
Pediastrum	B	B	O	O	O	A	O	O	O	B	B	O	O	O	O	O	O	O
EUGLENOPHYTA																		
Euglena	C	C	D	E	A	A	O	O	O	O	O	A	O	B	B	B	O	C
Phacus	O	O	D	D	D	B	A	A	A	O	O	O	O	A	O	A	O	O
Trachelomonas	A	A	C	C	E	O	O	O	O	A	B	B	A	A	O	O	O	A
MYXOPHYCEAE																		
Anabaena	B	B	O	C	C	C	O	O	O	O	O	O	O	O	O	O	O	O
Nostoc	O	O	O	O	O	O	O	O	O	O	A	O	A	A	C	C	O	O
Spirulina	E	E	D	D	B	B	A	A	C	O	O	A	B	B	E	E	O	A
Microcystis	B	A	C	C	A	B	B	B	O	O	O	B	O	O	A	A	O	O
Asphanocaspa	O	O	O	O	O	O	O	O	O	O	O	C	C	C	A	A	A	A
Aphanizomen	O	O	O	A	O	O	A	C	O	O	O	O	O	O	O	O	O	O
Schizothrix	O	O	O	O	O	A	O	O	O	O	O	O	B	B	D	D	C	C
Chara	C	C	E	E	B	A	D	D	D	E	E	A	O	B	B	O	O	A
Nitella	E	E	E	C	C	C	O	O	O	O	O	O	A	A	A	O	O	O
BACILLARIOPHYCEAE																		
Denticula	A	A	A	A	A	A	O	O	B	O	B	C	O	O	B	B	B	B
Synedra	O	O	O	O	O	O	A	A	A	B	B	B	B	O	O	O	O	O
Cyclotella	A	A	A	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Table 5 - zooplankton and their relative abundance in *Catla catla, Labeo rohita* and *Cirrhinus mrigala* Relative abundance expressed by the symbols: O = not present; A = < 1 %; B = 1-5%; D =10-15%; E = > 50%; j, a, s, o, n, d, months

	Catla catla						*Labeo rohita*						*Cirrhinus mrigala*					
	j	a	s	o	n	d	j	a	s	o	n	d	j	a	s	o	n	d
CRUSTACEA																		
Cyclops	B	B	D	E	E	E	O	O	O	O	C	C	O	O	O	O	O	O
Moina	D	D	C	C	O	O	B	B	D	D	E	E	A	A	O	O	O	B
Latona	A	A	C	C	C	C	A	B	B	D	C	A	O	O	O	C	C	O
Diaptomus	O	O	E	E	B	B	O	O	O	O	O	O	B	B	D	E	E	C
Branchinella	O	O	O	O	O	O	O	O	O	O	O	O	C	C	D	D	D	D
Polyphemus	O	O	O	O	O	O	C	C	E	E	B	D	B	B	C	C	C	A
Simocephalus	O	O	O	A	O	O	D	E	E	B	B	A	C	C	A	A	O	O
Bosmina	O	O	O	O	O	B	C	C	C	D	B	B	O	O	O	O	O	O
Daphnia	O	O	A	A	O	O	O	C	D	D	D	D	O	O	A	O	O	O
ROTATORIA																		
Branchionus	A	A	C	C	C	B	O	O	O	O	O	O	C	C	E	E	A	A
Keratella	O	O	B	B	B	B	C	C	E	E	A	A	O	O	O	O	O	O
Filinia	A	A	C	B	A	O	D	D	E	E	A	A	O	O	O	O	O	A
Adineta	B	B	O	O	A	B	O	O	O	O	O	O	O	O	O	O	O	O
Floscularia	C	D	E	E	A	O	O	O	A	A	O	O	O	O	O	O	O	O
Asplanchna	O	O	O	O	O	O	A	C	E	E	D	D	O	O	O	A	O	O
Mytilina	O	O	O	O	O	O	O	O	O	A	O	O	C	C	D	A	A	A
Euchlanis	O	A	O	O	O	O	B	B	O	O	O	O	D	D	C	C	O	O
Acylus	O	O	O	O	O	O	O	O	O	O	O	O	B	B	C	C	A	A
OLYGOCHAETA																		
Tubifex	O	O	O	O	O	O	O	O	O	O	O	O	A	O	O	O	O	O

might be due to feeding in the same ecological niche in the pond. However, detritus contributed maximum in their gut contents again because of their feeding on the bottom. Similar findings were also reported for common carp by Opuszynki (1981) and Spataru *et al.* (1983). The main food of grass carp (*Ctenopharyngodon idella*) consisted of aquatic macrophytes. There preference remained as minimum for zooplankton, probably because of the feeding habit of this fish. Food ingestion in fish is highly variable and depends on a variety of factors, including availability of the different food items, species combination and their interactions. Fishes can consume different food organisms in different amounts under various species combinations and densities (Milstein and Svirsky, 1996). Proper association of fish species may help to develop synergism. Stocking density influences individual food availability with high densities causing preferred foods to become depleted (Milstein, 1992). This might lead to shifts from planktivory to piscivory as with common carp eating tilapia fry at high density when there are insufficient other natural foods available (Spataru and Hepher, 1977).

Table 6 - zooplankton and their relative abundance in *Hypophthalmicthys molitrix, Ctenopharyngodon idella* and *Cyprinus carpio*. Relative abundance expressed by the symbols: O = not present; A = < 1 % ; B = 1-5% ; D =10-15% ; E = > 50%; j, a, s, o, n, d, months

	SILVER CARP						GRASS CARP						COMMON CARP					
	j	a	s	o	n	d	j	a	s	o	n	d	j	a	s	o	n	d
CRUSTACEA																		
Cyclops	O	O	O	B	B	A	O	O	O	O	A	O	B	B	C	C	D	B
Moina	C	C	D	E	A	A	O	O	B	B	O	B	B	B	D	D	E	E
Latona	A	A	O	O	O	O	A	A	A	O	O	O	A	A	O	O	O	O
Diaptomus	O	O	O	O	O	O	O	O	O	O	O	O	B	B	B	B	B	O
Branchinella	C	C	E	E	A	A	B	B	O	O	O	A	O	O	O	O	O	O
Polyphemus	O	O	O	O	O	O	A	A	A	O	O	O	C	C	C	D	D	A
Simocephalus	A	A	O	O	A	A	B	B	O	O	O	O	O	O	A	A	O	A
Daphnia	C	C	E	E	C	C	O	O	O	O	O	O	B	B	O	O	A	A
ROTATORIA																		
Branchionus	O	O	A	A	B	B	A	A	A	O	O	A	O	O	O	O	O	O
Keratella	B	B	O	O	A	A	O	O	O	O	O	B	C	C	C	O	O	A
Filinia	A	A	O	O	O	O	B	B	C	C	E	O	O	O	B	B	B	O
Adineta	O	O	O	O	O	O	O	O	O	O	O	O	A	A	D	B	A	O
Floscularia	O	O	B	B	O	O	O	O	O	O	O	O	O	B	C	A	O	O
Asplanchna	C	C	E	E	D	D	A	O	O	O	A	O	O	O	O	B	B	O
Mytilina	O	O	O	O	O	A	O	O	O	O	O	O	O	B	C	C	C	B
Euchlanis	D	D	E	E	C	C	A	A	A	O	O	O	O	O	O	O	O	O
Acylus	O	O	O	O	O	O	O	O	O	O	A	O	B	C	C	A	A	O
OLYGOCHAETA																		
Tubifex	O	O	O	O	O	O	O	O	O	O	O	O	B	C	B	A	A	A

CONCLUSION

Analysis of the quantity and composition of the food in major, common and Chinese carps led to the conclusion that this composite culture is a satisfactory substitute of polyculture or monoculture of only major carps in Pakistan. These fish species consumes their natural consumer i.e. phytoplankton and zooplankton. The main natural food of grass carp consisted of aquatic macropytes.

Table 7 - changes in phytoplankton density in various treatment stocked with six fish species (Density presented as number (X 10^5) of individuals l^{-1})

STOCKED FISH SPECIES IN ALL PONDS	TREATMENTS	MONTHS					
		JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Catla catla	T_1	15.50	27.75	38.00	32.25	23.50	12.00
Labeo rohita	T_2	12.75	30.00	45.75	65.00	27.75	18.50
Cirrhinus mrigala	T_3	7.50	17.00	29.50	25.00	18.50	6.50
Hypopthalmichthys molitrix	T_4	14.00	33.75	44.50	48.00	2O.50	15.50
Ctenopharyngodon idella	T_5	6.00	8.50	12.50	11.75	7.00	5.75
Cyprinus carpio	MEAN	11.15	23.40	34.05	36.40	19.45	11.65

Table 8 - changes in zooplankton density in various treatment stocked with six fish species (Density expressed as number of individuals l^{-1})

STOCKED FISH SPECIES IN ALL PONDS	TREATMENTS	MONTHS					
		JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Catla catla	T_1	790	1930	2850	3670	2550	1875
Labeo rohita	T_2	915	2445	3550	4205	3850	2275
Cirrhinus mrigala	T_3	550	1575	2210	2005	1650	780
Hypopthalmichthys molitrix	T_4	880	2260	3350	4050	3500	1875
Ctenopharyngodon idella	T_5	360	750	670	850	550	490
Cyprinus carpio	MEAN	699	1792	2526	3156	2420	1459

Table 9 - Frequency of occurrence, maximum number and reconstituted wet weight of food components in the gut of six fish species.
1= Frequency of occurrence: the proportion of fish in whose guts the given food components found in a single fish.
2= Maximum number of individuals of given food component found in a single fish.
3= Maximum reconstituted weight (mg): the weight of the maximum numbers of individuals found.

Food components	*Catla catla*			*Labeo rohita*			*Cirrhinus mrigala*		
	1	2	3	1	2	3	1	2	3
Phytoplankton									
Chlorophyta	12	$1.5x10^{11}$	30775.0	11	$1.2x10^{6}$	12375.2	12	$1.0x10^{5}$	7540.4
Euglenophyta	10	$0.7x10^{5}$	1663.4	09	$0.5x10^{3}$	794.2	07	$0.8x10^{5}$	386.1
Myxophyceae	12	$1.1x10^{7}$	4980.7	12	$0.8x10^{3}$	532.0	07	$0.6x10^{5}$	280.7
Bacilariophyceae	09	$0.8x10^{8}$	1854.2	06	$0.5x10^{4}$	185.9	08	$0.8x10^{6}$	395.6
Zooplankton									
Crustacea	12	102	1.1	12	451,237	10605.2	12	402,342	9685.5
Rotatoria	11	57	0.7	11	39685	2075.4	10	35243	1985.4
Olygochaeta				12	-		12	-	
Tubifex	12	-		-			02	07	05
Zoobenthos,									
Ostracoda	12	-		07	16	125.7	05	10	22.1
Chironomidae	12	-		12	-		-		
May fly nymph	12	-		12	-		01	02	2.3
Detritus	5		1.7	06	-	18.5	09	-	15.0

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