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Food and Feeding Habits of *Cyprinus carpio* Var. *communis*: A Reason that Decline Schizothoracine Fish Production from Dal Lake of Kashmir Valley

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Abstract

In this paper, we studied the food and feeding habits of exotic *Cyprinus carpio* Var. *communis*. The results obtained by analysing the gut contents of common carp showed that on an average basis, detritus formed 43.5% of total food, while the remaining food (56.5%) consisted of plant (31.21%) and animal matter (25.29%). The fish was designated as detri-omnivore with bottom feeding habit. Gastroosmatic index (Ga.S.I.) recorded its highest value during July (6.28), while lowest value was recorded in February (3.34).The index remained generally high during the warmer months, followed by a gradual decline with the approach of winter. On comparing, food and feeding habits and Ga.S.I. of exotic common carp with that of endemic schizothoracines was found almost similar and there might be existing a feeding competition between them, which might be one of the cause that declined endemic schizothoracine fish production from Dal Lake of Kashmir valley.

Keywords: *Cyprinus carpio*; Exotic; Endemic; Food and feeding habits; Schizothoracines.

Introduction

Valley Kashmir is bestowed with enormous and rich aquatic resources in the shape of rivers, lakes, streams, high altitude lakes, springs and low lying areas covering total water spread area of about 32765.3 hectares which is nearly 2% of total area of the Kashmir Valley. The major fish fauna of these water bodies comprises of exotic *Cyprinus carpio* and indigenous *Schizothorax* species. Other rarely found species are *Labeo, Glyptosternum, Puntius, Nemacheilus* e.t.c., *Schizothorax* is represented by many species v.i.z., *Schizothorax esocinus*, *Schizothorax curvifrons*, *Schizothorax niger*, *Schizothorax plageostomus*, *Schizothorax labiatus* e.t.c., which are commonly called as snow trouts. The Dal Lake is situated between 34º5' and 34º6'N latitude and 74º8' and 74º12' E longitude at an altitude of 1584 m above sea level. It is a shallow open drainage type water body spread over an area of 11.4 km^2. Till recent past, the Dal Lake was considered to be one of the finest lakes in the country and also as one of the most scenic spots in the world. However, due to over exploitation during the last fifty years this water body has turned into a highly polluted ecosystem. Addition of nutrients from anthropogenic perturbations in the catchment, creation of floating gardens and islands within its basins, anchoring of hundreds of house-boats within the lake and introduction of exotic common carp have changed the overall ecological setup of this water body. In the long run introduction of exotic species may turn out to be a deleterious problem as habitat loss and causes extinction of species [1]. The commercially important fish of the Dal lake are exotic *Cyprinus carpio-specularis* and *C. carpio- communis* and endemic ones are *Schizothorax niger, S. esocinus, S. micropogan* and *S. plagiostomus*.

The *Cyprinus carpio* (common carp) was brought to India in 1939 from Srilanka and introduced into the Nilgiris. Later in 1947 this species was introduced in Nainital and other lake of Kumaon and was carried to Bangalore. It is an ideal species for cold water of the hills and breeds in confined water. The common carp was introduced in Dal Lake of Kashmir in 1956 and since then this fish has shown remarkable adaptation in various water bodies of the state, and soon began to constitute a major fishery of flat land temperate waters of Kashmir [2]. The *Cyprinus carpio* formed almost 75% of the fish catch in Dal and Wular lakes of Kashmir [3]. The introduction of the exotic common carp caused a sharp decline in the population and almost exterminated the schizothoracine fishes in Kashmir valley [4,5]. The total fish production in Dal lake ranged from as low as 262 tonnes in 2007-08 to a maximum of 475 tonnes in 2003-2004 and fish production in 2010-2011 was 336 tonnes. The total fish production in Dal Lake was held up by increasing exotic carp fish production and the rate of decline in *Schizothorax* (local) fish production was steep as well as pronounced in variation when statistical models were applied [6] (Figure 1A-1C). So common carp caused a slow and steady decline in the initial phases and later an abrupt drop in the contribution of the *Schizothorax* species to the total fish production in Dal Lake of Kashmir.

The major reasons put forth by different zoologists for the predominance of common carp over the more prized endemic fish fauna in the lake were food competition due to more or less identical food spectra, higher fecundity, spawning facilities prevailing in the lake, shorter incubation period, better fertilization and better growth rate. The food and feeding habits of common carp and schizothoracines is almost identical, with many of the lacustrine species of schizothoracines feeding on detritus and benthos. So food competition is one of the important reason for declining the endemic fish production. It was with this background that a detailed study on food and feeding habits of exotic *Cyprinus carpio* in Dal Lake was undertaken and compared it with previous work based on food and feeding habits of endemic *schizothorax* species.

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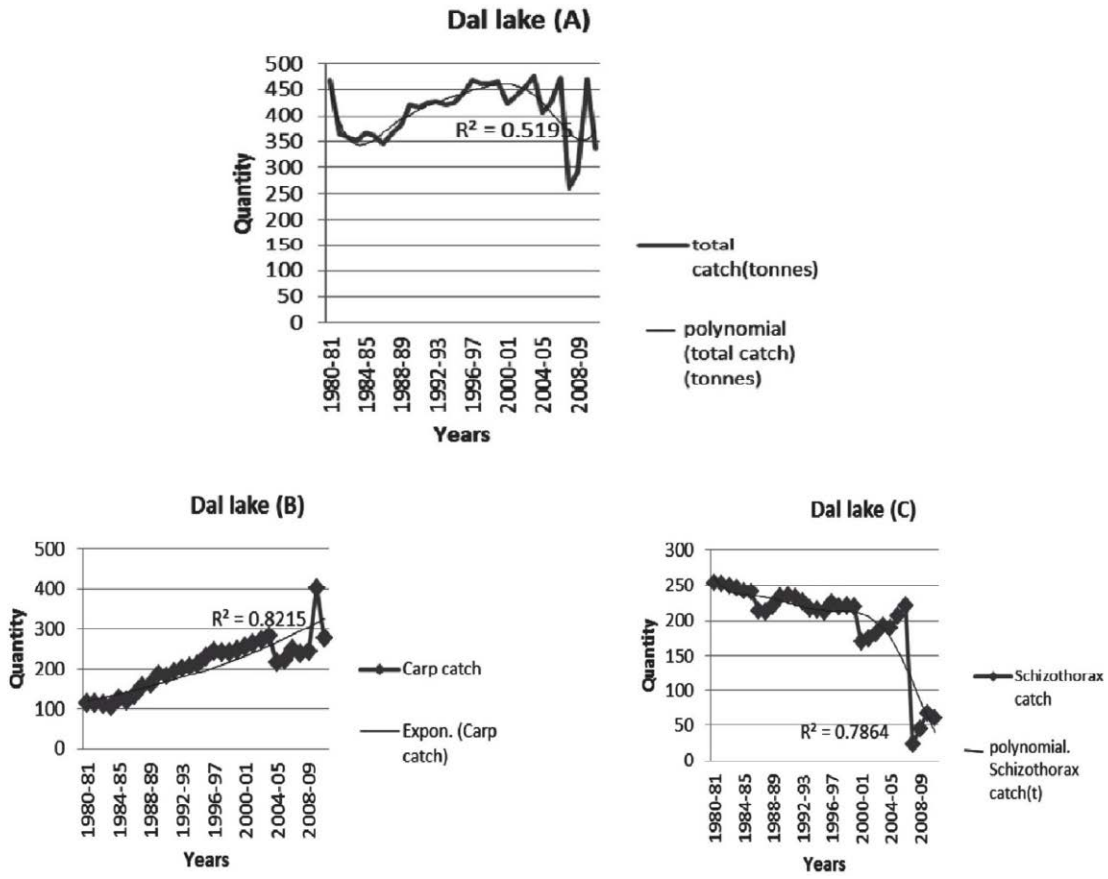

Figure 1: Trends in fish production in Dal lake (1980-2011) (A-C).

Material and Methods

In order to study the food and feeding habits of common carp, samples were collected from the commercial catcher during fishing in the year 2012 from January to December at Dal Lake Kashmir. All the fish specimens were weighed separately and then gutted for the collection of gut contents and preserved in 5% formalin. The collected guts were weighed and their content emptied in the watch glass. The same were analysed qualitatively as well as quantitatively by eye estimation, volumetrically [7] and occurrence method [8] for evaluating the relative importance of all food items. The various items were examined and sorted out using a binocular microscope and thus identified. Standard taxonomical keys were consulted for identification of plankton, oligochaetes, insects and other invertebrates [9,10]. The percentage occurrence of different items of food in different months was determined by summing the total number of occurrence of all items from which the percentage occurrence of each item was calculated. To find out the feeding rhythm of *Cyprinus carpio,* Gastrosomatic index was evaluated using the computational formula:

$$\mathbf{Ga.S.I} = \frac{\text{total weight of full gut}}{\text{total weight of fish}} \text{X100}$$

Results

The analysis of gut contents of the fish revealed that on an average 43.50% of it was detritus and 56.5% included plant and animal matter. The animal food was contributed by crustaceans, oligochaetes, insect larvae, insect remains, fish remains, molluscan remains, rotifers and protozoans. On the average the total contribution of animal food was 25.29% of which crustaceans (copepods, cladocerans and ostracods) contributed 13.01%, oligochaetes 1.6%, insects 3.97%, fish remains 2.4%, molluscan remains 2.44%, protozoans 0.28% and rotifers 1.05% to the total food. The total contribution of vegetative matter was 31.21% consisted of macrophytic tissue and algae, former contributing 27.36% and the latter 3.85% on an average annual basis (Table 1).

The present study revealed that the fish is detri-omnivore in feeding habit, as on the whole 43.50% of gut contents were contributed by detritus and remaining by animal and plant matter. The detrital component revealed its peak contribution during December (53.9%), while minimum in March (31.7%) & May (34.9) (Table 1). Among the animal food, crustaceans were present throughout the year with maximum & minimum contribution in May (19.9%) and December (4.2%) respectively. Oligochaetes recorded peak contribution during February (6.9%), while in July and October it contributed only (0.1%) and was absent in November and December. The contribution of fish remains in the gut was maximum (7.9%) during December and minimum (0.1%) during June and August, however, during July these were absent from gut contents. Insects recorded their peak contribution in March (8.0%) but were absent from gut contents during November. Macrophytes recorded highest contribution in November (31.7%), and minimum (20.0) in January. The algae contributed the maximum (7.1%) in March, while minimum in August (1.7%).

Gastrosomatic index (Ga.S.I.) recorded its highest value during

Food ⇨ Month ⇩	CRT	INS	FR	MR	OLI	PROT	ROT	ALG	MT	MIS	DET
Jan.	9.9	3.50	4.3	2.1	1.9	0.2	1.7	6.5	20.0	2.8	47.1
Feb.	10.3	4.41	2.2	3.3	6.9	0.9	1.2	2.1	23.5	2.6	42.6
March	15.6	6.4	1.3	1.1	5.7	0.3	1.6	7.1	29.9	1.4	31.7
April	14.5	4.2	0.9	1.3	1.2	0.1	0.9	3.5	30.6	2.7	38.3
May	19.9	8.0	0.3	0.3	0.9	0.1	0.3	2.9	30.9	1.50	34.9
June	17.8	7.4	0.1	0.1	1.3	0.2	0.8	2.3	28.0	1.40	40.6
July	18.0	7.1	0.0	0.05	0.1	0.3	2.1	2.1	25.3	2.65	42.3
Augt.	16.3	2.2	0.01	0.0	0.9	0.01	1.1	1.7	28.9	2.9	46.0
Sept.	13.2	2.1	2.1	0.9	0.2	0.02	0.6	3.9	24.1	2.9	50.0
Oct.	8.4	2.1	2.3	0.2	0.1	0.05	0.8	4.2	31.1	1.45	49.3
Nov.	7.0	0.0	7.3	0.0	0.0	0.15	0.5	5.1	31.7	2.15	46.1
Dec.	4.2	0.5	7.9	1.0	0.0	0.19	1.0	4.8	24.3	2.21	53.9
Mean	**13.01**	**1.61**	**2.4**	**2.44**	**1.6**	**0.28**	**1.05**	**3.85**	**27.4**	**2.21**	**43.5**

CRT=Crustacea; INS=Insects; FR=Fish remains; MR=Molluscan remains; OLI=Oligochaetes; PROT=Protozoa; ROT=Rotifera; ALG=Algae; MT=Macrophyte tissue ; MIS=Miscellaneous; DET=Detritus.

Table 1: Monthly percentage of different food components in the gut of *Cyprinus carpio* at Dal Lake of Kashmir from January 2012 to December 2012.

Month	No. of fishes examined	Mean total wt. of fishes (g)	Mean wt. of gut (g)	Ga.S.I
Jan.	23	518	20	3.86
Feb.	16	910	31.4	3.34
March	14	1270	43.4	3.42
April	10	1800	88	4.89
May	12	1400	86	6.14
June	15	900	52	5.78
July	11	1450	91	6.26
Augt.	14	1190	70	5.89
Sept.	11	1350	83	6.14
Oct.	14	1430	87	6.10
Nov.	17	1080	61	5.65
Dec.	17	1020	50.5	4.95
Maximum	**23**	**1800**	**91**	**6.28**
Minimum	**10**	**518**	**20**	**3.34**

Table 2: Mean monthly variation of Gastrosomatic Index (Ga.S.I) of *Cyprinus carpio* at Dal Lake.

July (6.28), while lowest value was recorded in February (3.34). The fish showed a marked reduction in Ga.S.I values from January (3.86) to March (3.42) at a time when the abdominal cavity was filled with Gonadal mass. An improvement was recorded in April (4.89) and the index remained generally high during the warmer months, followed by a gradual decline with the approach of winter (Table 2).

Discussion

Endemic schizothoracines are fast losing their ground in Kashmir lakes due to various anthropogenic factors. One of the factor is introduction of exotic common carp that has higher fecundity and breeds in confined waters [11,12]. By contrast, schizothoracines undergo breeding migration for spawning in streams, and they also have a lower fecundity than common carp. Further the food and feeding habits of common carp and schizothoracines are almost identical. Knowledge of food and feeding habits of a fish is important for understanding its biology as well as for the successful management of its fishery. Nature offers a great diversity of food to fishes and accordingly various species are known to differ in their feeding habits, some being the predators like pikes, some others are omnivores like the gold fish, while many others are herbivores [13].

In this paper, we studied the food and feeding habits of exotic *Cyprinus carpio* from Dal Lake of Kashmir Valley and compared it with previous work based on the food and feeding habits of endemic *Schizothorax* species. The results obtained by analysing the gut contents of common carp showed that on an average basis, decayed organic matter (detritus) formed 43.5% of total food, while the remaining food (56.5%) consisted of plant (31.21%) and animal matter (25.29%). On the basis of gut content analysis, the fish was designated as detri-omnivore. Bottom feeding habit of common carp was supported by the present data as benthic organisms like oligochaetes, insect larvae and ostracods were recorded from their gut contents. Bottem feeding habit of common carp was also reported by other authors [11,14,15]. Earlier studies revealed herbivorous feeding habit of *C. carpio communis* and

C. carpio specularis from Dal Lake and indicated that 29% of the food of *C. c. specularis* was of animal nature, while in case of *C. c. communis* animal matter contributed 34% of the food [11,14]. Most of the authors reported omnivorous feeding habit of common carp [15-19] *Cyprinus carpio* was designated as detri-omnivore when 45% of detritus and remaining of both plant and animal matter was reported from the gut contents of fish [15].

The previous work based on food and feeding habits of endemic *Schizothorax* spp. of Kashmir revealed that the gut contents of *Schizothorax* spp is composed of detritus, vegetative and animal matter in varying quantities. Jan and Das [14] reported *Schizothorax niger* and *Schizothorax esocinus* as herbivorous fishes in which the contribution of average annual animal food was 33.5% and 30.5% and plant food was 61.0% and 63.5% respectively. The animal food contributed of protozoans, rotifers, zooplankters, insect adults, insect remains, fish scales, fish eggs etc., and plant food consisted of green algae, diatoms, macrophytes, besides some amount of detritus and sand. The gut contents of *Schizothorax esocinus* consisted of 63.5% of plant matter and 30.5% of animal matter [20]. On an average diet of *Schizothorax curvifrons* was composed of dissolved organic matter (40.33%), sand and mud (17.51%), phytoplankton (38.78%), zooplankton (2.00%) and miscellaneous matter (1.38%) [11,12]. By studying the food and feeding habits *Schizothorax curvifrons* and *Schizothorax esocinus,* the author reported former as a phytophagus fish with average contribution of animal matter (12.43%), vegetable matter (51.25%), unidentified animal matter (6.25%), unidentified vegetable matter (27.67%) and sand particles (2.595) and latter i.e, *Schizothorax esocinus* as an omnivorous fish as 57.09% of animal matter was recorded from the gut contents of the fish [21]. *Schizothorax* spp. are usually surface feeders but sometimes feed at the lower levels also due to the scarcity of the food or disturbance of the upper water strata [14]. So food of common carp and snow trouts was found to be almost similar composed of detritus, vegetable and animal matter in varying quantities. In almost all cases percentage of vegetable matter was found to be higher than that of animal matter.

During spawning season the size of ovaries increases and most of the abdominal cavity is occupied by it. So feeding (gastrosomatic index) of fishes is usually found to be related to their maturity stages (gonadosomatic index) to a great extent. The two indices has an inverse relationship to each other with the result the gastrosomatic index is low during spawning season. In common carp during present study Ga.S.I. recorded its highest value during July (6.28), while lowest value was recorded in February (3.34). The fish showed a marked reduction in Ga.S.I values from January (3.86) to March (3.42) due to spawning season. The index remained generally high during the warmer months, followed by a gradual decline with the approach of winter. Feeding (gastrosomatic index) of *Schizothorax curvifrons* and *Schizothorax esocinus* was also found to be related to their maturity stages and was low during April to June in former and March to May in latter [21]. So Ga.S.I values were low in all the three species in first few months i.e, January to March in common carp, April to June in *S. curvifrons* and March to May in cases *S. esocinus* and was higer during rest of the year in all cases. It is reported that during spawning season, feeding rate would be relatively lower and it increases immediately after spawning as the organisms feed voraciously to recover from fast [22-26].

Present study revealed that food and feeding habits of exotic common carp was almost identical to endemic snow trouts and there might existed a feeding competition between them. So besides various other reasons that declined endemic snow trout fish production in Dal Lake of Kashmir valley, overlapping of food and feeding habits with common carp might be one of the important reason.

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