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Review article

A review on *Labeo calbasu* (Hamilton) with an emphasis on its conservation

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Abstract

Labeo calbasu is a freshwater fish species and is the most important carp species next to three Indian Major Carps *Labeo rohita*, *Catla catla* and *Cirrhinus mrigala*. It is a popular food fish and also is admired as a sport fish. Recently this fish species has also made its entry in ornamental fish markets of India and abroad. In last few years, the natural populations of this fish species has seriously declined due to over fishing and other anthropological reasons. In India it has been reported as Lower Risk near Threatened and in Bangladesh as endangered species. Earlier number of works has been conducted on different aspects of *Labeo calbasu* including food and feeding habit and reproductive biology. This report has been prepared with a view to sum up all those previously documented information along with pointing out the missing information further study of which will be beneficial for its fishery. Apart from this, it has been tried to note down some possible measures which should be considered for its conservation.

Keywords: Feeding habit, reproductive biology, conservation, *Labeo calbasu*

INTRODUCTION

Labeo calbasu is a freshwater fish species belonging to the family Cyprinidae under the order Cypriniformes. It is the most important carp species next to the three Indian major carps *i.e. Labeo rohita*, *Catla catla* and *Cirrhinus mrigala* (Chondar 1999). It is a popular food fish having good taste, less intramuscular bones and high protein content; is also admired as a good sport fish (Talwar and Jhingran 1991, Chondar 1999, Rahman 2005). This fish species supports an important commercial fishery in rivers and reservoirs of different countries mainly in India (Pathak and Jhingran 1977, Gupta and Tyagi 1992, Singh *et al.* 1998, Chondar 1999, Dwivedi *et al.* 2004, Nautiyal *et al.* 2004). Recently it has made its entry in ornamental fish markets of India (Gupta *et al.* 2012) and also has been reported to be exported from India as indigenous ornamental fish (Gupta and Banerjee 2014). The natural populations of this fish species has seriously declined due to overfishing, habitat degradation, aquatic pollution, dam construction and several other anthropological reasons which are affecting its feeding migration and spawning (Das and Barat 1990, CAMP 1998, Hossain *et al.* 2010, Hasan *et al.* 2013). In India it has been documented as Lower Risk near Threatened (CAMP 1998) while in Bangladesh as Endangered species (IUCN Bangladesh 2000).

SYNONYMS

Cyprinus calbasu (Hamilton 1822)
Cirrhinus calbasu (McClelland 1839)
Cyprinus micropogon (Valenciennes 1841)
Rohita calbasu (Valenciennes 1842)
Rohita belangeri (Valenciennes 1842)
Rohita reynauldi (Valenciennes 1842)
Labeo velatus (Valenciennes 1842)
Labeo calbasu (Günther 1868)

COMMON NAMES

Labeo calbasu is vernacularly known as Calbasu/Kurcha /Mahlee/Kalabeinse in India; Kalibaus/Kalbasu in Bangladesh; Nga-nek-pya/Nga-noo-than/ Nga-ong-tong/ Nga-gyeen-boo in Myanmar (Chondar 1999).

DISTRIBUTION

It is widely distributed in India, Bangladesh, Pakistan, Myanmar, Nepal, south China and Thailand (Day 1878, Talwar and Jhingran 1991, Chondar 1999).

HABITAT

It is a freshwater fish species; mainly inhabits rivers but is also well established in natural lakes, reservoirs, streams, ponds, beels, baors, haors and canals (Bhuiyan 1964, Chondar 1999, Riede 2004, Rahman 2005). Its favorite habitat is the deep pools of rivers, where it largely remains localized during the winter and summer months, and ascend to adjacent shallower region of the river for breeding during monsoon months (Chondar 1999). It is available both in plains (Khan 1934) as well as in the hill streams (Shaw and Shebbeare 1937, Rajagopal and Rao 1975). Mookerjee and Mazumdar (1944) have reported that it is fond of living in mud of the pond and occasionally comes to the surface and near the edge of the pond for feeding. The larvae and post-larvae mainly shoal on the surface and sub-surface regions of the water (Chondar 1999).

MORPHOLOGICAL CHARACTERS

Day (1878), Talwar and Jhingran (1991) and Chondar (1999) have well documented the morphological characters of *Labeo calbasu* which has been summarized here: Body is deep, strongly-built and torpedo shaped. Dorsal and ventral profiles are almost equally convex. Snout is obtuse and depressed, with pores on it and upper lip but without lateral lobe. Mouth is inferior, gape narrow; lips are thick and fringed (more specially the lower lip) and each is having a distinct inner fold. Gill rackers are very short. Barbels are two pairs in number; rostral and maxillary pair, the former being longer and are about as long as the diameter of the orbit. Teeth are pharyngeal, crooked, 5, 4, 2/2, 4, 5. Dorsal fin is large, commencing slightly anterior to ventrals, and midway between the snout and base of the caudal; its upper margin is somewhat concave. Ventral commences below the fourth or fifth dorsal ray. Caudal fin is deeply forked. All fins are black in color. Scales are cycloid in nature, usually blackish; sometimes many of them have a scarlet centre. Body color is blackish, but the ventral part is light dark.

MAXIMUM LENGTH

Till date 91.2 cm has been reported as the maximum length for *Labeo calbasu* by Day (1878). Apart from this, specimens with maximum length of 50.5 cm (Pathak and Jhingran 1977); 63 cm (Rao and Rao 1972); 64 cm (Khumar and Siddiqui 1989); 76 cm (Alikunhi 1957); 85 cm (Natarajan 1971) and 90 cm (Talwar and Jhingran 1991, Menon 1999) have been documented by different workers in their studied populations.

GROWTH PATTERN

Maximum of the earlier workers (Natarajan 1971, Rao and Rao 1972, Chatterji *et al.* 1980, Vinci and Sugunan 1981, Alam *et al.* 2000, Haroon *et al.* 2002, Naeem *et al.* 2012, Rizvi *et al.* 2012) have reported allometric growth pattern in *Labeo calbasu* though few (Natarajan 1972, Pathak 1975, Khan 1988) also have documented isometric growth pattern for this fish species.

FOOD AND FEEDING HABIT

Food and feeding habit of *Labeo calbasu* earlier has been studied by number of workers (Mookerjee and Mazumdar 1944; Mookerjee *et al.* 1946; Chacko and Kurian 1949; Alikunhi 1952, 1957; Das and Moitra 1955, 1963; Bhuiyan 1964; Natarajan 1971; Pathak 1975; Vinci and Sugunan 1981; Khumar and Siddiqui 1989; Chondar 1999; Dasgupta 2001; Laghari *et al.* 2015) and all of them have reported it as a bottom feeder.

Mookerjee and Mazumdar (1944) have documented in details the food and feeding habit of hatchling, fry, fingerling, immature young and mature adult of *Labeo calbasu* from West Bengal. They have reported that 5.6-5.8 mm pro-larvae imbibe unicellular organisms such as protozoa (*Paramoecium* sp., *Chaenia* sp. etc) and unicellular algae (*Chlorococcus* sp., *Closterium* sp. etc.) while the spawn and early fry (6.5-15 mm) subsist on small crustaceans (*Daphnia* sp., *Cyclops* sp., *Cypris* sp.), multicellular blue green algae (*Oscillatoria* sp., *Vaucheia* sp. etc) and protozoa (both ciliates and flagellates). Fry and fingerlings (16-80 mm) are used to consume varieties of food of both animal and plant origins like ciliates, flagellates, copepods, ostracoda, malacostraca (shrimps), mosquito larvae, green algae (*Chlorella* sp., *Closterium* sp., *Beyer* sp., *Chaetophora* sp. etc), blue-green algae (*Oscillatoria* sp., *Lyngbya* sp. etc), diatoms (*Synedra* sp.) and some vegetable debris. With advancement in growth, the juvenile, immature young and adult (180-480 mm) start to take semi-rotten aquatic vegetable debris (parts of petiole of *Nymphaea* sp.; leaves of *Vallisneria* sp., *Lemna* sp., *Hydrilla* sp. etc.; and some vegetable debris in the form of gelatinous mass); mosquito and other insects larvae (Agrionid larvae, Ephemerid larvae, parts of some insects larvae). Occasionally they also consume some

molluscs (*Viviparous bengalensis*, *Melanoides tuberculata* etc) even with the shell and crustaceans. Presence of *Spongilia* (Porifera) in the gut content has also been reported. All these findings are suggesting omnivorous feeding habit of *Labeo calbasu* which later has been supported by another work of Mookerjee *et al.* (1946) who have documented calbasu as an omnivorous fish, having the adult food composition as algae (10%), higher plants (48%), protozoa (12%), crustacean (10%), molluscs (5%) and mud and sand (15%). Calbasu from south Indian waters have been reported to feed on algal matter and macrocrustacea (Chacko and Kurian 1949). Alikunhi (1952, 1957) has reported adults of calbasu used to consume snails and worms at the bottom of pond in addition to the usual algae and other elements; the animal portion of the diet is generally very small. The main food of the adults is vegetable debris, microscopic plants, detritus and mud. The animalcules and the water fleas are the food of the fry; and the vegetable debris and microscopic plants, few water-fleas, and detritus and mud form the food of the fingerling. Natarajan (1971) has reported that 250-440 mm long Bhabanisagar calbasu are having preference for bottom rotifers, copepods, cladocerans, *Cypris* larvae, flagellates and diatoms; and in older group with changing feeding habit preferring bottom remains. Pathak (1975) also has reported omnivorous feeding habit of this fish species; he has reported decayed organic matter as its main food. Other food items which have been documented from its gut content in order of preference are bacillariophyceae (*Amphora sp.*, *Cyclotella sp.*, *Cymbella sp.*, *Diatoma sp.*, *Eunotia sp.*, *Fragilaria sp.*, *Gomphonema sp.*, *Gyrosigma sp.*, *Melosira sp.*, *Navicula sp.*, *Nitzschia sp.*, *Pinnularia sp.*, *Surirella sp.*, *Synedra sp.*, *Tabellaria sp.*), plant matter (represented by portion of aquatic plants like *Hydrilla sp.*, *Najas sp.*, *Vallisneria sp.* and portions of leaves and roots of unidentified plants), chlorophyceae (*Cosmarium sp.*, *Coelastrum sp.*, *Mougeotia sp.*, *Oedogonium sp.*, *Pediastrum sp.*, *Scenedesmus sp.*, *Spirogyra sp.*, *Ulothrix sp.*, *Zygnema sp.*), myxophyceae (*Anabena sp.*, *Oscillatoria sp.*, *Merismopoedia sp.*, *Phormidium sp.*, *Rivularia sp.*) and miscellaneous items (zooplankton, dipteran larvae, crustaceans appendages and fish eggs). Juveniles have been reported to have maximum preference for zooplankton followed by diatoms, algal matter, plant matter and decayed organic matter. Thus a clear difference in food preference between adults and juveniles has been documented by him; decayed organic matter which is a preferred food in adults has been observed to be ranked fifth in juveniles whereas zooplankton which is an insignificant food item in the gut content of adults has been observed to be the most preferred food in juveniles. This kind of difference in food preference between juveniles and adults has later also been reported by Khumar and Siddiqui (1989) who also have documented its omnivorous feeding habit. They have reported that it feeds on a large variety of food items like decayed organic matter, mollusc, diatoms, plant matter, green algae and blue-green algae. They have documented decayed organic matter as the main food of adult fishes followed by mollusc [represented by various forms of gastropods (*Viviparous bengalensis*, *Indoplanorbis exustus*, *Gyraulus convexiusculus* and *Melanoides tuberculata*) and pelecypoda (*Psicidium clarkeanum* and *Parreysia corrugata*, *v. bengalensis*)], bacillariophyceae (*Navicula* sp., *Amphora* sp., *Cyclotella* sp., *Nitzschia* sp., *Diatoma* sp., *Gyrosigma* sp., *Cymbella* sp., *Fragillaria* sp., *Melosira* sp., *Synedra* sp., *Tabellaria* sp., *Eunotia* sp., *Gamphonema* sp., *Pinnularia* sp., *Surirella* sp. and *Cocconeis* sp.), plant matter (represented by portion of aquatic plants like *Hydrilla* sp., *Vallisneria* sp., *Najas* sp. and portions of leaves and roots of unidentified plants), chlorophyceae (*Spirogyra* sp., *Scenedesmus* sp., *Ulothrix* sp., *Zygnema* sp., *Oedogonium* sp., *Cosmarium* sp., *Coelastrum* sp., *Mougeolia* sp., *Pediastrum* sp., *Selenastrum* sp. and *Ankistrodesmus* sp.), myxophyceae (*Microcystis* sp., *Anabaena* sp., *Oscillatoria* sp., *Merismopodia* sp., *Phormidium* sp. and *Rivularia* sp.) and miscellaneous food items (Zooplankton, protozoa, rotifers, cladocerans, dipteran larvae, crustacean remains and fish eggs). Vinci and Sugunan (1981) have documented that *Labeo calbasu* mainly feeds on organic detritus, diatoms and green algae; blue green algae and zooplankton have been reported as incidental food. Organic detritus matter (80.72%) has been reported as the mostly preferred food followed by bacillariophyceae (8.89%), mud (7.08%), and chlorophyceae (2.98%). *Fragillaria* sp. among the bacillariophyceae and *Spirogyra* sp. among the chlorophyceae have been reported to form the bulk of the diatoms and the green algae respectively. Bhuiyan (1964) has reported the presence of algae (10%), higher plants (48%), protozoa (12%), crustacean (10%), mollusc (5%) and mud and sand (15%) in its gut content.

Its herbivorous feeding habit has been reported by Das and Moitra (1955, 1963), Chondar (1999) and Dasgupta (2001). Chondar (1999) has documented decaying organic matter as the main food; he has also reported that the omnivorous feeding habit of early fry of calbasu used to gradually change to herbivorous dietary habit through advanced fry and early fingerling stages and become fully herbivore in juvenile. Das and Srivastava (1979) earlier have confirmed this changing feeding habit with growth in calbasu observing the Relative Length of Gut (RLG) values. Dasgupta (2001) has reported vegetable matter (60%), macrophyte tissue (10%), filamentous algae (5%), green algae (3%), roots of macrophytes (20%) and detritus (2%) in its gut content.

Change in feeding intensity with spawning periodicity has

been reported by Pathak (1975), Das and Srivastava (1979), Khumar and Siddiqui (1989) and Vinci and Sugunan (1981). All of them have reported low feeding activity in adults during the breeding season and recovery of the same after the spawning season.

SEXUAL DIMORPHISM

Male and female of *Labeo calbasu* can be identified by observing the secondary sexual characters which are used to appear only during the breeding season. The roughness of the pectoral fin, sandy texture on the scale, large size of the pectoral fin and the freely oozing milt coming out by putting slight pressure on the abdomen are the identifying morphological characters for the male whereas the smoothness of the pectoral fin and the scales, smaller size of the pectoral fin, bulging abdomen and the extrovert vent are the identifying characters for the female of this fish species (Chondar 1999). Chaudhuri (1959) has documented another identifying character in this respect; he has reported that when the pectoral fin is being extended backwardly and dorsally it reached the lateral line scale; 10^{th} or 11^{th} in male and 8^{th} or 9^{th} in female.

LENGTH AND AGE AT FIRST MATURITY

Natarajan (1971) and Rao and Rao (1972) have reported 40 cm (male) and 45 cm (female) as length at first maturity for *Labeo calbasu* at Bhavanisagar reservoir and Godavari river respectively. Later Pathak and Jhingran (1977) have documented 40 cm (male) and 33.6 cm (female) at Loni reservoir, Madhya Pradesh and Vinci and Sugunan (1981) have documented 30.6 cm (male) and 37.1 cm (female) from Nagarjunasagar reservoir, Telangana for the same.

Labeo calbasu used to mature in the third year of life (Gupta and Jhingran 1973), though attainment of maturity in second year is not also very rare (Chondar 1999).

SEX RATIO

Not much work has been done on this aspect except Pathak and Jhingran (1977) who have reported female dominance in their studied population of *Labeo calbasu*.

FECUNDITY

Labeo calbasu is a highly fecund fish. Khan (1934) has reported 739,400 as its fecundity while fecundity ranges of 288,000 - 438,000; 109,700 - 980,700; 40,200 - 517,500; 93,972 - 466,400; 67,500 - 572,460; 312,100 - 657,600 and 37,454 - 427,030 have been documented by Sukumaran (1969), Natarajan (1971), Rao and Rao (1972), Pathak and Jhingran (1977), Vinci and Sugunan (1981), Mishra and Saxena (2012) and Kabir and Quddus (2013) respectively. Chondar (1970) has reported relative fecundity of 8,76,000/kg of body weight for this fish species.

BREEDING PERIODICITY

Labeo calbasu is a seasonal breeder; breeds in monsoon months (Qasim and Qayyum 1961, Bhuiyan 1964, Natarajan 1971, Rao and Rao 1972). The breeding season used to vary in different regions coinciding with the monsoon floods of those regions. Khan (1924) and Qasim and Qayyum (1961) have reported July and August as spawning months for *Labeo calbasu* in Punjab waters. In Loni reservoir, Madhya Pradesh it breeds in between June to September with peak spawning occurs in July (Pathak 1975, Pathak and Jhingran 1977). Mishra and Saksena (2012) have reported May-August as its breeding season in Gohad reservoir, Madhya Pradesh. In south India, breeding is used to start by the end of May with the commencement of south west monsoon and continue till the end of October (Chacko and Kurian 1949). In Godavari river system, the peak breeding month is June (Rao and Rao 1972). Vinci and Sugunan (1981) have reported July-September as its breeding season with spawning peak in August at Nagarjunasagar reservoir, Telangana. Bhuiyan *et al.* (2013) have reported April-August as its breeding season while Kabir and Quddus (2013) have documented peak spawning in July in Bangladesh.

CONCLUDING REMARKS

Considering the information documented in this report, it is quite comprehensible that till date no firm conclusion is there regarding feeding habit of *Labeo calbasu*. Though all the earlier workers have documented it as a bottom feeder, but contradiction exists there regarding its feeding habit. Some workers (Mookerjee and Mazumdar 1944; Mookerjee *et al.* 1946; Alikunhi 1952, 1957; Bhuiyan 1964; Natarajan 1971; Pathak 1975; Vinci and Sugunan 1981; Khumar and Siddiqui 1989) have documented its omnivorous feeding habit while some others (Chacko and Kurian 1949; Das and Moitra 1955, 1963; Chondar 1999; Dasgupta 2001) have reported it as herbivorous fish. So an area of further research is there in this aspect. All the earlier workers have concluded on its feeding habit following gut content analysis which is a noble but a kind of preliminary analytical technique. In this regard, histo-morphological study of the alimentary canal along with enzymatic study of the same can be considered to get an apparent view. Difference in opinion among the earlier workers about its feeding habit may be due to number of reasons like habitat variability, difference in availability status of the food items, preference of the species for particular food item etc. So, all these factors must be kept in consideration while studying further. On the other hand, satisfactory

information is available on fecundity, length at first maturity and breeding periodicity of this fish species; but information on sex ratio is really very scanty. Further study is needed to get more information on this aspect as proper knowledge on sex ratio is useful to predict the potential of natural recruitment of the population. As the natural populations of *Labeo calbasu* are facing the threat of extinction, following measures can be considered for the conservation of this fish species:

(i) The conservation status of *Labeo calbasu* in its native countries has been assessed more than a decade ago. Thus there is high chance that the present condition has been worsened in between the time span due to factors causing declination of its natural population. So at first it is really needed to assess the current conservation status of the existing *Labeo calbasu* population.

(ii) The existing populations of *Labeo calbasu* must be protected and this can be done by (a) reducing the pressure on brood fishes imposing ban on fishing during the breeding season and by (b) regulation of mesh size to prevent the catch of young fishes to protect the stock.

(iii) The factors causing habitat degradation must be identified and proper steps to be taken to eradicate these problems.

(iv) In spite of its popularity as a food fish, not much information is till date available to improve its production in culture. Sahu *et al.* (2007) have reported lack of information on its culture is among the reasons which probably have restricted its incorporation into the commercial carp polyculture. So, further studies are needed to find out some improved culture technologies to enhance its production. Its compatibility with Indian Major Carps in polyculture system has already been documented (Hora and Pillay 1962, Chondar 1999). Hora and Pillay (1962) have recommended stocking of catla, rohu, mrigal and calbasu with ratio of 30: 50: 10: 10 for better production in polyculture. Chetia Borah et al. (2014) have tried to polyculture calbasu with catla, rohu, mrigal, silver carp, grass carp and common carp; they have reported that calbasu do not have any negative impact on the growth rate and survival of other carps. Hence this species can be considered compatible to other cultivable carps. Further they have pointed out that incorporation of calbasu in place of common carp may be a better strategy to get more production in polyculture. Apart from conventional culture methodology, its suitability with higher growth rate in periphyton-based aquaculture has recently been reported (Wahab *et al.* 1999, Sahu *et al.* 2007, Narejo and Rahmatullah 2010).

(v) Inadequacy in seed availability is one of the factors that has restricted its incorporation into the commercial carp polyculture system (Sahu *et al.* 2007). Artificial breeding can be an appropriate solution to solve this problem. Mishra *et al.* (2001) have reported that a single dose of 0.5 ml/kg of body weight of ovatide applied only to female is very effective for commercial seed production. Bhuiyan *et al.* (2013) have tried to compare the efficacy of pituitary gland extract (PG) and DOM+sGnRH in induce breeding of calbasu; and have found that PG is the best one in between these two. Dose of 1.5 mg/kg of body weight (1st dose for female and male) and 6 mg/kg of body weight (second dose for female) of PG are best in terms of achieving maximum percentage of ovulation, fertilization and hatching rate. They also have reported that DOM+sGnRH can accelerate the induced breeding process, reduce ovulation time and is cost-benefit to the hatchery operators and thus can be considered as an important alternative inducing agent for PG.

(vi) Success in artificial breeding largely depends on successful rearing of the larvae and fry to achieve better survivability and growth. So far not much work has been performed on this issue which must be done in near future.

(vii) Conservation of genetic resources can be a good solution to continue the supply of pure seeds as and when required. This can be achieved by conservation of gametes through gene banking. So far two outstanding achievements have been made by Nahiduzzaman *et al.* (2012) and Hassan *et al.* (2014) regarding sperm cryopreservation of *Labeo calbasu*.

(viii) General people should be made aware regarding the problem, and then using their interest and involvement conservation campaigns can be made successful.

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