

## **A Review on Feeding and Breeding Biology of *Systomus sarana* (Ham.-Buch., 1822); A Threatened Fish of Indian Subcontinent**

*Sandipan Gupta*

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120, India

**Abstract:** *Systomus sarana* is a freshwater fish species which is widely distributed in different countries of Indian subcontinent and is the most popular and favourite food fish among the barb species due to good nutritional value. It is also popular as an aquarium species. Recently due to number of reasons, population of this particular fish species is facing the threat of extinction. In India it has been reported as endangered while in Bangladesh it has been reported as critically endangered. So considering the declining trend of its population, proper management measures are needed to conserve this fish species. Among the different conservation management strategies, captive breeding is one of the best approaches, but success of captive breeding completely depends on proper information on feeding and breeding biology of that particular fish species. Earlier ample works have been carried out on feeding and breeding biology of *Systomus sarana*, but a consolidated report on these aspects is really lacking. So this report has been prepared to sum up all available information on these two aspects of this fish species along with noting down the missing information further study of which is needed to support the conservation of *Systomus sarana*.

**Key words:** *Systomus sarana* • Feeding Habit • Breeding Biology

### **INTRODUCTION**

*Systomus sarana* (Hamilton-Buchanan, 1822), commonly known as “olive barb” is a tropical freshwater fish belongs to the family cypriniformes under the order cyprinidae. It is the largest barb available in the Indian sub-continent [1, 2] which is used to inhabit rivers, streams, lakes, reservoirs, tanks, ponds, pools, beels and ditches [3-15]. During the monsoon season, this fish species can also be observed in inundated rice and jute fields while during winter season, in oxbow lakes, it used to take shelter in areas with aquatic vegetation [16]. This fish species is widely distributed in India, Bangladesh, Afghanistan, Pakistan, China, Nepal, Bhutan, Sri Lanka, Myanmar, Thailand and Vietnam [6-8, 11-12, 17-22]. The young and the adult of this fish species are bottom and column dwellers, while fry are used to wander in the surface and sub-surface regions [21]. It is the most popular and favourite food fish among the barb species available in Indian subcontinent; having high market demand due to high nutritional value having good amount of carbohydrate, protein and fat content in its

flesh [1-2, 11-12, 23-24]. It has also been reported to have good preference as ornamental fish among the aquarium hobbyists [25]. Recently the populations of this fish species have seriously declined or on the verge of extinction due to number of reasons such as overexploitation, environmental degradation, natural disasters, pesticide and aquatic pollution, spread of disease, uncontrolled introduction of exotic fishes, destruction of breeding grounds, excessive water abstraction, siltation, various ecological changes in its natural habitat and lack of proper management [11, 26-27]. In Bangladesh it has been reported as critically endangered [28-30] while in India it has been enlisted as vulnerable as per CAMP report [31]. So considering its present status, it is really needed to take some proper initiative to conserve this fish species. Captive breeding is one of the noble approaches to promote conservation of any fish species, but to get success in that detail information on feeding and breeding biology of that particular fish species is needed. So far, number of works has been carried out on feeding and breeding biology of *Systomus sarana*; but no such consolidated report is

available on these aspects. So with this view, the present report has been prepared to sum up all those available information along with noting down the missing information further study of which will be beneficial to promote its conservation and fishery.

**Morphological Features:** Talwar and Jhingran [7], Day [17] and Chondar [21] have well documented the morphological features of *Systomus sarana* which has been documented below:

Body is oblong, deep, moderately compressed; dorsal and ventral profiles both are much convex at anterior two-third of the body. Head is fairly small; its length is 4 to 4.7 times in standard length. Eyes are moderate, its diameter 3.5 to 4.5 times in head. Interorbital space is convex. Mouth is moderate; lips thin and without fringes. Lower labial fold is interrupted and no pores are present on the snout. Scales are cycloid in type, moderately large. Lateral line is complete;  $3\frac{1}{2}$  to 4 rows of scales between it and the base of the ventral fin, 10 to 11 rows before the dorsal fin. Barbels: Two pairs; the rostral pair about as long as the orbit, the maxillary pair a little longer, sometimes equalling  $1\frac{1}{2}$  diameters of the orbit. Fins: Dorsal fin is short, commencing slightly nearer to the snout than to the base of the caudal fin and opposite the root of the ventral; its last undivided ray is strong, osseous and finely serrated posteriorly and with its stiff portion  $\frac{2}{3}$  as long as the head, the fin is  $\frac{1}{2}$  to  $\frac{2}{3}$  as high as the body, with its upper edge concave. Color: Body is silvery in color, darkest superiorly; opercles are shot with gold; the young have occasionally a dull blotch on the lateral line before the base of the caudal fin. A small dark spot generally present on the body behind the opercle. When the fish is fresh there are sometimes horizontal bands along the rows of scales in the upper half of the body. Barbels are reddish brown. Fins are whitish or yellowish white and are externally stained with gray; caudal, pelvic and anal fins are tipped with red.

**Food and Feeding Habit:** So far number of works has been carried out on feeding biology of *Systomus sarana* but till now no such firm conclusion is there regarding its feeding habit. Mookherjee *et al.* [32], Das and Moitra [33-34] and Chitray [35] have reported it as herbivorous fish while Sinha [4], Pethiyagoda [6], Shafi and Quddus [16], Hossain *et al.* [25], Chacko and Kuriyan [36], Alikunhi [37], Menon and Chacko [38], Mustafa *et al.* [39], Riede [40] and Chetia Borah [41] have documented its omnivorous feeding habit. Chondar [21] has documented

it as an omnivore bottom feeder in young and adult lives, while it has feeding habits chiefly for plankton at fry and early fingerling stages. Sinha [4], Das and Moitra [33-34] and Mustafa *et al.* [39] also have documented its bottom feeding habit.

Studying the gut content of adult sarana from Bengal waters, Mookherjee *et al.* [32] have reported the presence of 72% of plant food items [algae (27%) and higher plants (45%)], 20% of protozoa and 8% of mud and sand in it. High preference of adult sarana for plant food items further has been supported by Das and Moitra [33, 34]. Das and Moitra [33] in their study at Lucknow have documented that dietary of sarana is dominated by higher aquatic plants with diatoms, bryozoans, desmids, unicellular and filamentous algae. Later also Das and Moitra [34] have documented 69.2% of plant food, 2% of bryozoans, 7.3% of insects, 2% of crustaceans and 13% of molluscs in the gut content of sarana from Uttar Pradesh. Chitray [35] has reported that its gut content comprise more than 75% of aquatic plants, but the frequent presence of crustaceans, molluscs, diatoms, algae and mud and sand has also been mentioned by him.

On the other hand, Chacko and Kuriyan [36] have reported omnivorous feeding habit of this fish species observing the presence of fish remains, diatoms (commonly *Mastigolia* sp., *Melosira* sp., *Turbellaria* sp.; *Eunotia* sp., *Fragilaria* sp., *Nitzschia* sp., *Pinnularia* sp. in few quantity while *Coscinodiscus* sp. very rarely), algae (commonly *Oscillatoria* sp. and *Spirogyra* sp.; *Cladophora* sp. has been reported to be present very rarely), crustaceans (copepods and daphnids in few quantity while cypris, coleopteran adults and larvae have been documented to be present rarely) and insects in its gut content but didn't encounter plant or molluscan matter in its gut contents in Madras waters. Alikunhi [37] has reported it as a voracious feeder, consuming quantities of decaying macro-vegetation, gastropod shells, worms, insects and filamentous algae. Menon and Chacko [38] while opining upon the food and feeding habits of some freshwater fishes of Madras state has enlisted sarana under the typical zooplankton feeders, determining the percentage composition of gut contents as protozoa (16.6%), copepods (21.6%), unicellular algae (5.3%), filamentous algae (8%), insects (8.6%), fish (20%), molluscs (16.6%) and mud and sand (3.3%). Sinha [4] has reported macro-vegetation [most abundant are *Hydrilla* sp., *Vallisneria* sp., *Najas* sp., *Potamogeton*], molluscs [gastropod (*Melanoides tuberculatus*, *Viviparus bengalensis*, *Indoplanorbis* sp. and *Gyrarurus* sp.) and

pelecypoda (*Parreysia corrugate* and *Piscidium clarkeanum*), insect matter [insect of order Trichoptera and Diptera, rarely insect larvae and egg has been reported], plankton [among phytoplanktons Chlorophyceae (*Scenedesmus* sp., *Pediastrum* sp., *Oedogonium* sp., *Cosmarium* sp., *Spirogyra* sp., *Mougeotia* sp., *Protococcus* sp., *Characiopsis* sp.), Bacillariophyceae (*Cyclotella* sp., *Coscinodiscus* sp., *Synedra* sp., *Navicula* sp., *Pinnularia* sp., *Cymbella* sp., *Amphora* sp., *Gomphonema* sp., *Gyrosigma* sp.), Myxophyceae (*Oscillatoria* sp., *Lyngbya* sp., *Meismopediella* sp., *Phormidium* sp.) have been documented while among zooplanktons Protozoans (*Phacus* sp.), Cladocerans (*Daphnia* sp.) and rotifers (*Brachionus* sp., *Monostyla* sp.) have rarely been enlisted], debris and stone and miscellaneous items (prawn, fish scales and fish bones) from its gut content. Small fishes (60-200 mm in size) have been reported to prefer macro-vegetation (73.9%) followed by plankton (8.5%), insect matter (4.2%) and molluscs (1.6%); debris and stone (11.8%) have also been reported from their gut content. Large fishes (more than 200 mm in size) has been observed to have comparative high preference for molluscs (30.2%) along with preference for macro-vegetation (51.5%), insect matter (6%) and plankton (5.5%); apart from that miscellaneous food items like prawn, fish scales and fish bones have only been reported from the gut content of large fishes. No seasonal variation in food composition in these two size classes has been reported by Sinha [4]. Mustafa *et al.* [39] have documented the presence of higher aquatic plants, algae (*Spirogyra* sp., *Zygnema* sp., *Oedogonium* sp., *Cladophora* sp., *Microspora* sp. and *Ulothrix* sp.), Protozoa (*Euglena* sp. and *Clamydomonas* sp.), diatoms (*Navicula* sp. and *Striatella* sp.), insects (insect pupae and flea), crustaceans (*Cyclops* sp., *Cypris* sp., *Daphnia* sp.), rotifers (*Keratella* sp. and *Philodina* sp.) and fish remains in the gut content of both small sized (60-150 mm in size) and large sized fishes (151-270 mm in size). Large sized fishes have been reported to have more preference mainly for higher aquatic plants (48.12%) followed by algae (14.95%), organic matter (9.78%), insects (5.45%), protozoans (4.87%) and diatoms (4.67%) while small sized fishes have less preference for higher aquatic plants (11.62%) compared to algae (16.8%), protozoans (15.7%), diatoms (16.5%), insects (12.5%) and organic matters (13.18%). Pethiyagoda [6] has documented that the species usually feeds on plants, shrimps, insects, molluscs, worms, detritus and phyto and

zooplankton. Shafi and Quddus [16] have reported that *Systomus sarana* is used to feed on algae, unicellular and single celled animals, larvae of aquatic insects and sands while Riede [40] has reported that it feeds on aquatic insects, algae and shrimp. Hossain *et al.* [25] have reported it as an omnivorous fish in all size groups with high preference for phytoplankton; Chlorophyceae (*Chlorella* sp., *Ulothrix* sp., *Pediastrum* sp.), Bacillariophyceae (*Cyclotella* sp., *Nitzschia* sp., *Navicula* sp.), Cyanophyceae (*Microcystis* sp., *Chroococcus* sp.) and Euglenophyceae (*Phacus* sp., *Euglena* sp.) have been documented from its gut content including very little amount of rotifera (*Brachionus* sp., *Asplanchna* sp., *Filinia* sp., *Keratella* sp.) and crustacea (*Daphnia* sp., Nauplius). Higher quantities of Bacillariophyceae, Cyanophyceae and crustacea have been documented in larger size group while Chlorophyceae, Euglenophyceae and rotifera have been reported in small size group. Size wise variation of feeding activity has been reported; large size fishes have been reported to have high feeding activity compared to small size fishes. Seasonal variation of feeding activity has also been documented; high feeding activity has been reported in summer months than in winter season.

**Sexual Dimorphism:** Chondar [21] and Siddik *et al.* [42] have reported some sexual dimorphic characters of male and female of *Systomus sarana*. Male and female of this fish species can only be separated when their gonads are fully developed during the breeding season. In mature female, the abdomen is soft, round and bulging and release ova on applying slight pressure on it while in male it is round, firm, not very soft and milt oozes out on applying slight pressure on abdomen. Among the other secondary sexual characters, males are with rough scale and operculum while in females these are smooth in texture. In male, dorsal surface of pectoral fin is rough while in female it is very smooth and slippery. Genital opening is elongated slightly and whitish color in male while genital opening is round, fleshy and pinkish in color with prominent papillae in female. The pectoral fin is used to reach to the 6<sup>th</sup> lateral line scale in female and 7<sup>th</sup> to 8<sup>th</sup> in male when stretched posteriorly and backwardly.

**Sex Ratio:** Not much information is available on this aspect except the information provided by Murty [5] and Chandrasoma and De Silva [43] who have reported female dominance in the population of *Systomus sarana* in their studies.

**Length and Age at First Maturity:** Chakraborty *et al.* [11, 44] and Chondar [21] have reported that *Systomus sarana* used to become sexually mature on first year of its life. Murty [5] has reported that in Kolleru Lake, males of sarana possibly spawn for the first time when they attain 170 mm and females at 180 mm while Alikunhi [37] has documented that sarana used to become mature at the age of 10 months and at the length of about 25 cm.

**Fecundity:** In India, numbers of works has been carried out on fecundity study of *Systomus sarana*. Sobhana and Nair [45] have documented fecundity range of 12,235-74,376 for sarana from a lake of Trivandrum, India while Murty [5] and Sinha [46] have documented fecundity range of 11,201-2,24,248 and 58,327-1,39,934 from Kolleru Lake and in Andhra Pradesh and in Loni reservoir at Madhya Pradesh, India respectively. Udit *et al.* [47] have documented relative fecundity of 3,20,438 for this fish species. Few works also have been done on this aspect in Bangladesh; Mustafa *et al.* [39] have reported fecundity range of 18,925-78,925 from a beel in Tangail, Bangladesh while Chakraborty *et al.* [48] have documented 34,443.83-65,485.14 as the fecundity range for *Systomus sarana* in their study at Mymensingh, Bangladesh. Fecundity range of 16,000-2,90,000 has been reported by Chandrasoma and De Silva [43] from Sri Lanka.

Sinha [46] has reported linear relationship of fecundity with body weight and ovary weight while cubic relationship with total length in this fish species. Later Mustafa *et al.* [39] and Chakraborty *et al.* [48] have reported that fecundity is strongly correlated with total length, body weight and ovary weight in *Systomus sarana*.

**Breeding Periodicity:** Ample information is available on breeding periodicity of *Systomus sarana* both in India and Bangladesh. It has been reported that sarana breeds in the Mahanadi river since May-June [49]; in the plains of northern India during late June to early September with maximum spawning periodicity in July-August [50]; in the Loni reservoir of Madhya Pradesh during July-August [46]; in the Kolleru lake in Andhra Pradesh during July-September with peak at August-September [5] and during the rainy months (June-September) in river and reservoirs [21]. In Bangladesh, it used to breed in between April/May to September [11, 44, 51] and in some places in between June to August [42]. Murty [5], Chondar [21] and Sinha [46] have reported it as a single spawner while Chandrasoma and De Silva [43] have documented its multiple spawning nature.

A correlation of breeding periodicity of this fish species with monsoon season has been documented by Murty [5], Talwar and Jhingran [7], Chandrasoma and De Silva [43] and Bhuiyan [52], though exception has also been documented by Job *et al.* [49] who have reported that it breeds even before the commencement of the regular monsoon rains in the Mahanadi. Chakraborty *et al.* [44] have reported that ovary and testis maturation is closely correlated with rise in temperature in this fish species.

## CONCLUSION

Considering the information documented so far on feeding biology of *Systomus sarana*, it is quite clear that till date ample works have been carried out on this particular aspect; but to be very precise no such firm conclusion is there regarding the feeding habit of this particular fish species which is just in alliance with another species of *Puntius*, *Puntius conchoni* [53]. Few workers [32-35] have reported it as herbivorous fish while few others [4, 6, 16, 25, 36-41] have mentioned its omnivorous feeding habit. So, further study is needed to ascertain something authentic on the feeding habit of this fish species. In this regard, histo-morphologic study of the alimentary canal can be done apart from gut content analysis. Enzymatic analysis of the alimentary canal will also be a good approach in this regard. Difference in opinion among the earlier workers about its feeding habit may be due to number of reasons like variation in fish size, 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, information available on feeding habit of adult fish is not only sufficient to get success in captive breeding as proper rearing of the fry and juveniles is also essential to support maximum survivability and in this aspect, feeding habit of all these stages must be kept in knowledge. Sinha [4], Mustafa *et al.* [39] and Hossain *et al.* [25] have reported omnivorous feeding habit of small sized fishes but there is also controversy regarding the mostly preferred food item for the particular stage; Mustafa *et al.* [39] and Hossain *et al.* [25] have documented higher preference for plankton food while Sinha [4] has reported macro-vegetation as its mostly preferred food item. So, further study is also needed in this aspect.

On the other hand ample information so far is available on fecundity and breeding periodicity of this fish species; though the available information is a bit with

contradiction for fecundity. Murty [5], Chandrasoma and De Silva [43], Sinha [46] and Udit *et al.* [47] have reported *Systomus sarana* as a highly fecund fish while moderate fecundity has been reported by Mustafa *et al.* [39], Sobhana and Nair [45] and Chakraborty *et al.* [48] for this fish species. This variation in fecundity may be due to many factors like habitat variation, variation in hydrological and climatic factors, health status, feeding activity etc. Regarding its breeding periodicity, maximum of the workers have concluded it as a monsoon breeder; though confusion is there regarding its spawning habit; Sinha [46], Murty [5] and Chondar [21] have reported it as a single spawner while Chandrasoma and De Silva [43] have documented it as a multiple spawner. This difference of opinion may be due to variation in hydrological and climatic factors mainly of temperature as already Chakraborty *et al.* [44] have reported a correlation between ovary and testis maturation with temperature rise for this fish species. Comparing the information present on fecundity and breeding periodicity of this fish species, very scarce documentation is there on sex-ratio and length at first maturity; both these are very important parameters of breeding biology study. So, further work is needed to collect much more information on these two parameters.

So finally it can be concluded that though earlier ample works have been conducted on feeding and breeding biology of *Systomus sarana*, further study must be done mainly for those parameters which are still lacking information, to support its conservation management.

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