

Some biological aspects of cyprinid fishes, *Pethia ticto*, *Systomus sarana* and *Puntius sophore* from India: An overview

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Abstract

The biology of cyprinid fishes viz., *Pethia ticto*, *Systomus sarana* and *Puntius sophore* in the fresh water habitats of India is reviewed based on published literature. These fishes are the popular ornamental fishes in India. These fishes has beautiful undulating structure during slow swimming activity The biological aspects of fish includes length-weight data, condition factor, food & feeding habits, fecundity, age determination, sexual category, reproductive biology, haematological and immunological aspects. The present review study is aimed at enhancing the information concerning to the biology of fishes and to make possible formulation of suitable managing measures towards a balanced exploitation and managing in lotic and lentic aquatic ecosystems.

Keywords: biological profile, fresh water fishes, *Pethia ticto*, *Systomus sarana*, *Puntius sophore*, India

Introduction

Pethia ticto is a type of 'barb' found in aquariums. There is a silvery white dazzling body with a black mark on the caudal peduncle. The maximum size is around 10 cm (Talwar and Jhingran, 1991) [52], Aquarium enthusiasts appreciate them because of their diverse dietary habits and robust nature. They are more demanding due to sexual dimorphism and seasonal colour changes throughout the breeding season. This fish found in lentic and lotic water bodies with muddy bottoms. Crustaceans, insects, and plankton are their favorite foods. About 150 eggs are laid in a batch with about 20 batches at a time. They are generally found in Asia, Pakistan, India Nepal, Bangladesh and Myanmar (Abir Lal Dutta *et al.*, 2013) [21].

The tropical freshwater fish *Systomus sarana* belongs to the minnow family. This olive barb can be used as a food fish as well as an ornamental fish. The fish's generic status is still unclear, fluctuating between *Barbodes* and *Puntius*. The *Systomus sarana* is a widely distributed species with no known major concerns. There is no evidence to support the assumption that this species is in decline; it is even listed as endangered in Bangladesh. It is now classified as Least Concern due to its widespread distribution and apparent lack of threats. However, before a re-evaluation, the species must be properly researched (Dipanjan Kashyap *et al.*, 2021) [16].

Puntius sophore is a freshwater cyprinid of Indian sub-continent which has popularity as a food fish because of its high dietary benefit alongside presence of good quantify of protein, micronutrients and nutrient. As of late it has made its entrance in decorative fish exchange and has been accounted for to been sent out as native fancy fish from India. Because of heavy fishing and anthropogenic exercises this fish species is currently confronting danger in regular condition (Sandipan Gupta, 2015) [42].

Small native fish species are particularly important sources of large scale and micronutrients. Because these small native fish species are consumed whole or without loss of

supplements due to cleaning or plate waste (Roos *et al.*, 2007) [41], their commitment to micronutrient ingestion is Higher than that of large carp fishes. Nutrients are found to be higher in these fishes than arge carps (Roos *et al.*, 2007; Thilsted *et al.*, 1997) [41, 53]. Science information is crucial for the proper administration of the species.

Yet, so far no such combined report is accessible on biological aspects of these two cyprinid fishes. Keeping this in see, the current review report has been arranged to summarize the lacunae of data which ought to be concentrated to help its future fishery.

Methodology

Data collection

Secondary data was collected by referring monographs, journals, thesis, books and web references as worked out by the different researchers of India. The collected data is compiled and written in the form of review text.

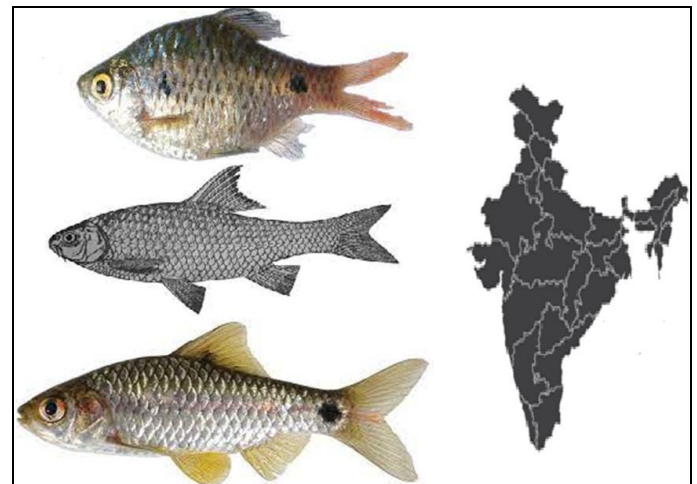


Fig 1: India map and views of *Pethia ticto*, *Systomus sarana* and *Puntius sophore* fishes

Biological characters

Table 1 depicts the work on biological aspects of *Pethia ticto* (Syn.*Puntius ticto*), *Systemus sarana* (Syn.

Puntius sarana) and *Puntius sophore* carried out by various researchers from India

Table 1: Some biological aspects of *Pethia ticto* (Syn.*Puntius ticto*), *Systemus sarana* (Syn. *Puntius sarana*) and *Puntius sophore* carried out by various researchers from India

Sl. No	Fish species	Area of Research	Habitat	References
1.	<i>Puntius ticto</i>	Sexual dimorphism	Kumaun Himalaya	Pankaj Bahuguna <i>et al.</i> , 2010 [33]
2.	<i>Puntius ticto</i>	Reproductive physiology and Biology	Tripura	Banik <i>et al.</i> , 2012 [7]
3.	<i>Puntius ticto</i>	Sexual maturity	-	Royal <i>et al.</i> , 2021
4.	<i>Pethia ticto</i>	Length-weight relationship & Condition factor	Gomti river, Uttar Pradesh	Ashish Kumar Maurya <i>et al.</i> , 2018 [5]
5.	<i>Puntius ticto</i>	Length-weight relationship	Ganga river	Sarkar <i>et al.</i> , 2013 [44]
6.	<i>Puntius sarana</i>	Age determination	Kolleru lake	SriRamachandra Murthy, 1976
7.	<i>Puntius sarana</i>	GSI and Fecundity	-	Chakraborty, 2008 [11]
8.	<i>Puntius sarana</i>	Haematological & immune parameter	-	Abhilipsa Das <i>et al.</i> , 2012 [11]
9.	<i>Puntius sp.</i>	Morphometric parameter	Assam, India	Choudhury and Dutta, 2013 [12]
10.	<i>Puntius sarana</i>	Length frequency & reproduction biology	Tamiraparani river, Tamil Nadu	Pon saravana Kannan <i>et al.</i> , 2016 [36]
11.	<i>Puntius sarana</i>	Spawning biology	-	Chakraborty <i>et al.</i> , 2007; Dipanjan Kashyap <i>et al.</i> , 2021 [9, 16]
12.	<i>Puntius sophore</i> & <i>Systemus sarana</i>	Length-weight relationship & Condition factor	Deepar Beel, Assam	Madhubant Das <i>et al.</i> , 2015 [23]
13.	<i>Puntius sarana</i>	Gonadal stages	-	Rather <i>et al.</i> , 2018 [37]
14.	Fresh water fishes	Length-weight relationship	Haro river, Rajasthan	Manish Kunwar sisodiya <i>et al.</i> , 2018 [24]
15.	<i>Puntius sophore</i>	Food habits	Wetlands of West Bengal	Mitra <i>et al.</i> , 2006
16.	<i>Puntius sophore</i>	Reproductive biology	Gho-Manhasan stream, Jammu	Seema Lanager <i>et al.</i> , 2013 [45]
17.	<i>Puntius sophore</i>	Food and feeding habits	-	Saon Das <i>et al.</i> , 2013 [43]
18.	<i>Puntius sophore</i>	Biological aspects	Gomti and Feni river	Sibani Saha, 2015 [46]
19.	<i>Puntius sophore</i>	Lipid and fatty acid profile	-	Snigdha Dey <i>et al.</i> , 2015 [48]
20.	<i>Puntius sophore</i>	Biological aspects	Rivers of Tripura	Choudhury <i>et al.</i> , 2015 [13]
21.	<i>Puntius sophore</i>	Length-weight relationship & Food and feeding habits	Mudagodu tank, Karnataka	Kiran, 2015 [20]
22.	<i>Puntius sophore</i>	Fecundity	Jammu water bodies	Krishan Raj Kant <i>et al.</i> , 2016 [21]
23.	<i>Puntius sophore</i>	Biochemical & mineral composition	Mudagodu tank, Karnataka	Dhananjaya, 2012
24.	<i>Puntius sophore</i>	Diet composition	Brahmaputra valley, Assam	Rehena Akhtara Begum and Saibal Sengupta
25.	<i>Puntius sophore</i>	Feeding and Breeding biology	-	Gupta, 2015 [42]
26.	<i>Puntius sophore</i>	Length-weight relationship & Condition factor	Kolkata and sub urban fish markets	Monalis pal <i>et al.</i> , 2013 [30]
27.	<i>Puntius sophore</i>	Reproductive biology	-	Monalisa Pal and B. K. Mahapatra, 2017 [29]
28.	<i>Puntius sophore</i>	Length-weight relationship	River Ghargharia at Cooch Behar, West Bengal	Supratim Pal <i>et al.</i> , 2018 [50]
29.	<i>Puntius sophore</i>	Age and growth	Ganga river	Singh and Rajshree Srivastava, 2008 [47]
30.	<i>Puntius sophore</i>	Length-weight relationship & Relative Condition factor	Deepar Beel, Assam	Madhubanti Das <i>et al.</i> , 2005
31.	<i>Puntius sophore</i>	Moisture and total lipid	Manipur	Chabungbam Bijayalakshmi <i>et al.</i> , 2014 [8]
32.	<i>Puntius sophore</i>	Nutritional properties	Manipur	Wahengbam Sarjubala <i>et al.</i> , 2018 [54]

Pethia ticto/Puntius ticto

Pankaj Bahuguna *et al.* (2010) [33] investigated the sexual dimorphism of *Puntius ticto* within the Kumaun Himalaya, India. They noticed significant sexual dimorphism. The dorsal and ventral fins of the male bear a little black blotch. The male features a distinct dark pink color the lower half his body. Ted with other observations, females have a somewhat pinkish and dark yellow tint on each side. In Tripura, Banik *et al.* (2012) [7] investigated the reproductive physiology and biology of *Puntius ticto*. A number of the most factors researched thus far in reproductive physiology include gonad development in connection to length and weight, gonado-somatic index, maturity stages in reference to age, fecundity and breeding

periodicity, and so on. Within the field of feeding biology, research is being conducted on the analysis of varied digestive enzymes during adulthood, growth and development in reference to age, RLG, and condition factor assessment.

To determine the sexual maturity of *Puntius ticto*, Royal *et al.* (2021) [33] used the Gonado-Somatic Index and Dobriyal Index in comparison to other observations, the Dobriyal Index was more accurate than the Gonado-Somatic Index in predicting sexual maturity. Diet of *Puntius ticto* has been reported by Pethiyagoda *et al.* (2012) [35], and it's herbivorous consistent with Mitra *et al.* (2011). Ashish Kumar Maurya *et al.* (2018) [5] described the length-weight relation of small fish *Pethia ticto* from Gomti River,

Sultanpur district of Uttar Pradesh, India. Their analysis showed that the allometric coefficient is on the brink of isometric value of 3.0. Allometric growth indicates a more rotund population of fish when the values of growth coefficient are above 3.0 ($b > 3$). Isometric growth indicates that the form of fish doesn't change because it grows ($b = 3$). The coefficient of determination was also found significant ($= 0.97$). Fulton's factor ranged 1.041 to 1.660 shows the well-being. Their study was helpful in providing relevant information within the assessment of stock and estimation of the fish condition. The condition factor about fishes was found to be comparatively less for middle length groups (40-49 to 70-79mm) in comparison to initial and final length groups.

The similar findings has been reported by Sarkar *et al.* (2013)^[44] in *P. ticto* from the river Ganga. The factors such as sexual category, size, seasons and gonadal maturity in fishes have affected the K values (Heincke, 1908)^[19]. Ecological factors, food supply and parasitism, have a big influence on the well-being of the fish (Le Cren, 1951)^[22].

Systomus sarana* Syn. *Puntius sarana

Sri Ramachandra Murthy (1976) has studied the scales of *Puntius sarana* from Lake Kolleru showed distinct growth checks. Data was analysed to work out the validity of growth checks in age determination. Different tests applied during this work show that growth checks on scales of *P. sarana* from Lake Kolleru aren't useful in its age determination. It's hoped that similar analyses of knowledge on other species would yield some positive results.

Developmental stages of both male and female gonad and estimation of gonado-somatic index (GSI) and fecundity of *Puntius sarana* were investigated by Chakraborty (2008)^[11]. From the histological analysis, 04 developmental stages were distinguished in males, such as, spermatogonia, spermatocytes, spermatids and spermatozoa. 06 developmental stages of oocytes were identified in females, viz., oogonia, previtellogenic oocytes (early and late perinucleolus stage), cortical alveoli, yolk granules and mature oocytes. The testes at early development stages contained mostly spermatogonia, spermatocytes and spermatids, with a little amount of spermatozoa.

Abhilipsa Das *et al* (2012)^[1] studied seasonal and annual variations in haematological and immune parameters of juvenile *Puntius sarana* in 75-100 gm fishes during three seasons over 02 years. Conversely, serum lysozyme antiprotease activity, total erythrocyte count and TLC profiles were consistent during all the seasons.

Choudhury and Dutta (2013)^[12] have studied the morphometric parameters of 11 quantitative body parameters of six species of *Puntius* genus – *Puntius chola*, *P. gelius*, *P. conchoniis*, *P. sophore*, *P. sarana* and *P. ticto* occurring from Assam, India. A correlation study between total length vs. other morphometric parameters and a multivariate principal component analysis were conducted by them. The results obtained showed a big correlation between total length and other morphometric parameters ($p < 0.05$) apart from total length and pre-orbital length, while the PC immeasurable *P. sophore* were the foremost dissimilar. Their findings will help in developing new strategies for conservation and breeding programmes of those species.

Pon Saravana Kannan *et al* (2016)^[36] studied the length frequency analysis, species composition, catch and energy and reproductive biological aspects of *Puntius sarana* in Tamiraparani riverine system of state in Western Ghats of India. The estimated b and z value was found 2.246 and 1.16 respectively. They reported maximum fishing mortality in 30.3 cm. Reasonable fishing mortality started from 22.8 cm. the utmost steady state biomass was observed in 21.3 cm. The decayed organic matter, algae and sand grains were also recorded by them. The quantity of ova was found to vary 34,218 to 43,296 within the size range of 170 mm - 260 mm. The length at 50% maturity was estimated was 200 mm in total length for females. They observed that the fecundity was relatively low which indicates that, this species should be exploited carefully. The minimum legal size for capture will be fixed below 200 mm for female fishes.

The species is omnivorous and feeds on aquatic insects, fish, algae and tiny prawns. in step with Mookerjee *et al.* (1946)^[31], food of *P. sarana* was 27% algae, 45% higher plants, 20% protozoan, 8% mud and sand. *Puntius sarana* breeds during monsoon in running waters amongst submerged boulders and vegetation (Talwar and Jhingran 1991)^[52]. Spawning of this barb occurs in two stages, once between May to mid-September but prominent in June and also the second spawning time within the months of August and September (Chakraborty *et al.* 2007; Dipanjan Kashyap *et al.*, 2021)^[9, 16].

Photoperiod plays a serious role in controlling the reproductive activity of this fish. It attains the sexual maturity within the first year of its life and prefers shallow water of floodplain areas for the breeding (Chakraborty *et al.*, 2006)^[10]. There's a necessity to conduct in-depth studies on the biology of this species and enact strict conservation strategies for its protection. Limited studies on development of breeding and rearing of the species are conducted by variety of researchers and academic institutions in Bangladesh and India (Mijkherjee *et al.*, 2002; Chakraborty *et al.*, 2006; Dipanjan Kashyap *et al.*, 2021)^[27, 10, 16].

Madhubant Das *et al* (2015)^[23] have studied the length-weight relationship, relative condition factor of two fish species *Puntius sophore* and *Systomus sarana* of Deepar Beel (wetland) of Assam. Their growth performance of length-weight relationship was found high since the correlation 'r' exhibits high degree of relationship but shows negative allometric correlation. The negative allometric growth could also be thanks to low feeding, environmental or seasonal incompatibility for correct growth of fishes. The kn value of sub adult and adult *Systomus sarana* were 0.90-1.13 and 0.86 - 1.06 respectively which are more or less similar. Rather *et al* (2018)^[37] recorded the phases of gonadal of *P. sarana sarana* under captive conditions. Microscopically the various stages of oogenesis and spermatogenetic development were examined. Their study revealed 05 different morphological phases in testis development and 06 morphological phases in ovarian development. They concluded that, 8 stages for oocyte development and 5 stages of spermatozoa of the species were identified under microscope.

Manish Kunwar Sisodiya *et al* (2018)^[24] reported the length-weight relationship parameters for a few economically important fish species from Haro river, Rajasthan. The high correlation (r^2) $y = -0.020x + 1.782$, R^2

= 0.006 is critical for all the species. The condition factor for both season extended 1.6450 to 2.3521. The appliance of the length-weight relationships presented here should be limited to the observed length ranges. The low condition factor recorded their investigation can be effects of sedimentation. Their study has contributed to the knowledge of fish populations during this economically important area that would assist fishery management scientists in polishing off future ecological studies.

Puntius sophore

Geetha *et al* (1990) [17] reported that many of the smaller fishes viz., *P. vittatus*, *P. sophore* were herbivorous. Herbivorous nature of *P. sophore* has also reported by Mitra *et al.*, (2006) [28] and Kiran (2015) [20]. However, Mitra *et al* (2006) [28] opined that *P. sophore* was herbivorous in feeding habit and consumed diatoms followed by chlorophycean algae. Banik and Saha (2013) [6] recorded pico plankton, zooplankton, fishes and shrimps in the gut of *P. sophore*. Nazneen and Bari (1982) [32] observed phytoplankton in the gut of *P. sophore*.

Singh and Rajshree Srivastava (2008) [47] studied the age and growth of *Puntius sophore* from the Ganga river using its scales. The cycloid scales has distinct larval mark under the SEM. The age of this fish was 4 years. The fish should harvested when it reached 62 mm length.

Length-weight relationship and condition factor of *P. sophore* were estimated by Monalisa Pal *et al* (2013) [30] from Kolkata and sub-urban fish markets of India. They reported r value of 0.934. The logarithmic equation of the species was established as $\text{Log } W = -2.130 + 3.242 \text{ Log } L$. The coefficient of determination value was $r^2 = 0.871$. The mean condition factor was 1.10.

Saon Das *et al* (2013) [43] have studied the morphometric relationship and phytoplankton and zooplankton in the gut content of *Puntius sophore*. It feeds maximum of zooplankton at a later stage. Chabungbam Bijayalakshmi *et al* (2014) [8] reported the proximate composition of small indigenous fishes and estimated the moisture and lipid content of some selected small indigenous fishes of Manipur. They reported 78.95 % moisture and 2.34% of lipid in *Puntius sophore* respectively.

Kiran (2015) [20] reported that this fish was a column feeder in the Mudagodu tank of Karnataka. Seema Lanager *et al* (2013) [45] worked on the reproductive Cycle and Oogenesis of *Puntius Sophore* from Gho-Manhasan Stream of Jammu, India. 07 stages of oocytes were recognized by them and oogonia were present throughout the reproductive cycle. The breeding period was from July to August.

Choudhury *et al* (2015) [13] have determined the length-weight relationship, fecundity, GSI, ovarian development and sex ratio of *P. sophore* in the rivers of Tripura, India as it has commercial value as a food fish as well as an ornamental fish. The value of 'b' was 3.322 suggesting that the length-weight relationship followed the cubic law for isometric growth. K value is less than 1, except for male the general well-being of fish is poor. The GSI indicates the state of gonadal development which reflects the maturity stages in fishes (Parween *et al.*, 1993) [34]. The average GSI in male and female fishes was highest during July. Fecundity was peak in spawning season The sex ratio observed for the *P. sophore* was different from the expected ratio of 1:1 (female: male). The breeding season of *P. sophore* was observed during July to August which was

observed in other *Puntius* species by Arunachalam & Sankaranarayanan (1998) [4] and Mannan *et al.* (2010) [25]. The raise in GSI indicates advanced ovarian developmental stages and this fish shed its eggs once within a short spawning phase as reported in other three barbus species by De Silva *et al.* (1985) [14].

Snigdha Dey *et al.* (2015) [48] analyzed the major lipids and fatty acids in a small sized Indian minor carp *Puntius sophore*, by thin layer and gas liquid chromatography. The muscle lipid is <1%, for which fish can be regard as very low fat fish. Among the lipid classes, Phospholipids (PL) is maximum and the fatty acid (FA) symphony consists of altogether 36 members which are quantified by open gas liquid chromatography. In *P. sophore* the DHA is 2.5 times higher than EPA and $\omega 3/\omega 6$ ratio is ranging from 3.69 to 5.57 in the major lipid fractions.

The length-weight relationship, relative condition factor of two fish species *Puntius sophore* and *Systomus sarana* of Deepar Beel of Assam was studied by Madhubanti *et al* (2015) [23]. The length-weight relationship data shows negative allometric correlation. The negative allometric growth may be due to lower feeding proficiencies and/or may be due to environmental or seasonal incompatibility for proper growth of fishes. The Kn value of sub adult *Puntius sophore* and adult *Puntius sophore* are 0.93 - 1.07 and 0.85 - 1.19, respectively which are more or less similar.

Sibani Saha (2015) [46] studied the biology of two fish species *Puntius sophore* and *Puntius ticto* in Gomoti river and Feni river in Tripura. *Puntius sophore* and *Puntius ticto* fingerling consumes small zooplankton. Adults consumes zooplankton, insects, broken small prawn etc. During fingerling stage certain quantity of alpha-amylase and pepsin were recorded. During adult stage both the alpha-amylase and pepsin were increased quantitatively. Based on relative length of gut the two fish species were identified as omnivorous. The length-weight relationship in these species followed cube law signifying isometric growth. In *Puntius sophore* and *Puntius ticto* the variations in the condition factor may be due to the result of different nature of effect. Those effect might be because of some fluctuation in the environmental character, variability in abundance of food and the gonad maturity etc. The fertilized eggs hatch in about 72-96 hrs. The size of the mature eggs were ranging from 0.96-1.02 mm. In *Puntius sophore* fecundity was studied in fish population ranging from 108-116 mm in total length and 41-52 g in total weight respectively. The ratio of male and female in *Puntius sophore* was about 1:3. In *Puntius sophore* the gonado-somatic index was 64.87 for female and 62.88 for male. Length at first maturity in *Puntius sophore* was 74 mm. In *Puntius sophore* the rate of fertilization was varied from 75-80%.

Krishan Raj Kant *et al* (2016) [21] have reported the fecundity of *Puntius sophore* from Jammu water bodies. They recorded fecundity of 1560 to 2314 eggs. The relative fecundity ranged from 390.85 to 480.18 and absolute fecundity from 6106.73 to 6942.35 eggs.

Rehena Akhtara Begum and Saibal Sengupta (2016) [39] revealed that *Puntius sophore* is an herbivore fish and occasionally feeds on zooplankton in Brahmaputra valley of Assam. The food item were found to be diatoms, desmids, blue green algae, chlorophyceae and zooplankton in its gut. They reported that the fish has a narrow niche width.

Talukdar *et al* (2016) [51] investigated the karyotypes of *Puntius sophore* from the Brahmaputra river of Assam,

India. Chromosome preparations were used in the anterior parts of the kidney cells. The karyotype of the population consisted of 48 diploid chromosomes with fundamental arm number of 54.

Monalisa Pal and Mahapatra (2017) [29] have reported the embryo development and larval period of *Puntius sophore* under captive conditions. The newly deposited fertilized eggs were demersal, slightly sticky in nature, translucent, unpigmented, light yellowish in colour and almost spherical in shape with dimension of 909.200µm to 871.609µm. The hatchlings were transparent with 3.0±1mm in length with a large oval head, large yolk sac and short tail.

Supratim Pal *et al* (2018) [50] deliberate the length-weight relationship of *Puntius sophore* from river Ghargharia in West Bengal. The "b" value was 3.3204 and the equilibrium constant does not follow the cube law.

Manoj Kumar Das *et al* (2018) [26] reported native fishes with larvivorous habit against mosquito larvae control in endemic malarious region of Ranchi district, Jharkhand, India Their analysis revealed that *Puntius sophore* and other nine fishes possess high level of larvivorous potentiality to control malaria.

Wahengbam Sarjubala *et al* (2018) [54] have estimated the total free amino acid, polyunsaturated fatty acid, minerals and antioxidant properties of 06 fresh water fishes and *Puntius sophore* was one among them and were collected from different sites of Manipur. The high moisture, protein, Mg, K, Ca, antioxidant activity and ash contents were recorded in *Puntius sophore*. The total amino acid content was lowest in *Puntius sophore*.

Anju Rani *et al* (2019) [3] studied the morphometrics of *P. sophore* from the Yamunanagar and Faridabad fish markets in Haryana, India. Their t-test revealed no significant difference between the otolith length and width of both the right and left otoliths ($p > 0.05$).

Dhananjaya (2021) [15] studied the biochemical and mineral composition of freshwater cyprinid fish *Puntius sophore* from Mudagodu tank of Chikmagalur district, Karnataka. Protein level deviated 18.5 to 23.7%. While, moisture content fluctuated from 69.8 to 75.3%. However, fat, ash and carbohydrate levels ranged in between 1.0 and 2.3%. Potassium content ranged from 650 to 698 mg/100gm. Calcium and magnesium levels varied from 120-155 and 110-139mg/100gm respectively. Phosphorus in the fish deviated from 242 to 248 mg/100gm. Trace metals like zinc and copper ranged between 18-24 mg/100gm and 3.9-4.2 mg/100 gm respectively.

References

- Abhilipsa Das, Joy K Jena, Pramoda K. Sahoo. Haematological and innate immune responses in *Puntius sarana*: normal range and seasonal variation. Cent. Eur. J. Biol, 2012;7(3):460-469. DOI: 10.2478/s11535-012-0026-3
- Abir Lal Dutta, Debargha Chakraborty, Sajal Kumar Dey, Ashim Kumar Manna, Pankaj Kumar Manna. Ornamental Fishes of Coastal West Bengal, India-Prospects of Conservation and Involvement of Local Fishermen. Natural Resources, Article ID: 32233, 2013;4(2):8. DOI:10.4236/nr.2013.42020.
- Anju Rani, Deepak Rai, Anil K. Tyor. Morphometrics Analysis of Sagitta Otolith in Pool Barb, *Puntius sophore* (Hamilton, 1822). Journal of Morphological Sciences, 2019;36(2):85-90.
- Arunachalam M, Sangaranarayanan A. Ornamental stream fish (*Puntius aruliuistambiraparniei*) endemic to Tamiraparani river basin, Western Ghats of South Tamil Nadu. Proceeding of the Workshop on Germplasm Inventorisation and Gene Banking of Freshwater Fishes, October 1998, held at CMFRI, Cochin, India, 1998, 12-13
- Ashish Kumar Maurya, Laxmi Prasad I and Ravi Kumar. Length-weight relationship and condition factor of *Pethia ticto* (Hamilton, 1822) from Gomti river in Sultanpur, Uttar Pradesh. Journal of Applied and Natural Science, 2018;10(1):487-490.
- Banik S, Saha S. Reproductive physiology and feeding biology of *Puntius sophore* of Tripura, India. Res. Environ. Life Sci, 2013;6(4):115-118.
- Banik S, Saha S. *Puntius ticto* (Hamilton, 1822) of Tripura, India: Reproductive Physiology and Biology, 2012.
- Chabungbam Bijayalakshmi, Romen Singh Ngasepam, Ningthoukhongjam Indira, Maibam Shomorendra. Estimation of Moisture and Total Lipid Content of Some Small Indigenous Fishes of Manipur, International Journal of Science and Research, 2014;3(12):1091-1094.
- Chakraborty BK, Mirza ZA, Miah MI, Habib MAB, Chakraborty A. Reproductive cycle of the endangered sarpunti, *Puntius sarana* (Hamilton, 1822) in Bangladesh. Asian Fisheries Science, 2007;20:145-164.
- Chakraborty BK, Miah MI, Mirja MJA, Habib MAB. Induction of gynogenesis in endangered sarpunti, *Puntius sarana* (Hamilton) and evidence for female homogamety. Aquacul, 2006;258:312-320.
- Chakraborty BK. Gonadal differentiation of the endangered sarpunti, *Puntius sarana* (Hamilton). Journal of the Inland Fisheries Society of India, 2008;40(1):1-9
- Choudhury S, Dutta K. A Study on the Morphometric Variation in Selected Ichthyofauna under Genus *Puntius* Hamilton-Buchanan (Teleostei: Cyprinidae). IOSR Journal of Pharmacy and Biological Sciences, 2013;5(3):01-06.
- Choudhury TG, Singh SK, Baruah A, Das A, Parhi J, Bhattacharjee P *et al*. Reproductive Features of *Puntius sophore* (Hamilton 1822) from Rivers of Tripura, India. Fishery Technology, 2015;52(2015):140-144.
- De Silva SS, Schut J, Kortumudler K. Reproductive biology of six *Barbus* species indigenous to Sri Lanka. Env. Biol. Fish, 1985;12(3):201-218.
- Dhananjaya SG. Biochemical and mineral composition of freshwater cyprinid Fish *Puntius sophore* from Mudagodu tank of Chikmagalur District, Karnataka. International Journal of Biology, Pharmacy and Allied Sciences, (In press), 2021, 10(11).
- Dipanjana Kashyap, Sonmoina Bhuyan, Pronob Das, Sagar C, Mandal Rajita Devi. *Puntius sarana sarana* (Olive barb), a candidate species for diversification of aquaculture, 2021. <http://aquafind.com/articles/Puntius-sarana-sarana.php>.
- Geetha S, Suryanarayanan H, Nair NB. On the food and feeding habits of *Puntius vittatus* (Day). Proc. Indian natn. Sci. Acad, 1990;B56(4):327-334.
- Gupta S. An Overview on Feeding and Breeding Biology of Freshwater Cyprinid *Puntius sophore* (Hamilton, 1822). World Journal of Fish and Marine

- Sciences,2015:7(2):100-104,
DOI:10.5829/idosi.wjfm.2015.7.2.93104.
19. Heincke F. Berichtu"ber die Untersuchungen der Biologischen Anstalt auf Helgoland zurNaturgeschichte der Nutzfische. (1. April 1905 bis 1. Oktober 1907). In: Die Beteiligung Deutschlands an der Internationalen Meeresforschung, 4. & 5. Jahresbericht. Verlag von Otto Salle, Berlin, 1908, 67-150.
 20. Kiran BR. Food and Feeding habits and Length-Weight relationship of Cyprinid Fish, *Puntius sophore* (Hamilton-Buchanan) From Mudagodu Tank, Karnataka. International Journal of Industrial Chemistry & Biotechnology,2015:1(1):46-50.
 21. Krishan Raj Kant, Kadambri Gupta, Seema Langer. Fecundity in fish *Puntius sophore* and relationship of fecundity with fish length, fish weight and ovary weight from Jammu water bodies J and K (India). International Journal of Fisheries and Aquaculture Sciences,2016:6(2):99-110.
 22. Le Cren ED. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology,1951:20:201-219.
 23. Madhubanti Das, Geetali Das, Parag Deka. Length-Weight relationship and relative condition factor of *Puntius sophore* (Hamilton, 1822) and *Systomus sarana* (Hamilton, 1822) of Deepar Beel (wetland) of Assam, India. International Journal of Fisheries and Aquatic Studies,2015:3(2):476-479.
 24. Manish Kunwar Sisodiya, Lalit Choudhary, Seema Bhardhwaj. Length-weight relationships of freshwater fish species in Haro river. International Journal of Applied and Pure Science and Agriculture,2018:04(6):62-68.
 25. Mannan MM, Maridass M, Thangarani S. Gonad developmental cycle of *Puntius filamentosus*. Int. J. Biol. Technol,2010:1(2):69-77.
 26. Manoj Kumar Das, Rajesh Kumar Rao M, Kulsreshtha AK. Native larvivorous fish diversity as a biological control agent against mosquito larvae in an endemic malarious region of Ranchi district in Jharkhand, India. Journal of Vector Borne Diseases,2018:55:34-41.
 27. Mijkherjee M, Praharaj A, Das S. Conservation of endangered fish stocks through artificial propagation and larval rearing technique in West Bengal, India. Aquaculture Asia,2002:7(2):8-11.
 28. Mitra K, Suresh VR, Vinci GK, Mazumdar NN. Food habits of the soft-fin barb *Puntius sophore* (Ham.-Buch.) in a floodplain wetland, West Bengal. J. Inland Fish. Soc. India,2006:38(2):73-76.
 29. Monalisa Pal, Mahapatra BK. Early life history of Indian ornamental barb, *Puntius sophore* (Hamilton, 1822).Journal of the Inland Fisheries Society of India,2017:49(2):10-21.
 30. Monalisa Pal, Mahapatra BK, Basudev Mondal. Length-weight relationship and condition factor of *Puntius sophore* (Hamilton, 1822) collected from Kolkata and sub urban fish markets. Environment and Ecology,2013:31(3):1255-1259.
 31. Mookerjee HK, Sen Gupta SN, Roy Choudhury DN. Food and its percentage composition of the common adult food fishes of Bengal. Sci. & Cult. Calcutta,1946:12(7):247.
 32. Nazneen S, Bari GA. Gut content of Halezi Lake fishes for determination of the importance of phytoplankton as fish food. Pakistan J. Agric. Res,1982:3(3):156-169.
 33. Pankaj Bahuguna, Sanjay Kumar, Rakesh Kumar, Hemant Kumar Joshi, Rakesh Verma. Studies on sexual dimorphism in the cyprinidae fish *Puntius ticto* (Hamilton– Buchanan) from Kumaun Himalaya, India. International Journal for Environmental Rehabilitation and Conservation,2010:1(2):88-93.
 34. Parween S, Begum N, Rahman MH, Hossain MA. On the breeding periodicity of *Esomus danricus* (Hamilton). Univ. J. Zool. Rajshahi Univ,1993:12:31-34.
 35. Pethiyagoda, R, Meegaskumbura M, Maduwage K. A synopsis of the South Asian fishes referred to *Puntius* (Pisces: Cyprinidae). Ichthyological Exploration of Freshwaters,2012:23(1):69-95.
 36. Pon Saravana Kannan A, Rajkumar M, Jawahar PN, Jaya kumar, Sundaramoorthy B. Stock assessment and reproductive biology of *Puntius sarana* (Hamilton, 1822) in Tamiraparani River basin of South Tamilnadu, India. International Journal of Research in Biological Sciences,2016:6:20-25.
 37. Rather MA, Nagappa B, Gull R. Morphological and histological studies on the reproductive system of *Puntius sarana sarana* (Hamilton, 1822) (Cyprinidae). Environment Conservation Journal,2018:19(1,2):93-102.
<https://doi.org/10.36953/ECJ.2018.191212>
 38. Rayal R, Selakoti A, Bahuguna P. A comparison between Gonado-Somatic Index (GSI) and Dobriyal Index (DI) for determination of sexual maturity in *Puntius ticto* from Aasan river, India. Uttar pradesh journal of zoology,2021:42(15):60-66. Retrieved from <https://mbimph.com/index.php/UPJOZ/article/view/2295>.
 39. Rehena Akhtara Begum, Saibal Sengupta. Diet composition of pool Barb *Puntius Sophore* (Hamilton, 1822) of Brahmaputra valley, Assam, India. Helix', Journal of the School of Biological Sciences, USTM, 2016,1 27-31.
 40. Risal A, Shrestha S, Mahaseth VK. Food and feeding behaviours of Spotfin Swamp Barb *Puntius sophore* (Hamilton, 1822) of Singhiya River, Biratnagar. Our Nature,2019:17(1):31-36. DOI: <http://doi.org/10.3126/on.v17i1.33989>.
 41. Roos N, Wahab MA, Chamman C, Thilsted SH. The role of fish in food based strategies to combat vitamin A and mineral deficiencies in developing countries. Symposium: Food-based approaches to combat-ing micronutrient deficiencies in children of developing countries, 12-15 December, Bangladesh, 2007, 65.
 42. Sandipan Gupta. An Overview on Feeding and Breeding Biology of Freshwater Cyprinid *Puntius sophore* (Ham-Buch, 1822).World Journal of Fish and Marine Sciences,2015:7(2):100-104.
 43. Saon Das, Sudarshana Nandi, Sandip Majumder, Surjya Kumar Saikia. New Characterization of feeding habits of *Puntius sophore* (Hamilton, 1822) through morphometry. Journal of Fisheries Sciences.com,2013:7(3): 225-231.
 44. Sarkar UK, Khan GE, Dabas A, Pathak AK, Mir JI, Rebello SC *et al*. Length weight relationship and condition factor of selected freshwater fish species found in River Ganga, Gomti and Rapti, India. Journal

- of environmental biology,2013:34:951-956.
45. Seema Langer, Krishan Raj Kant, Jyoti Sharma. Reproductive Cycle and Oogenesis of *Puntius Sophore* from Gho-Manhasan Stream of Jammu region, India. International Journal of Scientific and Research Publications,2013:3:(7):1-4.
 46. Sibani Saha. Biology of two important ornamental fish species *Puntius sophore* and *Puntius ticto* With special reference to their conservation in Tripura. Ph.D thesis, Department of Zoology Tripura University (a Central University) Suryamaninagar-799 022, Tripura, 2015.
 47. Singh HR, Rajshree Srivastava. Scale structure and age and growth of *Puntius sophore* (ham.) from the Ganga river system at Allahabad. Journal of Inland Fisheries Society of India,2008:4(1):16-22.
 48. Snigdha Dey, Kamales K, Misra, Sumit. Homechoudhuri Analysis of major lipid classes and their fatty acid composition of an Indian minor carp *Puntius sophore* in order to evaluate its nutritional aspects. Int. J. Adv. Res. Biol. Sci,2015:2(8):100-119.
 49. Sriramachandra Murty V. Studies on growth checks on scales of *Barbus (Puntius) sarana* (Hamilton-Buchanan) from lake Kolleru, Andhra Pradesh, with comments on growth checks reported on hard parts of some Indian fishes. Proc. Indian Acad. Sci,1976:83B,(3):5-102.
 50. Supratim Pal, Sukanta Debnath, Kaushik Chakraborty. Studies on length-weight relationship of fish *Puntius sophore* (Hamilton) from the river Ghargharia at Cooch Behar, West Bengal, India. Int. Res. J. Biological Sci,2018:7(5):7-12.
 51. Talukdar B, Mili S, Kalita H Kr, Sarma D. Karyology of *Puntius sophore* (Pisces, Cypriniformes) from the Brahmaputra River, Assam, India. Poult Fish Wildl Sci,2016:4:167. doi:10.4172/2375-446X.1000167
 52. Talwar PK, Jhingran AG. Inland Fishes of India and adjacent countries. Oxford-IBH Publishing Co. Pvt. Ltd., New Delhi, 1991.
 53. Thilsted SH, Roos N, Hassan N. The role of small indigenous fish species in food and nutrition security in Bangladesh. NAGA, ICLARM Quarterly, 1997, 13-15.
 54. Wahengbam Sarjubala, Mayanglambam Shantosh, Hawaibam Romharsha, Chungkham Sarojnalini. Nutritional properties of some freshwater fish species of Manipur, India. Journal of Coldwater Fisheries,2018:1(1):48-53.