

Biology of Gangetic Leaf Fish, *Nandus nandus* (Hamilton, 1822): A Review

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Abstract

Study on bird diversity in the campus of Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur was done, over a period of six months from September 2017 to February 2018. A total number of 45 bird species belonging to 23 families were recorded during the study covering an area of about 1.214 km². University campus is 0.02% of total Gorakhpur area, and has 12.5% of the total bird species reported in Gorakhpur region. The study was divided into different regions that are: Botanical garden, Arts faculty, Law department, Helipad region, Pant bhawan. Of the 45 bird species observed, 4 were migratory namely Yellow-footed green pigeon, Rosy-starling, Robin accentor, Ashy drongo. The common bird species were Jungle babbler, common myna, spotted dove, blue rock pigeon, house crow, black drongo etc. The University campus has wide variety of trees, which may be one of the major contributing factor for the richness of bird species.

Keywords: *Nandus nandus*; Feeding habit; Breeding biology

Introduction

Nandus nandus is commonly a freshwater fish species belonging to the order Anabantiformes under the family Nandidae [1]. This species is commonly known as mud perch or Gangetic leaf fish. In India, specifically in West Bengal and in Bangladesh, it is vernacularly known as meni, bheda and roina. It has already been considered as a potential candidate species for freshwater aquaculture [2]. It has also been considered as Small Indigenous Species (SIS) [3], having good nutritional value with 52.5%, 2%, 0.21% and 5.7% of protein, fat, carbohydrate and mineral content respectively [4]. This species has been reported to have high demand as aquarium fish in domestic ornamental fish markets of India due to its brilliant color pattern [5-7] and has also been exported from India to other countries in recent years as indigenous ornamental fish [7].

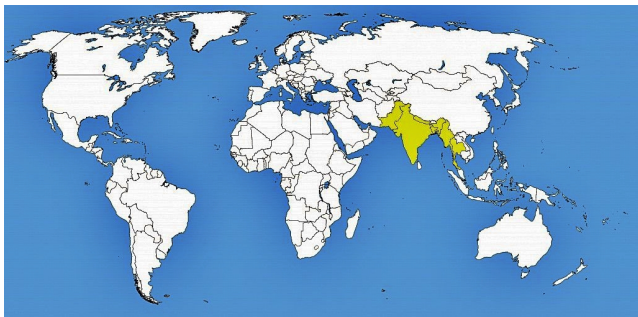


Figure 1: Map representing the geographical distribution range of *Nandus nandus*.

Distribution and Habitat

Nandus nandus is widely distributed in India, Bangladesh, Pakistan, Nepal, Myanmar and Thailand [8] (Figure 1).

Adults of *Nandus nandus* occur frequently in ditches and inundated paddy fields; most commonly inhabit standing or sluggish waters of lakes, reservoirs or canals [9,10]. It can inhabit both in fresh and brackish water [8,11].

Morphology

Day [12] and Talwar and Jhingran [8], have earlier documented the morphological characters of *Nandus nandus*; this has been summed up here. The body is deep and laterally compressed; its profile over the orbit is rather concave, while the abdominal part is nearly straight. Head is large, compressed with pointed snout. Eyes are large. Mouth is very large and protrusible. Teeth are in villiform bands on jaws.



Figure 2: A fresh specimen of *Nandus nandus* collected from river Damodar at Bagnan, Howrah (12.8 cm Total Length).

Dorsal spines are rather strong. Anal spines are moderately strong and the second anal spine is the longest. Caudal fin is slightly rounded. Scales are ctenoid type; lateral line is interrupted at about 36th scale.

Color: Body is greenish brown in color with brassy reflections; vertically marbled with three broad patchy blotches. A dusky blotch is present on caudal fin base while some narrow dark bands can be observed to radiate from eye. Fins are greenish; yellowish narrow bands of spots across soft portions of dorsal, anal and caudal fins can be found (Figure 2).

Parameswaran et al. [14] have reported that smaller post larvae (3.5-7 mm in size) of *Nandus nandus* feed predominantly on zooplankton (93.29%) consisting of small rotifers (*Brachionus*, *Keratella*, *Conochilus*, and *Polyarthra*) and cladocerans (*Moina*, *Bosmina*, *Simocephalus* and *Ceriodaphnia*) and a few phytoplankters (6.61%), mainly composed of blue-green algae (*Anabaena* and *Microcystis*), green algae (*Cosmarium*, *Staurastrum*, *Arthrodesmus* and *Closterium*), euglenoids (*Euglena*, *Phacus*, and *Trachelomonas*) and diatoms (*Navicula*, *Synedra*, *Stauroneis* and *Gomphonema*). The larger post larvae (8-20 mm in size) has been reported to consume cladocerans (53.09%), copepods (*Diaptomus*, *Cyclops* and nauplii; 38.85%) and blue-green algae (8.06%) like *Microcystis* and *Anabaena*.

The juveniles (21-35 mm in size) are used to subsist on notonectids (57.43%) and small aquatic beetles (20.91%), in addition to lesser percentage of zooplankton (13.92%; mostly copepods), plant roots (5.04%) and mud (2.69%). Adult fish (45-138 mm in size) mainly feeds on carp fry (9.87%) and small minnows, and weed fishes (70.16%) like *Oxygaster spp.*, *Puntius spp.*, *Amblypharyngodon mola*, *Ambassis nama* and *Ambassis ranga*. Aquatic insects (12.41%) and shrimps (5.64%) are used to form supplementary food for the adults. Stage wise variation in food preference has been reported by Parameswaran et al. [14]; post-larvae are predominantly planktivore, juveniles are mainly insectivore while adults are piscivorous in nature.

Goswami [16], has documented semi-digested unidentifiable organic matter (35.93%) and prawn and prawn body parts (26.64%) as the basic food for *Nandus nandus* while fish and fish body parts (10.02%), insect body parts (11.55%), macrophyte tissue (6.55%), semi-digested unidentifiable animal matter (3.32%) and insect larva (2.26%) have been regarded as the secondary food. Rotifers (0.04%), nematodes (0.06%), microcrustacea (0.11%), non-parasitic flat worm (0.12%), algae (1.68%) and semi-digested unidentifiable vegetable matter (0.25%) have been reported as the incidental food items for this fish species.

Change in feeding habit in juveniles and adults has also been documented by Goswami [16]. Prawn and prawn body parts, semi-digested fish and fish body parts have been reported to form the basic food in case of juveniles while semi-digested unidentifiable organic matter has been documented as the basic food for the adults. Studying the histology of the alimentary canal and digestive gland of the species, its carnivorous, feeding habit has further been confirmed by Goswami [16].

Reproductive Biology

Sexual dimorphism

Pal et al. [18], have documented some sexual dimorphic characters for *Nandus nandus* which has been summarized in Table 1. Sheenaja [19], further has incorporated some information in this aspect. He has reported that adult females of *Nandus nandus* are normally fuller-bodied and larger than males.

The females also possess more conical, pointed and upward directed mouth than males. During the breeding season, prominent black blotch is also noticeable in the caudal peduncle of females.

Male	Female
Smaller and slender in appearance	Relatively larger and robust in appearance
Bright in color	Comparatively dull in color
Pelvic fin is rough	Pelvic fin is smooth
Eject white milt while put light pressure on abdomen	Eject brown eggs following gentle pressure on abdomen

Table 1: Sexual dimorphic characters of *Nandus nandus* as documented.

Sex ratio

Das and Zamal [20], have reported male dominance in the population of *Nandus nandus* while Parameswaran et al. [14], have documented maximum number of female in their studied population.

Fecundity

Mustafa et al. [15] have reported fecundity range of 7,381-46,222 for *Nandus nandus*. Fecundity range of 1,106.25-37,922; 1,573-23,546 and 3,937-42,460 have been documented by Parameswaran et al. 14, Goswami 16 and Ray 17 respectively for this fish species.

Length and age at first maturity

Parameswaran et al. [14] and Das and Zamal [20], have reported that *Nandus nandus* is used to mature in the very first year of its life. Goswami [16], has documented 9-10 cm as length at first maturity for this fish species.

Breeding periodicity

All the earlier researchers [14,16,21-23] have reported *Nandus nandus* as a single spawner. Raizada [22,23] has reported April to August as the breeding season for this fish species while March to July and April to June have been documented as its breeding season by Parameswaran et al. [14] and Goswami [16], at Assam and West Bengal respectively. Alikunhi [24], has reported that *Nandus nandus* breeds in ponds little prior to or at the commencement of the monsoon season. April to September has been reported as its breeding season from Bangladesh by Hossain et al. [21].

Conclusion

Information on food and feeding habits of fishes is very much important in fishery biology and in fisheries management program [25]. For successful fish farming, a thorough knowledge about the food and feeding habit of the fish species under interest is necessary [26, 27]. Considering the information documented in this report, it is quite clear that a concise knowledge is available on food and feeding habit of *Nandus nandus*.

Unlike some other indigenous fish varieties [28-42], no such contradictory information is available on its feeding habit as all the earlier researchers have reported its carnivorous nature. Apart from gut content analysis, modern methodologies like morpho-histology

and enzymatic analysis of alimentary canal have already been considered to study the feeding habit of this fish species [13].

Proper nutritional support to the brooders and other developmental stages is needed to achieve maximum success in captive breeding. Considering the information so far available, it can be reported that post larval stages mostly prefer planktons more specifically zoo planktons. Specific information on the most preferred food items of the juveniles and adults is lacking as earlier researchers have not documented any particular preference of these two stages for any particular food items.

Parameswaran et al. [14], have reported insects as the mostly preferred food items for the juveniles while Goswami [16], has documented prawns and fishes as the dominant food items for the same. On the other hand, for adults Parameswaran et al. [14] have reported maximum preference for fishes while Mustafa et al. [15] have reported maximum preference for prawns and fishes for them. Rain both [10] has documented aquatic insects and fishes as the most preferred food items for adults while Ray [17], has enlisted prawns and snails for the same. Agarwal and Sharma [13], have documented insects and crustaceans as the most preferred food items for the adults while Goswami [16], has reported maximum preference for some organic matter and prawn (though no such proper information has been documented on this organic matter).

Though stage wise variation in food preference has been reported for this fish species, further studies are needed to identify the most preferred food items for different stages more specifically for the juvenile and adult stage as this information is very much important considering captive culture.

Stage wise, which possible food items can be supplied (considering the common preferred food items reported by the early researchers) during the captive breeding of *Nandus nandus* has been represented in Figure 3.

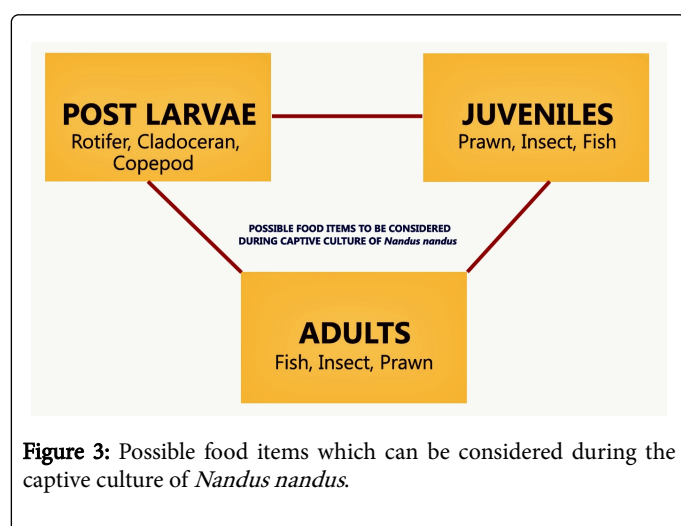


Figure 3: Possible food items which can be considered during the captive culture of *Nandus nandus*.

Meanwhile, further studies can be made to identify some of the food ingredients which can be used to promote larval growth as well as breeding performance of the adults in captive culture. In this context, the study of Rakhi et al. [43] and Reza et al. [44] can be mentioned. Rakhi et al. [43], have suggested the supply of live tubificid worms to get maximum growth and survivability of the larvae. In the absence of live feed, dry tubificid worms supplemented with 1% Docosa Hexaenoic Acid (DHA) can also be supplied which has the potential to

support considerable growth and survivability of larvae almost in close percentage of the live feed.

In another experiment, Reza et al. [44], have reported better breeding performance (high sperm count, better, oocyte development and maximum hatching rate) of the brooders when they were supplied with a formulated diet supplemented with Poly Unsaturated Fatty Acid (PUFA).

Reproductive potential of a fish population is one of the basic exigencies to designate the individuals of that population in respect to their gonadal status [45]. Knowledge of gonadal development and spawning season of a species allow subsequent studies on spawning frequency of its population, which is important for its management [46]. The Study of sex-ratio, length at first sexual maturity, fecundity and spawning periodicity etc. are essential part of reproductive biology study of fishes [47,48].

Considering the information summed up here on reproductive biology of *Nandus nandus*, it can be concluded that though the knowledge available on breeding periodicity and fecundity of this fish species is quite satisfactory; information existing on its sex-ratio and length/age at first maturity is scanty. So, further studies are needed to fill up the information gap which will be helpful for better management of its fishery and trade.

Though *Nandus nandus* has been enlisted as “Least Concern” species in IUCN Red List of Threatened Species [49], once in nature it was abundantly available, but at present its availability has been drastically declined due to indiscriminate fishing, unplanned construction of bridge and flood protection embankments, use up of low land water for irrigation, residual effect of pesticides/insecticides, destroying breeding ground etc. [50]. Reduced availability of this fish species from Southern part of West Bengal has also been reported by Gupta and Banerjee [51].

Fisheries of *Nandus nandus* is basically capture based; no such culture methodologies has so far been designed for this fish species and it used to come to the fish markets along with the catch of other SIFS. Thus to sustain its fishery, it is important to design some suitable culture methodologies for this fish species along with standardization of techniques for its captive breeding. It has already been considered as a potential candidate species for freshwater aquaculture [2]. Das and Zamal [20], have reported the suitability of this fish species for integrated farming as it can be cultured in shallow waters of rice fields.

In respect to the captive breeding of *Nandus nandus*, works of Pal et al. [18] and Sharmin et al. [50], can be considered. In both these cases, carp pituitary gland extract was used as the inducing agent for its captive breeding.

Information on feeding habit and reproductive biology is important to get proper success in captive culture of any particular fish species.

The proper use of the information so far available on food, feeding habit and reproductive biology of *Nandus nandus* followed by further studies to fill up the information gap will be helpful in respect to initiate its culture and also to enhance the success rate in captive breeding in coming days.

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