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Food, feeding habit and reproductive biology of freshwater garfish, *Xenentodon cancila* (Hamilton, 1822): A short review

Sandipan Gupta and Samir Banerjee

Abstract
Xenentodon cancila is a freshwater fish species, commonly known as freshwater garfish. Though this fish species is not that much popular as a table fish; its acceptability and high demand as an ornamental species among the fish hobbyists have already been reported. Not much research has so far been conducted on food, feeding habit and reproductive biology of this species. The present review aims to consolidate the earlier documented information on feeding habit and reproductive biology of *Xenentodon cancila* along with pointing out the information gap which to be filled up to sustain its trade as an ornamental fish.

Keywords: *Xenentodon cancila*; Garfish; feeding habit; reproduction; biology

1. Introduction
Xenentodon cancila is commonly known as freshwater garfish which belongs to the family Belonidae under the order Beloniformes. Though no such information is so far available on its nutritional quality, this fish species is almost common in fish markets of its native ranges where it is used to come along with the catch of other indigenous fish varieties. It has been reported from domestic ornamental fish markets of India; having high market demand among the aquarium fish hobbyists [1, 2] and recently has also been exported from India to other countries as indigenous ornamental fish [3].

2. Vernacular names
Xenentodon cancila is vernacularly known as kokila/kakila/kankley in India; kakila/kaikka in Bangladesh; kauwa/kauwo in Nepal; Yonna in Sri Lanka and Pla katung heo mueng in Thailand [4, 5].

3. Synonyms
Esox cancila (Hamilton, 1822)
Belone graii (Sykes, 1839)
Esox indica (McClelland, 1842)
Esox hindostanicus (Falconer, 1868)
Belone cancila (Day, 1878)

4. Habitat
Xenentodon cancila is a freshwater species, primarily inhabits in rivers [4]. It can also be found in ponds, canals and inundated fields [6].

5. Distribution
Xenentodon cancila is widely distributed in India, Bangladesh, Nepal, Pakistan, Sri Lanka, Myanmar and Thailand [4, 5].

6. Morphological characters
Talwar and Jhingran [4] and Day [7] have described the morphological characters of *Xenentodon cancila* which has been summarized here.

Body is very elongated and slightly compressed. A deep longitudinal groove is present along the upper surface of the head. Lower jaw is the longer; the maxilla, which is partially concealed by the preorbital, reaches to beneath the first-third of the eye. Eyes are rather small. Teeth: a row of large, sharp, widely separated ones in both the jaws; with an external row of numerous fine ones; none is present on the vomer. Scales are small; present over the body and in irregular rows, some over front end of the groove on head, also on sides of head except on opercles. Dorsal fin commences opposite to the anal fin; and is rather more than, or else twice as far from the anterior extremity of the orbit as it is from the posterior extremity of the tail. Pectoral fin equals half the distance of the head behind the front edge of the eye. Pelvic fin is inserted rather nearer to the base of the caudal fin than the hind edge of the eye. Caudal fin is slightly emarginated. The last dorsal fin and anal fin rays are not elongated. Color: greenish gray superiorly, becoming whitish along the abdomen. A silvery streak having a dark margin extends along the body from opposite the orbit to the centre of base of the caudal fin. The whole upper two-thirds of the body is closely marked with fine black spots ; while there are from 4 to 6 larger blotches along the side between the bases of the pectoral and anal fins, these are absent in the young. Dorsal and caudal fins are dark edged; anal fin is whitish with a greyish margin. Eyes are golden.

7. Food and feeding habit

Information so far available on food and feeding habit of *Xenentodon cancila* is very much scanty. Bhuiyan [8], Gupta [9] and Ward-Campbell *et al.* [10] have reported carnivorous feeding habit of this fish species. Bhuiyan [8] has documented its maximum preference for fishes while Ward-Campbell *et al.* [10] have reported that this fish species fed primarily on fishes (41.2 %), crustacean (22.5 %) and immature forms of Odonata (20 %) and to a lesser extent on immature Ephemeroptera (12.4 %) and Hemiptera (7.7 %).

8. Reproductive biology

8.1 Sexual dimorphism

Sehgal *et al.* [11] have documented some sexual dimorphic characters for *Xenentodon cancila* which has been enlisted in Table 1.

Table 1: Sexual dimorphic characters of *Xenentodon cancila* as described by Sehgal *et al.* (1989).

S. No.	Characters	Male	Female
1.	Shape of the body	A hump in the mid-dorsal region, just behind the head groove.	Hump absent.
2.	Vent	Small deep, pit like.	Projecting like a small papilla with a narrow median slit.
3.	Abdomen	Not round.	Rounded, bulging.
4.	Body coloration		
5.	Abdomen	With yellow patches up to pelvic fin, rest part of the body is white.	White
6.	Dorsal (above lateral line)	Olive green	Olive green predominant with greyish tinge.

8.2 Sex ratio

Not much study has so far been conducted on this particular aspect except by Hossain *et al.* [12] who have reported equal proportion of male and female fishes in their studied population.

8.3 Fecundity

No such research so far has been done to study the fecundity of *Xenentodon cancila* except by Bhuiyan and Islam [13] who has reported average fecundity of 1,432 with a range of 750 to 2,852 for this fish species.

8.4 Gonadal maturity stages

Subba and Meheta [14] have documented six ovarian developmental stages for *Xenentodon cancila* while Bano *et al.* [15] have reported three ovarian developmental stages in their study which have been enlisted in Table 2 and Table 3 respectively. On the other hand, Chakrabarti and Banerjee [16] have documented four reproductive phases of male *Xenentodon cancila* following histological study; those stages along with their distinguishing characters have been enlisted in Table 4.

Table 2: Histo-morphological characters of different maturity stages of ovary following the documentation of Subba and Meheta (2012).

S. No.	Maturity stage of Ovary	Histo-morphological Characters
1.	Resting Phase (October to November)	Ovaries are thin, translucent, pale and dirty brown in colour, with less vascular supply. The ovary is with ovigerous lamellae, packed with oogonia. The oogonia are budded off from the germinal epithelium and are arranged in nests.
2.	Early Maturing Phase (December to January)	Ovaries become slightly thicker, opaque and yellowish in colour. Vascularisation is feeble. The ovigerous lamellae are greatly swollen and laden with oocytes of different stages. Tunica albuginea becomes slightly thinner than in previous months. Increase in the weight of the ovary is recognizable.
3.	Advanced Maturing Phase (February to March)	Colour of the ovaries is deep yellow. The blood capillaries become inconspicuous because of profuse vascular supply. Number of immature oocytes decreases. The ova are tightly held and the ovary cannot be striped by applying gentle pressure. The tunica albuginea becomes extremely thin. The ovocoel is greatly reduced. Migratory nucleus reduced in size is seen towards the periphery. The yolk globules become enlarged because of their fusion with one another. There is further increase in the weight and volume of the ovaries.
4.	Pre-spawning Phase (April to May)	Ovaries become deep yellow in colour. Vascularisation is extensively developed. Both transparent and opaque ova are present and the ovaries attain maximum weight in this phase. During this phase, nuclear extrusion is seen. Histological condition is the same as that of the previous months.

5.	Spawning Phase (Early June to late July)	Ovaries are yellowish in colour and turgid due to the presence of a large number of translucent eggs. Ripe eggs are present in the oviduct to be discharged outside. Vascularisation of the ovary reaches its peak and the ovaries are said to be in running phase. Tunica albuginea becomes extremely thin and inter follicular space is greatly reduced. The ovigerous lamellae are inconspicuous. Histological section of the ovaries shows a number of discharged follicles.
6.	Spent Phase (August to September)	Ovaries become thin, flaccid, delicate, slender and dull in colour. There is a decrease in the volume and weight of the ovary. Vascularisation is reduced. In this phase, oogonia are seen budding from the germinal epithelium. The tunica albuginea again becomes thicker. Histologically, the ovary shows some residual oocytes as well as discharged follicles. The nests of oogonia are seen among the ovigerous lamellae.

Table 3: Histo-morphological characters of different maturity stages of ovary following the documentation of Bano *et al.* (2012).

S. No.	Maturity stage of ovary	Histo-morphological Characters
1.	Pre-spawning phase (January to April)	Ovaries are small and cylindrical in shape. They are smooth in appearance and yellowish in colour. In the ovaries of January, February and March, the ovarian wall is thick. The ovigerous lamellae are distinct and contain oocytes of early and late yolk-vesicle stages along with the oocytes of the early stages. In the ovaries of April, few oocytes of early and late yolk stages, varying in number from a very few to many, are also present. Few corpora atretica have been observed during this period, while post-ovulatory follicles are absent.
2.	Spawning phase (May to September)	Ovaries are large in size, beaded in appearance and orange in colour. In the month of July, the ovarian wall is thin and the ovigerous lamellae lose their identity. The ovary is closely packed with oocytes of yolk stage, premature stage and mature stage. In the month of August and September, the ovarian wall is thick, the ovigerous lamellae begin to reappear and the ovary is loosely packed with all the stages of oogenesis. The number of corpora atretica increases during this period while few post-ovulatory follicles are first located in the month of May and their number increases considerably till the end of the spawning period.
3.	Post-spawning phase (October to December)	Ovaries are thin, small in size and smooth in appearance. They are yellowish in colour. The ovarian wall is thick and ovigerous lamellae are distinct containing oocytes of chromatin-nucleolus and peri-nucleolus stages. The corpora atretica are few in number. The post-ovulatory follicles are not present.

Table 4: Histological characters of different maturity stages of testis following the documentation of Chakrabarti and Banerjee (2015).

S. No.	Maturity stage of testis	Histological Characters
1.	Growth phase (December to February)	During early growth phase the predominant spermatogonia are arranged in a definite pattern and few spermatocytes and spermatids are also present in between them. In the late growth phase, the testis is characterized by the presence of all stages of the spermatogenic cells. The primary and secondary spermatocytes are gradually increased in number and cluster of spermatozoa can be seen inside the lumen.
2.	Maturation phase (March to May)	The lobule boundary wall of the testis has become considerably thin and spermatogonia cells are reduced in number and restricted along the boundary wall of the lobules. The spermatocytes are reduced considerably and gradually transformed into the spermatids and spermatozoa. The active interstitial cells are noticed in between the lobules.
3.	Spawning phase (June to August)	The lobule boundary wall is extremely thin and the spermatogenic activity within the lobules is at their peak. The spermatogonia are reduced in number. The testicular lobules are full of spermatozoa and the maximum activity of interstitial cells can be seen in this stage adjacent to blood vessels as they increase in size.
4.	Post spawning phase (September to November)	The diameter of lobules decreases due to release of sperms and boundary wall gradually becomes thicker. The spermatogonial cells are present in clusters. The testicular lobules contain residual spermatozoa and few cysts of spermatids. The interstitial cells are considerably smaller in size.

Fig 1: Lateral view of fresh specimen of *Xenentodon cancila.*

Fig 2: *Xenentodon cancila* in display along with other indigenous ornamental fish varieties at Galiff street market, the wholesale ornamental fish market of Kolkata.

8.5 Reproductive periodicity

Early June to late July has been reported as the spawning season for *Xenentodon cancila* by Subba and Meheta [14] while May to September and June to August has been reported for the same by Bano *et al.* [15] and Chakrabarti and Banerjee [16] respectively.

9. Conclusion

As per the information documented in this review, it is quite clear that no such contradiction regarding feeding habit as reported earlier for some other indigenous fish varieties [17-30] is present for *Xenentodon cancila*. All the earlier researchers have reported carnivorous feeding habit for this fish species. So far, food preference of only adult *Xenentodon cancila* has been reported; but for captive culture, proper knowledge on food preference of different life stages is required. Thus further study following histo-morphological and enzymatic analysis of the alimentary canal can be considered to get information on age-wise and stage wise variation in food preference if any existing for this fish species. On the other hand, though considerable information is available to distinguish different gonadal maturity stages of *Xenentodon cancila*, information documented so far on sex-ratio, fecundity and reproductive periodicity is scanty. Thus further studies are needed to gather proper knowledge on these aspects.

This fish so far has not been considered as a highly relished table fish; is used to be consumed by the poor people mainly. In markets this fish species is used to come along with the collection of other indigenous fish varieties. On the other hand, in ornamental fish markets this fish species is just recently introduced. So may be considering its less importance in fishery and ornamental trade, earlier researchers have not paid much attention to study its biology. The supply of *Xenentodon cancila* both in food fish markets as well as in ornamental fish markets is capture based. The population declination of this fish species has already been reported in its native ranges [31]; thus unscrupulous collection of this species may even further accelerate the declination. Hence to sustain the trade of this fish species, initiatives to be taken to start its captive culture and in this regard, proper information on its feeding habit and reproductive biology is required. Thus, the information so far available on its biology to be used judiciously and the existing information gap demarcated in this review to be filled up with further research to support its trade.

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