BREEDING BIOLOGY, CAPTIVE BREEDING AND FRY NURSING OF HUMPED FEATHERBACK (*NOTOPTERUS CHITALA*, HAMILTON-BUCHANAN, 1822)

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ABSTRACT

A study was conducted to observe the captive breeding performance with maturing stages and fry nursing of the threatened indigenous fish species *Notopterus chitala* at Arabpur Fish Farm (Longitude 89°12'15" E, Latitude 23°10'30" N), Jessore, Bangladesh during 1998 to 2001. The peak period of ovulation for *N. chitala* was found from July to August and the fish attained its first maturity at third year of age. Captive breeding is the most effective and basic process in case of *N. chitala* when cemented tank was used for collection of fertilized eggs, percentage of fertilization and hatching in stead of bamboo pole, plastic barrel, cemented tank and barrel made of tin. In the nursery practices live benthos, hatchling of thai punti and silver carp were used as feed of the spawn but the highest growth and survivability of the fish fry obtained by using *Barbodes gonionotus* (thai punti) spawn and live *Tubifex* sp. (benthos).

Key words: Fertilization, hatching, growth, survivability.

INTRODUCTION

Humped featherback, locally known as Chital *(Notopterus chitala)* is one of the esteem and largest fish of Bangladesh belonging to the Family, Notopteridae and Order, Osteoglossiformes (=Clupeifonnes). It is widely distributed in deep and clear water of rivers, canals, beels, haors, reservoirs and ponds of Bangladesh (Islam and Hossain 1983, Hafizuddin 1985, Azadi *et al.* 1994) and south-east Asian countries including Myanmar, India, Pakistan, Malaysia and the Philippines (Sterba 1989, Khan 2000). The *chitala* species of *Notopterus* attains over 100 cm in total length and 10 kg in body weight (Quddus and Shafi 1983, Rahman 1989). However, the maximum weight of 19 kg has also been found (Azadi *et al.* 1994). The fish has extremely high demand for its deliciousness and less bone feature especially in the abdomen.

Parween *et al.* (2000) opined that the adult *Notopterus* is carnivorous and predator in food habit. It grows in ponds in large size, but due to its feeding habit it is difficult to raise chital in carp nursery pond. This problem is making a scientific management for commercially valuable cultured and auto stocking species (Azadi *et al.* 1994). It has been observed that *N. chitala* prey on other smaller fishes, crustaceans and uptake mud and debris while searching for molluscs on the bottom. It is notable that chital breeds in June and July

having an egg size of 3.0 to 4.5 mm in diameter (Rahman 1989). Though the fish is enlisted as an endangered species (Khan 2000) but the fish is now facing the danger of extinction and have almost disappeared from the market.

Among the notopterid fishes, *N. notopterus* and *N. chitala,* appear to have received little attention (Ghosh 1996). Also there is very scanty work on artificial or control breeding and rearing of chital fry. The study was, therefore, undertaken for augmenting the ways of rearing the fry and to save its population from being threatened to a critical level.

MATERIALS AND METHODS

Species collection and identification of maturity, fecundity and spawning

Four pairs of matured females (weighing 4.2 to 5.0 kg) and males (weighing 2.8 to 3.6 kg) were collected from Modhumoti river, Faridpur, Bangladesh on first week of July and stocked in pair in four ponds having an area of 0.09 to 0.13 ha and a water depth of 150 to 170 cm. Maturity was identified through the culture of F_1 generation. Fecundity was estimated by the sample of substratum where the eggs were deposited by the fish and the egg laying month was counted as the spawning period. Twenty two fishes were used during breeding season for determination of sex-ratio and also the colour of gonad for both female and male. To identify the colouration of gonads, Asian paints (Bangladesh) LTD, manufactured under license from Asian Paints (India) Limited, Mumbai (Colour Index) was used.

Collection of fertilized eggs

For collection of eggs, bamboo pole (ht 190 cm) and either sides opened plastic barrel (r 30 cm, ht 75 cm), cemented tank (r 24 cm, ht 75 cm) and a barrel made of tin (r 50 cm, ht 75 cm) were used in 1998 as substrates in all four ponds separately at a depth of one meter from the surface. The first one was placed horizontally and the rest three were placed vertically at one corner of the ponds. The substrates were thoroughly checked every day during full moon or new moon period in the year of 1998. The eggs were found in July 27 (full moon) on bamboo pole; August 10 (new moon) in plastic barrel; August 25 (full moon) in cemented tank and August 27 (full moon) in barrel made of tin.

Determination and duration of fertilization, hatching, deformities, yolk sac absorption

The spawned eggs from all four substrates were collected immediately and placed inside the cistern with a water flow created by a pipe near the substratum for hatching. The water temperature and flow rate of the cistern, were 27 to 28°C and 3.01/sec, respectively. After hatching of the fertilized eggs (4 days) all hatchings were transferred by siphoning to aluminium tray for nursing of about a total period of 22 days. Percentage of fertilization was identified by compound microscope which was earlier detached from substratum. Hatching and deformities percentage of spawn were counted by visual observation. The yolk sac absorption was denoted by its free movements instead of feeding because this fish start feeding before fully yolk sac absorption at the water temperature of 27 to 28°C. Period of air breathing after yolk sac absorption was observed by the sign of air bubble formed on the surface of tray water.

Tray nursing of spawn

Post-larvae (500 g spawn=10,000 individuals approx.) were maintained in an aluminium tray (160 cm x 70 cm x 10 cm water depth) with continuous water flow under a shade from 01 to 22 September, 1998 in addition of 12 days nursing at pre-larval stage. It is of interest to note that *N. notopterus* show relatively slow embryonic and larval development and the eggs are provided with abundant supply of yolk (Parameswaran and Sinha 1966). After fourth day of hatching when the yolk

sac was partly absorbed, the spawns were fed with only poultry egg yolk merge of every three hours for two consecutive days. Then they were fed with *Barbodes gonionotus* spawn and *Muina* sp. (D_1), *Barbodes gonionotus* spawn and *Hypophthalmichthys molitrix* spawn (D_2) and *Barbodes gonionotus* spawn and *Tubifex* sp. (D_3) at 4 h interval for first 6 days. Over the following 10 days only *Moina, Hypophthalmichthys molitrix* spawn and *Tubifex* sp. were used as food for 6 h intervals to chital hatchlings. Some shade and shelters were used in the tray and the fecal wastage were removed before next feeding. The growth in terms of length (mm) and weight (g) were determined when air breathing started within 20 to 22 days of hatching after which the fry were stocked in rearing pond and kept until attaining the juvenile stage. All these nursing experiments were conducted in duplicates. The physico-chemical parameters of tray water were found; water temperature 27 to 28°C, pH 7.2 to 7.8, DO 5.4 to 6.2 mg/l, total alkalinity 380 to 410 mg/l and total hardness 540 to 610 mg/l.

Statistical analysis

The data on breeding performance and nursery practices were normalized by arcsine transformation. Statistical analysis of the data for all experiments were done by one way Analysis of Variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) to determine differences between the means taking at 1% ($P<0.01$) significance levels (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Breeding biology

Maturity was observed in 2001 with F_1 generation that is the fish mature at 3 years of its age and the female and male sex-ratio was 0.69:1.0. In 1998, fecundity was observed 5761 eggs of 4200 g female weight and spawning was found in July to August, 1998. During this period the colour of gonad were light brown and light creamy for female and male, respectively. The fertilized egg average weight and average diameter was 54 mg and 4.58 mm, respectively.

The F_1 generation of *N. chitala* was cultured for three years, after that the egg released by the fish on substratum which was indicated that the fish became matured after three years in natural pond conditions. The fish showed a slow growth during first year and rapid growth during the next two years of maturity. Chugunova (1963) stated that the study of growth constant has led to the discovery that majority of the fish population show two phases of growth and some even three, while first phase coincided with sexual immaturity, the second with sexual maturity and the third with old age.

It is mentioned by Rahman (1989) that chital breeds in June and July having an egg size of 3.0 to 4.5 mm in diameter which is almost similar to the present findings with fertilized eggs (avg, 4.58 mm). It can be concluded from the present findings that the species *N. chitala* breeds once in a year after getting maturity and the peak reproductive activities in the month of July to August of either new moon or full moon. The fish *N. notopterus* was found to breed once a year during the rainy season (June to August) in the Kaptai reservoir which seemed to be influenced by rain (Azadi *et al.* 1995). Hossain (1999) reported that "chital" laid eggs during May to June, which is earlier than that of present observation.

In general *Notopterus* (Pallas) is not highly fecund species. In the present study the fecundity was 1.371 for *N. chitala*. Hossain *et al.* (1991) reported 3.107/mm body length and 9.226/g body weight for *N. notopterus*. Low fecundity was found to be related to the bigger size of eggs, single lobed ovary and the presence of nest building behaviour (Azadi *et al.* 1995). The lower fecundity is also related to nest building habit and guarding

the nest for protection of the eggs (Shafi and Quddus 1982).

Notopterus species like other air breathing teleosts is bisexual. The sex ratio of female to male of *N. notopterus* in natural catch has been reported by Parameswaran and Sinha (1966) as 0.7:1.0, which is almost equal to the present study where it was 0.69:1.0 for female (9) and male (13), respectively. Out of 156 specimens of *N. notopterus,* 67 were females and 89 were males, i.e., the ratio was 42.99:57.05 (Hossain *et al.* 1991). The ratio of females to males of *N. chitala* was found to be 0.721:1.0 (Azadi *et al.* 1995).

Captive breeding

Controlled breeding was observed in July to August, 1998 and data placed in Table 1. *N. chitala* can breed naturally in captive condition without hypophysation. The fertilized eggs are adhesive to the substrate but not to each other. So the prime importance was paid to identify the shape, size and the condition of substrate used for fertilized eggs deposition. It was known that the fertilized eggs hatch out by the parental care in natural condition, i.e, fanning is necessary to supply dissolved oxygen.

Quantity of water hardened eggs

There was a significant variation among the substratum used to collect the water hardened eggs. The maximum amount of eggs (193.17 g) were found in T_3 (cemented tank) followed by T_4 (drum made of tin) (176.16 g). On the other hand, the lowest number of eggs were observed in T_1 (bamboo pole) (131.92 g) preceded by T_2 (plastic pipe) (144.55 g).

Percentage of fertilization

Significant variation was found among me substratum used to collect the fertilized eggs. The maximum number of fertilized eggs (82.0%) were found in T_3 followed by T_4 (65.33%). On the other hand, the lowest number of fertilized eggs were observed in T_1 (bamboo pole) (45.00%) preceded by T_2 (plastic pipe) (55.00%). In the present study, the fertilization rate was found more or less similar for all treatment groups and ranged between 45 to 82%. Lin *et al.* (1986) observed from several experiments that fertilization rate of ovulated oocyte for common carp were consistently high (90%).

Percentage of hatching

The hatching of larvae took place between 96:00 to 104:00 h after ovulation at 27 to 28°C in all the generations. There was a significant variation among the substratum used in respect of hatching percentage of fertilized eggs. The maximum number of hatching of hatchlings (78.00%) were found in T3 (cemented tank) followed by T4 (drum made of tin) (59.00%). On the other hand, the lowest number of hatching were observed in T_1 (bamboo pole) (30.00%) preceded by T_2 (plastic pipe) (43.67%).

Percentage of deformities

Significant variation was observed among the substratum used as treatment in regard to deformities of hatchlings. The maximum number of deformities of hatching (0.5%) were found when bamboo pole was used as substratum (T_1) followed by plastic pipe as substratum T_2 (0.4%). On the other hand, the lowest number of deformities were observed in T_3 (cemented tank) (0.1 %) preceded by T_4 (drum made of tin) (0.2%).

Quantity of spawn produced

The yolk sac absorption required from 192:00 to 288:00 h after hatching at the water temperature of 27 to 28°C in all generations. There was a significant variation among the substratum used to collect the water hardened eggs to produce the spawn (Table 1). The maximum number of spawn was produced (128.09 g) in T_3 (cemented tank)

followed by T_4 (drum made of tin as substratum) (88.30 g). On the other hand, the lowest number of spawn was observed in T_1 (bamboo pole as substratum) (36.99 g) preceded by T_2 (plastic pipe as substratum) (48.84 g).

The cemented substrate with larger diameter showed highest quantity of eggs; fertilization, hatching and production of spawn in the present study. This might be due to easy entrance of the parents to the substrate, which facilitated higher opportunity of supplying dissolve oxygen by fanning. Similar findings also reported by Potts (1984), who noted that the more sheltered the spawning side, the greater the vulnerability of eggs to bacterial, protozoan and fungal infections. The infection danger is greater in the two *Economidichthys* species than in other nesting species, first because the eggs are deposited in narrow and not well-aerated holes, and second because the nesting substratum is of organic origin where infections are more likely to develop (Daoulas *et al.* 1993).

Fry nursing

The nursery management of *N. chitala* fry was studied on 1 to 22 September, 1998 and data placed in Table 2.

Table 1. Control breeding performance of *Notopterus chitala* used different substrates (in all experimental treatments, one individuals of both female and male fish were used as brood).

Treatment	Egg (g)	Fertilization (%)	Hatching (%)	Deformities (%)	Spawn (B)
T1	131.92	45.00	30.00	0.50	36.99
T2	144.55	55.00	43.67	0.40	48.84
T3	193.17	82.00	78.00	0.10	128.09
T4	176.16	65.33	59.00	0.20	88.30
LSD	24.74	11.95	9.12	0.21	15.46
Level of significance	**	**	**	**	**

** Significant at 1% level, T1 = Used bamboo pole as substratum for collection of fertilized eggs, T2 = Used plastic pipe as substratum for collection of fertilized eggs, T3 = Used cemented tank as substratum for collection of fertilized eggs, T4 = Used drum made of tin as substratum for collection of fertilized eggs.

Table 2. Growth production and survival of *Notopterus chitala* in tray nursery (1998).

Treatment	Length (mm)	Weight (mg)	Production (kg/0.004)	Survival (%)
D1	30.60	374.33	3.57	92.00
D2	31.00	401.00	3.85	96.00
D3	33.80	468.25	4.61	98.50
LSD	0.72	9.89	0.14	2.62
Level of significance	**	**	**	**

** Significant at 1% level, Initial length and weight of *Notopterus chitala* spawn were (17.2 to 18.0 mm) avg., 17.6 mm and (45 to 55 mg) avg., 50 mg, respectively after 288 h of hatching, D1 = Used *Barbodes gonionotus* spawn and *Moina* sp. both, D2 = Used *Barbodes gonionotus* spawn and *Hypophthalmichthys molitrix* spawn both, D3 = Used *Barbodes gonionotus* spawn and *Tubifex* sp. both.

Length of fry

There was significant variation among the treatments (feed) in relation to length of fry. The longest fry (33.8 mm)) was found in D_3 (*Barbodes gonionotus* spawn and *Tubifex* sp.) followed by D_2 (31.0 mm) and that was the lowest (30.6 mm) in D_1 (*B. gonionotus* spawn with *Moina* sp.).

Weight of fry

Highly significant variations in weight of fry was found with the different food items used. The highest weight of individual fry (468.25 mg) was found in D_3 (*Barbodes gonionotus* spawn and *Tubifex* sp.) followed by D_2 (401.0 mg) and that was the lowest (374.33 mg) in D_1 (*B. gonionotus* spawn with *Moina* sp.).

The growth of hatchlings was slower than that of Indian major and exotic carps and needed careful nursing due to their sluggish nature. The growth in length was found to be very high in comparison with weight. It might be due to laterally flattened body of *N. chitala* which gain less weight with increase of body length (Azadi *et al.* 1994). Alikunhi (1957) reported that "chital" could grow to 30 cm in size in 60 to 70 days time. It is interesting to note that the higher length and lower weight of chital is contrasting to other carp species. This might be due to the thinner and flattened body shape of chital, which resulted in lower weight per unit body length.

Production of fry

The effect of feed on the production of fry was significantly different. The use of *Barbados gonionotus* spawn and *Tubifex* sp. (D_3) produced the highest (4.61 kg/0.004 ha) quantity of fry followed by D_2 (3.85 kg/0.004 ha) and the lowest production was observed (3.57 kg/0.004 ha) in D_1.

Survival of fry

The survivability rate of *N. chitala* fry was significantly affected by different feed used. The highest survival rates of fry (98.50%) was observed when *Barbodes gonionotus* spawn and *Tubifex* sp. was used as feed (D_3) followed by (96.0%) *Barbados gonionotus* spawn and *Hypophthalmichthys molitrix* spawn (D_4), while it was the lowest (92.0%) when *Barbados gonionotus* spawn and *Moina* sp. was used (D_1).

It was evident from the result that the highest length, weight, production and survivability of spawn were recorded from D_3 (*Barbodes gonionotus* spawn and *Tubifex* sp.). The average mortality rate was very low (1.5 to 8.0%) during the rearing period. It was in agreement with Hossain (1999) that there was less effect of stocking density because the fry of "chital" exhibited a characteristic pattern of congregation with their heads converging together and the tails radiating outwards like petals in a flower (Hossain 1999). The fry was seen to avoid direct sunlight and preferred to settle motionless in a shady place. Hence, during fry rearing small shade made of PVC pipe was provided for shelter and shade of the fry.

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