

BROOD REARING AND INDUCED BREEDING OF PABDA (*Ompok pabda*) AT BFRI, MYMENSINGH

A Thesis

By

SAIFUL ISLAM

Examination Roll No.: 10 Fish Aqua JD-21 M

Semester: July-December, 2011

Registration No.: 32590

Session: 2005-2006

MASTER OF SCIENCE (M. S.)

IN

AQUACULTURE



**DEPARTMENT OF AQUACULTURE
BANGLADESH AGRICULTURAL UNIVERSITY
MYMENSINGH**

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Submitted to the

Department of Aquaculture

Bangladesh Agricultural University, Mymensingh

In partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE (M. S.)

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NOVEMBER, 2011

ABSTRACT

Experiments on induced breeding of the endangered butter catfish pabda, *Ompok pabda* using Pituitary Gland (PG) were carried out during 15th June to 27th August 2011 in the Bangladesh Fisheries Research Institute, (BFRI) Hatchery, Mymensingh. Brood stock of *Ompok pabda* was produced in the hatchery. A total of 20 (10 male and 10 female) brood fishes of *Ompok pabda* were used in this experiment. Brood fishes were reared in the brood rearing pond by providing artificial diet for good health and full maturation. Brood fishes were treated with PG dose in different months during the present experiment. Both males and females were treated with double PG dose. Females were injected with 3 mg PG/kg body weight followed by a second dose of 16 mg PG/kg body weight 6 hours later. Males were injected with 6 mg PG/kg body weight followed by a second dose of 8 mg PG/kg body weight 6 hours later at the same time of female injection. It was observed that female and male brood fishes eject eggs and milt respectively at the contemporary times. Ovulation occurred naturally after 6-7 hours of second injection during the experiment. The fertilized eggs were hatched within 18-24 hours. The fertilization rates ranged from 71.42% to 84.46%, hatching rates from 57.25% to 71.20% and survival rates from 42.76% to 60.40%. The temperature ranged from 27.90 to 30⁰C, the p^H from 7.0 to 7.30, dissolved oxygen from 4.90 to 5.70 mg/l and transparency from 21.90 to 26.60 cm in brood rearing ponds. The mean gonadosomatic index (GSI) ranged from 0.81 to 1.08 cm. The mean fecundity of *Ompok pabda* ranged from 15560.00 to 17369.33 for the female having average body weight of 120 g. The male and female ratio was maintained as 1:1. The cost benefit ratios were 2.35 in June, 2.02 in July and 1.78 in August. The net profit was BDT 2, 10,120 per 2 acres during the whole experimental period.

ACKNOWLEDGEMENTS

The author expresses the heartiest and sincere praises to the Almighty “Allah” the omnipotent, omnipresent, omniscient, the supreme Authority of the Universe who has created us to explore the hidden fast of the nature for the benefit of mankind and enabling him to complete this piece of research work successfully in time.

The author would like to extends his heart-squeezed gratitude, deepest appreciation, best regards and indebtedness to his honorable teacher and research Supervisor Dr. Md. Ruhul Amin, Professor, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, for his untiring guidance, scholastic supervision, valuable advice, innovative suggestions, constant encouragement, helpful comment, affectionate feeling and inspiration in all phases of conducting the research work and preparation of the thesis.

The author would like to express his sincere appreciation, heartfelt gratitude and immense indebtedness to his research co-supervisor Dr. Mohammad Mahfujul Haque, Associate Professor, Department of Aquaculture, for his kind cooperation, encouragements, affectionate feelings, technical help, valuable advice and helpful discussion throughout the entire period of research work and preparation of the thesis.

The author acknowledges with sincere gratitude, cordial respect and profound indebtedness to his honorable teacher Prof. Dr. Md. Ali Reza Faruk, Professor and Head, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, for his constant and untiring supervision, immense guidance, precious advice, valuable suggestions, constructive criticism and painstaking correction for successful completion of this thesis.

The author expressed his boundless gratitude to his respective class teachers Prof. Dr. Kirtunia Juran Chandra, Prof. Dr. Md. Mohsin Ali, Prof. Dr. Bazlur Rashid Chowdhury, Prof. Dr. Monoranjan Das, Prof. Dr. Gias Uddin Ahamed, Prof. Dr. M. Mamnur Rashid, Prof. Dr. S.M. Rahmatullah, Prof. Dr. M. Ahsan Bin Habib, Associate Prof. Md. Sazzad Hossain, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, for their valuable suggestion and co-operation during the study period.

The author feels pleasure to express the deepest gratitude and profound appreciation to Dr. Md. Golam Hossain, Director General, Bangladesh Fisheries Research Institute, Mymensingh, for his support, co-operation and suggestion during the study period.

The author specially acknowledges to Dr. Md. Kohinoor Hossain, Senior Scientific Officer, Md. Helal Uddin, Assistant researcher and Md Tabir Hasan, field assistant, BFRJ, Mymensingh, for their valuable techniques, co-operation and encouragement during the study period.

Cheerful acknowledgements are expressed to the sweet surroundings of well wishers and friends specially Md. Nazmul Hossain, Golzar, Rasheduzzaman, Mominur Rahman, Sarowar Hossain, S.M. Rakib, Shawon, Tushar, Mamun, Jalal Tanbir, Nafisa and all his well wisher.

Finally the author is ever grateful to his beloved mother and his affectionate youngest sister Ishrat Jahan Snighdha for their everlasting love, patience, moral and constant blessings.

The Author

November, 2011

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INTRODUCTION

Over population together with global warming is an alarming threat to the human civilization. To defend the recent consequences, food security and its sustainable production have got considerable attention throughout the world. Fish is a major food item of human being from the very beginning of the civilization. Ample production in a sustainable way can be a probable measure for recent consequences. For example in Bangladesh fish has been a major source of protein, contributing about 63% of the animal protein in the daily diet of her people (DoF, 2006).

Bangladesh is endowed with vast aquatic resources having around 4.57 million hectors' of inland water bodies which are comprised of rivers, ponds, beels, baors, kaptai lake, flood plains etc. The flood plains which cover around 2.83 million hectors', has been a major source of capture fishery. The vast inland fresh water area of Bangladesh is enriched with 260 fresh water fish species (Rahman, 1989). The total fish production of the country is about 2.44 million MT of which 1.95 million MT is produced from the inland water bodies (FRSS, 2008). However, the production from the inland open water bodies is declining alarmingly due to various reasons for the past few decades.

Among 260 indigenous fish species identified and listed in the freshwater of Bangladesh, one third of the total are considered as small indigenous species (SIS). The SIS is generally considered to be those fishes which grow to a length of about 25 cm (Hossain and Afroze, 1991; Flets *et al.*, 1996). Moreover, some of the small fishes are important for their significant contribution of protein and minerals to the daily diet. They also provide a substantial income for the small –scale fisherman. The SIS e.g. Pabda (*Ompok pabda*), Koi (*Anabas testudineus*), Veda (*Nandus nandus*), Gulsa (*Mystus villatus*), Shing (*Heteropneustes fossilis*), Magur (*Clarias balrachus*) etc. are among the highly priced fishes in the market due to their palatability.

Although fish are the primary source of protein for over 1 billion people of the world, aquatic biodiversity remains a neglected issue (Maclean and Jones, 1995). Due to natural

phenomena and increased human interventions occurring in aquatic ecosystem, natural breeding and feeding grounds and habitats of some of the important fishes in the open water bodies have been severely degraded. Open water capture fisheries are now under great stress and their sustainability is in danger because of changing aquatic ecosystem, soil erosion, siltation, construction of flood control dam, drainage structures, dumping of agro-chemicals and industrial pollutants. In addition, indiscriminate and destructive fishing practices have also been posing a threat to the aquatic biodiversity. Recent estimates suggest that 20% of the freshwater species are extinct, endangered or vulnerable worldwide (Moyle and Leidy, 1992). As a result, fish stocks particularly those swelling in inland open water areas, have gradually become endangered, IUCN (2000) has documented about 54 freshwater fish species as critically or somewhat endangered in Bangladesh. Hence, there is an urgent need for developing the artificial breeding and mass seed production techniques of such endangered fish species for genetic conservation of their “gene pool” as well as biodiversity.

***Ompok pabda* an esteemed food fish**

The catfish *Ompok pabda* (Hamilton) locally called “Madhu pabda” is an indigenous, fresh water small fish belonging to the family Siluridae of the order Siluriformes. It is very favorite food fish and eagerly devoured by the consumers because of its delicious taste. The appearance of the fish looks very attractive and its coloration is silvery grey with a tinge of yellow, dark on back, fading to dull grey on belly, often with two dark lateral bands on body and a dark oval shoulder spot on lateral line.

In Bangladesh, it inhabits in all types of freshwater habitats, especially in rivers, canals, beels, swamps and ponds. It is also geographically distributed in India, Pakistan, Afghanistan and Myanmar (Mukhopadhyay and Ghosh, 2007). It is omnivorous in nature; food item comprises small fishes, crustaceans, protozoans, algae, insects, parts of higher plant and debris (Taleb *et al.*, 1991). It is a Potamodromous fish (Riede, 2004) growing to a length of maximum 30 cm. The fecundity of the fish varies from 1,447 to

6,658. It is mentioned worthy that the fry and juveniles of this species show cannibalistic tendencies (Parameswaran *et al.*, 1971).

Justification of the study

The total production of Pabda is only 144MT from different water bodies of Bangladesh (FRSS, 2008). The production of Pabda can be increased through culture practice but the availability of large number of fry and fingerlings is a prerequisite to flourish the culture of this species. Sufficient number of fry and fingerlings of this catfish is, however, quite difficult to obtain from natural waters for stocking in the ponds. Proper techniques of induced breeding and mass production of fry in commercial scale seem to be the most crucial factors in expanding culture practice for the species.

Nutrition in the diet of brood fish is known to have a profound effect on gonad development, fecundity, quality of eggs and larvae. Although precise information on the nutritional requirements of brood stock for gonad maturation is scanty, it has been known quantity and quality of feed as well as the feeding regime is important for maintenance of egg quality and successful spawning.

In commercial aquaculture, market price of fish bears the major importance. For example, the production of Thai Pangas, *Pangasius hypophthalmus* is higher than many other species available in the market, but its culture tendency is decreasing day by day due to very low market price. In this context, *Ompok pabda* is a potential fish for aquaculture as it fetches very high market value about 3-5 times higher than those of Pangas. Considering its high market price and consumer demand fish farmers show considerable interest in its culture, but the non availability of fry sets the biggest constraint.

Pabda, *Ompok pabda* in addition has many other unique features that make it a popular species for aquaculture, such as-

- High market price.
- Cultivable by using locally available supplemental feeds.
- Cultivable in small seasonal ponds.
- Matures within a year in pond condition and artificial breeding is possible in confined waters.
- Prolonged breeding season extending from May to September.
- No specialized hatchery system required for induced breeding other than hapas or trays.
- Larval rearing possible using the available feed such as zooplankton, Tubificid worms and does not need the costly food like Artemia etc.
- Very delicious to eat.
- Indigenous endangered but environment friendly fish in Bangladesh.

In spite of many advantages very little attempt has been made in Bangladesh to promote breeding and culture of *Ompok pabda*. Although some works have previously been conducted on its induced breeding and larval rearing techniques but the techniques available have not yet been standardized to be recommended at farmer's level. More comprehensive works need to be carried out on its induced breeding, especially on mass fry production. In the present work, some attempts have been made to focus on induced breeding and mass production of fry of *Ompok pabda*.

The present study was carried out with the following objectives:

- To understand the brood rearing technique of *Ompok pabda*;
- To know induce breeding technique of *Ompok pabda*;
- To assess the water quality parameter; and
- To determine the cost benefit ratio of fry production.

CHAPTER 2

REVIEW OF LITERATURE

Availability of literature indicates the importance of a particular problem on one hand and scarcities on the other indicate the due attention to be paid on the matter. According to IUCN (2000), *Ompok pabda* is currently placed in the list of 54 endangered fishes in Bangladesh. The annual production of Pabda is only 144MT from different beels and floodplains (FRSS, 2008) which justifies the earlier statement. Despite of the present situation, only few works have been done on breeding of *Ompok pabda*. Although it is a delicious food fish, published reports or scientific papers on its nutritional requirement to improve the growth and breeding seem to be very scanty. In our country very little works had been done about induced breeding of *Ompok pabda*. The research works done so far were studied during the present studies which are furnished below:

Parameswaran *et al.*, (1970) found that the ponderal index of *Ompok bimaculatus* is related to the maturity cycle and it is generally higher in case of female than the male. They observed the largest percentage of both the sexes to mature during April to June which suggested its breeding season to be in these months in Assam. The studies on the fluctuations in the ponderal index, gonadosomatic index and size of ova through different months also support this view.

Parameswaran *et al.*, (1971) used several sets of *Ompok pabda* for experiments on induced breeding by the administration of carp pituitary hormones. During these experiments the females were administered with a preliminary dose of 2 to 3 mg and a final dose of 8 to 22 mg/kg body weight of fish. The second dose was injected 4 to 6 hours after the first injection. Males on the other hand, received only a single injection of 3 to 5 mg of pg/kg body weight at the time of second injection to the female. Spawning occurred six to eight hours after the second injection in all successful instances.

Devaraj *et al.* (1972) performed first successful induced spawning of *Clarias batrachus* carried out by using pituitary extract at the rate of 70-75 mg/kg and 140-150 mg/kg as first and second injection respectively with an interval of 6 hours. The percentages of fertilization of eggs varied from 50-90% while the rate of survival of hatching up to 5th day was 60-84% at 28-29°C.

Sarker (1984) also achieved success in breeding Magur, *Clarias batrachus* using HCG at the rate of 2-3 iu/g body weight.

Ahmed *et al.* (1985) reported that the successful doses of HCG for induced breeding of *Clarias batrachus* were 2-3 iu/g and 1 iu/g body weight of female and male respectively.

Spruingate *et al.*, (1985) observed that *Salmo gairdneri* breeders fed on full-ration spawned 2-3 weeks earlier than those fed half-ration and also added that all fish under full ration spawned whereas 11% under half-ration failed to spawn. The nutritional quality of brood stock diet and the feeding regime are the important factors for complete gonadal maturation.

Rao *et al.* (1986). Spawning biology of *Ompok bimaculatus* was also studied. They found that the mean value of size at first maturity was 210 mm. maturity was attained in the months of April to May. The spawning was observed to be in more than one act in a single spawning season during July- September. Maximum Gastro somatic index observed as 8.1. Feeding behavior was erratic during maturing and spawning seasons. The relationship between fecundity and total length was calculated as $F=4.355 \times 10^7 \times L^{3.3338}$. The population had equal representation of males and females.

Knox *et al.*, (1988) did not observe any difference in hatchability of rainbow trout eggs produced by females fed with half or full ration nor they influence the larval size.

Hoque (1990) found that maturation of the ovary was achieved about one month earlier in Silver carp (*Hypophthalmichthys molitrix*) and Catla (*Catla catla*) fed on diets containing vitamin premix and higher lipid levels.

Bhuiyan *et al.*, (1991). *Ompok pabda* is a carnivorous fish. Interestingly, it is known to show cannibalistic tendencies in the fry and juvenile stage, the larger and healthier once preying upon the smaller and weaker ones. The adults usually feed on fishes, crustaceans, Protozoan, insects, algae and aquatic plants. However, the food and feeding habit changes with alteration of season.

Rahman, (1992) found no deleterious effects on the growth of catfish of the physico-chemical parameters such as, water temperature, p^H and dissolved oxygen ranging between 22-32⁰ c, 6.7-8.2 and 4.40-5.90 ppm respectively.

Rahman *et al.*, (1993) was successful in induction of breeding of pabda by using either carp pituitary extract at a rate of 8 mg/kg body weight of female spawners at a water temperature of 27-29⁰c. Fertilization and hatching rate was 75-85% and 60-70% respectively. The incubation period range from 20 to 33 hours. No difference was observed between fish injected with carp pituitary and HCG respectively.

Akhteruzzaman *et al.*, (1993). The induced breeding technology for *Ompok pabda* was developed for the first time in Bangladesh during May through July. Female fishes weighing 55-110 g each were given single injection of 10-18 mg pg/kg body weight of acetone dried carp pituitary gland and male fishes weighing 45-90 g each were given a dose of 12 mg pg/kg body weight. Ovulation occurred in all the injected females. Spawning was accomplished in the spawning hapas within 9-10.30 hours at the ambient temperature of 24 to 29⁰c. Best results were obtained using doses of 13.0 to 16.0 mg pg/kg body weight.

Kohinoor *et al.*, (1997) performed a six- month semi intensive culture of *Ompok pabda* with Rajpunti (*Puntius gonionotus*) and Mirror carp (*Cyprinus carpio* var. *specularis*) in mini ponds with rice bran and mustered oil cake; and rice bran and duck weed. After completion of the experiment they found a growth increment of 33.5 g and 28.85g in two feeding treatments respectively for *Ompok pabda* in the polyculture system.

Sridhar et al. (1998). *Ompok bimaculatus* was induced to spawn by a single intramuscular injection of Ovaprim (dosage 0.5 ml/kg body weight). Spawning was observed 5-6 hours after injection. An average of 4012 ± 100 eggs was spawned by each female. Hatching occurred 24 hours after spawning.

Siddiqua *et al.*, (2000). Made an attempt to define the successive maturational stages of male gonads histological for detecting the spawning season of *Ompok pabda*. For the study, male gonads of more or less same year-class were collected month wise from January to September at fresh water station, Bangladesh fisheries research institute, Mymensingh. From the analysis, 4 stage of sperm formation, namely, Spermatogonia, Spermatocyte, Spermatis and Spermatozoa, were distinguished. The percent distribution of spermatozoa was highest in July. Maximum GSI value was 1.129 ± 0.271 found in July. By analyzing the histology of spermatogenesis it was established that this species breeds once in a year.

Haque *et al.* (2000) found that the water temperature varied from $29-32^{\circ}\text{C}$, transparency from 20-30 cm, dissolved oxygen from 3.5-7.5 mg/l, pH from 6.8 to 7.8, during the investigation of water quality parameter in six pond which were situated at the south-east corner of Fisheries Faculty Building, BAU, Mymensingh.

Mukherjee *et al.* (2001). Successfully breed the cat fish *Ompok pabda* by inducing agents during monsoon. They compared the efficacy of using synthetic hormone ovatide as well as carp pituitary extract. The ovulation rate and the number of eggs released were maximal in the brood fish treated with the synthetic inducing agent ovatide. Hatching percentage of the eggs were 70 ± 3.24 and 50 ± 5.19 from the female treated with ovatide and carp pituitary hormone respectively.

Changeux, T *et al.* (2001). Observed that the National Fishing Council has developed a general method for the formulation of departmental fishery management plans. More than half the departments of France have been involved in this programme since 1995. The approach focuses on the potential number of adult wild fish in each homogeneous

ecological unit called a 'context'. The cost of any rehabilitation work needed to restore habitat and to place the context under self-sustaining management (called 'patrimonial management') is estimated. The analysis takes into account the value of wild fish in relation to stocked fish.

Rahman, (2001). The major challenge that remains for the expansion of culture practice at a commercial scale of *Ompok pabda* is the successful rearing of their larvae up to the stage when they can be stocked in nursery ponds. Only a few studies seem to have been conducted on the rearing of *Ompok pabda* larvae. However, because of paucity of literature on the rearing of *Ompok pabda* at the initial stage, works conducted with other species that were considered relevant for the present work have also been briefly reviewed.

Lupin, H, (2007). Conducted that the paper presents a general review of cost-benefit techniques applied to public health regulations. It reviews those techniques from the perspective of official government agencies having jurisdiction, from the perspective of industry, and from the perspective of society as a whole. In the formulation of new food safety regulations government agencies can assess the costs and benefits of regulatory alternatives in order to select those that maximize net benefits.

Haniffa *et al.* (2007). Conducted that this paper presents the results of the development of a breeding technology for large-scale production of seeds of the native Indian catfish, singhi, (*Heteropneustes fossilis*) by an aquaculture research centre. This has been done in an effort to overcome a major obstacle to the widespread farming of the species. The use of induced breeding and artificial fertilization for seed production and larviculture of singhi is discussed.

Rupam-Sharma ,(2008). Studied that Chromosomal studies are the basic requisite for genetic improvement programme and conservation of wild gene pool. The catfishes, *Ompok bimaculatus* and *O. pabda*, are getting endangered due to habitat destruction and lack of proper management of the stock. For the present karyotypic study on these 2

freshwater endangered catfishes, 25 samples of each species were examined and 307 and 330 chromosome spreads of *O. bimaculatus* and *O. pabda*, respectively, were screened.

Afamdi and Peter (2008) determined the fecundity of female fish gravimetrically after the sex was established. The ratio of male and female was 1:1. The female fishes were greater in 110-140 mm size group. Males were 70-90 mm size group. Gonadosomatic index ranged between 0.7 to 1.1 with a mean of 1.0867 ± 0.04163 . And mean fecundity of 17369.33 ± 213.463 .

Ali *et al.* (2008) conducted an experiment at the south-east corner of the Fisheries faculty Building, Bangladesh Agricultural University, Mymensingh. He found that the temperature varied from 27.53 to 28.46⁰c, pH from 7.86 to 8.49; dissolved oxygen from 5.16 to 5.63 and transparency from 30.65 to 35.71 cm.

Chakrabarti, *et al.* 2009. Conducted the fish attained maturity at the end of the first year. Males matured earlier than females, which became mature at 30 – 40 g in weight. Fertilization is external and spawning occurs once a year during the monsoon season (June – August) with a peak in July. Fully ripe females and males were segregated and used in induced breeding. Females can be distinguished by a rounder, fuller abdomen, reddish vent colour and rounded genital papilla. Males have an elongated and pointed genital papilla. We used Ovaprim to promote induction of spawning.

Many researchers conducted experiments on induced breeding of perch in captive condition. The above review and discussions indicate that very few studies were undertaken on the induced breeding of *Ompok pabda*. Induced breeding technique is not available because *Ompok pabda* is an endangered species. Addressing the fact, the present study was designed to explore the whole things regarding induced breeding of Pabda.

CHAPTER 3

MATERIALS AND METHODS

An appropriate methodology is like a heart for conducting a scientific research. In a scientific research the acceptability of the results depends to a great extent on the appropriate methodology. The results may be erroneous for the use of imperfect methodology. In this study a scientific and logical methodology had been taken by the researcher. The present study was aimed at Brood fish rearing and induced breeding of *Ompok pabda* at BFRI, Mymensingh Plate 1.



Plate 1: Study area of the Fresh Water Station, BFRI, Mymensingh.



Plate 2: Brood fish of *Ompok pabda*

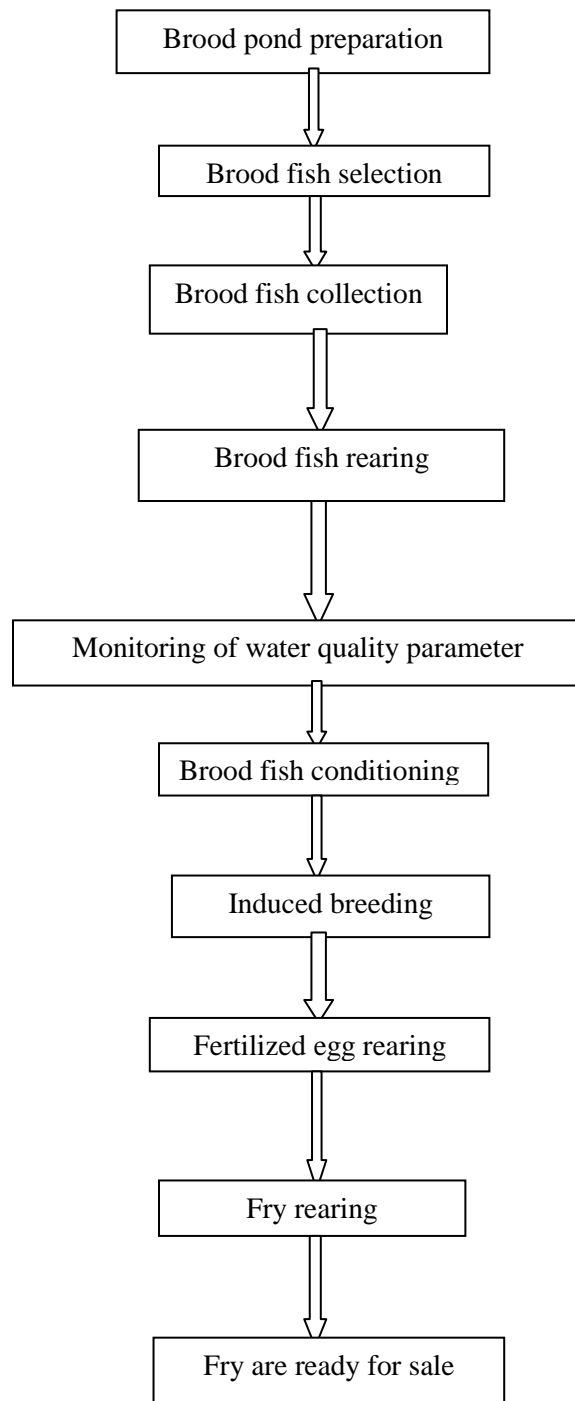


Fig.1. Schematic diagram of methodology followed in the present study.

3.1 Brood pond preparation

Management practices of brood stock are the important step for good seed production. Artificial breeding mainly depends on sufficient amount of quality brood fishes. Brood stock was managed scientifically so that mature broods could be obtained during the full breeding season. They were managed in one brood pond with area of 20 decimal and the water depth between 0.9-1.1 meters. For preparation of brood pond, the predator and unwanted fishes were eradicated by dewatering and drying. Rotenone and Phostoxin were also used to kill any unwanted fish species and aquatic insects. Aquatic vegetation was removed manually. After cleaning the pond, lime was used at the rate of 1kg/decimal and 5-7 days after liming, cow dung was applied at the rate of 5-7 kg/decimal as organic fertilizer. Inorganic fertilizers such as Urea and TSP were also used at the rate of 200g and 100g per decimal respectively. Seven days after fertilization, the brood pond was ready for brood fish stocking.

3.2 Brood fish selection

Brood fish selection is one of the most important aspects for successful induced breeding. Good looking, healthy and sexually mature broods were selected for breeding. Mature male and female broods were identified on the basis of secondary sexual characteristics. The mature males were identified by their flat abdomens and long protruded genital papillae. On the other hand, the females could be easily recognized by their soft and swollen abdomen and round and swollen urogenital papillae. Broods were collected by reducing the water of the pond and the selected broods were kept in cisterns with continuous water flow on the day of trial. Identification of male and female broods was done on the basis of some external features presented in Table 1.

Table 1: Criteria followed to select mature breeders of *Ompok pabda*

Male	Female
1.Small in size	1. Relatively large in size
2.Abdomen normal; not bulky like female	2. Abdomen bulging, elastic and soft
3. Body slender, more translucent and less pigmented	3. Body robust and pigmented
4. Serration of the pectoral spine is pronounced	4. Serration of pectoral spine is not pronounced

3.3 Brood fish collection

Required number of healthy male and female pabda broods were collected from the Brahmaputra hatchery in Shombhugonj and the Satota hatchery in Tarakanda were stocked in the previously prepared brood ponds.(plate.2).

3.4 Brood fish rearing

Proper rearing and management of brood fish of both sexes is a prerequisite for successful induced breeding. The brood fish was reared in brood rearing ponds at a stocking density of 25-30/decimal. Pond size was 20 decimal and water depth 0.9-1.1meters. During rearing lime, fertilizer, and cow dung were properly applied. Fertilization with Urea and TSP at the rate of 200g/decimal and 100g/decimal respectively were applied at 15 days interval. Brood fishes were also fed 5-6% body weight with supplementary feed (fish meal 30%, meat and bone meal 10%, mustered oil cake 15%, rice bran 20%, soybean oil cake 20%, ata 4%, vitamin and minerals 1%). Feed

were used twice daily at 8.00am and 4.00pm. During the breeding season the abdomen of female was swollen and soft. Eggs came out by gentle pressure on the abdominal region from anterior to posterior. Milt came out following gentle pressure on the abdominal region of male from anterior to posterior.

3.5 Monitoring the water quality parameters

The water quality parameters have direct impact on induced breeding which varied with the different seasons. The fecundity, fertilization rate, hatching rate and survivality largely depends on the water quality parameters. Water quality parameters like dissolved oxygen (mg/l), water temperature ($^{\circ}$ C), p^H and transparency (cm) were monitored fortnightly in fry-production ponds and monthly in brood rearing ponds during the study period.

3.5.1 Water temperature ($^{\circ}$ C)

Water temperature was measured fortnightly in brood rearing ponds during the study period. Temperature was measured by centigrade thermometer.

3.5.2 P^H

P^H of the water was recorded fortnightly in brood rearing pond during the study period. The water P^H was measured by using a P^H meter. P^H meter L20 METTLER TOLEDO, Switzerland from the central laboratory of BAU, Mymensingh.

3.5.3 Dissolved oxygen (mg/l)

Dissolved oxygen value was recorded fortnightly in brood rearing ponds during the study period. DO value was recorded by using a dissolved oxygen (DO) meter. DO meter Model Oxi 3150i, Germany from the central lab. of BAU, Mymensingh.

3.5.4 Transparency (cm)

The water transparency was recorded fortnightly in brood rearing ponds by using secchi disk (15cm or 20cm) and measuring tape.

3.6 Conditioning of brood fish

Selected brood fish were kept in tank for about 6 hours for conditioning prior to injection with PG extract. Handling and carrying of fish was done very carefully to avoid possible injury and secondary infection. Males and females fish were kept in separate tanks and constant water flow was maintained to ensure proper aeration.

3.7 Induced breeding

Pituitary gland (PG) was used as the inducing agent for induced breeding of Pabda (*Ompok pabda*). PG solution was injected on dorsal region of the brood fish for stimulation.

3.8 Fry rearing in hapa

Fish fry that hatched from egg were kept in hapa for 2-3 days. Then fry were transferred in to cement tank or metal tank. Egg yolks are used as feed for 1-2 days. Next 4-6 days *Artemia* larvae or *tubifex* were used as feed. Zooplankton was used as feed for next 8-10 days. When the fry gain 2.0-2.5 cm in size, the fry were ready for transfer to nursery pond.

3.9 Fry rearing in nursery pond

The size of nursery pond was 5-10 decimal and depth 0.8-1.0m. Stocking density was about 3000-4000 per decimal when the fry size was 2.0-2.5 cm. Supplementary feed (Rice bran 40%, mastered oil cake 30%, and fish meal 30%) were used on the basis of their 12-14% total body weight four times per day.

3.10 Sale of fry

When the fish fry become 4-5cm in size then the fry were ready for sale. The fish fry sold were transported with open or oxygenated closed system

3.11 Gonadosomatic index

Gonadosomatic index (GSI) was frequently applied to determine the spawning frequency of fish. The GSI was calculated according to the following formula:

$$\text{GSI} = \frac{\text{Weight of gonad}}{\text{Weight of body}} \times 100$$

3.12 Estimation of fecundity

The counting method was performed. The ovaries were dissected out by a pair of scissors. The external connective tissues were removed from the surface of each pair of ovaries. The eggs were separated from each other and counted directly to find the total egg numbers.

3.13 Calculation of fertilization rate

Total number of eggs and rate of fertilization were calculated one hour after natural spawning by direct counting method. For this three bowls were used with a capacity of 1.25 liter. Three replications were used for each sampling day. The average values of three bowls are used in formula. In each bowl having water flow from porous PVC pipe and outlet facility. For determination of fertilization and hatching rates, approximately 100 eggs were placed in bowls. After two hours of fertilization, the transparent eggs were considered as fertilized eggs whereas, the opaque eggs were considered as dead eggs. The fertilization rate was determined by following formula:

$$\text{Fertilization rate (\%)} = \frac{\text{No.of fertilized eggs}}{\text{Total no.of eggs}} \times 100$$

3.14 Calculation of hatching rate

The hatching rate was counted by direct counting method. At first the hatchling were taken in white enamel bowl which have a capacity of 1.25 liter, then the water with hatchling were shifted to another bowl by siphoning method. The average values of three bowls are used in formula. The hatching rate was determined by following formula:

$$\text{Hatching rate (\%)} = \frac{\text{No.of hatchling}}{\text{Total no.of eggs}} \times 100$$

3.15 Calculation of survival rate

The survival rate was counted by direct counting method. At first the hatchling were taken in white enamel bowl which have a capacity of 1.25 liter. Hatchlings were collected from homogenously distributed water in three bowls. Hatchlings were counted by naked eyes. The average values of three bowls are used in formula. The survival rate was determined by following formula:

$$\text{Survival rate (\%)} = \frac{\text{No.of hatchlings survives}}{\text{Total no.of eggs}} \times 100$$

3.16 Cost-benefit analysis

Cost-benefit analysis of brood rearing and breeding of Pabda at BFRI was done. The capital cost, operating cost revenue income, cost-benefit ratio and net profit were calculated. After analysis the cost benefit ratio and net profit of the hatchery were known.

3.16.1 Capital cost

The capital cost including lands, hatchery building, pump house, motor, equipments, generators, pond construction costs etc.

3.16.2 Depreciation cost

The depreciation cost was calculated using the following formula:

$$\text{Annual depreciation cost} = \frac{\text{capital cost}}{\text{project life}}$$

$$\text{Monthly depreciation cost} = \frac{\text{annual depreciation cost}}{12}$$

3.16.3 Operating cost

The operating costs include the cost involved to run the hatchery. The operating costs were including labor, salary, feed, fertilizer, lime, medicine, electricity, security, net, and selling cost.

3.16.4 Total cost

The total cost was calculated using the following formula:

$$\text{Total cost} = \text{operating cost} + \text{depreciation cost}$$

3.16.5 Revenue income

The revenue income was calculated using the following formula:

$$\text{Revenue income (BDT)} = \text{Fry production (kg)} \times \text{Unit price (BDT)}$$

3.16.6 Cost benefits ratio (BCR)

The cost-benefit ratio was calculated using the following formula:

$$\text{Cost benefit ratio} = \frac{\text{Revenue income}}{\text{total cost}}$$

3.16.7 Net profit

The Net profit was calculated using the following formula:

Net profit = Revenue income – Total cost

CHAPTER 4

RESULTS

The results of the experiment on induced breeding, of *Ompok pabda* at Bangladesh Fisheries Research Institute (BFRI) are presented below under the following headings:

4.1: Brood stock management

Brood stocks were properly managed in the brood rearing pond. Selection of mature male and female brood fish was an important step in induced breeding. Fully mature and ready to spawn broods were selected for breeding. It was observed that the success of induced breeding depends on the proper brood selection. All of the fish did not mature at a time and fast growing fishes were found to mature in early breeding season followed by others.

4.2: Age and weight of brood stock

It was observed that the Bangladesh Fisheries Research Institute (BFRI) used the same brood for up to 2-3 years. Minimum age 1 year and weight ranged from 120-150 g of the brood stock were used for successful breeding at BFRI.

Table. 2. Age and weight of brood fishes of Pabda at BFRI.

Name of the species	Sex	Minimum age (months)	Minimum weight (g)
Pabda (<i>Ompok pabda</i>)	Male	10-12	120-150
	Female	10-12	70-100

4.3: Conditioning of brood fish

The brood fishes were transferred to the conditioning tanks for conditioning for 6-8 hours. During conditioning the male and female were kept separately, prior to administration of the inducing agents. Continuous water flow by shower was given in the conditioning tank to ensure proper aeration.

4.4: Hormone injection

It was observed that the PG injection was administered into the muscular basal region of the pectoral fin. During injection the brood fishes were handled carefully. The fishes were kept in foam and the head region of the fish was wrapped by a wet and soft towel or cloth. The injection administration was done very carefully with a 1 ml syringe. The needle was inserted at about 45° angles to the body surface. The administration of PG injection was showing in the plate 4.

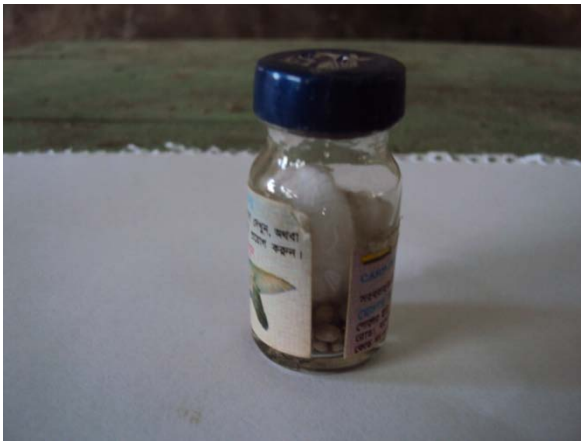


Plate 3. Vial of dried PG and PG incubate for the preparation of solution.



Plate 4. Homogenize PG for the solution preparation and administration of PG injection.

4.5: Doses of PG used for Pabda

In induced breeding of Pabda (*Ompok pabda*), Pituitary Gland (PG) solution were used as inducing agent. In early of the breeding season more PG solution was required for responding to the breeding. On the other hand, normal amount of PG solution was required in the peak season. The females (120-150g) were given an injection of 16 mg PG/Kg body weight and the males (70-100g) were given an injection of 8 mg PG/kg body weight. The doses of PG were ranged between 15-18 mg/kg of body weight of females. The doses of PG were ranged between 6-8 mg PG/kg body weights of males.

4.6: Breeding behavior of Pabda, *Ompok pabda*

The breeding behavior was observed continuously after the PG injection. Just after PG injection both male and female shows normal activities and movement. At that time they stay on the bottom at one corner of the tank. After 6h of injection the activities and movement of male fishes were increased. The male fish started to move around the female fish; it started to nudge with its snout at the ventral region of female fish after 5-6 h of injection. At that time higher rate of opercula movements was observed in female fish. The activities of female were also increased. It started to move and stay at middle of the water column. These activities of male and female and the male bents its body sideways and tried to bring its genital papilla in proximity of female's genital pore. On the bending condition the male brought the female fish at the surface of the water. Pressure was created on the ventral region of the male fish to the abdomen of the female. Eggs were ejected and at the same time male released milt. These activities were observed several times until the total eggs and milt was released. Fishes become calm and quite after spawning. After releasing eggs and milt, fishes were shifted in another tank. At that time they were found to stay on the bottom of the tank.

4.7: Induced breeding

It was observed that the broods were stocked in the breeding tank and maintained male and female ratio as 1:1. Brood fishes were injected by PG solution. After 6-7 hours spawning occurs naturally. Fertilized eggs were kept in hatching tank for hatching. The fertilized eggs were hatched after 18-24 hours. In this hatchery fertilized eggs were kept in the same tank for 72 hours.

4.8: Calculation of fertilization, hatching and survival rates

For determination of fertilization, hatching and survival rates, approximately 100 eggs were placed in bowls of 1.25 liter capacity with three replications each having water flow from porous PVC pipe and outlet facility. At first the number of fertilized and unfertilized eggs in bowl was counted with naked eye. Fertilization rate (%), hatching rate (%) and survival rate (%) were calculated as shown in Table 3 and appendix 2.

4.8.1: Fertilization rate (%)

The fertilization rate was calculated monthly. The number of fertilized eggs in each bowl was counted. The fertilization rates were $84.46 \pm 4.11\%$, $71.46 \pm 5.45\%$, and $71.42 \pm 3.68\%$ during the whole experimental period. The highest fertilization rate was $84.46 \pm 4.11\%$ in June and lowest fertilization rate was $71.42 \pm 3.68\%$ in August, 2011 as shown in Table 3 and Fig. 2.

4.8.2: Hatching rate (%)

The hatching rate was calculated monthly. The number of spawn/larvae in each bowl was counted. The hatching rates were $71.20 \pm 1.69\%$, $66.55 \pm 1.81\%$, and $57.25 \pm 2.47\%$, during the whole experimental period. The highest hatching rate was $71.20 \pm 1.69\%$ in June and lowest hatching rate was $57.25 \pm 2.47\%$ in August, 2011 as shown in Table 3 and Fig. 3.

4.8.3: Survival rate (%)

The survival rate was observed monthly. The number of fry in each bowl was counted. The survival rates were $60.40 \pm 0.59\%$, $55.21 \pm 1.11\%$ and $42.76 \pm 0.55\%$ during the whole experimental period. The highest survival rate was $60.40 \pm 0.59\%$ in June and lowest rate was $42.76 \pm 0.55\%$ in August, 2011 as shown in Table 3 and Fig. 4.

Table 3: Mean (\pm SD) Fertilization rate (%), Hatching rate (%), and Survival rate (%) of *Ompok pabda* during the study period (June to August, 2011)

Sampling date	June	July	August
	Mean \pm SD	Mean \pm SD	Mean \pm SD
Fertilization rate (%)	84.46 ± 4.11	71.46 ± 5.45	71.42 ± 3.68
Hatching rate (%)	71.20 ± 1.69	66.55 ± 1.81	57.25 ± 2.47
Survival rate (%)	60.40 ± 0.59	55.21 ± 1.11	42.76 ± 0.55

*The means were calculated as mean \pm standard deviation of the mean.

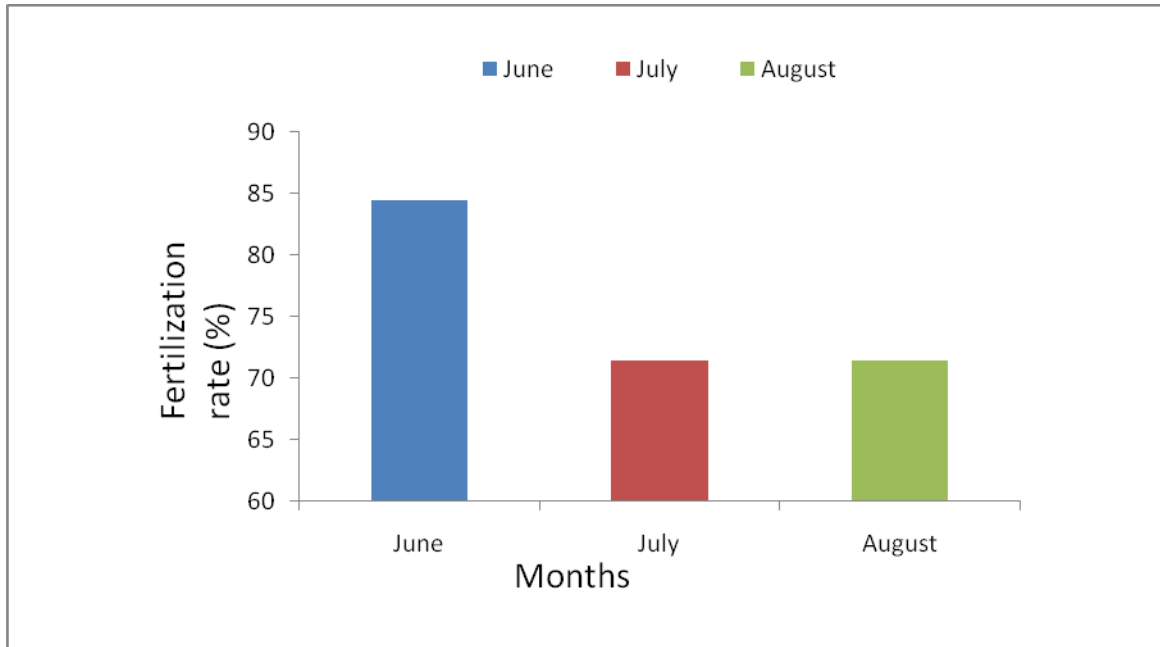


Fig. 2: Monthly variation of fertilization rate (%) of *Ompok pabda* during the study period.

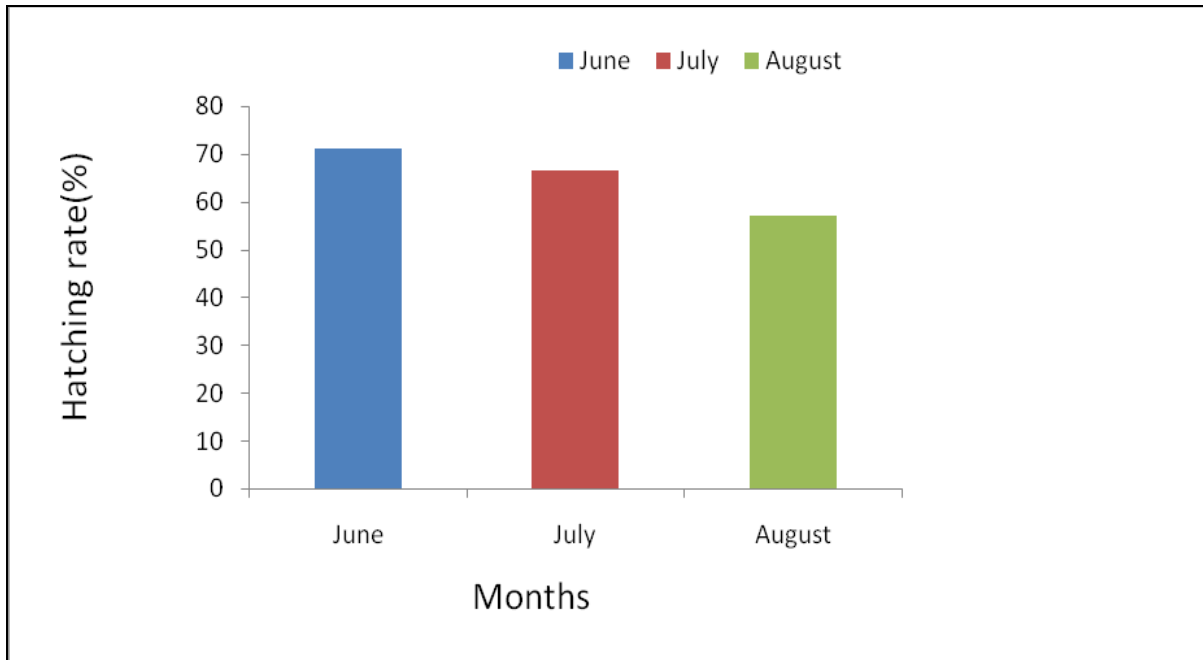


Fig. 3: Monthly variation of hatching rate (%) of *Ompok pabda* during the study period.

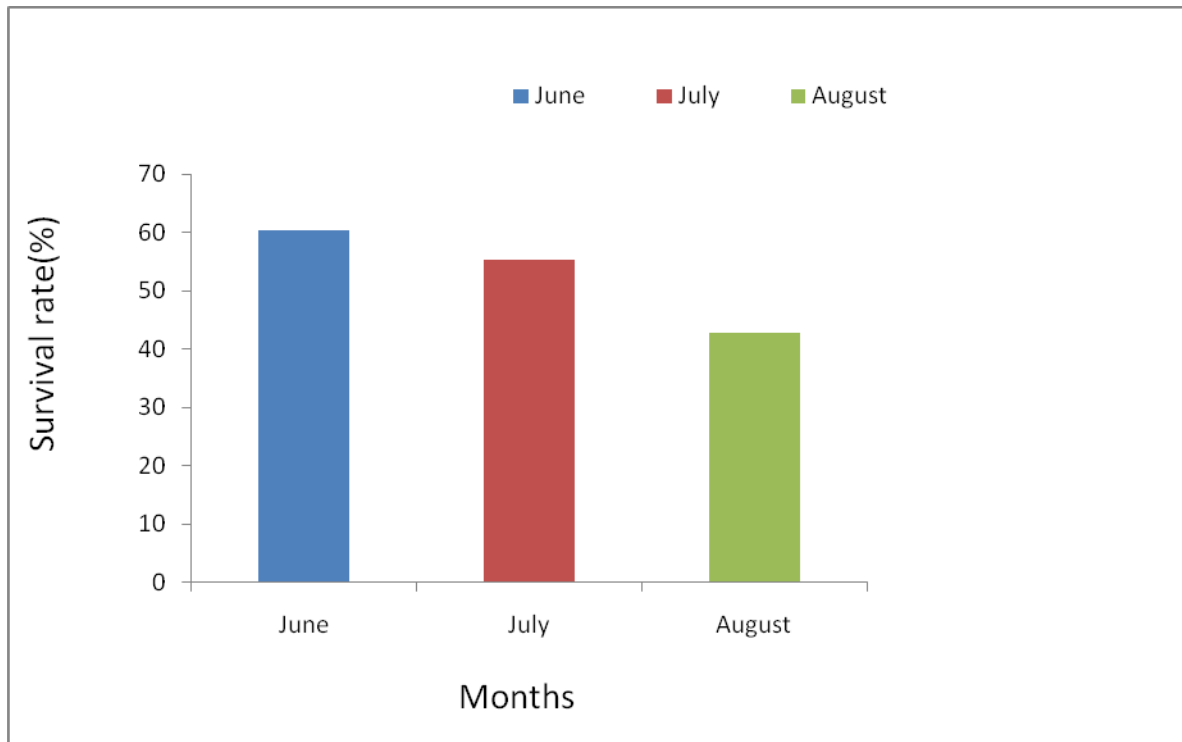


Fig. 4: Monthly variation of Survival rate (%) of *Ompok pabda* during the study period.

4.9: Water quality parameters

Water quality parameters such as, temperature ($^{\circ}\text{C}$), p^{H} , dissolved oxygen (mg/l) and transparency (cm) were monitored fortnightly in the brood ponds during the period from June 15 to August 27 and the values of these parameters are shown in Table 4 and appendix 3.

4.9.1: Temperature ($^{\circ}\text{C}$)

It was observed that the water temperature ranged from 27.5 to 30.0°C during the experimental period. The maximum temperature was 30.0°C recorded on June 15, while the minimum was 27.9°C on August 13, 2011 as shown in Table 4 and Appendix 3.

4.9.2: p^H

It was observed that the water p^H ranged from 7.00 to 7.3 during the experimental period. The highest p^H value was 7.3 observed on June 15, while the lowest p^H value was 7.0 observed on July 14 as shown in Table 4 and Appendix 3.

4.9.3: Dissolved oxygen (mg/l)

It was observed that the dissolved oxygen is one of the most important factors for aquatic organisms. The value of dissolved oxygen varied from 4.90 to 5.70 mg/l. The highest dissolved oxygen value was 5.70 mg/l on June 15 and lowest dissolved oxygen value was 4.90mg/l on July 28 as shown in Table 4 and Appendix 3.

4.9.4: Transparency (cm)

It was observed that the water transparency varied in the brood pond during study period. The transparency of water varied from 21 to 26 cm. The highest transparency was 26.5 cm on June 29 and lowest transparency was 21.9 cm on July 14 as shown in Table 4 and Appendix 3.

Table 4: Mean (\pm SD) water quality parameters in different brood rearing ponds during the study period from June 15 to August 27, 2011

Sampling date Parameters	15.06.2011 Mean \pm SD	29.06.2011 Mean \pm SD	14.07.2011 Mean \pm SD	28.07.2011 Mean \pm SD	13.08.2011 Mean \pm SD	27.08.2011 Mean \pm SD
Temperature (°C)	27.9 \pm 0.5	29.9 \pm 0.5	27.9 \pm 0.5	28.0 \pm 0.6	27.8 \pm 0.6	27.9 \pm 0.6
pH	7.2 \pm 0.2	7.3 \pm 0.2	7.1 \pm 0.1	7.1 \pm 0.1	7.1 \pm 0.2	7.1 \pm 0.1
Dissolved Oxygen (mg/l)	5.7 \pm 0.6	5.3 \pm 0.3	5.0 \pm 0.2	4.9 \pm 0.2	5.0 \pm 0.2	5.1 \pm 0.2
Transparency (cm)	24.5 \pm 1.2	26.6 \pm 1.2	21.9 \pm 1.9	22.9 \pm 1.6	22.5 \pm 0.9	22.9 \pm 0.6

4.10: Gonado-somatic index of *Ompok pabda*

The mean GSI ranged from 1.0867 ± 0.04163 to 0.8150 ± 0.07697 during the study period from June to August. The highest mean GSI value was in June and lowest mean GSI value was in August as shown in Table 5 and Fig. 5.

4.11: Estimation of fecundity

By sampling and direct counting method the fecundity was estimated. During the study period the mean fecundity ranged from 15560.00 ± 185.27 to 17369.33 ± 213.46 for female of *Ompok pabda* having average body weight of 111.5 ± 1.2 g to 126.4 ± 1.2 g. The fecundity as shown in Table 5 and Fig. 6.

Table 5: Mean (\pm SD) of total length, body weight, GSI and fecundity of *Ompok pabda* during the study period (June to August, 2011)

Sampling Month	June	July	August
Parameters	Mean \pm SD	Mean \pm SD	Mean \pm SD
No. of fish examined	10	10	10
Total length	26.5667 ± 0.3214	22.4333 ± 0.4163	19.4667 ± 0.3055
Body weight	126.4333 ± 1.1676	123.6333 ± 0.7767	111.5000 ± 1.1789
GSI	1.0867 ± 0.0416	0.9250 ± 0.0567	0.8150 ± 0.0769
Fecundity	17369.3333 ± 213.4627	16344.0000 ± 236.9134	15560.000 ± 185.2673

*The means were calculated as mean \pm standard deviation of the mean.

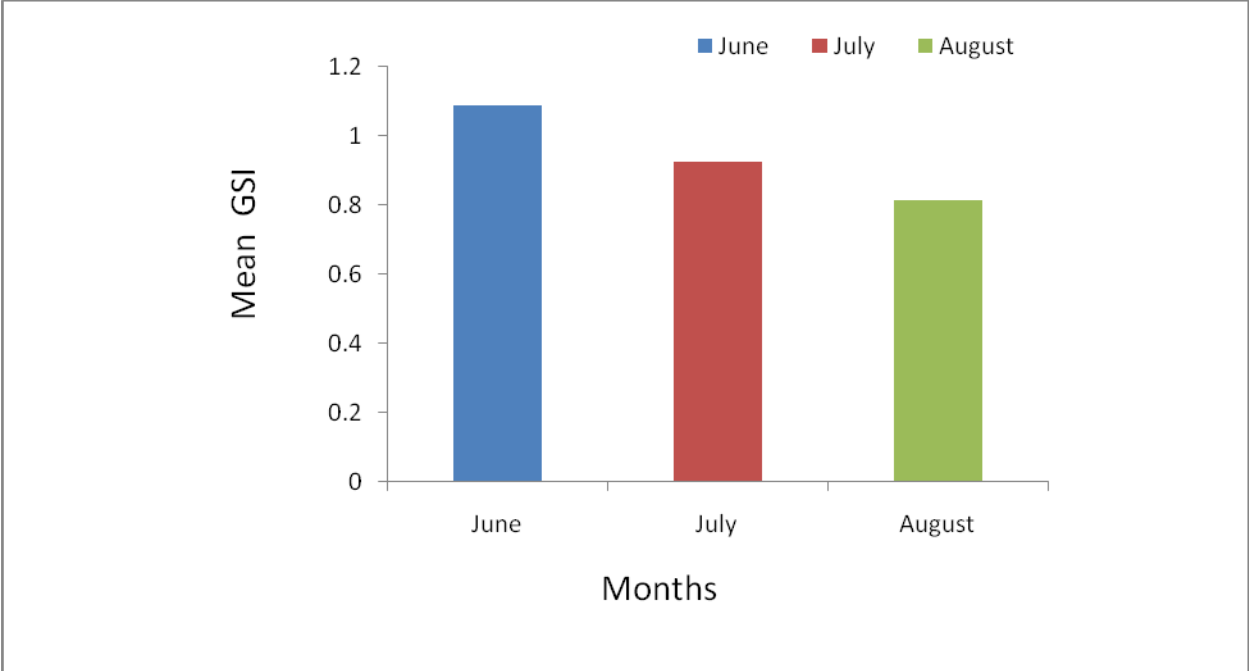


Fig. 5: Monthly variation of gonadosomatic index of female *Ompok pabda* during the study period.

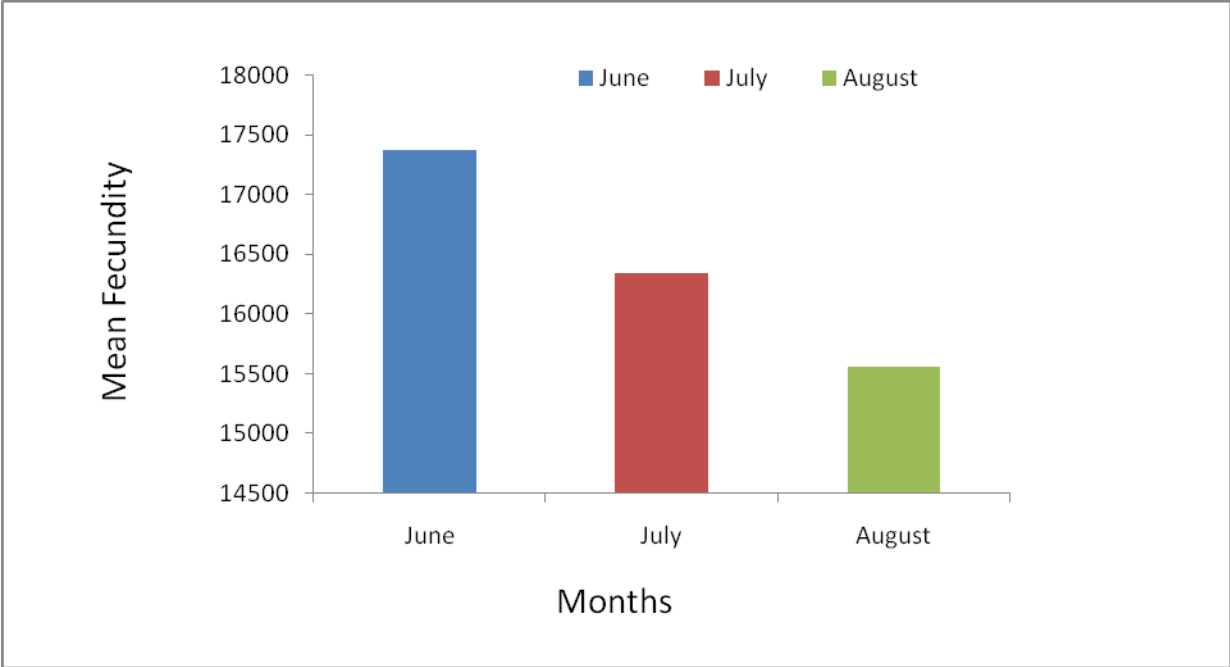


Fig. 6: Monthly variation of mean fecundity of female *Ompok pabda* during the study period.

4.12: Fry rearing in nursery ponds

It was observed that the size of nursery pond was 8 decimal and depth 1.0m. Stocking density was about 3000-4000 per decimal when the fry size was 2.0-2.5 cm. Supplementary feed (Rice bran 40%, mastered oil cake 30%, and fish meal 30%) were used on the basis of their 12-14% total body weight four times per day.

4.13: Sale of fry

Fish farmer, depot owner, fry traders and hatchery owners bought the fry from BFRI. Hatchery owners bought fry for brood purpose. Buyers come from different places such as Comilla, Rangpur, Jamalpur, Netrokona and Tangail districts. The value of price was BDT 1/fry during the study period.

4.14: Cost-benefit analysis

Cost benefit analysis is very important for any hatchery operation. If monthly operating cost and revenue income were known, benefits of any hatchery operation could be known.

Cost – benefit analysis of *Ompok pabda* fry production at BFRI were done as below:

4.14.1: Capital cost

The capital cost including lands, hatchery building, pump house, motor, equipments, generators, pond construction costs etc. The capital cost was BDT 25, 75,200 for 10 years (project life), annual depreciation cost was BDT 2, 57,570 and monthly depreciation cost was BDT 21,460 during the experimental period as shown in Table.6.

Table 6: Outline of the capital cost of *Ompok pabda* at the BFRI for 10 years.

Items	Estimated cost (BDT)
Land (2 acres)	14,00,000
Hatchery pipelines	80,000
Pond construction and preparation	2,00,000
Hatchery building	3,00,000
Brood fish	30,000
Drainage system	55,000
Pump house	60,000
Deep tube well	50,000
Electricity	80,200
Mortar	60,000
Equipment	1,00,000
Generators	60,000
Miscellaneous	1,00,000
Total cost	25,75,200

4.14.2: Depreciation cost

$$\begin{aligned}\text{Annual depreciation cost} &= \frac{25,75,200}{10} \\ &= \text{BDT } 2,57,520\end{aligned}$$

$$\begin{aligned}\text{Monthly depreciation cost} &= \frac{2,57,520}{12} \\ &= \text{BDT } 21,460\end{aligned}$$

4.14.3: Operating cost

The operating costs include the cost involved to run the hatchery. The operating costs were including labor, salary, feed, fertilizer, lime, medicine, electricity, security, net, and selling cost. The total operating cost was BDT 1, 34,700 during the study period as shown in Table 7.

Table-7: Outline of the operating cost at the BFRI of fry production sector.

Items	Estimated cost (BDT) in June	Estimated cost (BDT) in July	Estimated cost (BDT) in August
Labor salary	12,000	12,000	12,000
Feed (brood)	9,000	9,100	9,200
Feed (fry)	3,500	3,600	3,800
Fertilizer	1,100	1,000	1,000
Lime and salt	1,000	1,000	1,000
Electricity	1,500	1,700	1,900
Medicine	2,000	2,000	1,900
Net (for fencing)	2,000	2,000	2,000
Selling cost	1,200	1,200	1,200
Netting cost	1,200	1,200	1,200
Security	6,000	6,000	6,000
Miscellaneous	4,000	4,000	4,000
Total cost	44,500	44,900	45,500
Grand total cost			1,34,700

4.14.4: Total cost

The total cost includes capital cost + depreciation cost. The total cost was BDT 65,960, in June, BDT 66,360 in July and BDT 66,960 in August during the study period as shown in Table 8.

Table-8: Calculation of total cost during the whole study period

Month	Operating cost + depreciation cost/cycle (BDT)	Total cost (BDT)
June	44,500 + 21,460	65,960
July	44,900 + 21,460	66,360
August	45,500 + 21,460	66,960
Grand total cost		199,280

4.14.5: Revenue income

The pabda fry were sold at BDT 1.00/fry; total sale of fry was 4, 09,400 and total price BDT 4, 09,400 during the study period. The revenue income was BDT 1, 55, 030 in June, BDT 1, 34, 570 in July and BDT 1, 19, 800 in August, 2011 as shown in Table 9.

Table 9: Outline of the revenue income for Pabda fry production sector at BFRI

Species	Month	No. of fry	Total income (BDT)
<i>Ompok pabda</i>	June	1, 55,030	1,55,030
	July	1, 34,570	1,34,570
	August	1, 19,800	1,19,800
Grand total		4, 09,400	4,09,400

4.14.6: Calculation of cost- benefit ratio (BCR)

Capital cost (10 years) = BDT 25, 75,200

Total operating cost (during study period) = BDT 1, 34,700

Total revenue income (during study period) = BDT 4, 09,400

Cost- benefit ratio (BCR)

$$\text{BCR in June} = \frac{1,55,030}{65,960}$$
$$= 2.3504 \text{ BDT}$$

$$\text{BCR in July} = \frac{1,34,570}{66,360}$$
$$= \text{BDT } 2.0279$$

$$\text{BCR in August} = \frac{1,19,800}{66,960}$$
$$= \text{BDT } 1.7891$$

4.14.7: Net profit

The total net profit was BDT 2, 10,120; the highest net profit was BDT 89,070 in June and lowest BDT 52,840 in August during the study period. The total study area was 2 acres and average net profit was BDT 70, 040/month/2acre as shown in Table 10.

Table 10: Calculation of net profit during the whole study period

Month	Revenue income - Total cost (BDT)	Net profit (BDT)	Average net profit(BDT)
Net profit in June	1,55,030-65,960	89,070	
Net profit in July	1,34,570-66,360	68,210	70, 040
Net profit in August	1,19,800-66,960	52,840	
Grand total net profit		2,10,120	

CHAPTER 5

DISCUSSION

Broodstock management

Brood stock management bears one of the major priorities while working with breeding of any fish species. With the development of modern aquaculture activities brood fish maintenance has become one of the most important aspects of hatchery management.

A good brood stock management practiced with balanced feed, the fish *Ompok pabda* attained maturity at early May. According to Akhteruzzaman *et al.* (1993), *Ompok pabda* was found to have a single spawning season extending from June to August, nutrition was very important for sound growth and maturation of the gametes of the breeders. The number and quality of eggs depend on the water quality parameters and feed provided. Hoque (1990) reported that diets containing 1% vitamin premix showed better result in all aspects such as selectibility, spawning success, fertilization rate and hatching rate. Spawning performance of the reared broods indicated that the spawners might have been at their optimal breeding condition. In contrast to the findings of Akhteruzzaman *et al.* (1993), the fish were found to respond to PG extract treatment for breeding in May during the present study. This might be due to good management practices of brood stock, which elongated their breeding season in artificial condition. It was observed that the success of induced breeding depends largely on the availability and proper selection of brood fishes.

The fish attained maturity at the end of the first year. Males matured earlier than females, which became mature at 30 – 40 g in weight. Fertilization is external and spawning occurs once a year during the monsoon season (June – August) with a peak in July. Fully ripe females and males were segregated and used in induced breeding. Females can be distinguished by a rounder, fuller abdomen, reddish vent color and rounded genital pore. Males have an elongated and pointed genital papilla.

Induced breeding of *Ompok pabda*

We used Ovaprim to promote induction of spawning. Ovaprim was applied at 1 – 1.5 ml/kg body weight for females and 0.5-1.0ml/kg body weight for males, applied in a single dose. Females were stripped for spawning 8 – 10 hours after hormone injection and the eggs were collected in a tray. Milt was obtained from males by surgically removing the testes, which were macerated to produce a suspension to be mixed with the eggs for fertilization. Fertilized eggs were subsequently washed thoroughly with clean water and transferred to a cement tank for hatching with constant aeration.

In the induced breeding trials the fishes were treated with heteroplastic pituitary extract. Gonadotropin hormones of pituitary gland of most teleost are non-species specific (Ibrahim and Chauduri, 1970). We treated cat fish with a double dose to achieved better production.

It was observed that the females were injected with 3 mg PG/kg body weight followed by a second dose of 16 mg PG/kg body weight 6 hours later. Males were injected with 6 mg PG/kg body weight followed by a second dose of 8 mg PG/kg body weight 6 hours later at the same time of female injection. Following this procedure we got the best result in consideration of ovulation, fertilization and hatching rates. Parameswaran *et al.* (1971) achieved success by using a preliminary dose of 2 to 3 mg and a final dose of 8 to 22 mg PG/kg body weight of the fish administered 4 to 6 hours after the first injection for the female and a single injection of 3 to 5 mg PG/kg weight to the males, at the time of second injection to the female *Ompok pabda* both in laboratory aquaria and hapas fixed in ponds. Rahman (2001) was able to breed *Ompok pabda* in hapas by administration of a single PG dose of 14 - 16 mg/kg fish for female and 12 mg/kg fish for male.

Fertilization rate ranged between 71.43% and 84.46% for doses of 16 and 18 mg PG/kg fish in the present study. Present findings of fertilization rate coincide with the result of Akhteruzzaman *et al.* (1993), who recorded a fertilization rate between 55% and 75% at the doses of 10-18 mg PG/kg body weight for females and 12 mg PG/kg body weight for

the male *Ompok pabda* in hapa, among which doses of 13-16 mg PG/kg fish gave the best results.

It was observed that the highest hatching rate was 71.20% and lowest hatching rate was 57.25% during the present study. Rahman (2001) found a hatching rate of 95% in hapa by administration of a single PG dose of 14 and 16 mg/kg fish to female and 12 mg/kg fish to male. Akhteruzzaman *et al.* (1993) reported the hatching rate of *Ompok pabda* to vary from 40%-60% when treated with PG doses of 10-18 mg/kg body weight of fish. The present result was more or less similar to the findings of Akhteruzzaman *et al.* (1993) and Rahman (2001).

It was observed that the survival rates were $60.4048 \pm 0.59490\%$, $55.2130 \pm 1.11867\%$ and $42.7633 \pm 0.55444\%$ during the whole experimental period. The highest survival rate was $60.4048 \pm 0.59490\%$ in June and lowest rate was $42.7633 \pm 0.55444\%$ in August, 2011.

Water quality parameters

Water temperature is one of the most important factors, which influence the growth, reproduction and other biological activities of fish. The temperature was varied from 27 to 30.0°C during the present study. Hussain (1989) recorded that in Bangladesh, pabda breeds from June to August when temperature remained around $22-32^{\circ}\text{C}$. The findings of the above author more or less agreed with the present study.

The optimum level of DO is required for fish culture and reproduction. In the present study, dissolved oxygen concentration in water varied from 4.90 to 5.70 mg/l., Ali *et al.* (2008) found more or less similar results.

p^{H} (Hydrogen ion concentration) indicates acidity- alkalinity condition of a water body. It is called the productivity index of water body. Most water bodies have p^{H} within the range of 6.5 to 8.5. The slightly alkaline p^{H} is most suitable for fish culture. Acidic p^{H} of water reduces of the growth rate, metabolic rate and other physiological activities of

fishes (Swingle, 1967). In present study the range of p^H varied from 7.0 to 7.3. The findings of present study were more or less similar to the findings of Bhuyan (1970).

The transparency is a gross measure of pond productivity. It has an invasive relationship with the abundance of plankton. Boyd (1990) recommended that the transparency ranged from 15 to 40 cm is appropriate for fish culture. The transparency ranged from 21 to 26.6 cm during the present study, which was similar to findings of Rahman (1999) and Uddin (2002).

Gonadosomatic index (GSI) of *Ompok pabda*

The mean gonadosomatic index (GSI) values throughout study period showed the existence of one breeding season in Pabda from June to August.

The GSI, which indicates the breeding season of fish. The mean GSI ranged from 1.0867 ± 0.04163 to 0.8150 ± 0.07697 during study period from June to August, 2011. The highest mean GSI value was observed in June and lowest mean GSI value was observed in August. These findings agreed with the findings of Klahan *et al.* (2003) and Vincent and Allison (2010).

Fecundity is one of the most important aspects of biology of the fish which must be understood to explain the variations in the level of reproduction as well as to make efforts to increase the amount of harvest. Fecundity may be expressed in terms of number of eggs produced per brood fish in a breeding season. It is sometimes referred to as total or absolute fecundity or more usually just as fecundity (Heese, 1990). The number of ripe or mature eggs produced by a brood fish in a particular spawning season is readily ascertained at full maturity by artificially striping the eggs to estimate the fecundity. Alternatively fecundity may be expressed per unit body weight of post striped fish when it is known as relative fecundity because the number of eggs produced for each unit increase in weight shows significant linear variation. The mean fecundity was 17369.33 ± 213.46 in June, 16344 ± 236.91 in July, and 15560 ± 185.27 in August. These findings were more or less similar to the findings of Tsadik *et al.* (2007).

Cost-benefit analysis

It was observed that the hatchery business was a profitable in our country. In a hatchery cost- benefit analysis is the most important criteria for a hatchery operation. If monthly operating cost and revenue income are known, profit of any hatchery operation can be known. The demand of BFRI produced Pabda fry was very high. Most of fish farmer, hatchery owner, arotdar etc. were more interested to purchase Pabda fry from BFRI, because fry quality was so high and the fry price was fixed at BDT 1.0/fry. It was observed that the total capital cost was BDT. 25, 75,200 for 10 years (project life), annual operating cost was BDT. 2, 57,570 and monthly depreciation cost was BDT. 21,460 during the experimental period. The total operating cost was BDT. 1, 34,700 during the study period. The total cost includes depreciation cost + operating cost. The total cost was in June BDT 65,960, July BDT 66,360 and August BDT 66,960 during the study period. The cost-benefit ratios were 2.3504 in June, 2.0279 in July and 1.7891 in August during the study period which was more or less similar to the findings of Kohinoor *et al.* (1999). From the Findings of the cost-benefit analysis, total cost was BDT 1,99,280; revenue income BDT 4,09,400 and net profit BDT 2,10,120 during the study period.

CHAPTER 6

SUMMARY AND CONCLUSION

Studies on induced breeding of endangered fish species *Ompok pabda* were carried out at the Bangladesh Fisheries Resource Institute (BFRI), Mymensingh during 15th June to 27th August, 2011.

Brood fishes were reared in the rearing brood pond of the hatchery. They were reared for spawning in the hatchery. Brood fish management such as optimization of stoking density, feeding and fish health care is of great importance in the production of spawn in captivity. In Bangladesh Fisheries Resource Institute Hatchery, management of brood stock was satisfactory. The hatchery workers were very much careful in hatchery operation so the quality of hatchery produced spawn and fry was good. They maintained proper age and weight of brood stock during spawning. The survival rate and growth rate of hatchery produced spawn and fry was satisfactory.

The breeders were conditioned for a period of 6 hours in conditioning tank during this experiment. Females were injected with 3 mg PG/kg body weight followed by a second dose of 16 mg PG/kg body weight 6 hours later. Males were injected with 6 mg PG/kg body weight followed by a second dose of 8 mg PG/kg body weight 6 hours later at the same time of female injection.

Injection was given to them for spawning. It started to occur after 6-7 hours of injection. The male fish started moving around the female. After nudging and circling, the male bends its body around the female. The genital papilla of male was brought nearer to the genital pore of female. Eggs were ejected and at the same time male released the milt.

The fertilization rate and hatching rate was highly depended on quantity of PG solutions injected, male and female ratio, temperature, water flow, water quality, maturity of brood fishes, season and other environmental conditions. The average fertilization rate was $84.4613 \pm 4.11906\%$ in June, $71.46 \pm 5.45730\%$ in July and $71.4266 \pm 3.68098\%$ in

August; average hatching rate was $71.2007 \pm 1.69191\%$ in June, $66.5583 \pm 1.81599\%$ in July and $57.2544 \pm 2.47513\%$ in August; the survival rate was $60.4048 \pm 0.59490\%$ in June, $55.2130 \pm 1.11867\%$ in July and $42.7633 \pm 0.55444\%$ in August.

The water quality parameter of the brood ponds was studied. Water temperature was ranged between 27 to 30.0°C , the p^{H} of water was ranged between 7.0 to 7.30, the dissolved oxygen content of water was ranged between 4.90 to 5.70 mg/l and the transparency of water ranged between 21.90 to 26.60 cm in brood ponds.

The value of mean gonadosomatic index (GSI) ranged from 1.0867 ± 0.04163 to 0.8150 ± 0.07697 . The fecundity was measured by direct counting method which varied from 17369.33 ± 213.46 to 15560.00 to 185.27 .

The fry production in hatchery is a profitable business in our country. The cost benefit ratios were BDT 2.3504 in June, BDT 2.0279 in July, and BDT 1.7891 in August. The net profit was BDT 2, 10,120 per 2 acres during the whole experiment period.

Pabda fetches a relatively high market price and a fish popularly sought after in eastern Indian states. Spineless, except a soft vertebral column, the fish has good quality flesh and taste and is widely accepted by the consumers of East Asian countries. The technology for breeding and fry production had been developed and we anticipated that a Pabda grow out industry would emerge among progressive fish farmers in due course.

Ompok pabda has fine flesh with a soft meat texture, good taste and high nutritional value. It is commonly sold fresh locally or ice preserved. *Ompok pabda* had been listed as an endangered fish species in India due to its decrease in abundance and restricted distribution. Causes of the decline were likely to be indiscriminate fishing during the breeding season, wide use of pesticide and insecticides in agricultural fields causing pollution and siltation in habitat. Pabda is a highly priced, delicious and nutritious catfish and well preferred fish because it contains relatively few bones. It had not received much attention in aquaculture mainly due to non-availability of information regarding its

breeding and culture technique. However, success has been achieved in breeding and fry rearing of pabda in Bangladesh. Bangladesh has been successful in breeding and mass seed production of pabda (*O. pabda*), so that the fingerlings can be produced locally for grow out culture to overcome the constrain of procurement of seed from wild sources.

REFERENCES

- Afamdi, A . and U. Peter. 2008. Some aspects of the reproductive biology of pabda in a small lake in southeastern Nigeria. *African J. Biotechnol.* **7(14)**: 2478-2482.
- Ahmed, K., G. Mustufa, S. Ali and M. Shahjahan, 1985. Induced spawning of Magur fish *Clarias batrachus* by stripping method in a plastic bowl hatchery. *Bangladesh J.Fish.*, 2001. **13(1)**: 19-24
- Akhteruzzaman, M., A. H. M. Kohinoor, M. S. Shah and M. G. Hussain. 1993. Observation on the induced breeding of Silurid catfish, *Ompok pabda* (Hamilton) in Bangladesh. *Bangladesh J. Life Sci.*, **5(1)**: 71-75pp.
- Ali M. A, M. H. Rashid, S. Islam. R. Sarker and A.M. Shahabuddin. 2008. Effects of stoking density on growth and production performance of Tilapia in pond. *Intl. J. BioRes.* **4(3)**: 33-38.
- Bhuiyan, B.R. 1970. In physic-chemical qualities of some cement tank in Sibbdsgsr, Asian. *Environmental Health.* **12**: 129-134.
- Bhuiyan, A.S. and Islam, M. N., 1991. Observation on the food and feeding habits of *Ompok pabda* from the river Padma. *Pak. J. Zool.*, **23(1)**: 75-77pp.
- Boyd, C.F. 1990. Water quality in ponds for Aquaculture. Alabama Agricultural Experiment Station, Alabama. 482 pp.
- Chakrabarty, N.M. and S.C. Mondal, 2009. Observed breeding and seed production of butter catfish, *Ompok pabda* (Siluridae) at Kalyani Centre of CIFA, India.
- Changeux, T.F. Bonnieux, C.Armand, . 2001. Cost benefit analysis of fisheries management plans. Conseil Superieur de la Peche (CSP), Direction Generale, Service Technique, 134, Avenue de Malakoff, F-75116 Paris, France. Fisheries-Management-and-Ecology-An-international-symposium,-Fisheries-and-Society,-

Budapest,-Hungary-1-3-June-2000-organized-by-European-Inland-Fisheries-Advisory-Commission. 2001; **8(4/5)**: 425-434pp.

Devaraj, K. V., T. J. Verghse and G. P. S. Rao, 1972. Induced breeding of the fresh water catfish *Clarias batrachus* by using PG from marine catfish. *Curr. Sci.*, **41**: 868-870.

DoF (Department of Fisheries), 2006. Annual report (2005-06). Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh, 111pp.

Flets, R. A., Rajts, F. and Akhteruzzaman, M., 1996. Small indigenous fish species culture in Bangladesh (Technical brief), IFADED sub-project-2. Development of Inland Fisheries, 41p.

FRSS, 2008. Fisheries Resources Survey System. Department of Fisheries, Bangladesh, 48pp.

Haniffa, M.A; Sethuramalingam, T.A; Dhanaraj, M. Muthuramkrishnan, C; Kumar, Y. A; Singh, S.V.A. 2007. Breeding and larval rearing of the native Indian catfish *Heteropneustes fossilis*. Centre for Aquaculture Research and Extension (CARE), St Xavier's College (Autonomous), Palayamkottai, Tamil Nadu, India.
INFOFISH-International. 2007; **(6)**: 16-19.

Haque, M.S., M.A. Wahab, and M.I. Wahid. 2000. Impact of the Thai silver barb *Puntius gonionotus* inclusion in the polyculture of carps. *Bangladesh J. Fish.* **(1)**: 15-22.

Heese, T. 1990. Gonad development and fecundity of whitefish, *Coregonus lalaretus* (L.) from the Pomeranian. *Bay. Acta-Icthyological-et-Pascutoria*, Poland. **20**: 3-12

Hoque, M. M. 1990. Effects of different food on the gonadal maturation of some species of carps. A thesis submitted to the Department of Aquaculture for M. S degree in Aquaculture. Bangladesh Agricultural University, Mymensingh. 81pp.

Hossain, M.A. and Afroze, S., 1991. Small fish as a resource in rural Bangladesh. *Fishbyte*, **9(2)**: 16-18.

- Hussain, M.G. 1989. A manual on improved technique of nilotica culture in ponds. FRI Extension Material Series No.2. Fisheries Research Institute, Mymensingh. 97pp.
- Ibrahim, K.H. and H. Chaudhuri. 1970. Studies on the role of sex specification of carp pituitary glands in induced spawning of the Indian carps. *J. Inland Fish. Soc. India*, **2**:130-137.
- IUCN, Bangladesh, 2000. Bangladesher Bipanno Prani. IUCN. The world Conservation Union, 294pp.
- Klahan, R., O. Jintasataporn, P. Tabthipwon, S.Mahasawasde, S.Chumkam. 2003. Effect of White Kwao woody climber on growth and reproductive system in Tilapia, Faculty of Fishery, Kasetsart University, Bangkok, Thailand. 111-118 pp.
- Knox, D, N. R. Bromage and R. Cumaranatung, C. B Cowey and R. C. Springle. 1988. The effects of broodstock ration size on the composition rainbow trout (*Salmo gairdneri*) eggs. *Aquaculture*, **69 (1-2)**: 93-104.
- Kohinoor, A.H.M., P.C. Modak and M.G. Hossain. 1999. Growth and production performance of red tilapia and Nile tilapia (*O. niloticus* Lin.) under low-input culture system. *Bangladesh J. Fish Res.* **3(1)**: 11-17.
- Kohinoor, A. H. M., M. A. Hossain and M. G. Hossain. 1997. Semi – intensive culture and production cost of Pabda (*Ompok pabda*) with Rajpunti (*Puntius gonionotus*) and Mirror carp (*Cyprinus carpio* var. *specularis*) in mini ponds. *Bangladesh J. Zool.*, **25(2)**: 129-133.
- Lupin,-H, 2007. Cost-benefit analysis and risk management. Food and Agriculture Organization of the United Nations, Rome, Italy. *FAO-Fisheries-Proceedings*. 2007; **(7)**: 199-206.

- Maclean, R.H. and Jones, R.W., 1995. Aquatic biodiversity conservation: a review of current issues and efforts. Ottawa, ON. SIFR.
- Makherjee, M. and Das, S., 2001. Artificial propagation of a silurid fish pabda *Ompok pabda*. *Fish Chimes.*, **21 (1)**: 75-79p.
- Moyle, P.E and R. A., Leidy, 1992. Loss of biodiversity in aquatic ecosystems: evidence from fish fauna. In: Fielder, P.L. and S.K. Jain (eds.), Conservation of biology; the theory and practice of nature conservation, preservation and management. Chapman and Hall, New York.
- Mukhopadhyay, T. and S. Ghosh, 2007. Lipid profile and fatty acids composition of two silurid fish eggs. *J. Oleo. Sci.*, **56 (8)**: 390-403.
- Parameswaran, S., C. Selvaraj and S. Radhakrishnan. 1970. Observation on the biology induced breeding and cultural possibilities of the catfish, *Ompok bimaculatus* (Bloch) in ponds. *Proc. Nat. Acad. Sci. India*, **40(B)**: 145-162.
- Parameswaran, S., C. Selvaraj and S. Radhakrishnan. 1971. Notes on the life history and biology of the catfish *Ompok pabda* (Hamilton). *J. Zool. Soc. India*, **23(2)**: 137-150 p.
- Rahman, A.K.M., 1989. Freshwater Fishes of Bangladesh. The Zoological Society of Bangladesh, Dhaka, Bangladesh, 168-169p.
- Rahman, M. M. 2001. Induced breeding, larval rearing and chromosomal studies of *Ompok pabda* (Hamilton). A thesis submitted to the Department of Aquaculture for M. S. degree in Aquaculture. 93p.
- Rahman, M. S. 1992. Water quality management in aquaculture, BRAC Prokashana, Dhaka, Bangladesh. 24-25pp.

- Rahman, M.S. 1999. Effect of species combination on pond ecology and growth of fish in carp polyculture system. M.S. Thesis. Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh.342pp.
- Rao, J. B. and S. J. Karamchandani. 1986. On the spawning biology of *Ompok bimaculatus* (Bloch) from Kulgarhi reservoir of Modhya Pradesh. *Inland Fish. Soc. India*, **18(2)**: 40-47.
- Riede, K., 2004. Global register of migratory species-from global to regional scales. Final report of the R&D-project 808 05 081. Federal Agency for Nature conservation, Bonn, Germany, 329p.
- Rupam-Sharma ,2008. Chromosomal studies on two endangered catfishes-Ompok bimaculatus (Bloch) and Ompok pabda (Hamilton-Buchanan). College of Fisheries, Central Agricultural University, Tripura 799 210, India. *Indian-Journal-of-Animal-Sciences*. 2008; **78(2)**: 234-236
- Sarker, M. N., 1984. Induced spawning of fresh water catfish Magur in Bangladesh using PG extracts and HCG. Paper presented at the 9th Annual Bangladesh Science conference, held at BARC and BJRI, Dhaka, Oct. 20-21.4 pp
- Siddiqua, K. A., M. S. Islam, M. G. Hossain and A. T. A. Ahmed. 2000. A histological study of the spermatogenesis in *Ompok pabda* (Hamilton-Buchanan 1822). *Bangladesh J. Fish. Res.*, **4(2)**:185-189.
- Springate, J., N. Bromage and R. Cumaranatung. 1985. The effects of different ration on fecundity and egg quality in the rainbow trout (*Salmo gairdneri*). In : Cowey, C.B., A.M. Mckie and J.G. Bell (eds.), *Nutrition and feeding in fish*. Academic Press, London. Pp. 371-393.

- Sridhar, S, C, Vijayakumar and M. A. Haniffa. 1998. Induced spawning and establishment of a captive population for an endangered fish, *Ompok bimaculatus* in India, Bangalor, *Curr. Sci.*, **75(10)**:1066-1068 .
- Swingle, H.S. 1967. Standardization of chemical analysis for mud pond water. FAO. *Fish Res.* **44(4)**: 397-421.
- Taleb, M.A., M. H., Rahman, and M.A., Hossain, 1991. Food and feeding habit of small omnivorous fish, *Ompok pabda*. Proceedings of 15th Annual Bangladesh Conference. Abstracts: Section 9, No. 20. 17p.
- Tsadik, G. G., A.N. Bart. 2007. Effects of feeding, stoking density and water-flow rate on fecundity, spawning frequency and egg quality of Nile tilapia, *Oreochromis niloticus* (L.). *Aquaculture.* **272(1/4)**: 380-388.
- Uddin, M.A. 2002. Effect of addition of small fish on pond ecology and production of polyculture. M.S. Thesis, Department of Fisheries Management, B.A.U. Mymensingh. 81 pp.
- Vincent, A.I.F. and M.E. Allison.2010. effect of chronic exposure to drilling fluid XP-07 on gonad histology in *Tilapia guineensis*. London UK. *Toxicol. Environ. Chemistry.* **92(2)**: 271-277.

APPENDICES

Appendix-I

The taxonomic classification of Pabda is given bellow:

Phylum: Chordata

Class: Actinopterygii

Order: Siluriformes

Super family: Siluroidea

Family: Siluridae

Genus: *Ompok*

Species: *Ompok pabda*

Appendix-II

ANOVA table for fertilization rate (%), hatching rate (%), and survival rate (%) during the study period from June to August, 2011.

Date	Statistics	Fertilization rate (%)	Hatching rate (%)	Survival rate (%)
15.06.2011	Mean	84.4613	71.2007	60.4048
	Std. Deviation	4.11906	1.69191	0.59490
	Std. error	2.37814	.97683	0.34347
	Minimum	80.24	69.26	59.79
	Maximum	88.46	72.36	60.97
14.07.2011	Mean	71.46	66.5583	55.2130
	Std. Deviation	5.45730	1.81599	1.11867
	Std. error	3.15078	1.04846	0.64586
	Minimum	5.45730	64.57	54.13
	Maximum	3.15078	68.12	56.36
13.08.2011	Mean	71.4266	57.2544	42.7633
	Std. Deviation	3.68098	2.47513	0.55444
	Std. error	2.12522	1.42902	0.32011
	Minimum	68.25	54.59	42.13
	Maximum	75.46	59.48	43.13

*The means were calculated as mean standard deviation and standard error of the mean.

Appendix-III

ANOVA table for water quality parameters of brood rearing ponds during the study period from June to August, 2011

Date	Statistics	Brood ponds			
		Temperature	pH	Dissolve O ₂	Transparency
15.06.2011	Mean	27.9500	7.2833	5.7083	24.5433
	Std. Deviation	0.53198	0.17224	0.63496	1.17168
	Std. error	0.21718	0.07032	0.25922	0.47834
	Minimum	27.10	7.00	5.04	23.17
	Maximum	28.50	7.50	6.37	25.98
29.06.2011	Mean	29.9833	7.2833	5.2933	26.5583
	Std. Deviation	0.55287	0.19408	0.25773	1.22826
	Std. error	0.22571	0.07923	0.10522	0.50143
	Minimum	29.30	7.00	4.94	25.12
	Maximum	30.70	7.50	5.69	27.87
14.07.2011	Mean	27.9167	7.0500	5.0300	21.9583
	Std. Deviation	0.53821	0.10488	0.17944	1.78385
	Std. error	0.21972	0.04282	0.07326	0.72826
	Minimum	27.30	6.90	4.87	20.09
	Maximum	28.70	7.20	5.33	23.86
28.07.2011	Mean	28.0833	7.1000	4.9550	22.9017
	Std. Deviation	0.69402	0.14142	0.19316	1.57000
	Std. error	0.28333	0.05774	0.07886	0.64095
	Minimum	27.10	6.90	4.76	21.00
	Maximum	28.80	7.30	5.27	24.54
13.08.2011	Mean	27.8833	7.1167	5.0350	22.5400
	Std. Deviation	0.61779	0.17224	0.18480	0.95940
	Std. error	0.25221	0.07032	0.07544	0.39167
	Minimum	27.10	6.90	4.76	21.53
	Maximum	28.60	7.40	5.24	23.63
27.08.2011	Mean	27.9667	7.1333	5.1033	22.9983
	Std. Deviation	0.62183	0.12111	0.16379	0.64440
	Std. error	0.25386	0.04944	0.06687	0.26308
	Minimum	27.20	7.00	4.84	22.15
	Maximum	28.80	7.30	5.30	23.87

*The means were calculated as mean standard deviation and standard error of the mean.

Appendix-IV

ANOVA table for total length, body weight, GSI and fecundity of female during the study period from June to August, 2011

Date	Statistics	Total length	Body weight	GSI	Fecundity
June	Mean	26.5667	126.4333	1.0867	17369.3333
	Std. Deviation	0.32146	1.16762	0.04163	213.46272
	Std. error	0.18559	0.67412	0.02404	123.24276
	Minimum	26.20	125.40	1.04	17123.00
	Maximum	26.80	127.70	1.12	17500.00
July	Mean	22.4333	123.6333	0.9250	16344.0000
	Std. Deviation	0.41633	0.77675	0.05679	236.91349
	Std. error	0.24037	0.44845	0.03279	136.78207
	Minimum	22.10	123.00	0.86	16120.00
	Maximum	22.90	124.50	0.97	16592.00
August	Mean	19.4667	111.5000	0.8150	15560.0000
	Std. Deviation	0.30551	1.17898	0.07697	185.26737
	Std. error	0.17638	0.68069	0.04444	106.96417
	Minimum	19.20	110.20	0.75	15358.00
	Maximum	19.80	112.50	0.90	15722.00

*The means were calculated as mean standard deviation and standard error of the mean.