Freshwater prawn hatcheries in Bangladesh: Concern of broodstock

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Dead broodstock are sold in prawn market.

In Bangladesh, freshwater prawn (*Macrobrachium rosenbergii*) farming is currently one of the most important sectors of the national economy, and during the last two decades its development has attracted considerable attention for export potential. Within the overall agro-based economy of the Bangladesh, the contribution of prawn (locally known as golda) production is important to its people for livelihoods, income and food supply. In 2006, Bangladesh exported 49,317 tons of prawn and shrimp valued at US$415 million, of which around 25% was contributed by prawn (DOF, 2007). This figure is expected to rise with the increasing expansion of freshwater prawn cultivation into new areas of Noakhali, Patuakhali, Pabna and Mymensingh districts. Prawn farming is mostly concentrated in southwest Bangladesh, mainly Khulna, Bagerhat and Satkhira districts.

The expansion of M. *rosenbergii* farming depends on availability of prawn fry, the supply of which is currently the main bottleneck for further expansion of prawn culture. The prawn culture sector in Bangladesh still relies on wild postlarvae (PL). Farmers prefer to stock wild PL rather than hatchery produced fry as production of the hatchery PL is limited and farmers consider them to be of lower quality. In addition, the survival of wild PL is much higher than that of hatchery produced PL (Ahmed, 2001). However, there is a growing acceptance of hatchery fry by producers.

Since the late 1980s, there has been concern over the effects of intensive fishing of prawn PL (Ahmed, 2000). Indiscriminate fishing of wild PL with high levels of by-catch (i.e. non-target species caught incidentally) and biodiversity impacts on the coastal ecosystem has provoked imposition of restrictions on wild PL collection (Ahmed 2003). In September 2000, Department of Fisheries imposed a ban on wild PL collection. The rationale for the ban was to protect biodiversity from the harmful effects of intensive PL fishing in the coastal zone (DOF, 2002). However, the lack of alternative livelihoods for poor people engaged in PL fishing is one of the principal constraints on implementing such a ban.

Due to the scarcity of wild PL supply, a prawn hatchery sector has emerged over the last few years. However, the quality of hatchery PL remains a concern for prawn farmers. It is assumed that source of broodstock (i.e. mother prawns or berried females) is an important issue for producing quality fry in hatcheries. Hatcheries are currently unregulated with no quality assurance of broodstock. One of the problems in regulating and managing the supply of brood to prawn hatcheries is the lack of information. At the same time, there is no information on the projected demand of broodstock by hatcheries. The aim of this study was therefore to identify potential sources of broodstock and appropriate harvesting, marketing and transportation systems. Addressing these issues should lead to higher production of quality PL that will help to expand freshwater prawn farming into new areas of Bangladesh through developing and sustaining prawn hatcheries.

Methodology

The study was undertaken in Khulna, Bagerhat and Satkhira districts in southwest Bangladesh, situated in the coastal areas of the Bay of Bengal. Geographically these districts have been identified as the most important and promising areas for freshwater prawn farming, because of the availability of prawn hatcheries and sources of wild PL. These districts were therefore selected for the study. In addition, data were collected from hatcheries in other parts of Bangladesh.

Primary data were gathered by field survey. This survey involved the inspection of the study areas in terms of hatchery operation with broodstock, sources of broodsstock to hatcheries, broodstock collection methods, their marketing and transportation systems. Data were collected for six months from March to August 2007. A total of 24 hatchery operators, 20 broodstock suppliers and 32 wild broodstock collectors participated in questionnaire interviews. Hatcheries were selected through simple random sampling. For this sampling method, a database of prawn hatcheries was collected from Winrock International. The site for wild broodstock collection was selected in the coastal area of Mongla under Bagerhat district. A boat was hired for data collection and observation of wild brood fishing on the Pasur River. Broodstock fishers were interviewed on the river and/or river bank. Visits were also made to Fakirhat and Mollahat areas of

Bagerhat district where broodstock were harvested from prawn farms, locally known as ghers. Broodstock transportation and marketing systems were also observed. Data from questionnaire interviews were coded and entered into a database system using Microsoft Excel software for producing descriptive statistics.

Cross-check interviews were conducted with key informants such as District and Sub-district Fisheries Officers, researchers, policymakers, prawn farmers, NGO workers (i.e., BRAC, PROSHIKA, etc), and staff of Winrock International and WorldFish Centre. Where information was found to be contradictory, further assessment was carried out. A total of 22 key informants were interviewed.

Broodstock ready to use in the hatchery.

Harvested wild broodstock.

Plastic container is commonly used for broodstock transportation.

Harvested broodstock stored in a bamboo basket.

Hatchery development

Although the freshwater prawn culture industry in Bangladesh still depends on wild fry, expanding production and the trend towards intensification require the development of prawn hatcheries. In recent years, increasing shortages of wild fry and their high prices, together with the ban on catching wild PL have stimulated the expansion of the hatchery industry. Prawn hatchery technology in the private sector has been developed rapidly. The growing acceptance of hatchery fry along with government incentives to boost hatchery production has resulted in a sharp increase in the number of prawn hatcheries in Bangladesh. There are 81 freshwater prawn hatcheries in Bangladesh of which 42 (52%) are operational (Winrock International, 2007). A lack of technical knowledge and inadequate skilled manpower are important reasons for the poor results of many hatcheries.

In Bangladesh, an M. *rosenbergii* hatchery first started in Cox's Bazaar in 1986 (Angell, 1994; Winrock International, 2007), after which it spread throughout other parts of Bangladesh. According to the survey, 5% of prawn hatcheries started in or before 1990, 8% between 1991 and 1995, 13% between 1996 and 2000, and 74% after 2000. Almost all hatchery owners stated that the primary reason for starting this business was profitability. However, 12% of owners were attracted to hatchery operation because of own interest. In spite of various constraints, most of the hatchery owners (95%) would like to continue PL production in the future, because of high profit. Those are undecided about continuing to hatchery operation are concerned about inadequate knowledge, lack of experience, high mortality of PL and limited supply of broodstock.

According to the survey, the average annual production capacity of a hatchery was estimated at 2.63 million PL in 2007. From this figure it seems that total annual production of PL is around 110.46 million in Bangladesh

A fisher with char net that is commonly used for broodstock fishing.

(i.e. 2.63 million/hatchery x 42 hatcheries). Hatchery output is insufficient to meet demands in terms of both quality and quantity. Currently hatcheries can only meet 22% of the total annual demand in Bangladesh of around 500 million PL (Dr Abul Hossain, Winrock International, personal communication).

Hatchery operation

Berried females are an essential component for continuous operation in hatcheries. Female prawns generally become reproductively mature within six months of age. Mating can occur only between hard shelled males and soft-shelled females, i.e., females that have just completed a pre-mating or prenuptial molt (D'Abramo et al., 1995). Fecundity can be as high as 80,000 to 100,000 eggs in mature females while first broodstock may be around 5,000 to 20,000 (Brown, 1991). The eggs are carried on the female abdomen attached to the pleopods before hatching. In the nature, female M. *rosenbergii* migrate downstream from their normal habitat in freshwater to brackishwater areas.

According to the hatchery operators, female prawns first mature after reaching a size of 20 to 30 g. Eggs obtained from these females are of good quality and their larvae show high percent survival after hatching. However, females of farmed origin often mature while 30 to 40 g. Use of such precociously mature females results in eggs and larvae of poor quality. Offspring of these females may mature even more precociously.

Although *M. rosenbergii* breeds throughout the year under optimum climatic conditions (28 to 32ºC), the peak breeding activity occurs in Bangladesh during pre-monsoon and monsoon seasons, i.e., from March to August, a production period of around 4 to 5 months, depends on number of production cycles, availability of broodstock and favourable environment. According to the survey, most of the hatcheries (67%) operate two production cycles in a year, while 21% and 12% of hatcheries operate one and three cycles, respectively. Each production cycle normally ranges from 35 to 45 days, an average 40 days. After completion of one cycle, a few days (7 to 10 days) are required for preparing to operate the next cycle. In general, the first cycle produces more PL rather than other cycles due to high demand and the peak stocking season. However, most hatcheries do not operate at full capacity due to low survival of PL, technical constraints, outbreak of disease, and difficulty in securing good quality broodstock.

Broodstock are commonly selected on the basis of readiness to spawn. In general, healthy broodstock are selected for hatchery operation. The average size of broodstock is 75 g and ranges from 40 to 200 g. Broodstock are disinfected with 10% formalin for 30 minutes before use in hatcheries. About two to three broodstock are stocked in a brackishwater tank with 12 PPT salinity and reared until hatching, which is completed within two to three days if advanced berried females are stocked with grey eggs on their pleopods. Once hatching occurs it may continue for 24 to 48 hours. The spent females are removed and released back to the broodstock tank. Brine shrimp nauplii are fed to the prawn larvae. The appearance of first PL is usually observed 20 days after hatching, normally between 22 and 26 days, and 90% of larvae metamorphose within next 10 days. The PL are gradually acclimatised to the freshwater and reared at high densities (2,000 to 5,000/m^2) for 10 to 15 days in the hatchery.

With a few exceptions, the hatchery operators never directly communicate with prawn farmers, market communication normally being made through intermediaries: transporters, fry traders and suppliers. The average price of hatchery PL varies from Tk 1,000 to 1,200 (1 US$ = Tk 67) per 1,000 PL depending on their availability, quality, season, supply and demand. The average price of wild PL is much higher than that of hatchery PL, because of quality. The average price of wild PL varies from Tk 1,800 to 2,400 per 1,000 PL.

Sources of broodstock

Prawn hatcheries require an uninterrupted supply of berried females during the season. For the consistent operation of hatcheries broodstock are collected at regular intervals. The principal sources of broodstock to prawn hatcheries are wild and prawn farm. According to the survey, 33% of hatcheries use natural broodstock, 13% use farm-reared broodstock and the remainder (54%) both sources. In those hatcheries using both sources, it is believed that broodstock are commonly being sourced from prawn farms rather than wild. Among the farm broodstock, almost all are grown from wild PL. A few hatcheries have their own prawn farms for continuous supply of broodstock. The quantity of broodstock used in hatcheries rather obscure because hatchery operators often do not distinguish between wild and farm broodstock. However, it was estimated that only 15% of broodstock were from wild and the rest (85%) were from prawn farms.

Most hatcheries prefer to stock wild broodstock rather than farm-reared broodstock because of quality. However, the supply of wild broodstock is not regular and therefore hatcheries also use farm broodstock. Hatchery operators noted that the demand for wild broodstock has increased due to expansion of hatchery operations and increased number of hatcheries. Inadequate supply of wild broodstock can therefore be a significant constraint for producing quality fry. A few hatcheries were reported to prefer farm broodstock due to low price and availability in markets. However, according to the hatchery operators, the quality of PL, its production rate and survival rate is higher when wild broodstock are used rather than farm broodstock.

The wild broodstock mainly come from Mongla, Joymoni and Sharankhola of Bagerhat district, while farm broodstock mostly come from Fakirhat and Mollahat areas in same district. Suppliers carry these broodstock to the hatcheries in Khulna, Bagerhat and Satkhira districts, and other parts of Bangladesh. According to the survey, a hatchery

Transporting broodstock by van over short distance.

Fishers are drying nets after fishing.

A fisher and his prawn fishing site near the Sunderbans.

uses an average 520 broodstock in a season, ranging from 310 to 2470. From this figure, it seems that a total of 42,120 broodstock are required for operation of all 81 hatcheries in Bangladesh, and is projected to increase to 80,000 broodstock for successful operation in the future.

Broodstock collection

Various methods are used to collect broodstock from different sources (Table 1). In nature, berried females are caught as a bycatch of prawn. A large number of fishers are known to be engaged in fishing of prawns including broodstock. Fishers are involved in broodstock capture on the Pasur River from Mongla through to Joymoni on the coast. The peak season of broodstock fishing is from March to July during the daily high tides and monthly full moons when numbers of broodstock are high. According to the survey, fishing for

broodstock first started in 2002 in this area. Since then it spread throughout other parts of coastal areas. Over this time, broodstock fishing has become a profitable business for its participants and has generated new employment. Broodstock collectors are mostly from the rural poor and this activity is a substantial part of their income. It is considered that broodstock collectors contribute substantially to the economy and to a part of the foreign exchange earnings (i.e. most prawns are exported to the international market), although the collectors themselves benefit little.

According to the survey, a fisher caught an average of 32 broodstock (ranging from 19 to 44 pieces) during the season in 2007, while in some years previously the rate was 50 to 60. Broodstock collectors reported that the availability of broodstock has reduced due to over fishing, use of destructive gears, environmental degradation and massive PL collection. A large range of bycatch species are caught and discarded due to the fine mesh nets (i.e. set bag net and pull net) used for PL fishing which may have severe long term impacts on wild prawn production including broodstock. As a result, uncontrolled fishing of PL may pose a threat to the natural population.

Harvesting of prawn including broodstock in a farm.

Broodstock kept in net cages.

Table 1. Fishing of *Macrobrachium* broodstock by using different methods and their percent of catch.

Source	Harvesting technique	% of catch
Wild broodstock	1. Char net	11
	2. Set bag net	1
	3. Pull net	1
	4. Hook and line	2
Farm broodstock	1. Seine net	68
	2. Cast net	17
Source: Survey data (2007).		

Table 2. Average farm-gate prices of broodstock from different sources.

Grade	No. of broods/kg	Average weight of a broodstock (g)	Wild broodstock (Tk/piece)	Farm broodstock (Tk/piece)
5	5 or less	200	300	150
10	6-10	125	230	90
20	11-20	70	180	75
30	21-30	40	120	50
Source: Survey data (2007).				

Marketing of broodstock

In Bangladesh, the market for broodstock is associated with strong demand, driven by continued increases of hatcheries. However, in terms of volume, value and employment, the broodstock market is very small. The broodstock marketing system is less competitive but plays a vital role in connecting the broodstock and hatcheries, thus contributing significantly freshwater prawn farming as well as earning foreign currency. A small number of people, many of whom live below the poverty line, find employment in the broodstock marketing chain as fishers, suppliers, agents, transporters and day labourers, including women and children.

In wild broodstock marketing, fishers are the primary producers. With a few exceptions, fishers never directly communicate with hatchery owners, market communication normally being made through suppliers. A small number of people (around 10 to 15) are engaged in broodstock marketing as suppliers. Their role is to buy broodstock from the fishers in coastal areas and carry them to the hatcheries. Communication between the suppliers and hatchery owners is generally good and takes place by mobile phones. The demand for wild broodstock is high within coastal markets but supply is limited, and a strong network has developed with suppliers and fishers. Around five to six fishers are connected with a supplier and one supplier is linked to two to four hatcheries. A fisher carries typically two to five broodstock per day from remote fishing areas to the supplier in a depot. In general, suppliers rear broodstock for few days in net cages with pelleted feed. Consignments are sent to the hatcheries once sufficient quantities have been obtained, an average 300 broodstock per week per supplier.

Marketing of farm broodstock is almost entirely managed, financed and controlled by a group of powerful intermediaries. Market communication is normally being made through local agents and suppliers. Broodstock marketing is seasonal and suppliers are involved in prawn and fry trading during the rest of the year. In general, farmers sell their broodstock to the suppliers through local agents. A local agent carries typically 25 to 30 broodstock per week from remote villages to the depots of suppliers. Sometimes local agents take small amounts of credit from depot owners to ensure the supply of broodstock from farmers. Local agents also often take temporary credit from the farmers, buying broodstock one day and paying one or two days later. Suppliers also receive cash loan from hatcheries in return for a promise to sell all their broodstock. Hatcheries are linked to suppliers when they act as fry traders. A few hatcheries often take temporary credit from suppliers, buying broodstock

one season and paying in exchange of fry during the fry trading season. The hatcheries capital installations and much of their working capital is provided by the banks. Hatcheries typically enjoy a very close working relationship with their banks, for which this sector is big business.

The price of broodstock depends on size and weight, quality, season, and supply and demand. In coastal markets, price is generally higher in early season during March to April and drops in the following months. The average price of wild broodstock from fishers to the suppliers varies from Tk 120 to 300 per piece (Table 2). Comparatively the price of wild broodstock is higher than farm broodstock. The average price of farm broodstock varies from Tk 50 to 150 per piece, depending on grade. Due to higher price of wild brood, suppliers sometimes camouflage farm broodstock as wild in order to get a higher price. Suppliers sell wild broodstock to hatcheries at Tk 350 to 800 per piece, while farm broodstock at Tk 150 to 500 per piece.

Transportation of broodstock

A considerable number of people are involved in the transport of broodstock. Transport of live broodstock to hatcheries takes place in the very early morning hours, to take advantage of cooler temperatures. Pickups, microbuses, taxis, motorcycles, trawlers and vans are used for transportation. In general, taxis, motorcycles, vans are used for small quantities (5 to 20 broods), and others are used for large quantities (50 to 200). Plastic and aluminium containers with 12 PPT brackishwater are commonly used for holding broodstock during transport. Most broodstock are transported with oxygen at a low temperature to reduce their metabolism. Brackishwater is used normally at a ratio of two liters per one broodstock for eight hours transportation. According to the suppliers, the broodstock mortality rate is very low, less than 10%. Mortalities reported by the suppliers are due to the poor transport conditions, water temperature, long duration of transport and poor handling. According to the respondents, 5% of the broodstock are wastage from the time they are caught to the time they are stocked in hatcheries due to poor handling. Because broodstock are caught using different nets and hooks, mortalities are common.

Fishers with hook and line fishing for prawns including broodstock.

A typical prawn hatchery.

Conclusions

Despite strong demand of broodstock by the hatcheries there is no broodstock bank in Bangladesh. Due to the scarcity of wild broodstock supply to the hatcheries, it is urgently needed to establish a broodstock bank in prawn farming areas. To meet a part of immediate demand for quality broodstock, both the public and private sector should come forward to establish their own broodstock banks. Hatcheries could be linked to the public and private broodstock bank to ensure the availability of quality broodstock. It would also necessary to encourage private entrepreneurs to start commercially producing good quality broodstock. Rearing broodstock of good quality requires special techniques and fresh spawns from the nature. Improving the quality of broodstock will result in better quality spawns, reduce mortality rate and increase productivity. However, concerns may arise about the sustainability of broodstock banks in terms of technical, biological, environmental and economic aspects. It is therefore necessary to provide institutional and organisational support and government support for sustainable development of broodstock banks. In addition, broodstock rearing techniques to be developed to maintain genetic quality. Moreover, a certification system should be developed and implemented to maintain the quality. Training of broodstock bank operators in areas of stocking, feeding, rearing and harvesting should be provided. It is also necessary to improve handling and transportation practices to reduce the mortality of broodstock.

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