GENERAL DISCUSSION
CHAPTER-5

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The Climbing Perch, *A. testudineus* (Bloch) is a highly priced air breathing, freshwater food fish species which belongs to the family Anabantidae and order Perciformes. It is locally known as “Kawoi” or “Koi” and can be found in most parts of tropical or subtropical Asia including Malaysia, Southern China, Thailand, Vietnam, Philippines, India, Taiwan and Indonesia (Rainboth, 1996; Wang *et al*., 1999; Kottelat, 2001 and Tan and Lim, 2004). It is an omnivorous species and often found in swamps, lakes, canal, rice paddies and streams (Rainboth, 1996; Iwata *et al*., 2003 and Sarkar *et al*., 2005).

It possesses a special accessory air breathing organ and situated just above the gills is a large extension on the upper part of each gill chamber, which facilitates the utilisation of atmospheric air for their respiration (Graham, 1997).

One of the most celebrated local fishes, *A. testudineus* is capable of wandering "cross-country" from one water body to another. Climbing Perches use the tail for forward propulsion when on land. The spiny gill covers are used to obtain purchase on the substratum.

This species has also been reported as one of the successful larvivorous fish for controlling mosquitoes like *Aedes* sp. *Culex* sp. and *Anopheles* sp. in sewage waters (Hussain, 2005 and Chandra *et al*., 2008). The habitat is similar to the immature mosquito and the ability of these fish to tolerate low level of oxygen in aquatic systems favour their augmentative release as a part of a biological control programme (Bhattacharjee *et al*., 2009).

Many fish populations worldwide have experienced drastic reduction in number, largely due to the effects of the high fishing intensity and habitat loss. One of the many ways in which to replenish declining natural stocks is through captive breeding or hatchery...
programme. Since 1981, population of climbing perch *A. testudineus* has been decreasing. The fish has been designated as “threatened species in Indian waters” by National Bureau of Fish Genetics Resources, Allahabad, India (Dehadrai *et al.*, 1992) and also has been declared as endangered by NBFG, ICAR, India in 1998. Although, *A. testudineus* is believed to be “difficult to breed” in laboratory conditions, reports of success with the induced breeding of this species are also available, though scanty (Banerji and Prasad, 1974; Khan and Mukhopadhyay, 1975 and Banerji and Thakur, 1981). However, these studies are restricted to analyse the overall breeding performances. Although, some information regarding this species is available, adequate knowledge on its breeding biology, food habit and culture is yet to be unfolded. Till date there is no report of organised breeding and culture of this species from Assam. In view of above, the present study is aimed to investigate the breeding and performance of *A. testudineus* under controlled condition by induced breeding with Ovaprim in cemented tank and rearing of the species in large scale in ponds.

**Breeding technique**

In the north eastern region the most popularly used breeding technique is the Chinese eco-hatchery. Though, it is a popularly used technique but a lot of money and area is required for the infrastructure development for this technique. Thus, in the present study, there has been an attempt to develop a low cost technique for this small sized live fish.

The present study was conducted in two cemented tanks of size 150 cm X 60 cm X 75 cm and a rearing pond of size 25 m X 30 m for a period of two years (from August, 2009 to July, 2011) at West Jalukbari in Guwahati, Assam, India under natural condition. The tanks were made up of bricks, sand, gravel and cements. The tanks were connected directly to the rearing pond through an electric aqua pump (Model: Tullu-60, Power: 250 W, Max. Dis.: 900 litres per hour) to collect water from the rearing pond to the tanks. Before starting the
experiment, the water of the tanks was filtered by synthetic cloth (with 50 meshes to a cm) collected from the pond to avoid entry of predators of hatchlings like *Cyclops*.

Dip treatment in Potassium permanganate solution (5%) was made for the injurious fishes which were collected from the natural habitat to avoid any infection to the other fishes of the pond or tanks. Fishes were kept in quarantine tank for 5 hours for adjustment of temperature as well as for acclimatisation prior to release in the rearing pond.

The culture pond was also pre-treated with common lime (CaO) depending on the pH of soil prior to 15 days of releasing of the brooders (Khanna, 1996). As the fish *A. testudineus* cannot climb a slope more the 30° (Davenport and Matin, 2006) the slope of the embankment of the rearing pond was modified to 35-45°. Around, 10 cm small wall or bana (made up of bamboo split) was constructed or placed where slope modification was not possible to prevent the escape of fish mainly after heavy rain.

Induced breeding of Climbing Perch, *A. testudineus* was conducted by synthetic hormone- Ovaprim in the intensity level of 2.0 ml per kg body weight for male and slightly higher (2.2 ml per kg body weight) in case of female and much higher in both the cases in comparison to the recommended dose for carps. Highly physically injured fishes were discarded. The juvenile fishes were also discarded as they had no role for breeding purpose.

**Developmental stages**

*A. testudineus* is sexually dimorphic but the sexual dimorphism occurs generally with the approach of breeding season. The females are relatively large in size and are faint reddish coloured, particularly in the pectoral and ventral fin region. The fully ripe females have bulging yellowish abdomen with a prominent bulging at the vent resembling genital papilla. The matured males are reddish coloured and possess some bands at their lateral sides which become distinct during breeding season and generally longer and brighter than the female.
Similar findings were reported by Mookherjee and Mazumdar (1946), Dehadrai et al. (1973) and Banerji and Prasad (1974). The female in contrast to the male, has a prominently bulging abdomen. The ventral distance between the bases of the two pectoral fins in the female is significantly greater than the male. In the breeding season, the female exhibits a prominent bulge at the vent, resembling the genital papillae while in the male this structure is absent. Matured male oozed out white milt and matured female oozed out ova even at a gentle pressure at the abdomen during breeding season.

Increased water temperature and rainfall is an important factor which influence the maturation of gonads. Besra (1997) reported breeding season of *A. testudineus* from middle of April to middle of June. But in the present study, it was found that it started from middle of March to 1st week of July. Rainfall plays an important role for early start and extended period of breeding season. If the rainfall starts from the 1st week of March then matured fish will be available at the end of March and if the rainfall starts from the 1st week of April then matured fish will be available till the end of June or 1st week of July. The peak spawning season in all the species is inferred from the brood and seed abundance during June-July, coinciding with peak rainfall. The temperature gradually starts rising from March onwards and gonads too start to mature in both male and female. This is an indication that the species is an annual breeder.

Fishes are well known for their biotic potentiality; with most species releasing thousands to millions of eggs annually (Bond, 1979). In the present study, the range of fecundity of *A. testudineus* varied from 2668 to 44942 for a corresponding length and weight 12.1 cm – 14.7 cm, and 33.32 – 60.10 g. Ova diameter was ranged from 0.60 mm to 0.84 mm. Doha and Hye (1970) reported that the variation of fecundity is very common and observed in fishes and the number of eggs produced by an individual female is dependent on several factors like

[106]
size, age, environmental conditions. Reproductive potential of the fishes is also influenced by availability of space and food (Mookerjee and Mazumdar, 1946).

The largest individual fish with total length 16.6 cm and body weight 85.40 g was observed to carry 39667 eggs (ovary weight-11.3 g) and the smallest sized fish with total length of 9.4 cm and body weight 16.90 g was found to carry 7354 eggs (ovary weight- 1.87 g). The minimum number of eggs was calculated as 2668 (ovary weight- 0.82 g) for 33.32 g body weight with 12.1 cm total length and maximum number of eggs was calculated as 44942 (ovary weight- 7.34 g) for 60.10 g body weight with 14.7 cm length. But, the variation of fecundity was found even in the similar size female with equal length and body weight.

In the present study, it was found that in case of so many fishes with same length, the number of eggs was different. The same type of variation was also reported by Marimuthu et al. (2006) in spotted snakehead Channa punctatus, Akter et al. (2007) in Hilsa ilisha and Musa and Bhuiyan (2007) in Mystus bleekeri. The variation of fish fecundity is believed to be not only due to fish length and weight but also due to nutritional diet, running water and influence of vitamins (Dube, 1993). Further, environmental condition in the water bodies and food availability and supply might affect the fecundity of fish (Bagenal, 1957). It is possible that the variation in fecundity of the A. testudineus may be due to environmental conditions of the water bodies. In the present study on fecundity revealed that A. testudineus is a low fecund fish when compared to carps, other catfish species and other air breathing fishes. Khan and Mukhopadhyay (1972) and Marimuthu et al. (2009) reported the similar observations. It is possible to suggest that lower number of eggs is also correlated with shorter development time and reduced mortality rate of fry and fingerlings, which means higher survival rate during the juvenile period.

Fecundity was found to increase with increase in ovary weight. However, the fecundity per-unit of the ovary weight gradually decreases inspite of the fact that weight of
the ovary increases as the fishes grow in size and weight. In many fishes the somatic weight changes significantly towards spawning activities due to nutrient flow from somatic to ovarian tissue. Hence, the relation between fecundity and weight differs as breeding season approaches (Rath, 2000). It is important to note that the relative fecundity generally decreases as the fish grows. This may be due to increase in egg size coupled with the presence of large number of fatty tissues as observed by Biswas et al. (1984). Svardson (1949) proposed that increase egg size (an associated decrease in fecundity) is common in fish populations because the bigger size or resultant offspring have better chances of survival.

It is well known that precise combinations of environmental factors are essential for maturation, ovulation and spawning of fishes. This process is accelerated by the gonadotropin hormone from the pituitary gland. Franchis et al. (2000) studied the effect of various inducing agents in *Channa striatus* for artificial propagation. They reported that Ovaprim showed better performance in higher fertilisation (93%) than other inducing agent. Many other workers reported Ovaprim as the most potent agent for induced breeding in fishes. As for instance, Nandeesha et al. (1990) reported positive response of Mrigal to Ovaprim at a dose of 0.3 ml/kg body weight and recommended 0.3 ml to 0.4 ml/kg body weight for carp breeding. In the present investigation, Ovaprim at a dose of 2 ml/kg body weight (slightly higher in case of male) is found satisfactory for artificial propagation. About 94% success in fertilisation of eggs of *A. testudineus* has been achieved in cemented tank. However, water circulation with the help of air pump and water temperature in the range of 26.5°C to 31°C is necessary for high rate of fertilisation and survival. Bhattacharyya and Homechaudhuri (2009) also recommended 2 ml/kg body for *A. testudineus* breeding. While studying the factors responsible for the spawning of Indian carps, several workers have suggested a number of factors like rain water, flood, temperature etc. that play vital role in spawning of fish. While making a critical study of the results of the fish breeding experiments conducted
in trial experiments, it was observed that environmental factors during the spawning season had great influence on breeding of *A. testudineus*. Among the important environmental factors- monsoon weather, rain water, temperature are very important environmental cues for breeding of *A. testudineus*, and best results are obtained when the weather conditions are cooler, on cloudy and rainy days, especially after heavy showers. According to Chaudhuri (1960), the temperature of water in all the cases of successful spawning varied between 24°C and 31°C.

The yolk sacs were completely absorbed within 138 to 144 hours after hatching. All larval mouths were open at 34 to 38 hours after hatching and at 48 to 52 hour after hatching the fish started feeding when the remaining yolk sac was almost 50% of its initial volume. But Jalilah *et al.* (2011) found that the yolk was absorbed on 5-6 day after hatching and Amornsokun *et al.* (2004) observed that the yolk sacs were completely absorbed within 92 hours after hatching at water temperatures of 27.0 to 30.5°C. All larval mouths were open 28 hour after hatching and at 32 hour after hatching the fish started feeding when the remaining yolk sac was 52.20% of its initial volume. But Shinsuke *et al.* (2008) observed the time taken for complete absorption of yolk sac was the 7th day after hatching which was almost similar to the present study.

The newly hatched larvae around 3 mm in size, sluggish and buoyant are disposed to destruction by the larger broods of *Anabas* itself besides other harmful organisms. Ultimate number of survival in a brood of *Anabas* is found limited by belligerent tendency between the individuals in the same brood marked by the fact that nearly 3% of them out-grow the rest as ‘shoot’ fry (Banerji and Prasad, 1974).

A paradox is that the *Cyclops*, otherwise a preferred item of food for the fish larvae, can on the other hand prey on it sucking through its soft body wall. Dehadrai and Banerji (1973) have referred to the risk from *Cyclops* to the survival of spawn of air-breathing fishes.
in general. Through, the series of laboratory trials the density at which the Cyclops can become substantially harmful to Anabas spawn was ascertained as 1,500 numbers per litre and the stage at which the spawn can ward off the attack was found to be the total length over 7 mm. Notwithstanding the risk from Cyclops, micro-crustacea and rotifers are the preferred items of food for the larvae of Anabas right from the start of the feeding behaviour which it manifests within 44 to 48 hours of the hatching. In this respect, the present observations vary from the report of Mookerjee and Mazumdar (1946) that the larvae do not feed on micro-crustacean till it attains the size of 9 mm in 6 to 8 days.

The hatchlings were stocked at the rate of two larvae per litre of water (1 cubic meter = 1000 litres) in the tanks, which was just double to the stock density applied by Banerji and Prasad (1974). Supply of minute plankton dominated by rotifers as food was maintained in the tanks. Upto the size range of 7.6 to 10.5 mm which was attained in about 10 days, there was over 40% survival in the tanks. From 10 days to 28 days the water volume was increased in the tanks upto double of the initial volume to provide one litre of water per larvae. Even though, the water space provided to each fry was about 1 litre, the survival rate in 1 month time came down to as low as 12 % apparently because of intra-brood cannibalism.

Food and feeding

The monthly percentages of the stomach condition of A. testudineus in the present study- 83.33% were with food and 16.67% were empty. Of 240 stomachs, 55 were full, 46 were ¾ full, 43 were ½ full, 29 were 1/4 full and 27 were 1/8 full. The highest percentage of fullness of the stomachs was observed in December and September (40%). After these months the percentage of fullness gradually decreased and it was least in March (5%). After
this, the percentage of emptiness gradually decreased and the lowest percentage of emptiness
was found in May (5%).

In the present study, it was found that stomach contents consisted mainly of insects
(17.43%), crustaceans (16.82%) and muck and unidentified components (14.88%). The less
significant food groups were zooplankton (3.37 %), annelids (2.77%), fish (10.02%),
molluscs (13.32 %), mosquito larvae (8.45%) and plant matters (13.29%).

In larval and fry stage *A. testudineus* is zooplankton feeder, but later the fish ingests
more animal food (80 to 99%) than plant food (0-15%)(Pandey, 1987). Although, *A.
testudineus* has been described as omnivorous fish, it has tendency towards carnivorous and
predatory habits. From seasonal gut content observation (Pandey, 1987) it is evident that
molluscs predominate in its food throughout the year, though a greater liking for insects is
exhibited in the post spawning period. But, in the present study it is found that the fishes
prefers insects and crustaceans more than molluscs, may be due to environmental conditions
and availability of the food items. The insects and crustaceans were very dominant food items
in *A. testudineus* throughout the year. On the basis of different food items found in the
stomach contents, *A. testudineus* may therefore be conveniently regarded as an omnivorous
live fish.

**Polyculture**

The growth of *A. testudineus* in the present study was satisfactory (around 40 g in first
year) and almost similar to the growth of natural habitat. Mookerjee and Mazumdar (1946)
found maximum weight of 28.2 g in 9 months in under laboratory condition and average
weight of 50 g in one year under natural condition.
Therefore, in the present study, it is found that if we use *A. testudineus* as bottom feeder instead of *C. mrigala*, it will be more benefitted for the following reasons-

1. The market value of 135 kg *C. mrigala* (300 X 0.45 kg) will be more than 39.4 kg *A. testudineus* (1000 X 0.0394 kg).

2. Transportation cost from the culture pond to market will be more in case of *C. mrigala*.

3. Preservation cost will be more in case of *C. mrigala*.

Water temperature is one of the most important factors, which influence the physico-chemical and biological events of a water body. The range of water temperature (20.5°C to 31°C) recorded from the experimental pond was within the suitable range for culture of fishes (Boyd, 1981 and Rahman *et al.*, 2008). In the present study the temperature of the pond was observed between the ranges of 9.5°C to 31.5 °C, where the fluctuation was more than the suitable range. Besides temperature, the onset of rainfall seems to stimulate initiation of peak breeding activity (Joshi, 1987). This may be the reason for the less breeding success in the session 2010-11, which experienced late monsoon and rainfall.

The fluctuation in pH of water influenced by the acidic character of the basin soil and dense aquatic vegetation (Yadav *et al.*, 1987) as well as by the inflowing surface runoff flood water. The pond water with pH of 3.6 to 5.4 has been reported to exert toxic effect on a range of fishes including mortality, reduced growth and poor reproduction (Wilkinson, 2002). The medium water neither strong nor alkaline supported by the findings of Sing (1980) and Pahwa and Malhotra (1996). Ellis (1937) observed that pH range of 6.7 to 8.4 is suitable for growth of aquatic biota. All aquatic organisms have a certain tolerance range of pH value. Fish survive and grow best in waters with a pH between 6 and 9. Thus, the pH of pond water (6.3 to 8.1) in the present study was suitable for fish culture.
Normally, dissolved oxygen level is low in ponds stocked with high density of fish compared to ponds where stocking density is low. This is due to the higher consumption rate of oxygen by the higher density of the fish and other aquatic organisms (Boyd, 1982). However, the DO level was within the acceptable range for fish culture (Mollah and Hossain, 1998 and Rahman et al., 2005). Maximum values of DO in the retreating monsoon might be due to inflow of oxygen rich water following the monsoon showers. According to Buttner et al. (1993), DO is changed dramatically over a 24 hour period in a pond. He assumed that during the day, oxygen is produced by photosynthesis, the process by which green plants convert water and CO$_2$ in the presence of light, to oxygen and carbohydrates.

At higher concentrations, Carbon dioxide causes fish to lose equilibrium, become disoriented and possibly die. High free CO$_2$ concentration was observed in the winter due to decomposition of organic matters by the microbes which release free CO$_2$. According to Boyd (1998), the desirable limit of CO$_2$ is from 1 to 10 mg l$^{-1}$. In present the study, the values recorded were almost within this limit (1.2 mg l$^{-1}$ and 11.2 mg l$^{-1}$). It indicates that the pond water was suitable for aquaculture.

The range of total alkalinity (48 mg l$^{-1}$ to 139 mg l$^{-1}$) of the study area indicate moderately alkaline condition can be considered as productive (Moyle, 1946). Natural waters containing 40 mg l$^{-1}$ or more total alkalinity are considered as hard water for biological purposes. The high values of alkalinity are indicative of eutrophic growth in the water body (Deka and Bhattacharyya, 2008). Abdo (2005) revealed that high bicarbonate alkalinity values of pond indicate their high productivity and consequently favourable contribution for fish production. It means that the water of pond was productive and suitable for fish culture.

Total hardness refers to the concentration of calcium and magnesium in the water. Hard water is generally more productive than soft water (Durfor and Becker, 1964). Present findings show maximum total hardness in winter may be because of higher concentration of
Magnesium (Abdo, 2005). The total hardness of the pond water during investigation period was soft to moderately hard (32 mg l\(^{-1}\) to 101 mg l\(^{-1}\)). The water that is higher in hardness can help to promote the normal growth of fish bone, build up fishes, digestion and absorption of food and stimulate the growth and reproduction of phytoplankton. It indicates that the pond water was mostly productive and acceptable for fish culture.