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Asian Catfish *Clarias batrachus* (Linnaeus, 1758) Getting Critically Endangered

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ABSTRACT

The presence of Asian catfish, *Clarias batrachus* in Malaysia is at a deteriorating state. It is hardly a cultured species since the supply of seed is unavailable. This species is found in lowland streams, swamp and rice fields. Therefore, they are greatly exposed to factors such as intermittent periods of drought, devastation of the natural habitat and agro-chemicals. Presently, fish farmers are more into the culture of *Clarias gariepinus*. This threatened the mere existence of this indigenous *C. batrachus*. Hardiness, good growth, efficient food conversion and excellent nutritional profile guarantee *C. batrachus* as a suitable aquaculture candidate. Some conservation efforts were looked into in order to prevent the extinction of this potentially important catfish.

Key words: *Clarias batrachus*, walking catfish, extinction, aquaculture

INTRODUCTION

The fish is a native to Asia and the most popular in aquaculture and aquarium trade among all the Asian species (Ng and Kottelat, 2008). It is widely distributed and available in Malaysia, Thailand, Pakistan, eastern India, Sri Lanka (Ceylon), Bangladesh, Myanmar (Burma), Singapore, Indonesia and the Philippines (Khan *et al*., 2000). Talwar and Jhingran (1991) noted the species has been introduced in America and Europe for the purposes of aquarium trade and aquaculture (Masterson, 2007). *Clarias batrachus* is a promising aquaculture candidate owing to its good growth, hardiness, efficient food conversion, excellent nutritional profile and high market value. It is one of the most economically important indigenous freshwater fishes in Asia because it is very attractive with good taste, hardy, rugged, medicinally valuable and has tremendous popularity among consumers (Hossain *et al*., 2006; Goswami, 2007; Debnath, 2011).

Clarias batrachus is threatened (Hossain *et al*., 2006; Ahmad *et al*., 2012) and is becoming critically endangered as it has started vanishing (Binoy, 2010). Ahmad *et al*. (2012) observed that, intermittent periods of drought and the devastation of the natural habitat couple with the uncontrolled introduction of alien species such as *C. gariepinus* are likely factors responsible for reducing *C. batrachus* to a threatened species. Binoy (2010) reported *C. batrachus* disappearance from waters of kerala due to over-exploitation, reduction in the habitat area as results of

reclamation of wetlands coupled with excessive use of pesticides, herbicides and inorganic fertilizers in agricultural farms. *C. batrachus* has recently been observed to be rare and identified as vulnerable to extinction because of the dominance of the introduced *C. gariepinus* (Wiecaszek and Krzykawski, 2010). This African catfish though grows better does not taste like the Asian catfish (Rahman *et al*., 1995). Goswami (2007) mentioned the indiscriminate use of pesticides in paddy fields, which constitute the preferred breeding ground of *C. batrachus* has greatly reduced the possibility of getting the seed of the catfish from natural water bodies.

STRIKING ATTRIBUTES

Clarias batrachus is a leading Asian catfish in terms of having the capability for terrestrial migration to nearby water bodies. It has the additional capacity to undergo aestivation in order to survive short spells of water scarcity (Ahmad *et al*., 2012). It has been established to conveniently cope in deoxygenated water environment for several days as long as it has free access to atmospheric oxygen. The species is more adapted to life in oxygen depleted water condition than *Saccobranchus fossilis* or *Unibus testudineus* (Singh and Hughus, 1971). Sitasit (1981) reported that the species can equally live in water with high content of carbon dioxide of up to 71.45 ppm (Areerat, 1987). This will make the species a suitable candidate for high density culture for maximization of production/unit area (Areerat, 1987). *C. batrachus* is cherished as a medicinal fish and is particularly popular among the pregnant and lactating mothers for medicinal purposes. It is equally used for the convalescent of the patients and malnourished persons because of its high nutritional status (Hossain *et al*., 2006; Debnath, 2011). It was found that *C. batrachus* could conveniently replace the commercial acetylcholinesterase (AChE) from *E. electricus*. It was also observed that the AChE from *C. batrachus* was immuned to heavy metal inhibitions (Tham *et al*., 2009). *C. batrachus* has the unique capacity to successfully survive under hyper-ammonia stress, which it used to face in its natural habitat at certain seasons of the year (Kharbuli *et al*., 2006). *C. batrachus* has excellent nutritional profile due to its high protein, low fat and high iron content of 15.0, 1.0 and 710 mg/100 g of tissue, respectively (Hossain *et al*., 2006). This species has an average High Density Lipid (HDL) of 150-180 mg dL^{-1} in the blood plasma, which confirm the comparative health and nutritional advantage of consuming the fish (Debnath, 2011). *C. batrachus* feeds on aquatic organism such as small fish and insects. They can eat nonstop when food is available, but when food is scarce they can survive for months without eating. The fish is remarkable because it can survive without food and water for some reasonable length of time. It also has the ability to sting when manhandled or captured, which can be quite painful. The defense mechanism is hidden in the pectoral fins and cannot be seen until it appears (Scheng, 2010).

CHARACTERISTICS

It is an air-breathing catfish. The body is elongated and becomes narrower towards the caudal. It has flat and wide head with small eyes and four pairs of sensory barbels. It has broad mouth with fleshy lips and several small teeth on both upper and lower jaws. It possesses large accessory breathing organ with which it uses atmospheric oxygen. The dorsal fin is lengthy and spineless and like the anal fin it terminates in a lobe near the caudal fin. The pectoral fins are characterized by rigid spine-like structure which is instrumental to the species remarkable ability to move on land and hence, it is named as "walking catfish" (Masterson, 2007). Sen (1985) noted that the complete spine/ray count of *C. batrachus* is: Dorsal = 62-72; anal = 45-58; pectoral = 1+8-11 (Masterson, 2007). Page and Burr (1991) observed that, generally, the body color is drab but they could be olive

to dark brown or purple to black color on the dorsal surface, pale to white on the ventral surface, blue-green on the sides and small white specks are present on the back half of the body. The color of the fins is grey-green (Nico and Neilson, 2012). Albino individuals are also available but they are mainly used for aquarium trade (Masterson, 2007). It grows to 19.8 cm the first year, 26.2 cm in the second year, 30.5 cm in the third and 33.5 cm in the fourth year and achieves sexual maturity at about the age of one year and spawns during rainy season which falls between June and August (Das, 2002). The adult male fish are identified on the bases of their long and pointed genital papilla while in case of female the genital papilla is short and roundish in shape (Sharma *et al*., 2010).

BREEDING

Thakur (1976) worked on the spawning behavior of *C. batrachus* and recorded very poor survival of the fertilized eggs and the resultant hatchlings. He attributed this scenario to the protracted spawning habits of the species which interfere with the eggs in a limited breeding environment. Cheah *et al.* (1990) conducted a preliminary study on induced spawning of the species in Malaysia using carp pituitary homogenate. The incubation took 30-36 h at the temperature of 26-28°C. While fertilization and hatching rates were in the ranges of 10-81 and 13-67%, respectively. In his study on seed production of *C. batrachus* in Dakshin Dinajpur district of West Bengal, India, Goswami (2007) reported *C. batrachus* as the most popular air breathing catfish which commands better price than the major carp due to its tastier flesh, high nutritional and medicinal significance. He recorded a range of fecundity of 5000-6000 eggs. The average fertilization rate, hatching percentage and survival rate were 68.5, 36.5 and 10.5%, respectively. The hatching took between 23-27 h at a temperature range of 33-36°C. Mahapatra (2004) propagated *C. batrachus* through artificially and introduced larval rearing technique in India. Hatching of the eggs took between 20-24 h at the temperature of 27-31°C and pH of 7-8. Optimum hatching percentage achieved was 75% and the fish reached fry stage after eight days of rearing with the length of 16 mm and weight of 30 mg. Azuadi *et al.* (2011) confirmed the effectiveness of ovatide in the induced spawning of *C. batrachus*. The authors stated that spontaneous captive breeding, poor quality seed and reliance on wild seeds, are not reliable, time-demanding and uneconomical constitute bottlenecks for culturing this fish. Hossain *et al.* (2006) worked on the artificial breeding and nursery practices of *C. batrachus*. Artificial breeding was successful in *C. batrachus* with 10.0 mg of pituitary gland kg^{-1} body weight in first dose and 45.0 mg in second dose for both wild and first filial (F_1) generation of female. The best survival and growth of the fish fry was achieved by using chopped *Tubifex*. Sahoo *et al.* (2007) studied the spawning performance and egg quality of Asian catfish *C. batrachus* at various doses of Human Chorionic Gonadotropin (HCG) injection and latency periods during spawning induction and observed that although the highest fecundity was obtained with 4000 IU HCG at 14 and 17 h latency, the response from 3000 IU HCG was only slightly less at these latency periods and was effective for up to 23 h. Sahoo *et al.* (2007) also investigated the effect of ovaprim doses and latency periods on induced spawning of *C. batrachus*. They discovered that 1-1.5 mL in combination with 14-17 h latency periods represent the combination that give the best result. This hormone showed similar success in the induced breeding of other tropical catfishes such as *C. gariepinus* (Karami *et al.*, 2011) and *Pangasius nasutus* (Christianus and Hatta, 2010). Sahoo *et al.* (2010) observed that the success in catfish culture is due to the availability of seed. As such the successful rearing of catfish seed at different stages of development is crucial and utmost care is needed at fry and fingerling

Table 1: Induced spawning protocols and performances of *C. batrachus* with different hormones

Country	Weight of broodstocks (g)	Inducing agent used	Doses	Remarks	Recommended dose and results	Reference
India	120-140	Ovatide	0.6, 0.8 and 1.0 mL kg^{-1} b.wt.	Total weight of stripped eggs, net fecundity, fertilization, hatching and survival rate were used for judgement	1 mL kg^{-1} of b.wt.	Sharma *et al.* (2010)
India	120-130	Ovaprim	0.5, 1.0, 1.5 and 2.0 mL kg^{-1} b.wt.	Different combination of latency periods used-11, 14, 17, 20 and 23. Deformed larva was used for judgement	1-1.5 mL with combination of 14-17 h	Sahoo *et al.* (2007)
Bangladesh	Not available	Pituitary gland (PG)	5-20 mg PG kg^{-1} female (1st dose), 30-60 mg PG kg^{-1} female (2nd dose), 15.0 mg PG kg^{-1} male (single dose)		10 mg PG kg^{-1} successful in 1st dose, 45 mg in 2nd dose for both wild and F1 generation of female.	Hossain *et al.* (2006)
Malaysia	200	Carp pituitary homogenate (CPH)	1.5 dose was used (pituitary from carp of 200 g is 1.0 dose)	Latency period of 12 h was recorded	Fertilization 10-81%, egg hatched after 30-36 h, iucubation at 26-28°C, hatching rate of 13-37% were recorded	Cheah *et al.* (1990)

stage to achieve success. Sharma *et al.* (2010) studied the effect of different doses of ovatide on the breeding performance of *C. batrachus* based on the total weight of stripped eggs, net fecundity, fertilization, hatching and survival and found 1 mL of ovatide per kg body weight of female brood fish was optimum among the three experimental doses for best breeding performance and egg quality in *C. batrachus*. Current used of chicken gonadotropin on the induced breeding of *C. gariepinus* showed a promising result (Taufek *et al.*, 2009) suggesting possible application on *C. batrachus*. Studies by Cheah *et al.* (1990), Hossain *et al.* (2006), Sahoo *et al.* (2007) and Sharma *et al.* (2010) on the induced spawning of *C. batrachus* are presented in Table 1.

CULTURE

The culture of *C. batrachus* was reported to have begun in Thailand in the late 1950s (Areerat, 1987). Kloke and Potaros (1975) reported that *C. batrachus* production accounted for about 90% of the total output of *Clarias* in Thailand (Areerat, 1987). Na-Nakorn (2004) indicated that the culture and breeding technologies for *C. batrachus* were developed by the farmers in Thailand since 1960. The technologies did not enjoy wide application since 1987 because the culture systems were being dominated by the hybrids (Na-Nakorn, 2004). By 1990, the culture of *C. batrachus* has been virtually fully replaced by a hybrid between *C. macrocephalus* and *C. gariepinus* (Na-Nakorn, 2004). Cheah *et al.* (1990) noted that, this *C. batrachus* is suitable for culture in Malaysia due to its resistance to low oxygen conditions and good growth rate but the unavailability of fry is a major obstacle. Thus, the popularity of *C. gariepinus* and *Hemibagrus nemurus* culture in Malaysia (Abdi *et al.*, 2011). Sahoo *et al.* (2010) studied the larval rearing of *C. batrachus* in hatchery conditions, reported initial length of the larvae as 5.0-5.5 mm

and the yolk sac took 3-4 days to be fully absorbed. At larval stocking density of 2000-3000 larva m^{-2}, growth rate was 40-50 mg with 70-80%. They noted the commencement of the aerial respiration after 10-11 days. The cleaning of the tank bottom and replenishing 70-80% of the water was done twice daily to maintain 10-15 cm depth. Live plankton is the best food for the larvae because they remain alive in the rearing environment, making it possible for the larvae to feed on them when needed. These plankton generally constitutes of rotifers, cladocerans or copepods (Damle and Chari, 2011). Feed having 45% protein in small ball was administered along with the live plankton to the larvae from 7-8 days of culture and gradual withdrawal of plankton at 13-14 days. Sahoo *et al.* (2010) observed that, production of fingerlings from fry requires small-sized tanks of 10-20 m^2 with 2-3 cm soil base and water level of 25-30 cm. Filtered cow dung (2 kg) and 100 g single-super-phosphate are applied and the tanks are inoculated with plankton and 6-7 days later, the advanced fry are introduced. The suitable initial stocking size was 40-50 mg and the stocking density was 200-300 fry m^{-2}. According to the researchers fry feed should contain 30% protein and fed at 5% body weight by splitting it into two meals. The fry usually grows to 1 g in 30 days. The success in seed production of this fish rely very much on how rearing tanks, feeding and environment are managed.

GENETICS AND TRIPLOIDY

Since imprudent and reckless human activities have reduced this valuable fish to the status of a threatened species, understanding its genetic compositions and subjecting it to productive and sustainable rational genetic exploitation is crucial for a successful conservation. Ataguba *et al.* (2010) confirmed the fertility of the hybrids and their capability to hybridize with the parent individuals. Ahmad *et al.* (2012) investigated the polymorphism in eye lens nuclear crystallins of the *C. batrachus* population in North-western India. They observed that with the exception of the locations associated with floods, selection pressures which have depleted the output of the catfish, have not tempered with the homogeneity of population structure in the region. Garg *et al.* (2010) assessed the genetic diversity of *C. batrachus* using RAPD markers in the three water bodies of Bhopal and recorded differences among the primers in producing similarities in the populations. It was acknowledged that RAPD (Random Amphfied Polymorphic DNA) is a method of analysis that is based on PRC (Polymerase Chain Reaction) which is cost effective in utilizing short primers to detect genetic variability (Hassanien, 2008; Phale *et al.*, 2009; Kumar *et al.*, 2011; Thangaraj *et al.*, 2011; Maya *et al.*, 2012). Khan *et al.* (2000) detected a profound differences in many morphological characters between F_1 hybrids and F_1 parents of *C. batrachus*. Na-Nakorn and Brummett (2009) noted that, generally in Asia, aquaculture is dominated by hybrids of the alien *C. gariepinus* and indigenous species which may jeopardize the purity and viability of wild populations. Significant variation exists among species and population, yet little work has been recorded on the selective breeding of the group. Increase in aquaculture production is important however the functional integrity of the ecosystem must also be preserved.

Triploidy refers to a condition in which cells are in possession of three haploid chromosomes bringing about sterility in fish (Siraj *et al.*, 1993). This application may have practical significance in aquaculture. Siraj (2011) asserted that triploidy in *C. batrachus* was induced by giving cold shock treatment to the newly fertilized eggs. Rustidja (1989) compared the performance of diploid and triploid siblings and observed that, the growth rate was not affected by triploidy but the body composition was greatly affected. Triploid fish accumulated less protein and more fat compared to

diploid individuals. Cold shock induced *C. gariepinus* showed slow growth during early life stage (Karami *et al*., 2010), however, study on European sea bass showed better growth in triploid upon reaching maturity as compared to diploid (Felip *et al*., 2001).

TOXICITY AND IMMUNOLOGY

Fish have been noted to be the favorites of the toxicity monitoring programme in water environments (Kaplan *et al*., 2011). Immunological status of an animal is can be reflected in its haematological profile (Dahiya *et al*., 2012; Yousefian *et al*., 2012). Finding showed that the presence of certain bacteria, such as *Pseudomonas aeruginosa* in catfish intestine can be used as an indicator of environmental pollution (Karami *et al*., 2012) in the aquatic environment.

Singh and Hughus (1971) examined the respiration of the air-breathing catfish, *C. batrachus* under various environmental conditions and confirmed that, *C. batrachus* can survive in oxygen depleted water for several days as long as it has access to the atmospheric oxygen. It shows sign of better adaptation to oxygen stress than *Saccobranchus fossilis* or *Unibus testudineus*. Maheswaran *et al*. (2008) studied the haematological parameters of *C. batrachus* exposed to mercuric chloride. It was discovered that, mercuric chloride could cause immunological impairments in *C. batrachus*, which implies that metal could interfere with the immune system and could result in severe physiological disorder, which may lead to the death of the fish. Kharbuli *et al*. (2006) studied the mitochondrial citrulline synthesis from ammonia and glutamine in the liver of ureogenic air-breathing catfish, *C. batrachus*. It was noticed that, this air-breathing catfish can withstand high concentration of external ammonia. This ammonia is known to cause a great problem to most cultured fish (Chezhian *et al*., 2012). Tripathi *et al*. (2009) studied the genotoxic alterations induced by fluoride in *C. batrachus*. It was concluded that fluoride is able to induce genotoxic effects in catfish. Benny *et al*. (2010) investigated immunostimulatory behavior of *Musa acuminata* peel extract in *C. batrachus*. It was observed that banana peel has immunostimulatory effects in catfish with no adverse effects observed in any of the vital organ studied. This suggested that it can be used in drugs formulation study. Dahiya *et al*. (2012) observed positive response in the values of the haematological parameters of *C. batrachus*.

CONCLUSION

Clarias batrachus is one of the notable Asian freshwater catfish. All the remarkable attributes of this species highlighted above, with proper focus, could be turned into economic and social advantages. Reviving the glory of *C. batrachus* in Asia is a worthwhile cause. If sustainable conservation of the genetic resources of *C. batrachus* for food and aquaculture is to be achieved, the functional integrity of the ecosystem has to be preserved. A concerted effort need to be made to significantly enhance the culture performance of *C. batrachus* to make it more competitive and attractive to both fish farmers and consumers.

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