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The minor carp, *Cirrhinus reba* potential candidate as an aquaculture species: A mini review

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Abstract
Aquaculture entrepreneur are becoming increasingly interested in culturing new species that would complement the production of contemporary commercial aquaculture species available in Bangladesh and broadened species diversity to expand the market for aquaculture species. Scientific and technical interests have motivated on indigenous species whose biological cycle can be reproduced using currently available breeding techniques. In this regards, *Cirrhinus reba* appears as a credible candidate for commercial aquaculture. Over the decades, a considerable number of scientific reports have been published concerning species distribution, determining the timing of gonadal maturation under natural conditions or describing its morphology, fishing production, captive breeding and nursery technique. In this review we synthesize our current knowledge of *C. reba* biology and ecology, and focus on the culture potentiality in captivity as well as future research insights.

Keywords: Aquaculture, biology, ecology, *Cirrhinus reba*, fishery

Introduction
Bangladesh has significant capture fishery and aquaculture potential due to having rich inland waters and river systems. Freshwater water bodies of Bangladesh are rich in fish biodiversity to support fisheries potential. Therefore, fish contributes as a second most valuable agricultural crop to the livelihoods and employment of millions of people. Economically and culturally fish considered as a popular complement to rice in the national diet, giving rise to the maxim *Maache-BhateBangali*. The fisheries can roughly be categorised into three groups: inland capture fisheries, inland aquaculture and marine fisheries, of which the inland aquaculture sector is contributing more than 55% of the total production [20].
In total about 267 fish species have been identified in the freshwater of Bangladesh [69], of which 200 species are truly freshwater while others are estuarine. Of these 200 species, 59 belong to 20 families that are commercially important along with some exotic fish species [19]. Among the commercial species majority belongs to carp and catfish. Currently, major carps such as *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala* and *Labeo calbasu* along with exotic carps such as silver carp (*Hypophthalmichthys molitrix*); grass carp (*Ctenopharyngodon idellus*) and common carp (*Cyprinus carpio*) are frequently practiced in ponds polyculture system. While catfish are cultured singly where carps are added an addition to maintain water quality. Besides these there are several minor carps and small indigenous fish species have high culture potential and occasionally being cultured with major carps or prawn mixed culture systems [28]. However, being having culture potentiality of medium minor carps species, such as bata, *Labeo bata*; fringed lipped carp, *L. fimbriatus*; reba, *Cirrhinus reba* etc are cultured in Indian subcontinent in a small scale only [8]. *Cirrhinus reba* is a commercially important indigenous minor carp species, distributed over south Asia [58, 68]. It is highly popular to the consumers due to its oily flesh and taste qualities and having a reasonable amount of protein, minerals and fatty acid [2, 58]. In this manuscripts we highlighted the biology, ecology, induced breeding and growth pattern of *C. reba* with emphasized on the culture prospective using existing technical facilities frequently available for contemporary commercial aquaculture species of Bangladesh. We also pointed out the future research gap while discussing current knowledge available for this species in general.

Fishery of the species

Cirrhinus reba is a commercially important freshwater minor carp (minnows) species belongs to the family cyprinidae under the order cypriniformes [27]. It is commonly known as Reba carp. However, in Bangladesh locally known as Raik, Tatkini, Bata, Bhagna [36] while in India and Nepal recognized as Raichang and Striped carp respectively [22], in Pakistan as Suhnee and Sunee [55]. Roberts [61, 62]. proposed synonym *Bangana ariza* for this species but was not considered as a valid alternative. The natural distribution of this species is Indian subcontinent. It is widely distributed over India [68], Bangladesh [31], Pakistan [52], Nepal [39], Myanmar and Thailand (Fig 1). Though, its distribution in Myanmar suggested by Menon [49] but later it is not confirmed again. In India, it is common in the Gangetic belt of the northern region of the country and also in the Cauvery River of the south. Whereas, in Bangladesh is dispersed in the main river systems and all types of water bodies mostly.

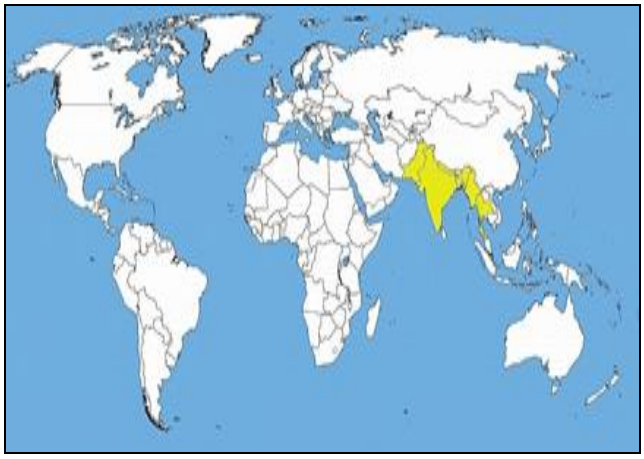

Fig 1: Map showing the natural distribution of *C. reba.*

Morphology and size

C. reba could be identified through their slender body and more slightly more convex dorsal profile than ventral one. Mouth is terminal and snout is slightly projecting, more noticeably in the young fishes. Lips are fleshy, upper lip is fringed in the young, sometimes entire in the adult while a tinny cartilaginous layer is present which shield the lower jaw and possess one pair of barbels. Single short medium dorsal fin with articulated rays originates slightly anterior to the pelvic fin and caudal fin is heterocercal. Cycloid and hexagonal silver scales makes its shiny appearance. However, darkest pigments of scales at the edges forming bluish longitudinal bands above the lateral line. (Fig 2).

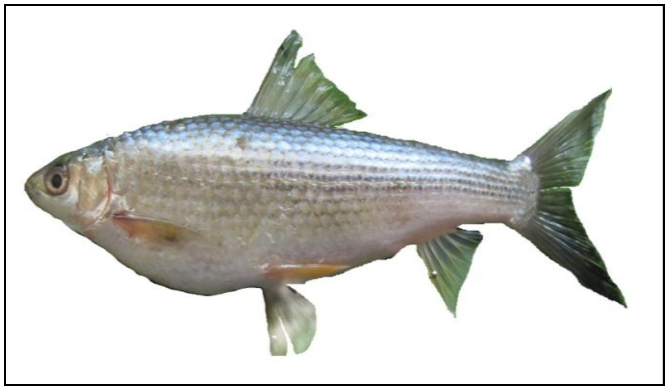

Fig 2: Specimens of *C. reba* caught from Padma River of Bangladesh.

Minimum and maximum sizes of the species in the whole study period were found 8.4 cm and 23.5 cm respectively. Maximum length of this species reported 60 cm by Hamilton (1822); 22 cm by Bhuiyan [9]; 32.5 cm by Rahman [59]; 30 cm by Talwar and Jhingran [68], and 29.3 cm by Hussain [34].Galib [23] measured highest length (23.5 cm) of this species in 2007 in the Chalan bee1 of Bangladesh.

Sexual dimorphism

Male and female *C. reba* can be differentiated easily by observing the external sexual characters developed in the course of maturation and during breeding season. In males the scales on the flanks, nape and anterior dorsal side are rough with sandy texture while in females scales are smooth. In male dorsal side of pectoral fins at the base is rough, the pectoral fins are slightly stouter and longer while in female they are slightly smaller; males are having stout abdomen with elongated, introvert and whitish vent, on slight pressure on the abdomen prior to vent milt oozes out while females are having bulging abdomen with extrovert, fleshy, round and pinkish vent, on slight pressure eggs come out [13]. Size at sexual maturity of male and female *C. reba* were estimated as 11.50 cm total length (TL) and 13.50 cm TL, respectively [13].

Food and feeding habit

The food is the most important and vital need for optimum production of the fish. So, the proper knowledge about food and feeding habit and selectivity is a pre-requisite for successful raising of fish [52]. *C. reba* is a bottom feeder [13, 18, 44]. Its herbivorous feeding habit has been reported by most of the earlier researchers [12, 16, 17, 50, 54,]. It feeds mainly on plankton and detritus [68] but also on mud, vegetables, crustaceans and insect larvae [9]. The young one feeds voraciously on zooplankton and grows very quickly, even faster than the young of catla and mrigal. Feed ingredients mainly composed of algae (10%), higher plants (70%), protozoa (5%), crustaceans (10%) and mud and sands (5%) [54]. Fry of this species exclusively feed on the animalcules and water fleas; while fingerlings consume in the order of preference the vegetable debris, unicellular algae, detritus and mud [7]. Young ones of this species are used to wonder around the column and the surface waters for feeding [13].

Habitat and Ecology

According to Bhuiyan [9], *C. reba* is available in all rivers and clear streams of Bangladesh. Although the fish is rarely available in the eastern part of the country, but it is abundantly available in the western and north western part of Bangladesh [1]. The fish is also found in large streams, rivers, tanks, lakes, reservoirs and inundated fields [49, 54, 68]. Availability of the fish is also recorded in Bookbhara baor [53], Chalan beel [24] and Halti beel [35] of Bangladesh. It is a bottom dweller and prefers to be in the deeper water. They often migrate at all regions of the water body, especially for the purpose of feeding and breeding. The fry and fingerlings are used to move along the surface and column waters [13].

Breeding Season

C. reba is a yearly breeder with a single spawning season limited to south-west monsoons ranging from May to July in Bangladesh and Assam, and June to August in West Bengal with a peak in June [13]. Bhuiyan [9] described in his article from June-September while in another study, Hossain [33] reported breeding season in Bangladesh from June to August.

However, in the latest study Akhter and Akhter [5] stated a long breeding season from April to October/November with spawning peak at June/ July in Bangladesh. In south India, the spawning season starts from the end of May and extends to the end of October with maximum spawning used to take place in the first half of the season [10]. In Cauvery River it breeds from June to September [6], though, later Rao *et al*. [60] reported its breeding season from June to august. On the other hand, Gupta [27] has been reported April to early September as its breeding season in Muzaffarnagar, Uttar Pradesh with spawning in July. According to Mathialagan and Sivakumar [48] the breeding season of *C. reba* is June to August in Tamilnadu with July as the peak spawning month. Lashari *et al*. [44] had been reported a short duration of breeding season for *C. reba* at Sindh, Pakistan from June to August and peak in July. Several studies confirmed that the highest Gonadosomatic index (GSI) weight or percentage of Gonadosomatic index (GSI) weight relative to body weight of for both sex were observed during the peak spawning season (Fig 3). The high variability in spawning time of Reba carp might be due to differences in environmental condition and physiological state of fish. Nevertheless, the exact reason of their inconsistency of spawning season need to focused more as a future research which could help more for the domestication of the species.

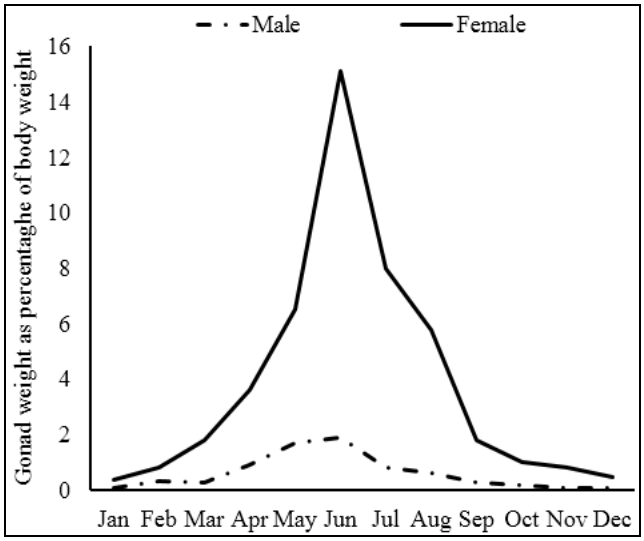

Fig 3: Seasonal variation in gonad weight/body weight of male (broken line) and female (continuous line) *C. reba*. (Adapted from Gupta, 1975).

Fecundity

Fecundity is one of the most important biological aspects of a fish species. This must be known to assess the reproductive potential and to evaluate the commercial potentialities of a fish stock [15]. For efficient fish culture and effective management practices it is prime important to know the fecundity of fish [51]. *C. reba* has been reported as a high fecund fish, fecundity ranging from 22,356 to 4, 37,400 [41] while Lashari *et al*. [44] have documented range of 20,722 to 2, 11,200. Both these researchers found a linear relationship of fecundity with gonad weight and body weight in this fish species. Therefore, fecundity increased with the increasing total length, gonad length, gonad weight and body weight of *C. reba*.

Artificial reproduction

Captive/induced breeding programs have become one of the principal tools used in attempts to compensate for declining fish populations and simultaneously to supplement and enhance yields for fisheries [11]. To get success in captive breeding, proper knowledge on the feeding and reproductive biology of that particular fish species is also required [25]. Captive breeding of *C. reba* has also been tried so far by some researchers. Chaudhuri and Alikunhi [12] and Dutta [21] have experimented induced breeding of this fish species using carp pituitary extract at the doses of 2 mg/kg (primary injection) and 5 mg/kg (secondary injection) of body weight in the females and 2 mg/kg (single dose) of body weight in the males. However, Sarkar et.al. [64] First used the synthetic hormone ovaprim for captive breeding of *C. reba*. Ovaprim was administered in the evening at the rate of 0.5 ml/kg body weight for females and 0.4 ml/kg body weight for males. Chattopadhyay *et al*. [11] have successfully induced bred this fish species using ovaprim at a dose of 0.3 ml and 0.5 ml per kg of body weight in male and female fishes respectively. Previous research showed that artificial reproduction of Reba was successful with the use of inducing agents available at commercial market like other commercially important aquaculture species.

Growth pattern

The length-weight relationship (LWR) is a useful tool for environmental monitoring programs especially for calculating weight at a certain length [45] as well provide information on the condition, growth patterns, ontogenetic changes and population dynamics [57, 66, 67]. It helps to calculate a condition factor which indicate the well-being of the organisms in their habitat where its higher value signalize better conditions for an animal [46]. The condition factor of aquatic organisms can be modulated by e.g. stress, food availability or habitat quality [40]. In case of *C. reba* collected from the Padma river of Bangladesh showed positive algometric growth through LWR, while condition factor was $\geq$ 1.0 which suggested better growth pattern in natural environment [30]. Similarly, other studies in India [47] and Pakistan [55] also indicated isometric growth and wellbeing of *C. reba*. In addition to, the value of condition factor of this species vary on the body shape, sex, individual state and rearing condition like other fish species [32]. However, no data available for growth pattern when cultured in captive condition.

Importance/Commercial value

C. reba is a popular table fish as having high nutritional value with good amount of protein, calcium and low fatty acid content [2, 27]. Even the protein, fat and carbohydrate calories of *C. reba* are relatively higher than those in the Indian major carps [42, 65]. Its flesh contains not much bone and has a good flavor [13]. Due to presence of hexagonal scales over its body surface, it has an attractive appearance and recently has also been documented to be exported from India as indigenous ornamental fish to other countries [26]. It is used as food fish in Bangladesh [23]. Flesh is oily and tasteful and liked by the consumers [59].

Aquaculture potentiality

Farming of the three Indian major carps (IMC), viz. catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*) and the three exotic carps viz., silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*) under composite culture system is in vogue in the

south Asian countries. Again, apart from the exotic carp, inclusion of other species into the IMC based composite culture system has been practiced, such as magur (*Clarius batrachus*), Asian catfish (*Pangasionodon hypophthalmus*), freshwater prawn and small indigenous fish species, often resulting in yield enhancement [37, 38, 43]. However, recent study recommended inclusion of minor carp species in polyculture increase the production significantly and economic return due to 20-30% higher market price than the Indian major carps [14].

Basically, the aquaculture potentiality of any chosen species would depend on the combination of the following: (1) demand (which depends on local preferences and retail prices), (2) the price and availability of, and ideological approach (animal or vegetable) to the sort of feeds needed, (3) the locally available technology, investment level and subsequent production costs, (4) availability and cost of space, water and energy), (5) socially environmental sustainability constraints (e.g. where fish farms dislocate small farmers and fishermen or replace mangrove areas), and obviously (6) general environmental conditions, such as climate, water temperature and quality, predators, pH level in earthen ponds, etc.

In relation to the above mentioned characteristics *C. reba* is a potential aquaculture species in Bangladesh as well as in south Asian countries being having high market demand, good growth pattern, adapt to polyculture systems, good response in artificial breeding, easy larval rearing and high consumer preference.

Conservation

Populations of *C. reba* have been declined recently in their natural habitats due to numbers of reasons like over harvesting, loss of habitat and ecological changes in habitat due to various anthropogenic activities like organic and chemical pollution, flow regulation and fragmentation etc. [3, 4, 36]. First and foremost, information on the present status of the existing natural population of *C. reba* is really essential and in this regard a detail survey is needed to collect the proper information. The existing population of this fish species must be protected by the following measures: (i) suitable sanctuaries establishment in selected areas of rivers, streams, canals, reservoirs, lakes and swampland is suggested [29] (ii) to protect the brood fish, fishing practices must be completely banned during the breeding season; (iii) the factors which are causing the habitat loss for this fish species must be identified and proper initiatives must be taken to conserve its habitat. Finally the conservation of gametes through gene banking should be adopted to conserve the gene pool of the minor carp species to enhance genetic diversity [29, 63]. Apart from all these above listed measures, awareness program also need to be undertaken to inform general people about the problem and then using their willingness and support conservation campaign can be promoted through education and extension programs.

Conclusion

Research on *C. reba* culture has drastically increased over the last few years, greatly extending our current knowledge of this species and promoting a growing interest in the aquaculture industry regarding its potential. Nevertheless, for large-scale culture to become profitable, several very important issues still have to be solved.

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