

Apprehensions and issues related to pacu *Piaractus brachypomus* (Cuvier 1818) farming in India

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Abstract

In India, recently introduced pacu fish farming is picking up fast without envisaging scientific track to promote or regulate it. The unofficially introduced pacu in India is projected to be *Piaractus brachypomus* relying on the identifying characteristics. However, the species available in aquaculture and that in aquarium trade is yet to be scientifically validated. The identification of juvenile fish available at hatcheries, farms and aquarium shops based on morphological features may not be correct particularly when possibility of existing different species of pacu and their interspecific hybrids may exist. Monitoring, risk assessment and identification of the individual species should be scientifically conducted. In India, the farm-raised pacu grows well but its production differs from farm to farm. The fish can utilize diets high in carbohydrates and plant proteins, tolerates poor water quality conditions, varied environments and culture conditions. Breeding of the fish is now well established for its farm raising and propagation yet ornamental value of the fish has also further fascinated aquarium shopkeepers and hobbyists to keep and propagate it in different states of the country. Farm raising, hatchery production and aquarium trading of pacu facilitated inadvertent releases of introduced pacu which has gravitated into several natural water bodies. It is proposed that the available pacu farms and hatcheries need to be urgently registered in view of proper management and scientific regulations on pacu farming. Based on the synthesized and field oriented information presented in this study, there are several apprehensions of adverse ecological concerns and consequences. The issues and concerns of rapid expansion of pacu in the country draws attention of the policy makers and the scientific community to address them keeping in view of the larger interest of the farmers community, society and the environment.

Keywords: Pacu, Aquaculture, Spread, Environment, Invasion.

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Introduction

The so-called fish pacu *Piaractus brachypomus* (Cuvier 1818) was unofficially introduced possibly during 2004 via Bangladesh [1, 2]. As per information available in Fishbase, there are 12 species of pacus [3]. The popular species of pacu are *Colossoma macropomum* (tambaqui), *Piaractus brachypomus* and *Piaractus mesopotamicus*. Red-bellied pacu and black pacu have been reported from India [4]. Nevertheless, *Piaractus brachypomus* (Cuvier 1818) commonly known as pacu, pirapitinga, roopchanda is understood to be available at many of the farms, markets and aquarium shops of Indian states and the fish has got both food and ornamental value. In addition, another pacu like species called piranha is also available which belongs to the family Characidae and subfamily Serrasalminidae belonging to the same group [5]. The morphological information, characteristics and biology of pacus found in India are yet to be scientifically validated. At the juvenile stage, pacu resembles piranha (*Pygocentrus natterii*), but differs greatly in behaviour and feeding habits even though they belong to the same family [2]. Since the boundaries of the country are porous, pacu piracy and unauthorized introductions have been carried out [2] and actually needed scientific information are lacking. The

unofficial culture and breeding of pacu in India has been expanding during recent past causing concern of local fish biodiversity management and encouraging aquaculture for food security. As per reports available, a significant subset of alien species can become invasive and have serious adverse impact on biodiversity and related ecosystem services, as well as have other social and economic impact [2].

Internationally, culture and breeding technology of pacus *Colossoma macropomum* (tambaqui), *Piaractus brachypomus* and *Piaractus mesopotamicus* is now well established and available [6]. However, it is also important to mention that in recent years, hybrids of pacus have also been produced and reported to represent recent advances in aquaculture of pacu [6]. Since three species of pacus *Colossoma macropomum* (tambaqui), *Piaractus brachypomus* and *Piaractus mesopotamicus* are very common at farms and hatcheries in several countries, morphological distinction of such unintentional or deliberate hybrids production from the parents becomes highly unidentifiable, particularly between interspecific hybrids and pure species individuals. It is thus difficult to generate species specific information of the individuals available at the farms and markets. Hybrids pacu can be erroneously identified as pure species in breeding facilities, which might reduce production on farms and

negatively affect native populations due to escapes or stocking practices [7]. These deliberate or unintentional activities of hybrid production if any is considered to be more resistant to varied environmental factors [8]. Further, mislabeling of the existing species may become a cheat to the market and farmers as the hybrids may not be as productive and remunerative for cultivation and aquaculture as that of pure species [6]. Nevertheless, genetic and environmental problems are also foreseen and since different species of pacus are reproductively compatible [6].

The propagule pressure on the pacu fish farming in India is equal for aquaculture as food and also for ornamental keeping [9, 10]. It is quite likely that attempts are in operation or may be made towards creating fancy appearance of the fish through crossbreeding of different species of pacu for value addition especially in ornamental trade. It is therefore, imperative to ensure what species farmers are cultivating and demonstrate authenticity. Absence of monitoring by competent agencies/authorities/scientific organizations, the warnings reported by Hashimoto et al. (2012) [6] based on experience elsewhere particularly in the USA and Asia will be needed towards the implementation of regulatory measures and management endeavours. Keeping in view of the above facts, present scenario on the culture and breeding of pacu in India has been synthesized and presented in this paper. Further, various environmental conditions required for the fish to spread has also been generated so as to make out possible invasions. The instances of inadvertent releases of the fish in different natural aquatic bodies are highlighted besides lessons to be learnt from the other countries to contemplate scientific measures to regulate culture and propagation of pacu in India.

Aquaculture of pacu

Both red-bellied pacu *Piaractus brachypomus* and the black pacu *Colossoma macropomum* have been found to grow well both in the natural environment [11] as well as in captivity. They exhibit excellent characteristics for use in aquaculture [12, 13]. They can:

- reproduce under captive conditions
- thrive low on the food chain
- accept prepared feed
- tolerate hardy conditions
- can easily be handled,
- grow rapidly
- be cultivated in high density
- be marketed and have consumers acceptability
- fetch good price and
- be preferred as food as well as ornamental fish.

They exhibit fast growth, and are able to utilize diets having high in carbohydrates and plant proteins. They are resistance to poor water quality conditions and diseases having good flesh quality. They have high ornamental value and attractive

aquaculture characteristics. Red-bellied pacu, *Piaractus brachypomus*, is though native of Brazil is now introduced to Iran, Colombia, Ecuador, Peru, Venezuela, India Bangladesh, Nepal, Malaysia and Philippines and many more countries. It is cultivated in India, under extensive or semi-intensive type of culture both as monoculture and polyculture [14].

Pacu in India is mostly cultivated in Inland coastal areas of West Godavari and Krishna Districts with low productive soils. In most of the areas, pacu is cultured in combination with mainly rohu (*Labeo rohita*) or even with catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*) at a stocking density of 7000 and 5000 per hectare respectively with total production levels of 12-15 MT/ha [14, 15]. Although *Piaractus brachypomus* is one of the introduced species being cultured in the state of Andhra Pradesh alone in an area of over 1000 hectares, its compatibility with Indian major caprs in mixed/poly culture has not been fully understood. Its culture has now spread in other states such as Maharashtra, Tamil nadu, Karnataka, Kerala, Uttar Pradesh, Bihar, Orrissa and north eastern states [1, 2]. Nevertheless, there is no standard practice of its culture; the farmers are doing it at their own discretions and convenience. The production of the fish varies from farm to farm and overall production in the country is assessed to cross 0.2 million tonnes /ha/year.

Breeding Strategies

The culture and breeding of the fish was begun in the state of West Bengal and gained popularity in Andhra Pradesh [1, 2, 9, 16]. Pacu has been found to attain maturity at 3 years or more with a stocking density of 2,000-2,500 fish/ha at different hatcheries. Today there are over 65 pacu hatcheries existing in different districts of the West Bengal (Table 1). The technology required for the reproduction of pacu through hormonal induction has been well established and widely used [1]. However, the major breeding activities are undertaken in West Bengal while farmers at other places such as Orrissa, Andhra Pradesh, Kerala, northeaster states, Uttar Pradesh etc have also successfully attempted breeding producing pacu seed in a limited numbers. As per report of NBFGR, seed production from West Bengal during the last five years indicated about three fold increase in spawn, fry and fingerlings production in the surveyed hatcheries which were approximately 553 millions, 196 million and 8,4 million respectively [17]. In view of perpetuating farms and hatcheries in the country, there is urgent need to register them in view of proper control and scientific regulations.

Table 1: Information on Pacu hatcheries available in the West Bengal

SI No	Name of District	Names of Blocks	No. of Hatcheries
1.	BANKURA	BISHNUPUR, ONDA	2
2.	BARDHAMAN	MONTESWAR, KALNA-I	2
3.	DAKSHIN DINAJPUR	TAPAN	1
4.	HOOGHLY	BALAGARH	1
5.	HOWRAH	BAGNAN-II	1
6.	JALPAIGURI	MAYNAGURI	1
7.	MURSHIDABAD	BERHAMPORE, NABAGRAM, SAGARDIGHI	3
8.	NADIA	CHAKDAHA, HARINGHATA	3
9.	NORTH PARGANAS 24	AMDANGA, BADURIA, BARRACKPORE-I, BONGAON, GAIGHATA, HABRA-II, SWARUPNAGAR, BASANTI-I, BHANGAR-II, BUDGE BUDGE-I, MOGRAHAT-II	51

Environments

Pacu fish species has been reported to be cultivated in a wide range of latitudes and temperatures [18, 19]. The natural distribution of the fish occurs on a wide range of temperatures ranging from 12°C-15°C up to 27°C [19]. Young ones have been found to survive at temperatures between 20°C and 30°C and at pH 6-8 [20] while the optimal temperature for growth is 23°C-28°C [21]. The fish is also reported to survive in depths of up to 20 m [21] and they are a thermophilic species capable of tolerating low and high chronic temperatures of 16.5°C and 35°C, respectively.

Piaractus brachyomus is highly capable of thriving in various aquatic environments and it is a hardy species, which can rapidly shift its dietary habits. It can survive in degraded environment and at depleted oxygen levels [2]. Adult pacu is highly adaptable to environmental hypoxia however, oxygen concentrations below 4 mg/L severely impacted survival of embryos [22]. The abrupt transfer of the fish from freshwater to slightly saline water and the return to freshwater did not affect the survival rates and the survival was found to range between 89 to 97%. The larvae can also quickly adapt saline environments and abrupt changes in salt concentration [23].

Invasion risks of Pacu in natural water bodies

Introduction of fish species is a globally widespread practice that is now serious consideration as such practices cause losses to native species and homogenization of diversity within and across continents [2]. In Florida, pacu was first observed in the wild during the 1960's and initially the pacu population was thought to be non-breeding and existed only as the escapees of residential aquariums and hence non-invasive. However, they later on colonised and today they are everywhere, from

South Florida canals, to Lake Okeechobee and through-out most of the continental United States .

Invasions of red-bellied Pacu populations have further been reported from many other countries such as Philippines, Iran, and Hungary etc. Pacu being South American native fish has been reported to occur near Yuma, Arizona in June 2006 and in New Jersey in June 2015 [24]. The occurrence of pacu has also been reported in Denmark, Michigan and other places. However, invasiveness of the species has yet to be determined. So far as the ecological issues are concerned, there is a report from Papua New Guinea in 2011, where incidence of two human deaths was reported due to Pacu attack by biting off the testicles of fishermen [25]. The species possesses a powerful dentition that can also cause serious bites to humans and other aquatic organisms and damage to fishing nets such as gill and cast nets as reported in the reservoir of Pune, India [2]. Some of the reports available from different countries where pacu were introduced and escaped into natural aquatic bodies are presented here so as to understand possible risks of its culture and propagation keeping in view of the international scenario:

Philippines

The Brazilian red-bellied pacu, has been found to adapt very well in ornamental aquarium fishes in the Philippines and also food fish after its introduction during 1980s. The fish can now reproduce in captive conditions and be cultured in ponds for use as an ornamental fish [26]. It is an expensive ornamental fish in the Philippines. The red-bellied pacu can spawn naturally in riverine condition however technique of artificial spawning using hormone is also practiced there. The production of red-bellied pacu is although confined in aquaculture ponds yet incidences of its occurrences in natural water bodies have been reported [26].

Pacu is although a plant eater, it is also molluscivorous. It has been found to control the abundance of the golden apple snail *Pomacea canaliculata* in simulated rice field in screen house condition. The molluscivorous feeding habit may be considered as a potential invasive character when the fish may impact on native mollusks such as the native snail *Pila conica* and freshwater clam *Corbicula manilensis*.

Iran

The red-bellied pacu, *Piaractus brachyomus* has also been reported to invade in Iran [27]. Two specimens of 177 mm (Standard Length) long pacu were captured from Zarivar Lake in October 2015 and January 2016 [27]. However, it could not be determined how this exotic fish species reached the lake nor the scientists could determine its actual abundance [27]. Nevertheless, the aquarium trade, which is though, a very small business is blamed for its inadvertent releases in the lake. The incidental releases by aquarium hobbyists and aquarium trade has been responsible for the introduction of *P. brachyomus* into the natural waters. Most exotic fish species introduced into the Zarivar Lake has been found as a result of unmanaged aquaculture by the Iranian Departments of Fisheries and Environment and Marivan's Fishing Cooperatives [27].

Hungary

A piranha-like fish has been reported to be captured from a natural water body in north eastern Hungary in 2016. The captured specimen was examined based on the morphological appearance and the teething patterns of the fish. It was identified as a member of pacus (Serrasalminidae family). Since three pacu species, *Piaractus brachypomus*, *P. mesopotamicus* and *Colossoma macropomum*, are common species available in Hungary in the aquarium fish trade, characteristics of the studied invaded specimen were when compared with their relevant morphological data of the three species and also from the literature it was found to resemble most closely with *Piaractus brachypomus*. The captured specimen from natural aquatic body was confirmed as the pirapitinga *Piaractus brachypomus* (Cuvier, 1818) [28].

India

Occurrences of red-bellied pacu in India have been recorded from several natural aquatic bodies raising alarms and concerns of scientists. It is reported to occur in the Vellayani, the second largest freshwater lake in Thiruvananthapuram district of Kerala State in the southern part of Western Ghats region [29]. Presence of pacu has also been reported from Pamba River in Kerala, which is known for its inland fishery resources and great biodiversity [30]. Zeena and Beevi (2014) [31] reported captures of pacu from Muvattupuzha River, Kerala. The occurrence of *Piaractus brachypomus* has also been interestingly reported from the Vembanad Lake. The Vembanad Lake is the largest coastal lagoon on the southwest coast of India with a catchment area of 14500 km² drained by seven rivers which are the Chalakudy, Periyar, Muvattupuzha, Meenachil, Manimala, Pamba and Achankovil, along with a large number of canals originating and flowing through Western Ghats. The region is known as one of the 34 global biodiversity hotspots of the world [32]. Presence of red-bellied pacu *Piaractus brachypomus* has also been reported from Krishna and Godavari rivers of Telangana [33, 34].

Conclusion

Some of the recent reports on the incidents of inadvertent releases of pacu that gravitated into natural water bodies especially in the biodiversity rich areas in India are definitely considered as serious concern and are alarming in response to the heedless interventions of the aquaculturists and emanating environmental changes. The pacu introduction in India has not been scientifically evaluated and hence its invasiveness still remains a query. A plastic diet, large body size and longevity (up to 70 cm SL and 28 years [35] and the capacity to achieve large local abundances and wide distributions, are some of the characteristics that support the invasive characters of the species [2]. Whatever may be the scenario, established self-sustaining populations *P. brachypomus* have not been recorded so far due to the low frequency of individuals occurring in natural bodies. Nevertheless, there is a great possibility that a gradual release of these long-living fishes provides favourable conditions for growth, spawning, and establishment. The issues and concerns of possibilities of adversities on the biodiversity

and ecosystem services attract serious attention of the policy makers and the scientific community to address them looking into larger interest of the farmers community, society and the environment.

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