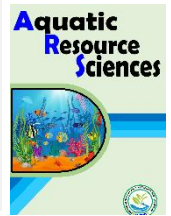




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Threatened Species Series

Threatened fish of the world Garua Bachcha, *Clupisoma garua* (Hamilton, 1822): Recommendations for Sustainable Conservation

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ABSTRACT

The *Clupisoma garua*, a threatened species which has high nutritional value, faces significant threats to its survival, primarily due to habitat loss and overfishing. This study offers a comprehensive overview of the species' and discussed current conservation efforts and offered a list of recommendation for the species sustainable management and conservation. Key aspects covered include taxonomy, morphology, distribution, habitat, feeding habits, reproductive biology, and genetic diversity. The findings underscore the urgent need for conservation measures, including habitat protection, sustainable fishing practices, and captive breeding programs. To enhance the survival prospects of this species, it is essential to understand the threats it faces and implement suitable conservation measures. Raising awareness of the species ecological significance can also help to ensure that it continues to exist for future generations.

Introduction

Clupisoma garua (Hamilton 1822), known as Garua Bacha or Garua Catfish belongs to the order Siluriformes and the family Schilbeidae. Generally, it is thoroughly dispersed among the South Asian region (Rahman 1989, 2005). *C. garua* is a species of freshwater fish which have a significant commercial value (Saraswat 2014) have a high market demand (Verma and Serajuddin 2017) and it is widely utilized as a food fish due to its boneless nature, excellent flavor and nutrient properties (Talwar and Jhingran 1991).

However, its population has drastically decreased, especially in Bangladesh and northern India because of overfishing, pollution, and habitat change though in some untouched regions, such as sections of the Brahmaputra River in Assam, India, where water quality is better preserved, the species is still reasonably numerous (Chakraborty and Chakraborty 2021). *C. garua* is listed as an endangered species which indicates that it facing a very high risk of extinction in the wild due to overfishing particularly during breeding seasons siltation and aquatic pollution (Nabi 2015; IUCN Bangladesh 2015).

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Several studies on *C. garua* have been conducted including those on length–weight relationship, reproduction, genetic characterization, condition factor, fecundity and gonadal development, morphology, anatomy, sex ratio, stock structure as outlined in Table 1. There is still lack of thorough research and documentation on *C. garua*, despite the species' ecological value in Bangladesh. The creation of efficient management and conservation plans is hampered by this disparity. Thus, the purpose of this publication is to provide a framework for the development of suitable conservation and management plans for *C. garua* in Bangladesh.

Morphological characters

This kind of fish has a thin, flattened body. There are not any scales on the body. The abdominal contour between the pelvis and the vent is keeled. The head has a rounded nose, is blunt, round, and medium in size (Rahman 1989). The fish features a distinct morphology with large, round adipose eyelids positioned partially on the bottom of the head and a sub-terminal mouth. The nasal barbels do not contact the eyes, while the maxillary barbels extend to the base of the pelvic fins. Both pairs of mandibular barbels reach the pectoral fins. In adulthood, the adipose dorsal fins are absent, although they are narrow and

Table 1: Available studies on different aspects of *Clupisoma garua* from worldwide waterbodies

Aspects	Habitat/country	References
Condition factor and health condition	Old Brahmaputra River, Bangladesh	Sultana et al. (2022)
A comprehensive impression	Bangladesh	Ullah (2022)
Fecundity and gonadal development	Old Brahmaputra River, Bangladesh	Hasan et al. (2020)
Impact of gonad weight on length–weight relationships	Old Brahmaputra River, Bangladesh	Akter et al. (2019)
Temporal variations of sex ratio and growth pattern	Ganges river, Bangladesh	Hossain et al. (2019)
Microscopic anatomy	Indus river, Pakistan	Pasha et al. (2019)
Morphometric and meristic	Ganga river, India	Biswas et al. (2018)
Stock structure	Coastal zone, Bangladesh	Nahar et al. (2017)
Variation in the life history traits	Coastal zone, Bangladesh	Siddik et al. (2017)
Genetic characterization	India	Sarawat et al. (2014)
Phylogeny based on truss Analysis	India	Verma et al. (2012)
Length–weight relationship	Betwa and Gomti river, India	Sani et al. (2010)
Modes of reproduction	New Jersey	Breder and Rosen (1966)

Taxonomy

Kingdom: Animalia

Phylum: Chordata

Class: Actinopterygii

Order: Siluriformes

Family: Ailiidae

Genus: *Clupisoma*

Species: *Clupisoma garua*

Synonyms

Silurus garua (Hamilton 1822)

Schilbeichthys garua (Hamilton 1822)

Clupisoma argentata (Swainson 1839)

Silurus argentata (Swainson 1839).

rugose at the front and weakly serrated at the back. Additionally, the pectoral fin contains a strong serrated spine, which does not extend to the pelvic fin. Long fins make up anal fins. The caudal fin is made by a deep fork. According to Talwar and Jhingran (1991), the back of the animal has a silvery grey color, while the sides and belly are paler and fins are grey (Fig. 1).

D. 1/7; P1. 1/11; P2. 6; A. 3/27-30 (Rahman 1989).

D. 1/7; P1. 1/11; P2. 1/ 5; A. 3/ 26-33; (Talwar and Jhingran 1991).

D. 1/7; P. 1/11; P. 6; A. 3/ 26-33; C. 17; (Mawa et.al. 2021).

Common name

Ghaira, Gang ghaira and Ghaura in Bangladesh (Rahman 1989); Kocha, Neria, Garua, Puttoshi,

Gaurcha, Ghero, Bachawa, Gharua, Buchua, Chelle, Gajari, Punia-cathua in India (Talwar and Jhingran 1991); Jalkapur, Baikha in Nepal (Shrestha 2008; Shrestha 1994); Chel-lee, Ka-raad in Pakistan (Misra 1976); Sillimomni in Finland (Varjo et al. 2004).

et al. 2024). Diatoms, green algae, blue-green algae, and debris were the most abundant plant matter in winter, whereas diptera was the second most popular food item. It consumes tiny fish, insects, and detritus (Mackey 1979).

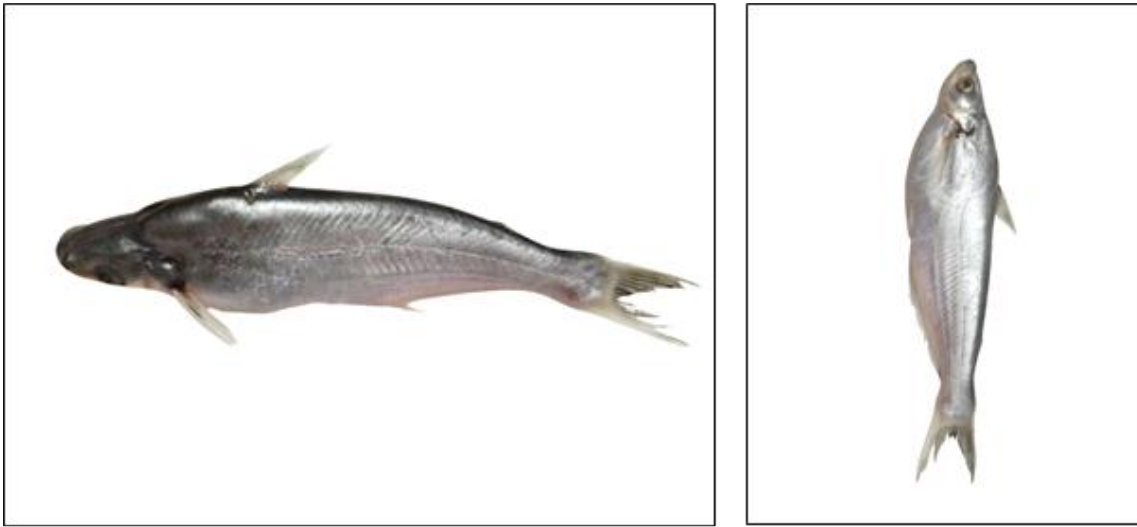


Fig. 1: *Clupisoma garua* collected from the Ganges River in Bangladesh.

Distribution and Abundance

The freshwater catfish *C. garua* inhabits the swift-moving, oxygen-rich waters of major rivers in India, Bangladesh, Nepal, and Pakistan, including the Ganges, Brahmaputra, and Indus. (Chakraborty et al. 2014; Rahman 1989 2005). This species typically prefers freshwater habitats but is occasionally found in brackish waters, primarily inhabiting large floodplain wetlands, rivers, and estuaries, which facilitate its migration and feeding. *C. garua* population densities are influenced by seasonal variations; higher numbers are typically observed during the monsoon season when river systems are more linked and provide access to a wider range of feeding and breeding locations. It may live at various depths depending on the circumstances, even though it is at the bottom (Tripathi et al. 2024).

Food and Feeding Habits

According to Tandon and MS (1972), *C. garua* is an omnivorous catfish that mostly feeds along the banks and floor of rivers. Due to their lack of consumer choice, they consume whatever is offered in their surroundings (Agarwal and Tyagi 1969). *C. garua* is classified as a member of the euryphagous fish family by Nikolsky et al. (1964). The gut analysis revealed that the fish are highly carnivorous, with Coleoptera forming a significant share in the gut content (Tripathi

Nutritional Profile

Bangladesh is home to the freshwater fish *C. garua*, also referred to as Garua Bachcha. Recently, Ullah (2022) looked at the fish's gross energy value and biochemical makeup which indicates that *C. garua* is a good source of protein, with a protein content ranging from 17.20% to 18.40%. Additionally, there are two essential fatty acids that are beneficial to the heart: omega-3 and omega-6. The energy content of *C. garua* was found to range from 76.40 to 77.57 Kcal. Comparative nutritional profile of *C. garua* are mentioned in Table-2.

Growth pattern

The growth pattern of *C. garua*, as presented by various studies, is shown through specific growth parameters like length (cm), a and b as regression parameter of LWRs, sex, and coefficient of determination (r^2). Sani et al. (2016) reported the fish length ranges from 5.4 cm to 36.6 cm in total length (TL), with growth parameter $a= 0.0056$ and $b= 3.1$ indicates positive allometric growth pattern with the coefficient of determination (r^2) is 0.98. Similar growth pattern also observed by Ray et al. (2022) with an r^2 value of 0.962, indicating a strong relationship between length and weight. However, negative growth pattern also observed by many researchers in different waterbodies which are mentioned in Table-3.

Table 2: Nutritional Profile of *Clupisoma garua* (Garua fish)

Nutrient	Amount (per 100g)	
	Nath and Banerjee (2012)	Sarma et al. (2019)
Energy	92 kcal	-
Proximate composition		
Protein	18.3 g	20.88g
Fat	1.2 g	2.91g
Moisture	-	75.36g
Ash	-	0.82
Saturated Fat	0.25 g	-
Monounsaturated Fat	0.34 g	-
Polyunsaturated Fat	0.26 g	-
Omega-3 Fatty Acids	0.08 g	-
Omega-6 Fatty Acids	0.18 g	-
Cholesterol	65 mg	-
Carbohydrates	0 g	-
Minerals		
Calcium	47 mg	407.30mg
Iron	0.8 mg	13.38mg
Magnesium	29 mg	-
Phosphorus	185 mg	-
Potassium	285 mg	474.96mg
Sodium	59 mg	128.37mg
Zinc	0.7 mg	6.31 mg
Manganese	-	1.32 mg
Vitamins		
Vitamin A	45 µg	-
Vitamin D	12 IU	-
Vitamin B12	1.5 µg	-
Folate	9 µg	-

Form factor

We calculated the form factor by using the formula $a_{3.0} = 10^{\log a - s(b-3)}$ (Froese 2006), where a and b represent the LWRs' regression parameters and s represents the slope of $\log a$ vs. b . A mean slope (s) of -1.358 was used for the regression analysis of $\log a$ vs. b . According to Table 3, the computed form factor ($a_{3.0}$)

indicates a moderately elongated body shape.

Reproductive Biology

The reproductive biology of the freshwater catfish *C. garua* is greatly impacted by environmental elements such as seasonal flooding and water quality. The species spawns during the rainy season, which

Table 3: Growth Pattern of *Clupisoma garua* (Garua Fish)

Habitat locality	Total length (cm)	a	b	sex	r^2	References	$a_{3.0}$
Gomti River	5.40-36.60	0.0056	3.1	unsexed	0.98	Sani et al. (2016)	00077
River Ganga	6.20-34.20	0.0900	3.12	unsexed	0.96	Ray et al. (2022)	0.1310
Southern coastal region, Bangladesh	8.60-25.20	0.0091	2.96	male	0.99	Siddik et al. (2017)	0.0080
	8.80-20.80	0.0101	2.89	female	0.98		0.0072
Ganges river of north-western Bangladesh	3.80-25.90	0.0150	2.71	Male	0.97	Hossain et al. (2019)	0.0061
	3.90-26.30	0.0118	2.80	Female	0.98		0.0063

TL, total length; a , intercept; b , slope; CL, confidence limit for mean values; r^2 , coefficient of determination

typically lasts from June to August, when rising water levels provide favorable breeding conditions (Rahman 1989). During this time, the fish migrate upstream to shallow, protected areas with sandy or gravelly substrates and submerged plants to safeguard their eggs and young (Khan et al. 2015). In *C. garua*, females exhibit group spawning behavior by producing thousands of small, sticky eggs that sink to the bottom and stick to substrates until they hatch. The larvae remain at the spawning site after being first fed by their yolk sacs before dispersing throughout the river system. (Rahman 1989).

The breeding season of *C. garua* occurs from April to September, with the peak spawning period taking place in June and July (Table-4). Hasan et al. (2020) observed that the scatter plot of the SL with corresponding GSI revealed that the length at maturity (L_m) for females was attained in 17.1 cm of standard length (SL). In contrast, Hossain et al. (2024) reported that most female *C. garua* had a considerable rise in GSI, MGS ($< 1.0\%$), and DI (< 0.08) at about 14.30 cm TL. As a result, 14.30 cm in length may be deemed the L_m for this species. They also reported that the L_m of *C. garua* was determined to be 15.18 cm (95% CL = 11.86–19.37 cm) in TL depending on the L_{max} . L_m of *C. garua* from different waterbodies are mentioned in Table-5. Fecundity ranged from a minimum of 6159 oocytes to a maximum of 22,166 oocytes (Hasan et al. 2020).

Table 4: Spawning Period of *Clupisoma garua* (Garua Fish)

Waterbodies	Period	References
Padma River, Bangladesh	May to August (peak: June and July)	Hossain et al. (2024)
The old Brahmaputra River, Bangladesh	May to August with a peak in June	Biswas et al. (2018)
Ganga, Gomti, Ramganga, Ghaghara, Betwa, Sone of Ganga basin, India	April–August	Praveen et al. (2017)
The Ghaghara River, India	June–July	Mishra et al. (2013)
Amaravathy River, Tamil Nadu, India	August–September	Arthi et al. (2013)
Kulgarhi Reservoir, India	July–August	Rao and Karamchandani (1986)

Genetics

According to Arkhipchuk (1999), *C. garua* possesses diploid (2n) chromosome number 56. But Vasil'ev (1980) reported diploid (2n) chromosome number 66. The cytochrome b gene and the D-loop region are two examples of mitochondrial DNA (mtDNA) markers that have been used in research on the genetic diversity

and population structure of *C. garua* to assess genetic variation within and between populations (Saraswat et al. 2014). According to Nath et al. (2014), geographical obstacles and habitat degradation significantly impact gene flow, leading to notable genetic differences among populations. Fish variation has been identified at both the intraspecific and interspecific levels using distinct mtDNA gene sequences.

Threats

Research indicates that pollution, overfishing, and habitat degradation pose significant threats to the *C. garua* population in many areas. Dams, water diversions, and urbanization cause hydrological changes that fragment populations and disrupt essential breeding sites, making it difficult for them to migrate to more suitable habitats (Singha and Lakra 2011). Furthermore, the species is targeted for its commercial value, and overfishing particularly in Bangladesh and India aggravates population declines (Chakraborty et al. 2014). Climate change also poses serious challenges by altering water temperatures, flow patterns, and rainfall distribution, which affect food availability and mating cycles.

Conservation Status

C. garua is widespread and common in its native environments. The species is classified as endangered in Bangladesh (IUCN Bangladesh 2015) due to

potential threats to its habitats and a continued decline in population. In India, it is classified as vulnerable (Lakra et al. 2010; Mouler and Walker 1998). There have been reports of population declines from their native habitat in a number of areas of the range nation (Bhokta and Solanki 2020). In addition, Biswas et al. (2018) confirmed that, besides overfishing in range

nations, the primary causes of population reduction include habitat loss, human activity, climate change, pollution, siltation, and overexploitation.

Conservation action

Table-5: List of minimum size at sexual maturity (L_m) of *Clupisoma garua* from different waterbodies

Waterbodies	Sex	L_{max} (cm)	L_m (cm)	References	Estimated L_m (cm)
Betwa and Gomti River, India	Unsexed	36.60	20.55 TL	Sani et al. (2010)	
Coastal region, Bangladesh	Combined	25.20	14.60 TL	Siddik et al. (2017)	
Ganga River, India		24.40	14.18 TL	Biswas et al. (2018)	
Old Brahmaputra River, Bangladesh	Male	18.90	-	Akter et al. (2019)	11.22
	Female	27.80	-		15.97
Old Brahmaputra River, Bangladesh	Female	27.80	17.1 SL	Hasan et al. (2020)	
Ganga River, India	Combined	44.6	-	Gopesh et al. (2021)	24.63
Ganges River, Bangladesh	Female	26.30	15.18 TL	Hossain et al. (2024)	

Due to the species' susceptibility to pollution, overfishing, and habitat degradation, conservation efforts for *C. garua* have focused on community-based resource management, sustainable fishing practices, and habitat protection (Campos-Silva and Peres 2016). In Bangladesh, sanctuary fisheries are a great way to preserve the country's native fish stocks (Khan et al. 2018). Since 1960, the Bangladeshi government and various non-governmental organizations (NGOs) have established numerous fish sanctuaries around open water bodies. There are 464 fish sanctuaries in the country, covering a total area of 1745.61 hectares (Ali et al. 2009). These sanctuaries have contributed to the survival of *C. garua* and other inland open water fish by providing safe habitats for feeding, spawning, and nursing.

Conservation Recommendation

The importance of conservation efforts to sustain fish populations is increasingly recognized in areas where damming and other infrastructure developments have disrupted river connections, affecting migratory routes essential to their life cycle (Rahman 2005; Sarkar et al. 2018). To support the survival of *C. garua*, conservation activities should focus on pollution management, regulation of fishing practices, and habitat protection (Yan et al. 2021).

Preserving riparian habitats and maintaining natural river flow regimes are crucial for ensuring the survival of breeding and feeding grounds. The decline in populations could be mitigated through the establishment of protected areas and zones that prohibit fishing during breeding seasons (Hossain et al.

2015). According to Rahman et al. (2012) *C. garua* is found in rivers all across South Asia and is significant both ecologically and economically. Since overfishing, habitat degradation, and water pollution are the main

risks to this species, conservation efforts should concentrate on reducing these issues. Excessive harvest can be avoided by establishing fishing limits, such as size and seasonal limitations. Additionally, community-based awareness campaigns that encourage local fishermen and communities to adopt sustainable fishing practices could help alleviate the pressures of overfishing. Lastly, since water contamination adversely affects the health and reproduction of *C. garua*, it is essential to enforce stringent pollution control measures in riverine systems (Rahman et al. 2012).

To preserve this species' survival, habitat conservation measures including preserving water flow and lowering industrial and agricultural effluents are crucial. Furthermore, raising public awareness and encouraging community-based fisheries management can strengthen conservation initiatives. To better inform policy choices and enhance conservation results, further study on the biology, population dynamics, and migratory behavior of the species is essential.

In Connection to the Sustainable Development Goals (SDGs)

The Garua Bachcha, a threatened fish species, is under threat from overfishing, habitat loss, and environmental changes. Its conservation is crucial for biodiversity and aligns with several Sustainable Development Goals (SDGs). These goals include SDG 14: Life Below Water, SDG 12: Responsible Consumption and Production, SDG 13: Climate Action, SDG 6: Clean Water and Sanitation, and SDG

17: Partnerships for the Goals. By promoting sustainable fishing practices, reducing overfishing, mitigating climate change impacts, and fostering collaboration among governments, NGOs, and local communities, conservation strategies can help ensure the survival of this threatened species.

Conflict of Interest

There is no competing interest that might influence the research work.

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