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REVIEW ON DISTRIBUTION, CULTURE PRACTICES, FOOD AND FEEDING, BROOD DEVELOPMENT AND ARTIFICIAL BREEDING OF SEABASS, *Lates calcarifer* (Bloch 1790): BANGLADESH PERSPECTIVE

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A B S T R A C T

Seabass, *Lates calcarifer* (Bloch 1790) is an euryhaline and a popular fish in south and southeast Asian countries due to its higher growth rate, giant size, excellent taste and higher market demand. It is locally known as Bhetki or Koral and available around the year in the estuarine and coastal regions of Bangladesh. In many countries (e.g. Australia, India, Malaysia, Philippines, Thailand etc.), the species is artificially propagated and commercially cultured. The breeding technology has not yet been developed in Bangladesh. Now a days Bangladesh is progressing day by day in freshwater aquaculture but it is far behind in case of coastal and mariculture. To get the mass seed production of fry/fingerlings of seabass, we need to develop the artificial breeding technology of the said species. There are only a few studies published on biology, aquaculture, brood development and artificial breeding activities of seabass in Bangladesh where investigators used live feed (Tilapia) and small indigenous fish species (SIFS) on brood development in captivity but none could adapt to formulated feed on seabass aquaculture. Some researchers made attempt to develop seabass broodstock for artificial breeding purpose, but none can success in captive condition in Bangladesh. Only one breeding trial conducted by stripping method using wild brood, but the development of the fertilized eggs ceased attaining up to the *neurola* stage.

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INTRODUCTION

Seabass (*Lates calcarifer* Bloch, 1790) is one of the important food fish of the family Latidae found in the estuarine systems on the coast of Bay of Bengal, Bangladesh (Rahman, 1989). This species is known by various common names in different parts of its range, including “barramundi” in Australia and “Bhetki/Koral” in Bangladesh and India (Siddik *et al.,* 2016). They are highly valued fish taken mainly by artisanal fishermen for food and sport. Due to its high market value, it has turned into anappealing item of both large and small-scale aquaculture companies. Evidence shows that the *L. calcarifer* has been recorded as a catadromous species, inhabiting rivers before returning to seawater to spawn, as well as protandric hermaphrodite, shows one of the most complicated life histories among fishes (Moore, 1979; Moore and Reynold, 1982; Vij *et al.,* 2014).
Sea bass is also widely distributed across the Indo-West Pacific region, including Bangladesh, India, Pakistan, Myanmar, Sri Lanka, Malaysia, Indonesia, the Philippines, Papua New Guinea, the Persian Gulf, Northern Australia and Southern China. (Al-Noor *et al.,* 2012; Siddik *et al.,* 2016; Vij *et al.,* 2014). From an aquaculture perspective, it is an important fish species. Farming began in Thailand in the 1970s, followed by rapid spread to Singapore, Malaysia, Indonesia, China, Brunei, Hong Kong, China, Saudi Arabia and Australia (Chou and Lee,1997; Frost *et al.,* 2006; Zhu *et al.,* 2006). It is a hardy species that can tolerate crowding and has significant physiological changes, high fertility (Mukhopadhyay and Karmakar, 1981). Seabass culture based on supplementary feed conducted by using different types of feeds like trash fish, crustacean pellets, formulated feed, and live food (Corre and Hassan, 1995; Biswas *et al.,* 2010; Boonyaratpalin *et al.,*1998; Bermudes *et al.,* 2010).

In Bangladesh, a preliminary study was conducted on the tilapia and seabass polyculture system (Hossain *et al.,* 1997) under wild seabass juvenile exploitation. In addition, researchers focus on seabass artificial breeding and culture technology, as well as their brood stock nutrition, to get quality fish fingerlings in Bangladesh. However, comprehensive knowledge of seabass biology, breeding and current aquaculture status in Bangladesh remains scarce and unidentified. In this paper, the distribution, lifecycle, food and feeding habits, brood development, breeding trial and aquaculture aspects of seabass in Bangladesh are discussed.

DISTRIBUTION OF SEABASS IN BANGLADESH

Seabass is a shallow water fish. The entire fishing of the *Lates calcarifer* is confined to the coastal waters and tidal rivers of Bangladesh. Their distribution does not extend to deep sea and is limited to 40-60 nautical miles from the shore. In Bangladesh, this fish is available in Naf river estuary of Teknaf Hossain *et al.,* (1998), Bakkhali river estuary of Cox’s Bazar (Hossain *et al.,* 1998; Das, 2000), Chakaria (Hossain *et al.,* 1998; Monowar *et al.,* 2013), Karnafully river estuary of Chattagram (Karmaker and Das, 2000), Feni river, Sandwip, Char kukrimukri, Char chapli, Galachipa, Urir Char and Hatiya, (Quddus and Shafi, 1983), Barisal, Patuakhali and Khulna (Rahman, 1989), Rupsha and Shibsha river near Khulna (Kamruzzaman, 2013), Bagerhat and Satkhira (Siddik *et al.,* 2016). The common habitats of *L. calcarifer* in Bangladesh are shown in Figure 1.

ECOLOGICAL DISTRIBUTION

Sexually mature fish are found in the mouths of the river and in the coastal area where salinity and depth range between 30-32 ppt and 10-15 m, respectively (Huda *et al.,* 2003). The newly hatched larvae (15-20 days old or 0.4-0.7 cm) are distributed along the coast of the brackish water estuaries, while the 1-cm larvae can be found in freshwater bodies such as rivers, canals, river side submerged areas etc. Under natural conditions, seabass grows in fresh water and migrates to more salt water for spawning (Kamal *et al.,* 2018). Adults and juvenile fish have territorial behavior, and migration is seasonal. The species is considered tropical, tolerant to temperatures from 15 ° to 40 ° C (Katersky and Carter, 2005).

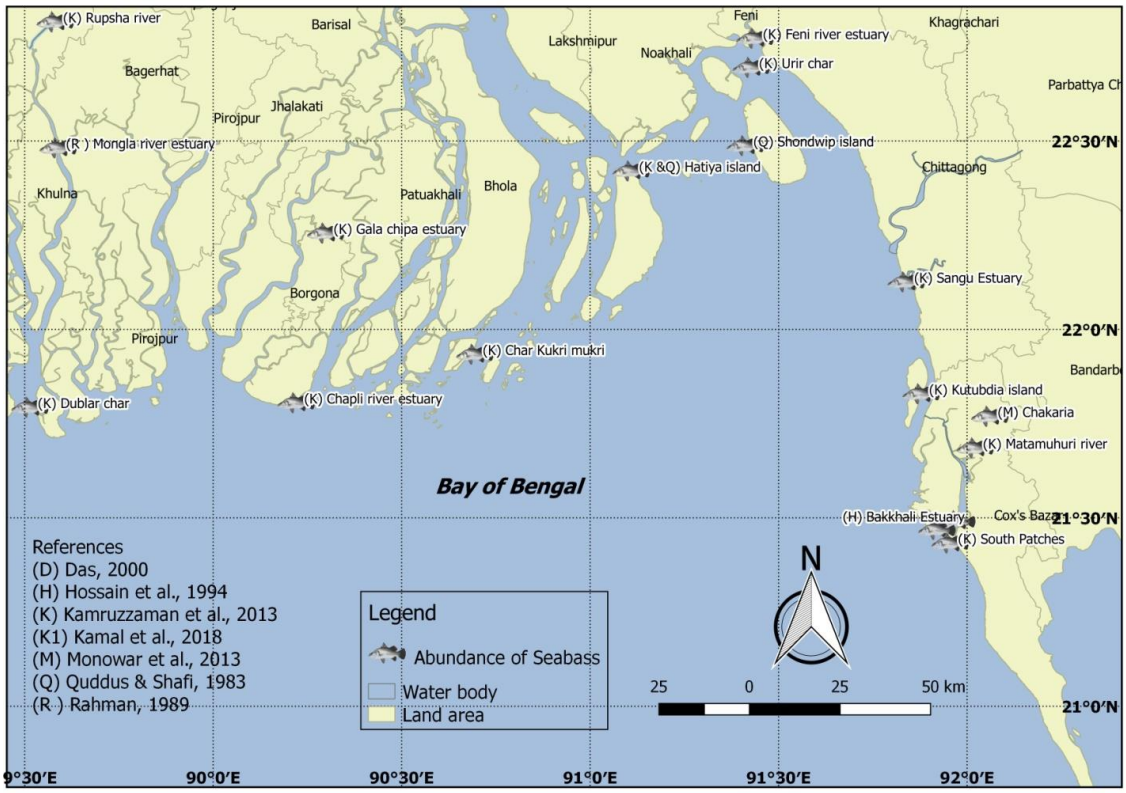

Figure 1. Seabass (*L. calcarifer*) distribution in the coastal region of Bangladesh

SEABASS LIFECYCLE IN BANGLADESH

Identification of the sexes is difficult except during the spawning season, the adult male and female seabass is shown in Fig 2. Seabass spends 2-3 years in freshwater areas i.e. rivers or lakes which are connected to the sea for its developing. It has a quick growth rate, regularly achieving a size of 3-4 kg within 2-3 years. Adult fish (3-4 years) move from fresh waters to the mouth of the river into the ocean, where salinity ranges from 28-31 ppt for gonadal development and resulting spawning (Moore, 1982; Davis, 1985). Several authors have described sea bass as an annual breeder with a single peak spawning (Patnaik and Jena, 1976; Kowtal, 1977; Russell and Garrett, I983, 1985; Davis, 1985. In Chilka Lake, India, Jhingran and Natarajan (1969) observed two spawning peaks. In Bangladesh, single peak spawning was observed, seabass spawned during the transitional monsoon from late April to early June Das (2000). The spawning season and duration vary from place to place, but breeding is synchronized with the wet season so that larvae can take advantage of the aquatic habitat resulting from rain, which provides a food-rich, predator-free environment for the development of young fish. (Moore, 1979; Davis, 1985). Seabass has been observed as a surface spawner (Moore, 1980). However, the fish spawn according to the lunar cycle (usually at the beginning of the new moon or full moon) in the late evening (1800-2000 hours) habitually synchronized with the incoming tide (Das, 2010). This enables the eggs and hatchlings to drift into estuaries and mangrove areas, mudflats and floodplain lagoons. Here, larval development takes place, after which they migrate upstream to grow. At present, it is not known whether the spent fish migrate upstream or spend the rest of their life in the marine environment (Das, 2010). Based on available information, a generalized conceptual model of the life history of seabass in Bangladesh is shown in Figure 3. The movement of fish to spawning areas and the maturation of gonads is triggered by an increase in water temperature at the end of the dry season (Haroon *et al.,* 2005). During the wet season, catadromous migration is observed where the fish migrate downstream to shallow mudflats in estuaries.

Figure 2. Adult male and female seabass *(L. calcarifer)* in Bangladesh

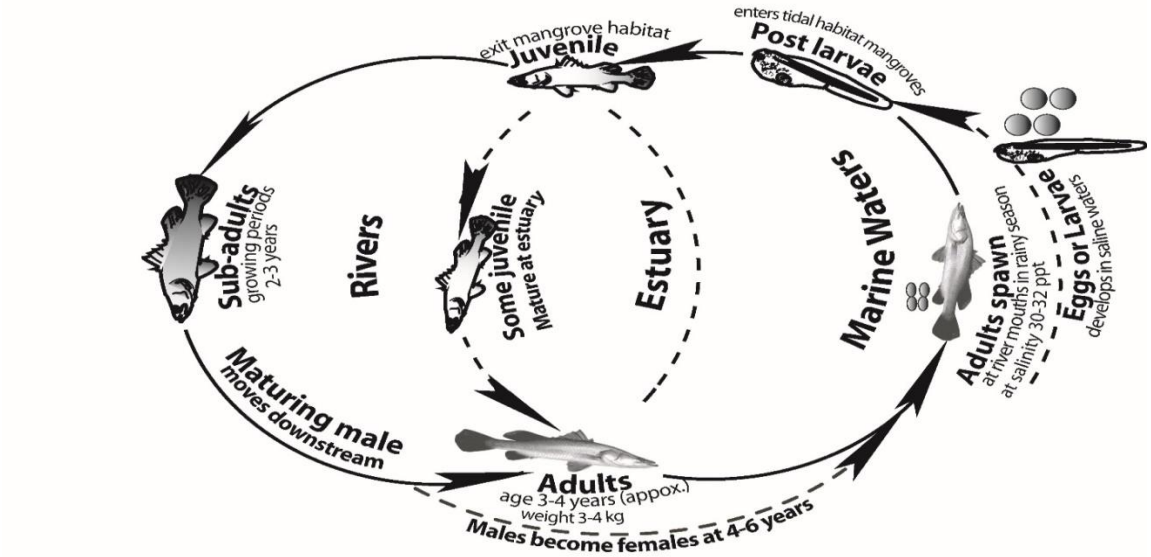

Figure 3. A schematic life cycle of *L. calcarifer* in Bangladesh

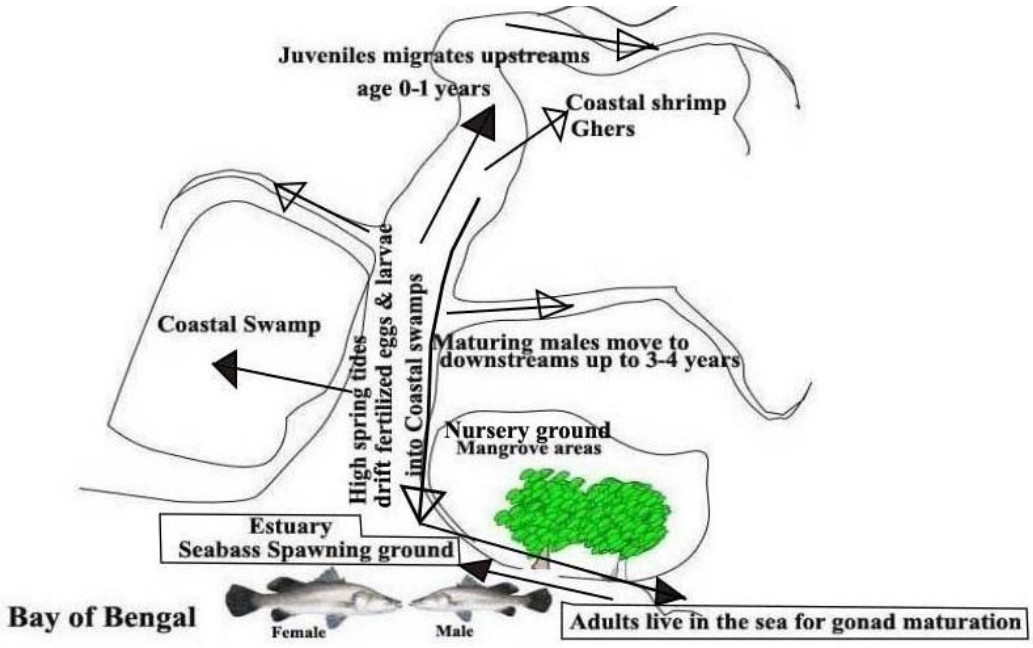

Figure 4. Migration pattern of *L. calcarifer* in Bangladesh

FOOD AND FEEDING HABIT

The adult seabass is considered an insatiable carnivore (Russell and Garrett, 1983) but juveniles are omnivorous and opportunistic predatory species, with ontogenetic dietary progression from crustacean to fish (Davis, 1985). Several authors (Mennon, 1948; De, 1971, Davis, 1985; Tacon *et al.,* 1991; Kailasam *et al*. 2002; Al-Noor *et al.,* 2012 and Kamruzzaman *et al.,* 2013) carried out a study on *L. calcarifer* food and feeding habits. These reviews reveal that fish and crustaceans (shrimp and crab) are the main foodstuffs of seabass in Bangladesh (Table 1). The seasonal variation in the food composition and feeding activity of seabass in Bangladesh's coastal waters is shown in Table 2.

Table1. Percentage of food items in gut contents of *Lates calcarifer* in Bangladesh.

Fish (%)	Crustaceans (%)	Mollusks (%)	Insects (%)	Polychaetes (%)	Zooplankton (%)	Algae (%)	Miscellaneous (%)	Unidentified (%)	Semi- digest (%)	Geographical location	References
32.4	22.7	-	9.9	-	17.2	10.4	-	6	-	Khulna	Al-Noor *et al.,*(2012)
49.9	35.1	2.7	-	-	-	-	12.2	-	-	Chittagong	(Karmaker and Das, 2001)
33.7	26.3	-	9.0	-	19.9	7.7		3.4	-	Shibsha river, Satkhira	(Kamruzzaman *et al.,*2013)

Table 2. Seasonal variations of food items (%) in the gut content of *Lates calcarifer* in Bangladesh

Food item	(Kamruzzaman *et al.*, 2013)		(Al-Noor *et al.*, 2012)		(Karmaker and Das, 2001)	
	High	Low	High	Low	High	Low
Fish (%)	40.45 in Nov.	28.75 in Sep.	40.5 in May	29.5 in July	72.3 in Monsoon	54.8 in Post-monsoon
Crustaceans (%)	36 in Oct.	17.5 in Aug.	26.5 in Sep.	16.5 in July	34.97 in Post-monsoon	12 in winter
Insects (%)	12in Feb.	6.25 in Dec.	16.5 in Apr.	6.5 in July	-	-
Zooplankton (%)	26.25 in June	13.5 in Dec.	26.9 in July	10.5 in Apr.	-	-
Miscellaneous (%)	12 in March	4.5 in July	14.5 in July	5.9 in Apr.	-	-
Algae (%)	4.35 in Dec.	2.1 in June	7.4 in Mar.	3.5 in May	-	-

Seabass brood rearing and breeding trial conducted in Bangladesh

The present review study found that, in the case of seabass brood breeding, Haroon *et al.,*(2005) reported an attempt was taken to develop gonadal maturation of seabass. They collected seabass both from wild and captive sources and reared for 4 years in 80 m^2 out-door cistern, but failed. Slight semen was observed in males of > 4.0 kg fish. In addition, Saleque and Hossain (2010) stated that in Teknaf, Cox's Bazar, about 500 fish were reared for breeding purposes in 5 earthen ponds, but gonadal maturity not occurred only increased in biomass in over three years. However, only one breeding trial study has been done in Bangladesh by Das (2000). The author reported that the breeding trial conducted by stripping method in where brood were collected from Moheskhali and Bakkhali river estuary, Cox's Bazar and that ripe eggs and milt were mixed together in the boat and hurriedly transfer to the FRI hatchery for embryonic development. However, due to insufficient filtered seawater at the FRI station, the development of the fertilized eggs ceased to reach the neurola stage. The experimental rearing of seabass brood conducted in Bangladesh is shown in Table -3.

Table 3. Experimental seabass *Lates calcarifer* brood rearing conducted in Bangladesh

Institution	Venue	Research period	Rearing environment (type, area, depth, salinity (ppt)	Brood source	Stocking density	Feed	Brood Development	Reference
IMS, CU	Chakari ,Cox's Bazar	April 1998 to March 2000 (3 months)	Coastal pond, 800 m^2, 1.5 to 2 m, 28-29ppt	Both Wild and captive	14 individual /pond	Live tilapia	Initial wt.2.5 kg Final wt. 3.0 kg	(Das, 2000)
BFRI	Cox's Bazar	July 2001 to June 2005 (4 years)	Semi-cemented pond, 80 m^2, 1.5m, 20 -30ppt	Both Wild and captive	1200 kg/ha, 24 kg/pond	Live tilapia	Initial 2kg Final 4kg	(Haroon *et al.*, 2005)
BRAC	Teknaf, Cox's Bazar	2007 Aug. to March 2010 (3 years)	Coastal pond, 800 m^2, 1.0m, 5-30ppt	Shrimp farm / Pond	100 individual /pond	Live tilapia	Fingerlings 50-150g Final wt. 4kg	(Saleque and Hossain, 2010)

IMS, CU, Institute of Marine Sciences, University of Chittagong; BFRI, Bangladesh Fisheries Research Institute; BRAC, Bangladesh Rural Advancement Committee.

SEABASS CULTURE PATTERN IN BANGLADESH

Wild seabass fry and fingerlings are collected from the coastal area of Sundarban, particularly during the post-monsoon period. According to Siddik *et* al. (2016), seabass farms are usually divided into two sections in Bangladesh; the large one is used to grow shrimps, where native tilapia is used as live food for seabass. Tilapia fish are highly fecund and are constantly producing larvae in the pond. The small section of the farm is used to store seabass until the end of shrimp farming. Nearly all shrimps are harvested and sold between July and September, then the entire farm devoted to seabass cultivation until the next shrimp cultivation season. Seabass is being replenished between December and February. The omnivorous juvenile stage and the carnivorous post-juvenile stage of seabass heavily influence feed input. There are no species-specific artificial feeds available in the Bangladesh seabass market, and farmers rely on local food and live food (tilapia) that is grown concurrently with the shrimp farm. Being extensive farming systems, tidal water allows the input of various invertebrate larvae such as shrimps, prawn larvae and crabs to supply live food to the seabass fingerling. Fish will be grown to a maximum of two years for a minimum of six months. Monwar *et al.,* (2013) investigated the polyculture of seabass with tilapia in a ratio of 4:1, 5:1, 6:1 in nine experimental earthen ponds in Chakaria, Cox's Bazar. They reported that after three months of cultivation, the highest biomass of seabass and tilapia was collectively found at 116g / m^2. It was found that 13 to 14 kg of fish was needed as live feed to

produce 1 kg of Seabass. Experimentally, the cultivation of 800 Seabass along with 8000 tilapias in six months and 16000 tilapias in one year together with the same ratio of Seabass is economically profitable (Hossain *et al.,* 1994). It was observed that 70 to 80 seabass fingerlings weighing 200 to 300 g were stocked in 15 decimal pond and small live tilapia, punti and tengra fish were given as Seabass feed. After 30 to 40 days of cultivation, 50 percent of the weight of the seabass in a shrimp culture demonstrated farm in Ellarchar, Satkhira, gains up to 1-1.5 kg (Kamal *et al.,* 2018).

CONCLUSION AND RECOMMENDATIONS

In Bangladesh, seabass is widely abundant in the coastal areas of marine and coastal environment. It breeds naturally in the estuaries of different regions of Bangladesh. Farmers are following extensive seabass farming system along with tilapia and other fish species by using natural sources seabass fry and fingerling. None can adopt reared seabass to trash fish or artificial feed. Though appreciated growth was recorded in pond or hatchery, seabass collected from freshwater sources did not respond for gonadal maturation in captive condition.

The major facilities that need addressing to make seabass breeding successful in Bangladesh are:

1. Seabass hatchery should be established in Cox's Bazar region.
2. Wild ripe seabass brood can be collected from nearby spawning grounds for an initial trial.
3. For regular supply of seabass brood, seabass will be reared in cage in offshore sea area.
4. Appropriate seabass artificial feed should be developed or to confirm availability as per demand.
5. Long term research should be carried out to develop the seabass artificial breeding in Bangladesh

CONFLICT OF INTEREST

There is no conflict of interest in this article.

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