Biological impact of fisheries of Hilsa shad in Bay of Bengal

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ABASTRACT:

Hilsa (*Tenualosa ilisha*) or river shad is an anadromous fish species widely distributed in the North Indian Ocean, mainly in the Bay of Bengal (BoB). Hilsa is the national fish of Bangladesh and it contributes 10% of the total fish production of the country, with a market value of $1.74 billion. Hilsa also holds a very important place in the eco- nomics of West Bengal of India with 12.5% of the catch and also tops the marine capture in Myanmar. During the last two decades Hilsa production from inland waters has been stable, whereas marine yields in the BoB increased substantially. In order to sustainably manage the trans-boundary stock of Hilsa, the taxonomy, distribution, hab- itat, migration patterns, population dynamics, fisheries and socio-economic aspects of the fishery have been reviewed here. To achieve a successful trans-boundary management for the Hilsa stock, complete ban on under-size fishing, well-targeted temporal and spatial bans, creation of protected areas in strategic points, incentive for Hilsa fishers and ecological restoration of Hilsa habitats and more work on technological development of Hilsa aquaculture are recommended.

Keywords: Hilsa shad, Bay of Bengal (BoB), Trans-boundary fishery management, Sustainable fishing.

INTRODUCTION:

The Hilsa shad, T. *ilisha* (Hamilton, 1822), locally known as ilish, is a major contributor to fish consumption in Bangladesh, east of India and Myanmar. The species is also found in Iran, Iraq, Kuwait, Malaysia (Peninsular Malaysia), Oman, Pakistan, Qatar, Saudi Arabia, Sri Lanka, Thailand, United Arab Emirates and Viet Nam (Freyhof, 2014). The fish is extremely rich in amino acids, minerals and lipids, especially essential and poly-unsaturated fatty acids (Alam et al., 2012). This euryhaline anadromous shad is found in

marine, coastal and freshwater environments and often shows schooling behavior in coastal waters.

Hilsa has a large market demand, with a global average annual production of N0.72 million tons, of which Bangladesh shares approximately 50–60%, Myanmar 20–25%, India 15–20% and other countries (e.g. Iraq, Kuwait, Malaysia, Thailand and Pakistan) contribute 5–10% (Rahman et al., 2010; Sahoo et al., 2018). The fish constitutes the largest single species fishery in Bangladesh, contributing N10% of the total fish production in the country. The average annual production of Hilsa in Bangladesh is more than three hundred thousand MT (inland 35% and marine 65%) (DoF, 2017). Marine Hilsa catch of Bangladesh represent nearly 40% of the total marine catch (worth USD 1.74 billion @ USD 5 kg^{-1}) of the country. It contributes to foreign exchange earnings of US$12.5 million per year (DoF, 2014). Hilsa shad is also an important contributor to catches in the Indian state ofWest Bengal (12.5%), yet it represents only 2.7% of total national catch (CMFRI, 2011; DAHDF, 2014). Due to its great demand and socio-cultural influences in West Bengal (Bladon et al., 2016), the state imports Hilsa from Bangladesh equivalent to 10% of its catches (CMFRI, 2011; DAHDF, 2014). Hilsa exported by Myanmar in 2007–08 amounted to roughly 9% of the total fisheries production, and 17,952 tonnes were exported by the country with a market price of US$ 39.53 million (the second highest exported fish following the rohu, Labeo rohita) (FAO, 2010). The Hilsa fishery in Myanmar, however, crashed to 2500 metric tons in 2015–16 – relative to almost 16,000 metric tons in 2006–07 (IIED, 2016).

A substantial number of fishermen in these countries are dependent on Hilsa fishery. Nearly half a million fishers in Bangladesh are directly employed in Hilsa fishing. With an indirect employment an additional 2.5 million people are engaged in the wider Hilsa sector through net and boatmaking, fish transport, ice production, fish processing, trading and export (BOBLME, 2010). A large number of fishers are also engaged in the exploitation of the Hilsa fishery in the marine, estuarine and freshwaters of the Hugly-Bhagirathi river system of West Bengal (Nath et al., 2016).

The present review aims to summarize the existing information and identify the knowledge gaps about productivity, life history and fishery structure of Hilsa in the BoB region needed for improving its sustainable exploitation. Finally, more viable trans-boundary

management options for sustainable Hilsa fishery in BoB have been provided considering existing policies from different countries.

Hilsa biology

The Hilsa shad, T. ilisha, belongs to the sub-family Alosinae of Family Clupeidae. It is one of three species of shad that occur in BoB waters under the genus Tenualosa and Hilsa. However, the Hilsa fishery of the BoB is dominated by T. ilisha, which contributes N99% of the total Hilsa catches (Stobberup, 2011). Hilsa is a silvery fish with gold and purple shots, with a strongly compressed and highly streamlined body (Fig. 1). To protect the abdominal region of this fast-moving migratory fish, the belly is covered with 17–18 pre-pelvic and 12–14 post-pelvic scutes or keelbones. The body is covered by large cycloid scales and the number of lateral line scales ranges between 45 and 47 (nos.). The fish has very slender and soft pin bones deeply embedded in its muscle. Branched pin bones are located on the dorsal broad muscle and unbranched ones are in the tail region (Sahu et al., 2014). Generally, the body of females is broader and the girth is comparatively bigger. The urino-genital opening of gravid females is relatively flatter, but is narrower in males where papillae are comparatively prominent (Shafi et al., 1977; Quddus, 1982).

Longevity, growth and age at the catch

The majority of the Hilsa caught are less than two years old (BOBLME, 2010). However, total life span was reported to be 2–6 years (Pillay and Rao, 1962; Bhuyan and Talbot, 1968; Hossain et al., 2014a). Otolith and length frequency data of Hilsa recorded by Rahman (2001) for different age classes are listed in Table 1. Hilsa have been classified into four size groups, small (b30 cm), medium (30–39 cm), large (40–49) cm and extra large (N50 cm) (M.J. Rahman et al., 2012). More than 90% of the Hilsa catch falls within a range of 30–40 cm (M.J. Rahman et al., 2012). The data from a recent survey by phone to fish vendors (2013–14) conducted under the ESPA-Deltas project in some of the largest Hilsa landing centers and markets of the Bangladesh coast show that 90% of the caught Hilsa is in the range of 25–75 cm (Fernandes et al., 2016). However, Dutta et al. (2012) found an asymptotic length of 47.7 cm and maximum length of 45.5 cm using 464 Hilsa. Commercial catches in both Bangladesh and Indianwaters show a general size range of about 15–52 cm (Azad et al., 1987; Gupta, 1989; Rahman, 2006).

Maturity, fecundity and breeding seasons

Hilsamales appear to attain maturity at a size range of 26–29 cm as compared to 31–33 cm in the case of females.

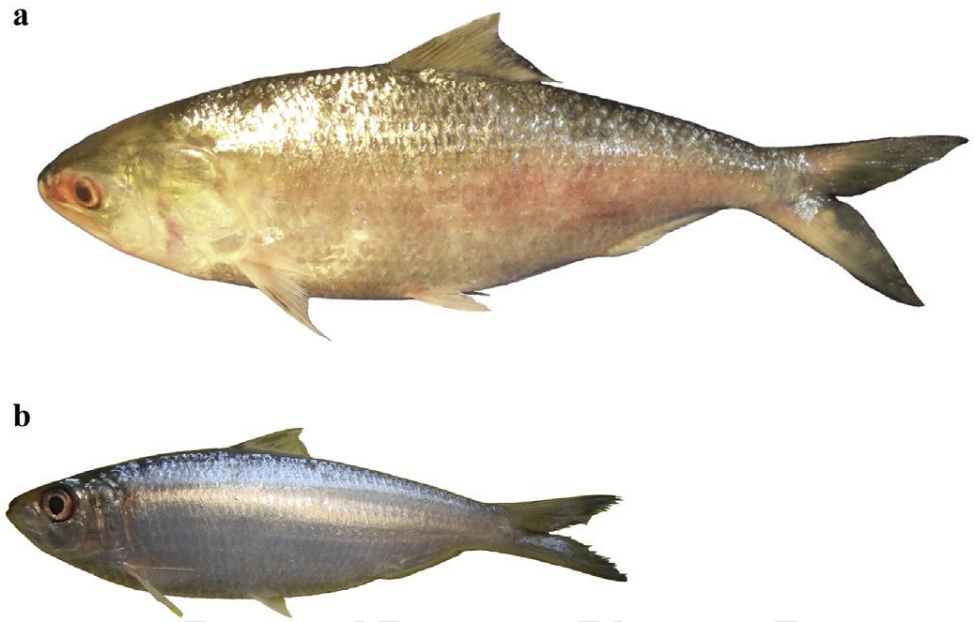

Fig.-1. Hilsa shad, T. ilisha; a. Adult and b. juvenile (jatka) (photo credit - Mostafa A R Hossain).

Table-1
Theminimum,maximumandmean total length (mm) of different age groups of male and female Hilsa in Bangladesh (Rahman, 2001).

Age group	From Otolith reading			From length frequency analysis		
	Average mm	Minimum mm	Maximum mm	Average mm	Minimum mm	Maximum mm
1+	265	248	277	263	236	290
2+	314	277	377	334	294	357
3+	380	339	429	382	351	427
4+	429	381	481	424	406	455
5+	478	447	514	479	454	506
6+	519	468	553	525	512	539

Blaber andMazid (2001), however, found sexually mature Hilsa at 20.0 cm size at1+years of age. During 1990–1994 the mean length of Hilsa was 356 mm (Mitra et al., 1994). It reduced markedly to 325 mm during 2003–2004 (Nath et al., 2004) and indicates deteriorating recruitment of the species (Banerjee et al., 2013). Hilsa shad is heterosexual (Bhaumik, 2013). Other species of Tenualosa were found to be sequential hermaphrodites (Allsop and West, 2003; Blaber et al., 2005). No Hilsa with transitional gonads were found

among N2000 histologically examined fish. The peak spawning season for Hilsa is September–October (M.J. Rahman et al., 2012). Other researchers, however, pointed out a minor peak in February–April (Mathur, 1964; Moula et al., 1991). The spawning varies from a few months to year-round and this duration varies in different rivers or parts of a river where the species is distributed (Shifat et al., 2003). The spawning cycle is closely synchronized with the lunar cycle, and intense spawning is observed during three-day periods before and after the new moon and the full moon (Miah et al., 1999).

The fecundity of Hilsa is very high and ranges between 0.1 million and 2.9 million (Table-2). Larger fish tend to produce a higher number of eggs. The fecundity was found to be 0.25 to 0.40 million, 0.4 to 1.6 million and 1.3 to 2.0 million, respectively, for Hilsa with size ranges of 25 to 40 cm, 40 to 50 cmand above 50 cm (Raja, 1985). The number of ova per gram of body mass was found to be 848 (Shafi et al., 1977) and 828 (De, 1980). As Hilsa do not show any sort of parental behavior that increases the fitness of assisted offspring, the high fecundity enables the fish to compensate for any great loss of progeny which may occur due to predation and adverse hydro-ecological parameters. The diameter of the fully ripe ovarian egg has been found to range between 0.60 and 0.90mm(Raja, 1985). The fertilized eggs are oily and transparent, look yellow in color and are demersal in nature (Qureshi, 1968).

Table-2
Hilsa fecundity in different waterbodies

Habitat/area	Length size (cm)	Fecundity	References
Hooghly	Average	250,000–1,600,000	Pillay, 1958
Godavari	30.3-350	100,000–2,000,000	Pillay and Rao, 1962
Indus	Average	700,000-2,900,000	Pillay and Rosa, 1963
Padma – Meghna	22.5-48.3	900,000–2,000,000	Qureshi, 1968
Meghna	38.0-52.0	382, 702–1,821,420	Shafi et al., 1977
Hooghly estuary	Average	373,000–1,323,000	De, 1980
Padma- Meghna	33.0-51.0	600,000–1,500,000	Quddus, 1982
Padma – Goalanda	26.6-51.1	179,000–1,302,000	Moula, 1992
Meghna	28.7-52.3	226,000–1,931,000	M.A. Rahman et al., 1998
Average Bangladesh	17.1-41.5	108,500–1,993,846	Blaber et al., 2001
Ramgoti (Luxmipur)	35.5-47.0	135,600–1,703,200	Haldar, 2004
Chandpur/Ramoti	24.0-48.0	112,554–950,625	BFRI, 2006–07

Global distribution of Hilsa

Hilsa inhabits coastal zones, estuarine waters, brackish waters and freshwater rivers up to the western rim of the Indo-Pacific faunistic region (Bhaumik et al., 2013; Bhaumik, 2016). The main distribution of Hilsa extends from Iraq and Iran, where it occurs in the Tigris

River basin and probably other rivers of the southern area of the country (Coad, 1995), eastwards to Myanmar, including the eastern and western coasts of India in the Arabian Sea and the Bay of Bengal (Raja, 1985; Sarkar et al., 2012).

Hilsa aquaculture

Production of market size Hilsa using hatchery produced seed in aquaculture farms has the potential to substantially reduce fishing pressure on its natural stock. In the past,many Hilsa researchers (Mojumdar, 1939; Hora, 1940; Pillay, 1958) have suggested the possibility of farming of Hilsa in culture ponds. Attempts at Hilsa domestication and culture in captivity have been made across Asia, particularly in India and Bangladesh without success to achieve a whole life cycle in captivity (Sahoo et al., 2018).

Conclusion

Hilsa shad is a species widely distributed across countries in the BoB and Indian Ocean of high economic and cultural value. Hilsa is known to be overexploited, but also an important income activity for coastal communities. For a long termsustainable exploitation, fishing of small sized Hilsa should be stopped through multiple socio-economic adaptation mechanisms, such as extending current food subsidies during fishing bans, extending fishermen literacy and training in alternative livelihoods. Sanctuary creation should continue, not only based on seasonal bans, but also towards creating fully protected areas. National policies can be modified to increase economic resilience with loans, minimum wages and insurances. Another set of required action are around ecological restoration, by dredging of the silted river channels, reducing discharge of pollutants and industrial effluents, provisioning fish passages or fish-friendly structures (FFS) in the dams and barrages, increasing water flow from the upstream regions (trans-boundary rivers) and construction of large reservoirs to hold water in the dry season and maintain normal river flow. In addition, provision of suitable formation of fishers' groups and representatives and other community-based approaches is vital. More works on technological development of Hilsa aquaculture by the researchers in collaboration with governments, NGOs and the private partners are needed. Strong and effective regional collaboration among three neighboring countries, Bangladesh, India and Myanmar – should continue based on recent works such as BOBLME, ESPA and the DECCMA project.

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