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Original Article

Risking lives for living: a study on underwater fishing in the Padma River, Bangladesh

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Abstract

Different types of fishing methods and gears are being employed across the globe including Bangladesh. This study describes the underwater fishing method in the Padma River- one of the three largest rivers in Bangladesh. Standardised efforts have been made for collecting data of interest between September 2016 and May 2017. Two types of underwater fishing, with or without using oxygen cylinders, were recorded. Mean duration of fishing per effort was higher (by 382%) when fishermen used oxygen cylinders. Mean water depth of fishing sites was also higher when oxygen cylinders were used. Three species of finfish (*Rita rita*, *Sperata seenghala* and *Labeo calbasu*) and one freshwater prawn species (*Macrobrachium dayanum*) have been identified in the catch. The catch was dominated by *M. dayanum* in both fishing types (27 ± 9.3 [with oxygen] and 15 ± 5.2 [without oxygen]). However, all the number of caught fish species varied significantly among different sampling months in both fishing methods ($P < 0.001$) except *L. calbasu* in fishing with oxygen cylinder. A number of health issues of the fishermen were also recorded.

Keywords: Fishing; Padma River; hand fishing; underwater fishing; dangerous fishing

1 | INTRODUCTION

Fishing has consistently been ranked as the most deadly occupation in the world as the fishermen are more susceptible to occupational hazards and endemic diseases and they typically face a risk of suffering a fatal job injury 20 to 30 times greater than the risk for all occupations (Drudi 1998; Lawrie et al. 2004; Frantzeskou *et al.* 2012; Pena and Gomez 2014). In a developing country like Bangladesh fishermen are one of the most vulnerable groups due to various reasons (Flowra *et al.* 2009; Islam *et al.* 2013; Galib *et al.* 2016) which sometime results in shifting to a new occupation or involvement in dangerous/risky fishing practices.

A wide range of methods and gears have been used across the globe including Bangladesh. The most common practice of fishing in the inland waters of Bangladesh are being done by using different types of fishing nets, traps, lines and hooks, and wounding fishing gears (e.g. Rahman *et al.* 1999; Galib *et al.* 2009). Operational details and catch composition of these fishing techniques or gears are well documented (e.g. Rahman *et al.* 1999; Galib *et al.* 2009; Sultana and Islam 2016). However, some other non-traditional fishing methods also exist in Bangladesh. Examples of these methods are katha fishing (temporary

shelter is provided during monsoon in the deeper parts of any water body, primarily floodplains and rivers, where fish take refuge which subject to catch by dewatering the section by draining out the water in the dry season; e.g. Ahmed and Akther 2008; Bernascek *et al.* 1992), otter (*Lutra perspicillata*) fishing (Feeroz *et al.* 2011), hand fishing, use of fish aggregating devices (FADs) and sometimes a combination of these methods (Galib *et al.* 2009).

In this paper we described the underwater hand fishing by a group of fishermen in the Padma River. Although scuba diving is in practice in marine water fishing, primarily to monitor trawls (e.g. Wickham and Watson 1976; Diniz *et al.* 2014) but, to the best of our knowledge, no such practice is common in freshwater environments, including Bangladesh. Our aim for this study was to describe this new underwater fishing practice in details along with some relevant issues.

2 | METHODOLOGY

2.1 | Study area

This study was carried out in the Padma River (approximately 24°17'56.8"N 88°43'30.3"E to 24°19'25.9"N 88°42'16.9"E) of Rajshahi district (Figure 1). The Padma is one of the three largest river in Bangladesh and harvested fishes from this river is being contributed a considerable part to the total fish catch from the inland waters in Bangladesh (Galib *et al.* 2018). A large number of sand-filled plastic bags and concrete blocks have been placed over the last two decades on the banks of Padma to prevent the bank erosion during monsoon season. Many of these bags and blocks have been displaced from its original position and reached the river bottom, now became a common shelter for several aquatic species of fish and shellfish (T. Pervez; personal observation).

For the last few years (since 2005) a group of fishermen in these areas are being involved in underwater fishing by using oxygen cylinders (Figure 2). However, some other fishermen in the study area were also involved in underwater fishing without using any oxygen cylinder. These fishermen dive into the river bottom from small fishing boats and catch fishes by hands. When fishermen do not use oxygen cylinders during fishing a long (~5 m) and soft tube is used to breathe oxygen from air. A sinker (of ~12 kg), generally in the form of a heavy iron chain, remains attached to the body of the fisherman at the time of fishing with oxygen cylinders to get to the bottom easily. A rope also remains attached to the fisherman's body whose opposite end remains tied to the fishing boat where a second person awaits to pull him up when fishing is done. However, no sinker and rope are used during fishing when fishermen do not use oxygen cylinder. On every fishing day these fishermen continue fishing for about five to six hours that involves repeated fishing attempts.

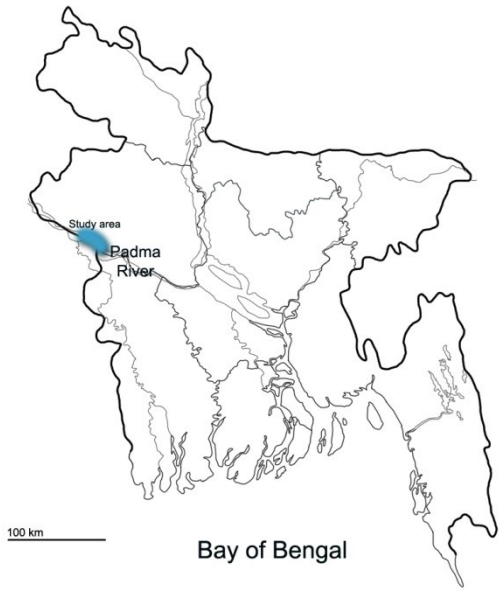

FIGURE 1 Map of Bangladesh showing the study area of the Padma River

FIGURE 2 A fisherman on a fishing boat just before diving into the water for fishing in the Padma River

2.2 | Sampling framework

Field survey was conducted for nine months from September 2016 to May 2017 to collect fishing data from the study area. No underwater fishing was carried out in remaining three months (June – August) of the year due to high water depth over the monsoon period and thus it was not possible to carry out sampling. To standardise the sampling method we monitored the fishing operation (single fisherman) for three hours that involved multiple fishing attempts.

Number of individuals of fish and shellfish caught during standardised sample monitoring time (i.e. three hours) was counted and lengths were measured (first 30 individuals of each species if catch is > 30) by using a digital slide callipers (to the nearest 0.01 mm). Water depth of the fishing spot was recorded by standard measurement gauge. Fishermen (N = 30) involved in this type of fishing were interviewed with a pre-developed questionnaire to collect necessary information of this method and also about health issues associated with this fishing practice. Caught finfishes and prawn species were identified following Rahman (2005) and Ahmed *et al.* (2008) respectively.

2.3 | Data analysis

Data of two types of underwater fishing (with or without oxygen cylinder) were analysed separately. The statistical software R (version 3.4.3; R Core Team 2017) was used to analyse the data employing an α significance level of 0.05. Linear Mixed-Effects Modelling (LMM) was employed to analyse repeatedly measured fishing duration, catch composition and fishing depth data using 'lmer' function of the 'lme4' package (Bates *et al.* 2014); *p*-values were obtained by 'lmerTest' package (Kuznetsova *et al.* 2016).

During modelling, sampling months were considered fixed effect and fishing efforts were considered random effect. Data were checked for normality by Shapiro-Wilk test (Peat and Barton 2005) and transformed on a log (x+1) scale to meet the statistical test assumption before the test (Clarke 1993).

3 | RESULTS

3.1 | Fishing duration and depth

Overall mean (± SD) duration of underwater fishing with oxygen cylinders was 53.96 ± 19.73 minutes per effort. Whereas this value was 11.2 ± 2.2 minutes per effort for fishing without using oxygen cylinders. While fishing by using oxygen cylinders the highest and lowest duration were recorded in September and January respectively (Figure 3) and fishing duration significantly varied in relation to sampling months (LLM; F = 11.8, P <0.001). Mean water depth at the fishing spots was higher when fishing was done with the aid of oxygen support (6.3 ± 2.1 m) than without oxygen support (3.2 ± 1.6 m).

3.2 | Catch composition

In total, three species of finfishes (*Rita rita*, *Sperata seenghala* and *Labeo calbasu*) and one species of shellfish (*Macrobrachium dayanum*) formed the catch composition of underwater fishing practice in the Padma River. All these species were bottom dwellers. In fishing with oxygen cylinders the most abundantly caught species (mean ± SD, range) was *M. dayanum* (27 ± 9.3, 12–44) followed by *R. rita* (25.1 ± 6.6, 15–39), *L. calbasu* (6.9 ± 10.6, 1–57) and *S. seenghala* (4.8 ± 4.3, 0–14). Maximum mean number of *R. rita* (37), *L. calbasu* (22.7), *M. seenghala* (13) and *M. dayanum* (41) in this type of fishing were captured in the month of November, October, May and May respectively (Figure 4).

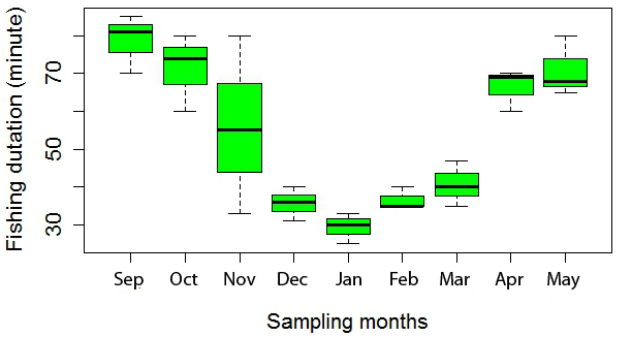

FIGURE 3 Underwater fishing duration per effort when fishermen used oxygen cylinders. Midline within the box is the median; upper and lower limits of the box represent the third and first quartile (75th and 25th percentile) respectively

However, in fishing without oxygen cylinders, the pattern of the caught species was similar to underwater fishing with oxygen cylinders- dominated by *M. dayanum* (15 ± 5.2, 7–26) followed by *R. rita* (14.6 ± 4.7, 7–27), *L. calbasu* (2.4 ± 1.7, 1–7) and *S. seenghala* (1.4 ± 1.2, 0–4). Maximum mean number of *R. rita* (24, in October), *L. calbasu* (5, in October), *M. seenghala* (3, in May and October) and *M. dayanum* (24, in November) in underwater hand fishing without using oxygen cylinders (Figure 5).

LLM analysis revealed that total number of caught individuals varied significantly among months in both types of underwater fishing (i.e. with and without using oxygen cylinders; P <0.001; Table 1). However, all the caught fish species varied significantly among different sampling months in both fishing methods (P < 0.001 for all the species except one) except *L. calbasu* in fishing with oxygen cylinder (Table 1).

TABLE 1 Linear Mixed-Effects Modelling (LMM) results showing variation in catch composition among different sampling months of underwater fishing

Fish	With oxygen		Without oxygen	
	F	***P*-value**	***F***	***P*-value**
Labeo calbasu	1.4	0.263	3.9	0.008
Rita rita	21.1	<0.001	7.6	<0.001
Sperata seenghala	73.1	<0.001	8.6	<0.001
Macrobrachium dayanum	76.4	<0.001	13.9	<0.001
Overall	11.6	<0.001	24.1	<0.001

No large individuals of fin fishes were caught during underwater fishing. Mean lengths of caught fish species

were 8.9 ± 3.6 cm for *R. rita*, 17.8 ± 5.4 cm for *L. calbasu* and 18.1 ± 5.3 cm for *S. seenghala*. Mostly adult size (about 8–9 cm) of *M. dayanum* was caught during fishing.

3.3 | Other issues

Health issue was a major concern of underwater fishing in the study area. All the respondents reported cold followed by skin diseases (96.7%) and asthma (30%). However, severity of asthma was higher during the cold months (December to February). It has also been observed that no fisherman used proper clothing during diving. Moreover, there were no additional safety measures for the fishermen engaged in fishing underwater. None of the fishermen had any training on scuba diving or similar issues.

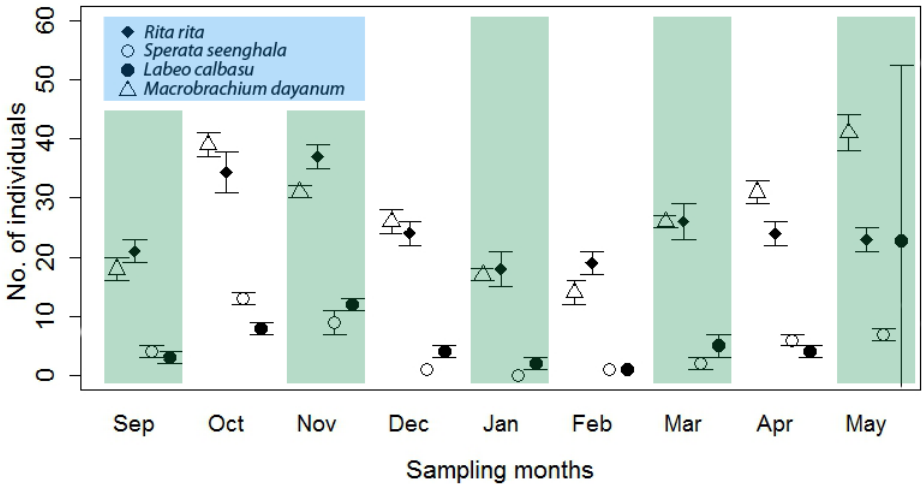

FIGURE 4 Catch compositions (Mean ± SD) of underwater fishing using oxygen cylinders in different sampling months

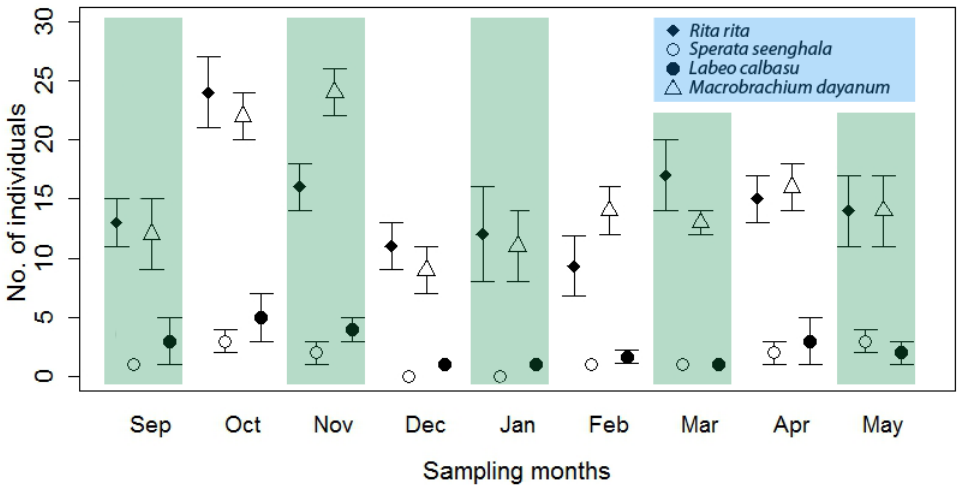

FIGURE 5 Catch compositions (Mean ± SD) of underwater fishing without using oxygen cylinders in different sampling months

4 | DISCUSSION

This study provides the maiden evidence of underwater hand fishing in the freshwater of Bangladesh. Fishing duration was much lower during winter months (primarily December to February) than other period which may be due to the cooler water in the river over winter months when temperature remains lower than other months (Chaki *et al.* 2014).

The aquatic habitats and biodiversity in the natural waters of Bangladesh have already been declined (Rahman *et al.* 2003) and reduced fish catch in these waters became a common phenomenon (Galib 2015). Because of this, along with some other reasons, many fishermen shifted to other occupations (Galib *et al.* 2016a). A major portion of the existing fishermen have started using non-traditional fishing gears and methods to increase the amount of catch. This involves use of illegal fishing nets (e.g. gill nets, locally known as 'current jal') and dangerous and harmful fishing methods (e.g. FADs and katha fishing) (Galib *et al.* 2009, 2016b). This underwater fishing in the Padma is another addition to this dangerous fishing method.

Mostly juvenile life stages of finfish species were caught in this method but these species can grow to a much larger size which is several times higher than the average catch size (Rahman 2005). This may have an impact on the successful recruitment of the species. Moreover

catching of individuals of these sizes for several months, which essentially overlaps with current study duration, is against the fish acts and illegal in Bangladesh (DoF 2017). It is a common problem in Bangladesh that fishermen use illegal fishing gears and catch fish species violating existing fisheries rules and regulations. Strict monitoring and implementation of fish laws by the appropriate bodies are often rare in the country.

Rita rita and *S. seenghala* are of high conservation importance and categorised as Endangered and Vulnerable fish species in Bangladesh (IUCN Bangladesh 2015). This underwater fishing method, thus, might seriously impact the species of threatened status in the country. Unfortunately, in Bangladesh, conservation priority is given primarily on only a few species (e.g. Hilsa, *Tenualosa ilisha*) and such efforts are seldom observed for majority of the threatened fish species.

Fishermen involved in underwater fishing in the study area did not use proper clothing which is a common problem in different parts of the world and their activities expose them to severe hazards (Pena and Gomez 2014). Poor knowledge of health and safety issues of the fishermen was reported from the Indian subcontinent (Ansuya *et al.* 2014) which is also reflected in this study. A number of health issues associated with existing fishing practices have been highlighted in this study that may serve as baseline information for further research- which needs to be prioritised because health issues of the fishermen have not been addressed properly through research (Lawrie *et al.* 2004).

The catch success in underwater fishing in the study area is subjected to availability of submerged sand-bags and concrete blocks. This fishing may negatively impact the breeding success of several indigenous fish species (e.g. clown knifefish, *Chitala chitala*) as these fishes build nests in these types of submerged shelters and bottom habitats are being disturbed severely during this fishing operation. The Padma is also a good breeding place for many of these fish species (Personal observation; MT Pervez and SM Galib). Moreover, this fishing practice may be responsible for increasing water turbidity (suspended solids) that can impact physiology and behaviour of other biota present in the altered ecosystem primarily by reducing food supply, degrading spawning beds and affecting gill functions (MPCA 2008; Bash *et al.* 2001).

In conclusion, we believe that this fishing method is extremely dangerous for the fishermen as fishermen had no training on diving and they did not use any proper precaution. This fishing may have a negative impact on the recruitment of caught species as the caught individuals are mostly juvenile. It also makes fishermen prone to occupational hazards and diseases. This fishing method may have a serious impact on the ecosystem as river bed is being disrupted during fishing.

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CONTRIBUTION OF THE AUTHORS

MTP primary data collection, draft MS preparation; **ABMM** research supervisor; **NC** data analysis, draft MS preparation; **SMG** data analysis, finalisation of MS.