Culture feasibility, Domestication and Breeding potentiality of *Penaeus indicus* in the southwest region of Bangladesh

Abstract

A preliminary observation was conducted on the culture potentiality, domestication at different stocking density and breeding competency of Chaka chingri (*Penaeus indicus*) in southwest region of Bangladesh from February to May in 2020 on Shrimp Research Station, Bagerhat for 120 days. There were three treatments with three replication of each where stocking density varied. Among the treatments, T_3 (200 nos./dec) was found more suitable with higher growth than T_2 (300 nos./dec) and T_1 (400 nos./dec). In regular samples of wild Chaka taken from the regions of Bagerhat, Satkhira, and Khulna, histological investigation revealed that no oocyte was discovered during the reproductive period. The explanations for why the right big shrimp could not be located. Since *P. indicus* needs more salinity and profundity for the growth of gonadal tissue, the ecological conditions were similarly unfavorable. In this instance, the areas that have greater salinities and shrimp of a reasonable size ought to be chosen for a breeding program. After analysis, the approximate composition of *P. indicus*'s flesh and shell was discovered to be below average. It's because *P. indicus* experiences prolonged stress and an adverse body condition due to reduced salinity, which has a significant impact on feeding and growth rates along with the rate at which dietary protein is converted to meat protein. Consequently, the current study suggests carrying out a breeding program and preserving the ideal natural conditions for Chaka chingri adaptation.

Keywords: *Penaeus indicus*; salinity; culture potentiality; domestication; breeding competency.

Introduction

Bangladesh is renowned for its extensive inland water (Mia et al., 2017; Ali et al., 2017) where coastal area occupies 710 km (DoF, 2023). In fiscal year 2021-22, total production of shrimp was 287497 metric ton where production per hectare is only 1093kg (DoF, 2023) which is very low but this sector plays a significant role in the economy, employment generation and poverty reduction. The two main production areas of shrimp are located in the southwestern part composed of Khulna, Satkhira and Bagerhat districts; and the other one is located in the Southeastern part of the country composed of Chittagong and Cox's bazaar districts (Rahman, 1998). Since the last decades, the sector has been suffering from various issues and problems related to culture, production, disease and shrimp seed collection (Ferdousy et al., 2017). Several studies have reported a wide range of diseases caused by viral and bacterial pathogens in shrimp farms of Bangladesh (Ali et al., 2016, Karim et al., 2012). Shrimp, including cultured and wild, face >20 different viruses, including six devastating viral diseases listed by OIE, which cause approximately 60% losses due to diseases to the shrimp aquaculture industry (Flegel, 2012). Many have not been associated with clinical signs of disease and some have been observed only by electron microscopy and are poorly characterized. Among the known disease, *Penaeus monodon* facing devastating crop loss due to White Spot Disease outbreak in Bangladesh. Shrimp production increased in 2014, dropped off in 2015, and it may not bounce back in the upcoming year. Disease is always a problem which harasses the healthy development of shrimp aquaculture. Both virus and bacteria can be dangerous pathogens of shrimp in aquaculture. Application of traditional antibiotics can alleviate bacterial diseases, but traditional strategy used to prevent viral diseases in vertebrate is not effective to cure viral diseases of shrimp since no adaptive immunity exists in them. All pathogens are highly contagious mainly to the commercially cultured species like *P. monodon* and *Litopenaeus vannamei*. But interestingly found less virulent to non- conventional export-oriented commodity viz *Penaeus indicus*locally known as Chaka Chingri. There are a few reports on the mass mortality of this species due to the OIE listed pathogens but have considerable potential in the local as well as in the international market. *P. indicus* is considered to be a potential candidate for shrimp aquaculture (Parado-Estepa et al. 1987). But there is no developed breeding program of *P. indicus* and never

been tried in this country. Therefore, indigenous knowledge of the breeding, seed production and culture program of this species in needed. That is why, it is high time to study the breeding behavior and culture potential of Chaka (*P. indicus*) in Bangladesh through field survey and domestication program. Henceforth, under this study, efforts were given to identify the breeding behavior and culture potential of this species as an impending export commodity of the country.

Materials & Methods

Domestication of Penaeus indicus in earthen ponds

The experiment was conducted on Shrimp Research Station, Bagerhat for 120 days (Table 1).

Table 1. Experimental Design of domestication of *Penaeus indicus* in earthen ponds

Site	Treatments	Replications	Cultured Species	Stocking density/Decimal	Culture Duration (days)
*SRS, Bagerhat	T_1	3	Chaka Chingri (*Penaeus indicus*).	400 nos.	120 (February to May)
	T_2			300 nos.	
	T_3			200 nos.	

*SRS= Shrimp Research Station, Bangladesh Fisheries Research Institute.

Pond preparation

Ponds were selected by examining ponds site, water retention capacity, and water depth (01 to 02m). Preparation of the ponds were done by repairing mouth of the ponds. Unwanted sludge was removed from the ponds bottom. Lime was applied at 250 kg/ha. A concerned ponds were fertilized with compost (mixture of chopped and sundried green plants 88%, cow dung 10%, urea 1% and lime 1%) at 1,250 kg/ha, urea at 37.5kg/ha and TSPat 25 kg/ha. Then, the ponds were left for 10 days to promote algal development.

Collection, stocking and feeding management of quality PL

Good quality PL were collected and stocked accordingly in each pond after proper acclimatization. CP prawn feed was supplied according to FAO Guidelines. The feed was adjusted periodically in accordance with the growth performance of *Penaeus indicus* (Table 2). Fertilization was done fortnightly with urea at 37kg/ha, TSP at 25kg/ha and lime 65/ha.

Growth performance and water quality parameters monitoring

At least 10% of each species of fishes were collected by seine net and growth was recorded fortnightly. Water quality parameters like air and water temperature, DO, free CO_2, total alkalinity; pH etc. were monitored fortnightly by using chemicals Kit Box.

Table 2. Feeding management for *P. indicus.*

Shrimp size (g)	Feed type	Feed shape	Feed size (mm)	Feeding rate (% of biomass per day)	Feeding frequency (no./ per day)
PL25-1	Starter 1		0.5-0.9	13-9	1-2
1–2	Starter 2	Crumble	0.9-1.2	9-6	2-4
2–4	Starter 3		1.2-1.8	6-4	4
3–7	Grower 4	Pellet	1.8 x 2-3	5-3.5	4
6–15	Grower 5		2.0 x 3-4	3.5-2.5	4

Size and availability of Chaka chingri (P. indicus)

Wild Chaka was monthly sampled to study the maturity and gametogenic cycle. Specimens were collected from the local markets and landing center adjacent to the coastal rivers of Khulna, Satkhira and Bagerhat region (Fig. 1).

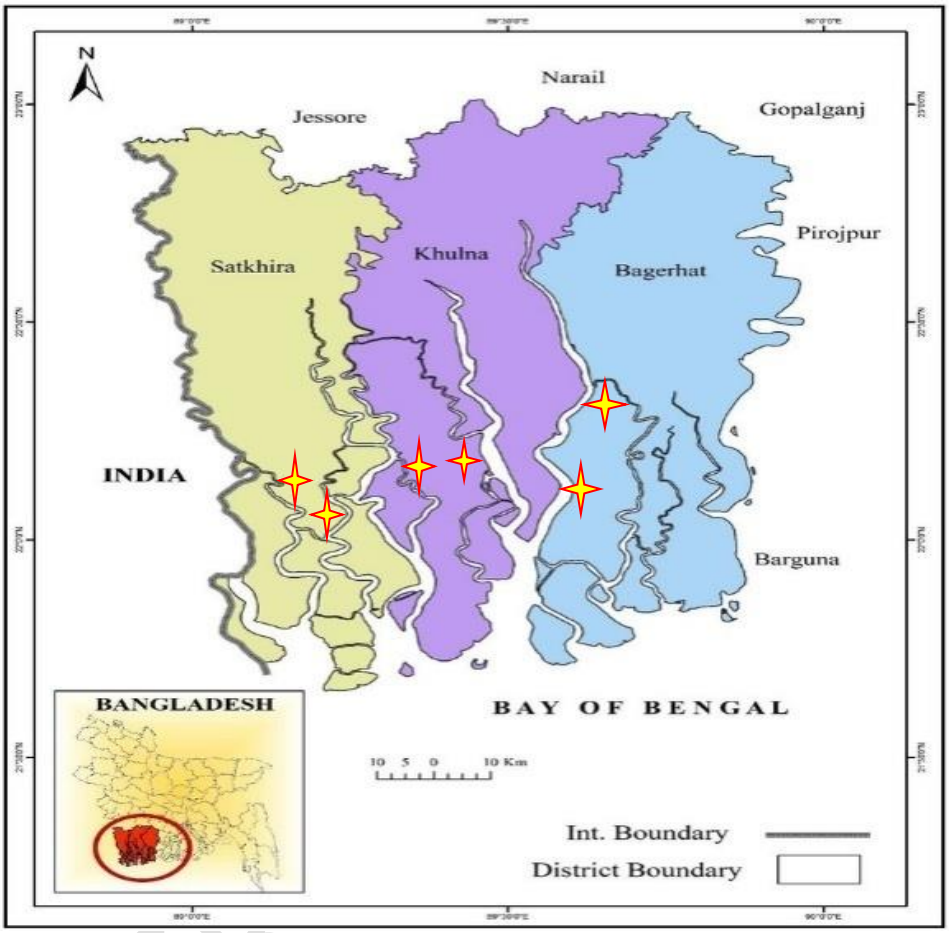


Fig. 1. Sampling points of Khulna, Satkhira and Bagerhat region.

Histology

Samples, conserved in the fixative were embedded in paraplast, cut in transverse serial sections (7µm) and mounted on slides. An increasing alcohol concentration protocol was adopted for dehydration. Slides were then stained with Harrys' hematoxylin and eosin. Histological sections were examined with a microscope at 5–100× and 5–200× magnification.

Results

Mean levels of physico-chemical parameters over the 120 days of domestication period are presented in Table 3.

Table 3. Physico-chemical characters of water (Mean±SD) during the experimental period.

Parameters	Treatments		
	T_1	T_2	T_3
Temperature (°C)	30±1.92	29±1.55	28±1.33
Dissolved Oxygen (DO) (mg/l)	8.07±1.07	8.37±1.19	9.37±0.90
pH	8.33±0.09	8.46±0.14	8.63±0.16

Salinity (ppt)	8.0±0.84	8.0±0.84	8.0±0.84
Alkalinity (mg/l)	124.0±17.68	124.0±17.68	124.0±17.68
Ammonia (mg/l)	0.30±0.03	0.25±0.05	0.28±0.04
Nitrite (mg/l)	0.04±.02	0.04±.03	0.04±.02
Iron (mg/l)	0.5±0.30	0.5±0.30	0.5±0.30

The mean water temperature, salinity level, alkalinity, nitrite and iron level were observed similar in all the treatment ponds. Slightly higher pH was recorded in T_3 (8.63±0.16) than other treatments. Highest dissolved oxygen was recorded in T_2 (9.37±1.19 mg/l)) and lowest in T_1 (8.07±1.07mg/l). On the other hand, ammonia was recorded 0.30±0.03 mg/l in T_1, 0.25±0.05 mg/l in T_2 and 0.28±0.04 mg/l in T_3. Salinity level of the study area fluctuated over the year (Fig. 2). September to May salinity was seen a range of 1 to 14. Since *P. indicus* prefers a higher salinity to grow, the salinity available can be used to select and modify the culture time.

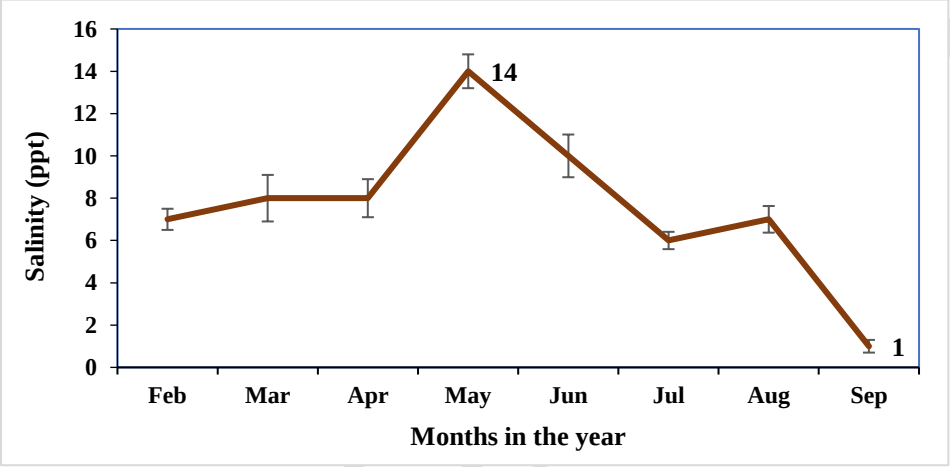


Fig. 2. Salinity level of domestication ponds in different months

The initial length and weight of stocked PL were 1.53±0.04cm and 0.30±0.03g respectively. After 120 days of culture, highest average length and weight were recorded in T_3; 17±1.32cm and 21.13±1.36g and lowest in T_1; 14±1.24cm, 17.25±1.48g, respectively (Table 4). That means the PLs in T_3 treatment showed the highest gain in both length and weight compared to the T_1 and T_2 treatments, where stocking density was 200 nos./decimal. The net weight gain, average daily gain and specific growth rate were also observed higher in T_3 treatment.

Table 4. Growth performance (Mean±SD) of *P. indicus* in earthen pond after 120 days of culture

Parameters	**Treatments**		
	T_1	**T_2**	**T_3**
Initial Length (cm)	1.53±0.04	1.53±0.04	1.53±0.04
Final Length (cm)	14±1.24	15±1.53	17±1.32
Initial Weight (g)	0.30±0.03	0.30±0.03	0.30±0.03
Final Weight (g)	17.25±1.48	18.75±1.39	21.13±1.36
Net Weight gain (g)	16.95±1.35	18.45±1.46	20.83±1.53
Average Daily gain (g)	0.14±0.01	0.15±0.01	0.17±0.01
Specific growth rate	3.38±0.21	3.45±0.31	3.55±0.23

Size and availability of Chaka chingri (*P. indicus*) in coastal region

In the month of May, the highest average length was 15cm and the weight was 24.18g in the Munshiganj and Shymnagor coastal regions of Satkhira District. The lowest average weight, 9.17g, was discovered in April in the coastal region of Khulna district. The Khulna district's coastal region had the lowest average length of 5.78cm in February (Fig. 3). So, Munshiganj and Shymnagor upazillas in Sathkhira district are considered to be supportive regions for Chaka brood growth as size is a crucial component therein.

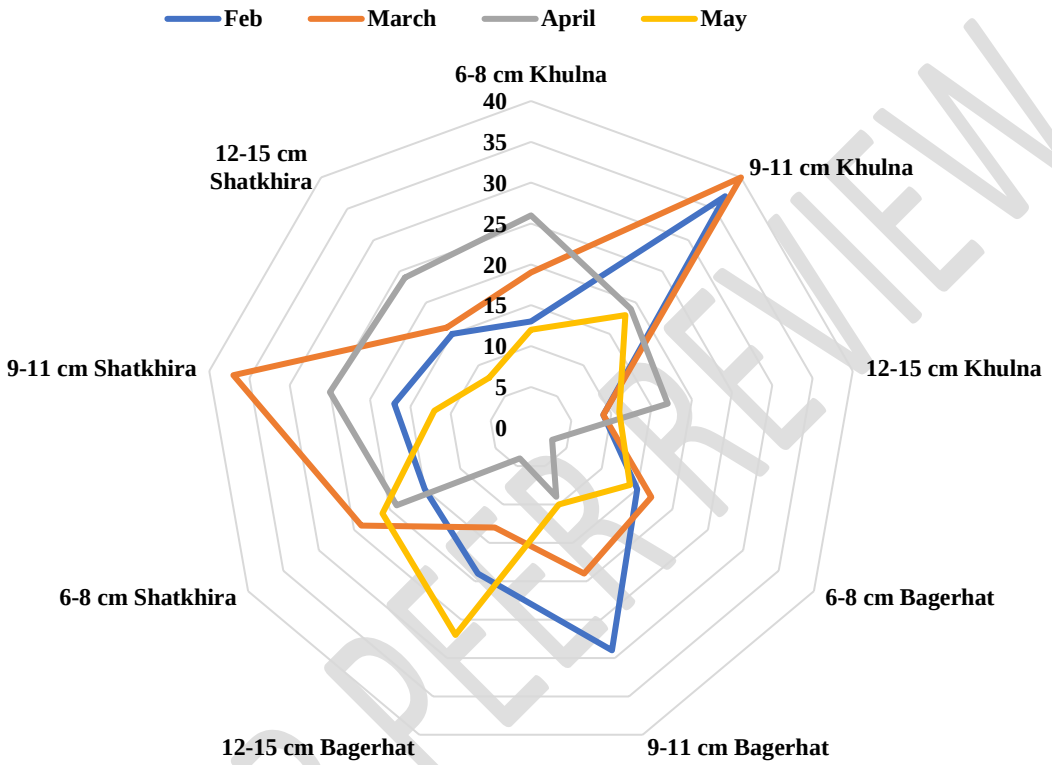
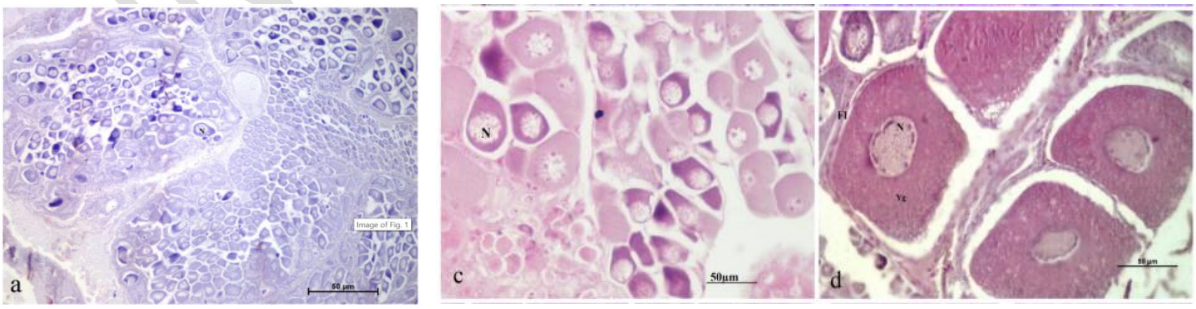


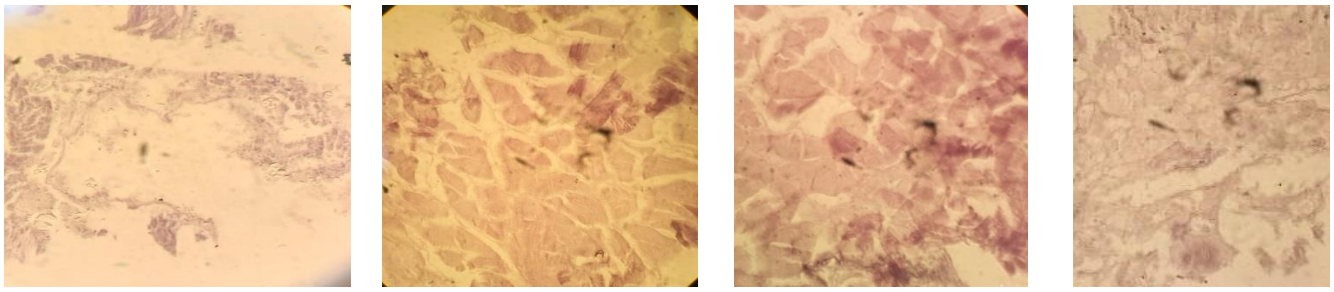
Fig. 3. Distribution of *P. indicus* in Khulna, Sathkhira and Bagherhat region.

Histology

Histological analyses were carried out to evaluate gonadal development throughout the reproductive season and to validate the macroscopic stage attribution. From histology analysis, no oocyte was found (Fig 4), so it can be said that in this area and ecological condition is might not congenial for the gonadal development of *P. indicus*.



a. Primary Oocytes on Day 0; b, c: Ovarian tissues collected on Day 7 (S Tomy *et al.*2015)



February March April May

d. No Primary Oocytes Found

Fig.4. Histological observation of *P. indicus*

Proximate study of *P. indicus* shell and meat revealed much higher levels of protein in the flesh. In contrast, the shell's lipid makeup was determined to be identical while its moisture and ash contents were discovered to be a bit greater (Table 5).

Table 5. Proximate composition of shell and flesh of *P. indicus* (% dry weight).

Parameters	Flesh	Shell
Protein	26.5	18.0
Lipid	3.5	3.5
Moisture	21.5	23.0
Ash	27.0	27.5

Discussion

According to available references and applied research, optimum temperature and salinity for propagation and culture of Indian white shrimp found 22 to 33°C and 15 to 25 ppt respectively (Pillay, 2005). The previous results showed that salinity plays an important role in chakachingri (*P. indicus*) domestication. Salinity level above 5 ppt is good for chakachingri (*P. indicus*) domestication in earthen ponds. In the study area, we observed the temperature and salinity level at 32±1.92, 8.0±0.84, respectively in all the three treatments during experimental period. The observed range was within the survival capacity of *P. indicus* (Vijayan, 2019).

In 2010, Emadi and colleagues reported about achievement of 20.5±0.45g average final weight of *P. indicus* after 156 days of culture. According to Vijayan, 2019; *Penaeus indicus* can grow as fast as up to 20g size, highly tolerant to the tropical climate with a wide range of salinity and found to be less susceptible to emerging diseases such as EHP, white fecal disease etc.

From histology analysis, no oocyte was found. Tomy et al., 2015 collected 60–90g sized live adult females of *P. indicus* at different stages of maturity from Chennai coast, TamilNadu, India while under the current study, the largest sample of *P. indicus* found in the study area was 24.18g which is significantly smaller sized for gonadal development. Jayawardane et al., 2002 reported that an estimated number (817,549 to 1,254,200) of eggs would be spawned by the shrimp of the size ranges 14.22 to 18.26cm collected by trawl catches from the western coastal waters of Negombo lagoon, SriLanka where the depth ranges from 30 to 90m and salinity ranges from 15.34 to 17.23ppt. These reports indicate that higher salinity and depth is mandatory for the gonadal development of the abovementioned species regardless to its size and weight.

Proximate composition of *P. indicus* was determined where flesh contains much higher protein than shell. Abdel-Salam, 2013 found 42.88±1.11% and 40.68±2.28% protein content in male and female*Penaeus indicus*,

respectively. The lipid content was observed in male and female 8.57±0.24% and 8.92±0.02% respectively, in his study. Both the protein and lipid content were considerably higher than our study. Ravichandran et al., 2009 observed higher (41.3%) percentage of protein in the flesh of *P. indicus*than that of shell (32.5%). They also noticed the highest amount of lipid (9.8%) and ash (26.6%) in shell, whereas moisture content was found higher (14.7%) in flesh. The protein and lipid content of *P. indicus*in that observation was also higher than our study but the moisture and ash content was lower. In our study, we found higher amount of protein content in flesh than the shell, which coincides with the previous studies. According to previous literatures, Proximate parameters in flesh were generally more concentrated than shell. As a general rule, protein and lipid in shrimp act as major food reserve and are subject to periodic fluctuations influenced by environmental variables like temperature (Nagabhushanam and Farooqui, 2000). The proximate composition of the individual can also vary with the feeding level, composition of diet and conversion capacity from dietary protein to flesh protein. The factors mentioned above might be the reasons of lower protein and lipid content found in *P. indicus*of our study.

Conclusions

The present investigation was a preliminary work on assessing the possibilities of breedingand domestication of chakachingri (*P. indicus*). More research should be carried out for development of domestication protocol and to facilitate mass seed production in hatchery condition. This study suggests thatthe selection of domestication and culture period should be based on the available salinity as higher salinity is more favorable for the growth of *P. indicus*. Stocking density at 200 nos/decimal is more suitable for maximum growth in chakachingri domestication. On the other hand, Munshiganj and Shymnagorupazila of Satkhira region could be a better option for the brood development program if higher salinity and depth can be maintained. Similarly, Cox's bazar could also be a considerable location for the brood development program because of higher salinity level.

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