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Preliminary observations on culture potentials of Indian white prawn *(Penaeus indicus)* in low saline earthen ponds

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Abstract. To assess the growth and culture potentials of Indian white prawn *Penaeus indicus*, locally known as Chaka Chingri, a preliminary trial was conducted for a period of 145 days in earthen ponds. The post larvae were collected from Sundarbans coast and stocked in 3 ponds of 0.056 ha each with the stocking density at 30, 40 and 54 m^{-2}in T_1,T_2 and T_3 treatments respectively. Commercial pelleted feed with 36% protein was fed. Production and physico-chemical parameters were recorded and analyzed according to standard methods. After 145 days of rearing, obtained average final weight was 22.18±6.71g, 25.25±3.11g and 29.25±2.88g; with the estimated yield of 1197 kg/ha, 3030 kg/ha, and 3632 kg/ha, survival was 18%, 30% and 23% in T_1, T_2 and T_3 treatments respectively. Results and findings of the present study suggested that *P. indicus* might be potential mariculture candidate in the coastal areas of Bangladesh.
Keywords: *Penaeus indicus,* Culture, Stocking density

Introduction

Shrimp industry is one of the important contributors of strengthening economy, employment generation and poverty reduction in Bangladesh. Since the last decades, this sector has been suffering from various issues and problems related to culture and production due to changing climate, disease and pollution. The two main commercial important shrimp/prawn species in Bangladesh are *Penaeus monodon* for brackish and marine water and *Macrobranchium rosenbergii* for freshwater. *P. monodon* is facing devastating crop loss in each year due to disease outbreak. Diversification of species is imperative for sustainable shrimp production, and Indian white shrimp *P. indicus* is considered to be a potential candidate for shrimp aquaculture (Parado-Estepa *et al.* 1987). *P. indicus* is widely distributed in the Indo-West Pacific from the south and eastern Africa to northern Australia including the Indian coast and Red sea (Carpenter and Niem 1998, Fischer and Bianchi 1984). Closing the life cycle of *P. indicus* and its domestication as well as rearing through several generations have been successful (Bukhari *et al.* 1997, Kumlu and Jones, 1995).The shrimp mature and breed mostly in marine habitats and spend the juvenile and sub-adult stages in coastal estuaries, backwaters or lagoons. *P. indicus* is euryhaline, continues to grow in prolonged confinement and attains very large size in brackish water enclosures. Juveniles can tolerate a much wider range of salinity (5-40 ppt) than adults (FAO 2018).In the southwest coast of India the juveniles support a good commercial fishery in the backwaters and paddy fields (CIBA 2018).The present study was performedto observe the growth, survival and production potentials of *P. indicus* under different stocking densities in earthen ponds.

Materials and Methods

Collection of baseline information: Baseline information regarding traditional culture practices of chaka chingri was collected through a pretested questionnaire survey in 2019. Sampling was done in Bagerhat sadar, Mongla, Rampal, Shoronkhola and Morelgonj upazila of Bagerhat district as well as Batiaghata upazila of Khulna district. A total of 60 sets of data were collected through direct personal interview and using Focus Group Discussion (FGD) tool with different stakeholders. Sampling frequencies were twice in every month from February to April 2019.

Pond selection and preparation: The culture experiment was conducted in tide fed three earthen ponds of Shrimp Research Station under Bangladesh Fisheries Research Institute. The ponds had an area of 0.056 ha each with a water depth of 1m. The ponds were prepared bydrying, removing of unwanted sludge and repairing of embankments .Lime was applied at the rate of 250kg/ha in the ponds and left for seven days. Ponds were filled with tidal water from the Daratana river during high tide and left for 3 days to settle down. Pond water was fertilized with compost cow dung@1,250kg/ha, urea @37.5kg/ha and TSP @25kg/ha. These ponds were left for10 days to promote primary food production.

Collection and stocking of PL: The wild post larvae (PL) were collected from the Sibsha River of Khulna districts adjacent to the Sundarbans mangrove forest, acclimatized and stocked in the pond in March, 2019.

Feed and feeding management: The shrimps were fed with commercial CP prawn feed with 36% protein level. Initially feed was provided at 13% of biomass of post larvae and subsequently decreased to 2.5%. Feed was adjusted periodically in accordance with the growth performance, total biomass and assuming 100% survival of *P. indicus.* Feeding schedule was twice in a day at dawn and dusk for the first month, while it was once in day for the rest of culture period. Feed was provided on 5 feeding trays having an area of 1 m^2each. The feed trays were hanged to the bamboo poles and allowed to submerge in the water column. Pond water was fertilized with urea (37 kg/ha) and TSP (25kg/ha) at 15 days interval to enhance natural foods, whereas limed with calcium carbonate at the rate of 65/ha at 15 days intervals to maintain congenial water quality.

Monitoring of physico-chemical water parameters: The physico-chemical parameters of pond water were monitored at 9:00to 10:00AMin every 7 days. Water quality parameters like water temperature (^oC), DO (mg/l), CO_2 (mg/l), total alkalinity (mg/l), pH, iron (mg/l),ammonia (mg/l) was monitored using HACH Kit Box. Transparency (cm) was measured by using secchi disc and water depth (cm) was measured manually by using meter scale.

Monitoring of growth and estimation of production: Health condition and growth of shrimp was monitored fortnightly during the full and new period. At least 5% of shrimp was collected by a cast net in early morning. Length was measured by using a centimeter scale and theweight by a portable weighing balance. After 145 days of rearing, all shrimp were harvested with seine net and the following parameters were calculated:

Average weight gain (g) = Mean final weight (b) – mean initial weight (a); Specific growth rate SGR (%body wt. gain/day) = [(Log_n Final wt.- Log_n Initial wt.)/ Time interval] × 100); Survival (%) = (Number of fish harvested/Number of fish stocked) × 100; Production/Yield (kg/ha) = [{Number harvested × average final wt. (g)/1000] × pond area (ha); and Food conversion ratio (FCR) = Supplied feed (kg)/harvested total biomass (kg).

Data analysis: Comparison of treatment mean was carried out using one-way analysis of variance (ANOVA), followed by Duncan's Multiple Range Test. Significance at the 5% level ($p < .05$) using the SPSS (Statistical Package for Social Science) version-20.

Results

Baseline information: Information regarding traditional culture practices and production of Indian White Shrimp are presented in Table I. Farmers stock chaka chingri during February to March with a very low density of 150/decimal. They follow mixed culture system with other shrimp and finfishes. Sometimes they follow integrated culture with paddy and dyke cropping with seasonal vegetables. Though they never keep records on production of specific species but harvested variety of native shrimp species including Indian White Prawn those entered through tidal water (Table I).

Growth, survival, stoking and harvesting details of *P. indicus* juveniles at the end of 145 days are detailed in this section. Recorded water quality parameters are also reported. The initial weight of *P. indicus* was 0.0123 g and stocking densities were 30/m^2, 40/m^2, 54/m^2 in T_1, T_2, and T_3treatments respectively (Table II). After culturing 145 days the average body weights were 22.18±6.71g, 25.25±3.11g and 29.25±2.88g, with a specific growth rate of 5.31%, 5.40%, and 5.50% in T_1, T_2, and T_3 respectively. The percentage of survival was 18%, 30%, and 23% in T_1, T_2, and T_3 respectively. The mean FCR value was1.05, 0.99, and 1.04 which indicates feed consumption was comparatively lower in T_2 treatments ($p < .05$).

Table I. Present status of traditional culture practice of *P. indicus* in coastal districts

Questions	Responses
Source of PL	Coastal river adjacent to mangrove forest
Time of PL collection	February/March
Stocking	February/March
Stocking density	150 PL/ decimal
Type of stocking	Artificial or Tidal auto-stocking (Chaka chingri 5%-10%)
Culturesystem	Mixed (shrimp+white fishes) and Intregated (paddy+vegetables+fishes)
Culture period	1.5-3 months
Time of harvest	April/May
Constraint	Water Crisis, Poor Salinity level, PL Death, Virus
Opportunityneed	Water in dry season, optimum salinity level, available PL
Species Found	Chaka, Chali, Motka, Galda, Bagda, Tiger, Goda, Horina, Rosni, Juboti, Chamti, Galangi,Kathali
Decreasing species	Chaka, Goda, Kathali

According to APHA (2005) and Boyd and Fast (1992) recorded all physico-chemical variables like dissolved oxygen, pH, alkalinity, ammonia, nitrite, iron and transparency; were found within the acceptable ranges for crustacean aquaculture except the lower salinity levels inT_1, T_2, and T_3 treatments respectively during the entire culture period (Table III).

Table II. Effect of stoking density on growth, survival and production performance of *Penaeus indicus* in earthen ponds*

Particulars	**T_1** (30/ m^2)	**T_2** (40/ m^2)	**T_3** (54/ m^2)
Mean length at stocking (cm)	0.5	0.5	0.5
Mean weight at stocking (g)	0.01	0.01	0.01
Survival rate (%)	18%[a]	30%[a]	23%[a]
Production rate* (kg/ha)	1197[a]	3030b	3632[b]
Mean length at harvest (cm)	16.88±2.20	20.95±1.70	24.33±3.47
Mean weight at harvest (g)	22.18±6.71[a]	25.25±3.11[a]	29.25±2.88
SGR (% day)	5.31%[a]	5.40%[a]	5.50%[a]
Total feed given (kg)	63	150	190
Total biomass produced (kg)	60	151[a]	181.5
Feed conversion ratio	1.05[a]	0.99[b]	1.04[a]

*Different superscript letters within the same row indicate a significant difference ($p<.05$)

Table III. Recorded water quality parameters of culturing *P. indicus* in the earthen ponds*

Parameters	**T_1** (Mean±SD)	**T_2** (Mean±SD	**T_3** (Mean±SD
Temperature (°C)	29.72±2.68[a]	28.72±3.44	27.72±2.99
Dissolved Oxygen (mg/l)	5.90±1.13[a]	5.00±1.17[a]	4.99±1.36[a]
pH	8.25±0.21[a]	8.05±0.24[a]	8. 50±0.61[a]
Salinity (ppt)	3.09±1.20[b]	4.23±1.88[b]	3.77±1.45[b]
Alkalinity (mg/l)	124.0±17.68[a]	134.0±19.60[a]	140.0±20.10[a]
Ammonia (mg/l)	0.30±0.04[a]	0.30±0.05[a]	0.30±0.07[a]
Nitrite (mg/l)	0.03±0.01[a]	0.07±.03[a]	0.09±.02[a]
Iron (mg/l)	0.4±0.20[a]	0.5±0.30[a]	0.8±0.10[a]
Transparency (cm)	25.46±1.36[a]	35.56± 1.16[a]	30.40± 1.77[a]

*Different superscript letters within the same column indicate a significant difference ($p<.05$). All the values were reported as mean with standard deviation.

Discussion

Semi-intensive farming of *P. indicus* was first introduced in late 1980s in India with stocking density of 50-100 PL/m^2 and feeding with artificial diets which augmented the production from 10000 to 20000 kg/ha/yr (CIBA 2018). In the present experiments, the estimated yield of *P. indicus* was achieved 1197 kg/ha, 3030 kg/ha and 3632kg/ha from 3.09±1.20 ppt, 4.23±1.88 ppt and 3.77±1.45 ppt, salinities in T_1, T_2, and T_3 treatments respectively. The yield of T_2 showed significant difference ($p>0.05$) with T_3 and T_1treatments ($p<0.05$) is therefore supported by the observations of Mohan and Nandakumaran (1980) who reported a production of 500 kg/ha for 112 days with a survival rate of 48%. Jones and Salama (1997) found higher growth of Indian White Prawn in salinity ranged between 25-50 ppt. They also found reduced

growth and survival in moderate to low (<15 ppt) salinities. Kumlu and Jones (1995) also reported poor survival (13.3%) at 10 ppt and recommended the optimum salinity level between 20 and 30 ppt for culture of Indian White Prawn. The manifestation of salinity stress and low survival at salinities lower than 10 ppt have also been reported by Parado-Estepa *et al.* (1987) and Primavera (1984). However, survival and production records of *P. indicus* at low salinities are often debated and have different doctrines and disagreements. Production of aquaculture species vary with stocking density, quality of feed used, productivity of watershed, water quality management and influence of various external factors. In this study, the yield of *P. indicus* obtained 1197 kg/ha, 3030 kg/ha and 3632 kg/ha with stocking densities of 30/m^2, 40/m^2 and 54/m^2in T_1, T_2, and T_3 treatments respectively within 145 days of culture is in agreement with the production record of 500 kg/ha for 112 days of culture with 18.5 m^2 stocking densities and 48% recovery rates (Mohan and Nandakumaran 1980).In another experiment they also reported a production of 1,600 kg/ha for 110 days with a survival rate of 98 % when the prawns were stocked at 42 mm mean size and a stocking density of 19/m^2. During the present experiments, only 18%, 30% and 23% survival at the stocking rate of 30/m^2, 40/m^2 and 54/m^2in T_1, T_2, and T_3 treatments respectively were obtained. whereas Lazarus *et al.* (1986) reported a good survival rates (86.7 and 89.8%) in this culture system when the stocking density was 6.4/m^2 and 7.1/m^2 and poor survival rates of 7.9 and 3.6% when the stocking density was 30.5/m^2 and 38.0/m^2 respectively. By rearing the wild stock of *P. indicus* for 145 days the harvest size was 16.88±2.20 cm, 20.95±1.70 cm and 24.33±3.47cm,in T_1, T_2, and T_3 treatments respectively showed better growth in a shorter time. In the normal course when the prawns are stocked at a larger size, the survival rates are expected to be good. Mohan and Nandakumaran (1980) got only 48% survival rate for the *P. indicus* which were stocked at an average size of 42 mm. This poor survival rate may be attributed to the higher stocking density (18.5/m^2). The higher survival rate reported by (Lazarus *et al.* 1988) for the prawns which were stocked at a mean size of 46.6 and 84.0 mm but at a low stocking density (6.4 and 7.1/m^2) lend to support that stocking densities has important role in growth and survival.

Temperature and salinity variations are considered the most important factors influencing the growth and survival of shrimps. According to Rahman *et al.* (2017) in the month of April-May these ponds were shown to have too low water depth to resist abrupt change in water temperature maximum 36°C that creates stress in survivility. Shrimp PL death may be due to the low water depth, rapid fluctuation of water level. The values of transparency 25.46±1.36 cm, 35.56±1.16 cm and 30.40± 1.77 cm were recorded in T_1, T_2, and T_3 treatments which indicate that these ponds were less productive and little bit turbid. Salinity represents the total concentration of dissolved inorganic ions or salts in water. The mean salinity was3.09±1.20 ppt, 4.23±1.88 ppt and 3.77±1.45 ppt in T_1, T_2, and T_3 treatments respectively. Shrimp shell become soften because of low salinity of water where the presence of carbonates/ bicarbonates are poor which accelerate shrimp PL death (Islam et al., 2014). The increase in the feed conversion ratio as the prawns grow larger in many of the ponds may be due to excess feeding as the quantity of feed was determined based on the original number stocked. This can be avoided by feeding the stock after periodically assessing the actual biomass present in the pond. However, the results obtained in the present experiments with *P. indicus* are almost in agreement with the results of Elam and Green (1974), on *P. indicus* using two different feeds in nursery and grow-out ponds. They obtained production rates of 224 to 667 kg/ha, with feed conversion ran-going from 1.8 to 2.3. In the present studythe yield of *P. indicus* was achieved

1197 kg/ha, 3030 kg/ha and 3632kg/ha was obtained in 145 days period with a feed conversion value of 1.05, 0.99 and 1.04 in T_1, T_2, and T_3respectively using commercial pelleted feed.

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