

## Mud Crab Culture: Relevance of Species Identity in Production Economics with Reference to Sundarban Coast

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### Abstract:

The present communication reviews the present state of mud crab fishery in the Indian Sundarban coast based on our field studies on capture and culture of crabs since 1980s. In this region, capture fishery depends on simple methods, using hook and line, while crab fattening in brackishwater ponds depends on household labour and indigenous feeds. The practice of fattening of crabs is based on discarded mud crab congeners of the genus *Scylla* viz., *Scylla serrata* (Forsk., 1775), *Scylla tranquebarica* (Fabricius, 1798) and *Scylla olivacea* (Herbst, 1796) without segregating species-wise. Uncertainty of species level identity as well as wild harvest of under-size crabs are major constraints in capture fishery and development crab fattening in this region. In this context, recognition of species level identity is considered vital towards sustainable wild harvest including fattening of discarded mud crabs, which plays an important role in the rural economy of Indian Sundarban. It is believed that species specific and size specific fattening enterprise may lead to easy aquacultural operation and precise production of crabs even in the reduction of cost of fattening operation.

**Keywords:** Mud crab; Species identity; Production economics; Relevance

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## Introduction

Despite sophisticated technology used in modern fishing, the coastal people almost all over the world largely depend on indigenous technology, based on indigenous knowledge, for capture and culture crabs including mud crabs. This is particularly true for farming or fattening of crabs in the Sundarban coast, West Bengal. Based especially on our observations from this coast of Bay of Bengal region since 1980s (Nandi and Pramanik, 1994; Pramanik and Nandi 2004, 2011) the present review is made with available information from this region. It is worth mentioning that publications from Indian Sundarban region though highlights on fishing implements, fishing methods and other fishing related aspects, hardly reflect on the farming or fattening of mud crabs (Job and Pantalu, 1953; Bal and Rao, 1984; Nandi and Pramanik, 1994; Mitra et al., 1997; Pramanik and Nandi, 2004, 2011). Recently, Pramanik and Nandi (2012) and Nandi and Pramanik (2015) reported crab fattening and production economics of crab fattening in brackishwater ponds of Sundarban region. The practice of fattening of crabs is primarily based mainly on discarded mud crabs belonging to the genus *Scylla* de Haan, 1833. All over the Indo-west Pacific region, this genus is represented by of four congeners (Estampador, 1949), viz., *Scylla serrata* (Forsk., 1775), *Scylla tranquebarica* (Fabricius, 1798), *Scylla olivacea* (Herbst, 1796) and *Scylla paramamosain* Estampador, 1949. Except *S. paramamosain*, three other species are known to occur in the Indian Ocean regions and possibly in the Indian Sundarban.

Earlier works in India as well as West Bengal mainly relate to the widely distributed species *Scylla serrata* supporting the acceptance of a single species, *S. serrata*, as opined by Stephenson and Campbell (1960) and Holthuis (1978). Recent research and world-wide genetic data show that there are at least four distinct species of mud crabs with little evidence of hybridization despite being sympatric in many areas (Keenan, 1996; Keenan et al., 1998). The uncertainty of genetic relationships is recognized as one of the major constraints in management of capture fishery and aquacultural development for which an understanding of taxonomy and recognition of species is very vital. In the Indian Sundarban such studies need to undertaken towards sustainable wild harvest of mud crabs as well as fattening of discarded mud crabs assembled the local markets, However, Pramanik (2014) made the beginning of an in depth empirical study on the life and livelihood of crab fishers of India Sundarban, including crab fattening practices prevailing in this region.

## Taxonomic Identity

### Systematic position

Mud crabs belong to the genus *Scylla*, family Portunidae, infra order Brachyura and order Decapoda, Class Malacostraca, Subphylum Crustacea.

### Recognition of species

The differential morphological features of the four species are shown in the key to species of the genus *Scylla* hereunder (Keenan et al., 1998):

## Key to the species

1. Carpus of chelipeds with two obvious spines on the distal half of outer margin ..... 2

Carpus of chelipeds without two obvious spines on the distal half of outer margin ... 3

2. Frontal lobe spines of high, bluntly pointed; anterolateral carapace spines narrow; polygonal patterning present in chelipeds and all legs for both sexes .... *Scylla serrate*.

Frontal lobe spines of moderate height, blunted; anterolateral carapace spines broad; polygonal patterning weak in chelipeds and first two pair of legs, while last two pairs of legs with stronger patterning for both sexes ..... *Scylla tranquebarica*.

3. Frontal lobe spines high, typically triangular; palm of cheliped with a pair of distinct spines; polygonal patterning weak in chelipeds and all legs for both sexes ..... *Scylla paramamosain*.

Frontal lobe spines of low, rounded; palm of cheliped with usually with a pair of blunt prominences; polygonal patterning not obvious in chelipeds, legs and also abdomen for both sexes ..... *Scylla olivacea*.

## Differential diagnosis

Comparative morphological features and morphological ratios of *Scylla* species is presented in **Table 1** for recognition and differential diagnosis of the species.

**Remarks:** Species level criteria used to differentiate these species especially of spines, seemingly not conclusive and debatable for not very distinctly demarcated or specified.

## Distribution of the species

*Scylla serrata*: Widely distributed in the Indo-west Pacific regions.

*Scylla tranquebarica*: Commonly occurs in the South China Sea and also found in some specific locations of Indian Ocean and the Pacific Ocean.

*Scylla olivacea*: Moderately widespread species commonly occurring in the South China Sea, but also reported from in specific locations across Indo-west Pacific.

*Scylla paramamosain*: Only reported to abundantly occurs from the continental coast of the South China Sea, Central Java and Vietnam.

## General Morphology of Mud Crabs

Chitinous carapace oval, wider than long, moderately convex with smooth surface; gastro-cardiac groove poor or moderately developed; front distinctly separated from supra-orbital angles, with four teeth; frontal width variables from species to species; anterolateral margins convex, with nine similar teeth; chelipeds massive, smooth, longer than legs; merus with three large spines on anterior border, two smaller spines on posterior border; carpus with acute tooth at inner angle; propodus with strong spine at

**Table 1:** Comparative morphological features and morphological ratios of *Scylla* species.

Parameters	<i>S. serrata</i>	<i>S. tranquebarica</i>	<i>S. olivacea</i>	<i>S. paramamosain</i>
<b>Morphological characters</b>				
Shape of frontal lobe spines	Blunt point	Blunted	Rounded	Triangular
Height of frontal lobe spines	High	Moderate	Low	Moderately high
Carpus spines of chelipeds	Both obvious	Both obvious	Inner absent, outer reduced	Inner absent, outer reduced
Propodus spines of chelipeds	Obvious	Obvious	Obvious	Reduced
<b>Morphological ratios (means)</b>				
ICS/ OCS	0.940	0.980	0.006	0.352
FMSH/ FW	0.061	0.043	0.029	0.058
FW/ ICW	0.371	0.412	0.415	0.377

**Source:** Keenan et al. (1998); ICS: Inner Carpus Spine, OCS: Outer Carpus Spine, FMSH: Frontal Median Spine Height, FW9: Frontal Width, CW: Carapace Width.

carpus articulation; legs stout, moderately compressed, first three pairs similar, fourth pair natatorial; male abdomen narrow, segments 3-5 fused; female abdomen broadly oval; colour variable, with or without polygonal patterning. Internal structures comprising of branchial chamber, gills, pericardial cavity, heart, gut, stomach, green glands, pre-oral brain, post-oral ganglionic mass, paired gonads, statocysts, muscles, endoskeleton, etc., may have biotechnological relevance.

## Brief Biology of Mud Crabs

### Habit and habitats

*Scylla serrata* inhabit mangrove forests inundated with full salinity oceanic water, but can tolerate reduced salinity in the estuarine regions, while *S. tranquebarica* also inhabit mangrove forests and coastlines with reduced salinity and even found buried within estuaries. *S. olivacea* is also associated with mangrove forests and coastlines inundated with reduced salinity. *S. paramamosain* is reported to occur in shallow coral reef rubble (in Singapore), shallow subtidal flats and estuarine ponds (in Central Java) and in mangrove forests in the Lower Mekong Delta, Vietnam (Keenan et al., 1998).

### Burrow pattern

Mud crabs are side burrowers, digging simple or complex burrows depending on the nature of substratum and experienced or anticipated threats by man and wild animals. The depth of the burrows varies from 0.7-1.45 m and width of the burrow measuring nearly twice the depth or thickness of the sheltering crab (Nandi and Dev Roy, 1991).

### Feeding habit

Mud crabs are opportunistic omnivores, feeding on a variety of foods, with a preference for animal food, dead or alive. Animal food mostly comprises of small mollusks, crustaceans and polychaetes. Crab fishers of Sundarban use flesh of eels, catfishes and frogs as bait (Nandi and Pramanik, 1994; Pramanik, 2014).

### Clinging habit

Mud crabs have a firmly clinging habit to their feed or bait or any object when agitated. Fishermen of Sundarban use this habit to pull out crabs from their burrows.

### Mating behaviour

In portunids including mud crabs soft female mating is characteristic (Hartnoll, 1969). Male is attracted to the female a few days before moult and hold her beneath his sternum until moulting. Copulation occurs just after her moult, during which ventral surfaces of both sexes remain appose to each other. Male mud crab guards the female even after copulation so long her carapace is somewhat hardened. After mating females retain sperm so as to produce 2-3 egg masses.

### Fecundity

Female mud crab can produce 1-6 million eggs. Larger species produces larger numbers of eggs.

### Life cycle stages

Eggs of mud crabs hatch into larvae which are released in the sea. Larvae lead a planktonic life, moult several times during their larval life. Larval stages are known as zoea and megalopa. Four zoeal stages (sometimes six) are followed by a single megalopa stage. Zoea feeds on diatoms and other tiny organisms and grows at each moult to develop into metazoea, and finally to megalopa stage. Megalopas develop into crablet and migrate to the coast from the sea. Biology and life cycle technological changes are key factors to cost benefit analysis in mud crab production economics.

### Mud Crab Fishing

Crab fishers of Sundarban use two types of boats, locally known as *dingi* and *paukha*. These crab fishing boats are light and built by local carpenters with local wood. The shape of the two types of boats varies, but the size, capacity and cost are almost the same. *Dingi* is round bottomed, while *paukha* is flat bottomed. The size of *dingi* ranges from 30 – 35 feet in length and *paukha* of 25 – 30 feet in length. Crab fishers of Sundarban use strongly built *dingi* made of *sal* wood when they resort to long duration (12 days trip) crab fishing expedition in the turbulent waters of Matla and Thakuran estuaries.

### Crab fishers of Sundarban coast used two types of gears as follows:

**Hook (sik):** Hook is an iron rod with 0.5-1.2 m in length and 4-8 mm in diameter, one end of which is slightly curved in the form

of J, while the other end is fitted into a wooden handle. Length and diameter vary from place to place, depending on the depth of crab holes and the soil condition. It is used in the intertidal mudflats to pull out mud crabs from their burrows.

**Line (don):** Single baited line (*Thopa* fishing) is used for capturing crabs, which consists of a coir or nylon rope of 2-4 mm in thickness and about 1-3 m in length, tied to a wooden or bamboo stick of 30-100 cm length in single baited line. The other end of the rope is tied with a small weight and bait. The free end of the stick is driven to the mud near shoreline.

Multiple baited line (*Suti* fishing) consists of long rope made of nylon ranging 400-1200 m in length and 5 to 10 mm in thickness. Length of multiple baited line (don) varies, depending on the stretch of the fishing site. Baited sub-strings of 5 to 15 cm length are hanged at regular interval of 40-50 cm. Weight, piece of brick or a burnt earthen circle, is tied to the rope as sinker at about 5 m apart. It is usually operated from a *dingi* in the estuaries.

Accessories, used by the crab fishers of Sundarban are primitive and indigenous, and include i) *Forceps (chimta)*, ii) *Scoop net (jal)* and iii) *Baskets (chakan, gacha, jhanka, jhuri, khancha, khalui, etc.)* for handling, catching and storing crabs.

Crab fishers skillfully operate hook (*sik*) in the intertidal mudflats for fishing crabs. The hooked end of the hook is thrust into the crab hole to detect the location of mud crabs. It is then maneuvered in such a way that the crab is hooked. Sometimes the crab being agitated firmly clings to the hook with its strong chela. Hook fishers with their experience can easily pull the crab out of the hole.

Multiple baited line (*suti*) is placed after selecting suitable creek, one end of it is tied to a bamboo pole driven into the mud and the other end is fastened to a post in the boat. Crabs are attracted to the bait tied with the sub-strings by means of slip-noose. When the bait is pulled, the slip noose becomes tighter. In harvesting crabs the fishermen use the clinging habit of the crab to their advantage. Three fishermen are required to operate line fishing, one reels the line, another operates scoop net to catch the crabs and the third person rows the boat towards the fixed bamboo pole with which one end of the line is tied (Nandi and Pramanik, 1994).

Mud crab fishers of Sundarban are subjected to two major threats, namely, tiger attacks and sea piracy, besides occupational hazards like physical injuries in feet from pneumatophores and risk of life from crocodile and snake bite, cyclonic storms, etc.

Professional crab fishers store their catch in the baskets and in the holds of country boats used in the fishing ground. They use to sprinkle saline water twice a day to prevent desiccation for storing them for longer duration to sell in the market alive. Traders segregate crabs in plastic baskets grading them into different sizes to airfreight them for export.

## Mud Crab Capture Fishery Production Economics

In 1993, hook fishers of Fatikpur stated that they earned Rs. 364, collecting an estimated 640 crabs in 8 trips (weekly 2 trips

of 2-3 days duration) with a total sale proceeds of Rs. 576 after selling them at an average Rs. 18 per score i.e., 20 crabs, spending an average expenditure of Rs. 212 a month which include boat owner's charge (Rs. 25/-), fooding expenses of Rs. 150, permit charge Rs. 12 and pocket / petty expenses of Rs. 25 only (Nandi and Pramanik, 1994).

In 1985, multiple baited line fishing unit comprising of 3 fishers of Tardah/ Protapnagar areas participating in the fortnightly trip of 12 days duration informed that a crab fisherman earned Rs. 186 in a fortnight, i.e., Rs. 372 per month. The boat owner who happened to be crab fishers in the unit earned double the amount receiving 2 out of 4 shares, one as a fisher and the other share for his boat (Nandi and Pramanik, 1994).

Marketing channel consists of catchers, paikars, suppliers, aratdars, and exporters. There are nine export agencies for live mud crab export from Sundarban region.

## Mud Crab Fattening

Aquaculture for grow out of Mud crab in Sundarban is not practised due to non availability/ inconsistent availability of crab seeds for farming, even though hatchery production of mud crabs continued over last few decades (Shelley and Lovatelli, 2011). Crab fattening in Sundarban, locally known as *Chamber chas*, is the culture of adult mud crabs (*Scylla serrata*, *S. tranquebarica*), considered unfit for export, in small brackishwater bodies (ca. 0.01 ha) for a short period of 15-20 days to meet the increasing demand of gonad-developed and meat-crabs for domestic and export markets. It is a new enterprise of late 1990s, recently gaining ground in Indian part of Sundarban. It is profitable because of fast turnover, low operating cost (due to use of domestic labour in most cases), high survival rate (90%) and good demand for the end products. Crab fattening is pursued by the coastal crab traders and crab fishers in small brackishwater ponds, where discarded soft crabs/water crabs available in the crab markets of Canning, Nazat, etc., are reared for about 15-20 days. Areas like Gosaba, Basanti, Minakhan, Hingalganj, Hasnabad and Sandeshkhali, nearer to mangrove forest, are found to resort to crab fattening to meet the demand of gonad developed female crabs and larger sized male meat crabs.

So far, *chamber chas* is encountered at 14 out of 19 Development Blocks of Indian Sundarban, 10 in South 24-Parganas district, viz., Gosaba, Basanti, Canning I, Canning II, Janagar II, Kultali, Namkhana, Kakdwip, Sagar and Pathar Pratima and 4 from North 24-Parganas district, viz., Hingalganj, Hasnabad, Sandeshkhali I and Sandeshkhali II. Both Hindus and Muslims are engaged in *chamber chas*, even taking on lease of local ponds. The details of two crab fattening case studies have been published entitled '*Sundarbane Chamber Chas*' in a local Bengali Magazine "*Sundarban Alekhya*" August 2011, 28<sup>th</sup> Year, 2<sup>nd</sup> Issue, pages 5-10, by the senior author to encourage and aware about this recent enterprise. One of us (NCN) on the occasion of *Sarberia Sundarban Mela* at Dhamakhali, South 24-Parganas, has also earlier in 1995 prepared one leaflet containing information relating to mud crab culture entitled "*Nonajale Kankra Chas*" for circulation and awareness by the *Mela* organiser. A book entitled

“Crab and Crab Fisheries of Sundarban” dealt with the prospect of mud crab culture giving a model culture pond was also published by us in 1994. Perhaps this book and the leaflet mentioned above have aroused the interest of crab fattening enterprise in this region.

Small and medium sized (partitioned by bamboo screen into 2-5 units) shallow brackish water ponds of 1-1.5 m water depth and ranging from 0.01-0.1 ha, usually with inlet and outlet systems available along the estuarine course are utilized with or without much modification for crab fattening purpose. Bamboo screens and nylon nets are used at the embankment and as partition in the pond to prevent escape of crabs (Pramanik, 2014).

Post moult adult male crabs and eggless female crabs unsuitable for export are procured and stocked. Mud crab farmers provide feed of trash fish, mollusk meat, etc., @ 7-8 kgs per quintal of crabs stocked for fattening. Field surveys and observations revealed that crab farmers use to stock discarded crabs @ 20-40 (30) kg crabs per cottah of pond and supply fresh fish and mollusk feed @ 7-8 kg per 100 kg of crabs i.e., @7-8 % of body weight (Nandi and Pramanik, 2015). Mud crabs are harvested by hand picking after dewatering the ponds.

## Mud Crab Fattening Production Economics

In 2011, a crab farmer of Sundarban owning a small pond of about 0.01 ha earned about Rs. 15,500 from *chamber chas* of 18 days using household labour as follows (Pramanik and Nandi, 2012):

Total expenditure (on purchase of eggless crabs, feed, etc.)  
.....Rs.23,200.

(Eggless crabs 100 kg @ Rs. 200per kg=20,000; feed comprising of trash fish, molluscs, etc., 7-8 kg @ Rs. 7-15 per kg for 18 days totalling around Rs. 2000, and labour charge, lime for pond preparation and welling out of water Rs. 1,200)

Total income from sale of 90 kg of crabs @ Rs. 430 per kg  
..... Rs. 38,700.

(End products 90 kg mud crabs with a loss of 10% due to mortality or escape)

Total household earnings from 18 days *chamber chas* .....  
.... Rs. 15,500.

However, It has been observed that a crab farmer having medium size of 0.4-0.6 ha pond with 2-3 units of bamboo screen partition earned Rs. 1,200-2,000 per month per cottah (*katha*), using his own brackishwater pond and household man-powers 8 times a year. It seems that *chamber chas* may provide a new horizon to the local inhabitants of Sundarban, West Bengal. But the main constraint of crab fattening enterprise is that it is entirely dependent on crabs caught from the wild as well as from brackishwater *bheries* available as by products. Another constraint is that there is no suitable feed other than trash fish which remains the major feed to *chamber chas*. Still, *chamber chas* may prove to be a potential and promising enterprise (Nandi and Pramanik, 2015).

## Marketing and Export

Crab markets of Sundarban buy and sell wild caught as well as fattened crabs from suppliers, *paikars* and also from crab catchers. At Nazat crab market there are 15 crab *arats* of which 4 *arats* directly sell their export size crabs to the export agencies located in and around Kolkata. The price of crabs of different grades is fixed by the exporters based on price prevailed in the export market. *Aratdars* come to know over phone and accordingly fix their purchase rate which runs down the suppliers, *paikars* and producers also over phone. Middle men/ intermediaries in the marketing channel often take *dadan* from their buyers/ *malik* hypothecating their collection of crabs (Pramanik, 2014).

Export trade of fattened live mud crabs is also undertaken by the nine exporters located in and around Kolkata (Pramanik, 2014).

## Concluding Remarks

Crab catching, in the Sundarban remains in its traditional form even today. Wild estuarine crab stock is increasingly exploited / over-exploited. Increasing demand of live mud crabs in the export market enhances the need for farming. It is needed to standardize the crab fattening technique using simple scientific methods of water quality monitoring in addition to size and sex-wise segregating of crabs, reducing mortality rate and escape of crabs, and also need for pond management and provision of cost effective feed supplement to augment the production potentials and to reduce the dependency on mangrove forest (Allan and Fielder, 2004; Shelly and Lovatelli, 2011). However, it is worth mentioning that Rajiv Gandhi Centre for Aquaculture (RGCA) and the R & D arm of the Marine Products Export Development Authority (MPEDA), have established a Hatchery at Thoduvai Village, Sirkali, Nagapattinam, Tamil Nadu. Scientists at RGCA have achieved a breakthrough survival of 7% to 14% against the world average survival rates of 3%. This encouraging breakthrough achieved by RGCA can open up avenues for commercialization of Mud Crab hatchery technology leading to organized Mud Crab Aquaculture in the coastal areas of the country (Benjamin, 2012).

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