Soft-shell mud crab production for export in Purba Medinipur, West Bengal, India

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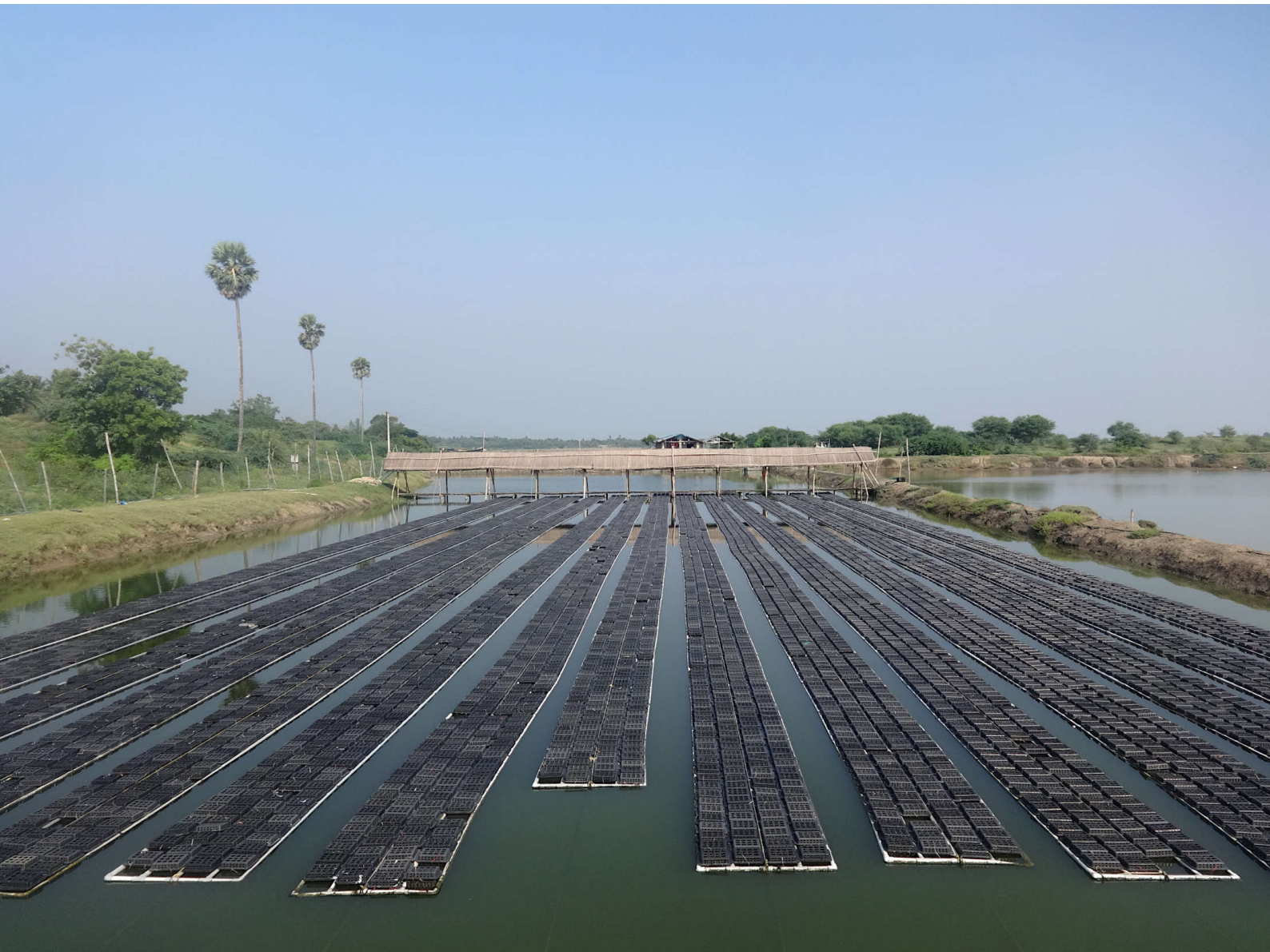
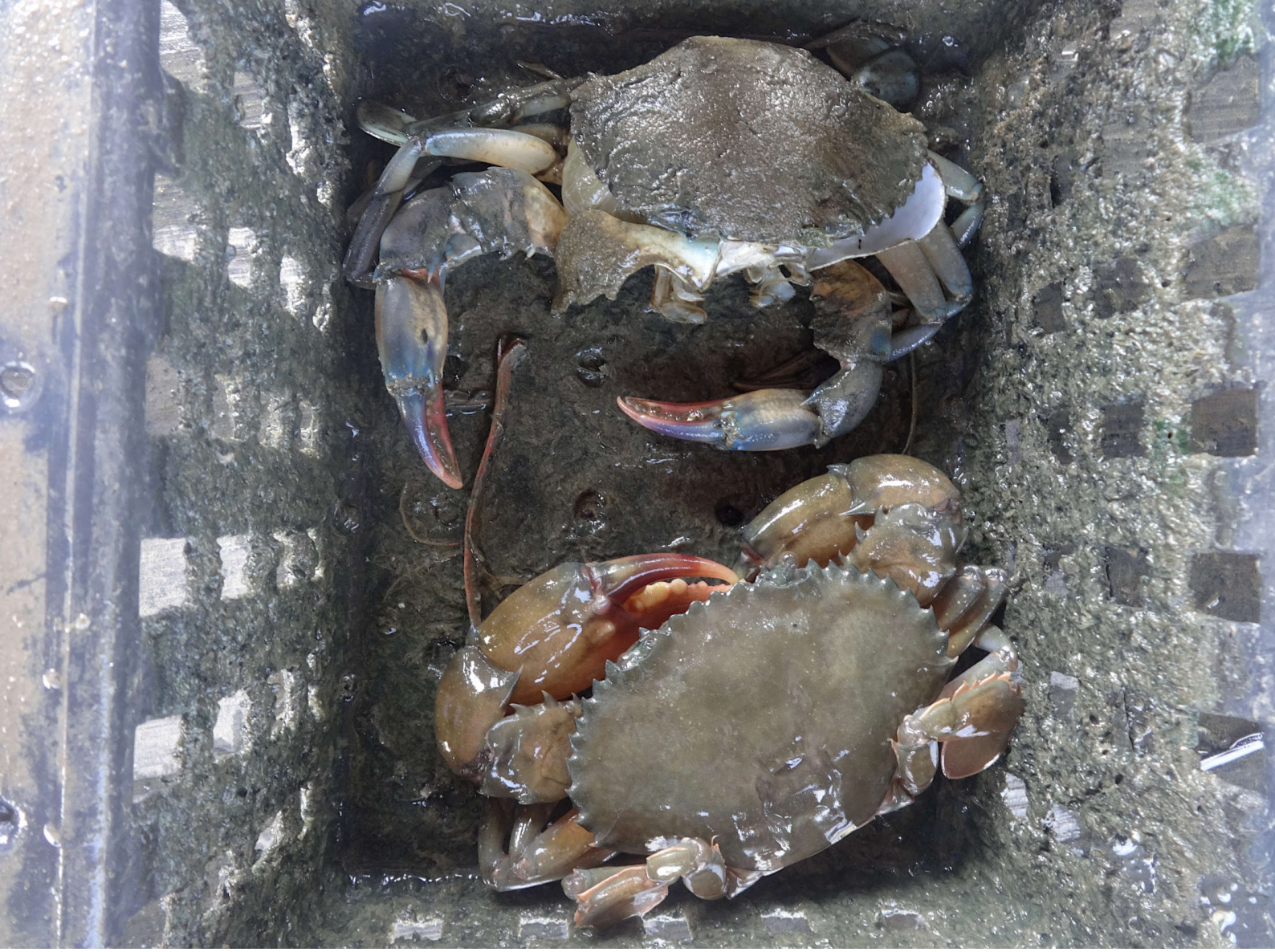
In India, the cultivable mud crabs *Scylla serrata*, *S. tranquebarica* and *S. olivacea* are high-value export items commanding a good market price, mainly in hotels and restaurants of countries in southeast Asia, including Singapore, Malaysia, Vietnam, and Indonesia, and more broadly in the United Arab Emirates, Europe and USA. Among the eleven diversified export items, the main forms include frozen cut crab (with and without claw), frozen mud crab, frozen whole crab, frozen soft-shell crab, frozen crab meat, chilled soft-shell crab, live mud crab, pasteurised crab meat, chilled crab[1] (Source: https://mpeda.gov.in). Both frozen soft-shell crab, that originated in Indonesia, and frozen crab meat can be considered as value-added edible seafood products. This promising and established trend of export of mud crabs to international markets encourages local production of adult market sized crabs, fattened crabs and soft-shell crabs in brackishwater aquaculture ponds on a commercial scale and their promotion in coastal districts of India. These are now emerging as feasible business ventures in India[2]. Higher production of *S. serrata* and *S. olivacea* and subsequently proper processing will sustain the sector and exporters of these products.

The naturally occurring coastal and estuarine waters in North 24 Parganas, South 24 Parganas and Purba Medinipur districts of West Bengal generate a large quantity of juvenile, sub-adult and adult mud crabs, which can be exported after their grow-out, fattening and production of soft-shelled

A panoramic view of the production unit for soft-shell orange-clawed mud crab, Scylla olivacea.





A recently-moulted crab and its shed exoskeleton within a box.

stock, as needed. When wild-caught mud crabs of 50-100 g are reared individually for a short period and harvested on moulting, the process is termed 'soft-shell crab rearing'. Since March 2020, this activity has been undertaken commercially and seriously on a medium- to large-scale at National Aqua Farm, which is producing good quality, soft-shelled, orange-clawed mud crab *S. olivacea*. The farm is located in a brackishwater region at Village and P.O. Narandia, Balisai Gram Panchayat under Ramnagar-II Community Development Block, PS Ramnagar, Purba Medinipur District, West Bengal. The first author, a non-local Kolkata-based business person is the sole proprietor of this farm. The details of current management practice on the farm are presented in this communication. The proprietor obtained hands-on training in green mud crab farming at the Rajiv Gandhi Centre for Aquaculture (RGCA), Nagapattinam, in 2017 and started *S. olivacea* grow-out farming in brackishwater ponds in 2018 on trial and error basis. He finally decided to get involved in soft-shell mud crab production in boxes, and further packing and freezing (similar to 'frozen whole round' form) for export, an idea he considered less risky than *Penaeus monodon* and *P. vannamei* farming.

Moulting in mud crabs

As we know, moulting is a physiological growth process in mud crabs and other crab species, whereby the existing hard exoskeleton (outer shell) is shed and replaced by a soft, newly formed one, which hardens over the next 48-72 hours. Crabs moult when, due to growth, they are unable to contain their additional meat within the existing shell. Just before moulting, a new exoskeleton forms on the mud crab body below the old, hard and dead shell. During moulting, crabs expand, emerge, and shed their older shell in about 15 minutes and become larger in size. Soft-shelled mud crabs are those which are within the transitional phase, possessing a soft exoskeleton, within the first hour of moulting. Under natural conditions, the new exoskeleton begins hardening after 1.5-2.5 hours post-moulting and gets progressively tougher after steadily taking in water.

Male and female soft-shell *S. olivacea* are harvested on this farm before their new shell starts hardening, within 30-120 mins after moulting. Once such newly moulted crabs are harvested and taken out of water, hardening of exoskeleton is stopped and it remains soft. The entire body of soft-shell mud crab (including exoskeleton and chelate legs) can be eaten after cooking; its shell is not at all crunchy but soft, unlike normal adult mud crab. Thus, soft-shell mud crabs have a more meat in comparison to normal adult/sub-adult crabs. In

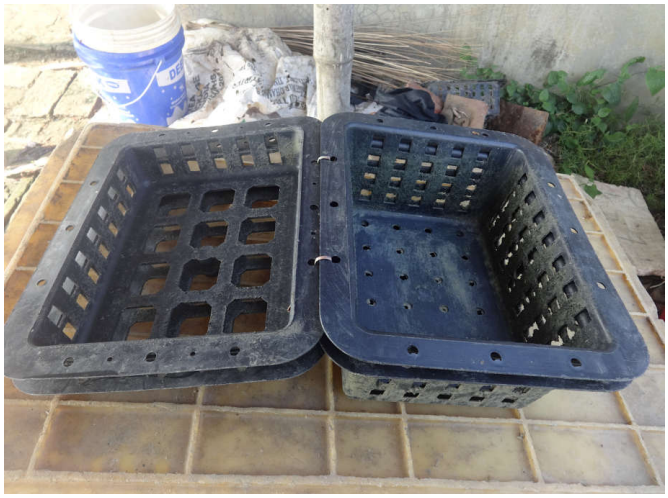
general, for 70-100 g *S. serrata* and *S. olivacea*, in controlled and confined farm pond conditions and grow-out farming, moulting occurs at one-month intervals and 1.4-2.0 times more weight is gained after moulting if the crabs are given good quality feed in sufficient amount. The stocked 40-60 g mud crabs moult at about fifteen-day intervals. The rate of moulting is slower in winter months.

Soft-shell mud crab production unit

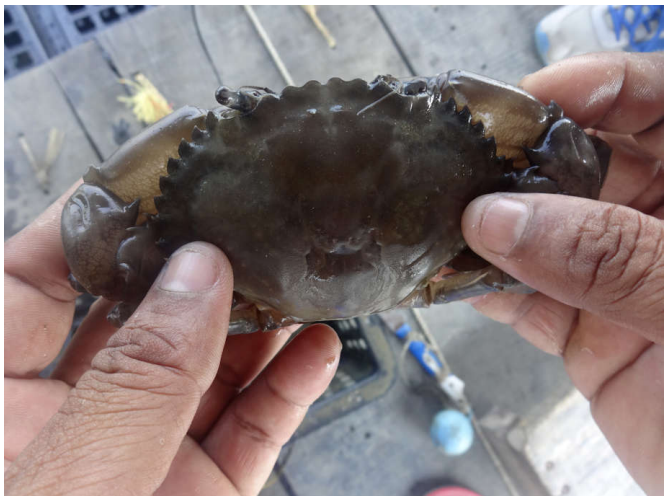
After recent completion of a moult, mud crabs remain defenceless until their new exoskeleton hardens, and may become prey to other animals, particularly other mud crabs or meat crabs of similar or larger size[3]. To prevent cannibalism amongst stocked *S. olivacea* and increase yield of the soft-shell form, submerged-type black-coloured durable plastic boxes with hinge lids and small openings on all sides are used to rear the crabs individually. The boxes have perforations of around 3 x 3 cm^2 on top, 1.5 x 1.5 cm^2 on the sides, and smaller holes on the bottom. The boxes are around 20 cm wide and 25 cm long, cost INR 80-100, and are purchased from south India. They can be used for both crab fattening and soft-shell crab production. Nine crab boxes can be accommodated within a 1 m^2 area in floating frame.

Likewise, the fourth author observed 600 fighting fish *Betta splendens* being maintained individually until adult and marketable size in used hospital saline bottles at a progressive aquarium fish grower's home at the 'freshwater ornamental fish hub' Udayrampur village, South 24 Parganas District. As *B. splendens* are aggressive towards one another, they must be reared separately. He previously learnt the state-of-the-art of fattening of mud crabs *S. olivacea* in larger boxes at the mud crab farm of Sri Dibakar Majumdar, located at East Ganeshnagar Village, Namkhana Development Block, South 24 Parganas[4].

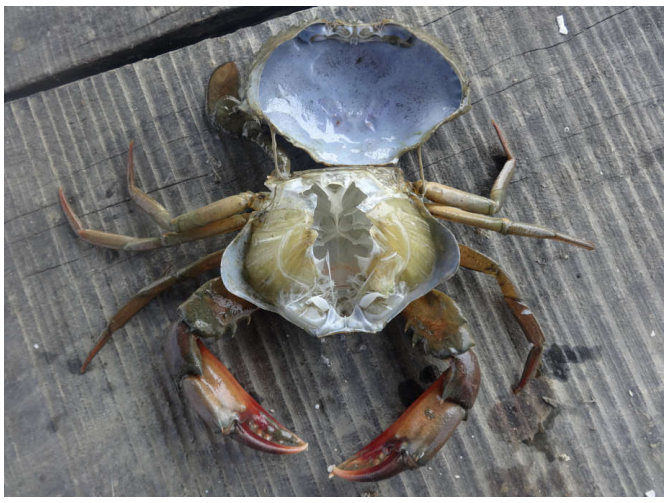
The soft-shell *S. olivacea* production unit is set up in a well-maintained brackishwater pond of 0.4 ha (one acre) in area and 0.9-1.0 m deep, taken on lease contract. In all, 15,000 crab boxes have been positioned within floating rafts or frame-like structures. All boxes float on the surface of the pond one after another in linear series along its length (108 m). Each raft or floating frame is comprised of five parallel long and white PVC pipes 5 cm diameter, which are further divided into four lanes filled by four rows of boxes, extending from one end of the pond. One raft holds 1,000 boxes (250 in one row), and a total of fifteen rafts are positioned in the pond. The length of a raft is about 52 m. This pond can hold a maximum of 20,000 crab boxes. The farm keeps an additional stock of 500 new boxes on standby. Each box is 75% submerged, allowing the resident crab to remain below the water surface. The location of the farm is just beside the 84 km long Tamluk-Contai-Digha State Highway in Purba Medinipur at Banksalghat point/bus stop in Ramnagar-II Block and 15 km on the way to Digha, a famous sea beach and coastal resort town in West Bengal. On new moon and full moon days, the bottom water in the pond is exchanged and fresh tidal water is let in through a sluice gate with a close-meshed screen from a nearby brackishwater canal, which extends for 5 km from this farm towards Bay of Bengal. The canal meets the sea at a point in between Mandarmoni and Tajpur, two other well-known sea beaches-cum-seaside resorts in the same district.



Close view of a LDPE plastic crab box.

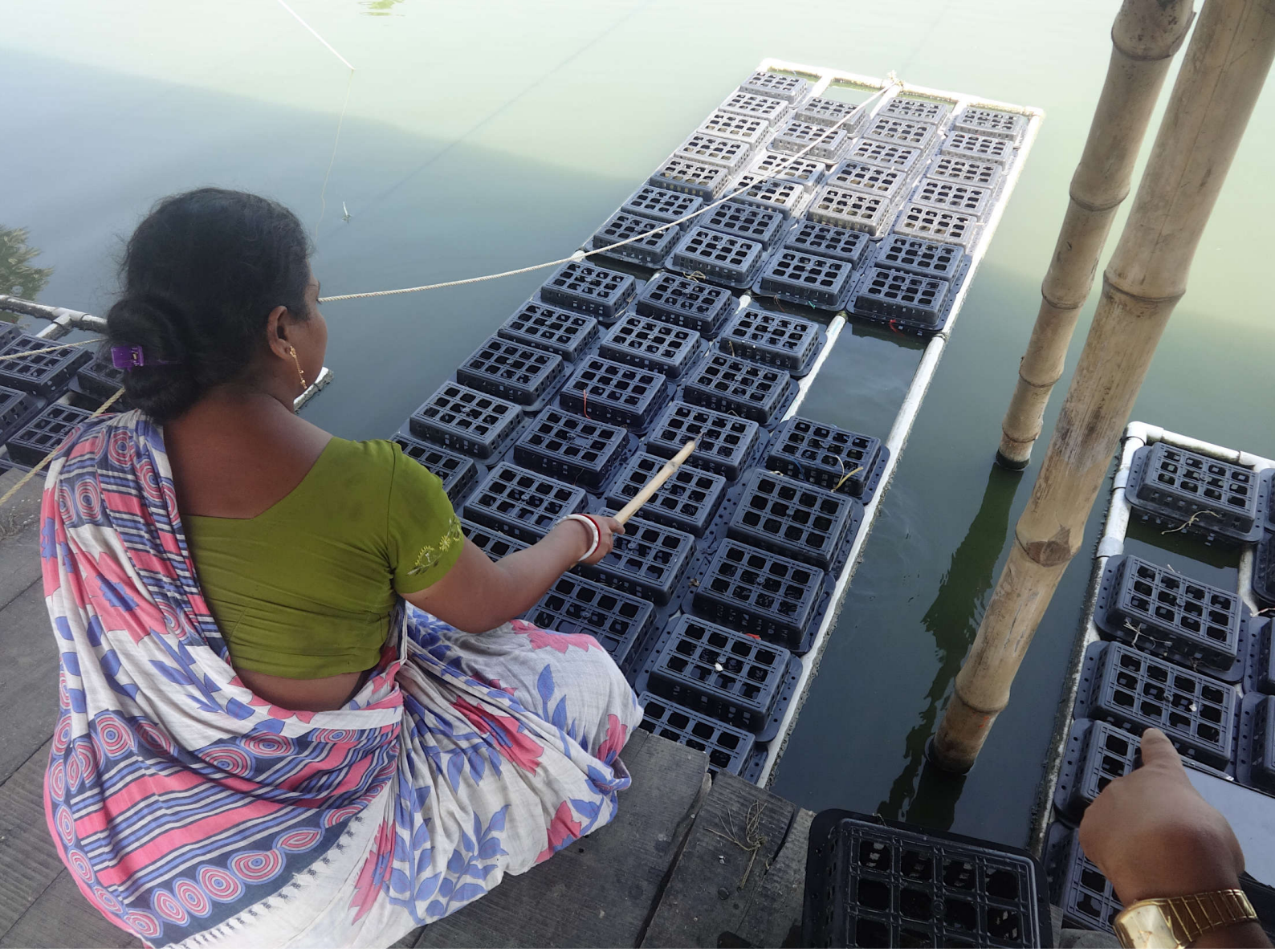


Close view of a recently-moulted S. olivacea.



Close view of a shed S. olivacea exoskeleton.

The farm obtains its stock as normal hard-shell male and female *S. olivacea* of 50-75 g, caught by crab collectors from tidal and estuarine areas occupied by mangrove vegetation in the coastal belt of Purba Medinipur and South 24 Parganas. The crabs are bought @ INR 120-200/kg at 3–6-day intervals and stocked in boxes individually. Within each batch, some *S. olivacea* may have moulted in nature 14 days before the day of stocking, some 10 days before and some 4 days before. The quantity of purchase depends on availability of mud crabs



An employee examining the boxes on one of the rafts.

of preferred size in depots, the stock available with collectors and the number of empty boxes the farm has after harvest of soft-shell crabs in the right condition.

The quantity needed for restocking is estimated. A straight walking platform or wooden footbridge with roof 1.5 m wide made of closely-placed planks of wood 20-30 cm wide is indigenously constructed across at the middle of pond along its width. Farm workers handle crab boxes individually, monitor the condition of each and every crab and feed them. Boxes in all fifteen rafts are kept under observation, checked individually at a three-hour interval (4-5 hours during night time) from the third day of stocking, and the moulting status of the crabs is monitored. If the crabs are not inspected to identify individuals in the soft-shell state, their exoskeleton will harden, and they will become unsuitable for harvest and sale. Rechargeable head torch lights are used by farm workers in late evening and night hours to inspect the boxes.

Using connecting ropes, an entire raft can be slowly moved over the pond surface forwards or backwards below the platform (0.5 m distance) by sitting on it. If shedding of exoskeleton is found to have taken place in any of the boxes with a soft-shell crab lying beside it, these particular ones are lifted from respective raft onto the platform, the recently moulted *S. olivacea* brought out, handled carefully and kept in a bucketful of water in live condition in the shade.

Moulting for lesser numbers of *S. olivacea* has been found to take place in this farm on the full moon and new moon days and also 3-5 days prior to (approaching to) these days. Normally no moulting is observed on the first 4-5 days of stocking; it increases from the sixth day until the 18th day, with harvesting of soft-shell crabs completed within 22-25 days of stocking from all boxes. Moulting of some mud crabs may take place on the fifth day (supposedly), and some may moult on the seventh and eighteenth day of stocking, depending on their growth. The first and second authors harvest 50 soft-shell *S. olivacea* from every 1,000 crab boxes every day.

Low-cost small- to medium-sized marine and brackishwater finfishes, viz., *Coilia dussumieri*, *Polynemus* sp, *Setipinna phasa*, *Lepturacanthus savala*, *Harpodon nehereus*, *Chiro-centrus dorab*, reddish *Johnius* sp., both in wet (fresh) and dried forms, are cut into smaller pieces and fed to stocked *S. olivacea* in individual boxes @ 5-6% of body weight on daily basis. Fresh fishes are brought from the nearby Digha Mohona (12-14 km from this farm) and Shankarpur marine fish landing centres. During the marine fishing ban period (March to June) and times when fishing trawlers do not operate, sun-dried fishes are brought from dry fish processing areas and fish drying yards (camps) of coastal villages namely Shankarpur, Mandarmoni, Khejuri, Jalda, Soula, Digha Mohona and Junput in Purba Medinipur. Wet

and dried fishes are bought @ INR 70-80 and INR 15-20/kg respectively. Dried fishes are mostly supplied by persons with whom a contract has been made beforehand.

Post-harvest management of soft-shell *S. olivacea*

At the mud crab processing hall of this farm, live soft-shell *S. olivacea* are collected in buckets are placed in big aluminium vessels (round mouth, 50 cm open diameter) @ 9-10 crabs/vessel, containing freshwater under continuous aeration for 20-45 minutes to clean the outer body surface and bring out residual faecal material from inside. Thereafter the live crabs are placed (closely spaced and one above another) in chilled water contained in 20-25 litre plastic buckets and kept inside a single-door chest freezer at 0-4°C temperature for 5-6 hours. The whole-bodied soft-shell *S. olivacea* are individually wrapped in 20 x 20 cm^2 thin and clear food-grade plastic polyethylene sheets, taking the shape of intact rolls of crab flesh, each 12-14 cm in length and 3-4 cm in diameter. One roll of polythene sheet costs INR 200-250.

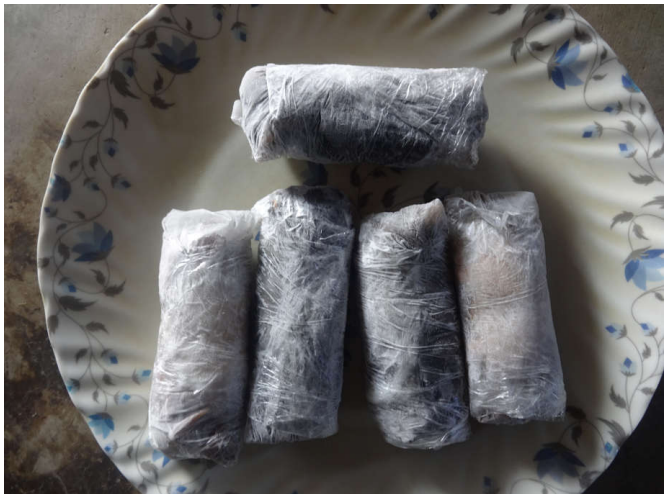
Individually packed soft-shell *S. olivacea* rolls are kept inside another deep freezer with double doors, maintained and preserved at -20°C. These are supplied in frozen 'ready to cook' form to licensed seafood (crab) exporters at the price INR 600-800/kg. *S. olivacea* of 60-75 g at stocking are typically 80-110 g at the time of harvest at this farm, with females gaining comparatively less weight. The first author supplies 70-90 kg material to exporters every time.

End note

In the open area of this brackishwater pond, the first author has stocked riverine seeds of *Liza parsia*, *L. macrolepis*, *L. tade*, *Rhinomugil corsula* and *Mystus gulio*, purchased from fish seed traders of Purba Medinipur and South 24 Parganas and practices modified-extensive polyculture of mullet. Another pond just beside this present one has been taken on lease for the same. To maintain an abundance of plankton as a natural food throughout the culture period, Sri Roychowdhury applies an organic juice, comprising a mixture of rice polish 750 g, wheat flour 350 g, sugarcane molasses 500 g, limestone powder 100 g, edible soda 200 ml/g, soya sauce 15 ml, commercial probiotic 100 g, and a small amount of vinegar for every 0.1 ha water area. For a 4,000 m^2 pond, a mixture of groundnut oilcake 100 kg, sugarcane molasses 10 kg and yeast 500 g may be applied at fortnightly intervals. Lime is applied @ 40-45 kg/ha twice a month to maintain good water quality and avoid growth of pathogenic micro-organisms. Both finfishes and *S. olivacea* in boxes benefit and remain healthy in good water conditions.

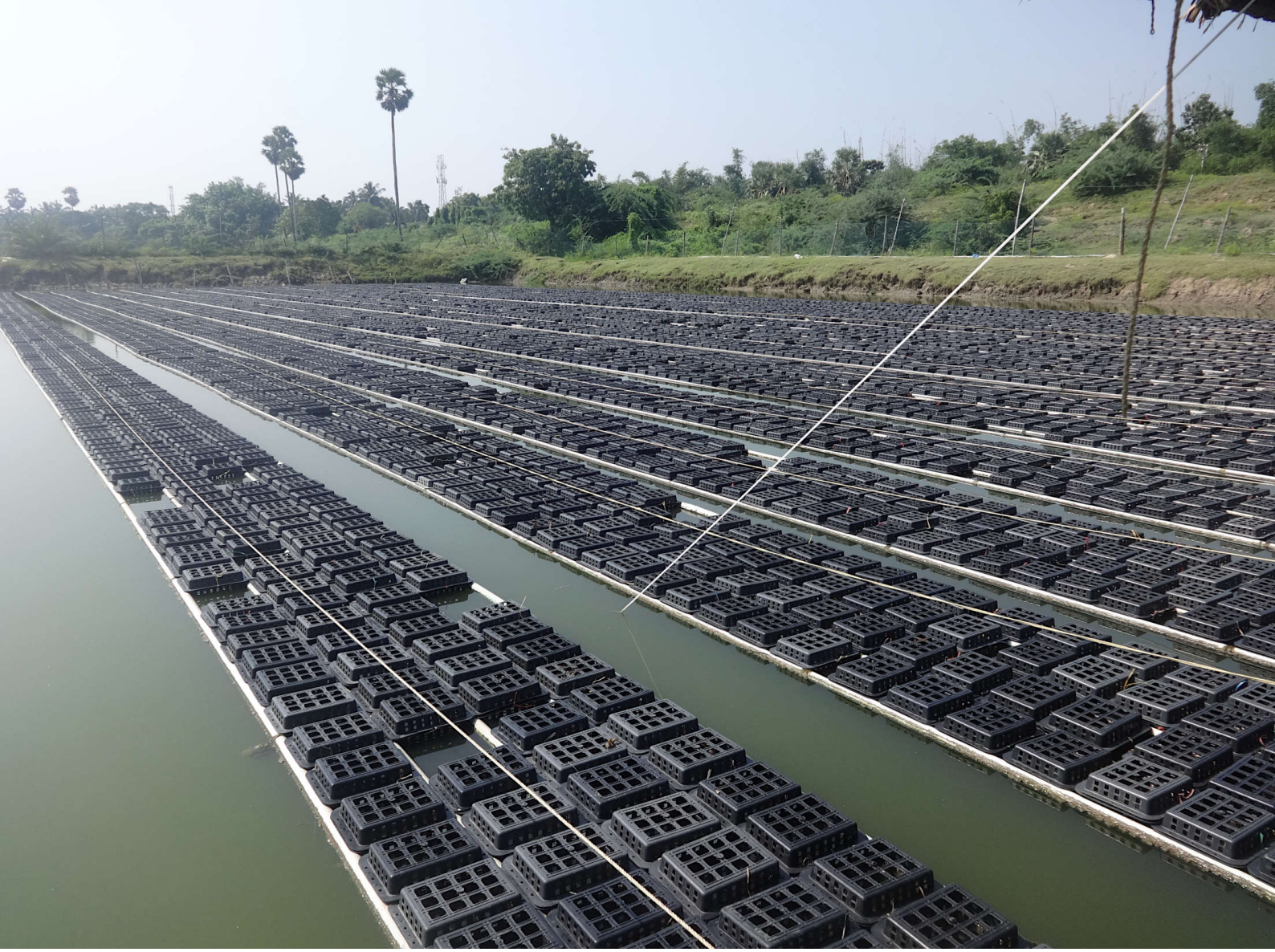
After harvesting soft-shell *S. olivacea* from boxes, the shed-off old, hard shells are collected and discarded. Plenty of such dried and semi-dried cast off shells (resembling dead whole-bodied mud crabs) remain heaped at one point on the pond embankment. These can be placed inside excavated holes on the earthen embankment and a useful organic fertiliser is produced after it decomposes, enhancing vegetable production in farms and that grown on pond embankments, if applied. For soft-shell mud crab production, 8-10 g of

Chilling down soft-shell S. olivacea.



Frozen and packed soft-shell S. olivacea for export.

Heap of discarded exoskeletons from moulting S. olivacea.



Series of rafts as seen from one corner of the pond.

chopped fresh finfish *Amphipnous cuchia* or small-sized *Tilapia nilotica* may be given to every 50-100 g *S. serrata* or *S. olivacea* stocked, once every three days.

The first author feels that such entrepreneurial activity should be promoted. He is willing to train interested agriculturists, small-scale marginal fishermen, brackishwater fish farmers and unemployed youth in nearby coastal villages on remunerative soft-shell mud crab production, its grow-out farming and fattening. Many are unaware of the techniques and its prospect as a livelihood option. These people can be united through groups. Many farmers are now less interested to invest in brackishwater shrimp farming due to the incidence of viral diseases and white faeces syndrome leading to crop failure. Nine local persons have been employed as permanent labourers on this mud crab farm.

For soft-shell mud crab production and also crab fattening using the 'box farming' technology, farmers have to depend heavily on wild-caught crabs and exploitation of natural resources. Recently fish farmers Sri Sambhu Maity, Sri Prasenjit Jana, Sri Amit Bera, Sri Sukumar Ari have started production of fattened mud crab *S. olivacea*, both males and females, for export, in boxes positioned within floating frames. They are doing it on small- to medium-scale in brackishwater fish ponds in the Nandigram, Haldia and Nayachar regions of Purba Medinipur on the bank of the Haldi River. Some farmers in Khejuri-I and Ramnagar-I Blocks in this district are practicing grow-out farming of mud crabs in open pond area (small and owned) with input support from the state government. It is hoped that in the near future, mud crab farm owners in the private sector in West Bengal will be able to avail of adequate numbers of crablets and stockable-sized stages of *S. serrata* and/or *S. olivacea* reared and produced from mud crab hatcheries and nursery rearing facilities of the Rajiv Gandhi Centre for Aquaculture and other government institutions and corporate enterprises.

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