MUD CRAB CULTURE IN INDIA

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PREFACE

Among the marine edible crustaceans, mud crabs which are larger in size (0.7 to 2.4 kg) rank third by virtue of their delicacy and demand for human consumption, the first two being penaeid shrimps and lobsters. Mud crabs are also preferred for their medicinal value. In Indian waters, two species of mud crabs, namely *Scylla tranquebarica* (larger species) and *Scylla serrata* (smaller species) are extensively exploited from both the inshore marine and adjoining brackishwater areas by indigenous gears. Major population of mud crabs is being caught from estuarine areas with specialized indigenous gears. Mud crabs can tolerate wide range of salinities and migrate into estuarine areas during their post larval stages, grow fast and attain maturity. They are found in the lower, middle and upper reaches of estuarine system and also in the traditional fish / shrimp culture fields of Kerala, Karnataka, Tamil Nadu and West Bengal. Among the marine crabs, mud crabs are the only species which can remain alive out of water for considerable time. The export of live mud crabs has started since 1987-88 and annually around Rs.25 million is earned as foreign exchange.

Culture of mud crabs in suitable enclosures is practiced for the last forty years in South-East Asian countries. Initially, juvenile mud crabs are cultivated along with milk fish (*Chanos chanos*) and later due to their great demand, monoculture practices are more prevalent. The stocking materials are drawn from wild, in the absence of hatchery raised seeds. Three types of culture are being practiced : 1) raising juvenile to marketable size in 4-6 months; 2) rearing "water crabs" for weight gain in 3-4 weeks and 3) rearing females of smaller species for full development of ovary in 4 weeks. At present, these three types of culture are followed in India.

There are several attempts to breed the mud crabs in captivity and rear the larvae to early juvenile stage in India and other South East Asian countries. Due to the low survival rate of the reared larvae, a viable commercial hatchery technology is eluding so far. Nevertheless, the Central Institute of Brackishwater Aquaculture (CIBA) has developed an appropriate technology for the production of berried female mud crabs. At present, CIBA is undertaking trials to develop a standard procedure for larval rearing to enhance the survival of mud crab larvae.

The sincere efforts made by Shri M.Kathirvel, Principal Scientist, Dr.S.Kulasekarapandian, Principal Scientist and Dr.C.P.Balasubramanian, Senior Scientist in the preparation of this bulletin with suitable illustrations is appreciated. It is hoped that the information on fishery, biology, captive broodstock development, larval rearing and culture presented in this bulletin will serve as a guide for the research personnel, entrepreneurs and administrators.

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Dr.Mathew Abraham
Director

CONTENTS

I. INTRODUCTION

Among the 700 marine littoral crabs of India, two species of mud crabs of the genus *Scylla* are the largest ones, growing to a maximum size of 0.7 to 2.4 kg and migrate into the estuarine systems, where they form a lucrative fishery. In India, mud crabs are extensively exploited from inshore and estuarine areas and are in the lime light due to their great demand for their delicacy, medicinal value and export trade. There are two species of mud crabs, namely, *Scylla tranquebarica* (larger species) and *Scylla serrata* (smaller species) which have high potentials for aquaculture. In view of thier importance as preferred species for aquaculture a brief account on their identification, exploitation, biology, utilization, present status of aquaculture practices in brackishwater areas, captive broodstock development, induced maturation, production of berried females, hatchery seed production trials, economy and a pictorial guideline of mud crabs are presented in this bulletin.

2. IDENTIFICATION

Scylla tranquebarica and *Scylla Serrata* can be identified in the field by their morphological and colour features as given in Fig. 1A & B.

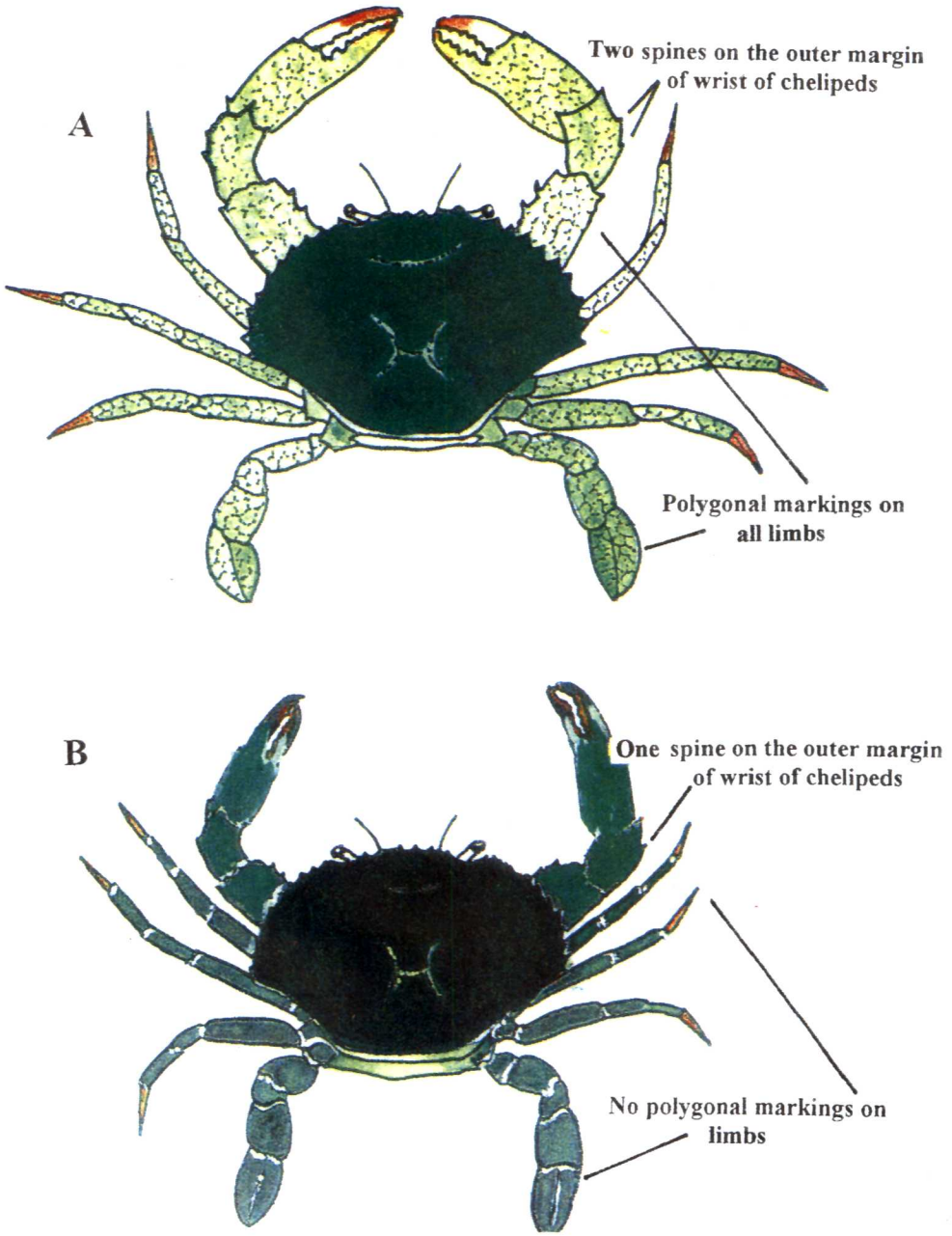


Fig. 1A. Larger species – *Scylla tranquebarica.*
1B. Smaller species – *Scylla serrata.*

3. EXPLOITATION

3.1 Fishing crafts and gears

The fishing crafts used are plank-built boat, dug-out canoe, out-triggered canoe, catamaran and mechanised trawler. Mud crabs are extensively caught from the marine sector by both indigenous (gill net, boat seine, shore seine, seine net, cast net, hoop net, line with bait, pair of tongs, iron rods, scoop net and hooked iron rods) and mechanised (trawl net) gears. In the major and minor brackiswater areas of the main land and the bays and creeks of Andaman and Nicobar Islands, indigenous gears such as gill net, line with bait, stake net, drag net, scoop net, cast net, bamboo pot, bamboo trap, hooked iron or steel rods and hand picking are employed to catch crabs.

3.2 Vernacular names

Mud crabs are known as:

"Khadapi chimbori" in Marathi,

"Patcha njhandu" in Malayalam,

"Kuzhi nandu" or " Kattu nandu" or

"Kora valai nandu" in Tamil,

"Pita" or "Manda peeta" in Telugu,

"Chilka kankada" in Oriya and

"Nona kankara" or

"Samudra kankara" in Bengali.

3.3 Catches from the marine sector

Among the commercially important crustaceans (penaeid and non-penaeid shrimps, lobsters, crabs and stomatopods) exploited from the inshore seas, crabs accounted for 8 % of the total crustacean landings. The mud crabs form about 5 % in the total crab landings and the quantity landed during 1959 to 1998 is given in Table 1.

Table 1. Mud crab landings in the marine sector.

Period	Average annual landings (in tonnes)	
	All species	Mud crabs
1959-1968	2,798	127
1969-1978	13,980	699
1979-1988	22,746	1,137
1989-1998	28,197	1,410

3.4 Catches from the estuarine sector:

The average annual mud crab landings from important estuarine systems of India are given in Table 2.

Table 2. Mud crab landings in the estuarine sector.

Maritime State	Locality	Period	Average annual landings (in tonnes)	
			All species	Mud crabs
Gujarat	Gulf of Kutch Narmada & Tapti estuaries	1981-98	301	200
Goa	Mandovi & Zuari estuaries	1981-98	50	50
Karnataka	Kali, Nethravati, and other extuaries	1981-98	93	93
Kerala	Vembanad backwaters Korapuzha estuary	1981-98	1,078	700
		1987-89	14	14
Tamil Nadu	Lake Pulicat, Kovalam backwaters, Vellar-Coleroon estuaries, etc	1981-98	1,088	650
Andhra Pradesh	Godavari-Krishna estuaries	1981-98	385	385
Orissa	Lake Chilka, Mahanadi estuary	1981-98	149	149
West Bengal	Hooghly-Matlah estuarine system	1981-98	474	474

On an annual average, 4,111 tonnes of mud crabs (1,410 tonnes from marine and 2,701 tonnes from estuarine sectors) were landed during 1981-98.

4. BIOLOGY

4.1 Habitat

Adult crabs are found both in the inshore seas and estuarine system. Being a member of the family Portunidae of brachyuran crabs, the mud crabs possess a pair of paddle-shaped swimming legs, which help them for fast swimming in the columnar waters. Mud crabs in their megalopa stage (postlarva) migrate into the estuaries, coastal lagoons and backwaters, grow fast, attain maturity and the females become berried. For hatching of the larvae, the berried female mud crabs emigrate to inshore seas. Though both the species bury under the sandy or muddy bottom, the adults of smaller species (*S. serrata*) are found inside the holes made in the bottom or the banks of estuary or the dykes of culture fields (Fig. 2). Hence, *S. serrata* is the most common among the mangrove environs. The larger species (*S. tranquebarica*) is a nomadic, preferring open areas of estuaries.

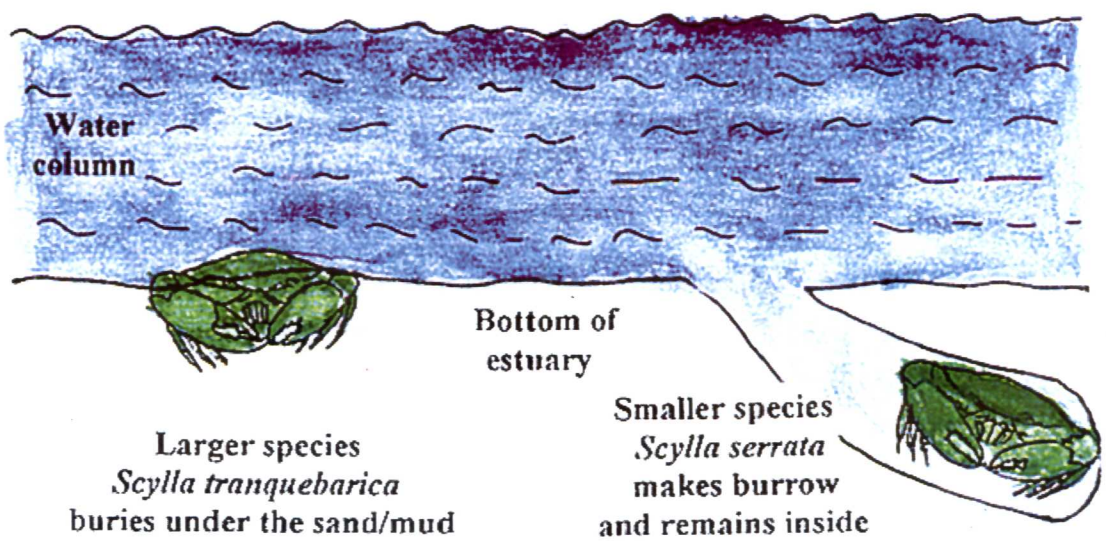


Fig. 2. Habitat of two species of mud crabs.

4.2 Sexual identity

The immature and mature males of mud crabs have a slender and triangular shaped abdominal flap on ventral side of the body (Fig. 3 A), while the immature females have a broad and triangular shaped abdominal flap (Fig. 3C) and the matured females with a semi-circular shaped flap (Fig. 3 B).

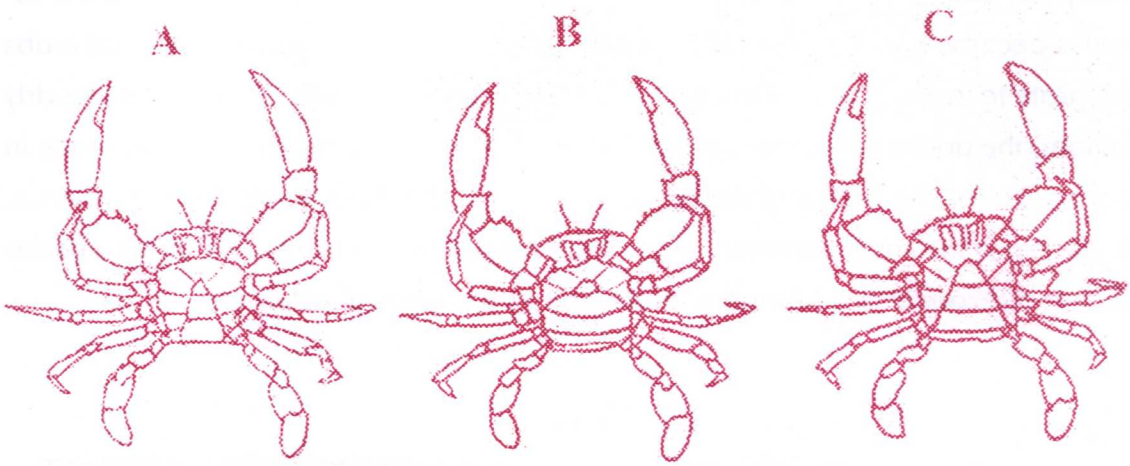


Fig. 3. Sex identification based on the shape of abdominal flap
(A: Male; B: Mature female and C: Immature female)

4.3 Growth:

The size-frequency studies have indicated that male and female mud crabs grow at a rate of 9 and 10 mm in carapace width (CW) per month, respectively. The larger species (*S. tranquebarica*) attain a maximum size of 220 mm/2.4 kg and the smaller species (*S. serrata*) 140 mm/0.7 kg in the wild. In experimental field culture, the early juvenile mud crabs (15 to 60 mm in CW/3 to 20 g in total weight-TW) grew at a rate of 7 to 12 mm/3 to 13 g , while juvenile crabs (61 to 80 mm/25 to 70 g) exhibited a monthly growth of 11 to 12 mm/45 to 97 g. In the sub-adult and adult stages, the monthly growth recorded was 8 to 10 mm/100 to 130 g.

4.4 Food and feeding habits

The feeding habit of mud crabs in different localities are summarized in Table 3 which shows that they are omnivorus feeder and feed on various items.

Table 3. Food of mud crabs in different localities.

Locality	Percentage remains of					
	Crustacea	Mollusc	Fish	Detritus	Plant	Unidentified
Cochin backwaters	78.4	3.5	15.2	2.5	0	0.4
Karwar	6	8.3	33	41.3	0	11.4
Ennore estuary	46.3	25	19.7	6.9	0.7	1.4
Lake Pulicat	46.6	20.3	21.2	9.2	0.5	2.2
Hooghly-Matlah estuarine system	38.5	3.9	19.2	19.2	19.2	0

They feed mainly on fish in Karwar waters and on crustaceans in the Cochin backwaters, Ennore estuary, Lake Pulicat and Hooghly-Matlah estuarine system. In the Cochin backwaters, the crustacean component consisted of the remains of a burrowing and slow-moving pinnotherid crab (*Xenophthalmus garthii*), an easy prey for the mud crabs. Laboratory experiments have shown that mud crabs cannot catch fast-moving prey like live shrimps. Hence, polyculture of tiger shrimp (*Penaeus monodon*) and mud crabs is practised in Taiwan.

4.5 Maturation

The stages of sexual maturity in mud crabs are summarised in Table 4.

Table 4. Different stages of maturation in mud crabs

Stage	Testes	Ovary
Immature	Transparent/creamy in colour; occupying less than 1/6th of body cavity; without a prominent vas deferens	Transparent/yellowish in colour; occupying 1/6th of body cavity; without a prominent seminal receptacle
Maturing	Creamy white in colour; occupying 1/4th of body cavity	Pink in colour; occupying 1/4th or 1/3rd of body cavity
Mature	Milky white in colour; with a thick vas deferens; occupying full body cavity	Orange in colour; with a prominent seminal Receptacle; occupying full body cavity

4.6 Size at maturity

The size at first maturity for females of the two species of mud crabs recorded by several authors is given in Table 5.

Table 5. Size at first maturity in two species of mud crabs.

Locality	Species	Size at maturity (CW in mm)
Karwar	*S. serrata*	80
S.W. coast of Inida	*S. tranquebarica*	129
Cochin backwaters	*S. tranquebarica*	120
	S. serrata	85
Lake Pulicat	*S.tranquebarica*	123
	S. serrata	83
Tuticorin	*S. tranquebarica*	127

4.7 Fecundity

The number of eggs found attached to the pleopods of female mud crabs varied from 0.3 to 0.5 million in southwest coast of India, 0.6 to 1.4 million in Cochin backwaters, 2.5 to 7.0 million for *S. oceanica* (= *S. tranquebarica*) from Cochin backwaters, 0.05 to 2.0 million in Karwar. Under captive broodstock development and induction of maturity experiments, the fecundity varied from 2.0 to 5.0 million for *S. tranquebarica* and 1.0 to 3.0 million for *S. serrata*.

4.8. Breeding season

The breeding season of mud crabs in different localities are given in Table 6.

Table 6. Breeding season of mud crabs in selected centers.

Locality	Period	Peak season
Southwest coast of India	Throughout the year	September-February
Karwar	Throughout the year	December-March & September-November
Tuticorin coast	Throughout the year	April-July
Lake Pulicat	Throughout the year	March-April & September-October
Kakinada region	Throughout the year	May-June & October-February

4.9 Availability of early juveniles

Data on the availability of early juveniles of mud crabs in backwaters, estuaries and coastal lakes are summarised in Table 7.

Table 7. Availability of early juveniles of mud crabs in brackishwater regions of India

Locality	Period	Peak season
Cochin backwaters	Throughout the year	May-October
Pitchavaram mangroves	December-September	January-February
Kovalam backwaters	December-October	December-May
Adyar estuary	December-October	January-April
Ennore estuary	December-October	December-April
Lake Pulicat	December-October	December-April
Lake Chilka	Throughout the year	March-June

4.10 Parasites

The acorn barnacles are found attached over the carapace, walking legs and chelipeds of adult mud crabs caught from the sea, while the goose barnacles (cirripeds) are known to infect the gill regions of the crabs collected from estuarine and marine regions.

5. UTILIZATION

5.1 Marketing

Generally the mud crabs are marketed and sold in live condition. The first pair of largest legs (chelate legs) of each live crab are firmly tied up with the body by jute/nylon thread to curb their movement and to avoid fighting among them. The bulk of the catch is usually packed in bamboo baskets. Wet seaweed is placed in the baskets to keep the live crabs cool and moist (Fig. 4). The basket-packed crabs are transported from remote fishing villages to the major cities by road or rail and sold through the middlemen to retailers.

Fig.4. Seaweed filled bamboo baskets for transport of live mud crabs

For live crab export trade, the leg tied-up mud crabs are washed with seawater and packed either in bamboo baskets covered with plastic sheets in the bottom or perforated thermocole boxes, as shown in Fig 5.

Fig. 5. Perforated thermocole box used for live mud crab export trade.

5.2. Export

The quantity and value of frozen and canned products of mud crabs exported along with that of other marine crabs and live mud crab export is given in Table 8.

Table 8. Export of crab and crab products from India

Year	Frozen crab meat		Canned crab meat		Live crabs	
	Quantity (tonnes)	Value (Rs. in Lakhs)	Quantity (tonnes)	Value Rs. in Lakhs)	Quantity (tonnes)	Value (Rs. in Lakhs)
1972	0	0	7	1.1	0	0
1973	0	0	19	3.8	0	0
1974	0	0	14	5.1	0	0
1975	0	0	3	1.1	0	0
1976	0.2	0.1	26	14.5	0	0
1977	23	6.5	50	31.4	0	0
1978	8	2.7	42	19.4	0	0
1979	0	0	55	29	0	0
1980	5	1.5	34	16.2	0	0
1981	0	0	31	15.7	0	0
1982	5	2.4	4	3	0	0
1983	31	16.4	10	5.2	0	0
1984	49	23.7	0	0	0	0
1985-86	9	3.9	0	0	0	0
1986-87	30	13.5	0	0	0	0
1987-88	86	40.8	36	66.4	36	6.5
1988-89	174	86.2	42	73.8	412	73.8
1989-90	641	199.5	0	0	619	133.6
1990-91	1045	390.8	0	0	654	160.4
1991-92	575	274.8	0	0	591	189
1992-93	630	540.6	65	29.7	550	287
1993-94	1309	1444.5	0	0	725	519
1994-95	1844	2282.9	17	16.9	934	935
1995-96	1402	1354.4	6	7.1	1,635	1,671
1996-97	1279	1501.8	0	0	1,896	2,304
1997-98	1266	1605	0	0	1,519	1,935
1998-99	556	836.3	0	0	1948	3380
1999-00	141	425.9	0	0	1412	2541

During 1978 and 1979, the canned crab meat was the main export item. However, frozen crab meat has been exported in large quantities from 1986-87 onwards. Due to higher demand from Malaysia and Singapore, the export of live mud crabs commenced with 36 tonnes during 1987-88. This has increased to a maximum of 1,896 tonnes in 1996-97. There is a gradual reduction in the quantity of live crabs exported in recent years, indicating that the optimum level of exploitation from their known habitat has already been reached.

6. AQUACULTURE

6.1 Traditional culture

Mud crabs are generally found in the traditional shrimp culture fields of West Bengal, Tamil Nadu Kerala and Karnataka.They enter into the culture fields either through the sluice gate of the fields or by crawling over the earthen dykes. In West Bengal there are 1,300 *Bheris* covering a water-spread area of 32,900 ha in the Sundarbans, from where it is estimated that the average production of mud crabs ranged from 10 to 35 kg / ha / year. It is reported that the smaller species, *S. serrata* cause damage to the earthen dykes of culture fields due to their burrowing habits.

6.2 Experimental culture

Though there are several reports on to the experimental culture of mud crabs in India, only a few are related to small scale culture practised by crab farmers. Juvenile mud crabs collected from the wild were reared either in monoculture system or polyculture with fish or other portunid crabs. The trials were conducted in earthen ponds and cages to record their growth, survival and production. The crabs were stocked at a rate of 1-2 no/m^2 and fed with animal matters such as trash fish, clam meat and wastes from butcher's shop at the rate of 5-10 % of biomass. Crabs measuring an initial size of 19-65 mm/1-47 g attained an average size of 140-150 mm/442-580 g at the end of 7-10 months of rearing in earthen ponds with a survival rate of 28-32 %. The production worked out to 494-1116 kg/ha/7-10 months.

In the polyculture trials with mullet (*Liza macrolepis*) and milkfish (*Chanos chanos*), the mud crab production was 690 kg/ha/10 months, while the share of mullet and milkfish was 954 kg/ha/10 months. In cage culture, the average monthly growth varied from 5 to 18 mm/5 to 23 g in 2months and from 11 to 12 mm/45 to 97 g in 6 months with 50 to 90 % survival rate.

6.3 Present status of culture

6.3.1 Fattening for weight gain

As the post-moulted crabs, known as "water crabs" are weak with less meat and weight, they have to be fattened in suitable rearing medium. The "water crabs" are also not accepted for live export trade, since the survival of such "water crabs" during transport from the place of capture to the export destination is very less. Further more, those shrimp farmers who have lost shrimp crops consistently due to white spot virus syndrome, ventured into species diversification as an alternative to *P. monodon*. The fattening of "water crabs" was considered as a boon to such farmers and also new entrepreneurs. As the bulk of live mud crabs export was shared by larger species *(S. tranquebarica),* the "water crabs" belonged to larger species alone were considered for fattening process. At present, the fattening of larger species (*S. tranquebarica*) is practiced in Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal either in fenced tide-fed/pump-fed earthen ponds or in suitable enclosures erected in creeks and canals adjoining the brackishwater areas (Fig. 6).

A

B

C

D

E

F

Fig. 6. Fenced earthern ponds (A, B & C) and pens in open backwaters (D, E & F)

The stocking rate followed was 1 to 3/m^3 and the rearing period lasted 3 to 4 weeks. The crabs were fed with animal meat such as trash fish, bivalve and gastropod molluscan meat, choked dried fish and wastes from chicken/goat meat shops. Generally, the stocked "water crabs" were in the size range of 350 g to 1500 g. Crabs of 350 to 500 g size gained 60 to 80 g. weight, while those crabs above 1000g added weight of 100 to 120 g. The reported survival rate was between 70 and 90 %.

In Kerala, both mud crab fattening and traditional shrimp/fish culture were carried out in a 0.4 ha tide-fed pond, where, "water crabs" (recently moulted crabs) and shrimp/fish seed were stocked and reared. The initial and operating cost for one year was Rs.4.2 lakhs and the value realised was Rs. 7.8 lakhs, of which, the mud crabs shared Rs. 7.0 lakhs. The net profit was Rs. 2.6 lakhs. In Karnataka, the crab farmer stocked 200-600 g sized "water crabs" at a rate of 1 no/m^2. The culture period was 240 days. Continuous stocking and repeated harvesting of the fattened crabs after a period of 25-45 days were followed. The initial investment was Rs. 37,853, while a gross income of Rs. 73,927 was realised from 6 crops and the net profit was Rs. 36,075. At Lake Pulicat, Tamil Nadu, a woman farmer stocked 200 "water crabs" in a 0.02 ha for fattening and realised a net profit of Rs. 7,925 in one month.

6.3.2 Fattening for full ovary development

To meet the increased demand for female crabs with fully developed ovary for export, farmers are practicing this type of fattening for the last 2 years. Spent adult females (those females with immature ovary) of smaller species (*S. serrata*) are stocked at a rate of 1 to 4/m^3 in net enclosures and fattened for about a month. During this period, 90 % of females attained full ovarian development. For this fattening, only smaller species is preferred as the time required for full development of ovary is about 30 days. For larger species (*S. tranquebarica*), it may take 2 to 3 months for the complete development of ovary. It is easier to check whether female crab is having fully developed ovary by looking through the integument between the posterior border of carapace and the abdominal cover. If an orange coloured material is seen through the integument, it indicates the presence of fully developed orange coloured ovary. Another way of observation is to focus a torch

light at the postero-lateral border of the carapace to find out the presence of orange coloured ovary. Fattening for full development of ovary is being carried out in West Bengal, Andhra Pradesh and Tamil Nadu.

6.4 Experimental hatchery trials

Few attempts were made to rear the larvae of mud crabs under laboratory condition. Berried crabs (Fig. 7) obtained from the wild were kept in the hatching tanks. Depending upon the water temperature, the incubation period varied from 7 to 15 days. Most of the hatched larvae were in the first zoea stage (Fig.8), while in few instances, a pre-zoea emerged, which in turn moulted to first zoea stage after 3-4 hours. The number of first zoea varied from 1 to 5 million. The larvae were stocked @ of 10 to 75 nos/litre and were reared on a diet of live feeds such as rotifers and nauplii of the brine shrimp (*Artemia*), whereas the megalopa (Fig. 9) and crab stages (Fig. 10) were fed with live/frozen adult brine shrimp and macerated clam/shrimp meat. The temperature and salinity of seawater used for larval rearing ranged from 27 to 30 ^{0}C and from 30 to 35 ppt, respectively. The larval rearing phase included 5 zoeal, 1 megalopa and first crab instar. The duration of each zoea stage varied from 3 to 4 days, while the megalopa took 8-11 days to metamorphose in to first crab instar. The time taken between the first zoea and first crab instar ranged from 26 to 31 days. The survival rate from first zoea to first crab instar varied from 0.5 to 15.27%

Fig. 7. A berried female mud crab

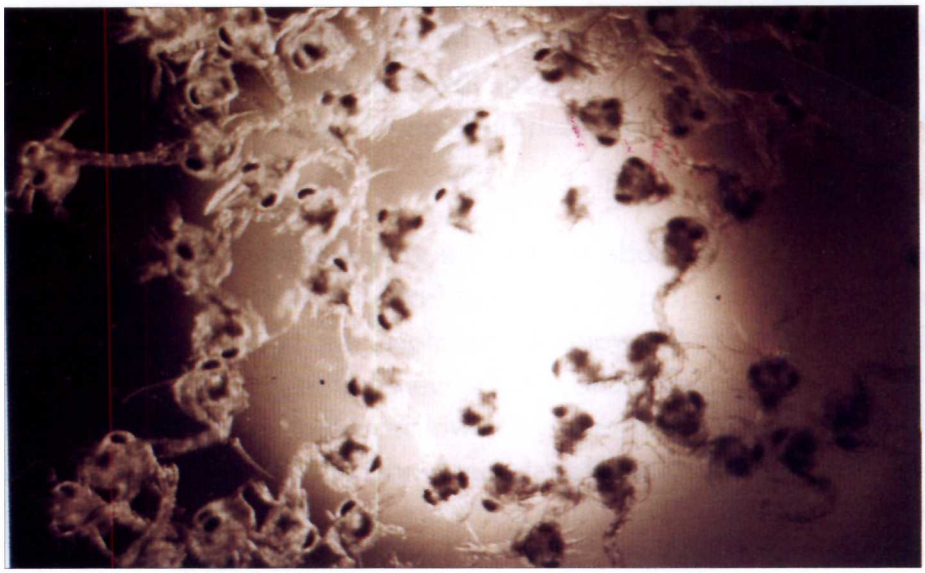


Fig. 8 First zoea larvae of mud crab

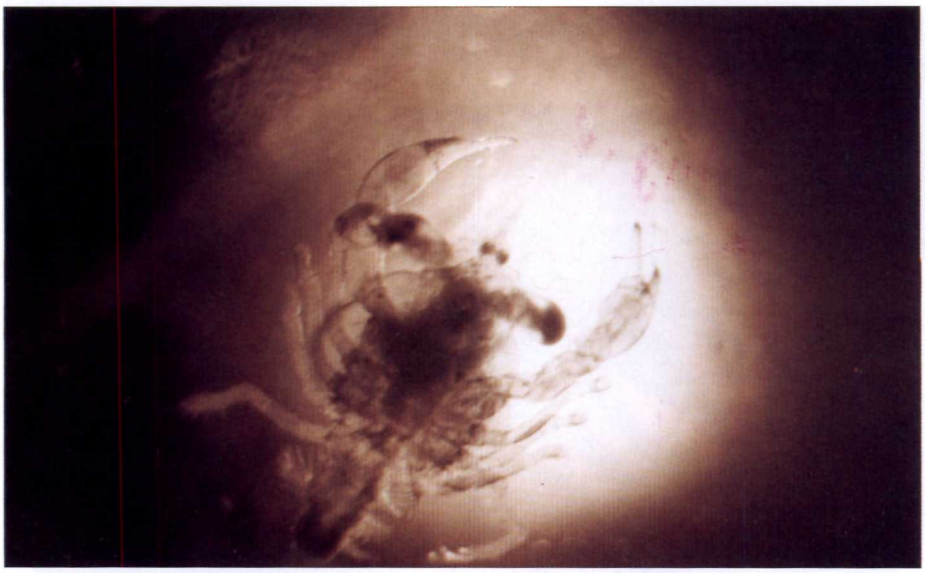


Fig. 9 Megalopa (Postlarval stage of mud crab)

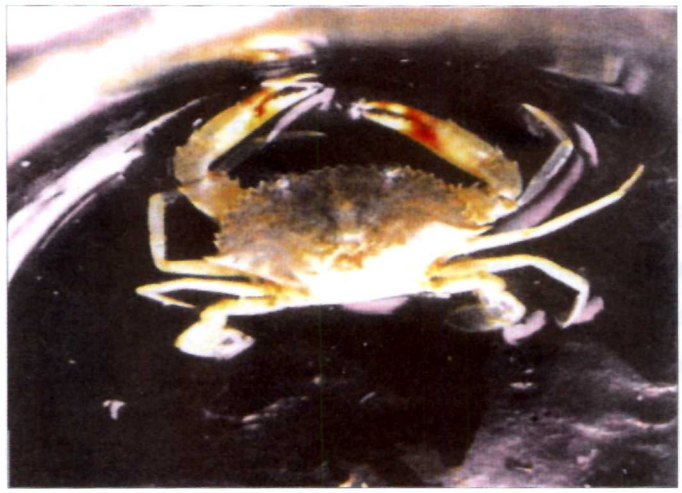


Fig. 10. Baby mud crab (First crab instar)

6.5 Present status of seed production

The fisheries institutions of Indian Council of Agricultural Research undertook R & D programmes for the development of captive broodstock, induced maturation, production of berried females and larval rearing of mud crabs. At Central Institute of Brackishwater Aquaculture (CIBA), Chennai, a viable technology for captive broostock development of mud crabs has been developed. Wild adult females of both the species (*S. tranquebarica*: 130-175 mm in CW/300-700 g in TW and *S. serrata*: 85-135 mm in CW/100-350 g in TW) were subjected to unilateral eyestalk ablation which has accelerated the development of ovary, subsequent spawning and the formation of berry. The time taken between eyestalk ablation and formation of first berry was 54 days for *S. tranquebarica* and 32 days for *S. serrata* and the interval between first and second berry was 47 days in *S. tranquebarica* and 30 days in *S. serrata*. The number of zoea larvae released varied from 0.2 to 5.5 million in *S. tranquebarica* and 0.1 to 3.1 million in *S. serrata*.

7. ECONOMICS

Based on the data collected from the studies conducted by CIBA and from crab farmers, the investment, running expenditure and cash return for grow-out culture, fattening in pen and cage, captive broodstock development and hatchery operation are worked out and presented in Annexure I, II, III, IV, and V.

ANNEXURE I

GROW-OUT POND CULTURE IN 0.2 ha

Candidate species : Larger species of mud crab, *Scylla tranquebarica*

A. FIXED COSTS	Rs.
Pond lease amount for one year	10,000/-
Pond development	5,000/-
Sluice gate, screens and fencing materials	15,000/-
Watchman shed	3,000/-
Miscellaneous	2,000/-
Total	35,000/-

B. OPERATIONAL COST FOR 1 CROP OF 4 MONTHS	
Seed crabs: 2000 Nos; 80-100 g in size; total stocked biomass: 180 kg; stocking rate: 1 crab per sq. m.; (Rs. 5 per crab)	10,000/-
Feed: Trash fish; feeding rate 5-10 % of stocked biomass; total quantity required for 120 days of culture: 2,880 kg (Rs. 15 per kg)	43,200/-
Labour: 2 labourers for 4 months	8,000/-
Pond maintenance	1,000/-
Miscellaneous	2,000/-
Total	64,200/-

C. INCOME	
Production at 70 % survival; 1,400 crabs; av. size: 450 g; 530 kg; Rs. 180 per kg	1,13,400/-
D. GROSS PROFIT FOR ONE CROP (C – B)	49,200/-
E. GROSS PROFIT FOR 2 CROPS PER YEAR	98,400/-
F. NET PROFIT (after allowing 20 % interest on capital cost)	84,400/-

ANNEXURE II

FATTENING (FOR WEIGHT GAIN) IN A 0.025 ha POND

Candidate species: Larger species of mud crab, *Scylla tranquebarica*

A. FIXED COSTS	Rs.
Pond lease amount for one year	5,000/-
Pond development	1,000/-
Sluice gate, screens and fencing materials	2,000/-
Watchman shed	2,000/-
Miscellaneous	1,000/-
Total	11,000/-

B. OPERATIONAL COST FOR 1 CROP OF 1 MONTH	
Water crabs : 500 nos. 250-350 g in size; total stocked biomass: 150 kg; stocking rate: 2 crabs per sq. m.; (Rs. 75 per kg)	11,250/-
Feed: Trash fish; feeding rate 10 % of stocked biomass; total quantity required for 30 days of culture: 450 kg (Rs. 15 per kg)	6,750/-
Labour : 1 labourer for 1 month	1,000/-
Miscellaneous	1,000/-
Total	20,000/-

C. INCOME	
Production at 80 % survival; 400 meat crabs; av. size: 400 g; 160 kg; Rs. 180 per kg	28,800/-
D. GROSS PROFIT FOR ONE CROP (C – B)	8,800/-
E. GROSS PROFIT FOR 10 CROPS PER YEAR	88,800/-
F. NET PROFIT (after allowing 20 % interest on capital cost)	86,600/-

ANNEXURE III

FATTENING (FOR WEIGHT GAIN) IN A BATTERY OF 10 CAGES FIXED IN OPEN BACKWATER

Cage size : 50 m^2; Total area : 500 m^2

Candidate species: Larger species of mud crab, *Scylla tranquebarica* & smaller species, *Scylla serrata*

A. FIXED COSTS	Rs.
HDPE knitted netting (2.0 mm dia. & 50 mm mesh size) 350 kg for 10 cages (Rs. 175 per kg)	61,250/-
Fabrication of cages and fixing	20,000/-
Total	81,250/-

B. OPERATIONAL COST FOR 10 CAGES FOR 1 MONTH	
Water crabs : 1000 nos; av. size: 250-350 g; total stocked biomass: 300 kg; stocking rate: 2 crabs per sq. m. (Rs. 75 per kg)	22,500/-
Feed: Trash fish; feeding rate 10 % of stocked biomass; total quantity required for 30 days: 900 kg (Rs. 15 per kg)	13,500/-
Labour: 2 labourers for 30 days	2,000/-
Miscellaneous	2,000/-
Total	40,000/-

C. INCOME	
Production at 80 % survival; 800 meat crabs; av. size: 400 g; 320 kg; Rs. 180 per kg	57,600/-
D. GROSS PROFIT FOR ONE CROP (C – B)	17,600/-
E. GROSS PROFIT FOR 8 CROPS FOR 10 CAGES IN A YEAR	1,40,800/-
F. NET PROFIT (after allowing 20 % interest on capital cost)	1,24,550/-

ANNEXURE IV

FATTENING (FOR WEIGHT GAIN) IN 500 SQUARE METRES PEN FIXED IN OPEN BACKWATER

(with 5 equal compartments; each 100 sq. m.)

Candidate species: Larger species of mud crab, *Scylla tranquebarica*

A. FIXED COSTS	Rs.
HDPE knitted netting (2.0 mm dia. & 50 mm mesh size) 370 kg for 500 sq. m. pen (Rs. 175 per kg)	64,750/-
Fabrication and fixing	20,000/-
Total	84,750/-

B. OPERATIONAL COST FOR 1 MONTH	
Water crabs : 1000 nos. av. size 250-350 g; total stocked biomass: 300 kg; stocking rate: 2 crabs per sq. m.; (Rs. 75 per kg)	22.500/-
Feed; Trash fish; feeding rate 10 % of stocked biomass; total quantity required for 30 days: 900 kg (Rs. 15 per kg)	13,500/-
Labour: 2 labourers for 1 month	2,000/-
Miscellaneous	2,000/-
Total	40,000/-

C. INCOME	
Production at 80 % survival; 800 meat crabs; av. size: 400 g; 320 kg; Rs. 180 per kg	57,600/-
D. GROSS PROFIT FOR ONE CROP (C – B)	17,600/-
E. GROSS PROFIT FOR 10 CROPS PER YEAR	1,76,000/-
F. NET PROFIT (after allowing 20 % interest on capital cost)	1,59,050/-

ANNEXURE V

FATTENING (FOR OVARY GROWTH) IN 500 SQUARE METRES PEN FIXED IN OPEN BACKWATER

(with 5 equal compartments; each 100 sq. m.)

Candidate species: Smaller species of mud crab, *Scylla serrata*

A. FIXED COSTS	Rs.
HDPE knitted netting (2.0 mm dia. & 50 mm mesh size) 370 kg for 500 sq. m. pen (Rs. 175 per kg)	64,750/-
Fabrication and fixing	20,000/-
Total	84,750/-

B. OPERATIONAL COST FOR 1 MONTH	
Female crabs :1000 nos; av. size 200-300 g; total stocked biomass: 300 kg; stocking rate: 2 crabs per sq. m.; (Rs. 75 per kg)	22.500/-
Feed: Trash fish; feeding rate 10 % of stocked biomass; total quantity required for 30 days: 900 kg (Rs. 15 per kg)	13,500/-
Labours : 2 labourers for 1 month	2,000/-
Miscellaneous	2,000/-
Total	40,000/-

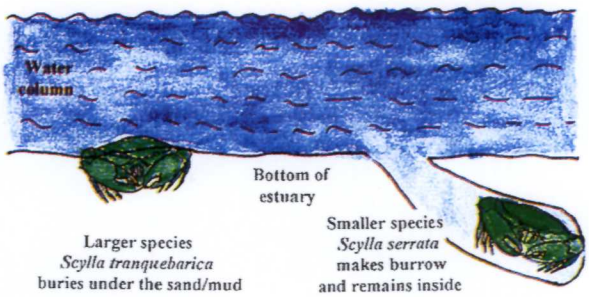
C. INCOME	
Production of 50 % of females with fully grown ovary; 150 kg; Rs. 380 per kg	57,000/-
D. GROSS PROFIT FOR ONE CROP (C – B)	17,000/-
E. GROSS PROFIT FOR 10 CROPS PER YEAR	1,70,000/-
F. NET PROFIT (after allowing 20 % interest on capital cost)	1,53,050/-

8. PICTORIAL GUIDE

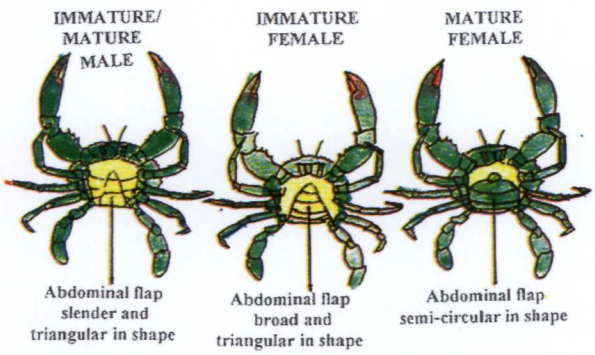
In order to facilitate a better understanding of the procedures to be followed in mud crab culture, captive broodstock development and larval rearing, coloured line drawings and colour photographs are given in Annexure VI. Brief notes are given at the bottom of the drawings/ photographs.

2. BIOLOGY AND FISHERY OF MUD CRABS

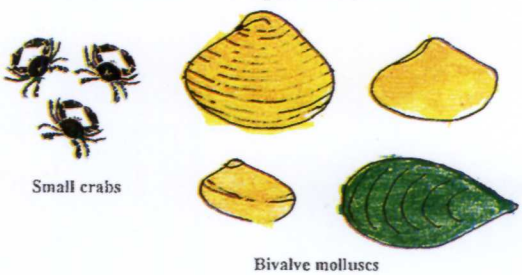
2.1. HABITAT



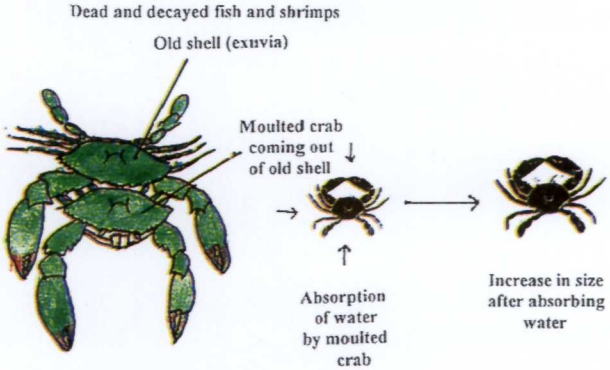
2.2. SEXUAL IDENTITY



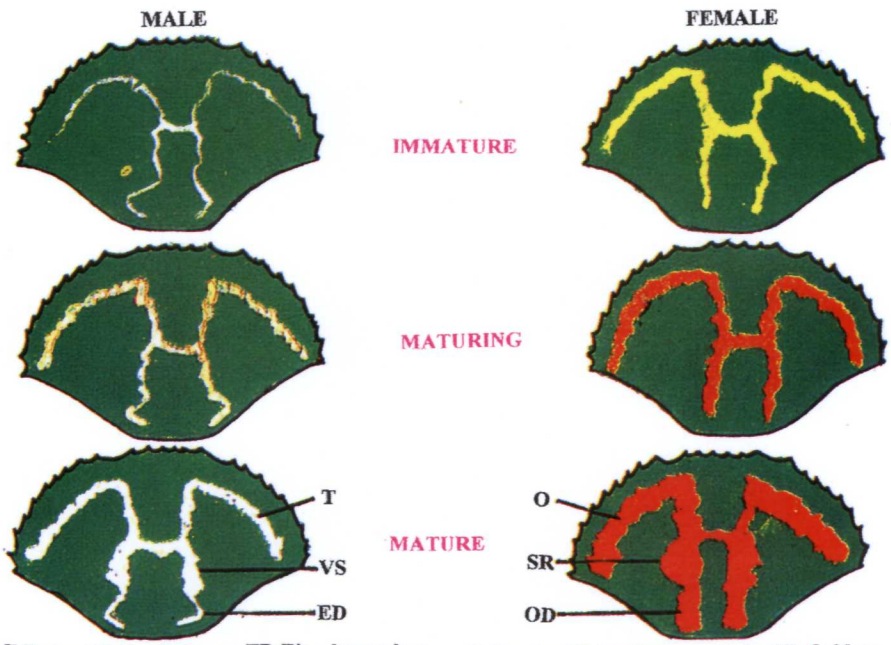
2.3. NATURAL FOOD OF MUD CRABS



2.4. MOULTING AND GROWTH



2.5. MATURITY

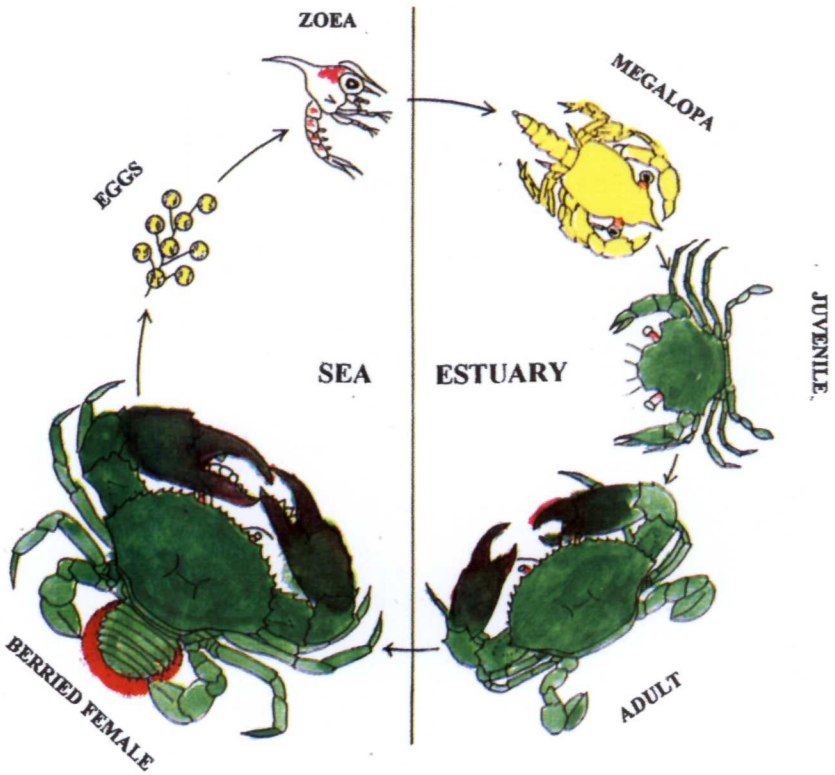


T-Testes; VS-Vas Deferens; ED-Ejaculatory duct O-Ovaries; SR-Seminal receptacle; OD-Oviduct

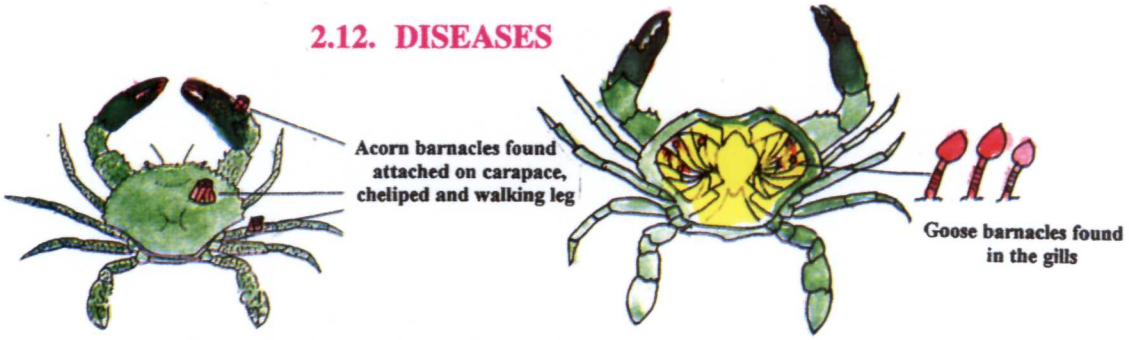
2.6. PRE-MATING EMBRACE

2.7. MATING

2.11. LIFE HISTROY



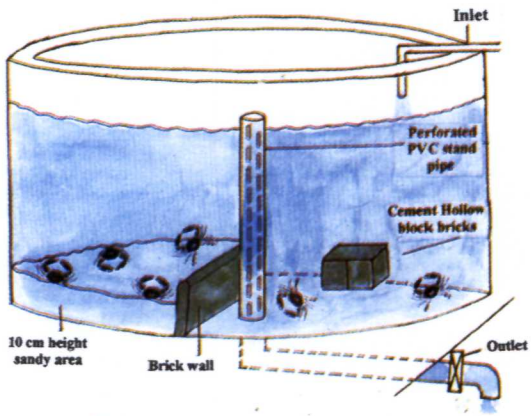
2.12. DISEASES

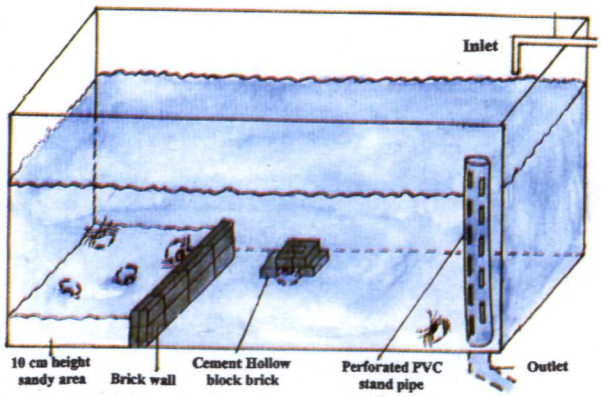


Helminth worms in gills, hepatopancreas and foregut.

3. CAPATIVE BROODSTOCK DEVELOPMENT

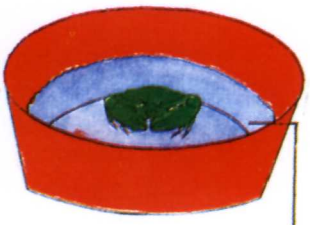
3.1. CAPTIVE BROODSTOCK FACILITY





3.2. COLLECTION AND TRANSPORT OF WILD ADULTS

3.3. PROPHYLACTIC TREATMENT OF BROODSTOCK

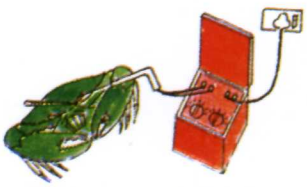


Dip for 10 minutes in 40 ppm formalin

3.4. ACCLIMATIZATION OF BROODSTOCK

3.5. INDUCED MATURATION

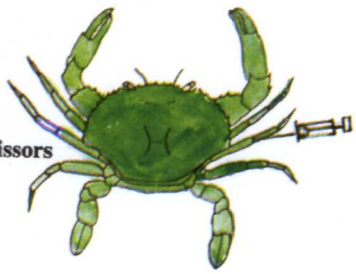
3.5.1. UNILATERAL EYESTALK ABLATION



By electrocautherization

By cutting with scissors

3.5.2. INJECTION WITH EXTRACT OF THORACIC GANGLION OF A ADULT BRACHYURAN CRAB



3.6. STOCKING

3.6.1. SIZE OF TANK

1.2 – 5 TONNES CAPACITY

3.6.2. STOCKING RATE

1 – 2 CRABS PER SQUARE METRE

3.6.3. SIZE OF CRABS

S. tranquenarica: Males 125-165 mm/330-685 grams
Females 129-175 mm/300-690 grams
S. serrata: Males 80-135 mm/90/590 grams
Females 85-137 mm/98-340 grams

3.6.4. SEX RATIO

MALE:FEMALE RATIO – 1 : 1

3.6.5. MARKING OF BROODSTOCK

3.7. MAINTENANCE OF BROODSTOCK

3.7.1. REFUGE SYSTEM

3.7.2. WATER QUALITY

Salinity: 30 to 35 ppt
Temperature: 27-32 ^{0} C

3.7.3. FEEDS AND FEEDING SCHEDULES

CLAM AND SQUID MEATS
FEEDING @ 8 – 10 % OF STOCKED BIOMASS PER DAY

3.8. MONITORING OF BROODSTOCK

3.8.1. RECORD OF MOULTING AND GROWTH

3.8.2. RECORD OF PRE-MATING EMBRACE

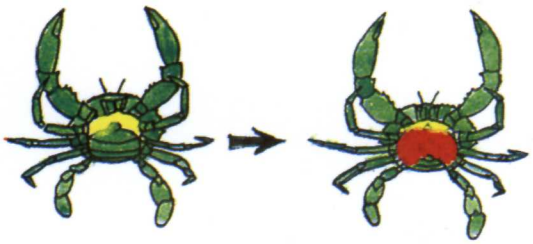
3.8.3. RECORD OF MATING

3.8.4. FERTILIZATION

DURING SPAWNING, EGGS GET FERTILIZED BY THE STORED SPERMATOPHORES

3.8.5. FORMATION OF BERRY

THE EXTRUDED EGGS GET ATTACHED TO THE HAIRS OF FIVE PAIRS OF PLEOPODS PRESENT IN INNER SIDE OF THE ABDOMINAL FLAP

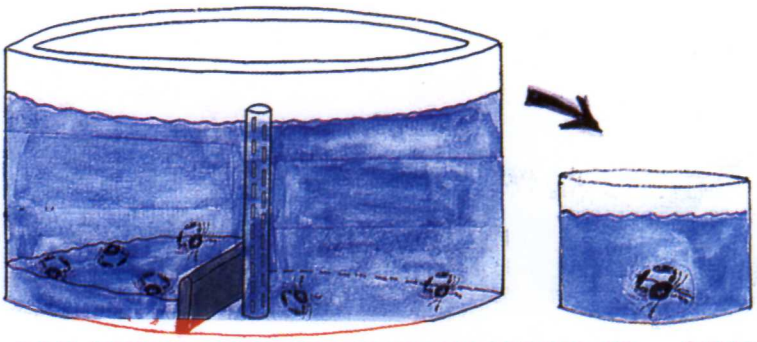


EGG MASS IS KNOWN AS BERRY

3.8.6. FIRMNESS OF BERRY

FERTILIZED EGG MASS FIRMLY AND CLOSELY ATTACHED
UNFERTILIZED EGG MASS LOOSELY ATTACHEDS

3.8.7. SEGREGATION OF BERRIED FEMALES



3.8.8. NUMBER OF EGGS EXTRUDED

S. tranquebarica:
2 - 5 MILLION
S. serrata:
1 - 3 MILLION

3.8.9. REPETITIVE FORMATION OF BERRY

BETWEEN TWO COPULATORY MOULTS, A FEMALE CRAB CAN EXTRUDE 2 TO 3 BATCHES OF EGGS

3.8.10. VIABILITY OF STORED SPERMS

VIABILITY LASTS FOR 9 TO 12 MONTHS

3.8.11. INTERVAL BETWEEN EYESTALK ABLATION/INJECTION AND FORMATION OF BERRY

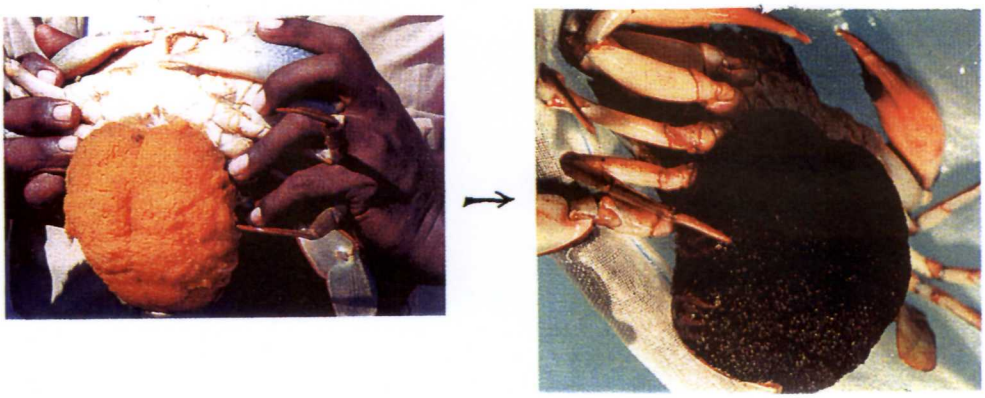
FIRST BERRY: *S. tranquebarica*: 26 to 89 DAYS (AVERAGE: 54)
S. serrata: 6 to 96 DAYS (AVERAGE: 32)
SECOND BERRY: *S. tranquebarica*: 34 to 56 DAYS (AVERAGE: 47)
S. serrata: 22 to-37 DAYS (AVERAGE: 30)
THIRD BERRY: *S. tranquebarica*: 38 to 42 DAYS (AVERAGE: 40)

3.9. INCUBATION

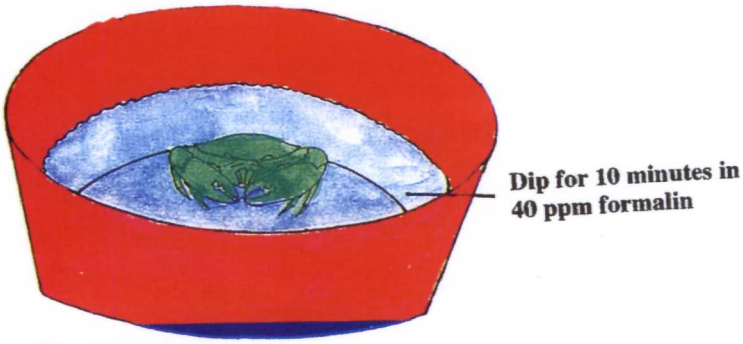
3.9.1. EFFECT OF WATER TEMPEATURE ON EMBRYONIC DEVELOPMENT OF EGGS

AT 27-33^0 C : 7-10 days
AT 23-27 ^{0} C: 10-14 days

3.9.2. COLOUR CHANGE IN THE BERRY

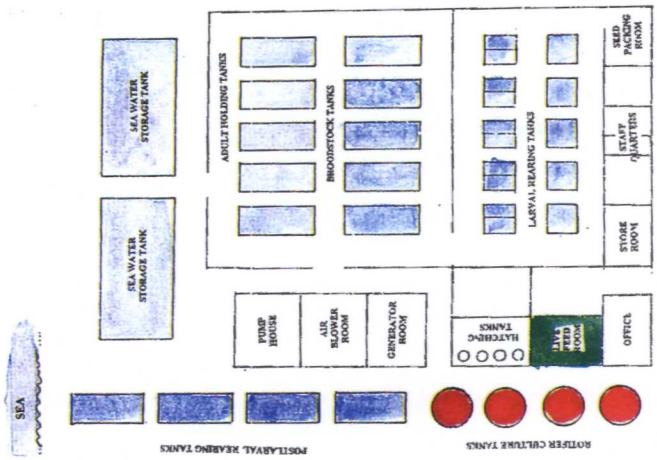


3.9.3. PROPHYLATIC TREATMENT FOR BERRIED CRABS

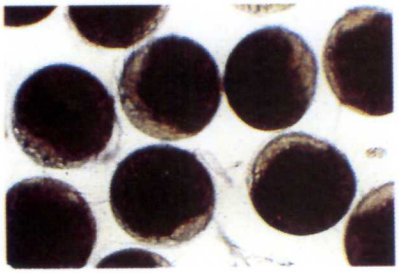


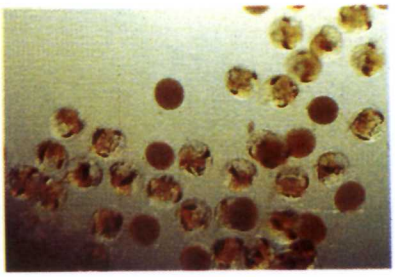
3.10. SEED PRODUCTION

3.10.1. LAY-OUT OF A MUD CRAB HATCHERY



3.10.2. HATCHING

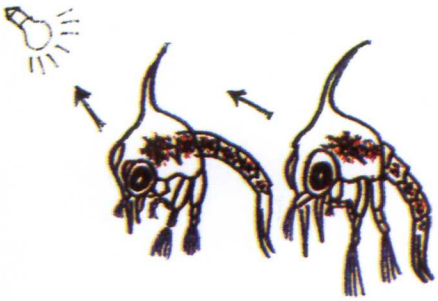




3.10.3. LIBERATION OF LARVAE

3.10.4. BEHAVIOUR OF LARVAE

first zoea larvae are phototatic



3.10.5. COUNTING OF LARVAE

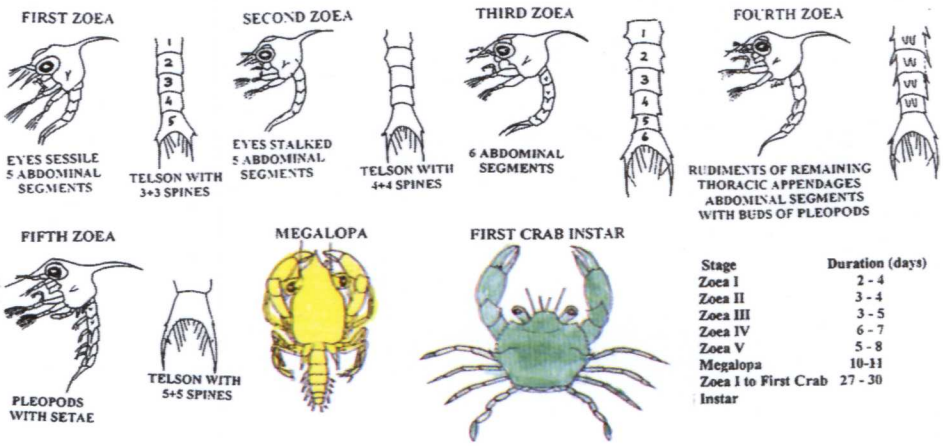
A) **Estimate the volume of water in the hatching Tank**
B) **After thoroughly mixing the water, draw three sub-samples of water**
C) **Count the larvae in the sub-samples and Then raise to total volume of hatching tank**

3.11. LARVAL REARING

3.11.1. STOCKING OF LARVAE

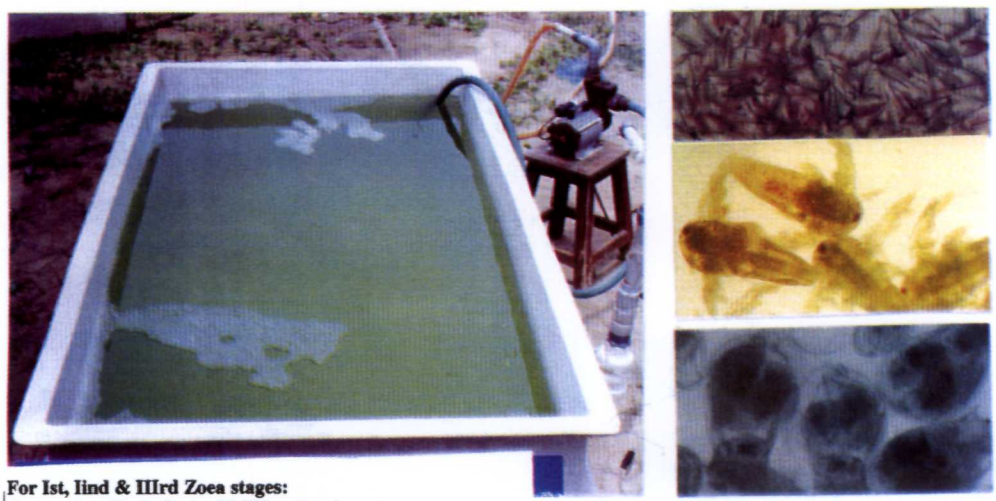
20 to 40 larvae per litre

3.11.2. LARVAL STAGES



Stage	Duration (days)
Zoea I	2 - 4
Zoea II	3 - 4
Zoea III	3 - 5
Zoea IV	6 - 7
Zoea V	5 - 8
Megalopa	10-11
Zoea I to First Crab Instar	27 - 30

3.11.3. FEEDS AND FEEDING RATES



For Ist, IInd & IIIrd Zoea stages:
Green alga *Cholrella* sp. 20,000 cells/ml
Unicellular diatom *Chaetoceros* spp.
Rotifers *Brachinus rotundiformis* 30-60 nos/ml & *B. plicatilis*
For Ivth & Vth Zoea stages:
Green alga *Cholrella* sp. 20,000 cells/ml
Unicellular diatom *Chaetoceros* spp.
Rotifers *Brachinus rotundiformis* 30-60 nos/ml & *B. plicatilis*
Nauplii of Artemia 50 nos/ml
For Megalopa stage:
2-day old Adult Artemia 50 nos/ml & chopped boiled flesh of shrimp, clam and fish @ 3-5 % of biomass
For first crab instar:
Flesh of shrimp, clam and fish @ 3-5 % of biomass
Articifical feed @ 0.3 g/tonne of water

3.11.4. WATER MANAGEMENT

Salinity: 28 – 35 ppt
Temperature: 27 – 32 ^{0} C

3.12. POSTLARVAL REARING

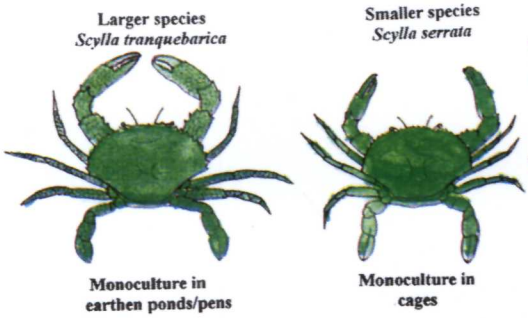
3.12.1. STOCKING RATE AND FEEDING

10 to 20 nos./sq.m.
Flesh of clam meat/trash fish @5-8 % of stocked biomass

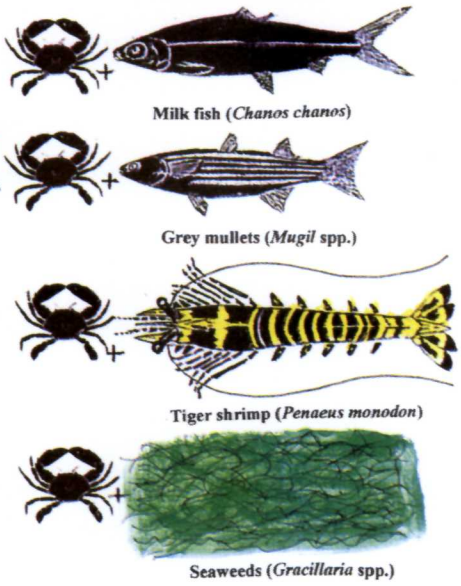
4. CULTURE PRACTICES

4.1. TYPES OF CULTURE

4.1.1. MONOCULTURE



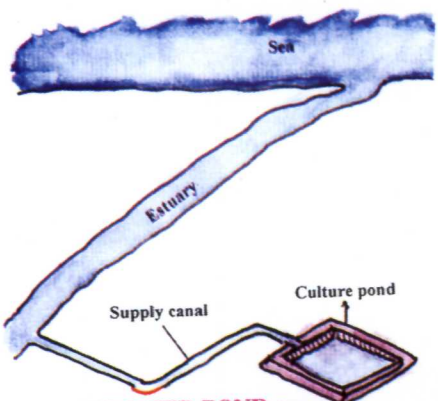
4.1.2. POLYCULTURE WITH FISH, SHRIMP AND SEAWEED



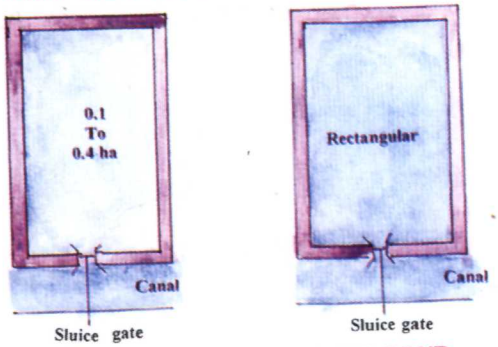
4.1.3. FATTENING FOR WEIGHT GAIN

4.1.4. FATTENING FOR OVARY GROWTH

4.2. LOCATION OF SUITABLE SITE

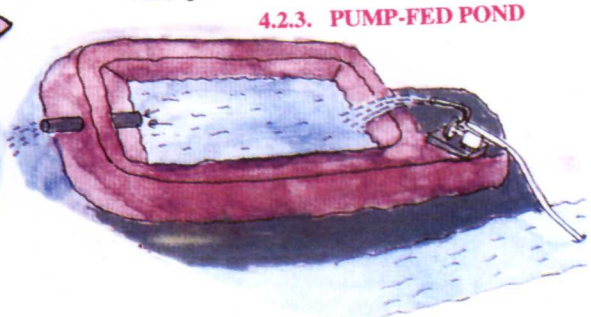


4.2.1. SIZE AND SHAPE OF POND



4.2.2. TIDE-FED POND

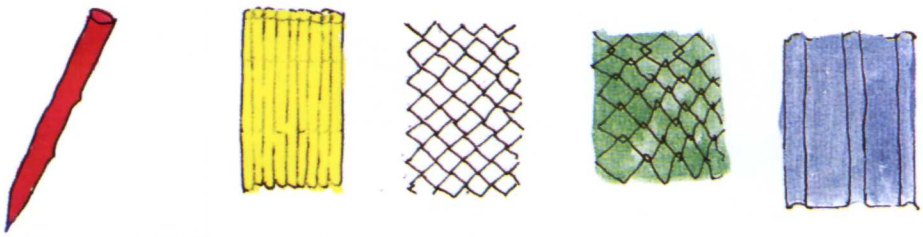
4.2.3. PUMP-FED POND



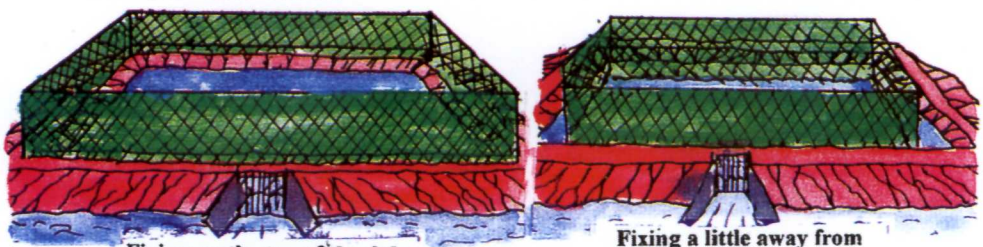
4.2. POND PREPARATION

4.2.1. FENCING MATERIALS

Casurina poles | Bamboo split Matting | Nylon netting | Plastic coated G.I. wire mesh | Asbestos sheet



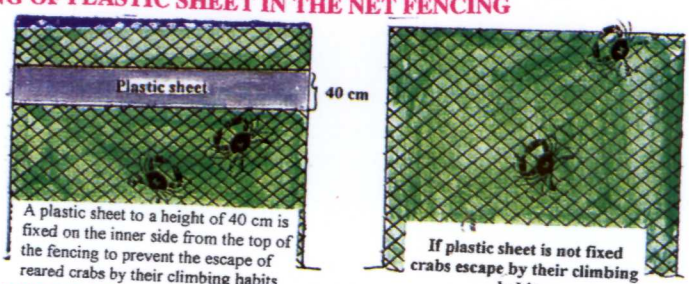
4.2.2. METHOD OF FENCING



Fixing on the top of the dyke

Fixing a little away from the inner periphery the dyke

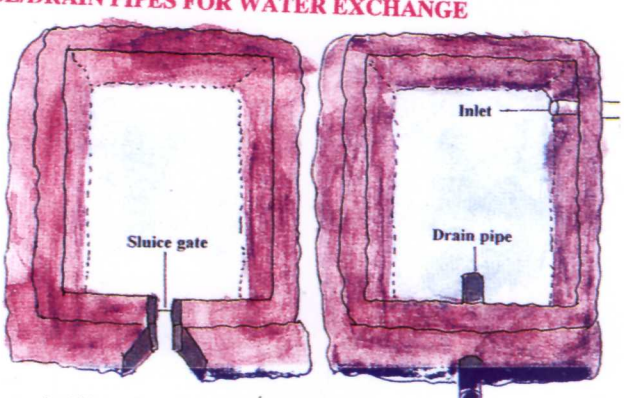
4.2.3. FIXING OF PLASTIC SHEET IN THE NET FENCING



A plastic sheet to a height of 40 cm is fixed on the inner side from the top of the fencing to prevent the escape of reared crabs by their climbing habits

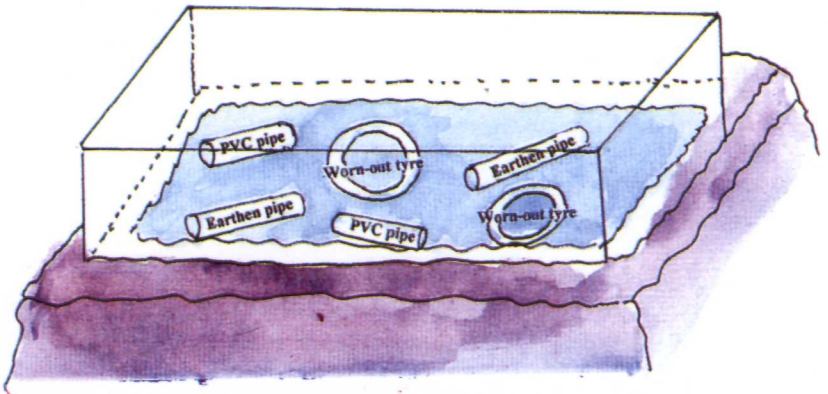
If plastic sheet is not fixed crabs escape by their climbing habits

4.2.4. SLUICE/DRAIN PIPES FOR WATER EXCHANGE

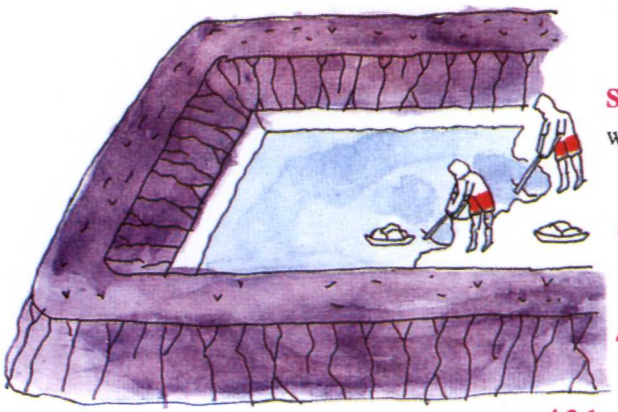


In tide-fed pond, water should be exchanged at every high and low tides
In pump-fed ponds, fresh saline water should be pumped into the pond at every alternate days after draining 30 % of bottom water through the drain pipe.

4.2.5. PROVISION OF HIDE-OUTS



4.2.6. REMOVAL OF BLACK SOIL FROM POND BOTTOM



4.2.7. WATER QUALITY

Salinity: 10-35 ppt; ideal 15-25 ppt

Weekly monitoring of water parameters such as salinity, dissolved oxygen and pH should carried out

4.2.8. SOURCE OF STOCKING MATERIALS

4.2.9. PERIOD OF CULTURE

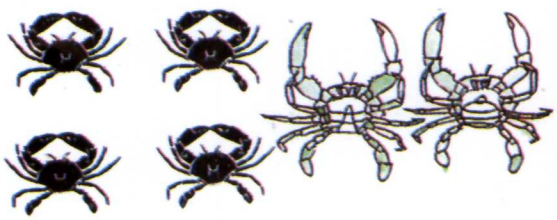
120 days for grow-out
3-4 weeks for fattening

4.3. STOCKING

4.3.1. STOCKING RATE

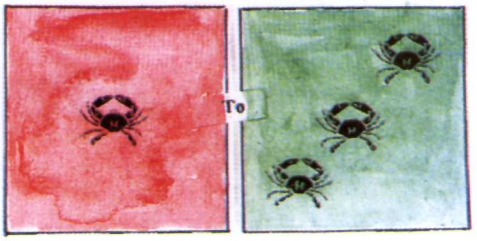
Uniform sized crabs

Crabs with all limbs intact

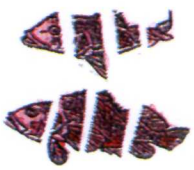


Number per square metre

Number per square metre



4.4. FEEDING



Chopped fish

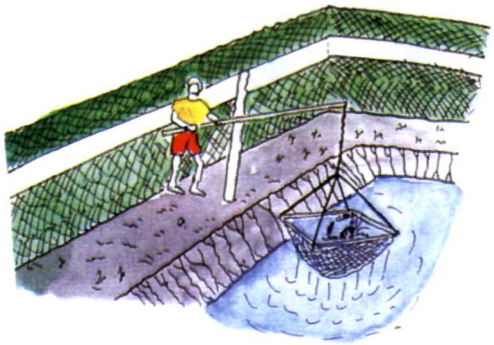
4.4.1. FEEDING RATE

For 0.2 ha pond

Day of culture	No. of crabs stocked	% of survival	Av. Body weight (grams)	% of feeding	Total quantity of feed required (kg)
1-30	2000	100	90	5	270
31-60	2000	90	150	6	486
61-90	2000	80	225	8	864
91-120	2000	70	300	10	1260
Total					2880

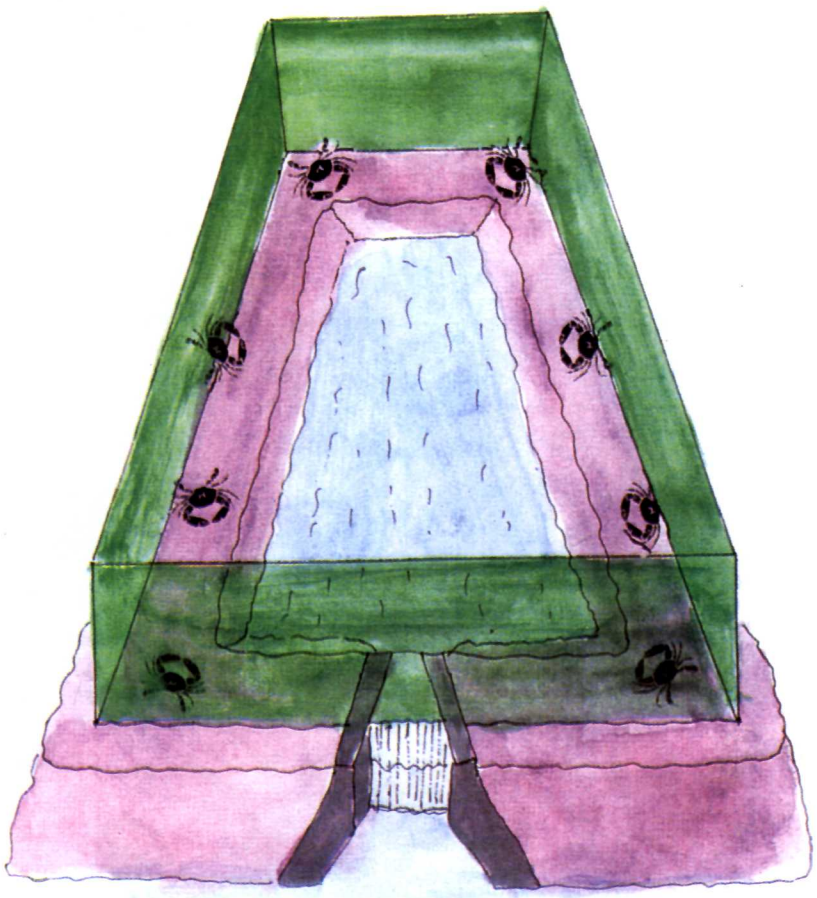
4.5. MONITORING OF REARED STOCK

4.5.1. METHOD OF COLLECTION OF CRABS FOR SAMPLING



RECORD OF SIZE OF CRABS
RECORD OF WEIGHT OF CRABS

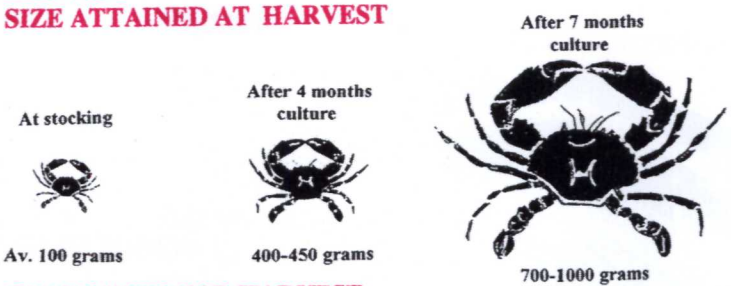
EFFECT OF FOULED WATER ON BEHAVIOUR OF STOCKED CRABS



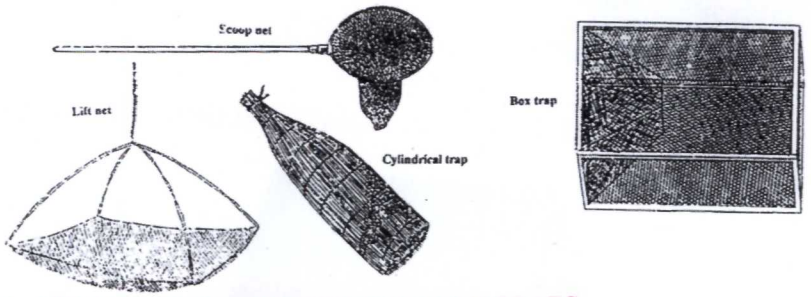
The reared crabs come out of water and occupy the dyke area during the day, when the pond water got polluted On such occasion, the entire pond water should be drained out and clean water should be provided

4.6. HARVEST

4.6.1. SIZE ATTAINED AT HARVEST

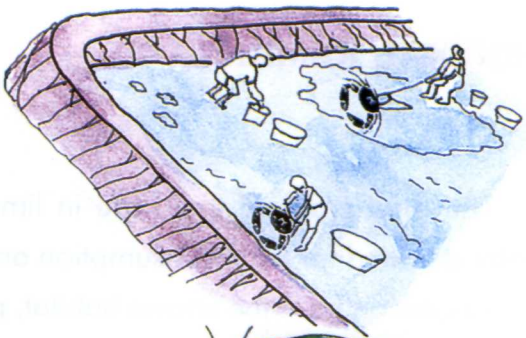


4.6.2. GEARS USED FOR HARVEST

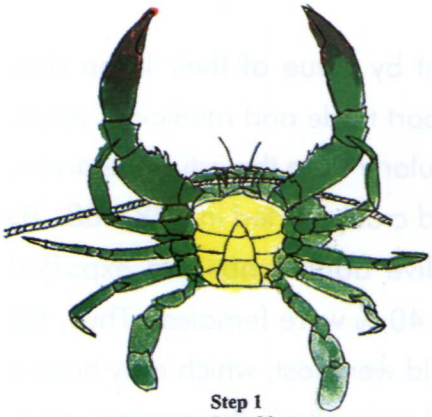


4.6.3. USING SWIMMING BEHAVIOUR OF CRABS

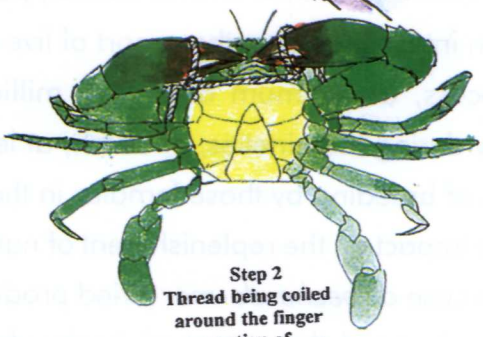
4.6.4. DRAINING AND HAND-PICKING



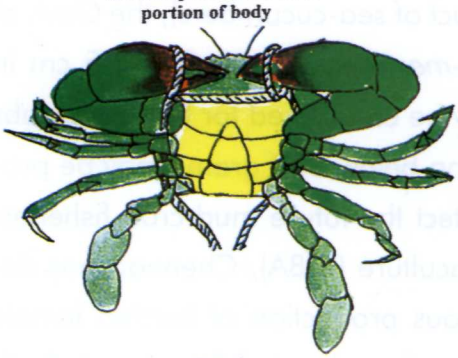
Method of handling of crabs



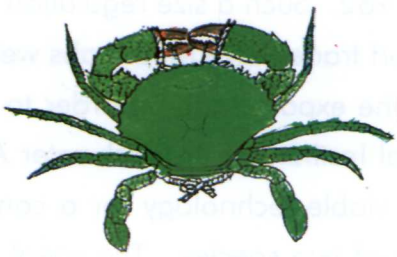
Step 1
Insert the thread between the chelipeds and ventral portion of body



Step 2
Thread being coiled around the finger portion of chelipeds

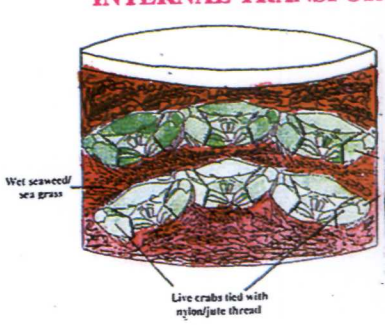


Step 3
Thread being drawn above all the four walking legs



Step 4
Both the ends of the thread knotted

4.6.5. PACKING
4.6.6. BAMBOO BASKETS FOR INTERNAL TRANSPORT



4.6.7. PERFORATED THERMOCOLE BOX FOR EXPORT

9. GENERAL REMARKS

The mud crabs of India are in lime light by virtue of their large size, greater demand for local consumption and export trade and medicinal value. The exploitation from the known habitat, particularly from the estuarine areas, has been intensified since the export of live mud crabs started in 1987-88. By this process, a minimum of 5 to 6 million live adult crabs are exported annually during the nineties, of which, at least 40 % were females. Thus, the chances of breeding by those females in the wild were lost, which may have a negative impact on the replenishment of natural resources in the coming years. As in the case of *beche-de-mer* (dried product of sea-cucumbers), the Govt. of India has banned the export of *beche-de-mer* measuring below 7.5 cm in length in 1982. Such a size regulation may be considered for live mud crabs in the export trade. Live mud crabs weighing below 350 grams may be prohibited in the export trade, in order to protect the future mud crab fisheries. The Central Institute of Brackishwater Aquaculture (CIBA), Chennai has developed a viable technology for a continuous production of berried female mud crabs of two species. The zoeal larvae from berried females of *Scylla tranquebarica* and *Scylla serrata* were reared successfully to first crab instar stage on a diet of live feeds. At present, attempts are being made to standardise the larval rearing procedures to enhance the survival rate at different phase of seed production at CIBA.

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