BIOLOGY AND NATURAL RESOURCES

A REVIEW OF THE CULTURE, MARKETING AND RESOURCES OF THE MUD CRAB (Scylla serrata) IN THE BAY OF BENGAL REGION

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ABSTRACT

Most hatchery work to dare has been experimental, but technology has developed ***for*** *the production of crab seed. Both closed and open rearing systems are in use. Ratifers.* **Artemia** *nauplii and trash fish are the most common feeds for all larval stages. High mortality may occur at any larval stage, hut shelters placed in the rearing tanks seem to improve survival of megalopa .*

Mud crab culture depends on natural seed collection. Taiwanese shrimp farmers stock megalopa and early crab stages. In the Philippines, farmers stock 2-3 cm seedlings in milkfish ponds. Market size, post-moult crab are held for periods of 15-30 days both for weight gain and the development of roe in females.

Most crab fattening ponds are small, with special precautions taken to prevent burrowing. In growout operations. crab are stocked at 5000-10,000/ha and the yield is 5000-9000/ha. The r-earing period in the Philippines varies with the season in polyculture ponds, 3-4 months during summer and 5-6 months during the winter season.

Little published information is available on marketing, but mud crab are widely distributed in the Indo-Pacific region. Specification in **Scylla** *also requires classification regionally.*

Females migrate offshore for spawning. but local stocks only move a few hundred metres. Commercial exploitation begins when the crab are one year old. Traps, gaffs. gillnets. dipnets and trawls are used for- mud crab capture.

The total world mud crab production is 10,00t/year according to FAO statistics. but serveral countries do not report separate statistics for mud crab.

In the mangrove biotope, mud crab production is about 2t/km². Given the importance of the mud crab to small-scale fisherfolk and increasing exploitation. it is necessary to improve knowledge of fishing effirt and biological parameters in relation to stock management.

Scylla serrata CULTURE

Crab culture incorporates seed production, either from natural sources or hatcheries, perhaps a nursery cycle and growout. In the growout phase, seedlings may he reared to market size. or large females may be stocked and fed until gonads develop. The latter is referred to as 'fattening'.

This brief overview of the 'state-of-the-art' has been gleaned from literature available to the authors.

Seed production in hatcheries

Although there arc reportedly commercial hatcheries in Taiwan. China and Japan (Cowan 1984). most work to date has been experimental. The following account of the hatchery cycle is based on the work of Cowan (1984) and Heasman and Field& (1983).

Mud crab mature at a carapace width of 10 cm and spawning will occur about four months after copulation. Eye-stalk ablation can dramatically shorten this interval to ten days. Hatching takes place 16 or 17 days after spawning at a temperature of 23-25°C between 5 and 8 am, depending upon water temperature. Females are placed in individual hatching tanks to avoid aggressive behaviour during hatching. A 200-250 g female produces 850,000 to I ,500.000 first stage Zoea larvae (Z_1). Hatching rates are routinely close to 100 per cent.

The first four zoeal stages take 2 or 3 days for each intermoult, while the Z_5 take 3 or 4 days to moult to the megalopa. The megalopa requires 7 or 8 days to metamorphose to the first crab stage.

Various feeds have been used, including the rotifer Brachionus. the brine shrimp Artemia. and copepods. Artemia nauplii seem to be an adequate food for Z, through Z,. Nauplii must be fed at specific densities, but values reported in the literature vary considerably. Japanese workers begin at 100 nauplii/ml. increasing to 300 nauplii/ml. In Australia, Artemia nauplii were fed at 5-30/ml. Adult copepods of the genus Trigriopus have been used in Taiwan. but Australian researchers had good results with macerated shrimp muscle.

Mortality is heaviest during changes between zoea. megalopa and the first crab. Japanese workers have had very good results with larvae of the genus Portunus. but have only been able to achieve about 6 per cent survival from Z, to the first crab in the case of Scylla serrata. Commercial hatcheries in Taiwan have achieved much higher survival by placing shelters in the rearing tanks at the onset of the megalopa stage. Survival may reach 60 per cent to the first crab with a production of 6000/t of rearing water. Workers in Australia have successfully reared mud crab larvae in a closed system, reporting 26 per cent survival.

Some recent advances in penaeid larval nutrition and feeding could be applied to rearing of mud crab larvae. It has been found that brine shrimp nauplii can be enriched with essential unsaturated fatty acids, greatly improving the survival of penaeid larvae (Leger. et *al.* 1986). Micro-encapsulated diets have been developed which can be fed to larvae in combination with *Artemia* or alone. Unfortunately, there is nothing in the recent literature to indicate that any of these advances has been applied to the rearing of Scylla serrata larvae.

High salinity seawater is best for rearing Scylla serrata larvae. Culturists employ sand-filtered seawater ranging from 25-33 ppt. There is no detailed information on water management in hatcheries. although, as mentioned above, closed system culture has been successful in Australia.

Natural seed production

Mud crab culture depends overwhelmingly on wild seed supply, hence this is frequently the limiting factor to expansion of the business.

Most culturists use juvenile crab of 2-3 cm. These are stocked directly into growout ponds. Crab fattening utilizes females measuring 8-10 cm. Only in Taiwan are megalopa and early crab stage larvae caught for stocking in nursery ponds. Milkfish (Chanos chanos) fry nets and beach-seines are employed and fishermen may catch 60,000 to 70,000 larvae/day with two or three nets during the peak season. Fry may be taken year round, but the peak season is during spring and summer. Larger seedlings of 2-3 cm carapace width are caught at night using an underwater light in water 0.5 m deep with sandy bottom.

In the Philippines, seedlings are collected in tidal rivers near the sea coast. They are available year round and range from 2-10 cm, but most farmers stock 2-3 cm seedlings. Many farms depend, to a greater or lesser degree, on autostocking during tidal water exchanges.

Crab fattening, as opposed to growout from seed stock, predominates in other Bay of Bengal countries. Only larger crab. nearing maturation size, are stocked for fattening.

Restocking and nursery culture

Japan is unique in having very large scale programmes for replenishing depleted marine fishery resources by restocking hatchery-bred seedlings in natural water beds. The Kuruma shrimp (Penaeus japonicus) programme in Kagoshima Bay is a well-known example. Other well-known programmes are for abalone and salmon.

Most restocking of crab has been directed at *Portunus trituberculatus,* but recoveries have been erratic. Mud crab seedlings were stocked in Lake Hamana. Normally, difficulties in marking crab seedlings make recovery estimates very difficult, if not impossible. However, Japanese biologists used the 'oceanic' variety of S. serrata, which can be easily distinguished from the inshore variety. The majority of the mud crab catch in the lake was estimated to have derived from restocked seedlings.

As with other aspects of mud crab culture, nursery rearing is most advanced in Taiwan. Production of seedling crab supports the growout business and serves as a source of demand for hatchery bred larvae. Nursery ponds are constructed with brick and concrete walls.

The bottom is sand-covered mud; apparently the sand prevents burrowing — a continual problem in mud crab culture! Seedlings are stocked at 2000-3000/m'. No aeration is given and the seedlings are fed trash fish. Harvest is after two weeks and survival ranges from 50-70 per cent.

Growout

Most mud crab grow-out operations are part of polyculture systems in which milkfish, penaeid shrimp and seaweeds are also produced.

In Taiwan, such farms vary in area from 1-200 ha. Individual rearing ponds are 0.2-I ha and I-4 ponds make up the average enterprise. Water is obtained from tidal channels through sluice gates in some farms, but many use saline groundwater which may be diluted with fresh well water to obtain the desired rearing salinity of 10- 15 ppt. Subsidence has become a serious problem where crab and shrimp farms are concentrated and there are increasingly strict controls on this practice.

Dykes must be protected with bamboo, brick or concrete panels. A sand bottom inhibits burrowing. Stocking densities vary from 5000- 10,000/ha. The best food for mud crab is the fresh and brackishwater snail, *Cerithidia.* Trash fish are also given, but the mud crab does not accept currently available pelleted feeds. Snail are fed at 10-15 g/m^2/day. Trash fish for crab and shrimp are fed at a rate of 4-5g/m^2/day. In polyculture systems, milkfish may be stocked at 1000-4000/ha. Crab are stocked only during early spring and midsummer. Market size is reached in 3-4 months during the summer and 5-6 months in the winter season. Yields are 5000-9000 crab/ha, depending on the culture system (mono- or polyculture). Crab with a carapace width of 8-9 cm are marketable.

Mud crab are an incidental harvest in the Philippines, although some farmers take special measures to increase their yield. These may include overhanging fences on dykes and soil mounds or tree stumps in the ponds for shelter. Seedlings are usually 2-3 cm and are stocked at only 1000/ha. Feeding is very casual; almost any kind of organic matter is given. The low level of management is reflected in the low yield of crab, averaging only about 111 kg. But 500 or more kg of milkfish and 52 kg/ha of shrimp are also taken. There are a few mud crab monoculture operations in the Philippines yielding 339 kg/ha.

Fattening

Gravid female mud crab with their internal orange-red egg masses filling the carapace are much in demand in seafood restaurants from Hong Kong to Indonesia. Because of the product's high price, crab 'fattening' has spread throughout ASEAN countries. Crab fattening is essentially a holding operation during which immature female crab are kept in some kind of enclosure and fed

until their gonads develop and fill the mantle cavity. Post moult or 'water' crab are also kept for short periods until they 'flesh out'.

Crab may be held in small ponds, pens or floating cages. In Taiwan, ponds are small, about 50-600 m². Most businesses have 5-15 such ponds. They are equipped with concrete dykes and water exchange is by tide or pump. Aeration, with regular cleaning of silt, and liming, are employed to improve water quality. Female crab of 8-12 cm carapace width are stocked at 2-4/ m², reduced to only l/m² during the summer. Feedings once a day consist of up to 200 g of trash fish per crab and live snail at 100/m².

Crab fattening has become very popular in Thailand. Both ponds and pens are used. The centre of this activity seems to be Surat Thani in southern Thailand. Some details have been provided by Hanvivatanaki (1990) in a report on the economics of crab fattening. Ponds are quite small, averaging about 270 m². but an operator may have several. These are strictly 'fattening' operations as seen from the stocking size of 415 g. The growing season is about a month and six crops a year can be had. Trash fish and horse mussel are fed during the fattening period. The seasonal supply of stocking material limits the operation to six crops annually. The farms are basically family operations and the major investment cost is land and pond construction. Crab fattening is considered to be very profitable in the Surat Thani area.

Floating cages are used to culture mud crab in Malaysia. These operations can be seen at Pulau Ketam (appropriately named 'Crab Island') and at the mouth of the Muar River in Johor State. Cages are about 6 m² with a depth of l m. Extruded plastic mesh is commonly used for the enclosures. Crabs are stocked at 10/m² and range in size from 7.5-18 cm carapace width. Chopped trash fish is given as food. The market size is 300-500 g, although they may reach l kg. Some of the growers obtain their seed stock from Thailand (INFOFISH, personal communication).

Marketing Scylla serrata

Very little published information can be found dealing with the marketing of live crab. Judging from anecdotal evidence, demand appears to be very strong. Buyers in Malaysia are importing mud crab from India, Sri Lanka, Indonesia and Bangladesh. As much as two tonnes may be imported into Malaysia daily, although this is merely a 'guesstimate'. Mud crab are very hardy and can survive several days out of water if kept moist. Literature on packing and shipping is lacking.

A REVZEW OF THE MUDIMANGROVE CRAB FZSHERY IN THE BAY OF BENGAL REGZON

Species and habitat

The mud crab, or mangrove crab, is widely distributed in the Indo-Pacific, including the Bay of Bengal, region. Generally, it is considered to belong to a single species, Scylla *serrata*. However, on the northeast coast of India and in some parts of Malaysia and Thailand, it is reported that a smaller type of mud crab is found. It is not clear whether this is a subspecies or a variation of the species, influenced by environmental factors.

The egg-release and larval development are in the open sea, while juveniles, subadults and adults stay in the mangrove biotopes, estuaries and channels, living under mud during daytime and moving around in the subtidal area at night in search of food. They can cover about 500 m in a night and populations from different bays may be considered as different stocks. Commercial exploitation is usually when the crab are about a year and more. Though major exploitation is in the estuarine mangrove environment, some adults are caught in the open sea during reproductive migration of, primarily, the females.

Fishing methods

Gear	*Fishlig habitat*	*Countries*
Wooden gaff	In burrows (Intertidal)	Madagascar
Dipnet	On mudflats outside burrows	Madagascar
Line with baited hooks operated with traditional craft	Channels. estuaries and lagoons	Madagascar. India
Hoopnet/basket/trap	-do-	Madagascar. Malaysia, Sri Lanka. Thailand
Barriernet/stakenet	-do-	India. Sri Lanka. Malaysia. Thailand
Gillnet	-do-	India. Sri Lanka. Malaysia. Thailand
Dragnet/Pushnet	-do-	India. Malaysia. Thailand, Indonesia
Wing set bagnet	Estuaries and lagoons	Thailand
Set bagnet	-do-	Indonesia, Thailand
Trawl (otter and pair)	Open sea	Malaysia
Castnet		India. Sri Lanka
Shore seine		India. Sri Lanka

Production trends

From the Bay of Bengal region, only Indonesia and Thailand declare production figures specifically for mud crab (FAO and SEAFDEC statistics). In the case of Malaysia, statistics combine mud and sea crab and, hence, mud crab production estimated here is based on the crab catches by typical gear used in the mud crab fishery (Anon 1983a).

In the cases of Bangladesh, Burma and Sri Lanka, guesstimates have been made. There is no mud crab production in the Maldives. The estimates are as follows:

Maldives		Nil	
Sri Lanka	West coast	**600** t	Average total 2300 t
	South coast	**200** t	(Guesstimates)
	East coast	1000 t	
	North coast	500 t	
India	West Bengal	1000t	(WB/DEV report by de Mautrot)
	Orissa	**300** t	Avg. total 3500 t
	Andhra Pradesh	**500 t**	(Derived from CMFRI
	Tamil Nadu	**2500 t**	Statistics for 1986) Guesstimates
Bangladesh	Sundarbans	1000t	
Burma	Mainly delta areas	**500** t	Guesstimates
Thailand	(west coast only)		
	(a) Avg total	1500 t	(FAO Statistics 1986)
	(b) Avg total	1700 t	(SEAFDEC statistics 1987)

Peninsular Malaysia* **(west coast only)**

Johor	5.6t
Kedah	56.0t
Melaka	
Negri Sembilan	9.4t
Penang	2.6t
Perak	464.0t
Selangor	38.0t

(a) Avg total 500 t (Anon 1983a)
(b) *SEAFDEC statistics for 1987 did not declare crab catches for Malaysia (SEAFDEC 1987)

Indonesia
(Sumatera 1982)

Langat	261.1 t
Deli Serdang	71.7 t
Kodya Medan	50.9 t
Asahan	145.4 t
West Coast ('86)	86 t (1987)

(a) Avg total 500 t (DOF statistics 1982)
(b) Avg total 700 t (FAO, 1986)
(c) Avg total 1360 t (SEAFDEC, 1987)

The estimated total catch for the BOBP region is 9-10,000 t/year. Recorded world total is about 10,000 t/year (FAO 1986). Only Indonesia, Thailand, Philippines and Papua New Guinea are included in the latter.

Potential yields

Maldives No estimate possible

Sri Lanka - The west coast is very intensively fished. The other coastlines may have possibilities for marginal increases in the future. N5o assessment has been made for the whole country.

India Total estimated backwaters is 7770 km^2 with a yield of 13.209 t, giving an average yield of I .7 t/km^2 (Rao *et al* 1973)

West Bengal (Sundarbans) : 2,100,000 numbers (33.6t) in 1954 (Anon 1960, year unknown).

Orissa (Chilika): Avg. 18 t in 103 km^2; 0.17 t/km^2 (Rao *et al* 1973)

Andhra Pradesh (Godavari) : 337,456 kg in 2 11 km^2: 1.60 t/km^2 (1967/68) (Rao. *et al* 1973)

Tamil Nadu (Pulicat) : 907 t in 103 km^2; 8.81 t/km^2 (1958/59) (Anon 1960)

Prasad (1990) has estimated the potential for the whole of India as 8400 t and stated that the resource is concentrated in southern peninsular India. He also estimates the maximum size at 2800 g/crab. There is probably room for increasing production.

Bangladesh - No estimate available, but the Sundarbans and other coastal belts should provide a yield very much higher than the estimated production.

Burma - Unknown

Thailand - Pataros *et* al (1987) estimated the area of the backwaters of Thailand to be about 2 192 km^2. Sanders (1989). taking the average production/year for the period 1981-83 at 4851 t, estimated a yield of 1.99 t/km^2 and considered it close to the 1.8 t/km^2 obtained for Madagascar.

Discussion

The overall average yield per km' for India also appears to be reasonably close to the range discussed by Sanders for Thailand and Madagascar, However, there are two points which call for attention:

— When three-year running averages of Thailand's production for the period preceding and following the one used by Sanders are examined. a steady increase in yield becomes evident :

	Peropd	Yield/unit area	
1.	1981-82	1.78 t/km^2	(Preceding period)
2	1981-83	1.90 t/km^2	(Period used hy Sanders)
3	1982-84	2.00 t/km^2	(Succeeding period)
4	1983-85	2.09 t/km^2	
5	1984-86	2.20 t/km^2	
6	*1985-87*	2.26 t/km^2	

The yield per km^2 for various states of India on the east coast also shows steady increases from a very low value of 0.17 t/km^2 to an abnormally high 8.8 t/km^2. Prasad (1990) also mentions high concentrations in southern peninsular India. but not details of his results are available.

— Sanders (1989) has used 560 gm as the average weight of a crab in Madagascar and the mean density as one crab/l 24 m^2 to calculate the sustainable yield of 18 t/km^2. However, the Ranong sampling programme indicates that the crab caught are 120-200 g in weight. If the yield value for Thailand is not so different from Sanders' rule of thumb, then the mean density in number of crab per unit area in Thailand should be more than twice that in Madagascar. Since the yield value for Thailand is showing further increases, the density (number per unit area) will become even greater. This will be a true situation if the mud crab in Ranong belong to a different subspecies or race. On the other hand, the situation could also have been caused by very intensive fishing (overfishing?), indicated by the increasing yield per unit area and, consequently. the average size of crab in the population being reduced. Unfortunately, fishing effort data are not available to check the effect of the fishery on the resource and length-weight relationship information or other morphometric data are not available to compare the biological differences between the so-called large and small varieties of mud crab in the Bay of Bengal.

According to Radhakrishnan and Samuel (1982), various authors have reported the occurrence of two or more species of mud crab, primarily based on differences in colour, relative length of the claws. minor differences in the carapace width at first maturity (10 and 12 cm), but hardly any reference has been made to the very significant differences in size or weight of these species.

Hyland (et al (1984) found that adults of Scylla serrata can generally move over a distance of 3.9 km. However, in long channels which extend further away from the sea, the females moved over 6.6 km while males covered only around 3.7 km. This is relevant to the estimation of the territory occupied by a population of this species and also raises the possibilities of some inter-mingling of populations in adjacent mangrove areas.

The guesstimated level of production from the Bay of Bengal contributes very significantly to the world production of mud crab, even though the figure available for the latter is considered to be a serious underestimation.

In view of the significant contribution to the production of mud crab, rapid developments in the export of this product and introduction of fattening processes to increase the weight of crab, there is an urgent need for a concentrated effort to investigate the biology, particularly the reasons for differences in maximum weight of mud crab in different locations (2800 g in some areas of India, 200 g in Ranong. 560 g in Madagascar), production levels and potential for increasing the production of mud crab in the countries of the Bay of Bengal region.

REFERENCES

ANON. 1960. Annual report of the Central Inland Fisheries Research Station, Barrackpore. 1958-59. ***Ind. J. Fish. 7(1)*** 233-74.

———— 1964-67. Administrative Reports. Dept. of Fish., Kerala, Ind.

———— 1983a. Annual Fisheries ***Stotistics*** 1983. Min. Agri., Malaysia.

1982a. 1982b. Results of fishery production survey. Report of data collection. processing and evaluation of fisheries ***statistics.*** Provincial Fish. Serv., North Sumatera, Indonesia.

———— 1989. Marine fish production in India, 1985/86. Mar. Fish. Info. Serv. Tech. Extn., CMFRI. Sr. No. 91.

COWAN, L. 1984. Crab forming in Japan. Taiwan and the Philippines. Dept. P.I., Old. 85p.

HANVIVATANAKI. P. 1990. Cosf and returns of crab fattening in Surat Thoni Provinces. Ms. Bay of Bengal Programme. Madras, Ind.

HEASMAN, M.P. and FIELDER, D.R. 1983. Laboratory spawning and rearing of the mangrove crab, Scylla serrata (Forskal). from zero to the first crab stage. Aqua. 43 (3-4) : 303-3 16.

HYLAND, S.J., HILL B.J. and LEE C.P. 1984. Movement within and between different habitats by the Portunid crab, Scylla serroto. ***Mar.Biol.*** Vol. 80, No. 1:57-61.

LEGER, P., BENGTSON, D.A., SIMPSON, K.L. and SORGELOOS, P. 1986. The use and nutritional value of Artemia as a food source. Ann. Rev., Occonogr. Mar. Biol. (1 986/24) : 52 1-623

ONG KAH SIN. 1964. Early development stages of ***Scylla serrata*** Forskal (Crustacea Portunidae), reared in the laboratory. ***Proc. Indo-Pacific Fish. Council*** I l(2): 135- 146.

PATAROS et al. ***1987. Management offisheries and aquaculture in mangrove ecosystems in Thailand.*** FAO Fish. Rep. No. 370. Suppl. 248 pp.

PRASAD, N. 1990. Mud crab resources. ***Seafood*** Intl. March 1990 (extract from The Hindu, date unknown).

QUINN, N.J. and KOJIS, B.L. 1987. Reproduction biology of Stylla sp. from Labu estuary in Papua-New Guinea. ***2nd Intl. Symp. on*** Indo-Pacific Mar. Biol; Western Soc. of Naturalists. Univ. of Guam. Bull. Mar. Sci.: 234-241.

RADHAKRISHNAN, C.K. and SAMUEL, C.T. 1982. Report on the occurrence of one subspecies of ***Scylla serroto*** in Cochin backwaters. ***Fish. Tech..*** Soc. Fish. Tech., Cochin, Vol. 19 N. 1: 5-7.

RAO, V.P., THOMAS, M.M. and RAO, S. 1973. The crab fishery resources of India. ***Proc. Symp. on Living Res. of the Seas around Ind.*** CMFRI Sp. Publ.: 581-591.

SANDERS, M. 1989. An approach to a preliminary value for the potential annual catch per unit area for the mangrove crab, Stylla ***serroto. SWIO Fish. Bull.*** Oct. 1989 and Dec. 1989 (RAF/87/008).

SEAFDEC. 1987. Fishery Statistical Bulletin for South Chino Sea area - 1987.

Other relevant literature

GEORGE, C., UNNITHAN, G.R. and GOPAKUMAR, K. 1986. Morphometric measurements as an index for estimating yield of meat in shellfishes. I. Crab ***(Scylla serrata*** Forskal); Fish. Tech., Soc. Fish: Tech., Cochin Vol. 23, N.2: 196-198

HILL, B.J. (ed). 1984. ***Queensland mud crab fishery.*** Inf. Ser., Dept. P.I., Qld.. 54 p.

HILL, B.J., WILLIAMS, M.J and DUTTON P. 1982. Distribution of juvenile sub-adult and adult Scylla serrata on tidal flats in Australia. Mar. ***Biol.*** Vol. 69, N. I : 1 17- 120.

JAMESON, J.D.I., MURUGAN, A.L. and NATARAJAN, P. 1982. Studies on distribution pattern and morphometry of ***Scylla serrata*** along the Tuticorin Coast. ***Seafood Exp. J.*** Vol. 14, N. 4: 17-20

JOEL, D.R. and RAJ, P.J.S. 1980. Taxonomic remark on two species of the genus Scylla de Haan from Pulicat Lake. ***Inland Fish Soc.*** Ind. Vol. 12, N. 2: 61-65

MUTHIGA, N.A. 1986. Edible crabs of Kenya. ***Kenya Aquatic.*** No.3,:61-65.

PRASAD, P.N.,and NEELAKANTAN, B. 1969. Fishery of mudcrab, Scylla serrata from Karwarwaters. ***Fish. Tech..*** Soc. Fish.Tech., Cochin. Vol.26, N. 1:15-18

SHANMUGAM, S.I. and BENSAM, P. 1980. On the fishery for the crab Scylla ***serroto*** at Tuticorin during 1974-75. ***Ind. J. Fish.*** Vol. 27, N. 1&2:102-1 IO.

WILLIAMS, M.J. and LEE, C.P. 1980. ***Methods*** for ***determining size and sex*** of ***marketed crabs*** (Scylla serrata) ***and sand crabs*** (Portunus pelagicus) in Queensland. Tech. Rep. Qld. Fish. Serv. 7p.

WILLIAMS, M.J. and HILL, B.J. 1982. Factors influencing pot catches and population estimates of portunid crabs Scylla serrata. Mar. ***Biol.*** Vol. 71, N. 2:187-192

A REVIEW OF THE STATUS OF THE MUD CRAB (Scylla Sp.) FISHERY AND CULTURE IN INDONESIA

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ABSTRACT

With an estimated 4.2 million ha of mangrove forest, Indonesia has the potential to expand both its mud crab fishery and culture industries. From 1981 to 1988, production increased 12.5 per centlannum. The proportion of production from culture also increased during the same period. The mud crab fishery is an artisanal one using simple traps, liftnets. hook-and-line and gaffs. Fattening. production of gravid females and growout from seed stock are practised in the country. Gravid females are cultured in floating bamboo cages, with 70-1 10 females, each over 150 g, stocked in a 3m³ cage. After one month of feeding with trash fish, 70-85 per cent of them develop ovaries. Fattening is done in ponds or pens and cages in lagoons. The fattening period is 3 to 4 weeks. Some fattening is done in small 0.09m³ compartments. each carrying one crab. Forty crab averaging 150 g can be carried in lm². Crab fattening ponds are 1000m² and equipped with sluice gates, fencing and a central platform. The stocking rate for 150 g crab is 2/m³ and the holding period is 3-4 weeks. Mortality ranges from 10-50 per cent. Growout from 20-50g seed stock is done in milkfish ponds. Zntensive crab culture is still experimental. Feed availability is a constraint on the expansion of all three forms of crab culture. Both local and export markets are supplied through a well-established distribution system.

INTRODUCTION

In recent years, mud crab capture and culture have been expanding in Indonesia because of the high economic value of the species and its potential as an export commodity. Crab production from wild capture and pond production in 1988 was 4,157 t, about twice that of 198 1. Crab exports also showed similar trends; in 1988 it reached 3,494 t against 1,994 t in 1981. The crab fishery in Indonesia is expected to continue to grow in the future for several reasons: an increasing demand for the commodity, indicated by the increasing price in the local and international markets; the fishery resource supports both wild capture and culture of this species; knowledge of and experience in crab culture techniques are improving. However, there has to be more careful planning of crab fishery expansion to ensure sustainability of the fishery and the resource. This planning should also take into consideration the undesirable impacts of other fisheries and sectoral development on the crab fishery anh its resource.

THE CRAB FISHERY

Mud crab species

Two groups of ***Scylla*** are found in Indonesia, one reddish or brownish green, the other greyish green. The former are ***Scylla serrata*** and S. ***serrata*** var. ***paramimosain,*** (Moosa ***et al.,*** 1985), while the latter are ***S. tranquebarica*** and ***S. oceanica.***

Scylla serrata is the dominant species in Indonesia. We estimate that about 80 per cent of the total annual landings of mangrove crab consists of this species.

Major crab producers and production

Mud crab are available in twenty of 27 provinces (Table 1). However, production *per se* is promising in only three provinces: Northern Sumatera, Eastern Java. and Eastern Kalimantan. Production from these provinces comprised more than 70 per cent of Indonesia's total crab pro duction in 1988. Northern Sumatera produced the maximum, essentially from wild capture. while in Eastern Java the catch was from ponds.

Table I: Mangrove crab production in Indonesia by province (1988)

Province	*Production (t) from*		*Total*
	Fishing	*Pond*	
Sumatera	1,440	159	1,599
Aceh	94	99	193
North Sumatera	1,315	60	1,375
West Sumatera	13	-	13
Riau	9	-	**9**
iambi	9	-	**9**
Java	**241**	728	**969**
West Java	-	63	63
Central Java	2	42	44
East Java	237	623	860
Yogyakarta	2	-	2
Kalimantan	745	**113**	858
West Kalimantan	101		101
East Kalimantan	596	113	709
South Kalimantan	48	-	48
Nusa **Tenggara Islands**	**82**	**9**	**91**
West Nusa Tenggara	44	9	53
East Nusa Tenggara	38	-	38
Maluku & Irian Jaya	**174**		**174**
Maluku	133	-	133
Irian iaya	41	-	41
Others	253	213	266
TOTAL	2,935	1,222	4,157

Source: **Fishery Statistics 1990**

Between 1981 and 1988 crab production grew at 12.5 per cent/year. Annual production of pond harvested crab increased 27 per cent/year, while the fishing grew by only 9 per cent annually (see Table 2.)

Table 2: Mangrove crab production from marine fishing and culture (1981-1988)

Year	Production (t) Fishing	Culture	Total
1981	1.684	390	2.074
1982	1.930	323	2.253
1983	1,958	245	2.203
1984	1,894	314	2.208
1985	2,987	609	3,596
1986	3.322	758	4.080
1987	2,824	691	3.515
1988	2.935	1,222	4.157

Source: Fishery Statistics 1990

The data also clearly show that pond-harvesting of crab is increasingly popular, as seen from narrowing ratios between pond and fishery production (1:4.3 in 1981, 1:2.4 in 1988)

Export

Crab are exported from 11 provinces. The major exporters are Northern Sumatera, Jakarta and Western Kalimantan (Table 3). Crab exports from these provinces were about 97 per cent of the total export volume of crab in 1989. Of this, 79 per cent was from North Sumatera. Total crab exports from Indonesia in 1988 amounted to 2,843 t valued at US$ 3.4 million. In 1989. this increased to 3,623 t.

The export consisted of 64.8 per cent live crab, 16.7 per cent frozen and 18.5 per cent processed. **In 1988, Singapore, Malaysia and Taiwan imported around 93.7 per cent of the total crab exported** by Indonesia (Table 3).

Table 3: Volume and value of crab export, by port of destination (1988)

Country	Volume (t)	Value L'S$ (FOB)	%
Japan	80.85	289.694	2.8
Hong Kong	5.77	9,080	0.2
South Korea	31.04	61,740	1.1
Taiwan	375.80	1,613.664	13.2
Singapore	1,868.73	1.140,300	65.7
Malaysia	421.51	187.875	14.8
Australia	3.50	35,278	0.1
Commonwealth (others)	44.31	44,740	1.6
France	12.08	58,075	0.5
TOTAL	2,843.59	3,440.446	100

Source: Fishery Export Statistics 1988 (Anonynious 1990b)

Capture

CAPTURE PRODUCTION POTENTIAL

Given that mangrove areas are the fishing ground for the mud crab, Indonesia has a high potential. The country has 4.2 million ha of mangrove forest scattered throughout the archipelago. The largest area is in Irian Jaya, 2.94 million ha (Darsidi 1982). Other provinces with large mangrove forest areas are : Riau (276,000 ha), East Kalimantan (266,800 ha), South Sumatera (195,000 ha), and Maluku (100,000 ha).

South Kalimantan, South Sulawesi, Jambi, North Sumatera and Aceh have between 50,000 and 70,000 ha of mangrove forests each, while West Kalimantan, Southeast Sulawesi, West Java, Lampung, Central Java, Central Kalimantan, East Java, North Sulawesi, West Nusatenggara, Bali, and East Nusatenggara have 1,000-40,000 ha each.

FISHING GROUND

Scvl/a serrata is found in almost all coastal waters, and brackishwater ponds in Indonesia. As the mud crab can tolerate a salinity range from 2-38 ppt (Hill, 1974), the crab are caught upstream too. In Bone, South Sulawesi, mud crab is usually caught in coastal waters that have a sandy mud bottom and a salinity range of 15-30 ppt. Optimal water current velocity appeared to be between 0.06 and 1.6 m/sec at crab fishing grounds in the estuarine area of the Tamuku River, Bone (Mallawa 1991).

FISHING SEASON

Monthly data of crab export collected from exporters in Jakarta, Medan (North Sumatera) and Ujung Pandang (South Sulawesi) indicate that crab exports are higher December-May (Table 4), in fact, exporters report oversupply of crab at this time. The climatic cycle indicates that December, January and February are the months of peak rain, while April and May are the transition months between the wet and dry seasons. The data clearly shows that the peak mud crab fishing coincides with the rainy season (December-May), although crab capture activity is generally carried on through the year (Mallawa 1991).

Table 4: Export volume (in kg) of crab, by province, 1989

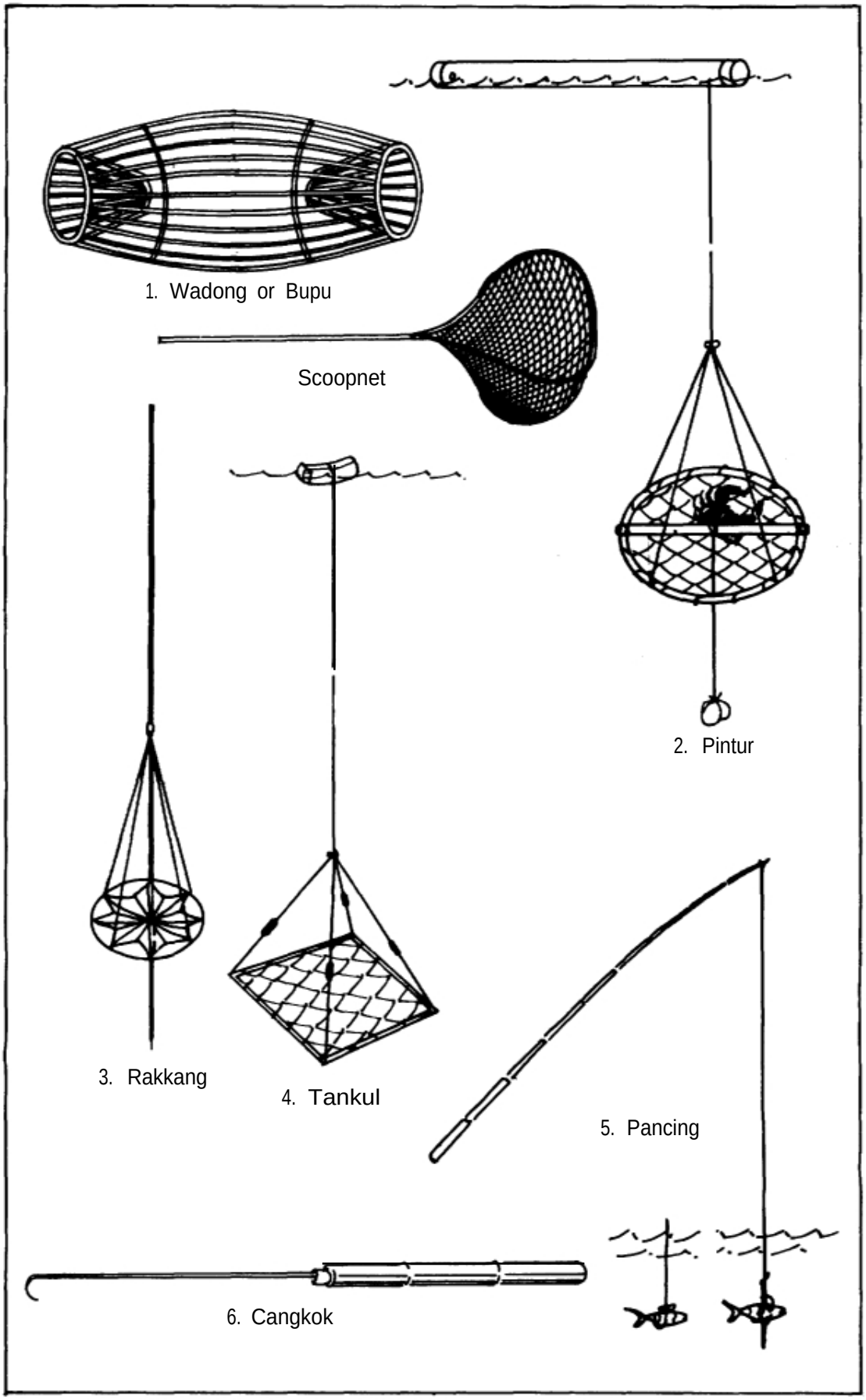
	Frozen	*Fresh*	*Processed*
North Sumatera	78,716	2,144.971	639,979
Riau	—	6.980	—
South Sulawesi	—	5.200	—
DKI-Jakarta	460.788	44,286	32,455
Central Java	34.2 14		
East Java	26,500	883	—
Bali	2.496	380	—
West Kalimantan	475	38.845	
East Kalimantan	—	5,500	—
North Sulawesi	320	75	—
South Sulawesi	1,231		—
Total	604,740	2.347,120	672,434

GEAR USED IN CRAB FISHING

Crab fishing in Indonesia is carried out with simple gear designed and developed by the fishermen themselves. To operate them efficiently, other supporting tools, such as canoes and scoopnets are required. In addition, skilful operators are necessary.

The most popular gear used in crab fishing are the *Wadong, Pintur. Rakkang, Tangkul,* and *Pancing.* The first four are trap-like gear, while *Pancing* is a line with, or without, hook. All are used with bait. Another method is to use an iron stick with a hooked end, locally called *Cangkok.* These gear are illustrated in Figures 1-6 (see facing page).

Fig 1-6. Gear used in crab fishing



The number of gear operated by a fisherman or carried per boat or per trip and their average catch rates are shown in Table 5.

Table 5: Gear used for the capture of **mud crab in Indonesia**

Gear	*Number* fished/ *per fishermen*	*Cutech rule*
I *Wadong* or *Buhu*	25 - 30	1 -2/trap
2 *Pintur*	60	0—3/trap
3, Rakkane	100	1-2/unit
4, Tangkul	20 - 30	1/unit
5. *Pancing*	40 - 50 / trip	5—10/trip
6, *Cangkok*	1	2 kg/day

Culture

CULTURE POTENTIAL

At present there are 274.000 ha of brackishwater ponds distributed in 26 provinces. However, there are only five provinces with major areas of hrackishwater ponds: South Sulawesi (78,79() ha), East Java (50,730 ha), Aceh (31. 030 ha). Central Java (30,300 ha) and West Java (28, 190 ha). The brackishwater pond area in these provinces was almost 80 per cent of Indonesia's in 1989. These ponds and the earlier mentioned mangroves are potential crab-culture development areas.

Crab culture in Indonesia has just started. It is a further development of the live crab holding technique practised by crab exporters and collectors. No scientific crab culture technology has been developed. As part of the effort to culture crab, work is going on, on seed production and growout, at the Research Institute for Coastal Aquaculture (Maros. Southern Sulawesi). Among the results obtained are the definition of water quality parameters (Gunarto *et al.,* 1987), separate sex culture (Mangampa et *al.*. 1987), stocking rates (Gunarto and Cholik. 1990). feed (Gunarto, 1988), substrates (Gunarto, 1989). shelter (Cholik. 1990). and gonad maturation (Gunarto and Pirzan, 1989). The ongoing activities comprise fattening. berried female culture and seed production experiments.

POND SITE

Sites suitable for shrimp culture are suitable for crab culture. Ponds with muddy beds are preferred by crab. A salinity range of 10-25 ppt is considered optimal for growth. Other water quality requirements are temperature 28-33°C, pH 7.5-8.5 pH. and DO over 4 ppm.

SEED SUPPLY

Small crab of less than 50 g for growout. water crab of 150-200 g for fattening and immature crab for berried female culture are considered as 'seed' All these stock, or 'seed', are collected from the wild. The fishing ground and season described earlier are. generally, suitable for 'seed' collection too.

Crab seed for growout are transported from collection sites in the same manner as crab to market. The 'seed', with their chelipeds tied, are placed upside down in a container measuring 50 cm dia x 60 cm (150-200 crab, each 20-50 g). Two hundred crab of 20-50 g each are carried in one such container. During transport, the crab arc rinsed with brackishwater of 10-25 ppt salinity (Gunarto, 1989). Mortality during transport of 7-8 hours varied between 0 and 40 per cent.

CRAB CULTURE PRACTICES

At present, three types of commercial crab culture are being practised in Indonesia: Cultivation of gravid females, fattening and growout. The first enables the production of ripe or egg-bearing females, the second that of fleshy crab from post-moult animals, and the third involves cultivation of crab from 'seed' to market size. The latter produces crab of various qualities (male, female immature or berried females, fat or slim crab).

CULTIVATION OF BERRIED FEMALE

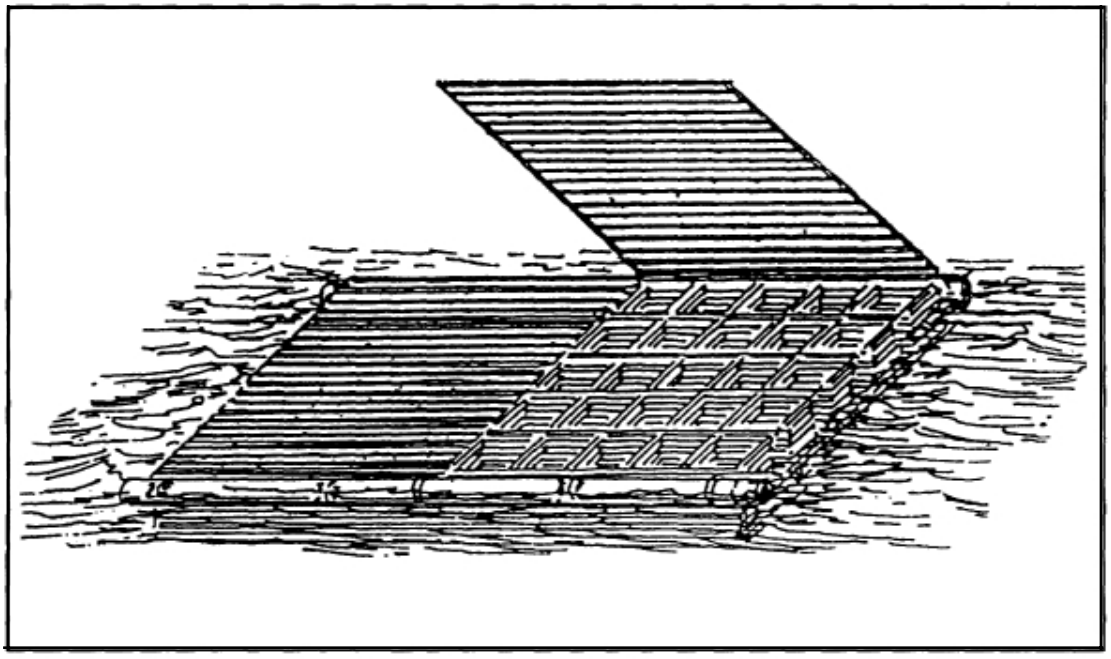
Increasing demand for egg-bearing female crab has stimulated berried female crab culture for the first time in areas such as Cilacap (Central Java) and Bone (Southern Sulawesi). Berried female crab are cultured in floating bamboo cages. Measuring 2 x 1.5 x 1m with a 30cm opening on the top. Crab stocking and harvest are done through this opening. The stocking rate varies from 70-110 crab/cage. The stocking size is over 150 g and crab are fed with trash fish at 3-5 per cent bodyweight/day. The culture period is one month until 70-85 per cent of the harvested crab are ripe. Egg production in mud crab, as in other decapod crustaceans, may be accelerated by eyestalk ablation (Gurnato and Pirzan 1989).

FATTENING

Crab fattening is carried out in brackishwater ponds or in shallow lagoons using floating cages or pens. Water crab, both male and female, are cultured for 3-4 weeks until they gain weight.

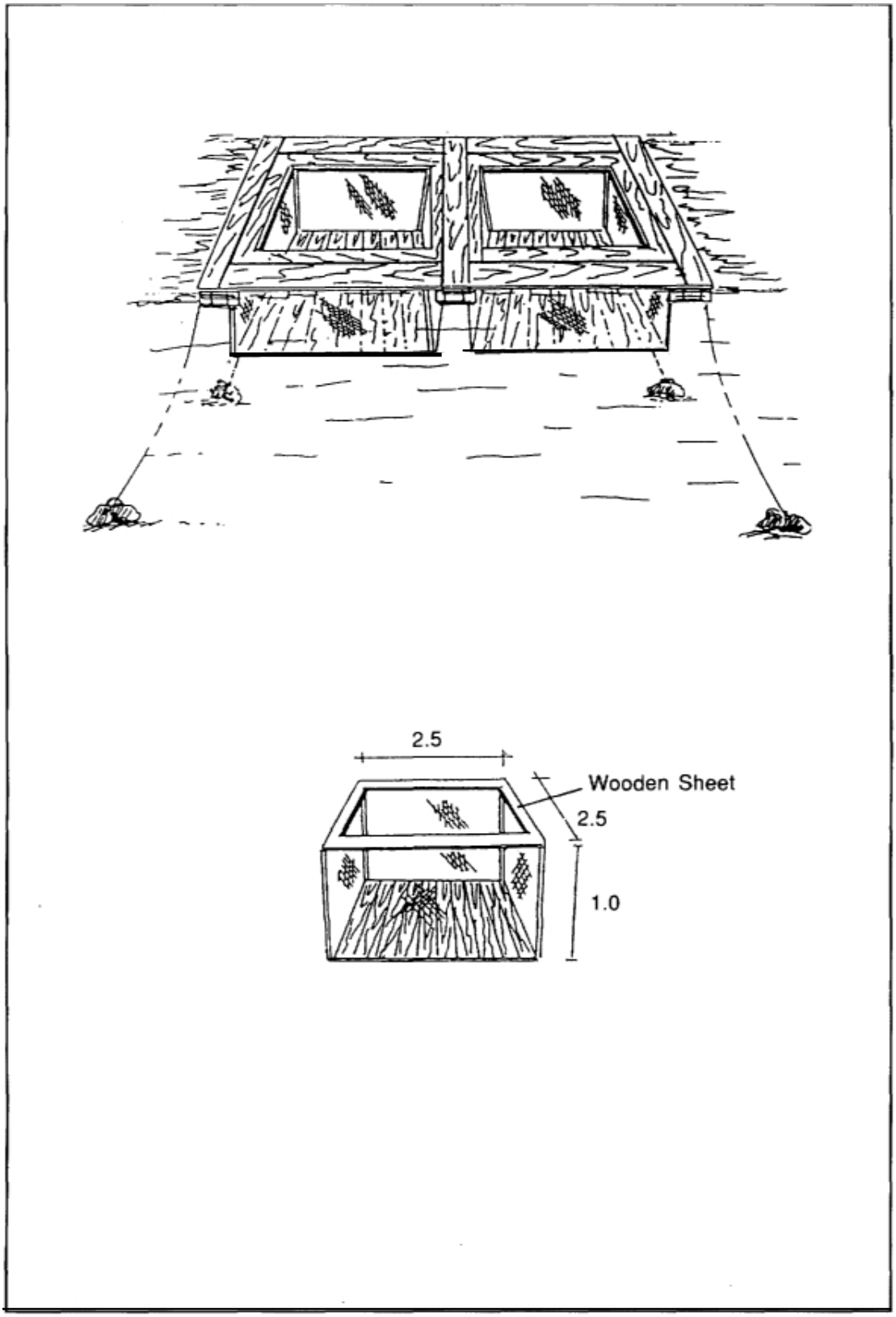
The cage may be of bamboo, polyethylene net, galvanized wire net or plastic. Farmers make the bamboo cages, while the others are commercial products. available in local markets (Figure 7). The bamboo cage measure 2.0 x 0.5 x 0.2 m, and is divided into compartments. each 30cm square. Each compartment can accommodate one crab. The cage is covered using woven split bamboo. A similar arrangement is also used with plastic baskets (60 x 40 x 20 cm) which are partitioned into nine equal compartments, each accommodating one crab. Compared to other culture practices, the stocking rate is relatively high, at 1 crab/compartment of width 0.025 m^2. This implies that 40 crab can be stocked in one sq.m. As long as water quality is maintained, the mortality rate is minimal. Farmers claim that even 5 per cent mortality is too high. One of the main causes of mortality is moulting failure.

Fig 7. Crab culture in cell-type floating bamboo cage



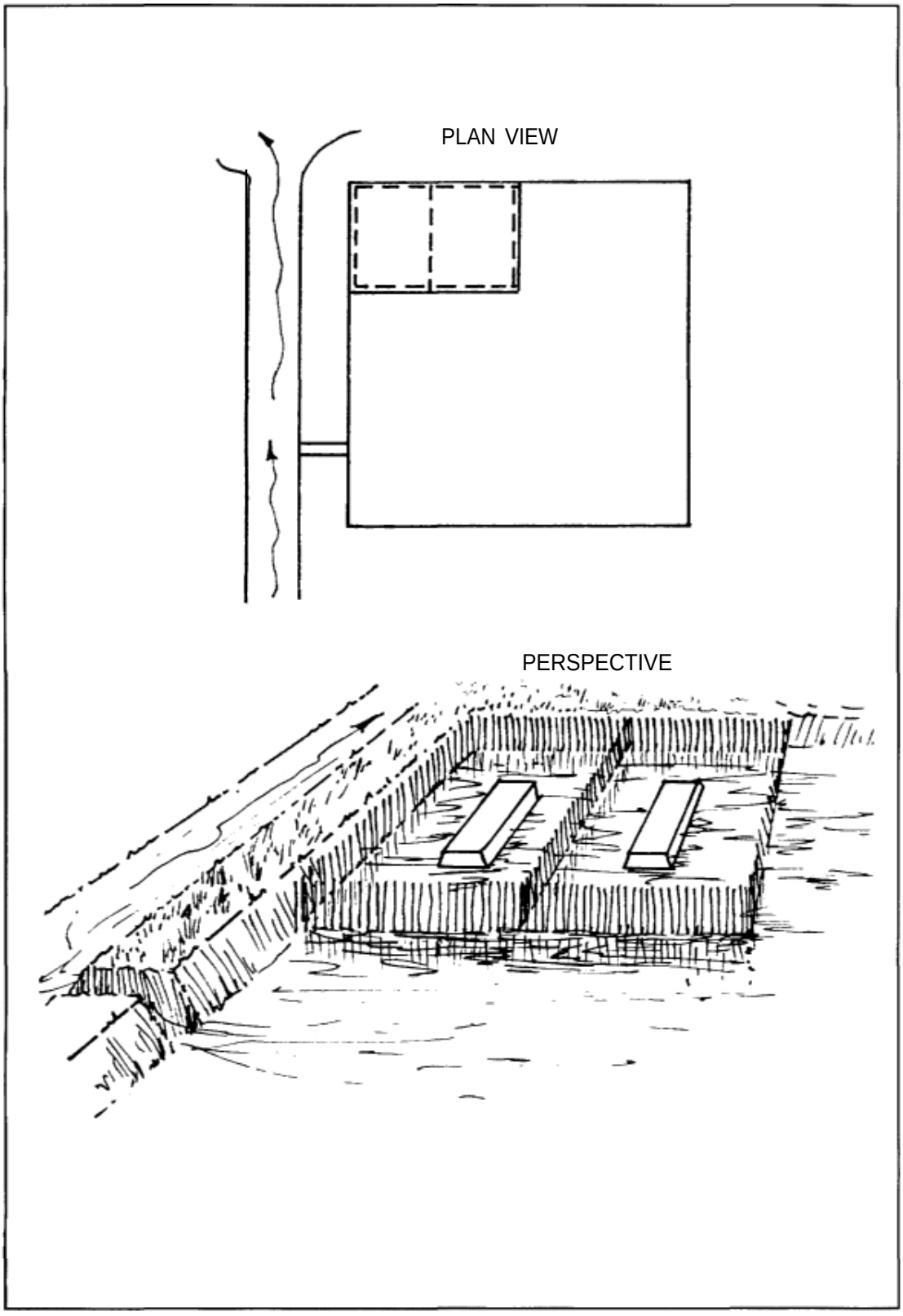
Another type of cage used for crab culture is the floating net cage measuring *2.5* x *2.5* x 1.0 m. Wooden sheets are used to partly cover the top of the net (Figure 8). In this floating net cage, the culturist cultivates female and male crab separately, thereby reducing cannibalism.

Fig 8. Floating net cage for crab culture



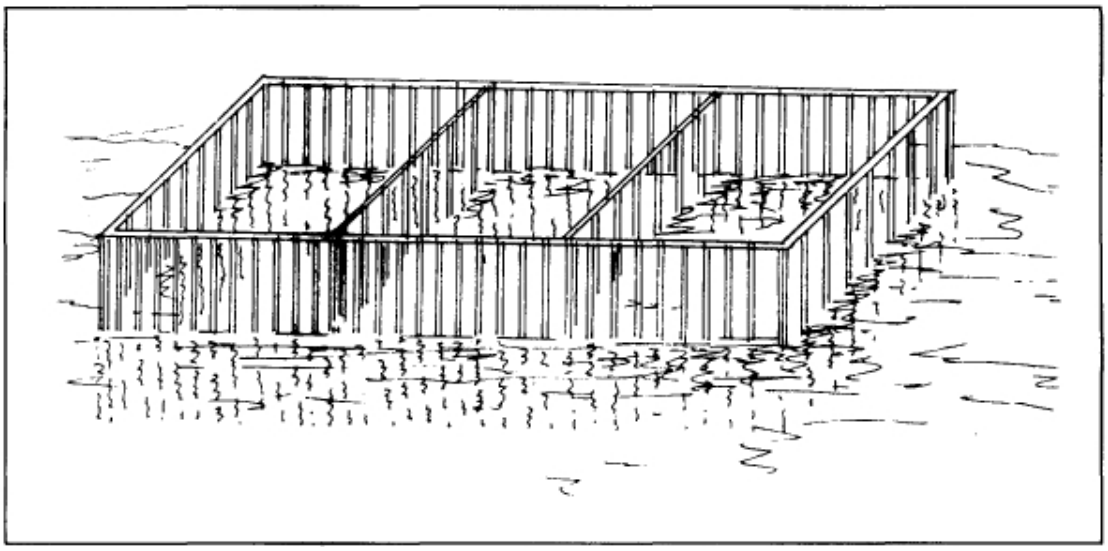
In Kamal (Jakarta) and Tanggerang (West Java) other types of crab fattening methods are practised. Farmers use brackishwater ponds of 20 x 50 m fenced with bamboo stakes, equipped with two watergates, peripheral canal and shelters made of bamboo baskets. Water depth in the peripheral canal is 50-60 cm, while the pond platform is 30-40 cm underwater (Figure 9).

Fig 9. Brackishwater pond for crab fattening with peripheral canal



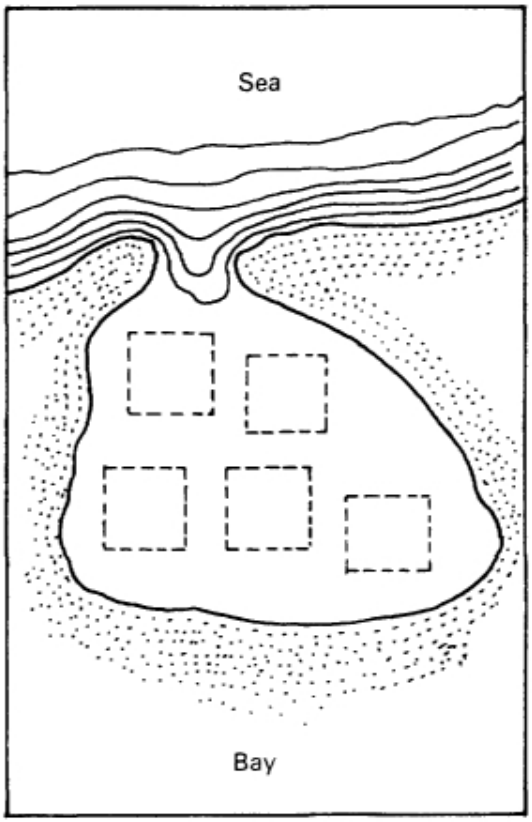
Another design of a crab pond is similar to the above, hut without any peripheral canal and shelters. Instead, the pond is equipped with a bamboo platform installed near the pond dykes. The platforni is placed about 2-3 cm below water level. In place of watergates this pond has inlet and outlet pipes. Water depth in the pond is 50-60 cm (Figure 10).

Fig 10. Crab **pen culture in pond**



The stocking rate is 2 crab/m^2 pond area. lndi-vidual size of the crab stocked is between 150-200 g. The crab to be stocked is directly stocked into the pond in the first pond model or placed on the bamboo platform in the sec-ond pond type. The crab are fed with fresh trash fish at the rate of 10-15 per cent hodvweight per day. The fattening process lasts for 3-4 weeks with an average individual weight gain of 50-80 g. Mortality during fattening varies from 10-50 per cent.

Fig. 11 **Pen culture of crab in lagoon**



Pen culture is carried out in a small lagoon in North Sumatera. Several uniis of pens of size 4 x 4 x 2.5 m are made of bamboo fencing and set in the lagoon (Figure **II)**

Crab, each of 150 g. are stocked iii the pen at the rate of 100 crab/pen. They are fed with trash fish, fresh or dried, at the rate of ID-IS per cent hodyweight/day. After 3-4 weeks, the crab are harvested and have an average individual size of 2(X) g. The average mortality rate is 10 per cent.

GROWOUT

Mud crab growout is carried out in brackishwater ponds. using an extensive culture technique. The crab pond design is similar to that of milkfish ponds, except that crab ponds are lined with bamboo fences along the inner side of their dykes to prevent the escape of crab. Some farmers also leave the central part of the pond bottom emerging above the water. The sizes of the ponds vary by location, from a few hundred

square metres to about 1/2 ha. The bamboo fence is driven into the pond bottom to a depth of 70 cm, leaving a width of 20 cm above the water surface. Other components of pond design are low dykes, one sluice gate and shallow pond water (40 cm). More intensive crab culture is still in the experimental stage.

Studies carried out by the Research Institute of Coastal Aquaculture, Maros, South Sulawesi. indicated that the best stocking rate in terms of production is two crab/m^2. This figure is confirmed by the experience of the farmers. The research also clearly showed that mortality increased with increasing stocking density. At a stocking rate of one crab/m^2. average survival was 77.03 per cent, and at three crab and five crab/m^2, the survival was 49. 17 per cent and 32.06 per cent. respectively (Gunarto and Cholik, 1990).

HARVESTING

Culturists practise three harvest methods. The first is by simply lowering the pond water level to 30 cm depth. Several people wearing rubber boots and carrying bamboo baskets collect the crab in the pond, using small bamboo poles. The pole is vertically stuck into the pond bottom and is grasped by the crab, which is then caught. However, crab may have their chelipeds broken, reducing their marketability.

The second method of harvesting is by manipulating the crab's rheotaxis behaviour. At low tide. the pond is drained leaving water only 20-30 cm deep. During filling on high tide. the incoming water creates a current at the sluice gate which induces the crab to swim against the current. A scoopnet is used to collect the swimming crab. Partial harvest may also be carried out using the *Rakkang* and scoopnet. This is done only in the peripheral canal near the pond bank.

SOCIO-ECONOMIC ASPECTS

Crab fishing has been practised by coastal people in Indonesia for years. However, crab culture is a recent development. In Bone, South Sulawesi, crab culture was started in 1980, while in Kamal, Jakarta, and Tanggerang, West Java, culture was started a decade later. In the last two mentioned areas, the culture has been developed from the live crab holding technique of crab exporters.

No statistical data on the number of crab fishermen and culturists is available. either at national or provincial level. The present study has succeeded in collecting data on crab fishermen, culturists and collectors only in Bone, Cilacap and Langkat. The data is presented in Table 8.

Table 8: Number of mud crab fishermen, culturists and collectors in several places in Indonesia

Location	Fishermen	Culturists	Collectors**
Segara Anakan (Cilacap)	403	2	19
Bone	298	100	25
Langkat	14*	5	ND
Lampung	127	1	10
Tanggerang, West Java	ND	2	ND
Kamal			1

* *Tangkul* fishermen: ND= no data; ** wholesaler

The economics of crab fishing and culture

In Jakarta, the current price of ripe female crab is 12,000 Rp*/kg, while meaty but unripe females and males may cost upto 8500 Rp/kg. In the local market, thin or less meaty crab are sold at less than 2000 Rp/kg. Crab prices outside Jakarta vary between 4000-6000 Rp/kg for ripe females and 2000-4000 Rp/kg for fat or meaty but unripe females and males. In Cilacap, crab prices are based on export standard quality. The data is presented in Table 9.

Table 9: Current price of crab by quality

Quality	*Price (Rupiah/Kg)*
Males over 300 g	2500 - 4000
Berried females over 200 g	4500 - 5000
Females without egg over 200 g	2500 - 3000

At these prices, a crab fisherman may earn as much as 5550-10,550 Rp/trip if he uses *wadong.* or as high as 9600 Rp/trip when using *pinlur* or *rakkang.* The *pancing* fisherman can earn between 2000-5000 Rp/trip.

Crab culturists' incomes also differ, depending on the culture method and location. A culturist who is specializing in the production of ripe females using bamboo cages may earn 40,000-60,000 Rp/month. Fattening activities provide the culturist with an income of around 173,000 Rp/month in Langkat, Northern Sumatera. Economic analysis of berried female culture and fattening of mud crab is presented in Tables 10 and 11

Table 10. Financial analysis of berried female production

	Trial 1	*Rp*
	EXPENDITURE	
(I)	70 crab stocked = 10.5 kg x Rp 2,000	21,000.00
(2)	Feeding 3kg/week x 4 x Rp. 300	3,600.00
(3)	Depreciation (Price of one *Karamba* Rp. 30.000 — economic life 2 years)	1,250.00
(4)	Labour	15,000.00
	Total operating cost	40,850.00
	INCOME	
(I)	60 crab with eggs 15kg x Rp. 5.000	75,000.00
(2)	10 crab no eggs 2kg x Rp. 2,500	5,000.00
	Total value of product	80,000.00
	Benefit = (Rp. 80.000 - Rp 40.850) = Rp. 39,150.00	
	Trial 2	*Rp*
	EXPENDITURE	
(I)	ll0 crab stocked = 16.5 kg x Rp 2,000	33.00000
(2)	Feeding 5 kg/week x 4 x Rp. 300	6,000.00
(3)	Depreciation (Price of one *Karamba* Rp.30.000 — economic life 2 years)	1,250.00
(4)	Labour	15,000.00
	Total operating cost	55,250.00
	INCOME	
(I)	78 crab with eggs 20 kg x Rp 5,000	100,000.00
	32 crabs no eggs 6 kg x Rp 2.500	15,000.00
	Total value of product	115,000.00
	Benefit = (Rp 115,000 - Rp 55.250) = Rp. 59,750.00	

US $ 1 = Rp. 2000 **appx.** (1991)

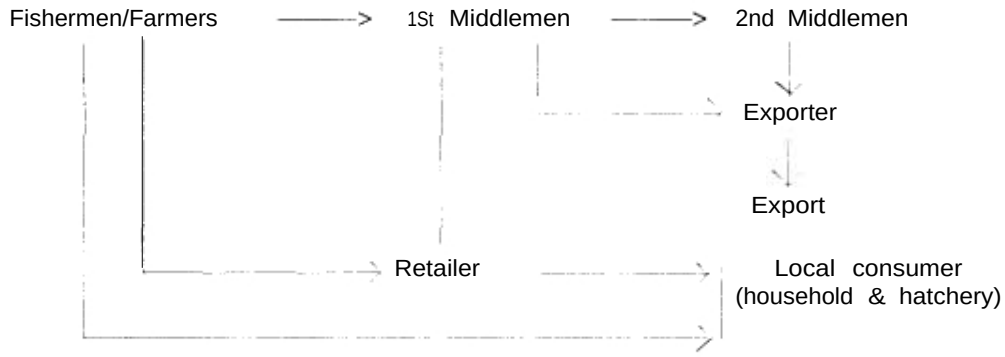
Table 11: Financial analysis of crab fattening

1. USING PEN CULTURE	*Rp*
a. FIXED COST	
Pen culture made of bamboo. size 2 x 2 m. 5 pens	15,000.00
Scoopnet 2 pes	2,000.00
Rakkang 5 pcs	5.000,00
Total(a)	32,000.00
h. OPERATION COST	
500 female crab export size > 150 gram @ Rp 500	250,000.00
Feeding 10 kg unsalted dried fish per day @ Rp 300	63,000.00
Labour 3 weeks	15,000.00
Depreciation of fixed cost	2,0000.00
Total (b)	330,000,00
c. GROSS INCOME	
450 crab (after 10% mortality) of average size 5 crab/kg @ Rp 6.500	585,000.00
d. Net **benefit** = (c) — (h)	255,000.00
e. BCR = (c(/(b(= 1.77	
2. USING FLOATING CAGE	*Rp*
a. FIXED COST	
Floating cage made of bamboo, size 2 x 0.5m 10 cages	15,000.00
h. OPERATIONAL COST	
500 female crab export size > 150 gram @ Rp 500	250,000.00
Feeding 10 kg unsalted dried fish per day @ Rp 300	63.000.00
Labour (3 weeks)	15,000.00
Depreciation	6,000.00
Total (b)	334,000.00
c. GROSS INCOME	
500 crab of average size 5 crab/kg @ Rp 6,500	650,000.00
d. Net **benefit** = (C) —• (b)	316,000.00
e. **BCR** (c)/(b) = .95	

Marketing and distribution

Marketing is carried out through at least four channels, as shown in the following diagram:

Fig 12. Marketing diagram of mangrove crab



Historically, the oldest marketing channel was from fishermen to the retailer, ending at local market or consumer. As the demand for crab increased, other channels arose. The first middlemen are collectors who buy crab directly from fishermen or crab culturists. These middlemen operate in the villages surrounding the fishing ground or brackishwater pond areas, while the second middlemen are in large cities like Ujung Pandang and Jakarta. The second middlemen are wholesale buyers and buy crab from collectors. In many cases, the second middlemen are also exporters.

There are three classes of crab based on their quality, namely Class A: ripe female of more than 200 g individual weight: Class B: female without egg and of more than 200 g: and Class C: male of 300 g individual weight. These are export quality crab. Other crab are considered non-explorable and are marketed locally.

Trussed crab are placed in transport baskets. rinsed with fresh seawater and covered by plastic sheets or (banana or mangrove) leaves and transported to their destination. For longer transport, water rinsing is usually done several times.

Packing of crab for export is done more or less as described above. However, the containers used are styrofoam boxes (45 x 30 x 30 cm). with holes on each side (1-2 cm dia) for ventilation. Sixty crab, weighing 16-18 kg are transported in each box. A cover of wet foam rubber is used to maintain humidity within the box.

FUTURE PROSPECTS OF CRAB FISHERY DEVELOPMENT AND THE CONSTRAINTS

Indonesia is endowed with a coastline 81,000 km in extent and has about 4.25 million ha of mangrove forests, the main habitat of *Srvlla serrata* and other marine fauna. Most of this resource is, however, still underexploited. In Irian Jaya, with 2.9 million ha of mangrove forest, crab production from fishing in 1988 was only 41 t or less than one per cent of the total crab production of the year! Production is also low in other provinces, such as West. South and Central Kalimantan, and Riau and Lampung in Sumatera.

The existing fishing gear are very simple tools with small catching rates. Transport infrastructure in the mangrove areas is usually very poor or non-existent. This hinders marketing the product. Lack of manpower is another constraint to crab fishing development. In the provinces outside Java. the human population is very thin (See Table 5).

The present study indicates a great variability of culture practices. The practices were developed from experience. No scientific technology is presently available. Consequently, yields are

inconsistent. Research on crab culture should be more intensively and extensively carried out if the development of crab culture is to be promoted.

At present, the crab culturists are using small crab of individual size of 20-50 g as stocking material. To collect crab of this stage in quantity is hardly possible. This is a serious problem for crab culture development. Meanwhile, hatchery technology of the crab is still at its inception.

Crab culturists, as described in the previous section, are using trash fish as feed. The availability of trash fish is seasonal and competes with human consumption. Thus, during off season the price of trash fish adds considerably to production costs. Research on feed and nutrition of the mud crab is, therefore, required.

REFERENCES

ANON. 1990a. Fisheries ***Statistics*** 1988. Dir. Gen. of Fish., Dept. of Agri., Indonesia, Jakarta.

———— 1990b. Fisheries ***Export and*** Import 1988. Dept. of Agri., Jakarta, Indonesia.

AKHMAD,T.. MANGAMPA, M., WEDJATMIKO, UTOJO. and MUSTAFA, A. 1988. Stocking composition of male and female crabs stocked in milkfish pond. ***Ann. Rep.,*** of Res. Inst. for Coastal Aqua., Maros, South Sulawesi, Indonesia.

CHOLIK, F. 1990. Effects of shelters of different materials on survival rate of mud crab ***(Scyllla serrata). Coastal Aqua. Res. J.*** RICA, Maros, South Sulawesi, Indonesia (In press).

DARSIDI, A. 1982. Mangrove Forest Management in Indonesia. Proc. ***2nd*** Sem. on Mangrove Ecosystem. Baturaden, Indonesia.

GUNARTO. and AKHMAD, T. 1988. ***Distribution of mangrove crab*** (Scylla serrata) ***in the estuarine area of Cenranae River.*** Interim Rep., Res. Inst. for Coastal Aqua., RICA, Manros, South Sulawesi, Indonesia.

————and CHOLIK, F. 1990. Effects of stocking densities on mangrove crab (Scylla ***serrata)*** in ponds. ***Coastal Aqua. Res.*** J. RICA, Manros, South Sulawesi, Indonesia.

————, MUSTAFA, A. and SUHARYANTO. 1987. Culture of Mudcrab ***(Scylla serrata)*** under different salinity levels in laboratory. ***Coastal Aqua. Res.*** J., RICA, Manros, South Sulawesi, Indonesia, 3(2):60-64.

————and PIRZAN, M. 1989. Gonadal maturation of mangrove crab ***(Scylla serrata)*** through eyestalks ablation. Proc. on ***Agri. Field Day.*** Res. Inst. for Tobacco and Fibrous Trees, Malang, Indonesia.

HILL, B.J. 1974. Salinity and temperature tolerance of zoea of the portunid crab, Scylla serrata. ***Mar. Biol.***

MALLAWA, A. 1991. ***Use of Pyramid trap in Mangrove Crab*** (Scylla serrata) ***Fishing.*** Torani. Hasanuddin Univ., Ujung Pandang, South Sulawesi, Indonesia.

MANGAMPA, M., MUSTAFA, A., UTOJO, and AKHMAD, T. 1987. The growth of female and male mudcrab (Scylla ***serrata)*** raised in brackishwater pond. ***RICA Res. J.***. J. Pen. BP. 3(2):94-102.

MOOSA, M.K.M., ASWANDY, I., and KASRY, A. (1985). ***Mangrove crab*** (Scylla serrata, ***Firskal.*** 1775). LON-LIPI, Jakarta. .PA

THE MUD CRAB (Scylla serruta) FISHERY AND ITS BIO-ECONOMICS IN BANGLADESH

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ABSTRACT

The *development of an export market for mud crab is a recent phenomenon in Bangladesh. Preliminary estimates put the countrywide production at 1937-2085t/atmum. Fishing occurs year-round.* but *the peak* reaspm *is* frp, April *to* July *Mud crab are collected* at the district *level and transported by truck and boat to the international airport at Dhaka. Major export markets are Hong Kong and Singapore. A high proportion of catch is r-ejected as undersized. These animals could be used as seed stock for culture. More government attention is needed to manage the fishery and promote culture.*

INTRODUCTION

Scylla serrata (Forskal), popularly known as mud crab and locally called *Haubba kankra,* appears to be the most important crab species in Bangladesh for food and trade, but information on it is poor in the country. Some reports are available on the biology, taxonomy and consumer processing of Scylla *serrata.* Islam (1977) studied its taxonomy, biology and ecology. Arshadullah (1976) described its industrial processing. This review summarizes the information recently collected by the authors. with the help of the Marine Fisheries Survey, Management & Development Project (December 1990-August 1991), in the major collecting centres of the country. It also incorporates relevant information from other sources.

Ecology

Scylla serrata are common in the mud flats of the littoral, parts of the supralittoral and the intertidal zones of the Bay of Bengal. The species hardly occurs in sandy and rocky areas. It is distributed over a wide range of salinity, from 2 ppt. to oceanic waters, from the coast to the interior brackishwaters. Though these crab seem to prefer mangrove swamps, they exist in large numbers in shrimp the ponds and in the burrows of the peripheral dykes. They are essentially euryhaline, but die beyond 70 ppt. *S. serrata* rarely tolerate turbid waters.

Crab live in mud burrows, which occur densely in intertidal mangrove swamps‘, a little above the low tide mark. The burrows are also frequent in embankments of shrimp culture ponds and coastal irrigation project areas. The density of burrows varies with seasons, increasing with rains and then gradually decreasing during the cool, dry winter.

Crab take shelter in burrows during the day when tides are low. During high tides at night they swim around in search of food. About 80 per cent of the catch from burrows are males. Each crab burrow is oblique, l-2 m deep and of 8-16 cm diameter at the opening.

DEVELOPMENT OF CRAB FISHERY

A particular group of people used to exploit the crab for their own consumption. Gradually, the mud crab has entered local markets and gained importance, but prices are lower than for any other seafood. An organized fishery has developed only recently with the opening-up of foreign markets. Now, extensive exploitation occurs.

Commercial exploitation of mud crab began when shrimp culturists were disturbed by crab which damaged their embankments and preyed on the cultured shrimp. As a result, the farmers engaged labourers to gather the crab from the ponds and the peripheral dykes. to thereby minimize the damage caused by their burrowing behaviour. This regular protective effort led to commercial exploitation.

Crab are traditionally eaten by tribals and, to some extent, by the minority Hindus. Some Muslims and others, particularly those not strongly bound by custom and religion, also eat crab. From the Eighties, traders have been trying to develop an export market for crab. Some trial exports were made to Hong Kong and Singapore over this period, hut export has been successful only in the last 2-3 years.

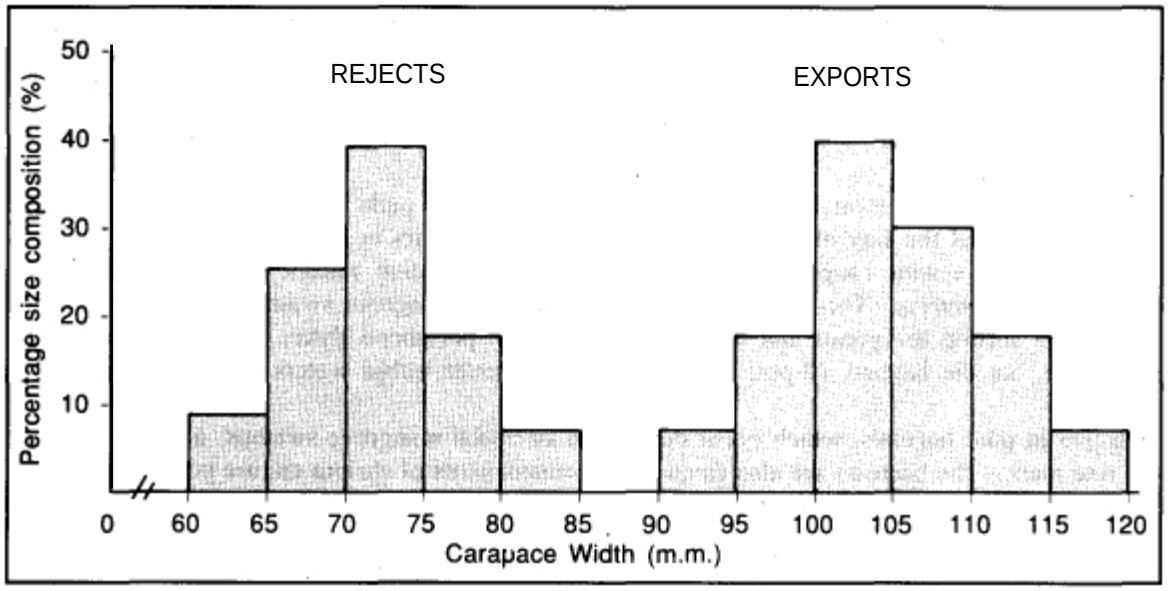
Distribution and abundance

In Bangladesh, mud crab occur abundantly in the coastal rivers of Cox's Bazar, Chittagong, Barisal, Potuakhali, Satkhira, Khulna, Noakhali, and the inshore islands of Moheshkhali, Kutubdia, Sandwip Hatia and Dubla, *i.e.* all inshore islands, except Saint Martin. They are most abundant in the Khulna and Chokaria Sundarbans areas. Interestingly. in these areas, shrimp culture is also well established. Shrimp and crab live in similar environmental conditions. They are quite abundant in places 40-50 km inland from the Bay, in the creeks and canals of the brackishwater estuaries.

Size distribution

The figure below, of size composition, is drawn from different samples of crab, both those rejected by traders as well as those exported. It appears that the modal rejected size is 70-75 mm and that of the export grade is 100-105 mm. The latter grade varies from 90-120 mm (Figure I).

Fig 1. Size distribution of rejected and exported S. *serrata*

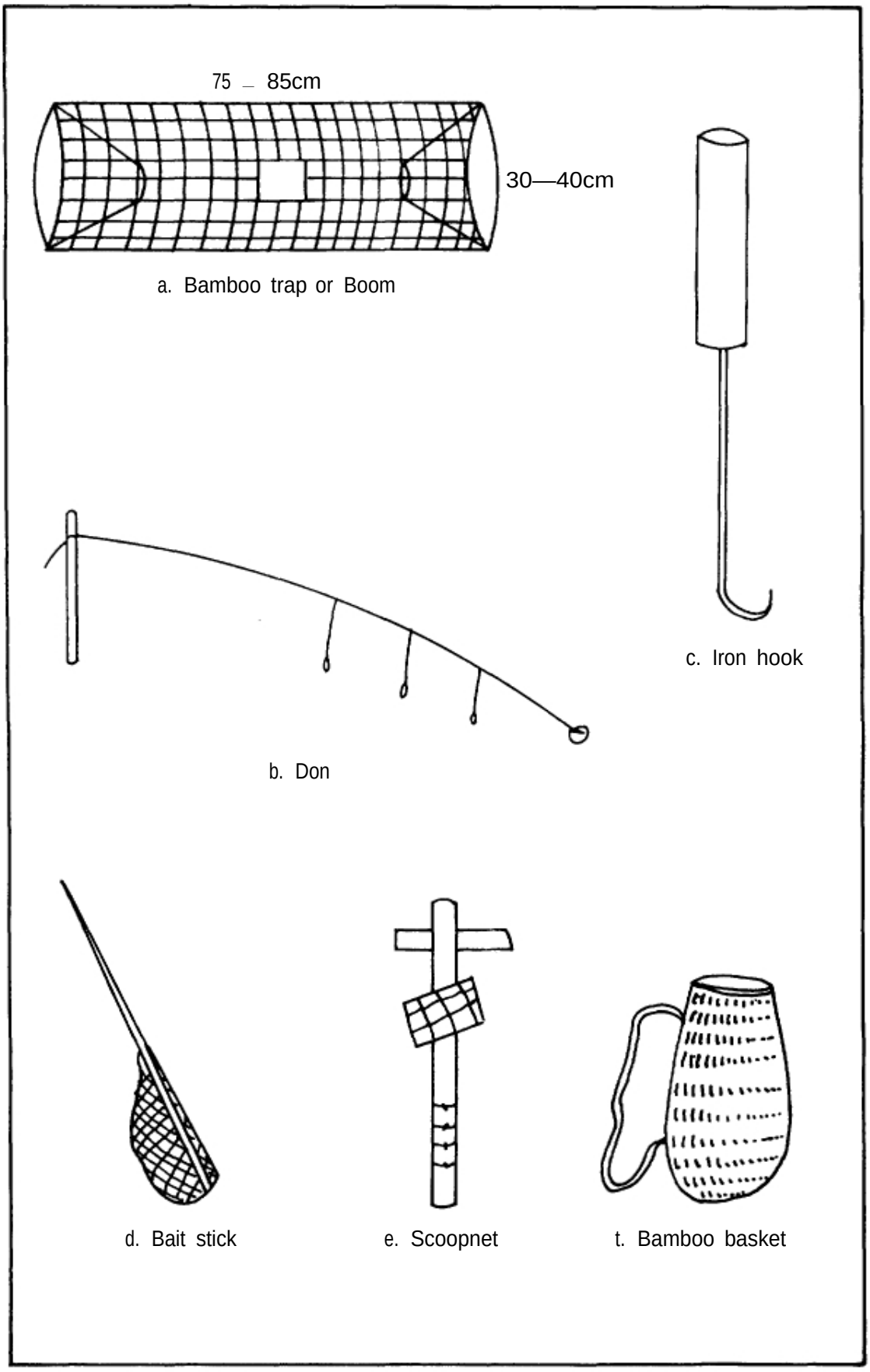


Further data are being collected to check whether the catch samples show a bimodal or unimodal distribution. This will help identify the cohorts and differentiate the export- and reject-grades among them, thus enabling population management concepts.

The craft and gear used and catch rates

The boat used for crab fishing is a roofed, dinghy type of boat, 6.1-7.6m long and operated by two persons. During spring tide, when the catch is higher, fishermen go out on 2-3-day trips, while during neap tides they go on *5-8-day* trips to catch crab. Different types of traps are used to

Fig 2. Traps used in crab capture in Bangladesh



capture crab: boom (bamboo trap), don (angling without hook), iron hook and net (see Figure 2). The boom, a trap made of bamboo, is extensively used in the Cox's Bazar area. Each dinghy boat carries 40-50 *booms*. A *boom* is cylindrical, 75-85 cm long, has a 30-40 cm diameter and both sides open (Fig 2a). The *boom* is baited with shark, skate, ray, eel or low priced (trash) fish. The gear is operated at one low tide and lifted during the succeeding low tide after a soak time of 5-6 hours.

According to fishermen, 6-8 crab are trapped in each *boom*. Usually they supply catches twice or three times a week to the nearest marketing centre. In some areas, crab fishermen have no other job. The major catch occurs during the rainy season when, during each trip of 2-3 days' duration, they collect 300-400 kg/boat. But in winter the catch falls to 100 kg/boat for the same duration. The boom is also operated in shrimp ponds. In some areas, fishermen exclusively target crab and do not fish other species.

The don, sometimes sutli. is an angling type of fishing device, used from the river or pond bank. It comprises of a polyester line 3-4 m long, a 1 m long wooden stick, sinkers, thread for tying bait and nets (Figure 2b). One end of the thread is tied to the stick and the other end to small sinkers, bricks or earthen pots. Starting 10 cm from the sinker, the bait thread is tied at 50 cm intervals.

One fisherman may have 3-4 dons. A fisherman generally catches 5-8 kg/day. Dons are used by 95 per cent of the fishermen in Khulna, Bagherhat and Satkhira. In the river channel, it is used during spring tides, but in shrimp ponds it is used all the time.

Fishing hooks are widely used all along the coast of Bangladesh; An iron rod, I 1/2-2 m long, is used to make a hook and is fitted with a wooden handle (Figure 2c). It is used in the inter-tidal zone shrimp ponds and at irrigation dams. Normally, a skilled fisherman can capture 15-20 kg/ day during the rainy seasons, but gets only 3-4 kg/day in winter. Older crab get caught with this gear, the males being usually found in burrows. They are captured only during low spring tides. It is very laborious work and, consequently, few people engage in this type of fishing.

Nets are used to some extent to fish in estuarine areas for crab. Up to one kilo of younger crab are caught with each lift of the set bagnet. However, other species are brought simultaneously.

Bait sticks (Figure 2d), Scoopnets (Figure 2e), and bamboo baskets (Figure 2f) are also used by fishermen using booms, dons and iron hooks.

ANNUAL PRODUCTION OF MUD CRAB

To assess the annual countrywide production of mud crab, statistical analysis would have been necessary. But since that was not possible, a preliminary estimate was made on the basis of a few surveys using structured interviews with fishermen, buyers and traders from different landing centres, as well as from the Export Promotion Bureau office, Dhaka, and the Fisheries Directorate Quality Control offices in Dhaka, Chittagong and Khulna supported by sampling of a few catches. The countrywide production of mud crab was estimated to be between 1923 and 2117 t. This excludes the production of the Khulna Sundarbans. The break-up for the production for different zones is given in Tables 1-4 on the following pages.

Table 1: Fishing efforts and production in the Cox's Bazar zone

1st season: April-July-(4 months)		*2nd season: September-Jan uary (5 months)*	
(Note: A. Fishing days in a week: 7 : B. Fishing days in a month: 14)			
Centre 1	*Production (season)*	*Centre I*	*Production (season)*
1. Boat (100 nos)		1. Boat (100 nos)	
2. Daily catch=100kg/boat and other traps		2. Daily catch = 25-30 kg/boat and other traps	
3. Daily landing in the centre 10000 kg = 10		3. Daily landing = Nil	
4. Weekly landing = 70		4. Twice or thrice in a week 5000-6000 kg.	
5. Monthly landing = 140		5. Monthly landing 10-12	
6. Landing in the season = 140 x 4	560 t	6. Landing in the season = (10-12) x 5	50-60
Centre 2		*Centre 2*	
1. Boat (50 nos)		1. Boat (50 nos)	
2. Daily catch = 100 kg/boat and other traps		2. Daily catch = 25-30 kg/boat and other traps	
3. Daily landing in the centre 5000 kg = 5		3. Daily landing = Nil	
4. Weekly landing = 35t		4. Weekly landing (Twice a week) 25x2x50-30x2x50=2.5-3.5t	
5. Monthly landing = 70		5. Monthly landing = 5-6	
6. Landing in the season = 70 x 4	280 t	6. Landing in the season = (5-6) x 5	25-30
Centre 3		*Centre 3*	
1. Boat (10 nos)		1. Boat (10 nos)	
2. Daily catch = 100 kg/boat and other traps		2. Daily catch = 25-30 kg/boat and other traps	
3. Daily landing in the centre 1000 kg = 1		3. Daily landing = Nil	
4. Weekly landing = 7t		4. Weekly (twice a week 500 - 600 kg	
5. Monthly landing = 14		5. Monthly landing=1-1.2t	
6. Landing in the season = 14 x 4	56t	6. Landing in the season = (1-1.2) x 5	5-6t
Total	896 t	Total	80-96

Total production at Cox's Bazar in a year (896 + 80) to (896 + 96) = 976 - 992 t (appx)

Table 2: Fishing effort and production in the Khulna zone

Ist season: April-July (4 month)		*2nd season - September-January (5 months)*	
Centre 1	*Production (season)*	*Centre I*	*Production (season)*
1. Weekly landing = 5-6 t		1. Weekly landing = 1.5-2	
2. Monthly landing = (5x2)-(6x2)= 10-12t		2. Monthly landing 3-4 t	
3. Seasonal landing = (10-12) x 4		3, Seasonal landing = (3-4) x 5	
	40-48 t		15-20
Centre 2		*Centre 2*	
I. Weekly landing = 3-4		I. Weekly landing = 1-1.5t	
2. Monthly landing 6-8 t		2. Monthly landing = 2-3	
3. Seasonal landing = (6-8) x 4		3. Seasonal landing = (2-3) x 5	
	24-32 t		10-15t
Centre 3		*Centre 3*	
I. Weekly landing = 4-5 **t**		I. Weekly landing = 1-1.5t	
2. Monthly landing = 8-10 **t**		2. Monthly landing= 2-3	
3. Seasonal landing = (8-10) x 4		3. Seasonal landing = (2-3) x 5	
	32-40 t		10-15t
Centre 4		*Centre 4*	
1. Weekly landing = 5-6 t		I. Weekly landing = 1.5-2t	
2. Monthly landing = 10-12 **t**		2. Monthly landing = 3-4	
3. Seasonal landing = (10-12) x 4		3. Seasonal landing = (3-4) x 5	
	40-48 t		15-20t
Centre 5		*Centre 5*	
1. Weekly landing = 4-5 **t**		1. Weekly landing = 2-2.5	
2. Monthly landing = 8-10 **t**		2. Monthly landing = 4-5	
3. Seasonal landing = (8-10) x 4		3. Seasonal landing = (4-5)x5t	
	32-40 **t**		20-25t
Total	168-208t **t**	**Total**	70-195t

Total landing at market point **in the year is (168 + 70) - (208 + 95)** = 283-303 **t** * **To add rejected quantity at different steps**
Total production **in** the **area in a year** is ***345.1-439.4*** **t (45% added*).**

Table 3: Fishing efforts and production in the Bagerhat zone

1st season: April-July (4 months)		*2nd season: September-January (5 months)*	
Centre I	*Production (season)*	*Centre I*	*Production (season)*
I. Weekly landing = 8-9 **t**		1. Weekly landing 6-7 tons	
2. Monthly landing = 16-18 **t**		2. Monthly landing 12-14t	
3. Seasonal landing = (16-18) x 4		3. Seasonal landing (12-14) x 5	
	64-72 t		60-70
Centre 2		*Centre 2*	
I. Weekly landing = 15-16 t		1. Weekly landing 10-11t	
2. Monthly landing = 30-32 t		2. Monthly larfding 20-22 t	
3. Seasonal landing = (30-32) x 4		3. Seasonal landing (20-22) x 5	
	120-128t		100-110t
Centre 3		*Centre 3*	
I. Weekly landing = *6-it*		1. Weekly landing = 2-3	
2. Monthly landing = 12-14t t		2. Monthly landing = 4-6	
3. Seasonal landing = (12-14) x 4		3. Seasonal landing = (4-6) x 5	
	48-56 t		20-30 **t**
Total	232 - 256t	**Total**	180 - 210

Total landing at the market in this year = **(232 + 180)** - **(256 +** 210) = 412 - **466**
Total production in the **year in the stations** = **535.6 to** 605.8 **tons (adding 30%)**
Note: This data is collected from landing centre, local **market and fishermen.**

Table 4: Fishing efforts and production at Satkhira zone

1st season:April-July (4 months)		*2nd season:Septemher-Januarv (5 months)*	
Centre **1**	*Production (season)*	*Centre* 1	*Production (season)*
1. Weekly landing = 1-1.5t		1. Weekly landing =0.4-0.6	
2. Monthly landing = 2-3		2. Monthly landing = 0.8-1.2	
3. Seasonal landing = (2-3) x 4		3. Seasonal landing = (0.8-1.2) x 5	
	8-12		4-6
Centre 2		*Centre 2*	
1. Weekly landing = 0.7-1t		1. Weekly landing = 0.4-0.5	
2. Monthly landing = 1.4-2t		2. Monthly landing = 0.8-1t	
3. Seasonal landing = (1.4-2) x 4		3. Seasonal landing = (0.8-I) x 5	
	5.6-8		4-5 t
Total	13.6-20 t	**Total**	**8 - 11t**

Total landing at market point in the year = (13.6 + 8) - (20 - 11) = 21.6 - 31t.
Total production in the area in the year is 31.3 - 45.0 **t** (adding 45%)

Table *5:* **Fishing efforts and production in the Barisal and Potuakhali zone**

1st season : April-July (4 *months)*		*2nd season : September-January (5 months.)*	
Centre	*Production (season)*	*Centre*	*Production (season)*
1. Weekly landing = *0.5* t		1. Weekly landing = 2	
2. Montly landing I t		2. Monthly landing = 4	
3. Seasonal landing = I x 4		3. Seasonal landing = 4 x 5	
	4t		20t

Total landing at market point = 24 **t.**
Total production in the area in the year in the station = 34.8 **t** (adding 45%)

Total production* in the country in the year is total of Tables I - 5:

(976 + 345.1 + 535.6 + 31.3 + 34.8) - (992 + 439.4 + *605.8* + 45.0 + 34.8)
= 1922.8 - 2117

* Note: This production figure excludes the Sunderbans of Khulna

Fifty to sixty per cent of the total crab catch is rejected by the buyers before it reaches the main collection centres. From main centres to the port of export, another 10-15 per cent is rejected. In totaL, *60-75* per cent is rejected up to the airfreight point at Dhaka airport. It is believed that another 10 per cent is rejected at the port of destination.

Seasonal variation in catch/effort and size distribution

Seasonal variation is evident in the total catch, catch rates, sex ratio and size. The rainy season (April-July) is the major fishing period for almost all areas, particularly shrimp ponds and mangrove swamps. During this time, the catch is relatively high, 3 - 4 times more by weight than in winter (Sept-January). Crab caught in the rainy season are larger in size than those caught in winter.

The sex ratio in the catch differs to a considerable extent between seasons. In the rainy season, the *boom* and ***don*** catch includes 50-55 per cent females. But in the winter. 55-60 per cent of the catch is male. During the rainy season, the fishermen land and sell their catches almost every day to the nearest markets. But in winter, they land their catches only on one or two days in a week or even less. Crab abundance appears to be poor in the winter.

The catch rate varies considerably between seasons. In winter, catch/effort by hook is 5-6 kg/day/man, whereas in the rainy season it is 15-20 kg/day/man. In the rainy season, the catch/effort by boat is 100 kg/day/per boat, while in winter it is 30 is kg/day/boat on an average. The sex ratio of the catch also varies seasonally. During the premonsoon season, the sex ratio is female: male, 55-60 : 45-40, whereas in the winter season it is the reverse.

Size, distribution and length-weight relationship

The previous data on size distribution were not collected in the length frequency pattern and, hence, while they were sufficient to see the rejected export grade modal sizes, they were not sufficient to represent the size frequency of the exploited population. So, further data were collected in October 1991 to enable the modal progressions to be followed.

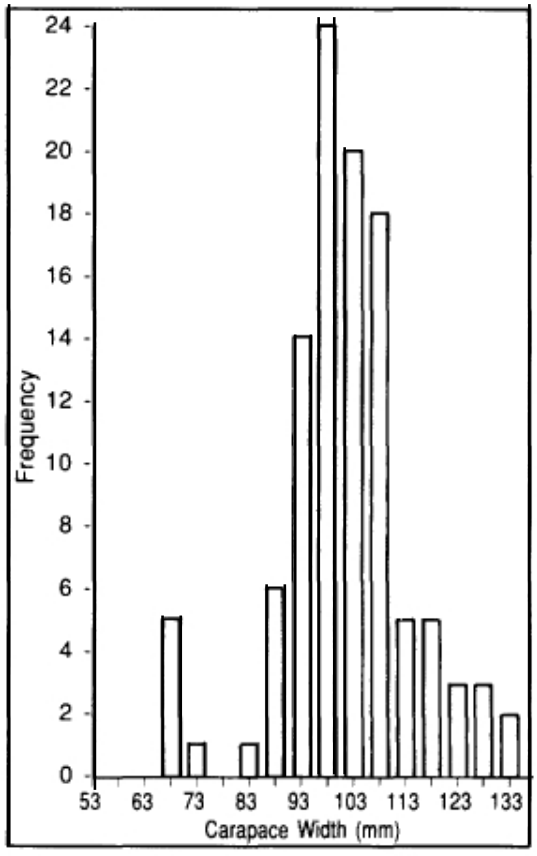
The results are shown in Figure 3. The length frequency histogram shows two modes. There is a distinct one and the other is indistinct. The fully exploited cohort appears to be the two-year age group with modal carapace width (CW) 96-100 mm range. The lowest size of this cohort was 81-85 mm. The largest size was the 143-145 mm group.

The rejected size mode was 70-75 mm. This size and lower were rejected at export-oriented markets. It appears that the second cohort is completely acceptable to the firsthand buyers: those rejected appear to be in the first-year age group.

The real picture of the first-year age group does not appear in the sample. The fishermen sort out the visually rejectable sizes immediately on landing. There is considerable difference in catch and landing.

The CW-weight relationship was estimated for males and females separately as well as combined. The combined CW-weight relation is found to be 0.00033 L^{2-2} For males it was .00158 L^{262} and for females it was .00071 $L^{2.73}$ (see chart on facing page - Figure 4).

Fig **3. Length frequency histogram of S. *serrata***



Flg. 4. Length/weight relationship of *S.serrata*

Fig. 4a. Length/weight relationship (Male and Female combined)

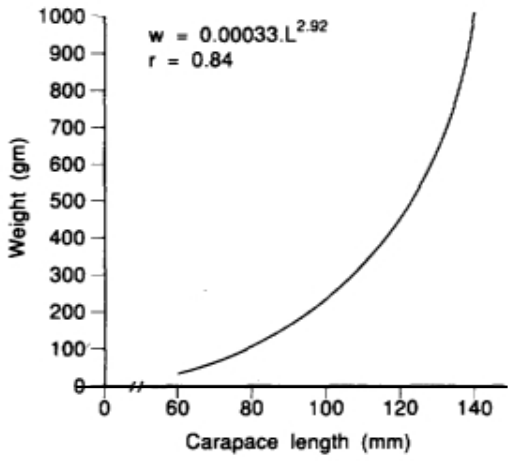


Fig. 4b. Log length vs log weight (Male and Female combined)

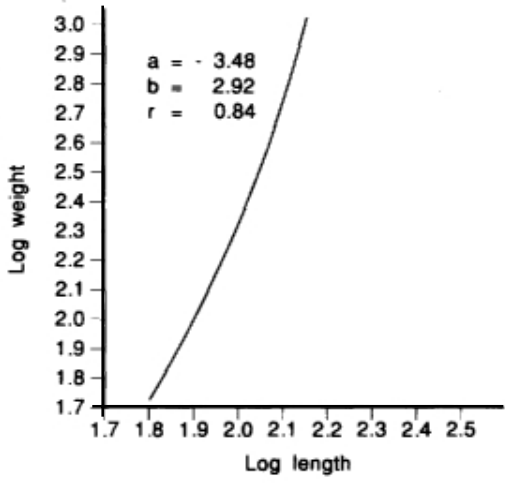


Fig. 4c. Length/weight relationship (Female)

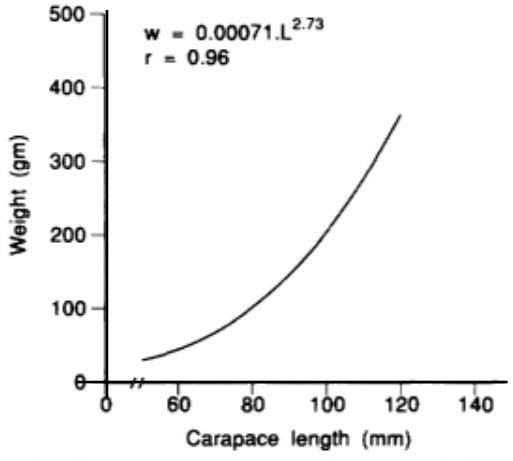


Fig. 4d. Log length vs log weight (Female)

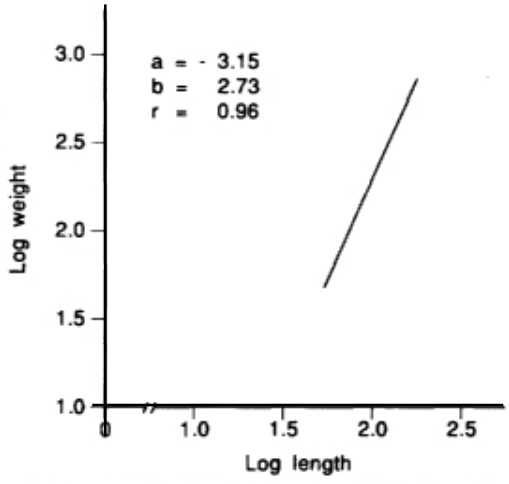


Fig. 4e. Length/weight relationship (Male)

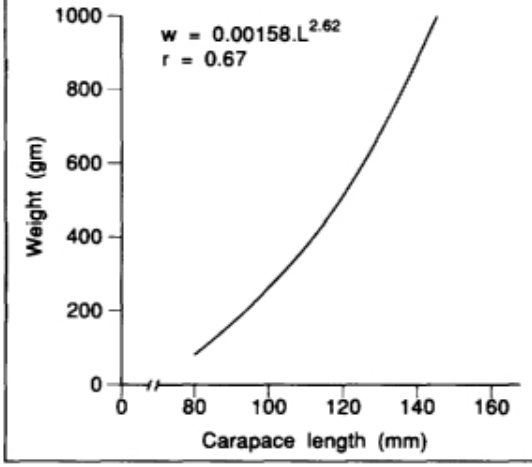
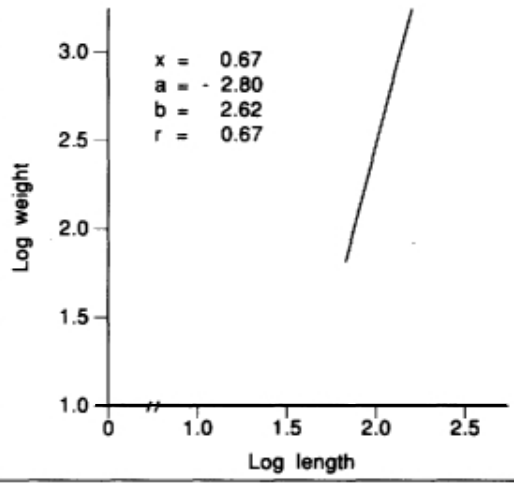


Fig. 4f. Log length vs log weight (Male)

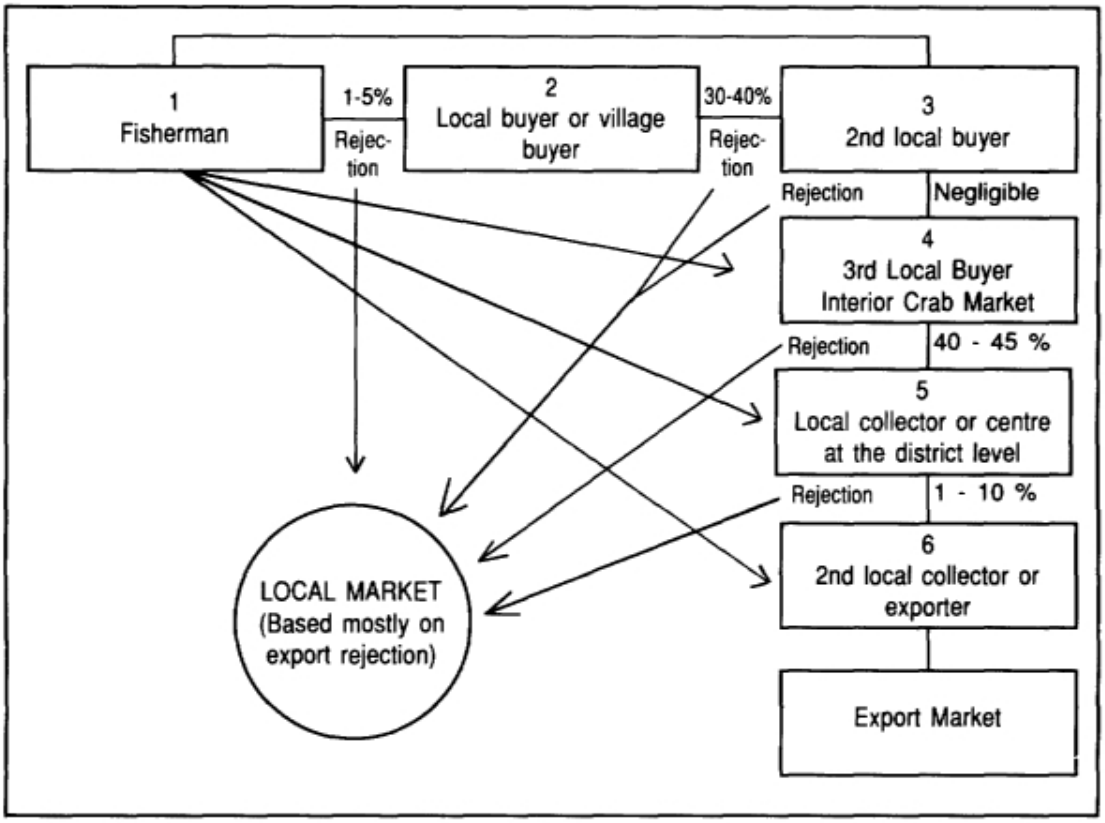


CRAB MARKETING, DOMESTIC AND EXPORT

The crab marketing system expanded during the last 2 - 3 years with foreign markets opening up. Before that, crab were marketed only locally and in negligible quantities. Now, crab marketing for domestic consumption has rapidly developed as well. But as domestic consumers are generally poor, the price is much lower than the export market price.

Fishermen usually market their catch 2 or 3 days after capture. Till then they keep the crab in their homes or boats, either in water or in cages, without water. Male crab weighing less than 200 g and female crab less than 150 g are rejected. The rejected crab are sold locally at about 15-20 Tk*/kg. The present domestic market is based mainly on this supply. Figure 5 illustrates the marketing flow.

Fig 5. Crab marketing flow chart



The district level market rate is 30-45 Tk/kg. The first level rate is 15-20 Tk/kg. Females are usually separated at the district level market or at the fourth or fifth local marketing step and, in some cases, even at the production point. The rate in the Cox's Bazar zone is, in general, higher than in the other zones. The marketing trend is improving both in quantity and price. There are also new local markets for crab.

The present international markets are Singapore, Hong Kong and a few other Southeast Asian countries. More than 95 per cent of the export involves live crabs. Processed and frozen exporting is negligible.

Bamboo baskets are used to airfreight the crab from Dhaka international airport two or three times a week. The international market rate for crab is 75 Tk/kg.

* US $1 = **TK** 35 appx (First half 1991)

Transport

Crab are transported is done in bamboo baskets packed 50-100 kg/basket. Transport from the main collection centre is by road and water. The transport cost upto Dhaka from different district - level collecting centres is 200-300 Tk/basket. From the district - level markets, crab are transported to Dhaka on, or just before, the day of export. The local market receives crab from collectors two or three times a week, which is when the crab are also transported by road to district level markets.

SOCIO-ECONOMIC OBSERVATIONS

The development of an export market has improved the income of professional crab fishermen in the Cox's Bazar area, but incomes are still below any acceptable standard. The wholesalers pay advances to crab fishermen and, in return, the latter have to sell their catch to the middlemen without bargaining. Men, women and children all go fishing. The men prefer to use the boom or hook, while the women use the don. They capture crab in the water channels between the islands. More than two hundred boats are engaged in operating booms in the Cox's Bazar area alone.

Of these crab catchers, 95 per cent are landless and jobless. The majority of the fishermen come from minority groups. Although Muslims also harvest crab, they are shy about admitting it. However, they are becoming less shy. Usually Muslims catch and sell crab, but do not eat them. New people are joining this profession daily. There is scarcity of government jobs and food during monsoon months, and crab provide some succour. As in other fishing businesses, here too the middlemen make the profit and the fishermen do not get what they deserve.

Culture of mud crab

Techniques for the culture of mud crab are yet to be developed within the country. There are a number of reasons for this. First, culture of Scylla serrata involves more labour and capital, while, at the same time, there is risk due to the crab's behaviour, including its cannibalism. Secondly, the crab is a non-traditional species and is not popular, being eaten by few people. While several traditional and popular fish and shrimp species are being cultured, the development of crab culture is not likely to be fast. But since foreign markets have opened up for Bangladesh crab, its culture may develop.

Since the technology is unknown to the private sector, it should be introduced through a government-supported programme. The technology may then be tansferred to the private sector.

A foreign national in Cox's Bazar recently tried crab culture. He carried out some trials by digging ponds, making bamboo fences and supplying supplementary foods, but did not succeed and ultimately abandoned his venture. The reasons for his failure have not been disclosed.

Nevertheless, crab capture and trade are increasing daily. S.Serrata is, thus, becoming, an important resource and needs special attention. Research on crab at present is virtually absent in Bangladesh, though the Marine Fisheries Survey Management and Development Project has undertaken taxonomic and ecological studies with crab culture in mind.

Development and conservation strategies

The crab fishery in Bangladesh has grown without any government support. Now government should take the initiative to encourage farmers and support their socio-economic growth by helping to develop production and trade to sustainable levels. It is necessary for this to study in detail the resource status and the population dynamics in order to conserve and manage the resource. An extension and motivation programme is also necessary to control the mesh sizes of crab fishing traps.

The undersized crab which are now sold at a very low price and do not contribute very much in terms of weight to the total production should be used for culture and fattening. This too needs an extension programme, with external and government support to transfer the technology and provide financial and credit facilities to crab culturists.

Catch assessment and population dynamics studies are envisaged and are very likely to be included in the UNDP/BOBP Bio-economics Project based in Chittagong.

REFERENCES

ARSHADULLAH, M.D. 1976. ***Industrial*** *processing* **of crab Scylla serrata (Forskal) (Decopoda Brachyura)** ***of the Karnaphully Estuary, Chittagong.*** *Bangladesh.* **M.Sc. Thesis. Dept. of Mar.** Biol.. **Univ. of Chittagong.**

ISLAM, J. ***1977.*** *Brachyura* ***of the*** *Karnafully* ***Estuary and north-rust*** *part* ***of*** *the* ***Bay of Bengal with*** *special* ***reference*** *to the biology* **of Scylla serrata. ● M.Sc. Thesis, Dept. of Mar.** Biol., **Univ. of Chittaponp. 160 pp.**