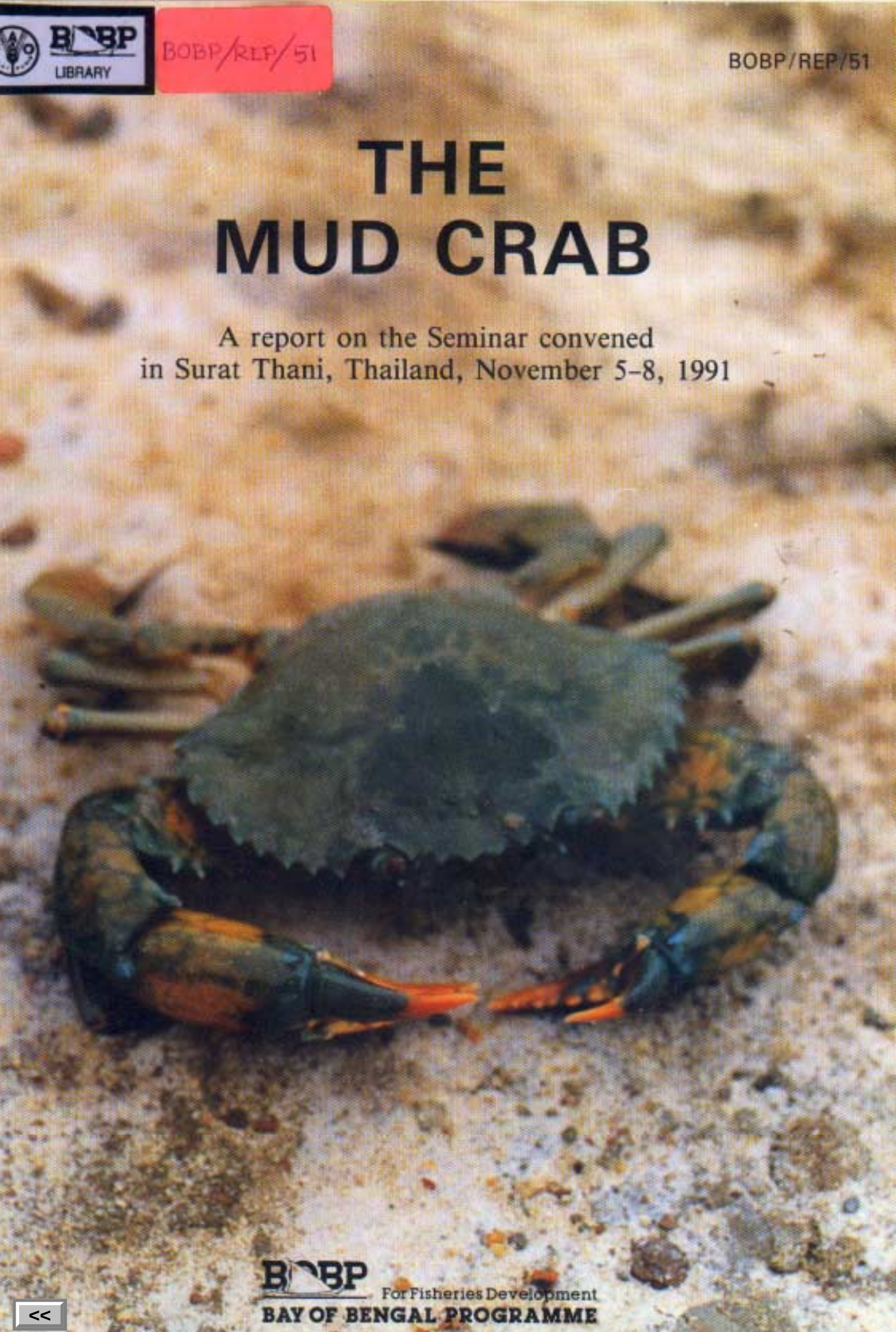
BOBP/REP/51

THE MUD CRAB

A report on the Seminar convened
in Surat Thani, Thailand, November 5–8, 1991



BOBP
For Fisheries Development
BAY OF BENGAL PROGRAMME

BAY OF BENGAL PROGRAMME BOBP/REP/51
Brackishwater Culture GCP/RAS/ I 18/MUL

REPORT OF THE SEMINAR ON THE MUD CRAB CULTURE AND TRADE held at Swat Thani, Thailand, November 5-8,1991

Edited:
C.A. ANGELL
Sr. Aquaculturist
BOBP

BAY OF BENGAL PROGRAMME,
Madras, India
1992

<<

The mud crab, Scylla sp.. found throughout the Indo-Pacific region. has become increasingly popular by virtue of its meat quality and large size. While regional trade in the species has been growing. very little attention has been given to the fishery and culture in the Bay of Bengal region.

The fishery, culture and trade in Scylla sp. is small-scale and involves artisanal fisherfolk, thus attracting the interest of the Bay of Bengal Programme (BOBP). As little is known of the state of the fishery, culture and trade. it was felt that a regional seminar might be an appropriate medium for an exchange of information among BOBP's member countries. A seminar would also provide an opportunity to update knowledge of the industry.

Southern Thailand, particularly the province of Surat Thani. has long been a centre for the capture and culture of the mud crab. With the proximity of the provincial brackishwater station and the opportunity to observe the industry first-hand. the town of Surat Thani promised to be an ideal venue for the seminar. And so. BOBP. in collaboration with the Department of Fisheries (DOCF) of the Government of Thailand, convened the seminar from November 5 to 8. 1991

Representatives from all the BOBP member countries, as well as the Philippines. Australia and U.S.A., attended. Aquaculturists, scientists. businessmen. socio-economists. feed manufacturers and development strategists were among the 54 participants.

There were five sessions: Biology and natural resources. Seed supply, Culture. Trade and a combined session with focus on Extension. Credit and Economic\. During these sessions, 22 papers and six backgrounders were presented. To our knowledge, this was the first seminar in the region. and perhaps the world. devoted exclusively to the mud crab.

The Bay of Bengal Programme (BOBP) is a multi-agency regional fisheries programme which covers seven countries around the Bay of Bengal — Bangladesh, India. Indonesia, Malaysia, Maldives, Sri Lanka, Thailand. The Programme plays a catalytic and consultative role: it develops, demonstrate\ and promotes new techniques, technologies or ideas to help improve the conditions of small-scale fisherfolk communities in member-countries. The BOBP is sponsored by the governments of Denmark, Sweden and the United Kingdom. by member-governments in the Bay of Bengal region, and also by AGFUND (Arab Gulf Fund for United Nations Development Organizations) and UNDP (United Nations Development Programmc). The main executing agency is the FAO (Food and Agriculture Organization of the United Nations).

This document has not been cleared by the FAO or by the governments concerned.

September 1992

Published by the Bay of Bengal Programme. 9 I St. Mary's Road. Abhiramapuram. Madras 600 018, India. typeset by PACE Systems, Madras 600 028 and printed for the BOBP by Nagaraj & Co., Madras 600 04 I.

<<

CONTENTS

<<

Culture

Trade

Extension, credit and economics

<<

SUMMARY OF THE PROCEEDINGS OF THE SEMINAR ON THE MUD CRAB

Convened in Surat Thani. THAILAND. November 5-8. 1991,

Biology and natural resources

The mud crab (Scylla sp.) is widely distributed throughout the region. The estimated total catch in the Bay of Bengal region is between 9-10,000 t/year. Mud crab culture and fattening operations depend solely on seed collected from the wild. The lack of management controls on the indiscriminate collection of natural seed has led to a decline in mud crab landings in most of the countries in the region. There has also been a gradual reduction in the maximum landed size. another indicator of over-exploitation. These observations call for an immediate focus on the effective management of mud crab resources and their fisheries, as well as on speeding up efforts to improve the existing mud crab seed production techniques in order to support a continued and sustained mud crab resource in the region.

Wide differences observed in coloration, maximum size obtained and preferred habitat have led to the conclusion that more than one species of Scylla exists in the region.

Sexual maturity in females is reported to be attained at a carapace width of 9-11 cm. Females migrate offshore to spawn and the larval development occurs in the open sea. while juveniles. subadults and adults occupy mangrove biotopes, estuaries and channels.

Seed supply

Attempts to develop techniques for mud crab seed production in the Bay of Bengal region and elsewhere have been very limited. One of the principal reasons for this slow pace of progress has been a combination of fisheries management control on the collecting of female crab (as in Australia) and the general lack of knowledge about certain aspects of larval and juvenile seed and water quality requirements.

Survival of up to 30 per cent from zoea to first crab stage has been obtained in the laboratory, but this has not been transferred to commercial practice. Continued applied research will be required it the technology is to become economically viable.

Culture

The culture of **Scylla** sp. is of two kinds: fattening and growout In fattening. post-moult 'water' crab of market size are held for short periods of time and fed until their meat content has increased. Growout operations stock small seed crab, usually in ponds, and provide feed and water exchange until they reach market size.

Crab are held for fattening in a variety of floating cages and pens. Most operations are small-scale and crab may even be kept in individual containers made of plastic or split bamboo and suspended from a raft. Pens can be erected in tidal areas and may even be found under the culturists' homes. Pens are usually quite small, measuring only a few square metres in area.

Trash fish is most commonly used as feed, but fish offal and slaughterhouse waste are also employed when available. Feeding rates are around 10 per cent of estimated bodyweight, although schedules are not rigorously adhered to. Experiments with artificial feeds show promise for future development along these lines.

Seed stock for crab fattening is usually obtained from local markets and dealers where 'water' crab have a relatively low value. Female crab are particularly sought after. Most of these will become gravid during the fattening period and command a significantly higher price when bearing the bright red roe in their ovaries. In Malaysia, stocking material for fattening operations is imported from

<<

Thailand, Sri Lanka and Indonesia. The fattening period may vary from a few days to a month. depending on the condition of the seed stock.

Ponds may also be used for fattening. Such ponds are usually quite small, and are dug by 'trenching'. leaving a mound of earth in the centre of the pond which can be used by the crab for burrowing and shelter. In Thailand. fattening ponds range from 500 to 800 m^2 Most fattening ponds in Malaysia are of a similar size, although a few may reach 1 ha in area. Indonesian crab fattening ponds are around 1000 m^2. The bunds have to be protected with some kind of facing material to prevent burrowing by the captive crab. Water exchange in these types of ponds is by tides and through simple concrete sluice gates.

Crab fattening is profitable due to the fast turnover rate and good survival. It is also very suitable for small-scale operations as an extra income source for fisherfolk. Its expansion will be constrained by seed shortages as well as feed. principally trash fish.

Crab culture is much less widely practised than fattening. Where it is widespread. in central Java, it is done along extensive lines. High mortality of over 50 per cent often plagues crab culturists, but it can be alleviated by the provision of shelters placed on the bottom of the pond.

Trade

Mud crab trade in the region has shown a consistently increasing trend in the past few years. Malaysia and Singapore are the main markets in the region. Apart from local production, these two countries absorb about 10 t of live mud crab a day. imported from Indonesia. India. Sri Lanka, Bangladesh and the Philippines.

The export of live mud crab from India and Sri Lanka started in the early and mid 80's. respectively. but has been a recent development in Bangladesh.

The fact that mud crab survive in air for about 4-5 days (under optimum conditions) has enabled their shipment to distant markets. Improved packaging and handling techniques have also significantly contributed towards the increase in regional trade.

The preference for ovigerous female crab and the high price they command. as compared to immature females and males. in countries like Malaysia. Singapore, Thailand and Indonesia, is of serious concern due to its implications for recruitment to natural populations.

There seems to be significant fluctuations in the market price of mud crab due to the wide seasonal variations in the landings. Increasing production through culture and fattening could contribute to a more stable situation.

Extension credit and economics

Studies undertaken in the Philippines on the economic viability of mud crab culture in ponds indicate that the operation is economically viable at a stocking rate of 5000 crab/ha. but not at higher stocking densities of 15.000 and 20,000/ha.

Reduction in the investment cost and the development of indigenous methods to suit local conditions, coupled with appropriate financing through institutions, would render crab culture and fattening operations a viable proposition and provide a reliable source of income to low-income groups.

Attempts at extension and training programmes aimed at popularizing mud crab culture and fattening have been very limited in the region. The Bay of Bengal Programme (BOBP). in collaboration with the Department of Fisheries, Thailand. initiated trials in 1987 to transfer the technology of mud crab fattening and culture to small-scale fisherfolk in Ranong Province in southern Thailand. The project was beset with high investment costs. low availability of seed and the reluctance of financial institutions to provide funds. Most operations failed due to heavy mortalities resulting from cannibalism and wide salinity fluctuations.

<<

BIOLOGYAND NATURALRESOURCES

<<

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

by K Sivasubramaniam and C Angell
of the Bay of Bengal Programme

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_1 through Z_5. 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_1 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 m^2. 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/ m^2, reduced to only l/m^2 during the summer. Feedings once a day consist of up to 200 g of trash fish per crab and live snail at 100/m^2.

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 m^2. 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 m^2 with a depth of l m. Extruded plastic mesh is commonly used for the enclosures. Crabs are stocked at 10/m^2 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	*Fishilg 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): l35- 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

by Fusd Cholik and -Adi Hanafi
of the Central Research *Institute for Fisheries*
Agency for Agricultureal Research ad Development, Jakarta, INDONESIA

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.

ZNTRODUCTZON

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

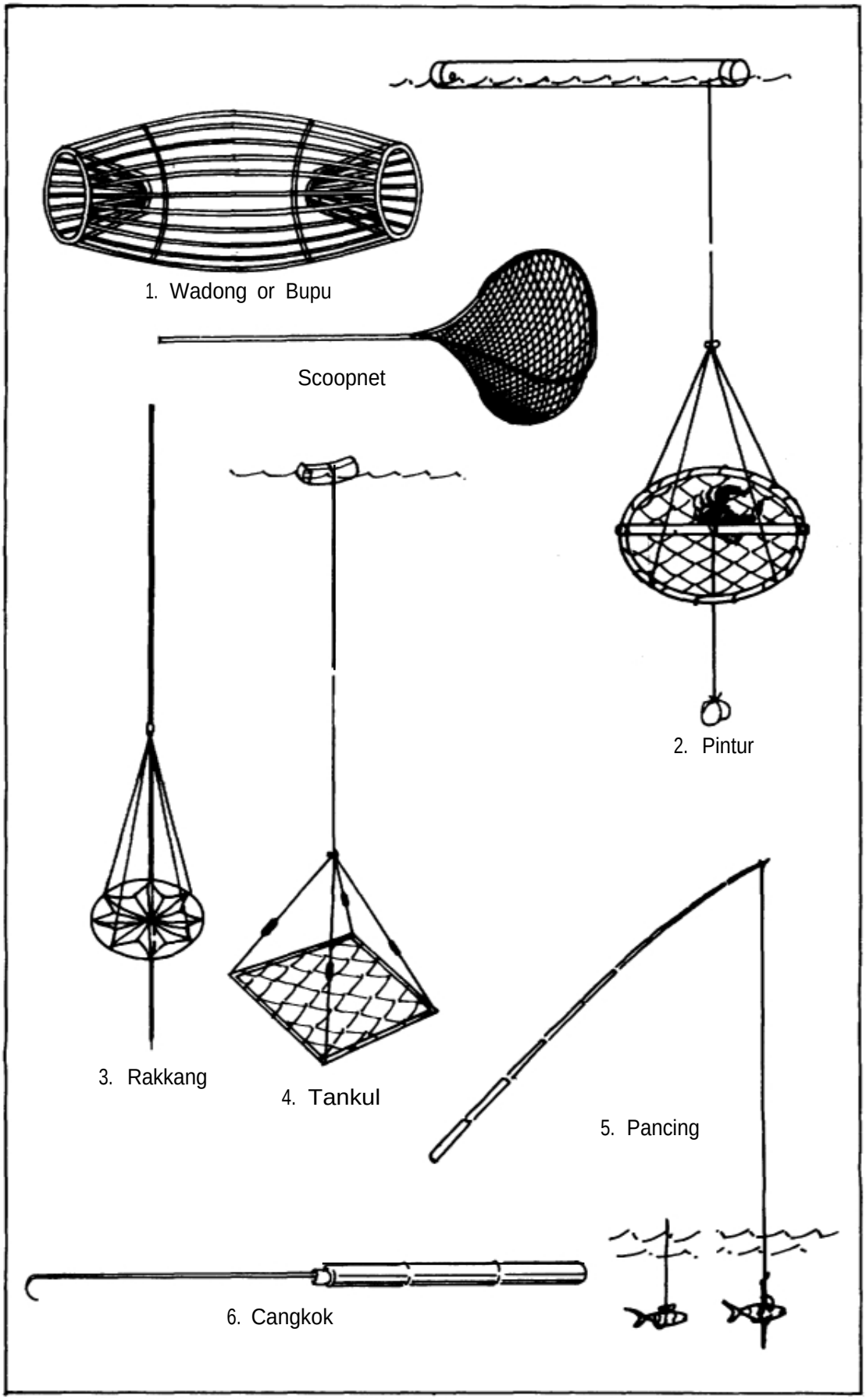
GEAR USED IN CRAB FISHING

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

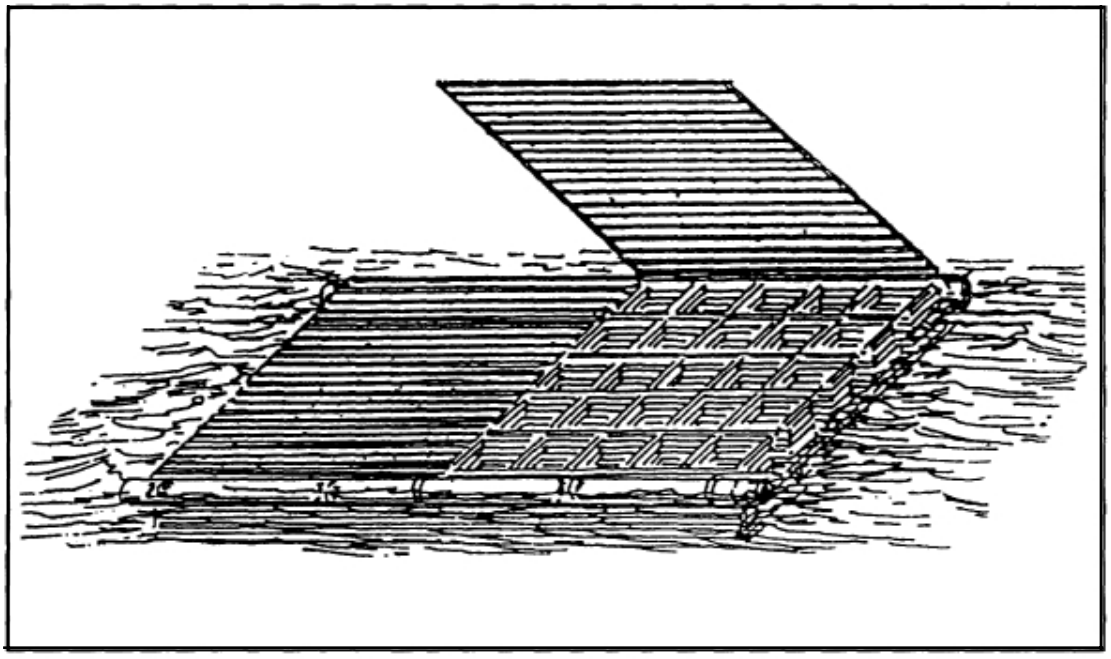
Increasing demand for egg-bearing female crab has stimulated berried female crab culture for the first time in areas such as Cilacap (Central Java) and Bone (Southern Sulawesi). Berried female crab are cultured in floating bamboo cages. Measuring 2 x 1.5 x 1m with a 30cm opening on the top. Crab stocking 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.

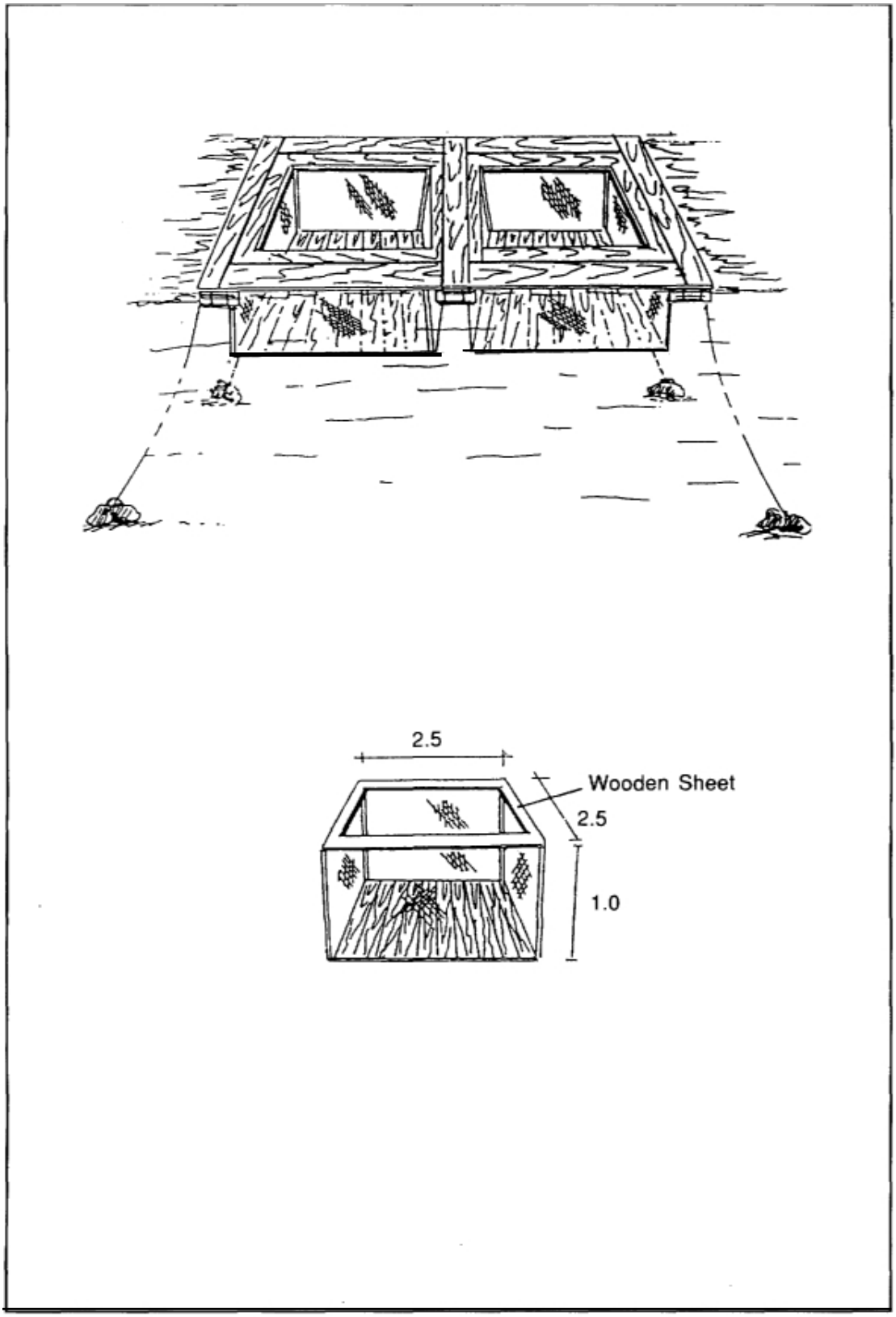
Fig 7. Crab culture in cell-type floating bamboo cage



<<

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.

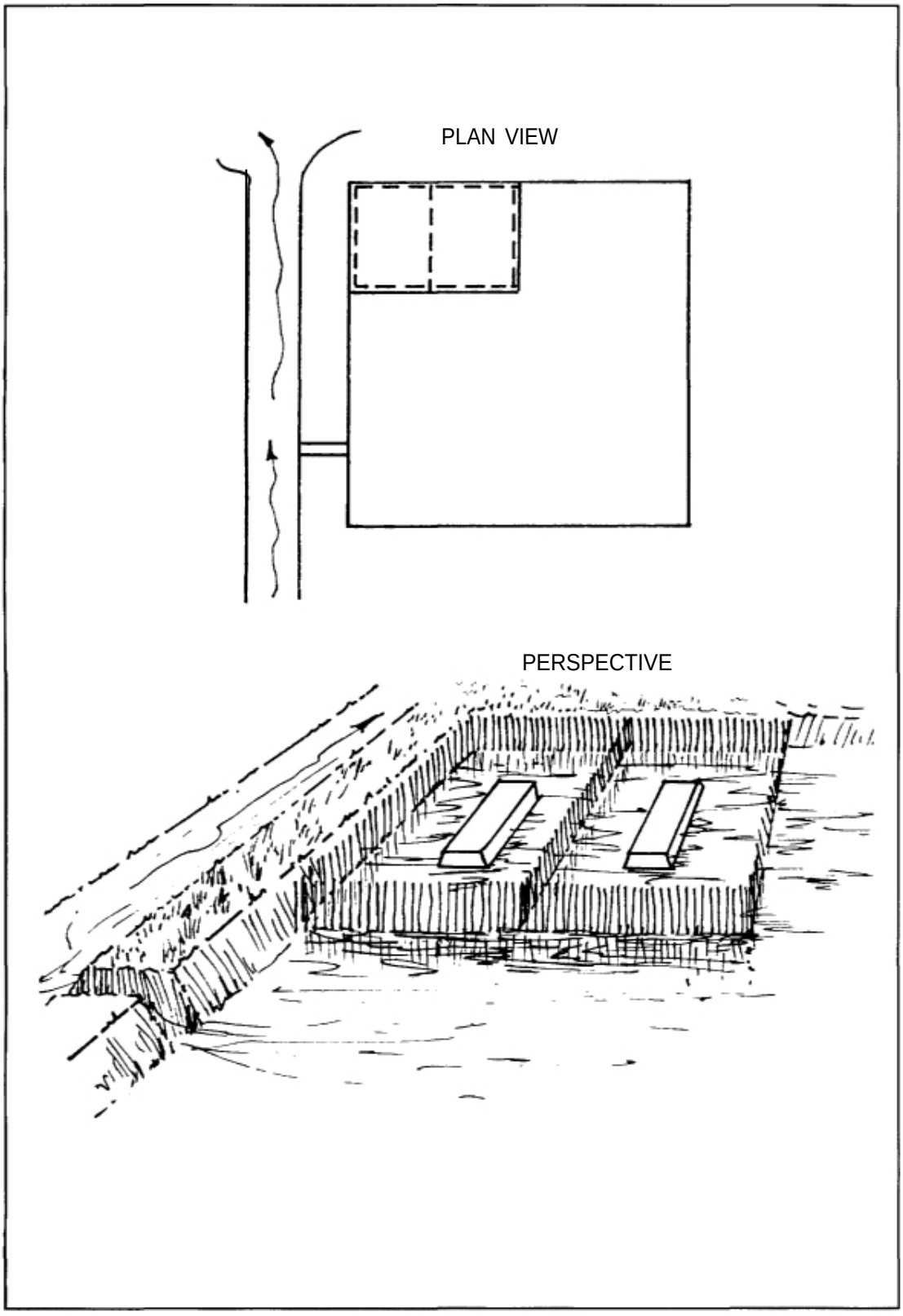
Fig 8. Floating net cage for crab culture



<<

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).

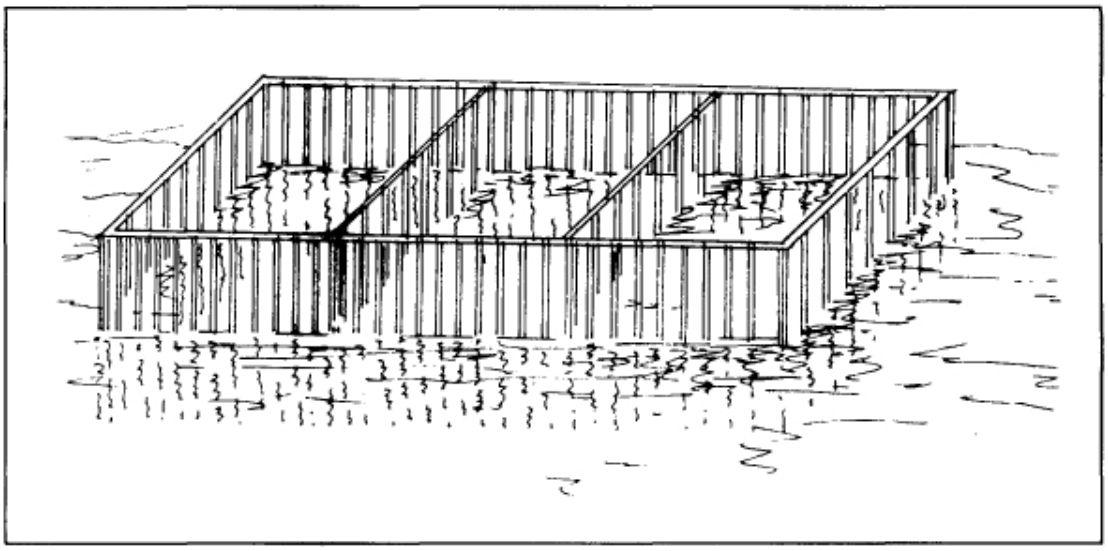
Fig 9. Brackishwater pond for crab fattening with peripheral canal



<<

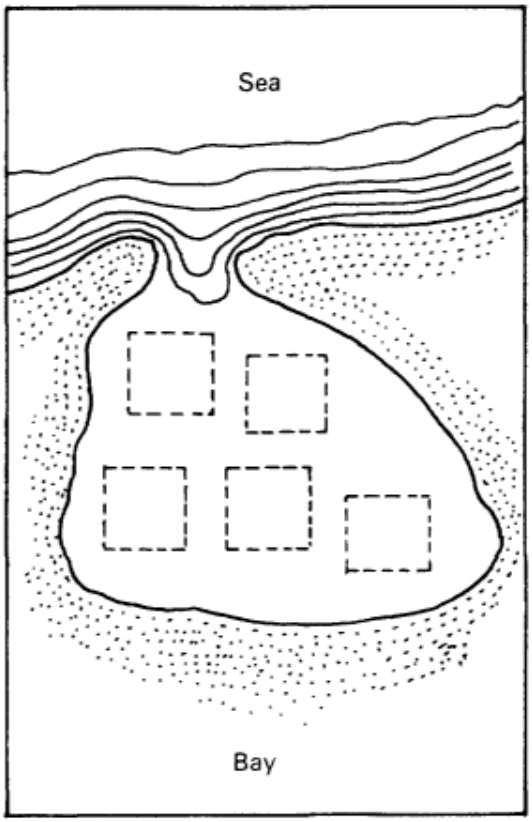
Another design of a crab pond is similar to the above, hut without any peripheral canal and shelters. Instead, the pond is equipped with a bamboo platform installed near the pond dykes. The platforni is placed about 2-3 cm below water level. In place of watergates this pond has inlet and outlet pipes.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

<<

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	15,000.00
	Benefit = (Rp 115,000 - Rp 55.250) = Rp. 59,750.00	

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

<<

Table 11: Financial analysis of crab fattening

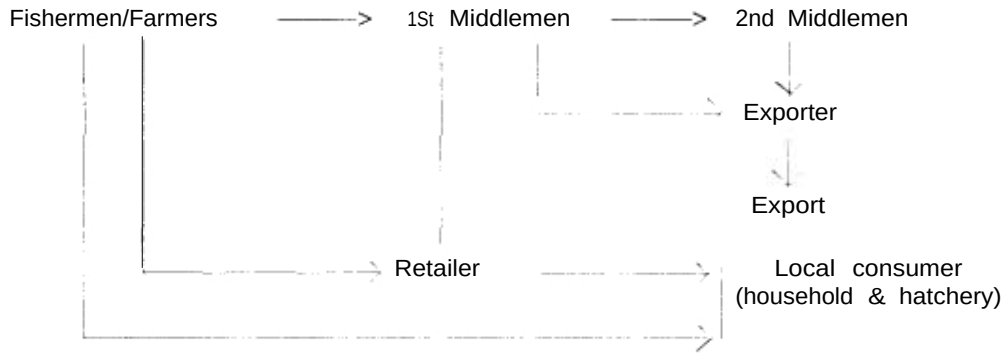
		Rp
1.	**USING PEN CULTURE**	
a.	FIXED COST	
	Pen culture made of bamboo. size 2 x 2 m. 5 pens	15,000.00
	Scoopnet 2 pes	2,000.00
	Rakkang 5 pcs	5.000,00
	Total(a)	32,000.00
h.	OPERATION COST	
	500 female crab export size > 150 gram @ Rp 500	250,000.00
	Feeding 10 kg unsalted dried fish per day @ Rp 300	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

by Md Giasuddin Khan and Md Fokhrul Alam
of the Marine Fisheries Survey. Management and Development Project.
Chittagong. BANGLADESH.

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.

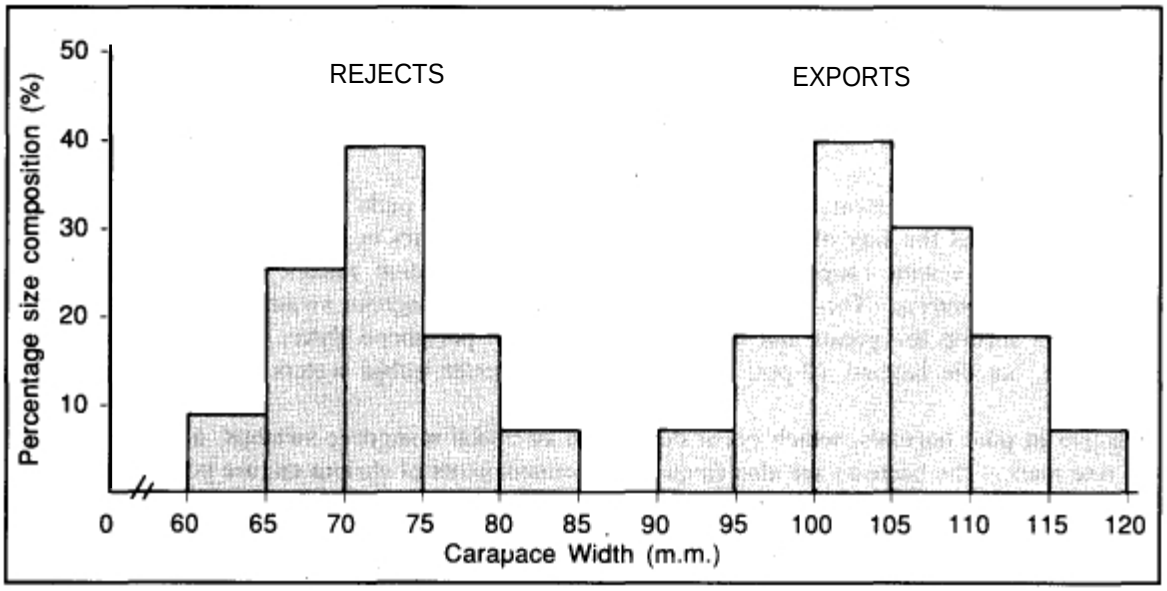
Distribution and abundance

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*

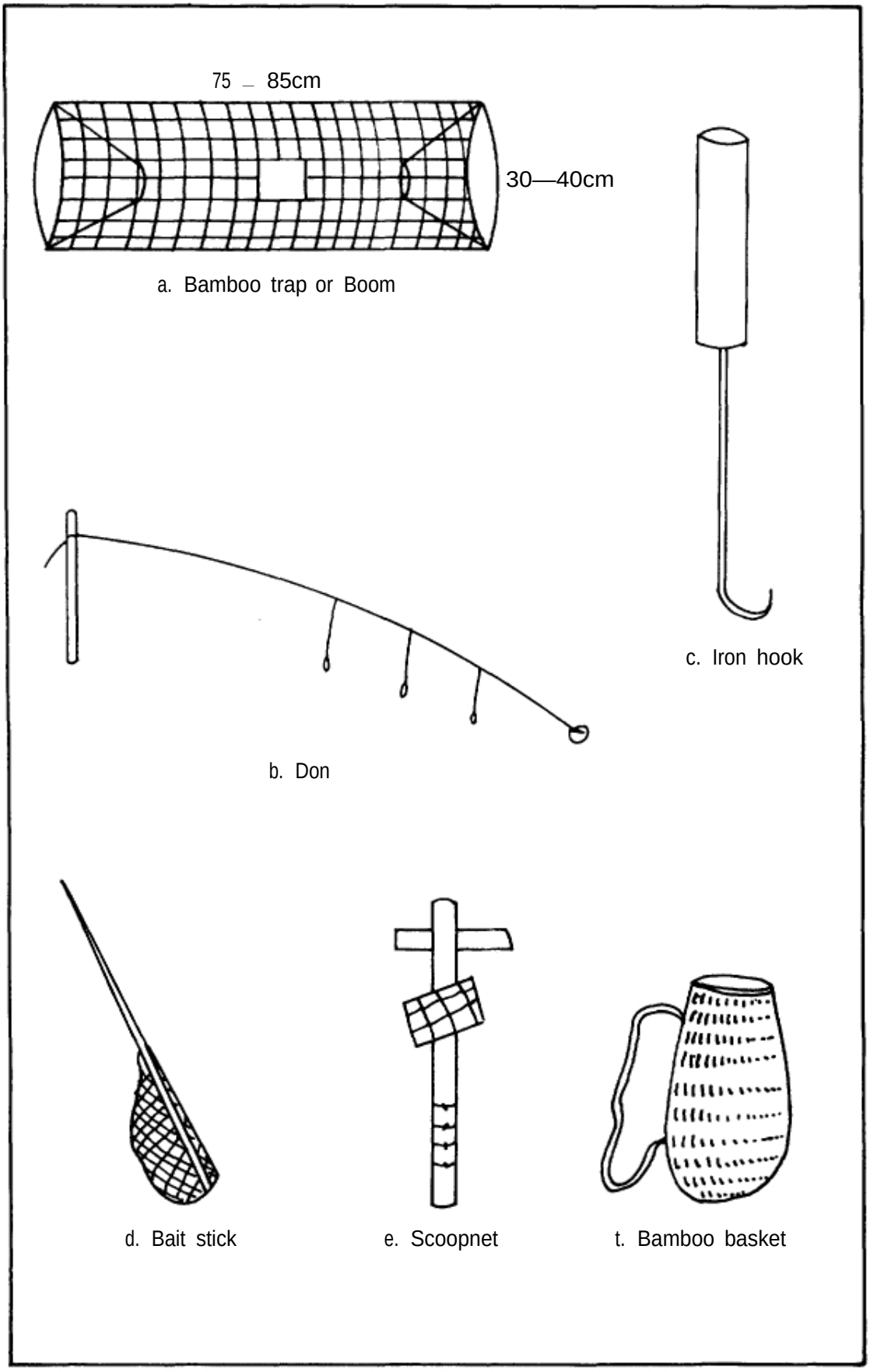


Further data are being collected to check whether the catch samples show a bimodal or unimodal distribution. This will help identify the cohorts and differentiate the export- and reject-grades among them, thus enabling population management concepts.

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.

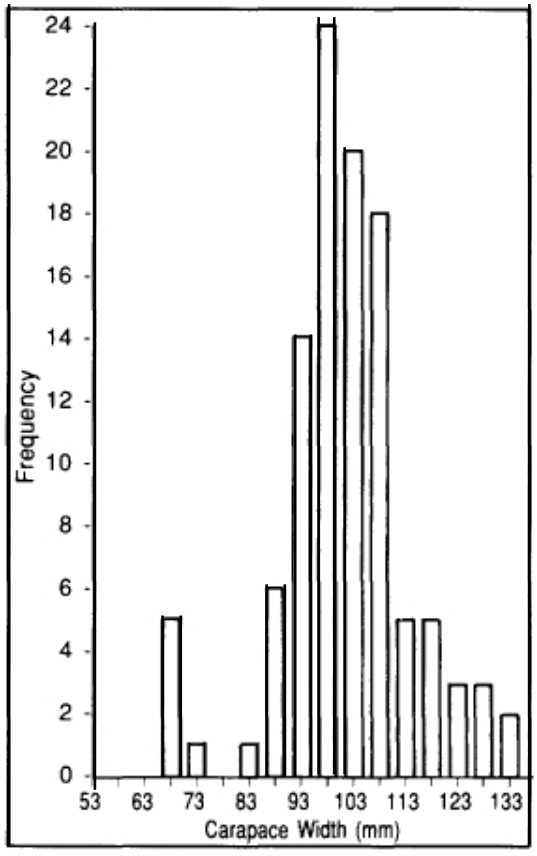
The results are shown in Figure 3. The length frequency histogram shows two modes. There is a distinct one and the other is indistinct. The fully exploited cohort appears to be the two-year age group with modal carapace width (CW) 96-100 mm range. The lowest size of this cohort was 81-85 mm. The largest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

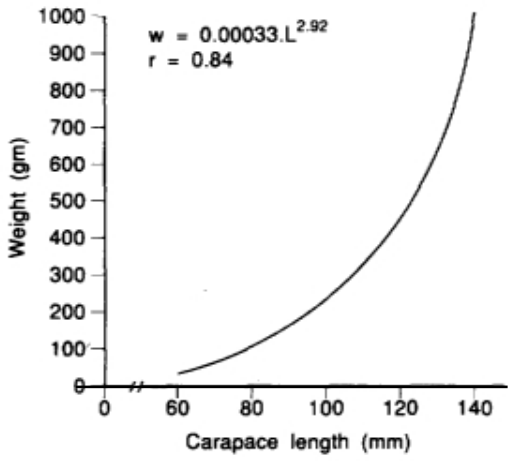


Fig. 4b. Log length vs log weight (Male and Female combined)

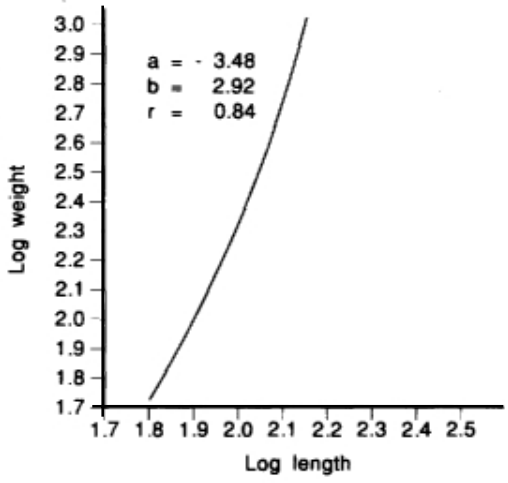


Fig. 4c. Length/weight relationship (Female)

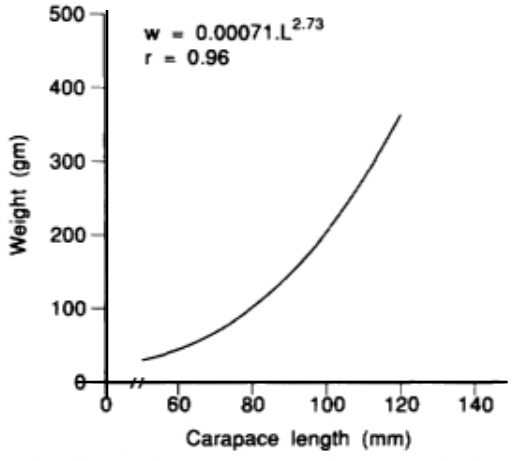


Fig. 4d. Log length vs log weight (Female)

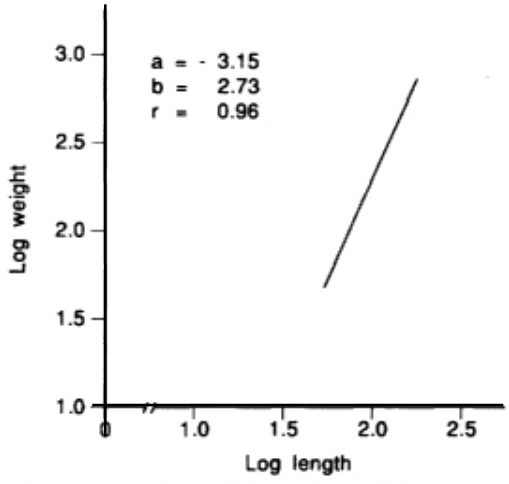


Fig. 4e. Length/weight relationship (Male)

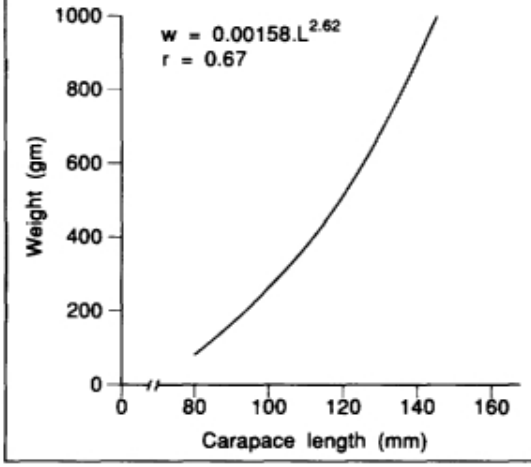
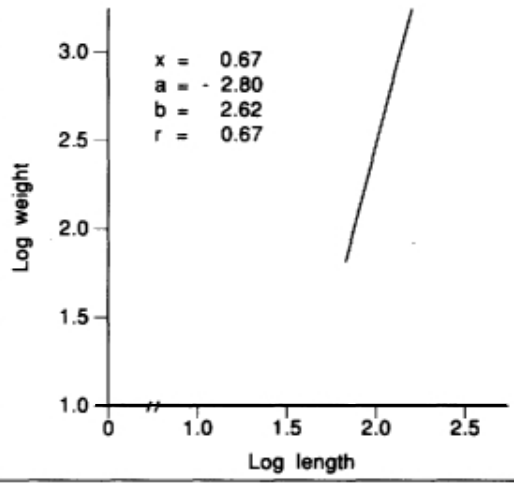


Fig. 4f. Log length vs log weight (Male)



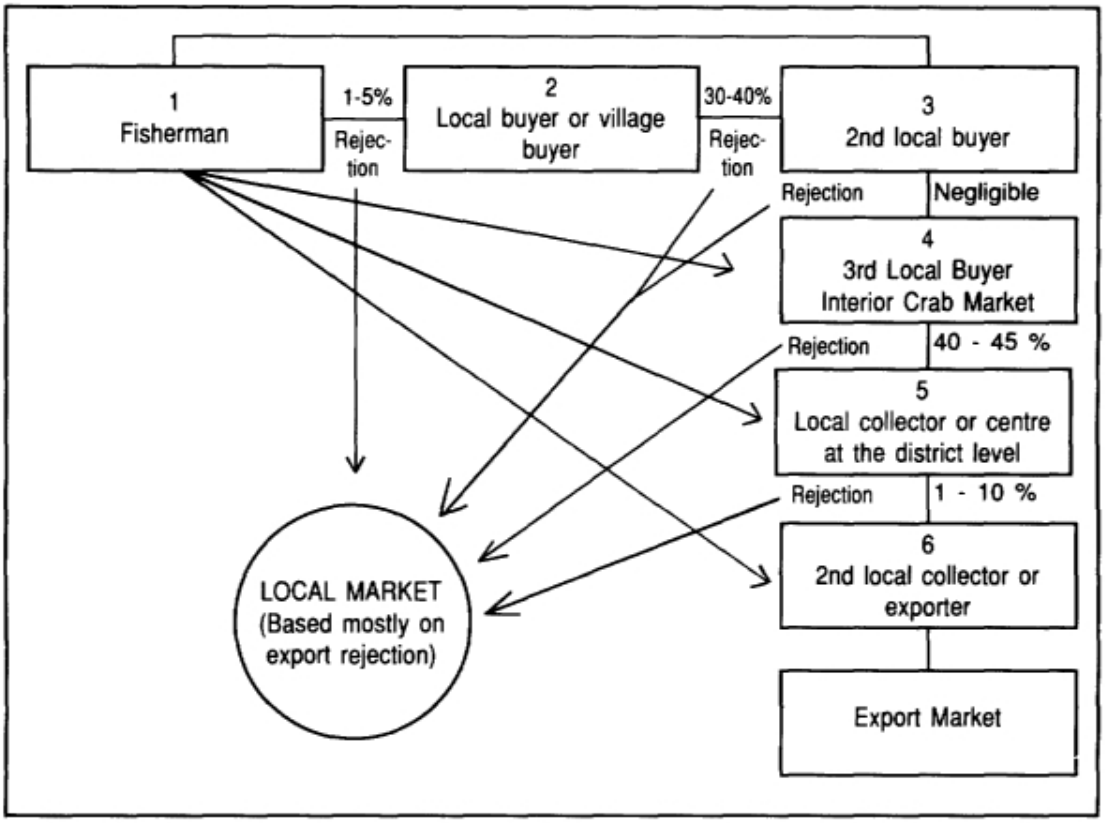
<<

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.**

<<

by S C Jayamanne
of the National Aquatic Resources Agency, Crow Island, Colombo 15.
SRI LANKA.

ABSTRACT

Mud crab production in Sri Lanka grew from 1422t in 1980 to 1973t in 1984, reaching a peak of 2309 t in 1983. Production has declined in recent years due to civil strife and overfishing. The average size and catch/unit effort of mud crab have declined in Negombo Lagoon, the principal fishing area. Sri Lanka mud crab are well known in the export trade and are considered a quality product. Singapore receives 90 per cent of Sri Lanka's exports. Recommended management measures include the prohibition of capturing immature crab, educating fisherfolk and developing aquaculture of the mud crab.

1NTRODUCTION

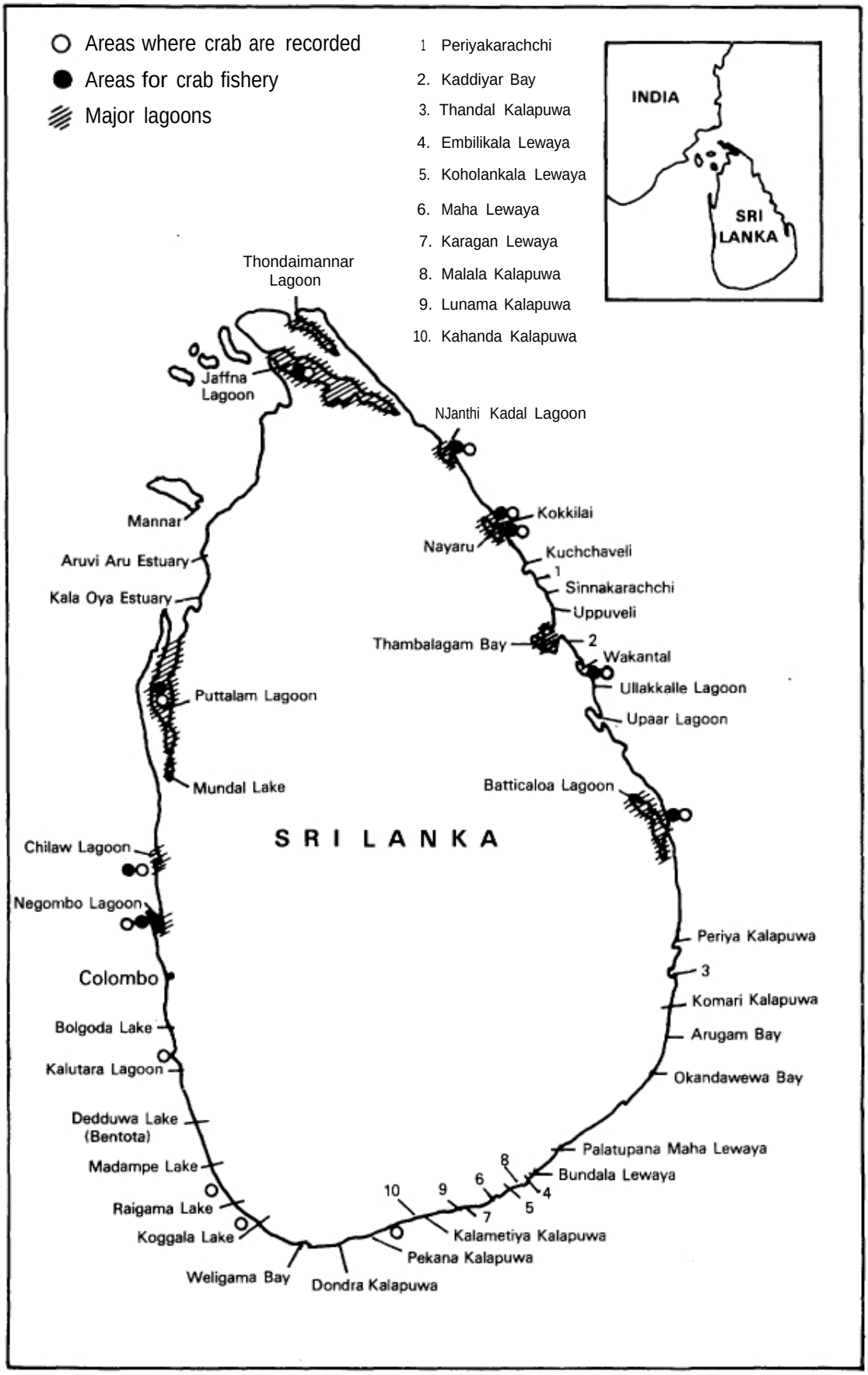
The mud crab Scylla serrata (Forskal) is widely distributed in the Indo-West Pacific region. It is a member of a group of swimming crab, portunid, characterized by a flattened hind pair of legs. Mud crab are predominantly estuarine, but depend on the marine environment for spawning and early larval life (Arriola, 1940). Scylla serrata is locally known as the kalapu kakuluwu (lagoon crab) or ala man kakuluwa (crab which lives in channels). It is one of the six species of crab which has a good world market. Alverson, 1971, emphasizes its importance to developing countries as a good foreign exchange earner. Only two preliminary investigations have been carried out on Scyalla serrata in Sri Lanka (Raphael 1970; Arudpragasam 1976). These related to the aquaculture potential of the mud crab and the host-parasite relationship of Scylfa serrata and Octalmis cor. Jayamanne (1991) has studied the biology and economics of the mud crab fishery in the Negombo Lagoon.

HABITAT

Mud crab mainly inhabit lagoons, but move into offshore areas to spawn. Early larval stages are marine and they begin their lagoon life only at the final larval stage, the megalopa, which is a benthic form. Megalopa, after living some time in shallow comers of the lagoon, moults into the crab.

Small crab, those measuring about 2-7 cm carapace width (CW), inhabit sea grass beds and the root props of mangroves. They usually stay hidden in sheltered areas in the subtidal zone of the lagoon. Subadults of Scylla serrata, those of about 7-13 cm CW, move more freely in the lagoon and inhabit open areas. They too are benthic in nature and occupy subtidal areas but frequently move into intertidal areas in search of food. The larger crab, measuring 13.0 cm or more CW, usually occupy deeper subtidal areas of the lagoon.

<<


Areas where crab are recorded
Areas for crab fishery
Major lagoons
1 Periyakarachchi
2. Kaddiyar Bay
3. Thandal Kalapuwa
4. Embilikala Lewaya
5. Koholankala Lewaya
6. Maha Lewaya
7. Karagan Lewaya
8. Malala Kalapuwa
9. Lunama Kalapuwa
10. Kahanda Kalapuwa
INDIA
SRI LANKA
Thondaimannar Lagoon
Jaffna Lagoon
NJanthi Kadal Lagoon
Mannar
Kokkilai
Nayaru
Kuchchaveli
Aruvi Aru Estuary
Kala Oya Estuary
Sinnakarachchi
Uppuveli
Thambalagam Bay
Wakantal
Puttalam Lagoon
Ullakkalle Lagoon
Upaar Lagoon
Mundal Lake
Batticaloa Lagoon
SRI LANKA
Chilaw Lagoon
Negombo Lagoon
Periya Kalapuwa
Colombo
Komari Kalapuwa
Bolgoda Lake
Arugam Bay
Kalutara Lagoon
Okandawewa Bay
Dedduwa Lake (Bentota)
Palatupana Maha Lewaya
Madampe Lake
Bundala Lewaya
Raigama Lake
Koggala Lake
Kalametiya Kalapuwa
Pekana Kalapuwa
Weligama Bay
Dondra Kalapuwa

<<

Distribution and areas of fishing

Scylla serrata occur in almost all the lagoons and estuaries of Sri Lanka. hut are abundant in the lagoons of the west, north and east coasts. Their presence along the south coast has been reported (Maitipe and De Silva 1986), hut they are not exploited commercially in the south to the extent they are in the Jaffna. Kokilai and Nayaru (north). Batticaloa. Trincomalee and Valaichchenai (east) and Puttalam. Mannar. Chilaw and Negombo (west) areas (see Figure 1

FISHING METHODS

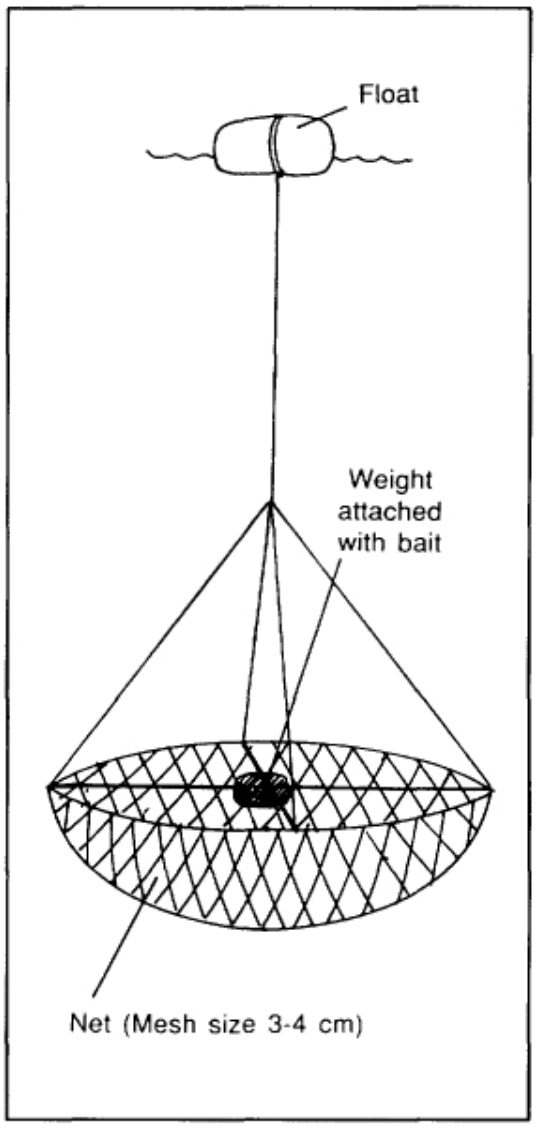
The gear used vary to some extent in the different lagoons of the country. Baited trap. the most common gear. is widely used by fishermen in Negombo. Chilaw. Puttalam. Batticaloa. Jaffna, Nayaru. Kokilai and Valaichchenai. Those in Trincomalee and Mannar seem to prefer gillnets.

The trap is a low cost device, designed specifically for trapping crab (Figure 2). The size of the trap and mesh size of the net used in the trap vary from lagoon to lagoon. hut the method used is similar everywhere.

Gear used for catching crab in some important lagoons of Sri Lanka are listed below:

Lagoon	*Fishing gear*
Negombo	Baited trap. Gillnet. Brushpi le
Chilaw	Baited trap. Gilinet. Brushpile
Putialam	Baited trap. Gilinet
Mannar	Gillnet
Nayaru	Baited trap. Gillnet
Kokilai	Baited trap, Gillnet
Jaffna	Baited trap. Gillnet
Trincomalee	Baited trap, Gilinet
Batticaloa	Baited trap, Gillnet
Valaichchenai	Baited trap. Gillnet

Fig 2. The baited trap used for catching crab



PRODUCTION

The data on annual production of mud crab in Sri Lanka, according to the Ministry of Fisheries, is given in Table 1.

Table 1: Annual production of mud crab in Sri Lanka from 1980-1984

Year	*Production (1)*
1980	1422
1981	1405
1982	1592
1983	2309
1984	1973

<<

Production data from Negombo Lagoon (1985 - 1987) are available from a study carried out by the author (Table 2).

Table 2: Production of mud crab in Negombo Lagoon, 1985 - 1987

Year	*Production (t)*	*Export (t)*	*Local* (t)
1985	35	18	17
1986	43	16	27
1987	40	16	24

Besides this information, very little data are available on mud crab production in any other part of the country.

Fifty per cent of the crab produced in Negombo Lagoon during 1985 were exported to Singapore, Japan and Malaysia. This has gradually declined to 40 per cent over the last few years (Jayamanne, 1991). Table 3 shows the exports of mud crab from the Mannar Lagoon during six months in 1991. The data indicate that more than 40 per cent of the production is not suitable for the export market although they are exported at a lower price. Exports were high in March and low in January. The low exports in January may probably have been due to the prevailing civil unrest in the region, which affected transport into Colombo. Mortality rate during transport was 8.0-28.2 per cent.

Table 3: Export of mud crab (in kg) from Mannar Lagoon, 1991

Quality	*JAN*	*FE6*	MAR	*APR*	*MAY*	*JUN*
Large	160	1786	4314	1123	I510	2361
Medium	I55	240	1048	311	753	936
Soft	431	711	2155	1497	2321	1745
Hard	116	210	1094	4471	785	962
Dead	339	608	831	303	560	641
Total	1201	3555	9442	7705	5929	6645

Source: J S Enterprises

CURRENT STATUS OF THE FISHERY

Production of mud crab in Sri Lanka has been showing a declining trend in recent years. The production data from the Ministry of Fisheries, from 1980 to 1984, show an increase, but since then a decline is reflected in the export figures provided by the Department of Customs (Table 4).

Table 4: Mud crab exports from Sri Lanka, 1985 - 1990

Year	*Quantity expcrted (t)*	*Eamings SL Rs (millions)*	*Price (SL Rs/kg)**
1985	913.75	33.38	34.28
1986	105.71	37.13	53.46
1987	337.53	26.93	79.78
1988	391.42	35.96	90.48
1989	443.11	31.50	84.64
1990	45.02	43.51	96.67

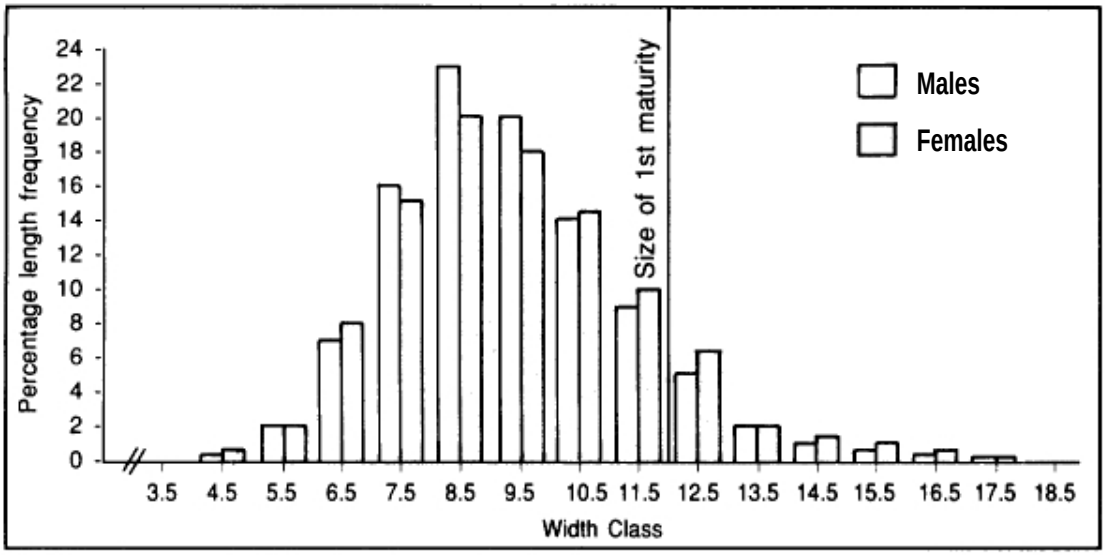
Source: Sri Lanka Customs

* 1 US $ = SL Rs. 35 Appx. (1985-1990)

<<

The quality of exported crab has also decreased since 1985, probably due to a lack of resource management in lagoons. For instance, over 80 per cent of the total catch from Negombo Lagoon consists of immature crab (Figure 3). A declining trend is also evident in the annual mean catch/unit effort (CPUE), calculated in terms of the number of crab caught/trap/hour. The CPUE estimate was 0.0022, *0.0015*, and 0.0014 in 1985, 1986 and 1987 respectively. The CPUE was highest in May 1986 and lowest in March 1987.

Fig 3. Annual width frequency distribution of male and female S. *serrata* from Negombo Lagoon



Length and weight relationship

The maximum size and weights of crab caught from different lagoons are given below:

Lagoon	*Maximum size (CW) (cm)*	*Maximum weight (kg)*
Negombo	19.0	1.0 - 1.5
Chilaw	19.0	1.0 - 1.5
Puttalam	22.0	1.5 - 2.0
Nayaru	26.0	1.5 - 2.2
Kokilai	28.0	2.0 - 3.0
Mannar	28.0	2.0 - 3.0
Jaffna	28.0	2.0 - 3.0
Trincomalee	28.0	2.0 3.0
Batticaloa	27.0	2.0 - 3.0
Valaichchenai	26.0	2.0 - 3.0

The maximum size of *Scylla serrata* ranged from 19.0 cm CW (Negombo and Chilaw Lagoons) to 28.0 cm CW (Mannar, Jaffna, Trincomalee and Kokila Lagoons). However, the average maximum size of the crab observed in the market is 22 cm CW.

Feeding habits

The feeding habits of *Scylla serrata* change with age. Juvenile crab, measuring about 2-7 cm CW, feed mainly on crustaceans, while subadults of about 7-13 cm CW feed chiefly on bivalves and gastropods. Larger crab consume smaller crab and fish.

<<

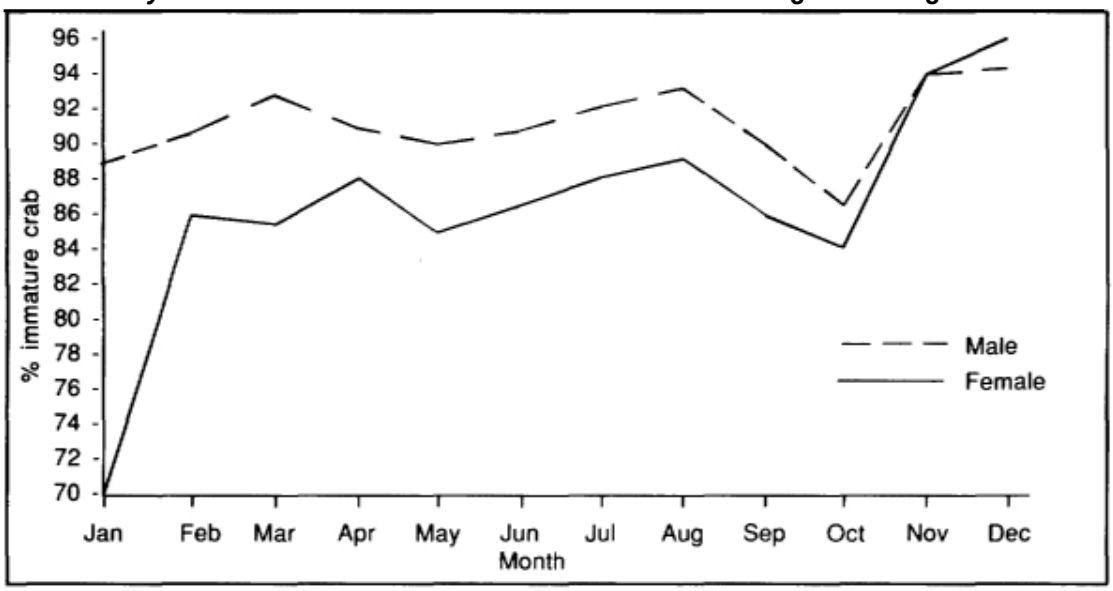
Growth and maturity

Scylla serrata in the Negombo Lagoon reaches its first maturity at 12 cm CW. Two recruitment periods occur in a year: The first is April-May, the second August-September. The pre-spawning fecundity of *Sevila serrata* is about 1.76-3.5 million, while the post spawning fecundity was around 1.28-1.84 million. Asymptotic length for both male and female *Scylla serrata* is nearly the same (22.3 cm male; 22.2 females) although the rate at which they reach that size are different. Males grow at a faster rate than females (growth co-efficient (k) = 0.72 males and 0.56 for females).

Relatively high values of mortality and exploitation rates were obtained for the crab population in the Negombo Lagoon. The present exploitation rate of 0.66 males and 0.60 for females is much higher than the optimum level of exploitation (0.50). The high value of the total mortality, which is 4.68 for males and 2.29 for females, is due to the high fishing mortality, which is 3.10 for males and 1.96 for females. The fishing intensity for crab is known to be very high in the Negombo Lagoon due to the export market demand. Year-round exploitation of immature crab by various gear is still continuing.

The percentage frequency of male and female mud crab of different sizes are shown in Figure 4. The proportion of immature crab exploited was more than 80 per cent for both males and females around the year. Highest exploitation of immature crab was in December and lowest in January and October. Exploitation of immature males is higher than that of females. This can be regarded as a veryharmful practice for mud crab in Sri Lanka.

Fig 4. Seasonal variation in the percentage distribution of immature *Scylla serrata* in the commercial catches in the Negombo Lagoon.



MARKETING

Local market

Crab are consumed locally in hotels, restaurants and households. They are purchased through intermediate vendors for hotels and restaurants. But households usually buy directly from fishermen. The crab sold locally are ones with low meat content or weighing less than 300 g/crab. There is very little availability of large, meaty crab in the local market due to high prices offered by exporters.

<<

Export market

Crab, rich in meat content and weighing more than 300 g, are considered export quality. Meaty crab are identified by pressing the branchial region with the fingers to determine the hardness. Worn claws and a hard carapace carrying barnacles are also good indicators of meaty crab.

Crab exported from Sri Lanka come from several lagoons in the northeast and west. The majority of the export quality crab come from the Nayaru. Nanthikadal, Kokilai and Jaffna Lagoons of the Northern Province and Valaichchenai and Batticaloa Lagoons of the Eastern Province. Crab are also collected from Mannar, Puttalam, Chilaw and Negomho Lagoons. In Negombo Lagoon, only 30-50 per cent of the crab catch is exportable; most crab caught here are of small size and low meat content. Mannar and Kalpitiya Lagoons are the main sources of supply for export quality crab from the west coast.

Recent exports (1991 -end) from the country comprise 45 per cent from the Mannar Lagoon, 38 per cent from the Jaffna Lagoon, 25 per cent from the Kalpitiya Lagoon and 2 per cent from the Trincomalee Lagoon. Catches from Kokilai and Batticaloa Lagoons are not considered suitable for the export market, as the animals are too weak.

Export quality crab are purchased and transported daily through the intermediate agents of various exporters. Cane baskets moistened with brackish water are used for packing and transport of crab.

Crab exports became a foreign exchange earner in 1985. The quantity of crab exported in 1985 was 973 t. The average foreign exchange earned per annum is around SL Rs. 30 million during the period 19X5-1990 (see Table 3). The average price of a kilogram of crab increased from Rs 34 in 1985 to Rs 97 in 1990 (see Table 4), but appears very low compared to the current prices for high grade crab both in local and foreign markets. A large proportion of crab dying during transport would bring the average price down. Crab must arrive live at the point of export; dead crab fetch very low prices.

Crab are now exported to many countries in Asia and Europe. Singapore receives more than 90 per cent of the export. Malaysia, Hong Kong, Japan, Taiwan, U.S.A, U.K, Pakistan, Syria, Saudia Arabia, South Korea, Switzerland, Australia and the Maldives take the balance (see Table 3).

Prices

The current prices offered to the fishermen by the exporters and the prices offered to the exporters by Singapore and Japan are given below.

Quality of the crab	*Purchase cost (SLRs/kg)*	*Selling* price *(SLRs/kg)*	
		Japan	*Singapore*
Large crab (weighing>600g)	I x0.00	300.00	250.00
Medium crab (300 g-600 ¦	125.00	184.00	
Hard. low meat crab	90.00		
Soft shell crab	50.00	103.00	

Average purchase cost = 2 10.00 SLRs/kg
Freight cost for 250 kg or more to Singapore = 39.40 SLRs/kg
Freight cost for 250 kg or more to Japan = 92.00 SLRs/kg.

<<

CONCLUSION

Mud crab resources are an asset to the country and can be developed to the status of a major foreign exchange earner if proper management measures are implemented. Legal prohibition of capturing of immature crab is essential to maintain the resource. This could be achieved by restricting the mesh size of nets (as in Australia) and by educating the fishing community on the gainful aspects of resource management of which they are the immediate beneficiaries. This warrants in-depth investigations on the mud crab resource in all parts of the country in order to achieve maximum utilization while sustaining the resource.

Techniques for mass breeding, culture and fattening are also important areas which should be developed and strengthened. Transportation techniques will have to be developed to get maximum earnings from the exports.

REFERENCES

ALVERSON, F.G *1971. International trade crab.* FAO/UNDP/IOPC/DEV/7 1/66. 20 pp

ARUDPRAGASAM, K. D. 1967. Distribution and variation in form of the cirripede Octolasmis cor in relation to the respiratory current of its host *Scylla set-rata. Ceylon J.Sci. 27 (I-2): 105-115.*

BOONE, LEE. 1934. Scientific results of the world cruise of the yacht Alva. 1931 William K Vanderbilt, Commanding. Bull *of the Vanderbilt Mar.* Mus. Vol 5. 210 pp.

JAYAMANNE, S. C. 1982. Unpublished report. Min. of Fish.

MAITIPE. P. and DE SILVA, S. S. 1986. The structure and function of krall. a fishing gear, in a Sri Lanka lagoon. *J. Fish.,* 33(1): 137-143.

RAPHAEL, Y.I. 1970. A preliminary report on the brackishwater pond culture of *Scylla serrata* (Forskal) in Ceylon. IPFC/C70/SYM21. 14th Session, Bangkok. Also *Coastal Aqua. in, rhe Indo-Pacific Region.* 1972. (ed.) T.V.R. Pillay, Fishing News Books, U.K.

<<

BIOLOGICAL STUDIES OF THE MUD CRAB *Scylla serrata* (Forskal) OF THE MANGROVE ECOSYSTEM IN THE ANDAMAN SEA

by Sombat Poovachiranon
of the Phuket Marine Biological Center, P.O. Box 60. Phuket 83000. THAILAND

ABSTRACT

Biological studies of *the crab* Scylla serrata *were conducted during 1986-1 989. The results are expressed in percentage of catch by size groups and show 53 per cent in size group 9-1 I cm. 22 per cent in size group 11· 13 cm. 23 per cent in size group of less than 9 cm and 2 per cent in size groups larger than 13 cm. The proportion of males tofemales varies in each season. More male crab were caught in October-January and more females in February-April. Female crab attain sexual maturity when their maturity index (FMI) value is at least 0.88, or their carapace width is about 11 cm. Reproduction occurs continuously throughout rhe year in* S. serrata *population However Gonad Somatic Index (GSI) values* show *peaks from October-December. Consequently, it is predicted that the migration of* mature female crab *to* spawn *occurs mostly during October-February. Possible* conservation *measures might include a ban on fishing during the spawning season and restrictions on capture of immature crab.*

INTRODUCTION

Mud crab are an economic species of the mangrove ecosystem. information on the biology of mud crab in Thailand is meagre, except for reports on crab fattening and the mud crab fishery in the Bangla mangrove area of Phuket (Poovachiranon 1987). Total catches and monthly production of mud crab were investigated in 1986. The female maturity index (FMI) was determined to classify the developing gonad stages.

This study includes biological data on mud crab generated during 19861989 in Phang Nga Bay, Andaman Sea. The monthly production by size frequency is shown. The FM1 was measured and compared with the developing stages of female gonads. The Gonad Somatic Index (GSI) of mature female crab was studied to determine the peak spawning season. Carapace width (CW) to weight **(W)** relationships for male and female crab were also estimated.

MATERIAL AND METHODS

Study area

Crab samples were collected in the Bangla mangrove forest in Phuket Province. They were also provided by a middleman in the mud crab business. Monthly crab samples were received from Phang Nga Bay, covering Phuket, Phang Nga and Krabi Provinces. Sampling size was 100-200 crab of both sexes.

Female Maturity Index (FMI)

Crab were separated into males and females based on the shape of the abdomen (wider and globular in the female and narrow in the male). In younger females, the abdomens were invariably triangular. Female Maturity Index (FMI) is calculated as follows:

$$\text{FMI} = \frac{\text{width of the widest part of the 5th abdominal segment}}{\text{the width of the widest part of the thoracic sternum between the base of the 5th pair of legs}}$$

<<

Gonad maturation

Crab carapaces were dissected and examined. Ovaries of Scylla serrata are H-shaped organs lying in pairs below the carapace (Shanmugam and Bensam 1950). The developing gonads are divided into three major stages. ***Scylla*** ovaries begin to enlarge and change colour when crab attain sexual maturity (Quin and Kojis 1987). Immature ovaries are translucent. When they become sexually mature, the ovaries initially become white, then tan. The immature oocytes of these ovaries have a reticulate cytoplasm with little yolk. As oocytes enlarge and mature, yolk globules form in the cytoplasm and the ovaries become yellow, orange or red and orange, the latter being the most common colour.

In the present study, based on the area covering the body-cavity and coloration, four major stages of maturity could be distinguished for female crab:

Maturity Stage	***Definition***
Stage 1	Gonad immature; thin and transparent. Abdomen somewhat triangular in shape and not quite globular in younger females.
Stage 11	Represents developing gonad condition. Creamy white or yellowish gonads occupying about a fourth of the area of both digestive glands.
Stage III	Maturing condition. Ovarian lobes enlarged, occupying about half to three-fourths of the digestive gland area. Gonad yellow-orange.
Stage IV	Prominent seminal receptacles. Gonads orange or orange-red.

Gonad maturity condition related to FM1

About twenty female crab were obtained during the monthly sampling (1987-1989). A total of 605 crab were examined and carapace widths and flesh weight were measured to estimate the Female Maturity Index (FMI). Different ranges of FMI were grouped while the gonad maturity condition of the individual crab was identified and grouped accordingly into Stage 1 to Stage IV.

Carapace width to weight relationship

Mud crab from the capture fishery were measured for weight and carapace width twice a month. The CW was measured to the nearest 0.01 cm using vernier calipers. The number in each size group was counted monthly from 1986 to 1989, making a total of 6070 crab. Carapace width and weight relationships were calculated separately for 3402 males and 2668 females.

The monthly size-frequency distributions of ***Scylla serrata*** caught by crab traps in mangrove forests were also computed for both sexes. A one centimetre interval was used.

Gonadosomatic index (GSI)

The mean index was calculated for sexually mature crab over 12 months, from March 1987 to March 1988. Twenty female crab, which represented different gonad stages from II to IV, were randomly sampled. The crab were examined by placing them in a freezer for 3-5 hours, weighing

<<

to the nearest gram, then dissecting the carapace and removing gonads into tared plastic containers and weighing to the nearest 0.01 g. A total of 437 crab were examined. The GSI was calculated as follows:

$$GSI = \frac{\text{drained ovary weight x } 100(\%)}{\text{total live weight}}$$

The Gonad Somatic Index values were grouped according to carapace width.

RESULTS

Gonad maturity condition related to FMI

Table I shows the grouping of the FMI relating to stages of gonad development. FMI values ranging from 0.650 to 0.850 represent the first stage of gonadal development. The ovaries of ALL female crab that were not sexually mature were translucent. When the FMI ranged from 0.850 to 0.875, all stage of gonadal development were present. The gonad developing stages constituted 54.2 per cent, 20.8 per cent, 8.4 per cent and 16.6 per cent for the first to the fourth stages, respectively. This range of FMI values shows that about half the female crab become sexually mature.

Table 1: Female maturity index (FMI) reflecting the different stages of gonadal development

Range of FMI	Number of samples	Percentage of gonad developing				Total
		(immature)	(mature)			
		Stage I	II	III	IV	
0.650-0.750	**50**	**100**	**0**	**0**	**0**	**100**
0.751-0.850	**64**	**100**	**0**	**0**	**0**	**100**
0.851-0.879	48	52.2	20.8	8.4	16.6	**100**
0.880-0.950	269	**0**	29.0	35.3	35.7	**100**
0.951-1.000	154	**0**	31.1	37.0	31.9	**100**
>1.00	20	**0**	41.7	41.7	16.6	**100**

All crab are sexually mature when either the abdomen is enlarged or the FMI values reach 0.88-1.00, respresenting Stages 11, III, and IV. Some female crab had enlarged abdomens entirely covering the width of the thoracic sternum, with FMI value slightly more than 1.00. Most of them were quite large crab. The percentage of Stage II, Stage 111, and Stage IV was 41.7, 41.7 and 16.6 per cent, respectively.

Results from Table I indicate that female crab are not sexually mature when FMI values are less than 0.85. They include various stages of gonadal development, depending on the duration of ocyte development after mating. Thus, an FMI equal to 0.88 is a critical point to assess sexual maturity.

Poovachiranon (1987) demonstrated a significant relationship between FMI and carapace width ($r=0.8277$, $P<0.001$). From this equation, the size of mature *S. serrata* females can be estimated in the Andamans population. When females reach 10.8 cm, or about 11 cm CW, they become mature. The smallest sexually mature female crab was 8.94 cm CW. Large crab generally had a high GSI.

<<

The main reasons for the low production are seasonal factors and poor accessibility to the area by road, as well as low sustainability of the standing stock. The topography of the southern estuaries differs from that of the tropical region in that it consists of vast mangrove forests interlaced with numerous small creeks and canals. In contrast, the mangrove forests of the northern coast are less extensive. The importance of the creeks and channels as habitat for subadult crab is illustrated by the fact that 61 per cent of the catch from these areas consisted of subadult male crab (Hill et al 1982). The low sustainability of the stock was illustrated by an eight-day tagging programme carried out in a bay on the northeast Queensland coast with a narrow fringing mangrove forest. During the short study period, the proportion of the catch of unmarked crab fell rapidly and by the end of the experiment SO per cent of the tagged crab were recaptured.

The landing data of the mud crab show a strong seasonal trend. In the southern part of the state, catches are highest from January to the end of May. The catch rate drops in winter. except for a small peak of one or two weeks at the end of August. The reason for this short burst of feeding activity is not clear. There is a progessive reduction in the length of the peak landing period from south to north, along the Queensland coast. Heasman (1980) showed that 90 per cent of the landings occur over ten months in the south but over only eight months in the north.

Despite fishermen's claims to the contrary, the annual commercial landing figures do not indicate a decline in the catch rate over the past ten years. The actual catch is very difficult to ascertain, because obtaining accurate data on the quantity of crab landed by amateur fishermen is almost impossible.

THE MARKET

The total recorded annual commercial catch is 13,000 crab with a market value of A $ 400,000* in 1979. A large percentage of crab caught in Queensland are sent live to the major cities in Australia where they command high prices, up to 30 A$/kg. The price of mud crab varies seasonally, depending on fluctuating landings and seasonal demand. Mud crab command their best price during the Christmas/New Year and Chinese New Year seasons. High demand and seasonality of supply of mud crab in Australia have led to imports of frozen mud crab from the South Pacific countries, such as Samoa. The import of live mud crab into Australia is prohihited by law.

Although the market preference is for live crab, it is possible to freeze crab in an uncooked condition or after being cooked. The demand for frozen mud crab exists only during the periods when live mud crab are not available.

The principal problem encountered with frozen crab is the mushiness in the body meat. Claw meat is less affected. Mushiness is caused by a strong proteolytic digestive enzyme released into the body cavity. To prevent the meat of the uncooked frozen mud crab from sticking to the shell, the crab must be blanched in boiling salt water for three minutes or steamed for four minutes before freezing. Storage temperature is a critical factor in producing a good quality product.

The texture of frozen crab is affected by long-term storage above -20ºC, while loss of texture was insignificant after three months at -30°C. In order to prevent dehydration, crab should he vacuum-packed in Cryovac Barrier Bags. Details of the freezing method of mud crab are discussed by Hill (1984).

THE MUD CRAB FISHERMEN

Mud crab are caught by three groups of fishermen: full time professional crabbers. professional fishermen who carry out other types of fishing and who catch crabs as a supplementary activity. and amateur fishermen. The number of fishermen engaged in the mud crab fishery fluctuates from year to year, but on the average there are about 100 professional crabbers and 120 secondary

*** US $ I = A $ 0.75 appx. (1992)**

<<

amateurs are recreational fishermen who fish on the weekends and holidays. There are over 70.000 registered private boats in Queensland.

Method of capture

Mud crab are trapped with baited pots or dillies. Crab pots are either rectangular or round. Rectangular pots are generally around 100 x 60 x 40 cm deep with elongated openings at both ends. Round pots are usually of 80 cm diameter and 40 cm deep, with two opposite oval openings. In the past, 'beehive'- shaped cane pots with one top opening were used, but the scarcity of materials and high labour cost have made wire pots more practical. Stackable plastic pots were marketed from time to time. but professional fishermen still prefer the conventional wire pots.

The dilly is a shallow bag of mesh netting on a wire hoop attached by bridle to a pulling cord. In a high crab density area, the hoop is about SO cm diameter, whereas in low density areas the hoop is around 80 cm diameter and the bag is made from gillnet materials. For obvious reasons, the latter is referred to as a 'suicide dilly'. Many crab are also caught by gillnet fishermen. Amateurs and a few casual fishermen capture crab by hooking them out of their burrows. The hook is a steel rod about 3-4 m long. This fishing method requires a great deal of experience, as beginners usually only damage the crab. The use of carbide, to force crab from their burrows, and other destructive fishing methods are prohibited by law.

To entice the crab into the pots and dillies, bait is placed inside the traps. The baits used by Queensland fishermen consist of fish or fish frames and bones from abattoirs. Their choice is dictated by availability. Fishermen believe that fresh bait is superior to old bait, therefore bait must be renewed every day. Given time, most crab are able to leave the pots after entry. Fishermen believe bones help to retain the crab longer inside the pots.

The spacing between pots can influence the catch. Williams and Hill (1982) reported that pots laid 50 m apart fished competitively, but that there were no differences between those placed 100 and 200 m apart. Depending on the fishing ground, professional fishermen disperse their pots over a wide area and frequently change their location. The distance travelled each day by fishermen from Southern Queensland is 19 km as compred to 88 km for those from Central Queensland (Hill, 1984). A typical crabber carries out his fishing operation in a 5 m aluminium runabout powered with a IO-40 hp outboard motor.

Other factors affecting the catch of mud crab include the size and sex of the crab, the moult stage and the water temperature. The typical crab pot is highly selective, and large crab are more likely to enter the pots than smaller ones.

The catchability of male and female crab varies, as reported by Heasman (1980) and Hill (1984). Moulted female crab less than 150 mm never enter the pots, while newly moulted males as small as 120 mm do. Both movement and feeding activity of mud crab are influenced by temperature (Hill 1980). Catchability was lower at temperatures below 20°C due to reduced feeding.

The economy

Catching mud crab is a low capital enterprise yielding a highpriced product and the fishery should have high returns. However, a survey conducted at the end of 1981 by the Institute of Applied Social Research of Griffith University found that the overall picture is of a very low-income industry. The continuing increasing cost of fishing has resulted in a marked decrease in income in recent years. But a small number of experienced fishermen did make a reasonable return. In 1977/78, for example, the lowest gross income was A$ 2,490, whereas the highest was A$ 21,810.

<<

HABITATS AND MOVEMENT

Hyland et al (1984) found that there are two categories of movement, a free ranging movement and an offshore migration by females. Crab in narrow creeks display limited movement. Tagging experiments reveal that in areas with large intertidal flats bare of mangroves, crab showed more movement and adults (carapace width (CW) of 150 mm and over) and subadults (100 to 149 mm CW) moved similar distances, of about 4 km. In an area with direct access to the sea, male and female crab moved almost twice the distance covered by the male crab. The distance travelled was not greatly affected by the time of release over a period of l-36 weeks. Although there are exchanges between populations in mangrove creeks and adjacent bays, there are very limited exchanges between populations of adjacent estuaries separated by regions of habitat unsuitable for mud crab.

Large numbers of female mud crab have been observed from as far as 45 km offshore in Queensland waters, but none of these observations have been verified. Large numbers of exclusively female mud crab were also found in the stomach of female Tiger shark (Galeocerdo cuvieri) caught in offshore waters. None of the over 3000 female mud crab captured in the mangrove area for tagging experiments were carrying eggs, but two tagged ovigerous females were caught at sea after having moved from the study area. The ten mud crab which moved outside the study area were females. Their movement ranged from 20 to 65 km (Hyland et al 1984).

Little is known of the natural spawning and larval recruitment of mud crab in Australia. Plankton samples taken from Moreton Bay in South Queensland during the incoming tide indicated that mud crab larvae were found from November to June, but always in small number. Lee (1975 unpublished) postulated that the distribution of mud crab and the New South Wales spiny lobster, (Jasus verreauzi). on the east coast of Australia and the east coast of New Zealand are influenced by the southerly East Australian Current. The oceanic planktonic larval existence suggests that the prevailing climatic influences are a major determining factor for the mud crab fisheries along the east coast of Australia.

Food and feeding

Mud crab are nocturnal feeders, remaining buried during the day and emerging at sunset. Hill (1976) concluded that mud crab are not well adapted to capturing mobile prey. Their natural food consists of 50 per cent of molluscs and 21 per cent crustacean, mainly grapsid crab.

Fish remains were rarely found in the foregut of mud crab. Gut clearance of organic tissues was almost completed after 12 hours. Fish bones and shells are retained in the gut for 3 and 6 days, respectively.

Enemies

In captive situations mud crab feed on other crab, especially newly moulted ones. Cannibalism exists from the megalopa stage onwards and constitutes serious problems for crab culture. Other natural predators are fish, such as the estuarine grouper (Ephinepphelus tauvina), ray, shark and sawfish. Turtle and saltwater crocodile also prey on crab.

In its natural surroundings, the mud crab does not appear to suffer from many serious diseases. The incidence of parasitic castration, caused by the rhizocephalid Loxothylacus sp., was observed in crab caught from northern Queensland (Cannon, 1974 and Hill 1984), but no parasitic infection was reported from south Queensland. The rhizocephalid parasite Saculina sp. is common in another portunid crab, Portunus pelagicus, in Australia.

GROWTH AND REPRODUCTION

Mud crab are highly fecund, producing 1-7 million eggs per spawning. The larval development

<<

and growth of mud crab under laboratory conditions is discussed elsewhere in this publication (Gillespie and Mann 1991). The incubation period is 12 days at 27°C and 32 ppt salinity. Larvae metamorphose into megalopa in 30 days, entering the first crab stage at 37 days of age.

The crab stage undergoes 15-17 post-larval moults. Heasman (1980) divided the crab stage into four phases: the larvae, the juveniles from 20 to 80 mm; the subadult from 70 to 150 mm and adult crab with CW 150 mm and more. Feeding activity and growth ceases in winter, when temperatures drop below 20°C. In southern Queensland, mud crab reach 120 mm at the end of the first year, 150 mm at the end of their second year (Heasman 1980; Hill 1984). The physical appearance of 150 mm male mud crab differs from the subadult males in that the ratio of the claw to total weight is significantly larger than the subadult. The claw of an adult male crab can make up around 45 per cent of the total bodyweight.

POPULATION ESTIMATE

The major problem associated with population studies of mud crab is the selectivity of the traps. Most pots have a tendency to catch larger crab. The presence of a large crab may deter other crab from entering the pots. The pots do not attract newly moulted crab equally. The crab density relates well to CPUE in a low population density area, but in a densely populated area, pot saturation makes comparison invalid.

Tagging experiments were carried out in four different sites along the east coast of Queensland during 1976-1981. The population density estimates were restricted to crab with CW more than 150 mm, since the smaller crab were not sampled effectively by the pots. As expected, the population density varied from estuary to estuary, ranging from 2 to I I crab/ha.

North Queensland crabbers popularly believe in the existence of two different 'types' of mud crab but, to date, there has been no concerted effort to study the taxonomy of mud crab in Queensland. A taxonomic study using electrophoresis and conducted at Darwin University found the existence of two races of mud crab in the Northern Territory.

Resource management

Under present legislation, male mud crab under 150 mm CW are protected. Hill (1984) suggested that the regulation yielded 44 per cent greater production than if a smaller size limit had been imposed. Because fishermen can, and do, remove the carapace, alternative measurements must be used to determine the size of the crabs. Williams and Lee (1982) showed the relationship between CW and a measurement between two points on the ventral side of the crab. Male claws are distinguishable from female claws by the absence of the fine row of hairs on the merus. Other simple physical methods for determining the sex of mud crab claws are used successfully in settling legal disputes.

The present legislation places a total ban on the capture and possession of female crab in order to conserve the brood stock. Heasman (1980) questioned the merit of placing a total ban on the female mud crab. He argued that mud crab are highly fecund and, therefore, large numbers of females are not required. Secondly, most mud crab do not live beyond the third year. Thirdly, adult crab compete with juveniles for food and shelter. However, the majority of professional crabbers fear that the lifting of the ban on catching female crab may have an adverse impact on the fishery.

Professional fishermen in Queensland are permitted to operate 50 pots, or dillies, whereas amateurs over the age of 15 are allowed only a maximum of four traps. The purpose of the age stipulation is to prevent a family claiming the right to use four pots or dillies for every child. The regulation also requires that the pots or dillies be clearly marked with identifying floats.

It is also illegal for anyone to damage mud crab burrows. Additional conservation measures for mud crab are provided by protection of mangrove forests and the creation of numerous national parks and fisheries reserves within which crabbing is totally prohibited.

AQUACULTURE

Heasman (1980) showed that 'empty' mud crab can be fattened to 'full' crab in a relatively short time, usually about 4-6 weeks. The writer found that, in the warmer months, 'empty' crab, which were given fresh fish daily at five per cent of their bodyweight, became almost 'full' in less than one month. While crab fattening is permitted under the fisheries regulation, crab growout operation cannot be legally carried out because it involves the capture and possession of undersized crab.

Several attempts at commercial culture of mud crab have been made in Queensland, but, to date, low survival has been the major constraint to commercial operation. A paper on mud crab culture in Australia is presented by Gillespie and Mann (1991) elsewhere in this publication.

REFERENCES

GILLESPIE. N.C. and BURKE, J.B. 1991. Mud crab storage *and* transport in ***Australian*** commerce. **A paper presented at Regional Sem. on Mud Crab Cult. and Trade in the Bay of Bengal Region. November S-8. 1991 at Surat** Thani. **Thailand.**

GILLESPIE, N.C. and BURKE, J.B. 1991. Culture ***of the mud*** **crab Scylla serrata** in *Australia* **A paper presented at Regional Sem. on Mud Crab Cult. and Trade in the Bay of Bengal Region. S-8 November, 1991 at Surat** Thani, **Thailand.**

HEASMAN, M.P. 1980. Aspect **of *the* general biology** *and fishery* *Of the mudcrab* **Scylla** serrata *(Forskal)* ***in*** *Moreton* ***Bay. Queensland. 506*** **p.**

HEASMAN, M.P. and FIELDER. D.R. 1977. The management and exploitation of the Queensland mudcrab **fishery.** *Aust. **Fish. (8) 36.***

HEASMAN. M.P. and FIELDER, D.R. 1983. Laboratory spawning and mass larval rearing in mangrove crab Scylla **serrata (Forskal), from first** zoea **to first crab stage.** *Aqua. **34,*** **303-16.**

HEASMAN, M.P., FIELDER, D.R. and SHEPHERD, R.K. 1985. Mating and spawning in the mud crab, Scylla **serrata (Forskal) (Decapoda: Portunidae). in** Moreton **Bay, Queensland.** ***Ansi. J.Mar. Fshw,. Res.*.** **1985. 35, 773-83.**

HILL. B.J. 1976. Natural food, foregut clearance rate and activity of the crab Scylla serrata Mar. Biol. **34, 109-116.**

———————— 1980. Effect of temperature on feeding activity in the crab *Scylla serrata.* ***Mar. Biol. 32.*** **119-126.**

———————— (ed). **1984.** ***The Queensland mud crab fishery.*** **Fish. Res. Br.. Qld. Dept. of P.** I., **Brisbane, Aust.**

————————, WILLIAMS, M.J. and DUTTON. P. 1982. Distribution of juvenile, subadult **and adult Scylla** *serrata* **(Crustacea: Portunidae) on the tidal flat of Australia.** ***Mar. Biol. 69,*** 1 **17-1 20.**

HYLAND. S.J., HILL. B.J. and LEE. C.P. 1984. Movement within and between different habitats by portunid crab Scylla serrata. ***Mar. Biol. 80,*** **57-61.**

LEE, C.P., 1975. ***Possible influence Of the east Australian current on the distribution Of marine organisms on the east coast of Australia ond*** New ***Zealand.*** (unpublished).

WILLIAMS, M.J. and HILL. B.J. 1982. Factors influencing pot catches and population estimates of portunid crab Scylla *serrata (Forskal)* ***Mar. Biol.*** **71,** 1 **X7-92.**

LEE, C.P. 1982. Method for determining size and sex of marketed mud crabs ***(Scylla*** *serrata)* **and sand crabs** *(Portunus pelagicus)* **in Queensland.** ***Q/d. Fish. Serv. Tech. Rep.*** **1, 1-7.**

<<

AN OVERVIEW OF THE MUD CRAB FISHING GEAR IN THE PHILIPPINES

by Daisy F Ladra and Jericardo S. Mondragon
of the Bureau of Fisheries and Aquatic Resources, 860 Arcadia Bldg. Quezon A venue. Quezon City, PHILIPPINES.

ABSTRACT

Only 1 per cent of the total municipal fisheries production in 1991 consisted of mud crab. However, it is an important income source for many artisanal fishermen. These fishermen use gillnets. liftnets, special crab liftnets, fish corrals, baby trawl, beach seine, pots, pushnets, castnets, fykenets and spears to catch mud crab. A few, fishermen resort to using their bare hands. Crab liftnets are the most popular gear. taking about 77 per cent of the total catch of 1842 t. The major source of mud crab is the Babayun Channel.

INTRODUCTION

The Philippines is endowed with numerous bays and coves which are well exploited by many Filipino sustenance fishermen. The supply of mud crab in the Philippines comes from only two sectors, the municipal fishery and aquaculture. Municipal fisheries involve artisanal fishing using small watercraft or fishing boats (called pumpboats in the Philippines) of three gross tons or less. Usually mud crab fishing is confined to coastal areas, and inland bodies of water like **estuarine** areas, tidal flats, river mouths and mangroves. The aquaculture sector includes production from fish ponds and fattening projects.

In 1991, the municipal fishery production in the Philippines was 1,131,866 t, valued at Pl9,300,084*. The municipal mud crab production, on the other hand, accounted for only 0.10 per cent, or 1232 t, of the total production. Although the amount appears negligible compared to the total fishery production, many artisanal fishermen depend on mud crab for their livelihood. In Region **VI (see** Figure 1, Annexure I) alone, about 50,000 fishermen are involved in the mud crab fishery.

While there has been improvement in mud crab production, from 823 t in 1983 to 1232 t in 1991, the municipal sector has always lagged behind the aquaculture sector by an average of 517 t. While the supply is dependent on the efficiency of the fishing gear used, it is also indicative of the productivity of the fishing ground. And there are indications that the supply is fast diminishing. In fact, many fishermen observe that their catches have declined. In Capiz alone, according to traders and exporters, the supply does not even meet 20 per cent of their requirements. The number of licensed exporters has decreased from 65 in 1987 to 39 in 1991.

The declining catch could be due to the rapid destruction of mangrove areas for fish pond development. This has deprived mud crab juveniles of their natural habitat. Further, from the three fishery sectors, the municipal fishery sector was the worst hit by the increase in prices of petroleum products. Most of the fishermen were using premium gasoline and its price skyrocketed by almost 200 per cent. The income of artisanal fishermen is too low to sustain a fishery in the face of high fuel costs.

---

us $ I = P 27 (appx)

<<

Crab specimens, caught while tuna purse-seining during March-May 1989 in the Andaman Sea, were received from (V. Pokapunt, pers. communication) the Fisheries Department Research Vessel MV4. They included 15 S. serrata caught in offshore waters approximately 15-84 n miles away from the mainland and at a depth of 97-200 m on the shelf slope. This supports the hypothesis that mature female crab in the Andaman Sea migrate offshore to spawn.

The present heavy exploitation of immature crab may affect the sustainable yield. Some guidelines for the conservation of the mud crab resource should therefore be considered. In Thailand, berried crab are prohibited from being caught between October and December, but few berried females are found inshore at this time. In the near future, control of the catching of immature crab should be considered. Crab fishing should be prohibited during the major spawning season of mud crab in the Andaman Sea. Mangrove forests are very important habitats for *S. serrata.* This ecosystem, the living and feeding grounds of the crab, needs to be conserved and protected.

REFERENCES

BUNDUKUL, S. 1957. Experiment on rearing Scylla serrata. Thai. Fish. Gaz. 1:61-82.

CHANGSANG. H. 1984. Structure of a mangrove forest at Ko Yao Yai, Southern Thailand. IN: Proc Symp. *Mangrove Env. Res.* and Mamnt. Ed. E. Soepadmo, A.N. and D.N. and D.J. Macintosh. : 86-105.

HILL. B.J. 1974. Salinity and temperature tolerance of zoea of the portunid crab Scylla serrata. Mar. Biol. 25(1): 21-24.

—— 1975. Abundance breeding and growth of the crab Scylla serrata in two South African estuaries. Mar. Biol., *32:1 19-126.*

ONG KAH SIN. 1977. Observations on the post-larval life history of Scylla serrata (Forskal). reared in the laboratory. Mol. *Agri. J. 45(4): 429-443.*

POOVACHIRANON, S. 1987. Mud crab Scylla serrata (Forskal) fishery at Bangla mangrove area. Phuket and some biological studies. *Proc.* of *the* Sem. on *Fish.* 1987. Dept. of Fish., September 15-17, 1987, Nat. Inland Fish. Inst., Bangkhen: *234-242.*

QUINN. N.J. and KOJIS, B.L. 1987. Reproduction biology of Scylla spp. (Crustacea: Portunidae) in-the Labu estuary in Papua New Guinea. Bull. *of Mar. Sci., 42(2): 234-241.*

ROBERTSON, W.D. 1987 Biology *of the* mungrove crab. Scylla serrata. The 6th Nat. Oceanogr. Symp.. Univ. of Stellenbosch.. July 6-10, 1987. Publ. Oceanogr. Res. Inst., Marineparade. Durban, South Africa, Poster No.8.

SHANMUGAM, S. and BENSAM, P. 1980. On the fishery for the crab Scylla serrata (Forskal) at Tuticorin during 1974. 75. *Ind. J.Fish.* 27 (1 and 2): 102-I IO.

VISESHOM. S. and POREEYANOND, T. 1990. *Fisheries oceanography in the Andamon Sea.* in *the EEZ of Thailand. during* 1988 · 1989. Exploratory Fishing Div.. Dept. of Fish., Min. of Agri. and Coop. No.33, 23 P.

MUD CRAB PRODUCTION IN THAILAND

by S Tookwinas, N Srichantulk and C Kanchanavasite
of the Coastal Aquaculture Division, Director of Fisheries. Ku Campus Bankhen. Bangkok, THAILAND.

ABSTRACT

Thailand has a relatively long coastline which the Thai people use efficient/v to harvest fish and other marine organisms for domestic consumption and export. Of this harvest, mud crab production is a small portion. This paper describes briefly the socio-economic condition of the people involved in mud crab fishing, the gear they use and the ways mud crab are marketed.

INTRODUCTION

Thailand has a coastline of approximately 2,600 km along the Gulf of Thailand in the east and the Andaman Sea in the west. Marine fish is the major protein food of the Thai people. Surplus production is exported, earning a considerable income for the country. Thailand is one of the top ten countries in the world in fish production and leads in export of canned tuna and marine shrimp.

MUD CRAB RESOURCES

Marine fish production has increased since 1977. However, landings have fluctuated from year to year. In 1988, the marine fish production was 2,377,200 t valued at 19,823 million baht*. Of the total marine fish production, mud crab forms only a small portion. However, crab production has been gradually increasing since 1984 (Table 1).

Table 1: Quantity **and value of crab fisheries in Thailand**

Quantity : 1.000
Value : million baht

	1984		1985		1986		1987		/988		1989	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Swimming crab	22.4	425.6	22.2	452.8	30.4	685.1	34.7	744.7	37.1	922.8	35.5	884.1
Mud crab	4.3	185.1	4.5	221.7	4,6	217.0	5.0	242.8	4.5	230.4	5.0	249.3
Other crab	0.3	2.0	0.1	0.8	0.6	4.3	0.7	8.4	0.3	4.2	1.9	24.0
Total	27.0	612.7	26.8	675.3	35.6	906.4	40.4	995.9	41.9	1157.4	42.4	1,157.4

Source: Fisheries Statistics of Thailand, 1988

The primary species of crab is the swimming crab, *Portunus pelagicus* (Linnaeus). Mud crab, *Scylla serrata*, (Forskal), comes next. However, the mud crab is more valuable than the swimming and other marine crab. In 1989, the production of marine crab was 42,400 t, valued at 1,157.4 million baht. This production was from capture fisheries only. Mud crab fattening is practised in some parts of the country.

* US $ = 25 Baht appx

<<

MUD CRAB MARKETING

Crab products are exported in various processed forms. Frozen crab is the most exported product, followed by salted, dried and smoked meat in airtight containers (Table 2). The species of crab exported are not officially listed, but export companies say the most exported species is the swimming crab. The export of all crab products in 1991 was about 3,179 t. However, the highest export was in 1988, when 12,453 t at a value of 1,567,785 baht was exported.

Mud crab are exported either alive or frozen. The countries that import crab products from Thailand are also shown in Tables 3, 4 and 5.

Table 2: Export statistics of crab from Thailand

Quantity
Value : baht

	1985		1986		1987		1988	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Fresh and frozen	159	9,348	279	10,313	658	34,064	1,032	59,413
Salted and smoked	62	8,193	7	1,074	9	1.211	167	23,348
In airtight containers	6.378	700,194	8,173	867,473	11,590	1,434,226	11,254	1,485,024
Cooked by steaming or by boiling in water	-	-	-	-	-			
Prepared or preserved	-	-						
Total	6.599	717,735	8,459	878,860	12,257	1,469,501	12,453	1,567,785

	1989		1990		1991	
	Quantity	*Value*	*Quantity*	Value	Quantity	Value
Fresh and frozen	623	38,368	290	20.909	114	9,236
Salted and smoked	124	14,493	22	1,228	19	1,027
In airtight containers	8,600	1,123,612	-	-	-	-
Cooked by steaming or by boiling in water	-	-	114	15,388	66	9,047
Prepared or preserved	-	-	10,001	1,313,414	2,980	355,681
Total	9,347	1,176,473	10,427	1,350,939	3.179	374,991

Source: Customs Department

<<

Table 3: Export statistics of fresh and frozen crab from Thailand

Quantity: t: Value: bahi

	1985		1986		1987		1988	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
France	N	12	3	280	N	12	N	23
West Germany	N	15	N	35	N	12	14	904
Hong Kong	35	713	27	739	108	5.086	246	5.037
Italy	—	—	4	197	—		N	29
Japan	5	210	21	1.135	39	2.103	4	273
Malaysia	27	1.220	20	562	10	226	I	46
Singapore	5	182	3	34	4	254	4	251
Taiwan	26	874	52	5.123	475	24,781	754	42.315
USA	61	6.032	39	2.036	18	1,455	7	396
Others	—	90	—	72	4	135	I	139
Total	159	9.348	279	10.313	658	34.064	1,031	59.413

Table 4: Export statistics for crab products (salted, dried and smoked) from Thailand

Quantity: t; Value: baht

	1985		1986		1987		1988	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantities	Value
Australia	7	1,184	2	177	I	54	19	1,685
Belgium	48	5.300	—	—	—	—	0	I
Hongkong	—	—	0	18	0	20	10	1,396
Japan	7	1,692	3	705	4	876	103	17,366
Singapore	—	—	I	104	0	63	11	1,189
England	—	—	0	1	1	—	9	1,056
America	0	17	1	42	2	24	14	581
Others	0	0	N	2	I +	174	I +	74
Total	62	8,193	7	1,049	9	1.211	167	23.348

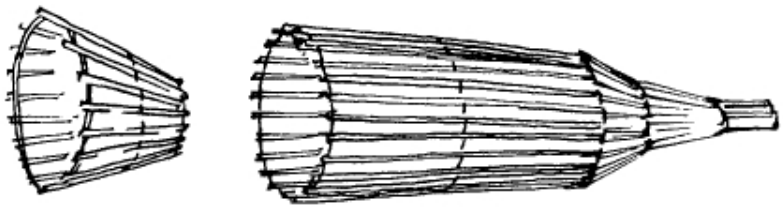
Table 5: Export statistics for crab products (in airtight containers) from Thailand

Quantity: t; Value: baht

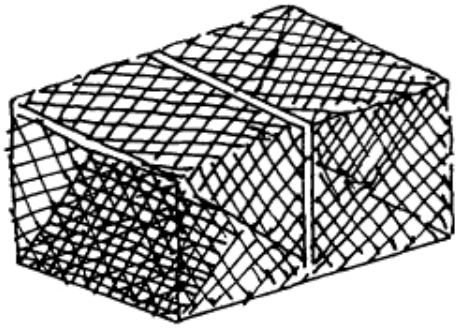
	1985		1986		1987		1988	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Australia	279	26,228	357	32,857	379	44,819	346	38,617
Belgium	302	38.986	380	34,645	474	48,175	504	60,389
Canada	328	45,930	465	57,339	483	75,298	314	49,776
Denmark	180	16,524	188	6,437	181	18,879	184	21,161
France	2,408	241,503	3,074	285,184	4,481	484,155	3,951	426,258
West Germany	49	4,497	36	3,499	30	3,365	18	2.332
Italy	I	115	154	19,691	506	80,556	359	58,380
Japan	49	5,760	21	3,632	839	136,985	1,202	215,679
Malaysia	610	32,011	734	61.640	611	69,314	566	77,037
Netherlands	173	20,692	365	40,786	610	73,873	481	62,554
Sweden	334	32.150	385	37,739	452	48,784	495	57,810
Singapore	10	909	17	1.931	13	1,389	25	2,889
Saudia Arabia	I	246	4	442	2	203	17	2,112
England	377	52,601	723	105,262	815	124,795	1,008	163,031
USA	1,245	178,730	1,170	157,993	1.492	197,526	1.460	200,894
Others	32	3,312	100	11,396	222	26.110	324	46,105
Total	6,378	700,194	8,173	867,473	11,590	1,434,226	11,254	1,485,024

<<

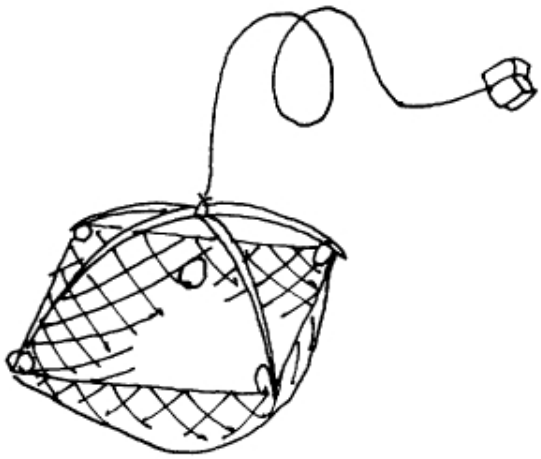
Fig **1. Gear used in the crab fishery**



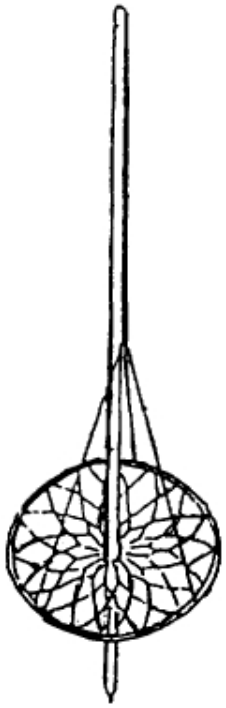
Cone-shaped bamboo trap set on line



Collapsible crab trap



Crab liftnet



Crab liftnet

<<

CRAFT AND GEAR USED IN THE MUD CRAB FISHERY

The mud crab fishery takes place mainly in mangrove and coastal areas. Crab traps. crab gillnets and set bagnets are used, out the crab trap is the main fishing gear. The crab gillnet is mainly used for swimming crab, while the set bagnet is chiefly used for shrimp and other fish.

The mud crab trap is a cone shaped bamboo device. Several of them are set one behind the other in a line. A collapsible crab trap, which can be very easily transported, has recently been developed by the Department of Fisheries (see Figure I facing page.) Fishermen can carry many more of these traps than other types when they go fishing. The efficiency is also higher than other gear. The catch per unit of effort (CPUE) is about 0.5 kg/day, while the crab liftnet is about 0.2 kg/day.

The craft used for the crab fishery is a small wooden boat, with or without a motor. Small wooden boats without motors are popularly used for crab fishing in the mangrove areas.

GENERAL SOCIO-ECONOMIC CONDITION OF MUD CRAB FISHERFOLK

Mud crab fisherfolk usually live in small fishing villages along the coast of the country. These fishermen have about 20-100 traps per family. They earn about 3,000 baht/month/family. Fishermen use other gear, such as gillnets or set bagnets, to earn additional income for their family.

Inter-moulted and post-moulted mud crab are also fattened by these fisherfolk. These crab are reared in enclosures and fed until they reach the pre-moulted or pre-spawning stage. Trash fish is fed them. Crab fattening is a profitable business because, with one crop, a farm would make a profit of about 9,200 baht (or 40 baht/kg), with a net profit of about 4,300 baht or 18 baht/kg.

<<

A BRIEF OVERVIEW OF THE ECOLOGY AND FISHERIES OF THE MUD CRAB, *Scylla serrata,* IN QUEENSLAND

by Christopher Lee
of the Queensland Department of Primary Industries, Brihie Island Aquaculture Research Centre, Brihie Island, Queensland, AUSTRALIA.

ABSTRACT

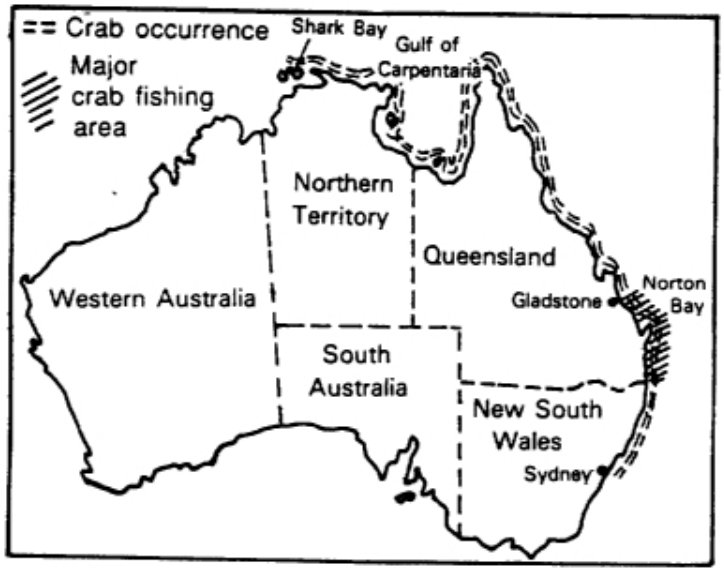
The annual commercial catch of mud crab in Australia is 600 t. These crab are caught by professional crabbers, fishermen taking crab as a supplementary catch and recreational fishermen. There are about 220 professional and secondary crabbers operating in Queensland. Baited pots are the predominant gear. Factors influencing the catch are distance between pots, size and sex, moult stage and water temperature. The increasing cost of operations has reduced income to fishermen. Mud crab move locally up to 4 km, while females migrate as much as 45 km offshore to spawn. Small quantities of larvae are found from November-June. The food of mud crab is predominately molluscs. They produce 1-7 million eggs whose incubation period is 12 days at 27°C and 32 ppt. Larvae metamorphose to the first crab stage in 37 days. Size regulation and ban on the capture of female crab, prohibition on disturbing burrows and protection of the mangrove habitat are measures taken to conserve the mud crab resource in Australia.

INTRODUCTION

The mud crab *Scylla serrata* is found in the northern part of the Australian continent, from around Shark Bay in Western Australia to slightly south of Sydney in New South Wales. The annual commercial catch of mud crab in Australia is about 600 t. The amateur fishery is an important part of the industry, since the majority of Australians live on the coast and fishing and boating are major weekend and holiday recreational activities.

This paper presents a broad but brief review of the mud crab ecology and fishery in Queensland. The discussions are based on the finding of investigations conducted by the Queensland Department of Primary Industries and the University of Queensland between 1972 and 1991.

Fig. 1: Map of Australia



THE RESOURCE

The mud crab occurs in the estuaries, rivers and on the leeward side of islands along the Queensland coast. At present, the major part of the catch comes from major bays and estuaries in the southern part of the state, between the New South Wales border and Gladstone (Figure 1). The major part of the Queensland coast does not support a significant crab fishery. The Gulf of Carpentaria, a region with large rivers and extensive creek systems, presently supports a low level crab fishery (Hill 1984).

<<

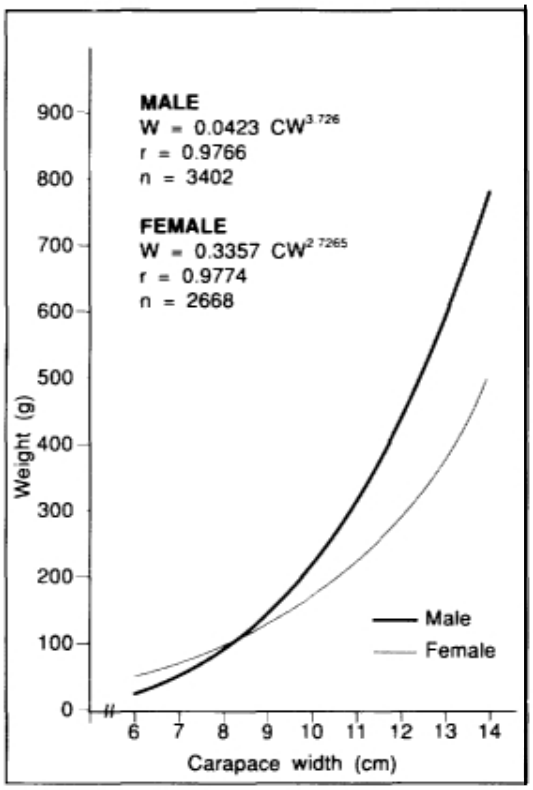
The carapace width-weight relationship

Carapace width (CW) to weight (W) relationship for males and females was estimated as follows (Figure 1):

Male log W = 3.7260
log CW = 1.3751 r = 0.9768

Female log W = 2.7285
log CW = 0.4740 r = 0.9774

Fig. 1. Carapace width and weight relationship for male and female S. *serrata*

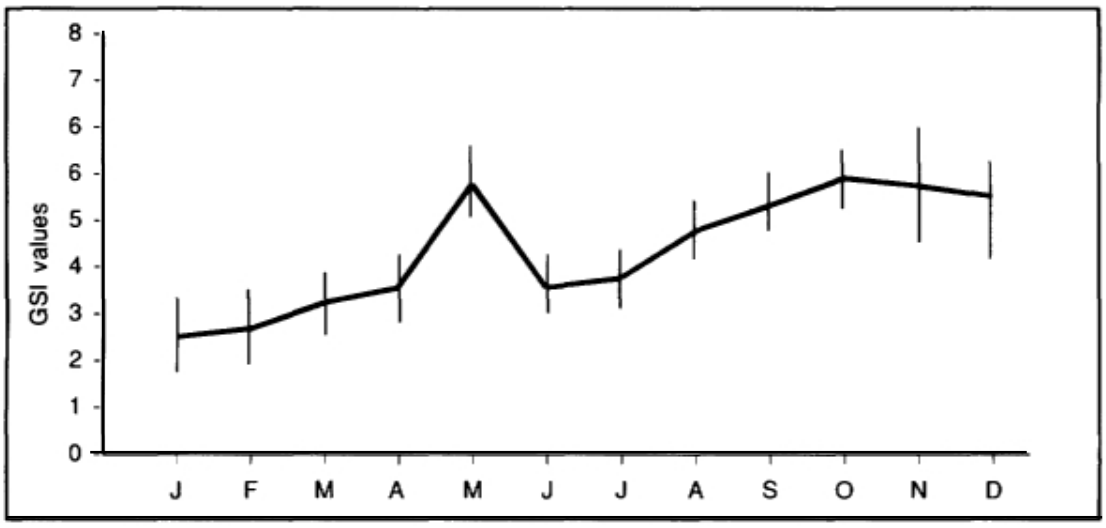


The rate of increase in the weight of male crab is usually more than that of female crab. Crab of size 9-11 cm constituted the largest group caught by traps. This group had a weight of 150-320 g for males and a weight of 135-235 g for females. Some of the crab examined had moulted not long before or were 'empty'. These could be fattened in ponds. Some premoult crab were also found.

Annual periodicity of female reproduction

The GSI values varied throughout the year as shown in Figure 2. A portion of the population was reproductive throughout the year, but with a seasonal pattern observed from two dominant peaks of GSI values that appeared in May and October-November. The mean values of GSI varied significantly by month (Table 2). The period of least reproductive activity was January, when the GSI was less than half the maximum values of May and October-December.

Fig 2. Monthly mean Gonad Somatic Index (GSI) for female S. *serrata*, 1988-1989



Note: Vertical lines show the standard deviation values.

<<

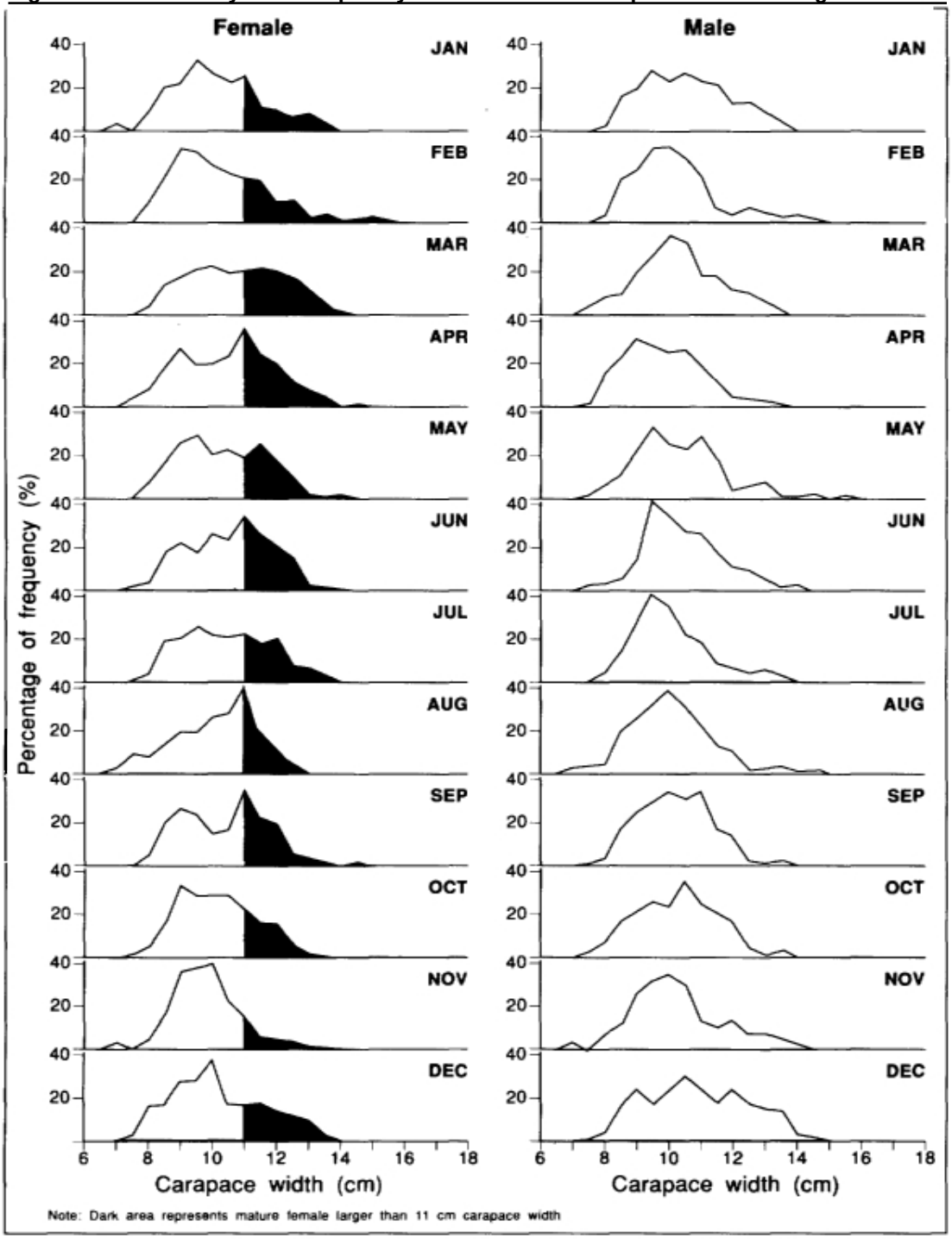
Table 2: One-way ANOVA of monthly GSI values

Source of variation	*SS*	*df*	*MS*	*F-ratio*	*Sig-Level*
Between groups (month)	675.9467	11	6 1.4497	3.721	0.0005
Within groups	7002.6591	424	16.5157		
Total (corrected)	7678.6058	435			

THE MONTHLY **SIZE** DISTRIBUTION OF S. *serrata*

The monthly size-frequency distribution of S.*serrata* caught by crab traps is illustrated in Figure 3. It shows that the distribution pattern of male and female crab exhibit some differences.

Fig. 3. Mean monthly size frequency distribution of carapace width during 1986-1989



<<

The dominant modal size in both sexes was in the 9-11 cm group. Shifting modal sizes may be due to growth. Most size frequency patterns were normally distributed, indicating that the population was not over-exploited. Therefore, recruitment of smaller crab is sufficient to replace those harvested from the stock.

It was clearly demonstrated that female crab belonging to the size group over 11 cm decreased from October - February. There was a highly significant difference (P>0.0005) between the percentage of mature females, comparing different periods (see Table 3).

Table 3: One-way ANOVA of mean percentages of mature female caught in traps during first period (October - February), second period (March - May) and third period (June - July, 1986-1989)

Source of variation	*SS*	*d.f*	*MS*	*F-ratio*	*Sig-Level*
Between groups (month)	2043.6755	2	1021.8377	9.420	0.0005
With in groups	4013.5376	37	108.4739		
Total (corrected)	6057.2090	39			

Table 4 shows the size group distribution of crab during 1986-1989. The production of males of 9-11 cm was a little over 56 per cent. Larger crab of 11-13 cm made up 18 per cent and those larger than 13 cm were less than 5 per cent. Twentythree per cent of the male crab represented a group of small crab less than 9 cm CW.

Table 4: Mean percentages of monthly catches of S. *serrata* divided into size groups, 1986-1989

Range of size class (CW in cm)		*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*	*Mean*
Male	7-9	18.42	23.84	21.45	35.14	22.71	15.75	23.93	26.11	21.37	23.24	23.20	21.79	23.08
	9-11	50.66	60.93	*55.81*	51.74	56.27	68.90	60.33	59.11	61.07	54.41	55.60	41.63	56.37
	11.13	28.62	11.92	20.93	11.97	19.66	14.57	14.43	11.33	16.03	19.41	18.00	30.74	18.13
	>13	2.30	3.32	1.81	1.16	1.36	0.79	1.31	3.45	1.53	2.94	3.20	5.84	2.42
Female	7.9	28.31	32.10	*15.85*	25.10	28.09	21.23	23.74	23.03	19.07	29.50	31.40	31.03	25.70
	9-II	50.60	48.15	44.06	45.10	42.98	50.00	49.42	57.58	45.76	53.24	60.47	48.28	49.64
	11-13	18.67	17.90	36.36	28.24	28.09	28.30	24.90	19.39	33.47	17.27	8.14	20.00	23.39
	>13	2.41	1.85	3.73	1.57	0.85	0.47	1.95	0.00	1.69	0.00	0.00	0.69	1.27

The size group 7-9 cm, that is, immature crab, was approximately 23-25 per cent for both the male and female catch. The crab trap is quite an efficient fishing gear to catch small crab in the mangroves. There was a range of *15.75-35.14* per cent for male crab and 15.85-32.10 per cent for female crab.

Approximately 50 per cent of female crab of 9-11 cm were caught using crab traps. Mature females of over 11 cm comprised about 25 per cent of the female catch. Table 4 also shows that small females (< 9 cm) too were exploited. The crab which were smaller than 11 cm CW made up to 70 per cent of the exploited population. The percentage of 9-11 cm animals fluctuated between 42-69 per cent, with the maximum catch of males being in June and females in November. The minimum catch was in December for males and May for females. Only a small amount of crab over 13 cm CW were caught in the mangrove area along the Andaman Sea. The catches of this size did not fluctuate for both males and females.

The percentage of male and female crab caught and their mean carapace widths are indicated in Table 5.

Table 5. Monthly mean carapace width and percentage of catch for male and female mud crab (S. *Serrata)* during 1986-1989

	Sex	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Mean CW (in cm)	Male	10.32	9.94	10.03	9.66	10.07	9.94	9.87	9.86	9.99	10.03	10.00	10.51
	Female	9.91	9.82	10.57	10.23	10.02	10.24	10.12	9.99	10.25	9.81	9.55	9.80
Percentage	Female	64.00	48.00	47.00	50.00	56.00	56.00	54.00	55.00	60.00	71.00	59.00	64.00
	Male	36.00	52.00	53.00	50.00	54.00	44.00	46.00	45.00	40.00	29.00	41.00	36.00

DISCUSSiON

Bundukul (1957) identified sexually mature crab by the abdomen size. He also found that the ovaries become red-orange in colour when the abdomen is fully enlarged or the crab reaches 10.69 cm and 200 g.

FMI values in this study can be used to predict the sexually mature stage of female crab from external measurement of their abdomens. The female crab population in the Andaman Sea matures at 11 cm CW, with a minimum size at 8.94 cm. Ong (1977) reported that male crab reared from the 16th or 17th instar and of approximately 10 cm CW appeared to mate with female crab when the latter reached approximately 10-11.4 cm. Robertson (1987) found that spermatophores were found in the genital tracts of male crab as small as 8 to 9 cm CW. Premoult females clasped by males prior to copulation measured between 10 to 13.9 cm CW. The geographical pattern suggests that S. *serrata* matures at a larger size in higher latitudes. Quinn and Kojis (1987) reported that the minimum carapace width at sexual maturity varied over a range of 5.3 cm in various countries (8.5 cm in the Philippines to 13.8 cm in Queensland, Australia). In the tropics, S. *serrata* becomes sexually mature at a smaller size compared with crab from subtropical areas, particularly those from Africa and Queensland, where they measure 13.8 cm and 13.7 cm, respectively.

A portion of the population is reproductive throughout the year (Figure 2). There are two dominant peaks of GSI values. During the later period of this peak, a portion of the mature females disappeared from the mangrove area (Table 4). This period is the late rainy season and the beginning of the dry season (Chansang 1984). Hill (1975) suggests that adult females are forced to migrate out of the estuaries to the sea to release their eggs due to the environmental requirements of first stage zoeae. Larvae hatching in these estuaries are probably not viable. The female crab, however, do not move more than 10 km offshore along the southeast coast of Africa. Table 4 also shows another high peak of GSI value in May, but the migration of female crab is unlikely at this time since the peak only lasts one month.

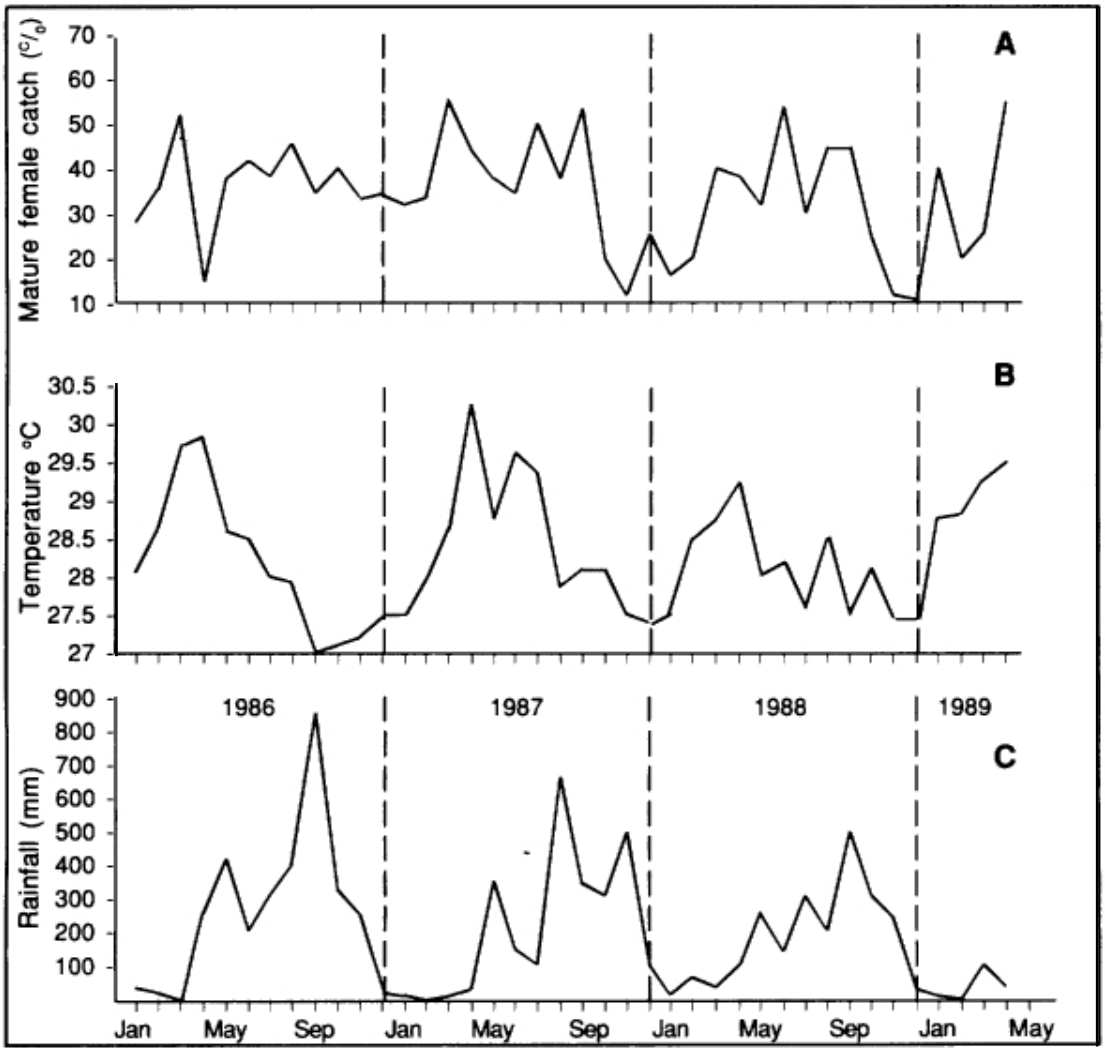
<<

Some majOr factors influencing the spawning migration

Figures 4A, 4B and 4C show that the incidence of mature females (>11 cm CW) decreased during the late rainy season and prior to the beginning of the dry season, when they were supposed to be migrating offshore. This would appear to indicate that the females move out of the estuaries when the mangrove area is influenced by fresh water. Temperature and salinity of sea water varied considerably during this period, particularly in Phang Nga (P. Limsaichol; pers. comn.). Viseshom and Poreeyanond (1990) reported oceanographical data such as air temperature, 27.6 - 30.8°C and salinity from 32 - 32.8 ppt during December-April. Both are within the range of the requirements of the zoeae of S. *serrata.* In tropical estuaries, the period of peak spawning generally coincides with high nutrient inputs associated with monsoonal or cyclonic rainfall. With the beginning of the dry season, phytoplankton develops in the offshore waters of the Andaman Sea (V.Jenakarn pers. comn.). However, nutrient availability and optimal salinity may be the most important factors for the larval stages of this crab.

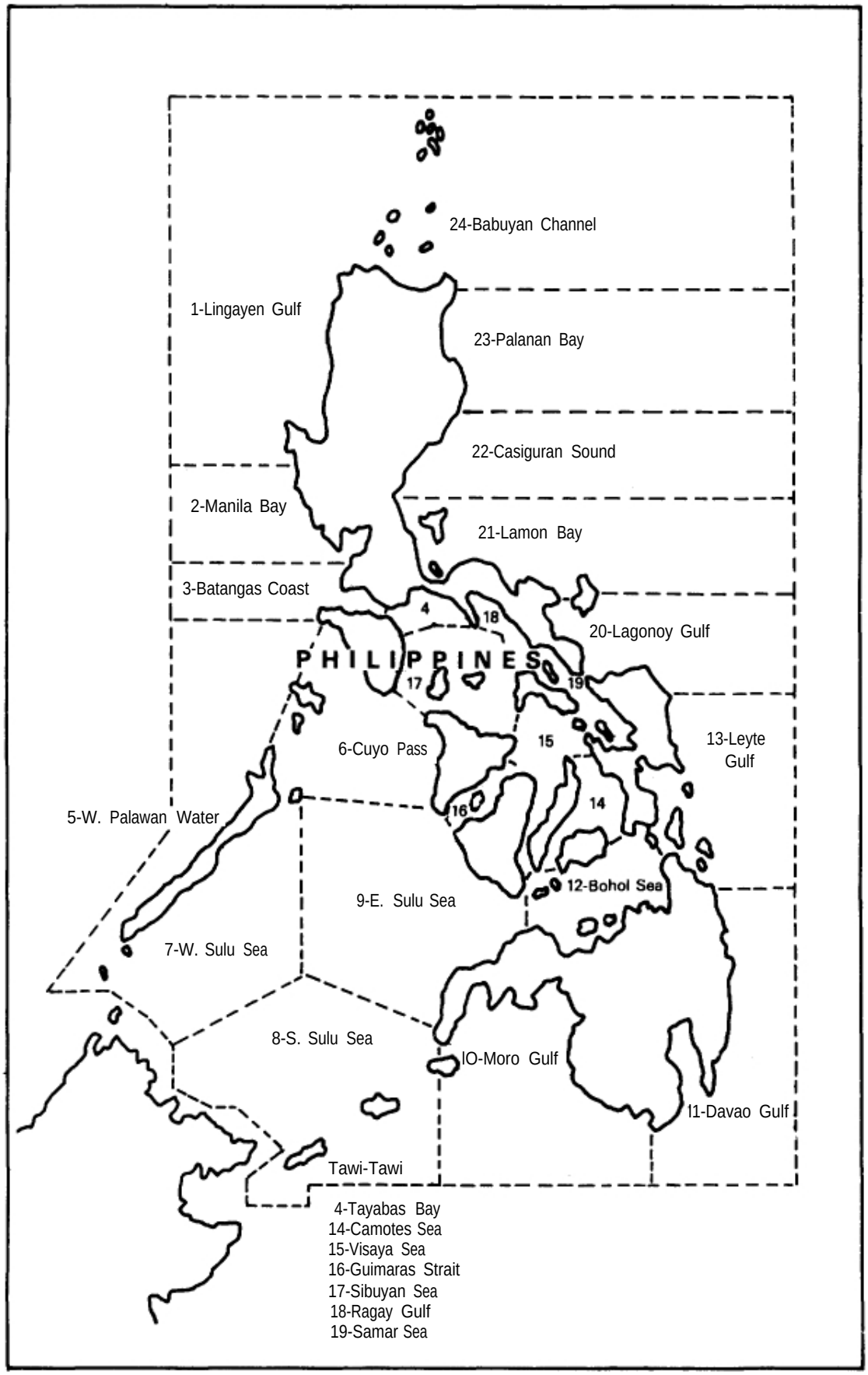
Hill (1974) indicated that the first stage zoeae of S. *serrata* are not tolerant of high temperature (above *25°C)* or low salinity (below 17.5 ppt). He suggested that zoeae of S. *serrara* from tropical areas may be more tolerant of high temperatures than those from the southeast African coast.

Fig 4. Percentage of mature female *Scylla serrata* (>11cm carapace width) caught in traps 1986-1989 compared with air temperature and monthly rainfall in the same period.



<<

Fig. 1 Locations of fishing grounds in the Philippines



<<

In terms ot regional contribution, there is a noticeable increase in municipal production in almost all mud crab producing areas, like Regions 11, III, IV, V, IX and XI (see Figure 1, Table I and Annexure I).

Table 1: Municipal crab production (1986 1990)

NCR	Year 1990	1989	1988	1987	1986
I	2	3	2	2	-
II	255	225	191	142	173
III	228	218	230	147	53
IV	36	36	37	28	39
V	191	259	190	130	28
VI	31	28	34	-	34
VII	-	-	-	-	-
VIII	-	-	-	9	2
IX A	89	8	83	43	117
B	-	68	-	I	52
X	-	-	-	-	-
XI	215	146	239	-	120
XII	9	8	7	-	18
Total	1056	999	1013	502	636

Eleven types of fishing gear are mainly used in the municipal waters, while fishpond grown mud crab are caught using only one type of fishing gear. Fishing gear in the Philippines vary considerably in the different regions, although there are basic design concepts. Modifications are made depending on available capital, and operation is based on the habits of mud crab in each locality. A classification of the fishing gear used in the Philippines is given in Table 2.

Table 2: Fishing **gear in the Philippines**

Vernacular name	*Dialect*	*Non-textile hand instruments (traps and harriers)*	*Nets*
Baklad	Tagalog	Fish corral	
Galadgad	- do-		Baby Trawl
Pante	- do -		Gillnet
Pukot'	- do -		Beach seine
Bavakos	- do -		- do -
Baling	Visayan		- do -
Salop	-do-		-do-
Baring	- **do** -		- do -
Bintol	Tagalog		Crab liftnet
Sellem	Ilokano		- do -
Bentoy	Visayan		- do -
Salyang	Pangasinan		- do -
Dala	Tagalog		Castnet
Lava	Visayan		- do -
Sihukol	Pangasinan		- do -
Tahukol	- **do** -		- do -
Sakag	Tagalog		Pushnet
Sudsod	Visayan		- **do** -
Buho	Tagalog	Fish trap	
Buho	Tagalog	Fish pot	
Sangab	Tagalog		Fykenets
Bukatot	Pampanga		- do -

<<

Fishing gear used in the niunicipal waters are the gilinet. fish liftnet crab liftnet fish corral, baby trawl, beach seine, fish pot. pushnet. castnet, fykenet and, surprisingly, the spear. Experienced gatherers also report catching mud crab with their hare hands.

Based on available records at the Bureau of Fishing and Aquatic Resources. 2.397 t of mud crab were harvested in 1985-1987 by these fishing gear. Crab liftnets proved to be the most widely used crab fishing gear: about 77 per cent, or 1.842 t of the total catch was obtained with it. Gilinets ranked second in ternis of usage and production at 198 t or about 8 per cent of the total mud crab catch. Fish corrals which contributed to catches in limited quantitites were beach seine (57 t or 2.4%). liftnets (30t or 1.3%), fykenets (12 t or 0.5%)), fish pots (26 t or 1.1%) and spears (5 t or 0.2%). Other fishing methods accounted for 5 t or 0.2 per cent. Crab caught by fishing gear with very low production can only he described as accidental catches.

In 1985. the biggest sources of mud crab were the Bahuyan Channel (392 t). the Bohol Sea (231 t). the Guimaras Strait (204 t). the Lagonoy Gulf (207 t) and the Leyte Gulf (231 t). In 1986. the highest catches were from the Bahuyan Channel (173 t). northeastern Mindanao (108 t), Manila Bay (54 t). South Sulu Sea (117 t) and the Moro Gulf (52 t). The other fishing grounds contributed 2-28 t only in each area. The biggest catches in 1987 were in Manila Bay (147 t), the Babuyan Channel (136 t). northeastern Mindanao (119 t). Lamon Bay (88 t) and the Samar Sea (51 t). The other fishing grounds. like Tayabas Bay. the West Palawan waters, the western Sulu Sea, South Sulu Sea, the Lingayen Gulf. the Ragay Gulf and the Bohol Sea contributed catches ranging from 2-19 tin each area during this period.

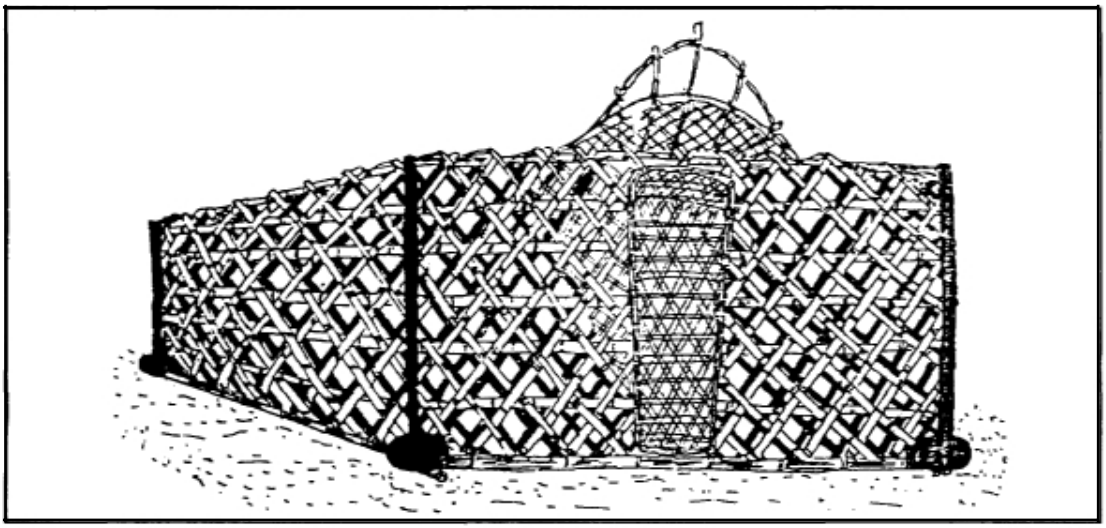
FISHING GEAR

Fish pots or fish traps

The fish pot. or *bubo* is a luring device made in different shapes and sizes. It is usually rectangular and made of woven split bamboo or, more recently. of chicken wire. Prior to use, the traps are baited with fish and set near suspected mud crab holes. Usually, a number of traps are set before sunset. One fisherman can set 40-50 traps. making them with buoys. Nowadays this is not commonly practised. to avoid poaching. The traps are retrieved in the morning and the catch is removed. Experienced fishermen study the behaviour and habits of mud crab and can differentiate the crawl marks made by mud crab during low tide. These indicators are often used in setting the traps. The information is kept secret to avoid others from encroaching on their fishing territories. In Palawan, a mud crab gatherer can catch 100 kg in one week.

In New Washington. Aklan. the traps are set before high tide and retrieved during low tide. About 15-20 kg of crab are obtained a day from 30-50 traps. (See Figure 2).

Fig 2. Fish pot



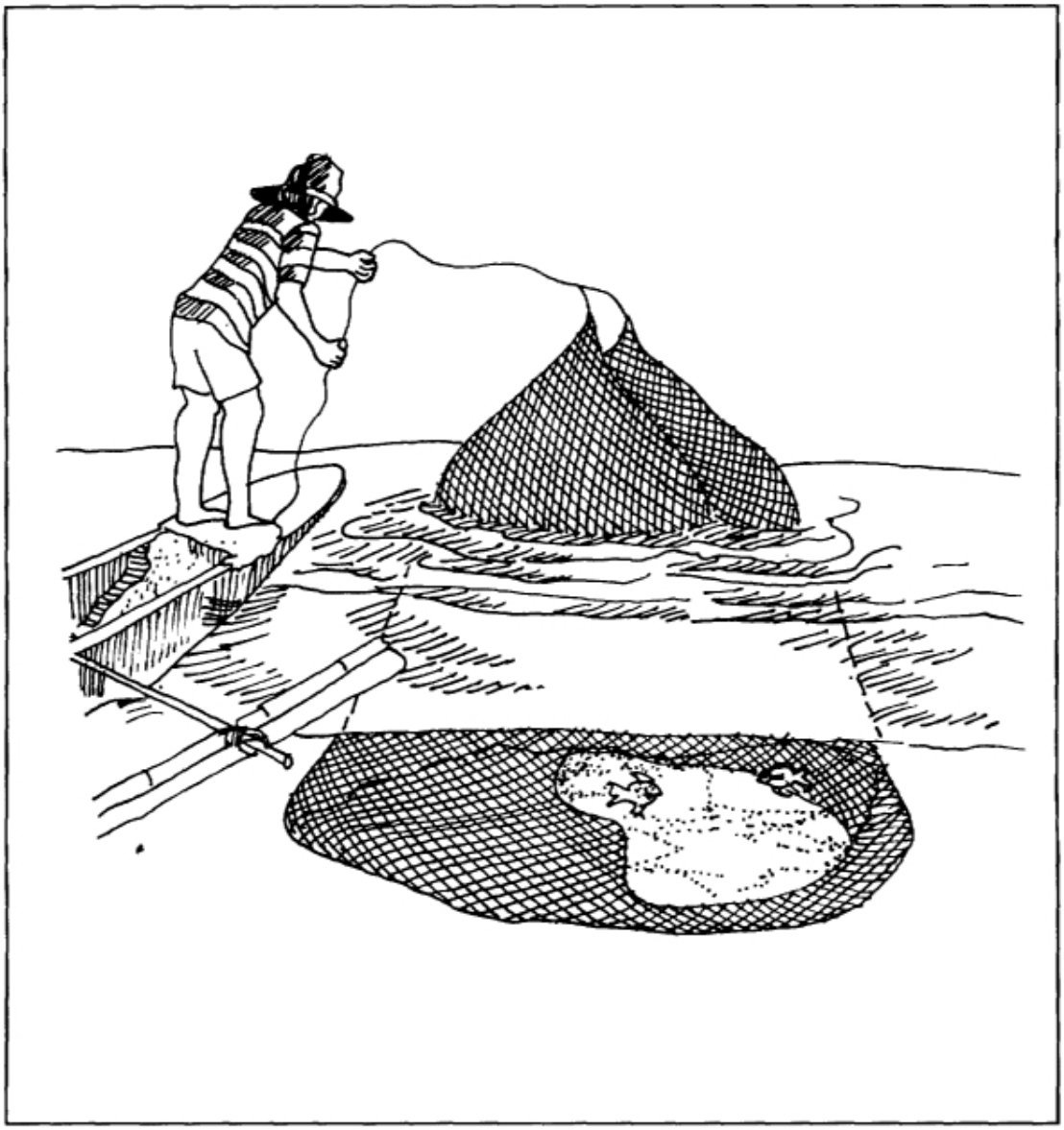
<<

A fish pot ot more recent design \k as one made by Antonio Cabalbag of Cagayan State University. His folding pot works like a mouse trap. the folding pot closing instantly as the crab touches the bait. The principle of design in the construction is based on the opening and closing of a hook. The base of the trap corresponds to the cover while the ribs, which trap the crab correspond to the leaves. About 50 folding traps are made and attached to a mainline. The folding pot had an average catch of 1. 18 kg for the 40 experimental Cahalbag traps.

Castii et

The castnet *(data* or *lava* in the local dialect) isac onical net made of fine meshed netting of 20—30 knots mesh size Artisanal fishermen use a net 8-It) in in mouth circumference. It is usually operated by one man. In deeper water, a *bancd* or raft, has to he used. The net is cast into the water to trap fish and other species and is heavily weighted around the base with lead sinkers. A retrieving line is attached to the apical portion ot the net. while the other end, with the retrieving line, is attached to the operator's arm. Upon retrieval, the mouth of the net closes. Mud crab caught by this gear are only accidental catches. The gear is usually operated in wading depth in coves and hays (see Figure 3).

Fig 3. Castnet

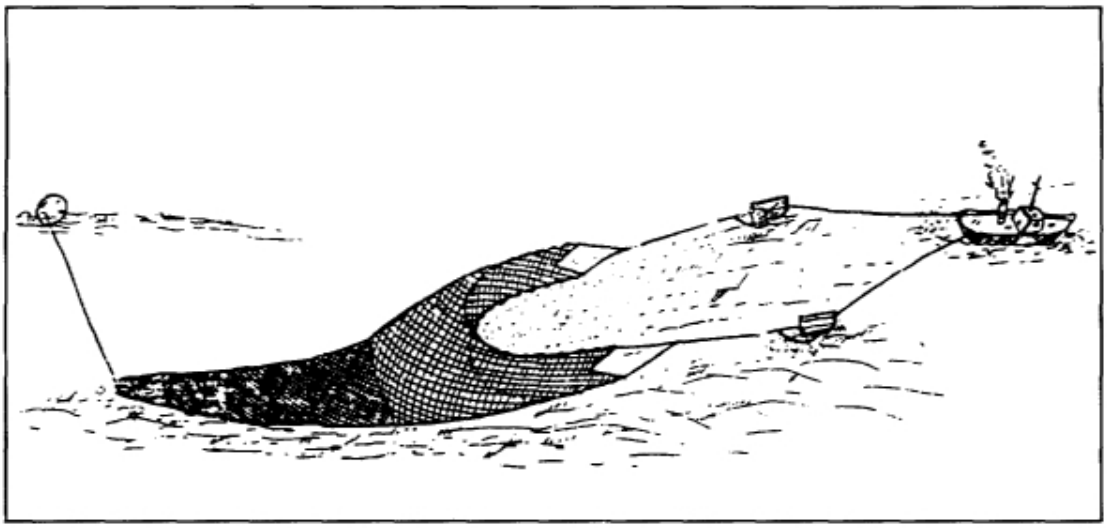


<<

Baby trawl

Trawls are nets made in the form of a conical hag. with the mouth kept open by otter boards. The entire gear is operated by towing over the bottom of the sea to capture demersal species (Figure 4).

Fig 4. Otter **trawl 'GALADGAD'**

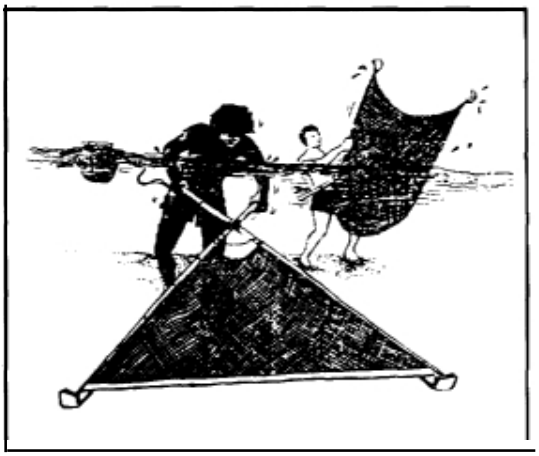


Trawlnets are operated from pumpboats. or *hamas.* which are less than three gross tons. During fishing. the net is held open by two otter boards located along the interior sides of the net. The horizontal opening is maintained by rubber or plastic floats on the head rope and lead sinkers on the foot rope. Trawling time is usually one hour or more. At least five hauls a day are possible.

Push net

The pushnet. or *sakag,* is made of *sinaniav.* cotton or polyethylene netting. The netting is mounted on two bamboo poles. each about 2-1/2 m long, crossed over each other, scissors fashion, to form a triangular frame. Both ends of the bamboo are fitted with wooden shoes. for easy sliding of the gear during operations. The gear is operated when the tide is subsiding. In deeper waters, the net is pushed by a motorized *hanca* with the frame attached to the anterior portion of the *hanca* (see Figure 5).

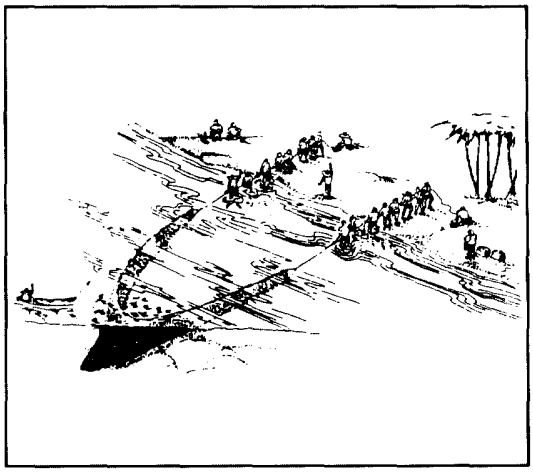
Fig 5. Shallow water push net



Beach seine

The beach seine (locally known as *pukot havakos. haling, salop. baring)* is a type of dragnet made with cloth. *sinamay.* polyethylene or cotton netting (see Figure 6). It is made with a pocket. The foot rope is provided with stones or lead sinkers. The lines are extended to the wing ends, to which a wooden brail is

Fig 6. Beach seine



<<

attached. A pair of towing ropes are tied to the brail and pulled by fishermen. A large crew is usually needed to pull the gear on to the beach.

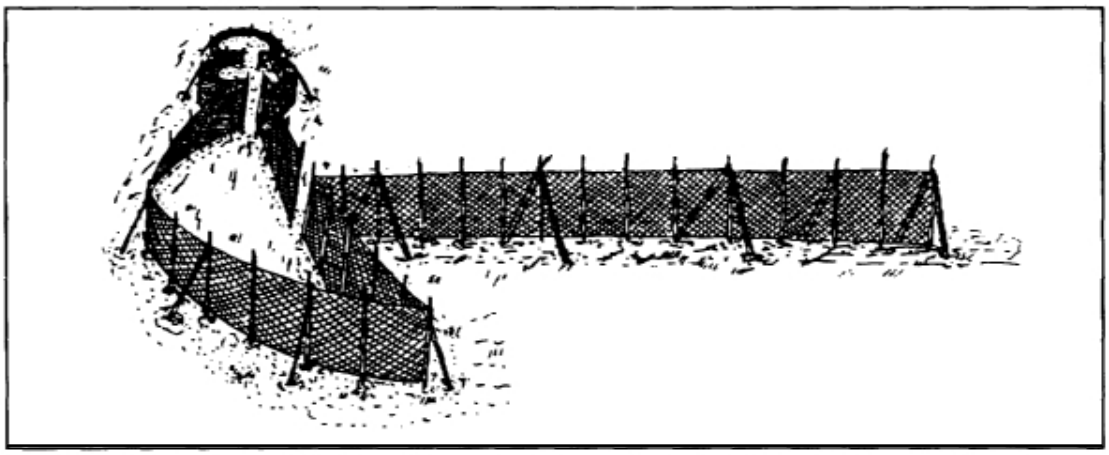
The seine is operated during the day in the shallow waters ot coves, bays and coastal areas. Sometimes the gear is operated during late afternoons and evenings.

Fish corral

The fish corral, or *hakiad.* is a stationary trap with a leader feeding into a number of enclosures. It has two wings. sometimes with or without the leader. The trap is set along the migratory path of fish and will guide them into the chambers. The walls of the trap are made of netting material and attached to bamboo poles staked to the bottom. Additional nets are set in the catching chambers. During the harvest, the nets in the catching chamber are lifted and the catch is brought to the waiting boat.

Fish corrals vary in shape. form and size, depending on the capital of the investors. They are operational tor 5-6 months a year. Usually two harvests are made a day, one in the morning (6:00 a.m) and other in the afternoon (5:00 pm). Fish corrals are usually set up in sheltered areas. The catch is a mix of fish, crab and squid, usually 5-20 kg/day (see Figure 7).

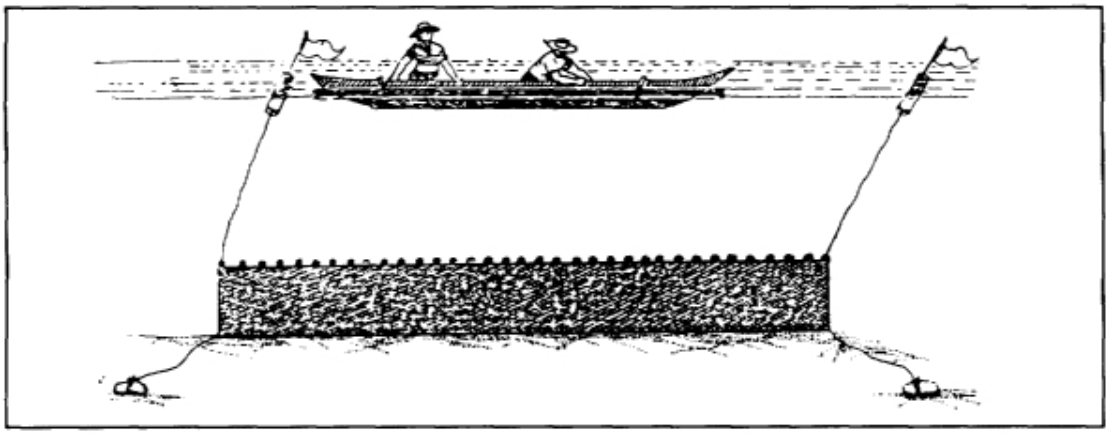
Fig 7. Fish corral



Gilinet

The *pante.* or gillnet. is curtainlike in shape and catches lish by gilling or entanglement. Gillnets are anchored to the bottom so that they are not free to move with the water current. They are usually set in rivers and estuaries before high tide. Sometimes the net may serve as a barrier. The mud crab concentrate in the lower portion of the net at feeding time and get entangled in its meshes. The length of the net depends on the amount of dapital available to the operator (see Figure 8).

Fig 8. Bottom gillnet



<<

Fvkenet

These are set nets consisting of a series of hoopnets with funnel-shaped entrances. They differ from hoopnets in that they have wings (see Figure 9).

Fig 9. Fykenet (set nets)

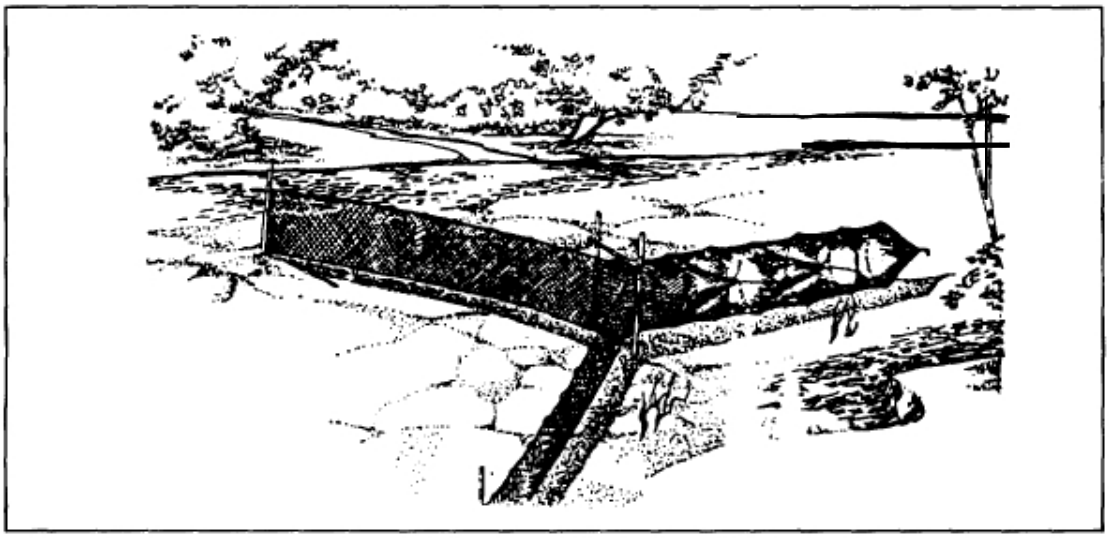
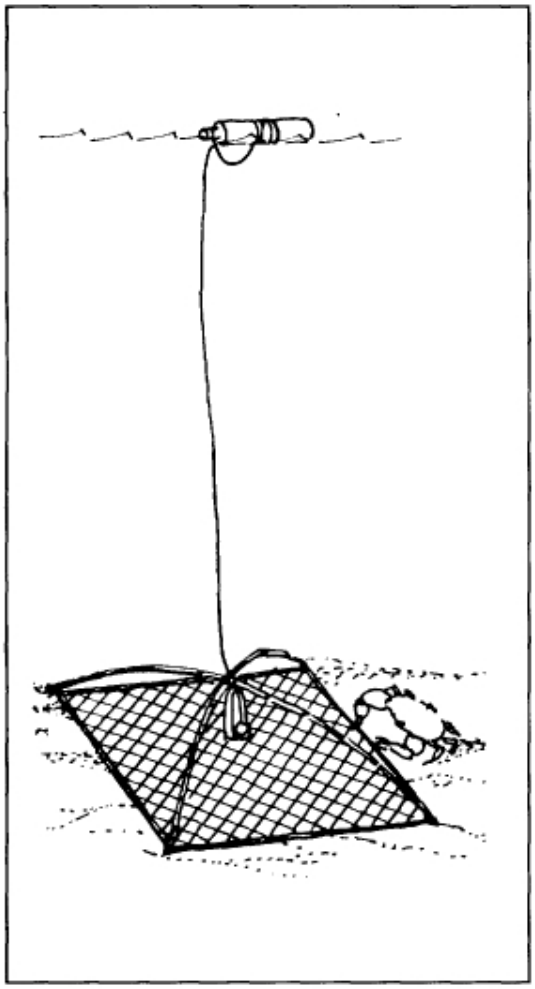


Fig 10. Crab liftnet



Crab liftnet

Crab liftnets, or *hintols,* are square nets hung on a cross bamboo frame and lifted using a handline (see Figure 10). The net, measuring 16 meshes square, is hung without selvege by No. 19 twine, 45 cm on each side. The length of the bamboo frame is about a metre. The lead. 2 cm in diameter and 2.5 cm in length, is placed on two opposite sides. A small *hanca* may he used to operate the gear.

Prior to use, the bait is hung directly Iam the centre of the crossed bamboo frame. It is sunk to the desired depth, which is determined by the length of handline. Several liftnets can be operated by one fisherman. Once the operator senses a crab taking the bait, a jerking motion is employed and the net closed, thereby trapping the crab.

In New Washington. Aklan, one fisherman sets 20-40 nets before sunset. The fishing season for mud crab is usually during the rainy months, or southwest monsoon. Most fishermen wait for the flowering of the mangroves *(Rhizophora* sp.) Flowering corresponds with the beginning of the mud crab fishing season.

A liftnet can catch about 12 kg of mud crab a day (8-15 pcs/kg). The nets are set before sunset or before high tide and retrieved the following day. In most parts of the country. traps are

<<

set during the Full Moon. Many fishermen claim that crab are heavier at this time compared with the New Moon catch.

Liftnets

The capture is affected by vertical lifting of the net. The net does not need to stay permanently in one place; in fact, it is more effective if transferred from place to place at short intervals.

REFERENCES

ANON. Fisheries Statistics of the Philippines 1985 1990. Bureau of Fisheries and Aquatic Resources, Phil.

CABALBAG. A.C. 1990. Use of folding pots. for a sure crab catch farming update. Dept. of Aqua.. Bur. Agri. Res.. March Vol. 2 No 2. April June 1990.

UMALI. AUGUSTIN F. 1950. Guide to the classification of fishing gears in the Philippines U.S Dept. of Interior Fish and Wildlife Serv. Res. Rep. #17. U.S Government Printing Office 165 p.

VITALINO. E.. DICKON. J. ALIMODIAN, A. and BALTAZAR. R. Some non-common and C ommon small medium scale fishing gears used in the Philippines. Tech. Serv. Div., Ben-lor Bldg., Quezon Avenue. Quezon City (unpublished).

ANNEXURES (see over)

<<

ANNEXURE I

The statistical fishing regions and marine fishing grounds

Statistical fishing region	*Marine fishing areas*	*Location grounds*
1 - LINGAYEN GULF	Bangui Bay	*Ilocos Norte*
	Dasol Bay	Pangasinan
	Ilocos Coast	La Union/Ilocos Norte
	Lingayen Gulf	Pangasinan
	Pasaleng Bay	Ilocos Norte
2 - MANILA BAY	Subic Bay	Zambales
	Manila Bay	Bataan/Metro Manila/Cavite
	Zambales Coast	Zambales
3 - BATANGAS COAST	Balayan Bay	Batangas
	Batangas Bay	Batangas
	Batangas Coast	Batangas
	Verde Is. Passage	Batangas/Or. Mindoro
4 - TAYABAS BAY	Mogpog Pass	Quezon/Marinduque
	Tayabas Bay	Quezon
5 - WEST PALAWAN WATER	Bacuit Bay	Palawan
	Balabac Strait	Palawan
	Imuruan Bay	Palawan
	Malampaya Sound	Palawan
6 - CUYO PASS	Coron Bay	Palawan
	Cuyo Pass	Palawan/Antique
	Dumaran Channel	Palawan
	Linapacan Strait	Palawan
	Mindoro Strait	Palawan/Occ.Mindoro
	Taytay Bay	Palawan
7 - WEST SULU SEA	Green Island Bay	Palawan
	Honda Bay	Palawan
	Island Bay	Palawan
	San Antonio Bay	Palawan
	West Sulu Sea	Palawan
8 - SOUTH SULU SEA	Basilan Strait	Basilan/Zamboanga del Sur
	Tawi-Tawi Bay	Tawi-Tawi
	South Sulu Sea	Zamboanga del Sur/Sulu/ Tawi-Tawi
9 - EAST SULU SEA	Coronado Bay	Zamboanga del Norte
	Dapitan Bay	Zamboanga del Norte
	Dipolog Bay	Zamboanga del Norte
	East Sulu Sea	Zamboanga del Norte/Negros
	Sibuco Bay	Zamboanga del Norte
	Siocon Bay	Zamboanga del Norte
	Sindangan Bay	Zamboanga del Norte

(continued)

<<

Statistical fishing region	*Marine fishing areas*	*Location grounds*
10 · MORO GULF	Dumaguilas Bay	Zamboanga del Sur
	Illana Bay	Lanao del Sur/Maguindanao
	Linao Bay	Maguindanao
	Maligay Bay	Zamboanga del Sur
	Moro Gulf	Zamboanga del Sur/ Maguindanao/Sultan Kudarat
	Pagadian Bay	Zamboanga del Sur
	Sarangani Bay	Southern Cotabato
	Sibuguey Bay	Zamboanga del Sur
11 · DAVAO GULF	Baculin Bay	Davao Or.
	Bislig Bay	Surigao del Sur
	Cateel Bay	Davao Or.
	Davao Gulf	Davao del Sur/Davao del Norte/Davao Or.
	Lanuza Bay	Surigao del Sur
	Lianga Bay	Surigao del Sur
	Mayo Bay	Davao Or.
	Pujada Bay	Davao Or.
12 BOHOL SEA	Butuan Bay	Agusan del Norte
	Gingoog Bay	Misamis Or.
	Guindulman Bay	Bohol
	Iligan Bay	Misamis Occ./Lanao del Norte
	Murcielagos Bay	Misamis Or.
	Panguil Bay	Misamis Occ/Lanao del Norte
	Sogod Bay	Southern Leyte
13 · LEYTE GULF	Cabalian Bay	Southern Leyte
	Dinagat Sound	Surigao del Norte
	Gamay Bay	Eastern Samar
	Leyte Gulf	Leyte Is./Samar Is.
	Matarinao Bay	Eastern Samar
	Oras Bay	Eastern Samar
	San Pedro Bay	Leyte/Western Samar
	Surigao Strait	Surigao del Norte/Southern Leyte
14 · CAMOTES SEA	Camotes Sea	Cebu/Leyte/Bohol
	Cebu Strait	Cebu/Bohol
	Maribojoc Bay	Bohol
	hoc Bay	Leyte
15 · VISAYAN SEA	Asid Gulf	Masbate
	Asuncion Pass	Negros Occ.
	Tanon Strait	Cebu/Negros Is.
	Visayan Sea	Panay/Negros/Cebu/Masbate Is.
16 · GUIMARAS STRAIT	Aguisan Bay	Negros Occ.
	Banate Bay	Iloilo
	Guimaras Strait	Iloilo/Guimaras/Negros Occ.
	Boilo Strait	Iloilo/Guimiras Is.
	Panay Gulf	Iloilo/Negros Occ.

(continued)

<<

Statistical fishing region	*Marine fishing areas*	*Location grounds*
17 · SIBUYAN SEA	Jintotolo Channel	Capiz/Masbate
	Nin Bay	Masbate
	Pilar Bay	Capiz
	Romblon Pass	Romblon
	Sapian Bay	Capiz
	Sibuyan Sea	Aklan/Masbate/Romblon
	Tablas Strait	Mindoro Or./Tablas Is.
18 · RAGAY GULF	Burias Pass	Camarines Sur/Burias Is.
	Ragay Gulf	CamarinesSur/Quezon
19 · SAMAR SEA	Biliran Strait	Leyte/Biliran Is.
	Carigara Bay	Leyte
	Maqueda Bay	Western Samar
	Samar Sea	Masbate/Samar/Leyte Is.
	Sorsogon Bay	Sorsogon
	Ticao Pass	Sorsogon/Ticao Is.
20 · LAGONOY GULF	Albay Gulf	Albay
	Cabugay Bay	Catanduanes
	Lagonoy Gulf	Albay/Camarines Sur/Catanduanes
	San Bernardino Strait	Northern Samar/Sorsogon
21 · LAMON BAY	Alabat Sound	Quezon
	Lamon Bay	Quezon/Camarines Norte
	Maqueda Channel	CamarinesSur/Catanduanes
	Polillo Strait	Quezon/Polillo Is.
	San Miguel Bay	Camarines Sur
22 · CASIGURAN SOUND	Baler Bay	Aurora
	Casiguran Sound	Aurora
	Dapitan Bay	Aurora
	Dingalan Bay	Aurora
23 · PALANAN BAY	Divilican Bay	Isabela
	Palanan Bay	Isabela
24 · BABLJYAN CHANNEL	Babuyan Channel	Cagayan/Babuyan Is.
	Balintang Channel	Batanes/Babuyan Is.

<<

ANNEXURE II

Fishing grounds frequented by commercial fishing vessels and their geographical locations

Fishing ground	*Geographical location*
Albay Gulf	Eastern coastline of Albay Province (opposite Legaspi city)
Asid Gulf	Southern coastline of Masbate Privince
Babuyan Channel	Northern coastline of Cagayan Province
Basilan Strait	Between Zamboanga del Norte and Basilan Provinces (southern part of Zamboanga and northern part of Basilan)
Batangas Coast	Western coastline of Batangas Province (Verde Island Passage)
Bohol Sea	Between Northern Mindanao and Bohol Provinces
Butuan Bay	Northern coastline of Agusan del Norte
Burias Pass	Between Burias Island and Albay Province
Cabugao Bay	Southern coastline of Catanduanes
Camotes Sea	Between Bohol, Cebu and Leyte Islands
Coron Bay	Between Busuanga, Coron and Culion Islands (Northern Palawan Province)
Carigara Bay	Northern coastline of Leyte Province
Davao Gulf	South of Davao city
Dinagah Sound	Northeast of Surigao del Norte
Dumaguillas Bay	Northwestern coastline of Zambaonga del Sur Province
Guimaras Strait	Between Iloilo and Negros Occidental Provinces
Iligan Bay	Between Misamis Occidental, Lanao del Norte and Misamis Oriental Provinces
Iliana Bay	Between northwestern Zamboanga del Sur, Lanao del Norte and Lanao del Sur Provinces
Iloilo Strait	Between Iloilo Province and Guimaras Island
Jintotolo Channel	Between Masbate and Capiz Provinces
Lagonoy Gulf	Between Catanduanes Island and Camarines Sur Provinces
Lamon Bay	East of Central Quezon Province
Leyte Gulf	East of Leyte Island
Lingayen Gulf	North of Pangasinan Province
Macajalar Bay	Southern coastline of Misamis Oriental Province
Manila Bay	Between Cavite, Rizal and Bataan Provinces (west of the city of Manila)
Mansalay Bay	Southeastern coastline of Oriental Mindoro (opposite province of Romb)
Maqueda Bay	Western coastline of Cental Samar Province (south of Catbalogan).
Mindanao Sea	Southeastern side of Sulu Archipelago and southern part of Mindanao
Mindoro Strait	Between Mindoro Occidental and Palawan Provinces
Moro Gulf	Between Zamboanga del Sur and Cotabato Provinces
Panay Gulf	Between southern Iloilo and southwestern Negros Occidental Provinces
Pola Bay	Eastern coastline of Oriental Mindoro (opposite Marinduque)
Pujada Bay	Eastern coastline of Davao Oriental Province
Ragay Gulf	Between southern Quezon and Camarines Sur Provinces
Samar Sea	Between Samar and Masbate Provinces
San Miguel Bay	Between eastern Camarines Norte and northern Camarines Sur Provinces
San Pedro Bay	Between Samar and Leyte Provinces (opposite Tacloban city)
Sarangani Bay	Southern coastline of Cotabato Province
Sibuguey Bay	Southern coastline of Zamboanga del Sur Province

<<

RESOURCE AND EXPLOITATION OF MUD CRAB Scylla *serrata* (Forskal) IN INDIA

by M Kathirvel and S Srinivasagam
of the Central Institute of Brackishwater Aquaculture, Madras 600 028. INDIA

ABSTRACT

The mud crab fishery in India has in recent years emerged as an export-oriented trade with potential. An eight-fold increase in the landings of S. serrata (995 t) *during the Eighties* was *estimated, compared to the Sixties. The major brackishwater bodies have yielded about 250 t during the Seventies. As the exploitation of the mud crab has been stepped up in recent years due to its demand in the export market, there is an urgent need to take up a detailed study of the exploited stocks in the major fishing areas.*

INTRODUCTION

The average annual landings of crab from the inshore waters of India during 198 l- 1989 was 22,104 t about 10 per cent of the total crustacean landing (Anon, 1982, 1983, 1986, 1989 and 1989-90). Among the fifteen edible crab contributing to the fishery, the mud crab, *Srylla serrata* (Forskal)*, is 4.5 per cent of the crab landings (Banerji, 1969). *S. serrata* is known to migrate into backwaters, estuaries and coastal lakes, where it is the target of a lucrative fishery (Hora 1935; Chopra, 1939; Jones and Sujansinghani, 1950; Evangeline 1967; Evangeline and Subbiah 1969; Mohanty 1973 and 1975; Datta 1973; Rao *et al* 1973; Ansari and Harkantra 1975; Trivedi and Pate1 1975; Shanmugham and Bensam 1980; Lalithadevi 1985; and Srinivasagam and Raman, 1985). This paper reviews the biological characteristics, fishery, marketing and export of the mud crab found in Indian waters.

EXPLOITATION

Various types of gear employed in crab fishing in general and for the mud crab in particular have been dealt with by Hora 1935, Jones and Sujansinghani 1950, Anon 195 l, Chhapgar 1962 and Rao

---

* Local names of mud crab

Maharashtra	:	*Khadapi Chimbori* (Marathi)
Tamil Nadu	:	*Pacha nandu/Kazhi nandu/Katu nandu Kora vafai nandu* (Tamil)
Andhra Pradesh	:	*Pita/Manda peeta* (Telugu)
Orissa	:	*Chilka Kankada* (Oriya)
West Bengal	:	*Nona Kankara/Samudra Kakra* (Bengali)

<<

et al 1973. Details of the gear used and the fishing seasons in different maritime states of India, with special reference to S. serrata, are given in Table 1.

Table 1: Gear employed and fishery season for S. serrata

State/Territory	*Gear* employed	*Fishery season*
MARINE SECTOR		
Gujarat	*Gillnet. stakenet, castnet.* line with bait. pair of tongs, iron rods	June-August
Maharashtra	Seinenet. hoopnet, hooked iron or steel rods, line with bait	August-October
Goa	Gillnet. line with bait. handpicking	June-September
Kamataka	Gillnet. trawlnet. scoopnet	October-May
Kerala	Gillnet, boat seine, shore seine. trawlnet	May-November
Tamil Nadu	Boat seine, shore seine. gillnet. castnet, trawlnet	March-June and October-December
Pondicherry	Gillnet. boat seine, shore seine. trawlnet	October-December
Andhra Pradesh	Gillnet. trawlnet	April-December
Orissa	Gillnet. seinenet	October-December
West Bengal	Gillnet, seinenet. stakenet	July-December
Andaman and Nicobar Islands	Gillnet. boat seine, shore seine, castnet, handpicking	December-April
BRACKISHWATER SECTOR		
Zuari and Mandovi estuaries	Gillnet. line with bait, scoopnet, bamboo pot, handpicking	June-September
Kundapur estuary and Natravati-Gurpur estuaries	Gillnet	June-September
Vembanad backwaters	Stakenet. castnet, dragnet, line with bait, scoopnet, trap	May-September
Mudflat areas at Tuticorin	**Scoopnet**	August-February
Killai backwaters	Gillnet, line with bait, castnet. scoopnet. dragnet	March-September
Kovalam backwaters	Dragnet, scoopnet	January-September
Adyar estuary	Dragnet, castnet, scoopnet	June-October
Ennore estuary	Dragnet. castnet. scoopnet	April-November
Pulicat Lake	Shore seine, dragnet, line with bait. scoopnet	March-October
Godavari estuary	Dragnet, stakenet	November-March
Chilika Lake	Gillnet. scoopnet, crab trap, line with bait	August-October
Sundarbans	Line with bait, hooked iron or steel rods.	April-June

<<

CATCH STATISTICS

Marine sector: The average annual landing of crab during 1959- 1968 was 2,798 t (Banerji 1969). The catch was composed of S. serrata and Portunus spp. The landings from different maritime states are given in Table 2.

Table 2: Maritime state-wise landings of S. serrata and Portunus spp.

	Catch in tonnes (Annual Avg. for 1959-1968)		
Maritime state	*S. serrata*	*Portunus spp*	*Total*
Gujarat			
Maharashtra		32	32
Kamataka	1	17	18
Kerala		97	97
Tamil Nadu	120	1817	1937
Orissa and West Bengal	6	708	714
Total	127	2671	2798

The average annual landing of S. serruta was 127 t during 1959-1968, which was only 4.5 per cent of all crab landings. The major portion was from Tamil Nadu (94.5 per cent), while the rest came from Andhra Pradesh and Kamataka.

*In the recent past (1981- 1989) average crab landings from the marine sector were 22,104 t, indi-*cating an eight-fold increase (Anon, 1982, 1983, 1986, 1989, and 1989-90). If we take the same percentage of S. serrata landed in 1959-1968 (4.5 per cent), the estimated annual landings of the species during 1981-1989 would have been 995 t.

Data on the landing of S. serrata from important fishing centres are lacking, except for the observations by Shanmugam and Bensam (1980) and Lalithadevi (1985). In Tuticorin inshore waters, 5.0 t of S. serrata were landed using gillnet, boat seine, dragnet and castnet (Shanmugam and Bensam 1980). Landings of S. serrata during 1979 and 1980 from the inshore and offshore waters of the Kakinada region by gillnet, boat seine and trawlnet were 36 t (Lalithadevi 1985). S. serrata formed about 6 per cent of the total crab landings during the years of study, with a catch rate of 0.1 kg/unit and 0.3 kg/unit for the indigenous gear (gillnet and boat seine) and mechanized gear (trawlnet), respectively.

Brackishwater sector: The available data are summarized in Table 3 (see on next page). The average landings of S. serrata during the Seventies amounted to 15.1 t from the Gulf of Kachchh, 49.9 t in Goa estuaries, 44.6 t in the Cochin backwaters, 35.5 t in Pulicat Lake, 38.2 t in the Godavari estuary and 61.6 t in Chilika Lake. Thus, the total yield from the major brackishwater areas was around 250 t. The percentage shared by S. serrata in the overall crab landings was 65.8 per cent and the rest was Portunus pelagicus. Srinivasagam and Raman (1985) recorded a catch rate in Pulicat Lake of 30.9 kg and 12.4 kg/unit for line with bait and shore seine, respectively.

<<

Table 3: Crab landings (in tonne) from important brackishwater areas of India

Locality	Year	Total crab landings (t)	Landing of S. serrala (t)	% shared S. serrata
Gulf of Kachchh	'72	9.5	9.5	100.0
(Trivedi and Patel 1975)	'73	11.7	11.7	100.0
	'74	16.6	16.6	100.0
	'75	22.7	22.7	100.0
Mandovi and Zuari	'72	51.8	51.8	100.0
estuaries	'73	49.0	48.0	100.0
(Ansari and Harkantra 1975)				
Netravati estuary	'75	1.0	1.0	100.0
(Ram & Chandramohan 1978)				
Cochin backwaters	'71	46.4	24.9	53.7
(Kathirvel 1981)	'72	69.8	34.9	50.0
	'73	115.1	51.7	44.9
	'74	105.0	54.9	52.5
	'75	171.8	56.7	33.0
Vembanad	'64-65	17.9	N.A.	N.A.
backwaters	'65-66	35.3	↓	↓
(Anon. 1964-65.	'66-67	20.4		
1965-66. 1966-67 and 987)	'76	350.0		
	'77	345.0		
	'78	321.0		
	'79	357.0		
	'80	370.0		
	'81	343.0		
	'82	352.0		
	'83	389.0		
	'84	398.0		
	'85	392.0		
	'86	376.0		
Tuticorin area	'74-75	4.4	4.4	100.0
(Shanmugam & Bansam 1980)				

Locality	Year	Total crab landings (t)	Landing of S. serrala (t)	% shared S. serrata
Killai backwaters	'73-74	12.1	9.9	81.8
(Srinivasagam 1975)				
Adyar estuary	'63-64	3.3	3.3	100.0
(Evangeline 1967)				
Ennore estuary	'60-61	5.9	N.A.	N.A.
(Chacko and Rajagopal 964:	'65-66	13.2	↓	↓
Evangeline & Subbiah 1969)	'66-67	11.5		
Pulicat Lake	'68	52.!	35.0	67.2
(Srinivasagam	'69	24.6	8.7	35.2
and	'70	89.4	47.2	52.8
Raman 1985)	'71	102.2	34.7	34.0
	'72	72.3	N.A.	NA.
Godavari estuary	'67-68	337.5	N.A.	N.A.
(Anon 1972 and	'72	-	16.6	↓
975; Rao e al1973	'75	-	3.6	
Lalithadevi 985)	'79	93.1	91.9	98.7
	'80	51.7	41.5	80.3
Chilika Lake	'52	18.0	NA.	N.A.
(Jones and	'71	52.9	52.9	100.00
Sujansinghani	'72	67.8	67.8	100.00
1950: Mohanty	'73	64.3	64.3	100.00
1973 & 1975;	'79-80	59.0	NA.	NA.
Anon 1986-87)	'84-85	90.0	↓	↓
	'85-86	79.8		
	'86-87	54.0		
Sundarbans area	'54	33.6		
(Anon 960; Datta 1973)	'72	350.0		

NA. = Not Available

As data on the exploitation of S. ***serrata*** during the Eighties are not available from both the marine and brackishwater sectors, the present yield **rate** cannot be stated. However, the average annual export of 561 **t** of live S. ***serrata*** between 1988-1989 and 1990-91 (see Table 7) indicates an increase in **the rate** of exploitation, compared to the Seventies.

<<

BIOLOGICAL CHARACTERISTICS

Some aspects of the biology of S. serrate have been studied from the inshore areas (Pillai and Nair 1973; Shanmugham and Bensam 1980: Lalithadevi 1985) and the brackishwater areas (Evangeline 1967; Datta 1973; Mohanty 1975; Srinivasagam 1975; Ram and Chandramohan 1978; Kathirvel 1981; Joel and Sanjeevaraj 1982 and 1983; Lalithadevi 1985: Srinivasagam and Raman 1985). The size of the crab in most of the observations was indicated by carapace width (CW) in millimetres (the distance measured across the carapace between the ninth anterolateral teeth).

Size distribution

The overall size range (CW) for the species was 75-205 mm in the inshore sea and 15 to 217 mm in the estuarine areas. The mean size of the exploited population was 105 mm in the Cochin backwaters (Kathirvel 1981), 150 mm in the inshore sea, and 153 mm in the mud flat areas of Tuticorin (Shanmugham and Bensam 1981). 102 mm in Pulicat Lake (Srinivasagam and Raman 1985) and 125 mm in Chilika Lake (Mohanty 1975). The largest size (153 mm) recorded on the mud flats of Tuticorin was due to the operation of a single gear (scoopnet), whereas various other gear were used in other centres (see Table I).

Sex ratio

Females dominated the catches from the Netravati estuary (Ram and Chandramohan 1978), Cochin backwaters (Kathirvel 198 1), Killai backwaters (Srinivasagam 1975), Pulicat Lake (Srinivasagam and Raman 1985), and the inshore and estuarine areas of the Kakinada region (Lalithadevi 1985), while males occurred in greater numbers in the inshore and mud flat areas of Tuticorin (Shanmugam and Bensam 1980) and Chilika Lake (Mohanty 1975).

Growth

While Mohanty (1975) and Shanmugam and Bensam (1980) did not attempt to trace the progress of dominant modes to assess the growth rate, Lalithadevi (1985) derived from length frequency studies a growth rate of 9 mm and 10 mm in CW for S. *serrata* males and females, respectively.

Food and feeding habits

The feeding habits of S. serrata observed in the Cochin backwaters (Kathirvel 198 1), Karwar (Prasad et al 1988) and in the Ennore estuary and Pulicat Lake (Srinivasagam, unpublished observations) are summarized in Table 4.

Table 4: Food of S. *serruta*

Food items	*Cochin*	*Karwar*	*Ennore*	*Pulicat*
	Percentage			
Crustacean remains	78.4	6.0	46.3	46.6
Molluscan remains	3.5	8.3	25.0	20.3
Fish remains	15.2	33.0	19.7	21.2
Detritus and sand	2.5	41.3	6.9	9.2
Plant matter			0.7	0.5
Unidentified and degenerated food	0.4	11.4	1.4	2.2

S. serrata is an omnivorous feeder and feeds voraciously on fish in Karwar waters. In the Cochin backwaters, Ennore estuary and Pulicat Lake, it feeds occasionally on crustaceans. In the Cochin

<<

backwaters, the crustacean component consists mainly of the remains of a burrowing and slow-moving pinnotherid crab, (Xenophthamus garthii), an easy prey for the mud crab (Kathirvel 1981). Laboratory experiments have shown that ***S. serrata*** cannot catch fast-moving prey (Hill 1976). ***S. serrata*** feeds on live shrimp in shrimp culture fields during harvest seasons, probably due to the lower water depth and the congregation of shrimp in the fields at this time (Prasad et al 1985).

Maturation

Shanmugam and Bensam (1980) described the stages of sexual maturity of the crab as follows:

Table 5: Different stages of maturation in S. serrata

Stage	*Testes*	*Ovary*
I 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 prominent seminal receptacle
II · Maturing	Creamy white; occupying 1/4th of body cavity	Pink ; occupying 1/4th to 1/3rd of body cavity
Ill · Mature	Milky white with thick vas deferens; ocupying full body cavity	Orange-red with a prominent seminal receptacle; occupying full body cavity.

Size at first maturity

The following authors have reported the minimum size at first maturity for females of the Scylla species listed below:

Author	*Size at first maturity (CW in mm)*	*Species*
Pillai and Nair (1975)	*129.*	*S. serrata*
Kathirvel (1981)	*85*	*S. serrata*
	120	*S. oceanica*
Radhakrishnan and Samuel (1982)	*98*	*S. serrata* serrata
	140	*S. serrata*
Joel and Sanjeevaraj (1982)	*83*	*S. serrata*
	123	*S. tranqueharica*
Lalithadevi (1985)	*39* (carapace length)	*S. serrata*
Shanmugam and Bensam (1980)	127	*S. serrata*

<<

Fecundity

The number of eggs found in the 'berry' of S. serrata are given below:

Size *of berried female (CW in mm)*	*No. of eggs*	*Locality*
115	318,720	South west coast of India (Pillai and Nair 1973)
150	521,450	
92	620,250	Cochin backwaters (Kathirvel 1981)
104	1,199,180	
107	1,479,680	
93	410,085	Ennore estuary (Srinivasagam) (Unpub.)

Breeding season

The breeding seasons for S. *serrata* in select areas are given below:

Locality	*Period*	*Peak season*
Southwest coast of India (Pillai and Nair 1973)	Throughout the year	September-February
Tuticorin coast (Shanmugam and Bensam 1980)	Not mentioned	April - July
Pulicat Lake (Joel and Sanjeevaraj 1982) (Srinivasagam, Unpub.)	Throughout the year	March-April and September-October
Kakinada region (Lalithadevi 1985)	Throughout the year	May-June and October-February

Availability of early juveniles

Data on the availability of early juveniles of S. *serrata* in backwaters, estuaries and coastal lakes are summarized in Table 6.

Table 6: Availability of early junveniles of S. serrata in brackishwater regions of India.

Locality	*Period*	*Peak season*
Cochin backwaters (Kathirvel 1980)	Throughout the year	May-Ott
Pichavaram mangroves (Chandrasekaran and Natarajan 1987)	Dec-Sept	Jan-Feb
Kovalam backwaters (Srinivasagam et *al* 1988)	Dec-Oct	Dee-May
Adyar estuary (Srinivasagam et *al* 1988)	Dec-Oct	Jan-Apr
Ennore estuary (Srinivasagam et *al* 1988)	Dec-Oct	Dee-Apr
Pulicat Lake (Srinivasagam et *al 1988)*	Dec-Oct	Dee-Apr
Chilika Lake (Jones and Sujansinghani 1950; Mohanty 1975)	Throughout the year	Mar-Jun

<<

UTILIZATION

Marketing

S.*serrata* is generally sold alive. The bulk of the catch is usually packed in baskets. Wet seaweed is used in the baskets to keep the crab cool and moist. The basket packed crab are transported from remote fishing villages to the major cities either by road or by rail and sold through middlemen to retailers (Jones and Sujansinghani 1952: Chhapgar 1962; Parida 1970: Ansari and Harkantra 1975; Trivedi and Patel 1975).

Export

Information about quantity exported and value realized from frozen, canned, and live products is given in Table 7.

Table 7: Export of crab products from India

Year	*Frozen crab meat*		*Canned crab meat*		*Live crab meat*	
	Qty (t)	*Value Rs.(100,000)*	*Qty (t)*	*Value Rs,(100,000)*	*Qty (t)*	*Value Rs.(100,000)*
1978	9	2.7	42	19.4	-	-
1979	-	-	56	29.3	-	-
1985-86	9	3.9	-	-	-	-
1986-87	30	13.5	-	-	-	-
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	-	-	619	133.6
1990-91	NA.	NA.	NA.	NA.	651	159.9

Source: MPEDA, Madras NA. = Not available

During 1978 and 1979, canned crab were the main export. However, frozen crab meat has been exported in large quantities in more recent years. Due to great demand from Malaysia and Singapore, the export of live crab commenced with 36 *t* during 1987-88. This has increased to 651 tin 1990-91, an 18-fold growth. Since catch statistics on S. *serrata* are lacking, the exact source of supply material for export is not known.

GENERAL REMARKS

The mud crab fishery of India has emerged in the Eighties as an export-oriented trade with considerable potential. It used to be a minor fishery catering to local consumption. S.*serrata* is fished extensively in the brackishwater regions of the country rather than in the marine sector. The contribution of the species to the brackishwater crab fishery is about 65.8 per cent, while in the marine sector it is only 4.5 per cent. However, there is a wide fluctuation in catches from the brackishwater sector. Though the present yield from both marine and brackishwater sectors is not known, the export of a considerable quantity of live crab in recent years is indicative of the quantum of exploition. Indeed, a close watch on the exploited stock in major fishing areas is necessary to ensure a sustained yield in future.

Biological studies on the species made in India have indicated that medium-sized crab have been the mainstay of the fishery in the different areas studied. Generally, females outnumbered males, with a few exceptions. The species has shown a preference for a crustacean diet in its feeding habits. The data on the size at first maturity in females has clearly indicated the existence of more than one species of the genus *Scylla.*

<<

The species appears to be a continuous breeder, with peak breeding activity generally in September-February along the southwest coast and in March-June and September-February along the east coast. The early juveniles of S. *serrata* occur throughout the year in brackishwater areas. Peak abundance was noticed in May-October along the southwest coast and in December-August along the east coast estuarine areas.

At present, the mud crab fishery in India is an unorganized one, with indiscriminate fishing of berried females continuing. Detailed investigations on areawise and gearwise exploitation, the rate of recruitment and abundance of early juveniles in the estuarine areas may explaine the causative factors responsible for the wide fluctuations in the exploited stock.

REFERENCES

ANON. 1951. Agricultural marketing in India. *Preliminary guide to Indian fish, fisheries, methods offishing and curing.* Marketing Series No 661. 1-138.

1960. Annual Report of Central Inland Fisheries Research Institute, Barrackpore. *Ind J. Fish.,* 7(1) 233-274.

1964-65, 1965-66. 1966-67 and 1987. *Administrative Report.* Dept. of Fish., Kerala.

1972, 1975. 1989-90. *Annual Report.* CMFRI. Cochin.

1982. Trends in marine fish production in India - *1981.* Marketing Fish. Inf. Serv. T&E Ser. No 41: 1-33.

1983. Trends in marine fish production in India - 1982-83. Marketing Fish. Inf. Serv. T & E Ser. No 52: 1.21.

1986. Marine fish production in India - *1983-84 and 1984-85.* Marketing Fish. Inf. Serv. T & E Serv.No 67: 1-67

1989. Marine production in India *1985-86.* Mar. Fish. Inf. Serv. T&E Ser. No 91: 1-32.

1986-87. Orissa fisheries at a glance. Dept. of Fish., Cuttack, Orissa. pp. 1-75.

ANSARI. Z.A. and HARKANTRA, S.N. 1975. Crab resources of Goa. *Seafood Export J.,8(3):* 2 1-24.

BANERJI, S.K. 1969. Crustacean production in India. *Bull. CMFRI,* No 14: 259-272.

CHACKO, P.L. and RAJAGOPAL. A. 1964. Hydrology and fisheries of the Ennore river system, near Madras from April 1960 to March 1961. *Madras J. Fish.* I(1): 102-104.

CHANDRASEAKARAN, VS. and NATARAJAN, R. 1987. Availability of juveniles of the edible crab *Scylla serrata* (Forskal) in Pitchavaram mangrove, Southeastern India. IN: *Aqua. Europe* 87-Intl. Conf. and Int. Exb., European Aqua. Soc., Amsterdam, p. 20.

CHHAPGAR, B.F. Crab fishing at Bombay. *J. Bombay Nat. Hist* 59(1): 306-309.

CHOPRA, B.N. 1939. Some food prawns and crabs of India and their fisheries. *J. Bombay Nat. Hist Soc.* 41(2): 221-234.

DATTA, SN. 1973. The edible crabs of the deltaic West Bengal. *Seafood Export J.* 5(12): 25-28.

EVANGELINE, G. 1967. Trend in the fisheries of the Adyar estuary during April 1963 to March 1965. *Madras.J. Fish.* 4:1 - 20.

EVANGELINE. 6. and SUBBIAH, K. 1969. Hydrobiology and fishery of the Ennore estuary from June 1965 to Mary 1967, *Madras.J. Fish.* 5: 139-151.

HILL, B.J. 1976. Natural food, foregut, clearance rate and activity of the crab *Scylla serrata. Mar. Biol..* 34: 109-116.

HORA. S.L. 1935. Crab fishing at Uttarbhag. Lower Bengal. *Curr. Sci.* 3(11): 543-546

JOEL. D. R. and SANJEEVARAJ, P.J. 1982. The breeding of three edible portunid crabs of Pulicat Lake. IN: *Progres.s in Invert. Repn. and Aqua.* Eds. T. Subramoniam and Sudha Varadharajan. Ind. Soc. Invert. Repn.. Madras. pp. 135-140.

JOEL, D.R. and SANJEEVARAJ. P.J. Taxonomic remarks on two species of the genus *Scylla* de Haan (Portunidae: Brachyura) from Pulicat Lake. *Ind J. Fish.* 30(1): 13-26

JONES, S. and SUJANSINGHANI, K.H. 1950. Notes on the crab fishery of the Chilka Lake. *J. Bombay Nat. Hist Soc.* 51(1): 128-134.

KATHIRVEL, M. 1980. Abundance of portunid crab seeds in Cochin Backwater. IN: *Proc. Svmp. on Coastal Aqua..* Mar. Biol. Ass. Ind., Abs. No 94.

KATHIRVEL, M. 1981. Present status of taxonomy and biology of *Scylla serrata* (Forskal). *Proc. Wkshp. on Crustacean Biochem. and Phvsiol..* CMFRI & Univ. of Madras, Madras pp. 1-13.

LALITHADEVI. S. 1985. Fishery and biology of crabs of Kakinada region. *Ind J. Fish.* 32(1) 18-32.

<<

MOHANTY, S.K. 1973. Notes on crab landings in Chilka Lake during 1971 and 1972. Souvenir, Cent. Inst. of Fish. Educ. Recreation Club, pp. l-3.

———————1975. Further observations on the crab landings in the Chilka Lake durmg 1973. Bull. *Dept. Mar. Sci. Univ.* Cochin 7 631 l-635.

PARIDA, N.C. 1970. A note on the Chilka Lake crab Scylla serrata. *The* Chilka *Lake.* Dir. of Fish. Orissa. Cuttack, pp.66-69.

PILLAI, K.K. and NAIR, N.B. 1973. Observations on the breeding biology of some crabs from the southwest coast of India. *J.* Mar *Biol. Ass.* Ind. 15(2): 745770.

PILLAI, K.K. and NAIR. N.B. 1975. Observations on the breeding cycles of certain estuarine crustaceans of the southwest coast of India. IN: *Recent Advances in Estuarine Biol.* (Ed) R. Natarajan, Hindustan. Publ. Corpn., Delhi, pp. 127-l 36.

PRASAD, P.N.. SUDHARSHANA. R. and NEELAKANTAN. B. 1988. Feeding ecology of the mud crab Scylla *serrata* (Forskal) from Sankari backwaters. *J. Bombay Nat. Hist Soc 85* (1): 79-89.

RADHAKRISHNAN. C.K. and SAMUEL, C.T. 1982. Report on the occurrence of one subspecies of Scylla serrata (Forskal) in Cochin backwaters. *Fish. Tech.* 19: 5-7.

RAM, B.H.M. and CHANDRAMOHAN, R. 1978. Some preliminary observations on the trend in commercial crab fishery of Mangalore. *Seafood Export J.* 10(5):25-27.

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

SHANMUGHAM. S. and BENSAM, P. 1980-81. On the fishery for the crab Scylla serrata (Forskal) at Tuticorin during 1974. *75. Ind. J. Fish. 27:* 102-l IO.

SRINIVASAGAM. S. 1975. *Studies* on *edible* crabs *of Porto* Novo waters. M. Sc. dissertation. Dept. Mar. Biol., Annamalai Univ., 43 p. (unpublished).

SRINIVASAGAM, S. and RAMAN, K. 1985. Crab fisheries of Pulicat Lake with special reference to catches from the southern sector. IN: Proc. Symp on Horvest *and Post-Harvest Tech.* of *Fish.* Soc. Fish. Tech. (Ind.) pp. 63-68.

SRINIVASAGAM. S., RAMAN. K.. JOSEPH, K.O.. ABDULKADIR, P.M. and KRISHNAN, S. 1988. Prawn, crab and fish seed resources from brackishwater bodies of Madras. IN: Symp on *Trop. Mar. Living Res.* Mar. Biol. Assn. Ind., Abs. No 18.

TRIVEDI, Y.A. and PATEL. M.I. 1975. Crab fishery of Gujarat. *Seafood Export J. 7 (11)*: 17-19

<<

MUD CRAB — A POTENTIAL AQUA-RESOURCE OF BANGLADESH

by Md. Kador Ahmed
Fish Inspection and Quality Control, Muradpur. Chittagong, BANGLADESH

ABSTRACT

Bangladesh has a substantial area of mangrove tidal flats that enables successful capture and culture of mud crab. Mud crab are a relatively unexplored marine resource in Bangladesh and very little information is known about them. Therefore. an attempt is made here to describe their occurrence, seasonal abundance, trapping techniques, post-harvest technology and transportation, besides marketing and export potential. Considering the income potential of this culture, a number of useful recommendations have been made to improve cultural practices and to encourage mud crab fishermen.

INTRODUCTION

The total inland freshwater area of Bangladesh is 4,299,964 ha, of which 4,047,3 16 ha are open water and the remaining 252,378 ha are closed waters, which include a coastal shrimp culture area of 100,000 ha. The open sea area within the E.E.Z. is about 166,000 sq. km. (Rahman. 1991). Animal protein sources from the land and freshwater are fast decreasing. Rivers, tributaries and their natural depressions are accumulating silt due to deforestation activities and damming operations in Bhutan, China, India and Nepal. The corresponding reduction in flood plain area has adversely affected inland fish production in Bangladesh. Therefore, it is time that rational capture and culture of inshore and offshore fishery resources of the Bay of Bengal are promoted. The Bay of Bengal is the least explored and investigated part of the world's oceans.

Bangladesh has a coast line of about 480 km and about 628,780 ha of potential mangrove tidal flats (Mac-Nat, 1974), where capture and culture of mud crab can be undertaken profitably. Many rivers and tributaries terminating in the Bay have formed an intricate network of cross-channels and creeks in Bangladesh's estuarine area.

A crab fishery has not yet been established in Bangladesh. Bhuyan and Das (1976) made a taxonomic investigation and reported 15 species of crab from the intertidal zone. Mahmood (1977) reported 16 crab species off the coast of Bangladesh. Islam (1977) worked on the Brachyura of Bangladesh, with special reference to the biology of *Scylla serrata*.

In this paper, the mud crab resource of Bangladesh, its occurrence, seasonal abundance, trapping techniques, post-harvest activities and transportation are discussed, besides its marketing status and export potential. With proper attention the culture of mud crab could play an important role in enhancing protein production, foreign exchange earnings and internal trade development. But above all, it could help create employment opportunities for the unemployed and underemployed fishermen of the coastal areas.

MUDCRAB RESOURCE

The mud crab *(Scylla set-rota)* supports a year-round local fishery in coastal mangrove areas. Among the 16 species identified, it is reported that only the mud crab and swimming-crab *(Neptunus pelagicus* L) are consumed in Bangladesh. *Only S. serrata* of the genus *Scylla* is known in Bangladesh (Islam 1977 and Mahmood 1977).

Estampador (1949) reported three species of the genus *Scylla,* namely *S.serrata* (Forskal), *S.oceunica* (Dana) and *S.transquebarica* (Fabricius). and one new variety *S.serrata* var. *paramamosain*

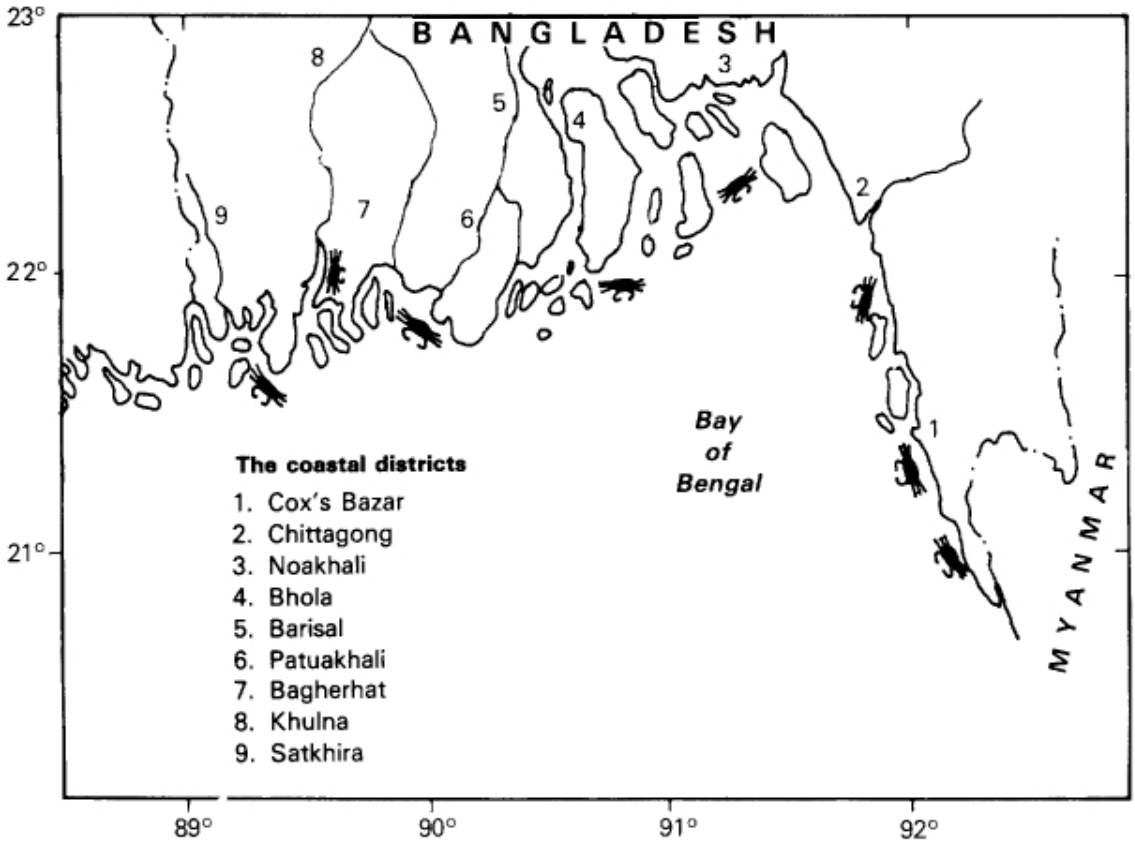
<<

(Estampador). The genus is reported to be represented by four species in Vietnam and Malaysia (Ong 1964). The number of species of genus *Scvlla* in Bangladesh waters should he ascertained.

In Bangladesh, the mud crab occurs throughout the coastal districts of Cox's Bazaar. Chittagong. Noakhali, Bhola, Bonsai, Potuakhali, Bagerhat, Khulna and Satkhira.

The population density of mud crab in the intertidal zones of the estuaries and coastal backwater swamps of Cox's Bazaar, Chittagong. Khulna, Satkhira and Bagerhat appears to he relatively higher than that of Noakhali. Bhola. Potuakhali and Bonsal. The first five coastal areas have mangrove vegetation, while the coastal areas of the other four districts are deltaic muddy shores with new vegetation (Figure 1).

Fig. 1 The coastal areas of Bangladesh



No estimate is available on the potential yield of crab from the estuarine and coastal backwaters of Bangladesh. In this paper we have made estimates for three coastal regions (Table I). This preliminary estimate was made through interviews with local crab catchers and suppliers.

Table 1: Present production of mud crab.

S.No	*Coasta! distri is (Region)*	*Produc tion* (t)
	Cox's Bazar and Chittagong southeast)	600
2.	Noakhali. Bhola, Bonsal and Patuakhali (middle southern)	350
3.	Bagerhat. Khulna and Satkhira (southwest)	1200
		2150

<<

SEASONAL ABUNDANCE

Observations on the capture of crab with traps and line show a seasonal abundance pattern in the coastal backwaters.

The peak harvesting season is from mid- to late monsoon (June-August). Late pre-monsoon, early monsoon (April-May) and early post-monsoon (September-October) are seasons of modest harvest. From winter to mid-pre-monsoon there is less abundance. But, whatever the season, the catch, has 30 per cent berried females in it.

Ferdouse (1990) stated that June to August is the peak season for mud crab fishing in Malaysia. Sastri (1950) recorded the fishing season for crab in West Bengal as May to June; in Madras it extends from March to June and in Bombay August to October. In Bangladesh, peak abundance appears to directly correlate with Ferdouse (1990), but varies slightly with Sastri (1950). Perhaps this is due to geographical variations.

The fishermen explain that, during winter the crab migrate offshore to breed. This might be the, cause of reduced abundance. Edwards and Early (1978) stated that European fishermen fish for crab throughout the year, the main season being March to September, with peak catches in May and June. They also state that crab move into deeper offshore water in winter, returning inshore in spring. This is more or less the same situation in Bangladesh, even though it is a subtropical country.

Field observations of Macintosh (1984) reveal that from October to January the ratios of females caught to the total catch in the mangrove areas of (Malaysia) were low compared to other months, whereas the ratios of berried females caught by offshore trawling increased during November and December. This clearly indicates that the female crab move out from the mangrove forest to spawn offshore, which is what the observations, in Bangladesh also indicate.

LARVAL (MEGALOPA) ABUNDANCE OF CRAB IN THE MATAMUHURY ESTUARY

Crab have been harvested indiscriminately in some maritime nations, resulting in a noticeable decline in the population. The question of restocking in their natural environment by artificial propagation is under consideration in some of these countries (Macintosh, 1991).

The author analyzed a year's (May 1985 to April 1986) plankton sample to study the relationship of megalopa with the post-larvae of tiger shrimp (Penaeus monodon), their breeding period and abundance in time and space. The average monthly occurrence of megalopa along with some physico-chemical parameters are given in Table 2.

Table 2: The average monthly occurrence of megalopa (invd/100m^3 of water) and some physico-chemical parameters of Matamuhury estuary (May '85-April '86)

Month	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Megalopa/l 00m^3	84.54	117.57	547.45	336.16	86.95	56.46	71.78	134.28	256.54	7,247.85	69.38	23.02
Salinity %	30.41	17.67	8.94	2.67	2.03	6.61	19.79	23.89	28.60	31.95	32.79	24.50
Dissolved 0. ml/l	3.85	4.45	5.18	5.75	5.91	5.80	6.68	6.57	5.64	5.50	5.03	4.06
Water temp. 0°C	31.23	29.36	28.49	28.43	29.78	28.93	27.04	22.47	21.22	23.43	26.47	28.50
Rainfall cm	42.50	55.20	80.10	32.60	17.50	8.60	0.00	4.20	1.70	0.60	8.80	14.30

<<

Megalopa was available the year round. The peak abundance was in February '86. Harvey (1990) stated that young mud crab are found throughout the year, but medium-sized crab appear more abundant in the rainy season in Malaysian waters. The present larval findings (megalopa) are in close agreement with those of Harvey (1 990).

Macintosh (1984) stated that brachyuran larvae (both zoea and megalopa) were in high density in the zooplankton communities throughout Klong Nagao, Malaysia, during all sampling periods. The high density recorded for zoea and megalopa were of the order 13,250 and 18.000/1000 m^3, with peak numbers recorded during wet seasons. The Bangladesh findings correlate with Macintosh's. but varies with peak abundance, although a secondary peak (548 indvls./100 m^3 in July) shows some similarity.

CRAB CULTURE PRACTICES

In Bangladesh, traditional shrimp culture is done simply by "trapping, holding and growing" the wild shrimp fry gathered from tidal waters. Mud crab larvae also enter the ponds along with the tidal waters, but the culturists do not take any special care of them. In fact, culturists complain about the nuisance caused by the crab: they make holes in the dykes, which drain out the water.

Using the experience of shrimp culture, some professional crab catchers have become interested in crab culture. Because of the rough weather during the monsoon, these crab catchers generally cannot go far out to fish for crab.

In 1987, a group of fishermen (Buddhopara in Chokoria) tried to culture juvenile mud crab to marketable size in the Matamuhury Estuary at Chokoria. They enclosed 46 ha of mangroves with earthen dykes. The topography of the pond was such that one side was slightly above the littoral zone and the other side was lower, allowing tidal water exchange through the little space between the bamboo poles. This provided a natural habitat for the crab to swim and burrow.

Juvenile mud crab of 2-4 cm were released into the pond and trash fish were used as supplementary feed. After 3-4 months of culture, the first crop was harvested and the next crop was started. Unfortunately, the fishermen did not keep any input/output record or follow any monitoring system. But they found the trial not profitable and abandoned it. A lack of previous experience, technical knowhow and financial constraints were, it would seem, the factors that led to the failure of the project.

CRAB FISHING IN BANGLADESH

Crab were a virgin stock in the past. Hindus, Buddhists and tribals were the traditional consumers of crab in Bangladesh; the majority Muslim population did not favour them as a food item. No specific reason could be identified for this; it was just a traditional convention based on preference and belief. But it might have been primarily because of the existence of extensive inland fish resources. These attitudes, however, are slowly beginning to change.

Over the years, inland fish production has declined, due to man-made and natural causes. After independence, in 1971, the importance of utilizing sea fish, and non-traditional items like crab, as a source of animal protein supply, was emphasized. The crab consumption habit of the coastal people helped to develop crab fishing in the country.

The mud crab, a popular delicacy in the Indo-Pacific region, is now finding more consumers in Bangladesh. A small local crab market exists in the southern coastal areas of the country. International trade in crab has also begun to grow recently. Live mud crab first appeared as an export item in 1977-78 and, from 1982, exports have been increasing.

<<

Methods

Bangladesh fishermen use indigenous fishing craft and gear to trap crab. A craft locally called nowka (country boat) is operated manually by these fishermen. It measures approximately 7-8 m in length, 0.9 - 1.2 m in breadth and 0.3-0.5 m in depth and is operated by one or two fishermen. Mechanized devices have not yet been developed for crab fishing. Generally, fishermen use the local gear suited to a particular habitat to trap crab. The types of gear and their ways of use are described below :

LONG METAL HOOK

The fishermen scout around the inter-tidal flats for crab burrows. When a hole is detected, this gear is used to corner the crab. Once the retreat of the crab is cut off, it rises on its hind legs, waving its large claws to frighthen away the assailant. When it grips the rod with its powerful claws, it does not let go. It can thus be easily taken out along with the rod. This technique is used by the small-scale fishermen of Noakhali, Barisal and Teknaf Districts.

SPLIT BAMBOO TRAP (Ckai)

The chai, or tonga, has two openings or eyes, which are funnel-shaped, the mouth being wide for entry and the inner end narrow to prevent escape. Fish and mussel are used for bait. Generally, at the beginning of high tide, 60-100 ckai are placed in rows across a canal, tied with a rope or fixed individually with a stick. Some fishermen also operate the trap in the channels during low tide. After the crab are collected, the chais are rebaited and set again. Trapping crab by this method is practised for 5-7 days at a stretch mainly by the fishermen of Chokoria and Cox's Bazar.

ROPE LINE

Crab are extensively fished in the estuarine and mangrove swamps of the Sundarbans using this method. A rope line of about 100-200 m is stretched across the estuary or swamp. One end of the rope is tied to a pole fixed on the bank and the other end is towed by boat to the extent the rope permits. This line is weighted at regular interval with bricks. Pieces of eel or green mussel meat are suspended as bait in between the weights. Each bait is secured by a noose, so that when the crab tugs at the bait, the noose tightens around the crab, which then clings to the line with its claws. When the line is sufficiently heavy with crab, the fishermen lift the rope to within 5-8 cm of the water surface. The crab are then captured with a scoopnet and stored in a tin basket to prevent their escape. Should the line be raised above the water surface, the crab will drop off the line.

CASTNET

This gear is generally used to catch shrimp and fish. During such fishing, a small quantity of crab are also entrapped. In semi-intensive shrimp culture farms, the culturists spread pieces of fish in a definite area where crab concentrate. Then they use the castnet to entrap the crab, which are considered pests by the shrimp farmer.

SET BAGNET

During the regular water exchanges through the sluice gates in shrimp farms, indigenous set bagnets are installed by the gates to prevent the shrimp from escaping. During this activity, some crab too are entrapped in the nets.

Among the five methods described above, the first three methods are specifically used for crab trapping. The rope line used in the Sundarbans is the most effective of these methods.

<<

DOMESTIC MARKETING

Two types of markets exist for crab in Bangladesh: (a) local markets in the vicinity of fishing villages, and (b) consumer markets away from the fishing areas. The non-Muslims and the tribal people of the Chittagong Hill Tracts are the major consumers of crab from Chokoria and Cox's Bazar. The non-Muslims of Da Koop Koira and adjacent areas are the main consumers of the Sundarbans crab. In addition, a good portion of the catch from Chokoria and the Sundarbans is sold in Chittagong and Khulna.

Direct sale by fishermen in the local market or in consumer markets is the genera1 mode of marketing. Sometimes a member of the fisherman's family participates in marketing. Previously, there were no middlemen in this trade. But now two purchasing centres, at Soron Khola and Buringualine in the Khulna region, have been set up. Crab are purchased at these centres by retailers, for supply to the consumer market.

The retailer sells crab in fish markets or, sometimes, door to door, keeping them in the bamboo baskets. Selling and purchase are generally determined by bargaining. Each pair of medium sized crab sells at about Tk.* 8-12. The larger, meat-heavy crab are selected for export.

EXPORT MARKETING

Mud crab are at present a good export item, either in the form of meat frozen in a block or in a cooked condition or alive. There is a growing demand for crab worldwide.

Mud crab are exported in live condition from Bangladesh through Dhaka airport. A few consignments have been exported in Individual Quick Frozen (IQF) and block frozen meat forms as trade samples. The present price trend of live, exportable-size crab in the selling centre are given in Table 3.

Table 3: Price trend of exportable mud crab in selling centres

Sex	*Individual crab/kf*	*Average price/kg (Tk)*
MALE	1-5/kg	35 · 40
FEMALE	1-8/kg	40 · 50

Although female crab fetch a better price than males, the fishermen usually get an average price from exporters. The exporters in Dhaka require the crab to be shipped to Dhaka. If there is any mortality during transportation to Dhaka, the value loss is deducted from the catcher's payment. Mortality generally varies from IO-20 per cent, but in summer it is more, due to high ambient temperatures. The export value of live crab is 2-3 US $/kg.*

Hong Kong, Malaysia and Singapore are the principal buyers of live crab from Bangladesh. Crab have also been exported to Thailand, Taiwan, Sweden, Pakistan and Kuwait.

Even with Bangladesh's limited mud crab trade, export earnings have been increasing (see Table 4).

Table 4: Yearly export earnings from mud crab

Year	*Value in 1000 Tk*	*Exchange rate US $ 1 = Tk*
1982-83	570	23.54
1983-84	867	24.54
1984-85	990	25.85
1985-86	1834	29.68
1986-87	6467	30.39
1987-88	9850	30.93
1988-89	4262	31.72
1989-90	1000	32.66
1990-9 1 (upto January 91)	12200	36.20

Source: Export Promotion Bureau

*** US $ 1 = 36 Taka appx. (1991)**

<<

TRANSPORTATION

There is no standard transport system for live crab. In the fishing grounds, crab are collected in a rectangular tin box or in split bamboo, long-necked baskets which prevent the crab climbing out. A layer of wet betel-nut leaf is placed in the bottom of the container to provide some cooling and to prevent dehydration.

The smaller or medium sized crab are transported by truck or bus to selected local markets in tightly packed bamboo baskets. The larger crab are transported to Dhaka for export. The night hours, when the ambient temperature is lower, are favoured for transport.

Export quality crab are packed in knitted bamboo baskets after tying their claws. Each basket contains 10-20 kg of crab. The baskets are stacked one above the other. The basket bottom is covered with polythene sheets to avoid leakage.

CONSTRAINTS

Traditional crab fishing and culture are not flourishing because of the following constraints:

1. Lack of proper transportation and marketing facilities.
ii. Lack of buyer and market information.
III. Inadequate aircraft space and desired flights to importer countries.
iv. Lack of technical knowhow to enable scientific production and the introduction of proper management systems.

Because of these constraints, fishermen receive low prices for their catch — mainly due to weight loss and high mortality. Sometimes they have to sell the crab at minimal prices.

CONCLUSIONS

From the above, it may be concluded that the mud crab fishery in Bangladesh could grow as a foreign exchange earner if the problems of aircraft space and flight frequencies could be solved. If exports could be increased, crab growing and fattening could develop as an income-generating occupation for small-scale fisherfolk in Bangladesh.

RECOMMENDATIONS

1. An investigation of mud crab in inshore and offshore waters to assess the stock size and sustainable yield.
2. Arrangement of adequate aircraft space and low freight rates.
3. Bangladesh Biman to consider the introduction of a live crab commodity concession.
4. Government participation in internal crab promotional activities.
5. Introduction of techniques for crab meat processing.
6. Arrangement with the help of international agencies for the training of professional crab fishermen in capture, culture and other relevant activities.
7. Research activities on mud crab biology to be given importance.

REFERENCES

BHUYIAN. A.L. and DAS, N.G. 1976. A preliminary study on the taxonomy of crabs (crustacea brachyura) of the north-eastern part of the Bay of Bengal Symp. P. 1st Bangla. Sci. Conf. 48 p.

EDWARDS. E. and EARLY. J.C. 1978. Catching, handling and processing crabs. Torry Advisory Note No. 26 (revised). 16 p.

ESTAMPADOR. E.P. 1940. Studies on Scylla (Crustacea : portunidae) I. Revision of the Genus. Phil J. Sci- 78 (1) 95-108.

<<

FERDOUSE. F. 1990. Live mud crab - a Malaysian favourite. ***INFOFISFI*** *international*. 6/90 MC (P) No. 96/5/85. 55-57

ISLAM. J. 977. *Brachvura of the Rarnati,llv Estuary and north-east part of the Bay of Bengal with special reference to the biology of* Scylla serrata. M.Sc. Thesis. Dept. of Mar. Biol.. Univ. of Chiuagong. 160 p.

MACINTOSH. J.D. 1984. Ecology and productivity of Malaysian mangrove crab populations (Decapoda: Brachyura). IN; *Proc. **Asian** Symp. on Mangrove **Env Res. and*** Mgmnt Soepadmo. E.. Rao. A.N. and Macintosh. D.H. (eds) Univ. of Malaya and UNESCO. 354-357

1991. *Final report of the integrated multidisciplinary survey and research programme of the Ranong Mangrove Ecosystem* RAS/86/I 20 183 p.

MAC-NAC. 1974. *Mangrove Forest and Fisheries.* FAO/UNDP/IOPC/Dev/74/34 VIII 35 p.

MAHMOOD. N. 1977. Crustacean fauna of the Bay of Bengal of the coast of Bangladesh. Paper presented at the Biol. Wkshp. organized by Banglad. Nat. Commission, for UNESCO. 6 p.

ONG KAH SIN. 1964. Observations on the post-larval life history of *Scylla serrata* (Forskal) reared in the laboratory. ***Malay** Agri. **J.*** 45(4) : 429-443

RADHAKRISHNAN. C.K. and SAMUEL. C.T. 1982. Report on the occurrence of one sub-species of *Scylla .verrafa* in Cochin Backwaters. *Fish. Tech.*. Cochin. Vol. 19 N I 5-7

RAHMAN. A. 1991. Strategies for the development of fisheries resources. Paper presented in 13th Foundation Tmg. Programme. Officers Trng. Inst.. Savar. Dhaka. May 11-July 9. 1991. 4 p.

SASTRI, B.N. 1950. *The wealth of India — **A** dictionary of Indian raw materials and individual products.* Vol. II. 427 p.

WATSON, J. 1969. Biology and conservation of the queen crab Proc. Meeting oil Atlantic crab fishery development. *Canadian* Fish. ***Rep.*** No. 13. 18-27.

<<

A REVIEW OF THE MUD CRAB *(Scylla Serrata)* FiSHERY ON THE EAST COAST OF INDIA AND IN KERALA STATE

by M Mahesh Raj
Nattonal Consultant, with the Bay of Bengal Programme,
9 l St. Mars's Road, Ahhirarnapurarn. Madras 600 018
INDIA.

ABSTRACT

Mud crab Scylla serrata *are landed in all the east coast states of India. The craft and gear used for its fishing and the fishing season varies with the region.*

Although the local market .tor mud crab is good, interest is being focussed on their exports, which started very recently. Export of live mud crab is a thriving activity today. Kerala. a state on the west coast of' India, is a major supplier to the export trade. Madras is the focal point of live mud crab exports front India. which are mainly to the Singapore and Malaysian markets.

INTRODUCTION

The crab fishery in India is yet to be recognized as a major fishery despite the abundant occurrence of food crab all along the Indian coast. This could he attributed to the fishery being seasonal and confined to narrow coastal belts, and crab being generally considered cheap food in India.

Most of the commericaily important edible crab belong to the family Portunidae, which includes such crab as *Scylla serrata* (Forskal), *Portunus pelagicus* (L), ***Portunus*** *sanguinolentus* (Herbst) and *Charrhdis crusiata* (Herbst). Among the edible species, *Scvlla serrata,* commonly called the mud crab or green crab, is important. It is popular because of its size, meat quality, high price and export potential. Mud crab are locally called *nandu* in Kerala and Tamil Nadu. *petha* in Andhra Pradesh. *kankada* in (Jrissa and *kankra* in West Bengal.

In recent years. the demand for seafood, especially shrimp, lobster and live crab, for export has been increasing quite considerably. There are also growing local requirements.

The ability of mud crab to grow fast and its suitability for culture in brackishwater and estuarine areas make it attractive to develop mud crab culture/fattening programmes in India to meet the increasing demand.

The objectives of this survey are to assess the state of the mud crab, *Scylla serrata,* fishery on the east coast of India and Kerala. with particular emphasis on the major landing centres, gear and craft used, the fishing communities involved and their socio-economic status, the fishing season. marketing structure (domestic and export), aspects of mud crab culture, and the current status of mud crab culture research.

<<

THE MUD CRAB FISHERY GROUNDS

The mud crab fishing grounds along the east coast of India and Kerala state are highly dispersed and are often located in remote areas especially in West Bengal, with poor accessibility. However, many places which could be categorised as major mud crab landing centres were identified during the survey (See Figure l, facing page).

Kerala: The major landing centres for the mud crab fishery are the Kochi (Cochin) areas, especially Vypeen island, Neendakara in Kollam (Quilon) and Kozhikode (Calicut),

Tamil Nadu: The important landing sites are Pulicat Lake, the Killai backwaters, Porto Novo, Muthupet (Thanjavur Dist.), Adiramapattinam, Pattukkotai, Nagapattinam, Mandapam, Tuticorin and Rameswaram.

Andhra Pradesh: The major landing areas are the villages around Kakinada. like Peddavalasala, Chinnavalasala and Gadimoga, and Dowleswaram and Rajahmundry near the Godavari estuary.

Orissa: Most of the landings are from the Chilika Lake. The major fishing grounds in the Lake. are by Parikud, Nuapada, Mahisa, Berhampur, Garubai, Satapada, Arkhakuda, and areas between Kalupada and Nuapada. Mud crab are also landed in Paradwip.

West Bengal: The mud crab fishing grounds are scattered all along the Sundarbans and include several ramote areas in the district of 24 Parganas. Important crab landing areas are Basirhat, Basanti, Sonakhali, Port Canning, Kakdwip, and Namkhana.

GEAR USED IN THE MUD CRAB FISHERY

The main gear used in the mud crab fishery are the longline, hook-and-line, gillnets. crab traps, dragnets and castnets. The kind of gear and the frequency of use varies from place to place. While longline, hook-and-line, crab traps and crab gillnets are used exclusively for crab fishing, other gear, like dragnets and castnets, are mainly used for shrimp and other fish. Crab are also landed as bycatch.

Longline: Longline with bait is the most widely used gear in the mud crab fishery along the east coast of India and Kerala. The construction of the gear and the way it is used varies slightly from place to place.

The longline essentially consists of a main line of coir rope (300 m.) and branch lines attached to it (See Figure 2, page 107) at intervals of l-2 m (I m intervals in Andhra Pradesh, 2 m intervals in the Killai estuary, where it is called *thamuni* kavaru). The bait are tied to the ends of the branch lines. In Kerala, bait is mainly fish head and gills, while in Tamil Nadu pieces of catfish, eel, shark, and ray are used. In Andhra Pradesh, dried bits of eel are used. The longline is operated at depths of l-4 m.

Longlines (75-100 m) with hooks attached at intervals of 3-3.5 m are used in Chilika lake, with decaying shrimp and catfish (Mysrtus sp.) as bait. One end of the longline is tied to a pole which is planted at a point selected by the fisherfolk. The line is then gradually released as the craft moves away from the pole.

The line is allowed to rest undisturbed at the bottom of the water for IS-30 minutes before being slowly hauled in by moving the craft towards the pole. Crab can now be noticed just below the water surface, clinging to the bait, and they are collected using a scoopnet.

<<

GENERAL REMARKS

In the carcinological study on brachyuran crab, the shape and structure of the first male pleopod has been considered as a specific tool for identification (Stephensen *1945).*

Joel and Sanjeevaraj (1983), who described the male pleopod of S. *tranquebarica* and S. *serrata,* found only minor variations. Such similarity in the shape and structure of the male pleopod in a closely related species of portunid crab has been shown earlier (Stephenson and Campbell 1959). While summarizing the evolution and ecology of Australian portunid crab, Stephenson (1960) thought that S. *serrata* was the only species of portunids that successfully invaded the estuarine habitat and that their estuarine life had led to the isolation of *Scylla* populations, enabling speciation. Speciation in *Scylla* is the result of 'translocation' of chromosomes (Estampador 1949a).

Colour, morphological and biological characteristics reported on *Scylla* from the Philippines, Vietnam and India have established the existence of more than one species. Further species-wise biological studies in the major fishing areas would throw more light on the population dynamics of a species co-existing in the same environment. To create an awareness of the existence of more than one species of *Scylla,* a critical colour photographic atlas may be necessary to conduct research and development programmes on this valuable seafood.

A critical study of the available information on the taxonomy of *Scylla* suggests that there are at least two distinct species, namely S. *serrata* (Forskal *1755)* (top, facing page) and S. *tranqueharica* (Fabricius 1798) (bottom, facing page), characterized by differences in size, spines on the outer border of the carpus of the cheliped, and habitat preferences.

S. *oceanica* appears to be a synonym of *S. tranquebarica.* Both of them grow to a larger size, do not live in burrows and have two sharp spines on the outer border of the carpus of the cheliped. Colour variations noted by various scientists may be due to geographic variations.

S: *serrata* grows to a smaller size, lives in burrows and has one one spine on the outer border of the carpus of the cheliped, the other tooth being absent or blunt. The differences noted in coloration may be due to geographic variations. However, a detailed study of material from various regions of the Indo-Pacific is needed to come to a definite conclusion.

REFERENCES

ALCOCK, A. 1899. Materials for carcinological fauna of India. No. LV. the Brachyura . Cyclometopa. Part II. A revision of the Cyclometopa with an account of the families Portunidae, Cancridae and Corystidae. *J. Asiat. Soc.* Bengal 68(2): 1-104.

DANA, J.D. 1852. Crustacea. IN: *United States Exploring Expedition during the years 1838-1842, under the command ot Charles Wilkes, U.S.N.* Vol. 13, Part 1: *1-685.*

DE HAAN,W 1833. Crustacea. IN: P.F. von Siebold's *Fauna Japonica* /pp.i-xvii, i-xxxL, 1-24 pls. 1-55 A-Q. J. Muller and Sons, Amsterdam. Dates of sections from: Hoithuis, L.B. 1953. On the dates of publication of W. de Haan's volume on the crustacea of P.F. von Siebold's *Fauna P Japonica. J of the Soc. of the BihI. of Natural History,* 3(1): 36-47.

ESTAMPADOR, E.P. 1949a. Studies on *Scylla* (Crustacea: Portundae). I. Revision of the genus. *Phil. J. Sci.* 78(I): 95-108.

———— 1949b. Studies on *Scylla* (Crustacea: Portunidae. II. Comparative studies on spermatogenesis and oogenesis. *Phil. J. Sci.* 78(3):301-353.

FABRICIUS, J.C. 1798. *Supplementum entomologiae s stematicae.* Hafniae, *572 p.*

FORSKAL, P. *1755. Descriptiones animalium, avium, amphihiorum. insectorum. vermium quae in itenere orientali ohservavit.* Petrus Forskal 19 . xxxii . 64 pp. Hafniae.

JOEL, D.R. and SANJEEVARAJ, P.J. 1983. Taxonomic remarks on two species of the genus *Scylla* de Haan (Portunidae: Brachyura) from Pulicat Lake. *Ind. J Fish.,* 30(1): 13-26.

KATHIRVEL, M. 1981. Present status of taxonomy and biology of *Scylla serrata (Forskal).* Wkshp. on Crustacean Biochemistry and Physiology, CMFRI & Univ. of Madras, p. 1-13.

<<

RADHAKRISHNAN. C. and SAMUEL, C.T. 1982. Report on the occurrence of one subspecies of Scylla serrata (Forskal) in Cochin backwater. Fish. *Tech. 19:5-7.*

SERENE. R. 1952. Les espacas du genre scylla a Nhatrang (Vietname) Proc. Indo-Pacific Fish. Council. 1 I: 133-137

STEPHENSEN. K. 1945. The Brachyura of the Iranian Gulf. With Appendix: The male pleopods of *the* **brachyura Danish Scientific Investigations in Iran 4:57-347.**

STEPHENSON, W. 1960. Evolution and ecology of portunid crabs with special reference to Australian species. Ed. M G W Leeper, The *evolution* **of** *living organisms* **Melbourne Univ., Melbourne. pp. 31 I-327.**

_____and CAMPBELL. B. 1959. The Australian portunids (Crustacea: Portunidae) III. The genus Portunus. *Aust. J. Mar. Fshw. Res.* **10(1):89-124.**

<<

SEED SUPPLY

<<

EXPERIMENTS ON LARVAL REARING AND SEED PRODUCTION OF THE MUD CRAB *Scylla serrata* (Forskal)

by R Marichamy and S Rajapackiam

of the Central Marine Fisheries Research Institute, Cochin - 682 031 INDIA

ABSTRACT

The minimum period for the larvae of syclla serrata *to metamorphosise into the crab stage from the time of hatching is* 24-30 *days. The incubation period of berried female crab is 8-15 days. Embryo development is faster during summer. Temperature and salinity have a significant effect on survival and development of the crab larvae. The most suitable range qt temperature is 27- - 30° C. with salinity around 35 ppt. In the present experiments. rotifers developed from* chlorella *diet, were fed to early :oea while newly hatched* artemia *nauplii were given to later :oeal stages. A maximum of 15 per cent of the larval Sto(k attained the crab stage The rate of production could he considerably increased with improved feeding strategies and water quality management.*

INTRODUCTION

Among portunid crab, the mud crab, *Scvlla serrata* (Forskal) is subject to intensive fishing in areas where they are concentrated, such as estuaries and contiguous brackishwater mangrove shores. Over fishing has stimulated aquaculture ventures in some Southeast Asian Countries (Escritor 1972; Marichamy *et al.,* 1986). Experiments on rearing larval stages to juveniles under controlled conditions have been conducted in Malaysia, the Philippines, Thailand and Australia with varying degrees of success. Practical techniques for commercial production of juveniles in hatcheries have been developed in Taiwan and Japan. A review of the literature shows that there have been a few efforts in recent years to culture the larvae of mud crab in other regions using a variety of techniques (Ong, 1964. 1966; DuPlesis, 1971; Brick 1974; Hill 1974, 1975; Heasman and Fielder 1983; Marichamy and Rajapackiam, 1984). The present investigation attempted to evolve in a hatchery in Tuticorin, India, suitable techniques for the mass rearing of larvae to produce crab seed.

MATERIALS AND METHODS

Ovigerous females are easily obtainable year round from the commercial catches of bottom set gilinets operated at 7-10 m depth off Kayalpatnam, south of Tuticorin. The percentage of females was relatively high during April-June and September-October.

Brood stock were kept in fibreglass tanks of l t capacity and covered with black cloth to cut out light and avoid physical disturbances. Filtered and aerated seawater was used. The spawner crab were separated after their eggs hatched and were kept separately so that subsequent spawnings could be observed. Soon after hatching, the active larvae were segregated and placed in small tanks of 300 litre capacity at stocking densities varying from 25-75/litre. Cultures of *Chlorella* and rotifers were also maintained simultaneously in the wet laboratory to feeding early zoea larvae. Locally collected *Artemia* cysts were used to feed later zoea. Frozen nauplil from *Artemia* cysts were fed to megalopa. Macerated prawn meat and boiled clam meat constituted the food for megalopa and crab stages. Dead larvae and exuviae were removed every day to prevent contamination of the rearing media. Active zoeae normally congregated in corners of the rearing tanks and were strongly photopositive. Such behaviour facilitated cleaning and water changing. Excess food was removed and three-fourths of the tank volume replaced every day. Larval numbers were estimated daily by counting five replicates of 200 ml samples collected from the rearing tanks.

<<

Assessment of each zoeal stage was done at the completion of different levels of metamorphosis to determine feeding rates. Larvae were fed at 6-hour intervals. Tanks were completely covered with a black cloth to maintain equal distribution of larvae and feed in the tank. The experiments were carried out to find natural environmental conditions suitable for the production of crab seed. Temperature and salinity were not controlled.

REARING OF BROODS AND INCUBATION

Sevila serrata spawns throughout the year in tropical waters. It is believed that maturation and spawning take place in the sea (Ong, 1964). However, Heasman and Fielder (1983) developed spawner crab by bilaterial eyestalk ablation under controlled laboratory conditions.

Spawner crab were obtained from brood stock at Tuticorin during the summer months when salinity was 34-36 ppt. Male and female crab of sufficient size for maturation (9-1 1cmin carapace width (CW)) were stocked at the rate of $1/m^2$ in a separate fenced area inside the crab culture ponds and fed intensively with fish offal and bivalves. After an interval of 4-6 weeks, 13 females out of 25 become ovigerous. These were removed from the ponds for further rearing in the laboratory. Gonadal maturation and spawning, it was apparent, is possible even in coastal ponds and confined waters. Ovigerous females collected from commercial catches were kept in the hatchery after releasing zoea in order to observe further spawning in aquarium tanks. Wild specimens reared as brood stock in separate tanks spawned more than twice in 5-6 months without undergoing any copulatory ecdysis and further mating. This kind of multiple spawning within a single mature instar was also observed by Ong (1966).

Twenty specimens of active, berried females measuring 117-140 mm CW were selected for hatchery operation. The duration of successful incubation varied from 7-15 days (Table 1).

Table 1: The results of crab seed production

Temperature regimen	*Expt. No.*	*Incubation period (Dates)*	No. *of* days	*Larval period*	*Salinity*		*Crab seed prodn.*	*% rate of prodn.*
					Range	*Mean*		
i. Low range	11	25.9.83 - 4.10.83	10	18	33.0-34.0	33.5	-	
22-24°C	12	1.10.83 - 11.10.83	11	22	33.0.34.5	33.8		-
	13	13.11.83 - 24.11.83	12	16	32.0-34.0	33.0	-	-
	17	30.11.84 - 14.12.84	15	15	33.0-35.0	34.0	-	
ii. Medium range	10	15.9.83 - 22.9.83	8	30	34.0-36.0	35.0	160	4.00
25-27°C	14	22.12.83 - 4.1.84	14	35	30.0-31.0	30.5	50	1.00
	16	8.9.84 - 16.9.84	9	30	33.0-35.0	34.2	85	2,13
	18	28.1.85 - 4.2.85	8	31	32.0-33.0	32.5	22	1.10
	19	6.2.85 - 12.2.85	7	30	32.0.33.0	32.6	320	5.33
	20	3.11.86 - 9.11.86	7	28	31.5-33.0	32.2	110	11.00
iii. High range	1	8.3.83 - 14.3.83	7	30	35.5.37.0	36.2	9	0.05
28-30°C	2	25.3.83 - 1.4.83	8	28	35.8.37.0	36.5	20	0.09
	3	29.3.83 - 7.4.83	10	28	36.0-37.5	36.8	20	0.13
	4	12.4.83 - 18.4.83	7	28	35.5-37.0	36.5	115	1.00
	5	13,5.83 - 20.5.83	8	27	35.0-36.5	35.8	180	3.60
	6	20.6.83 - 27.6.83	8	27	35.0.36.0	35.5	126	2.52
	7	5.7.83 - 14.7.83	10	26	35.0-37.0	35.2	527	13.20
	8	29.7.83 - 7.8.83	10	26	34.0.36.0	35.0	877	15.70
	9	25.8.83 - 4.9.83	11	28	34.0-36.5	35.2	582	11.60
	15	12.5.84 - 19.5.84	8	28	34.5-35.5	35.2	360	15.27

<<

In Andhra Pradesh, wooden canoes called nava are used. They are plank-built and are 4-6 m in length. The mode of propulsion is punting with a bamboo pole.

In Chilika Lake, the main craft used is a plank-built wooden boat (6-8 m in length). Many of these craft are fitted with outboard motors.

In West Bengal, wooden canoes (4-6 m) are used in the mud crab fishery. Propulsion is generally by punting or sculling.

OTHER FISHERY ACTIVITIES OF THOSE INVOLVED IN MUD CRAB (S. serrata) FISHING

Owing to wide seasonal variations in the mud crab fishery, the majority of those involved in it, generally do not depend on this fishery alone. They claim that income from mud crab fishing alone would not be sufficient for their sustenance. During peak seasons, however, their maximum effort is directed towards mud crab fishing.

Most of these fisherfolk, operate in the estuaries and backwaters, depend on castnets, dragnets, gillnets, and shore seines so that they can land shrimp and other varieties of fish. In the Cochin backwaters, mullet (Mugil sp), shrimp, like Penaeus *indicus, P. semisulcatus* and *P. monodon.* and other varieties of fish and crustaceans are landed. Similarly, in the Killai backwaters and in the Ennore and Pulicat Lakes in Tamil Nadu, several fish species and crustaceans, including juveniles of S. serrata and *Portunus* sp. and shrimp are landed.

In Chilika Lake, substantial quantities of pearl spot, ***Etroplus*** sp, is landed along with other fish, such as mullet. catfish and smaller species.

However. a few villages near Kakinada. Andhra Pradesh. appear to depend on mud crab fishing throughout the year. At Peddavalasala. a village about 25 km from Kakinada, the entire population depends mainly on this fishery. This village is surrounded by mangrove swamps and creeks, which are good crabbing grounds. About 100 craft (nava) are involved in crab fishing and the main gear used is longline. Hand picking is also to he widely seen in the swamps.

On an average, about 300-400 kg of S. serrata are landed here every day, mostly comprising small crab of CW 4-12 cm and weighing 50-300 g. Medium and large crab of above 15 cm in CW form only about 10- 15 per cent of the catch.

Other villages which depend on mud crab fishing to a large extent are Chinnavalasala, Gadimoga and Lakshmipathipuram.

ECONOMIC AND SOCIAL CONDITIONS

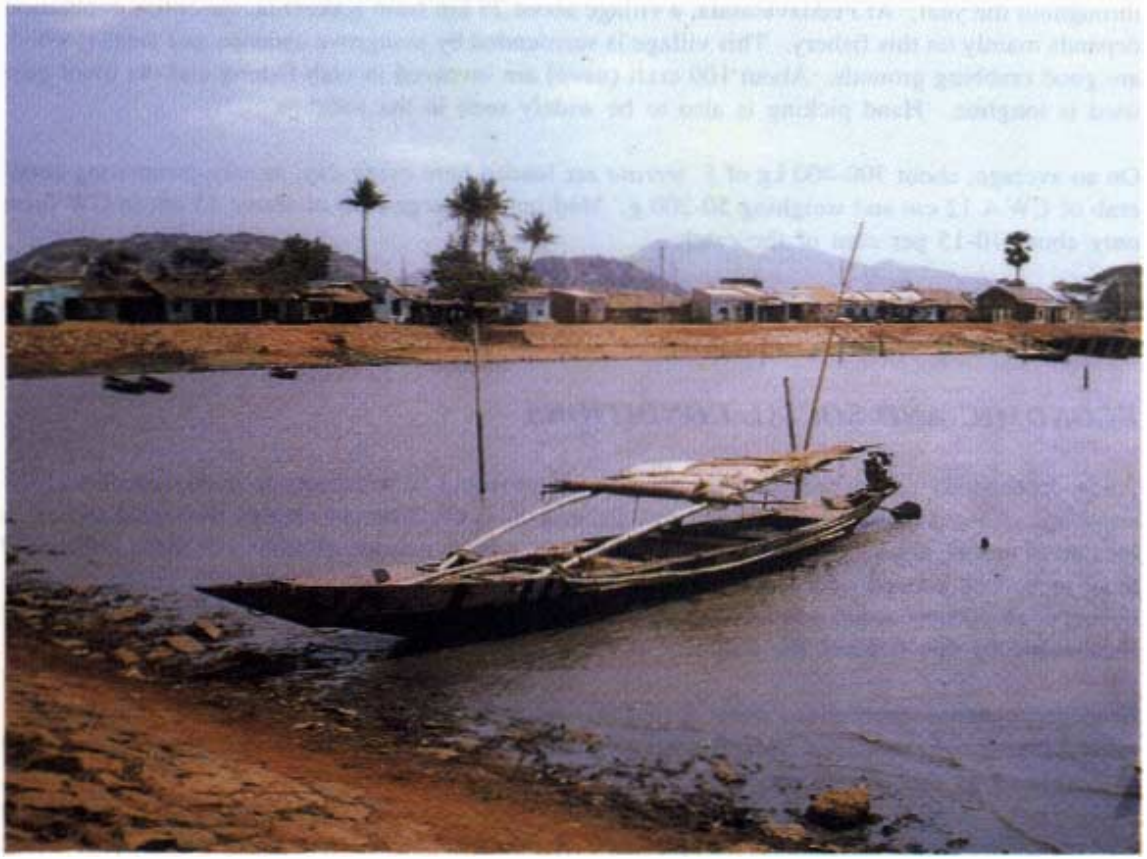
An in-depth study over a considerable period of time would be necessary to assess accurately the economic and social conditions of mud crab fishermen, as this fishery is highly dispersed and often located in remote areas. To get a representative idea, a large number of mud crab fishermen would have to be interviewed. Moreover, it would be necessary to visit the mud crab landing centres during peak seasons to get a reliable estimate of the general economic and social conditions of the fishermen, for this is when the majority of the mud crab fishermen are available.

However, cursory observations made during this study indicate that the mud crab fishing communities of Andhra Pradesh and West Bengal are economically and socially backward, whereas those in Kerala enjoy satisfactory economic conditions.

The reason for the latter faring better than their counterparts on the east coast is perhaps because of their better literacy and, consequent, greater awareness. Another reason is that the mud crab is considered a delicacy in Kerala and fetches a very good price locally compared with prices

<<

A craft used for mud crab fishing in Andhra Pradesh, India...



***and** one used in Chilika Lake, Orissa, India.*

<<

prevailing in other states. The recent spurt in demand for large mud crab for exporthas definitely increased daily earnings in Kerala. where these fishermen own different fishing gear which they could conveniently switch to for other fishery activities, depending on the season.

In contrast, in Andhra Pradesh. especially in mud crab fishing villages like Peddavalasala, it was observed that most of the mud crab, which are of small size, are sold locally. Large crab fetch good prices from agents who send them to Madras for export. It was also learnt that the number of large crab have diminished during the past few years and that the size of crab currently being landed is much smaller than what used to be previously caught. This is a possible indication of over-exploitation of the resource.

Literacy in the mud crab fishing communities of Peddavalasala village is extremely poor. compared to that of their counterparts in Kerala. Children are generally engaged in punting the canoes, while the womenfolk market the catch in the local market and nearby villages, often travelling distances up to 30 km.

The socio-econoniic status of the mud crab fishing communities of West Bengal is even lower than that of Andhra Pradesh. In West Bengal. crab are not popular, most people preferring freshwater fish to crustaceans and seafish. Mud crab fetch a very low price in the local market.

The crab fishermen here have to travel great distances, as the crab is found only in remote places in the difficult-to-access Sundarbans.

The literacy rate here is very poor. Almost all the members of a family engage in crab fishing. with the young children often hand-picking the mud crab from crevices and burrows in the Sundarbans, especially during low tide.

Table I: Estimated monthly household income of crab fishermen in various states

State	*Estimated monthly houshold inc ome (in / Rupees*)*
Kerala	2000-2500
Tamil Nadu	1500-2000
Andhra Pradesh	1000- 1500
Orissa	1500-2000
West Bengal	750-1000

*USS $! = I Rs. 27 appx **(1991)**

The estimated monthly household incomes of crab fishermen in the main fishing stages are presented alongside in Table I. The data are based on information provided by the mud crab fishermen themselves and includes income from other sources such as participation in agricultural activities, casual labour etc.

ANNUAL LANDINGS OF **Scylla serrata** *AND SEASONAL VARIATIONS*

An estimate of the total annual landings of mud crab along the east coast of India and in Kerala is rather difficult, owing to the fact that statistics from all sources are incomplete. This is because it is a highly dispersed fishery of an artisanal nature, making data-collection virtually impossible. The only dependable annual

<<

landing statistics available is from Chilika Lake. Table 2 presents the annual landings of S *serrata* from 1972-1990.

Other available statistics for S.*serrata* are from Pulicat Lake, hut they are only for 1968-72 (Table 3). Table 4 presents the size and sex composition of S *serrata* in the southern sector of Pulicat Lake from April 1968 to March 1969 (Srinivasagam and Raman 1985).

Table 2: Estimated annual landings of *scylla serrata* from Chilika Lake, Orissa, from 1972-90 (t)

Year	Total landings
1972-73	8362
1973-74	52.00
1974-75	70.00
1975-76	66.00
1976-77	63.00
1977-78	57.10
1978-79	59.20
1979-80	121.51
1981-82	79.93
1982-83	87.90
1983-84	141.44
1984-85	89.91
1985-86	78.66
1986-87	53.97
1987-88	39.06
1988-89	43.51
1989-90	23.57

Source: Directorate of Fisheries. Government of Orissa

Table 3: Estimated average monthly landings of *Scylla serrata* from Pulicat Lake from April 1968 to March 1972

Month	Total landings
April	1.189
May	2.947
June	0.850
July	1.995
August	1.876
September	1.777
October	.427
November	0.435
December	0,871
January	1.052
February	0.983
March	.309

Source: Srinivasagam and Ranian (1985

Table 4: Size and sex composition of *Scylla serrala* in the southern sector of Pulicat Lake during April 1968 - March 1969

Sex		Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Male	Range (mm)	55.175	65.169	64.140	70.175	74.178	71.198	64.160	60.161	65.17!	68.165	70.152	62.150
	Mean (mm)	100.2	104.8	90.9	108.8	115.9	101.3	99.1	83.5	110.2	106.5	103.1	93.3
Female	Range (mm)	61.172	64.175	68.141	62.152	74.170	68.171	62.183	60.158	60.160	66.182	70.185	69.152
	Mean (mm)	103.4	105.3	93.4	109.9	112.8	107.7	106.5	103.9	108.8	98.7	97.5	98.3
Sex	Male to Female	1:0.95	1:1.10	1:1.05	1:1.04	1:0.70	1:1.14	1:1.14	1:0.82	1:0.86	1:0.86	1:0.84	1:1.11

Source : Srinivasagam and Raman (1985)

<<

Table 5 presents annual crab landings of different regions along the east coast of India. This data. excepting that pertaining to Chilika Lake, include other crab — *Porrunus pelagicus* (Linnaeus) and *Portunus sanguinolentus* (Herbst) — as well. The peak fishing season for S.*serrata* in the various regions is presented in Table 6.

Table 5: Annual crab landings of different regions along the east coast of India and in Kerala

Region (Author)	*Area (Sq. km)*	*Production (t)*
The Sundarbans Area (Anon. 1960)		33.60
Chilika Lake (Mohanty. 1975)	906.00	64.53
Godavari estuary (Vedavyasa Rao *et al* 1975)	211.00	337.46
Pulicat Lake (Anon. 1960)	461.00	907.18
Ennore river estuary (Chacko and Rajagopal. 1964)	6.00	5.86
Vembanad Lake (Anon, 1964-65, 1966-67 avg)	300.00	24.53
Killai backwaters	6.68	12.05

Source : Srinivasagam (1974-75)

Table 6: Peak seasons for *Scylla serrata* fishing along the east coast of India and Kerala

Region	*Peak season*
West Bengal	September - March
Orissa	August - November
Andhra Pradesh	August - January
Tamil Nadu	May - September
Kerala	July - September

DOMESTIC MARKETING AND EXPORT OF S. serrata

Domestic marketing

S. *serrata* is much in demand in the domestic market and fetches a good price, compared to other species of crab. During this survey it was observed that *S. serrata* can be successfully marketed, but only in live condition, as there is a prejudice against purchasing dead crab. Medium and large crab of more than 14 cm CW and weighing more than 400 g are collected exclusively for export in Kerala, Tamil Nadu and Andhra Pradesh.

<<

As crab stay alive out of water only for a maximum of about 72 hours, they are generally sent to major cities by train. The crab are packed in bamboo baskets, each basket accommodating about 25-30 kg. Middlemen who collect the crab from thc fishermen often mark up the price by about 50-100 per cent, depending on the sizç, when reselling them to the retailer at the market. There is again a mark-up ranging from 50-100 per cent by the retailer in the local markets. For example, on Vypeen island near Kochi,in Kerala, mud crab, of 8-12 cm CW could be bought directly from the fishermen at 2-6 I Rs*/piece. The same were sold at the Ernakulam fish market not far away for 6-12 Rs/piece. At the same market market, a large crab weighing 1.5 kg and of 21 cm CW was priced at Rs. 80, whereas a middlemen would pay about 20-25 rupees for the same crab to a fisherman.

In Andhra Pradesh, especially in Peddavalasala village, where several people were interviewed, it was learnt that about 300 kg of mud crab were being landed every, day in the village at that time. During the peak seasons, the catch could be as high as 500-600 kg.

The crab, varying in size from about 4 to 12 cm CW and weighing between 50-200 g, were taken by women to markets in Ramachandrapuram, Dowleswaram and Kakinada and sold in groups at Rs. 2-8 for five. Bigger crab fetched Rs. 8-10 for five at these markets.

They claimed that they earned 60-80 I Rs/day and that this could go upto 100-140 Rs/day during peak season.

Claws being secured before packing at a fishing site in Andhra Pradesh. India.

Mud crab from Peddavalasala village (Andhra Pradesh) on their way to the market.

*US $ 1 = 1 **Rs 27/- appx. (May 1991)**

<<

The fishermen normally go out on 2-day fishing trips and earn Rs 200-250 during the peak seasons and Rs 100-150 at other times.

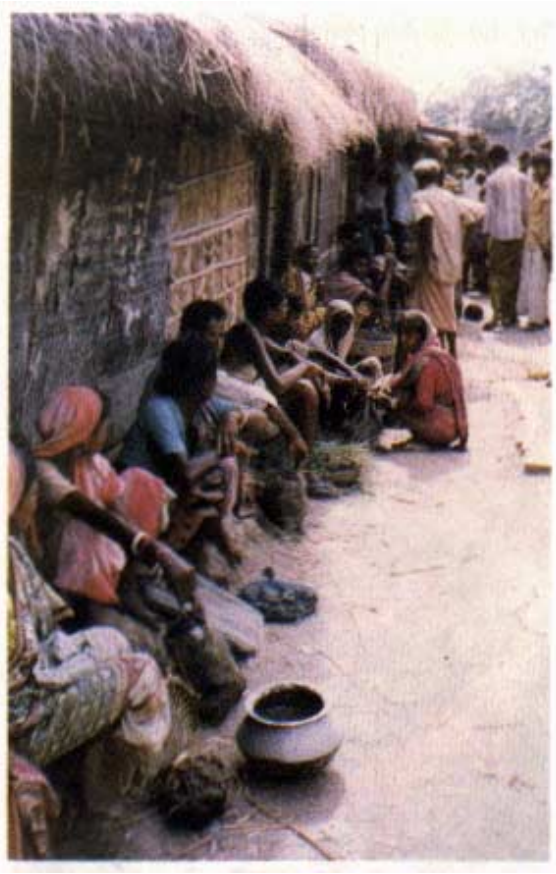
Large crab of more than 17 cm CW and weighing more than 1 kg were sold to middlemen at Rs 15-30. These in turn were sold to crab exporting agents in Kakinada at 45 - 50 Rs/pc. It was learnt that, on an average, 50-100 crab of exportable size, *i.e.,* above 15 cm CW. were being collected from this village every day by agents supplying exporters.

At the Kakinada fish market, crab of 9-10 cm CW were being sold at 2 Rs/pc, and those of 12-15 cm CW at 5 Rs/pc, while large crabs of 17.5 cm CW (weighing between 1100-1200 g) fetched 80 1 Rs/pair.

At Balugaon, on the hank of Chilika Lake, crab of 10 - 15 cm CW (weighing between 200 to 500 g) were being sold at 4-10 Rs/pc. Large crab of more than 16 cm CW and weighing more than 900 g fetched between 20-30 1 Rs/pc.

In West Bengal, prices were much lower. A visit to Taldi fish market, about 45 kms from Calcutta, revealed that, on an average, 50 - 60 baskets of live mud crab arrived every day. Each basket weighed 15-20 kg and each basket fetched, on an average, Rs. 50-60. A large crab of 17 cm CW and weighing 1000 g was quoted at Rs. 10.

Mud crab on arrival at Taldi Market (West Bengal), India.



***Mud** crab being sold at Taldi Market.*

<<

Export of mud crab Scylla serrata

Export of live mud crab, S. *serrata,* from India started in 1982. Madras is the focal point of live crab exports from India. About 20 **t** of live mud crab are at present being exported to Malaysia and Singapore every week. There are five major exporters based in Madras (See Appendix I).

About 3 **t** of live mud crab of exportable size arrive in Madras every day, out of which about 2 **t** arrive from the Cochin backwaters, 100-200 kg from Neendakara in Kollam (Kerala), about 500-750 kg from Kakinada, about 300 kg from the Nellore, Yelluru and Repally area, in Andhra Pradesh, about 100kg from Tuticorin in Tamil Nadu and 50-100 kg from iladuthurai near Thanjavar, and Adiramapattinam. The crab arrive in bamboo baskets. The mortality during transit is from *5* - 10 per cent.

Grading is done as follows:

Extra large	- 1 kg upwards	- Constitutes about 20 per cent of the daily arrival.
Large	- 500 g - 1 kg	- Constitutes about 30 per cent of ihe daily arrival.
Medium	- 300 - 500 g	- Constitutes about 25-30 per cent of the daily arrival.
Small	- 200 - 300 g	
Water crab	- 200 - 300 g	- Very low meat centre, but suitable for fattening
Red crab	- 200 - 400 g	- (about 25-30 per cent)

Singapore's daily requirement is about 10 **t** of live crab/day and Malaysia's requirement is about the same. About half this requirement comes from Indonesia, but though these crab weigh only 200-300 g, Malaysia and Singapore continue to buy from Indonesia because of the low airfreight and the short distances. Sri Lankan mud crab are comparable to those from India, but supplies are said to be not regular.

Importers consider Tuticorin crab the best, followed by crab from Kakinada and Cochin. Exporters say that June to September is the best season for procuring large crab; more than 5 **t** arrive every day during this period.

Mud crab basket on arrival at a Madras, India, exporter's premises.

The crab are graded before export.

<<

The crab, while being packed for shipment, are moistened with diluted sea water. Each bamboo basket accommodates 25 - 30 kg of crab. They survive easily, it is reported, for 72 hours and even up to four days. Mortality up to 5 per cent is borne by the buyers; more than that has to be borne by the shipper.

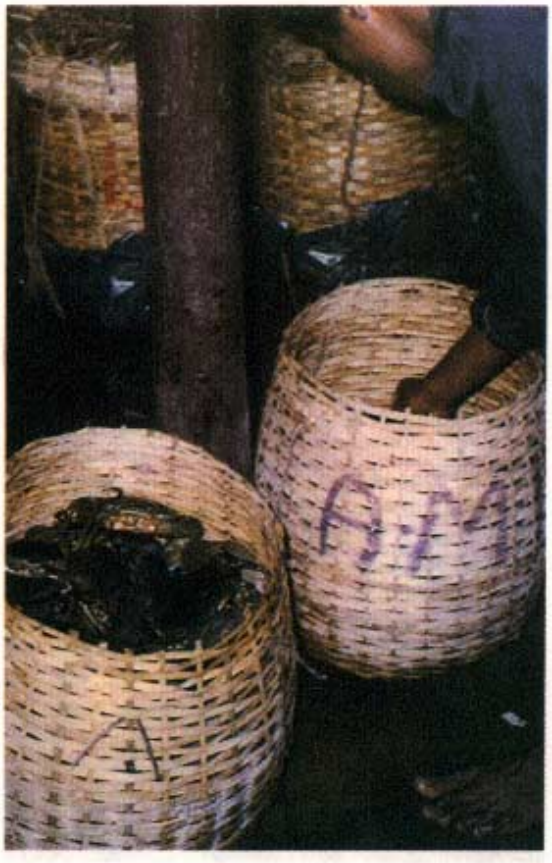
The costing is as follows:

	Landed price for fishermen	*Cost price for exporter*	*Cost of landing, freright and packing*	*Export market price*
	<		I Rs/kg	>
EL	30-40	75	2-5	100-110 **
L	30-35	70	Do	95-100
M	10-15	40	Do	65-70
S	5.10	15-16	Do	45
Red	5-10	Do	Do	45
Water	*5-10*	Do	Do	45

** **C.I.F.** Singapore

Exporters state that shipments to Singapore pose very few problems as Singapore is a free port and the consignment is cleared within an hour. But in Malaysia it takes about three hours for clearance and 5 per cent customs duty is levied, which has to be borne by the buyer.

Exporters say that the major constraint are the exorbitant airfreight rates. Three airlines carry live crab to Malaysia and Singapore, namely Indian Airlines, Air India and Malaysian Airlines. The cargo is containerised by all these airlines.



The crab are packed in baskets for export.

Crab-filled baskets are ready frr shipment from Madras.

<<

Indian Airlines has the lowest freight rates, *i.e.* 18.85 Rs/kg and adheres to IATA rates for perishables. It operates flights on Wednesdays and on Sunday nights. As the Sunday flight is a night flight, exporters have to spend an additional 1 Re/kg as Customs overtime and the consignment has to reach the airport by 3.00 p.m. About 10 **t** of live crab are sent by Indian Airlines every week. Indian Airlines operates only to Singapore.

Air India charges 21.85 Rs/kg and all its flight operate during the day. Malaysian Airlines, which accommodates about 40 baskets (1000 kg) in a container, charges Rs. 26,000/ container. Of the five major exporters, two export about 5 **t** each per week. The rest export about 10 **t** and this is shared by the other three exporters.

Crab meant for export are collected by agents who buy them from middlemen who, in turn, get them from the crab fishermen. In Vypeen Island (Kerala), middlemen advance money to crab fishermen well in advance, so that all their catches are committed to them. They also advance money to the crab fishermen during lean seasons and during the Monsoons, when sustenance becomes difficult. Therefore, the crab fishermen are generally found to be 'cornmercial!y tied' to the middlemen.

There are crab collection agents at Vypeen Island who directly represent exporters based in Madras. These exporters supply bamboo baskets to the agents for use in shipment. The agents at Cochin buy adult mud crab of more than 14 cm CW and weighing above 300g. Crab of 500-750 g weight are bought for 40 - 45 Rs/kg and large crab weighing more than 1 kg are bought for 60-65Rs/kg. The agents claim that they are paid a commission of only lRe/kg by the exporters for their services.

Samples of extra-large specimens of Scylla serrata.

<<

According to agents on Vypeen Island, they are able to ship only 50-100 kg during the lean season. This can go up to 200-300 kg/day during the peak season (February-March). The crab packed in baskets are sent to Ernakulam from where they are freighted to Madras by train. Agents based on Kollam and Kozhikode send their consignments by bus or train to Ernakulam to join the bulk consignment destined for Madras. On May 7 and 8. 1991, 34 and 28 baskets of live crab respectively were seen at Ernakulam railway station awaiting despatch to Madras.

Kakinada is another major collection centre of live crab for export. There are four agents who collect and send these crab to Madras. On an average, 5 or 6 baskets are shipped from Kakinada to Madras during May-June, but during the peak season, November-January, up to 15 baskets (each weighing about 23 kg) are sent to Madras. On a visit to the Kakinada port railway station on May 17, 1991, seven baskets were seen be awaiting shipment to Madras.

In November 1990, a ban was imposed by the Ministry of Environment, Government of India, on the export of live mud crab from India. It was notified that mud crub were an endangered species. This caused panic and confusion in the live crab export industry and large quantity of crab were held up in Madras. Eventually the exporters managed to get temporary approval from the government.

According to sources at the Marine Products Export Development Authority (MPEDA) office a Calcutta, they have received no intimation of the lifting of the ban and have been discouraging would-be exporters of live crab from Calcutta. Crab exporters are still uncertain about the future of live crab exports and are, consequently, rather hesitant to give information about the quantities of live crab exported, the source of the crab etc.

The exporters, however, have welcomed the idea of crab culture/fattening and have committed themselves to participating in such activities if they were provided information about the technology involved.

The data alongside clearly indicate the trend in live crab exports in recent years and its potential for the future.

Table 9: Export of live mud crab *Scylla **serrata*** from India

Year	*Quantity (tonnes)*	*Value in Rs.(lakhs)*
1987-88	36	6.45
1988-89	412	73.8!
1989-90	619	33.63
1990-91	654	60.37

Source: MPEDA. Export Review 1959-90.

CULTURE OF MUD CRAB S. serrata

S. serrata is not being cultured on a commercial scale in India at the moment.

Literature on aspects of S. *serrara* culture and related topics is rather scarce in India. Some literature is available, especially on the spawning and mass rearing of S*serrata* (Forskal) on experimental scales.

Very few scientists are, or have been, involved in S.*serrata* research in India. A list of some of the institutes and scientists who have worked on aspects of S.*serrata* is given in Appendix II. Among them, S. Srinivasagam and K. Raman have done many studies on various aspects of *S. serrata* (Forskal). Some of their findings are:

— Successful spawning of S. *serrata* under laboratory conditions was achieved and the eggs could be reared upto first zoea stage. The zoea were fed with *Artemia* nauplii, but they survived only for 21 hours after hatching. Salinity of 37-41 ppt and temperatures of 25-29°C were recorded. (Study conducted in 1980).

<<

Juveniles of S. *serrata 12-56* mm CW (avg. 30.3 mm and 6.2 g) reared in small ponds with trash fish meat as supplementary feed showed a monthly growth of 29.4 mm and 17.0 g. It was also noted that the crab could be transported in open containers over distances of 20-56 km with 55-100 per cent survival. (Study conducted between 1978- 1980 in Madras).

Eggs from an oviperous specimen of S. *serrata* (93.6 mm CW) kept in plastic pools with well-aerated seawater, hatched into pre-zoeal and post-zoeal stages after an incubation period of eight days. They were reared in giass jars and plastic trays with provision of freeze-dried diatoms *Coscinodicus, Navicula* and *Nitzschia* as food. At second zoeal stage, when they were fed with slightly larger diatoms *Amphipleura,* there was no further moulting and the larvae perished due to ciliate attack. The eye stalk ablated specimens of S. serrata (100 mm and 105 mm CW) maintained in plastic pools released their eggs prematurely. (Study conducted in 1982).

Four short-term, 35-55 day experiments on rearing S. *serrata (25-74* mm CW) were conducted in nylon *huppas* of 6m fixed in the lake, with varying stocking densities (16,666-23,333/ha) and trash fish meat as feed, showed varying monthly growth increments of 7.37-8.67 mm CW and 9.82-21.2 g weight, with 50-60 per cent survival. (Study conducted in 1982).

During a 4-year study (1982- 1985) at Pulicat Lake and in Madras, they found that eye stalk ablated females of S. *serrata* reared in a tide-flushed pond at Pulicat became berried and the eggs hatched into pre- and first zoeal stages in plastic pools. The eye stalk ablated females of 85 -125 mm CW (avg 99 mm and 176 g) recorded an average monthly growth of 8 mm and 63 g against 6.1 mm and 48 g in unablated ones (90-l 15 mm CW — avg 99 mm and 16 I g weight).

— Brood stock of S. serrata collected from nature were reared in plastic pools with aeration and feeding. Unilateral eye stalk ablation was done on 39 crab. After 21 days, one specimen became berried and, after an incubation period of two weeks, released its larvae. The larvae died soon after hatching. In another case, an eye stalk ablated specimen moulted after 16 days. On introduction of a male specimen, it mated with it for about 36 hours, including pre-mating embrace. However, it did not become berried. Ovigerous S. *serrata* collected from nature released their larvae in four cases. the incubation period ranging between 5 and 13 days. The larvae could be reared to the second zoeal stage in two instances and the third zoeal stage in one case (4-6 days). Different stocking densities (1-42 pcs/litre) and feed materials, such as egg custard, green suspension etc., were tried. Ciliate infection preceded the mortality in all cases. (Study conducted at Madras between 1982-84).

Other significant work on aspects of S. serrata culture has been done by R: Marichamy, Manickaraja and S. Rajapackiam in Tuticorin Bay. They iook up experimental culture of S. serrata in different types of cages in the shallow waters of the bay in 1978-79. Seed were collected from estuarine areas along creeks within the mangrove swamps. impoundments and intertidal flats in and around Tuticonn.

The young crab were first reared for 2-3 months in basket-type cages made of cane splits. Box-type cages made of soft, wooden planks, each comprising 8-10 compartments, and metal-framed synthetic twine mesh cages with compartments were preferred for culturing grown-up crab. The crab were fed with trash fish, clam meat and gutted wastes from the fish market. The growth rate appeared to be good, as a large number of the stock moulted frequently, at intervals of 25-30 days. They were observed to attain marketable size through four to five moults in a period of 9- 10months.

They found that eye stalk ablation accelerated the growth rate in young crab and promoted gonadal maturation in adult crab.

<<

Seed could be collected with hoopnets baited with gill rakers and other gutted wastes. The cages were cleaned regularly to avoid algal growth and fouling. Crab were cultured singly in different types of cages to prevent cannibalism. Basket-type cages were used to rear young ones. Grown-up crab measuring above 1 10 mm CW were shifted to box-type wooden cages or metal-framed, synthetic twine mesh cages.

The basket-type cages were suspended with coir rope tied to poles and kept submerged in seawater. The other cages were placed on racks erected in the creek. The dimensions of the cages were 2 x I x 0.3 m and 1 x 1 x 0.3 m respectively, with compartments of 0.03 m^3 each. The creek had good tidal flow and the cages were partially exposed during low tide. However. heavy mortalities occurred as a result of the water flow into the creek being cut off by salt pan operators.

P. Bensam too has worked on aspects of culture of S. *set-rata* in Tuticorin Bay. Between 1975 and 1977 he assessed growth and production and presented his observations at the Symposium on Coastal Aquaculture- 1984 in Kochi.

There has been some controversy recently over the possible presence of two different species of mud crab in Indian waters. To avoid confusion, mud crab has been referred to as *Scylla serrata* (Forskal) in this study.

DISCUSSION, OBSERVATIONS AND CONCLUSIONS

This survey provides a basic idea about the present status of the mud crab S. *serrata* fishery along India's east coast and in Kerala State. Constraints in assessing the status of this fishery are:

Lack of statistics on the landings of this species.

The fishery is highly scattered and often involves remote places with very poor accessibility, as for example the Sundarbans area in West Bengal.

— There are wide variations in the peak mud crab fishing seasons between the different regions.

Visits to landing centres/fishing grounds during peak seasons would have given more accurate information as many fishermen could have been interviewed and a more representative situation assessed.

— The study has revealed that the mud crab catches, especially in Chilika Lake (Ref. Table 2) and Pulicat Lake (S. Srinivasagam, personal commn.), have declined in recent years. The size of crab landed in villages around Kakinada are also reported to have declined over the past few years. This is a probable indication of over-fishing and suggests the need for proper management of the mud crab fishery.

Once the technology of mass rearing of S. *serrata* from larval stage to juvenile stage is perfected. areas showing depletion in stocks of S. *serrata* could be restocked with juveniles so that a sustained S. *serrata* fishery could be developed.

Culture of S. *serrata* in India would be readily accepted, as a lot of enthusiasm was noted amongst live crab exporters and fisheries departmental officials, during this survey.

There seems to be great potential for S. *serrata* culture in Chiiika Lake in Orissa and the Sundarbans area, Kakdwip and Namakhana areas in West Bengal. Pulicat Lake and the Killai backwaters in Tamil Nadu also have great potential for crab culture (S. Srinivasagam, persona1 communication).

The export market chain at the moment seems to be well organized. The only constraints expressed by the exporters are the high airfreight charges and the fear of a ban on mud crab exports being imposed again.

<<

From this study, it is evident that the mud crab S. serrata fishery along the east coast of India and in Kerala is an important fishery, making a significant contribution to both the domestic and export markets. Its importance and great potential calls for due attention to be focussed on the further development of this fishery. Although culture and fattening of mud crab are not practised on a commercial scale in India at present, significant studies at research level have been conducted on such aspects as larval rearing and culture.

REFERENCES

ANON 1983. Breakthrough in rearing green crab. Scylla serrata (Forskal). *CMFRI Newsletter. (20) : 1 .6.*

BENSAM, P. 1980. Culture experiment on crab Scylla serrata (Forskal) at Tuticorin to assess growth and production. IN: Symp. on Coastal *Aqua..* Cochin. Ind., 12-18 Jan. 1980. Abs. Mar. Biol. Assn. of Ind. · p. 97.

CHACKO. P.I. 1956. Studies on the green crab Scylla *serrata* (Forskal). Dept. of Fish. (Madras) Am. *Rep..* Mar. Biol. Stn.. Ennore, 1955-56. *Fish. Stn. Rep. und Year Book* P. 18

CHACKO, P.I. 1957. Crab landing at Pulicat Lake (April 1956 March 1957). *Fish. Stn. Rep. and Year Book* P. 86.

CIFRI, Barrackpore. *Ann. Rep. 1970 · 1985.*

ESTAMPADOR, E.P. 1949. Scylla (Crustacea: Protunidae). II Comparative studies on Spermatogenesis and Oogenisis. *Phil* J. Sci.. 7 8 (3). 301-353.

GEORGE, C. and GOPAKUMAR, K. Spoilage changes in the muscle of Crab Scylla serrata stored at three different temperatures. IN: *Proc. The* 1sr Ind. *Fish. Forum.* (Ed.) M. Mohan Joseph. Asian Fish.. Ind. Br.. Mangalore p. 347-349.

JAMESON. J.D., MURUGAN. A. and NATARAJAN, P. 1982. Studies on the distribution pattern and morphometry of Scylla *serrufu* (Forskal) along Tuticorin Coast. Seafood *Export J.. 14(4): 17:20.*

JOEL, D.R. and SANJEEVA RAJ, P.J. 1983. Taxonomic remarks on two species of the genus Scylla de Haan (Portunidae: Brachyura) from Pulicat Lake. Ind. *J. Fish..* Vol.30. No. I. 1983. p. 13-26.

JONES, S. and SUJANSINGANI. K.H. 1952. Notes on the crab fishery of Chilka Lake. *J. Bombay Nat. Hist. Soc.. 51(1)128-* 134.

MARICHAMY, R., MANICKARAJA. and RAJAPACKIAM, S. 1980. Culture of the mud crab Scylla *scrrata* (Forskal) in Tuticorin Bay. IN: *Proc. of the Symp. on Coastal Aqua..* Cochin, Ind.. Jan. 12-18. 1980.

———————, and RAJAPACKIAM. S. 1985. Culture of Larvae of *Scylla scrrata Mar. Fish. Inf. Ser.* CMFRI Pub. No. 58, June, July, Aug. 1984 p. 13-15.

MOHANTY, S.K. 1973. Observations on the crab landings on the Chilka Lake during 1972. 3rd All Ind. Symp. on Estuarine Biol. Abs. Cent. Inst. *Fish. Educt. Souv, 1. 13.*

NAIDU, K.G.B. 1955. The early development of Scylla *serrata* (Forskal) and *Neptunus Sanguinolentus* (Herbst). Ind. J. Fish. (2) : 67-76.

PRASAD, F.N. and NEELAKANTAN. B. 1988. Morphometry of mud crab Scylla *serrata* (Forskal). Seafood Export *J. Vol.* 88. No. 7.

RADHAKRISHNAN. C.K. 1979. *Studies on the Portunid qcrabs of Porto Novo (crustacea · Decapoda : Brachyura)* Ph.D. Thesis, Annamalai Univ.

———————————and SAMUEL, C.T. 1980. Prospects of Fishery, Utilisation and Culture of Crabs in India. *Fish. Tech. (1980)* Vol. 17, 67-69.

———————————and SAMUEL, C.T. 1982. Report on the occurrence of one subspecies of Scylla serrata (Forskal) *in Cochin backwaters. Fish. Tech..* Vol. 19. PP. 5-7.

———————————1985. Crab meat and its utilization. *IN: Harvest and Post Harvest Tech. of Fish.* pp. 545-547.

REKHA, D.D. 1968. *Some aspects of biology of the marine crab.* Scylla serrata *(Forskal)* Ph.D. Thesis, Univ. of Bombay.

SRINIVASAGAM, S. 1975. *Studies on rhe edible crabs of Porto Novo waters* M.Sc. Thesis, Annamalai Univ.

———————————1979. On the nutritive values of the meat of Portunid crabs. *J. Inland Fish. Soc. Ind. 11(2) 128-131.*

THOMAS. J. 1971. Crab fishery of Pulicat Lake. *J.M.B.A..* Vol.13(2)

VEDAVYASA RAO.P.. THOMAS. M.M. and SUDHAKAR RAO. G. 1973. The crab fishery resources of the seas around India. IN: *Proc. Symp. on Living Res of the Seas Around Ind.* Mar. Biol. Assn.. Ind., pp. 581-591.

<<

APPENDIX - I

List of major exporters of live mud crab, Scylla serrata, from Madras

1.	M/s. Maxwin Exports	31, West Coovam Road. Chintadripet, Madras 600 002.
2.	M/S. L.G. Seafoods	142, Wall Tax Road, Madras 600 003.
3.	M/s. Alagappa Exports	No. 24, Saraswathi Street, Mahalingapuram. Madras 600 034.
4.	M/s. Unimax Exports	No. 3-C. 3rd Floor, P.C. Road, Egmore, Madras 600 008.
5.	M/s. Susi Foods/ Rani Exports	26-32, G.A. Road, Madras 600 021.

APPENDIX - II

List of some of the scientists and institutes involved in *Scylla serrata* research

NAME OF SCIENTIST	INSTITUTE	ADDRESS
Dr C K Radhakrishnan	School of Marine Sciences, University of Cochin.	Fine Arts Lane., Ernakulam - Kochi 682 016.
Dr Joel Dr Santhanam Mr Jegatheesan Dr K Venkataramanujam Dr V Sundararaj	College of Fisheries, Tuticorin.	Fisheries College. Tamil Nadu Veterinary & Animal Sciences University, Tuticorin 628 008.
Mr S Srinivasagam Mr M Kathirvel	Central Institute of Brackishwater Aquaculture (CIBA).	12 Leith Castle Street, San Thome, Madras 600 028.
Mr R Marichamy Mr Manickaraja Mr Rajapackiam	CMFRI " "	CMFRI, P.B. No. 2704 Kochi 682 031.
Dr P Sanjeeva Raj	Centre for Research on New International Economic Order (CReNIEO)	No I First Street Haddows Road Madras 600 006.
Dr D E Babu Dr P Chandramohan Ms C Manjulatha	Department of Zoology, Andhra University	Waltair, Vishakhapatnam 530 003.

<<

TAXONOMY OF THE MUD CRAB, Scylla serrata (Forskal), FROM INDIA

by M Kathirvel and S. Srinivasagam
of the Central Institute of Brackishwater Aquaculture. Madras 600 028, INDIA.

ABSTRACT

Mud Crab of the Indo-Pacific region appear to belong to more than one species of the genus Scylla. Of the two species S. Serrata and S. tranquebarica. the latter appears to be synonymous with S. Oceanica. The two species may be differentiated by colour and habitat. S. Serrata inhabits burrows in the mangrove habitat. while S. tranquebarica. which grows to a larger size. is move free swimming Both species are found in the coastal waters of India.

INTRODUCTION

Taxonomy of the mud crab. Scylla *serrata* (Forskal). has become a subject of importance for carcinologists ever since a revision of the genus by Estampador (1949a: 1949b). Forskal (1755) described the species as *Cancer serrtus*.but did not mention the type of locality. Later. Fabricius (1793) described *Portunus tranquebaricus.* probably from a specimen obtained, from Tranquebar (Tarangambadi). India. Keeping the burrowing habits of the species in mind. de Haan (1833) chose the genus name as *Scylla serrata.* In Greek mythology, *Scylla* was a sea monster living in a cave near the sea. Dana (1852) placed these crab as *Scylla tranquebarica* variety *oceanica.* However. Alcock (1 899). who did extensive carcinological work on materials obtained from Indian waters. used the name for the specimens collected from various brackishwater areas in India. Estampador (1949a) recognized two species and one variety in Scylla. in the Philippines. namely S. *oceanica. S. tranquebarica* and var. *paramamosin,* based on colour markings on the walking legs. swimming legs and chelipeds, the general colour and shape of the carapace, the position of the frontal teeth. the spines on the cat-pus of the chelipeds. and their habitat. Subsequently. Estampador (1949b) justified his revision by studying the process of spermatogenesis and oogenesis and the differences in form and structure of their chromosome.

Estampador (1949a) classified the specimens of Scylla *serrata* into two groups: 'Banhawin' and 'Mamosain'. The first group consisted of crab with green colour and polygonal markings on all legs and chelipeds. while the second contained crab with dark brown colour and without any markings on legs and chelipeds. 'Banhawin' crab were free swimming. while 'Mamosain' inhabited holes.

Estampador (1949a) gave the status of a distinct species for S. *oceanica* and S. *tranquebarica* (belonging to 'Banhawin' group). as they were free swimming. *S. serrata* was assigned to the 'Mamosain' as they lived in burrows in the mangrove areas. justifying the generic name Scylla coined by de Haan. For the variations observed in the coloration, Estampador (1949a) described them as a variety of S. *serrata* and referred to them as S. *serrata* var. *paramamosain.*

<<

Estampador's (1949a) observations *on S. oceanic,. S. tranqueharica.* and var. *paramamosain* are given in Table 1.

Table 1: Colour, morphology and habitat of three species and one variety of Scylla from the Philippines

Colour/morpho-logical features	**S.oceanica**	**S. tranquebarica**	S. serrata	S. set-rata var paramamosain
Colour in carapace	**Greenish/ greyish**	**Olive**	**Deep-rusty brown**	**Brownish grey**
Polygonal pigmented area	**On chelipeds and all walking legs**	**Only on last pair of legs**	**Absent**	**Only white pig-** ments on last pair of legs
'H' mark on carapace	**Deeply impressed**	**Deeply impressed**	**Faint impression**	**Relatively less impressed**
Frontal teeth	**Blunt in shape; levelled**	**Blunt in shape; levelled**	**Blunt in shape; Median ones slightly projected**	Blunt in shape; Median ones **slightly projected**
Length of cheliped	**Not more than twice that of carapace**	**More than twice that of carapace**	**Not quite twice the length of carapace**	**Not mentioned**
Size attained	**To a maximum size of 9" *(220* mm CW).**	**Not mentioned**	**Not mentioned**	**Not mentioned**
Habitat	**Prefers a 'nomadic' life**	**Not mentioned**	**Lives in** burrows	**Lives in burrows**

Serene (1952) reported the occurrence of three species and one variety recognized by Estampador (1949a) in Vietnamese waters, agreeing with Estampador (1949a). But working on the systematics of Australian portunid crab, Stephenson and Campbell (l 959) did not agree with Estampador (1949a) and Serene (1952) on recognizing the three species and one variety in Scylla; they thought more work should be done on this group.

RECENT STUDIES ON INDIAN SPECIES ON **Scylla**

While studying the biology of the portunid crab of the Cochin backwaters, Kerala, Kathirvel (1981) came across one larger and one smaller species of Scylla. Colour and morphological characters of the larger and smaller species agree with Estampador's (1949a) S. oceanic and S. *serrata,* respectively. The examination of 622 specimens of S. tranquebaria (S. oceanica) and 934 S. serrata indicated the maximum size as being 202 mm for males and 198 mm for females of S. oceanica and 120mm for both sexes of S. serrata. Further, the size at first maturity for females was 120mm for S. *oceanica* and 85mm for S. *serratu.* Subsequently, Radhakrishnan and Samuel (1982) dealt with S. *serrata* from the Cochin backwaters and described a subspecies S. *serratu serratu,* while Joel and Sanjeevaraj (1983) reported S. *tranquebarica* and S. *serrata* from Pulicat Lake. The salient

<<

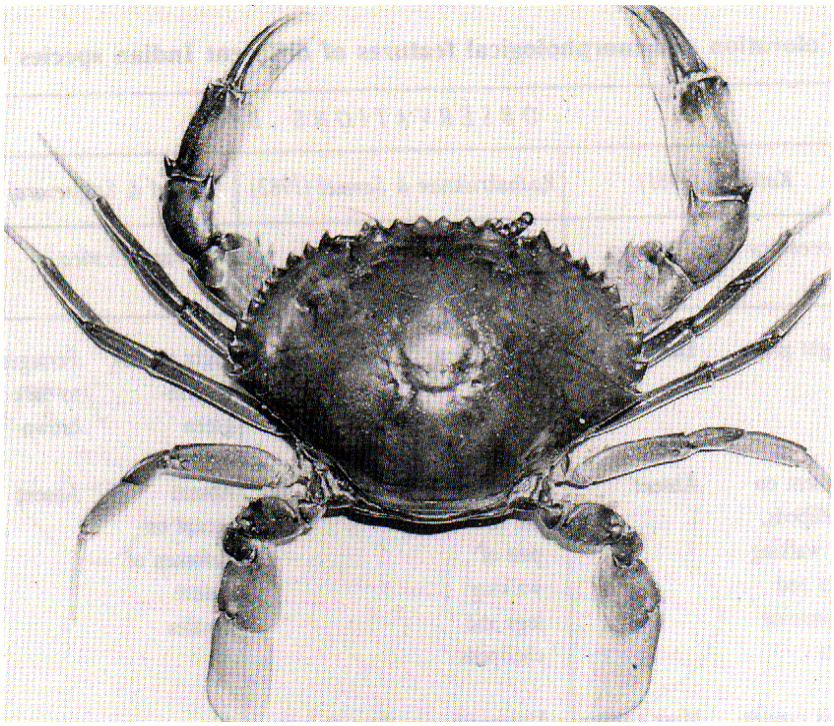
findings of Kathirvel (198 I), Radhakrishnan and Samuel (1982) and Joel and Sanjeevaraj (1983) are tabulated in Table 2.

Table 2: Coloration and morphological features of different Indian species of Scylla

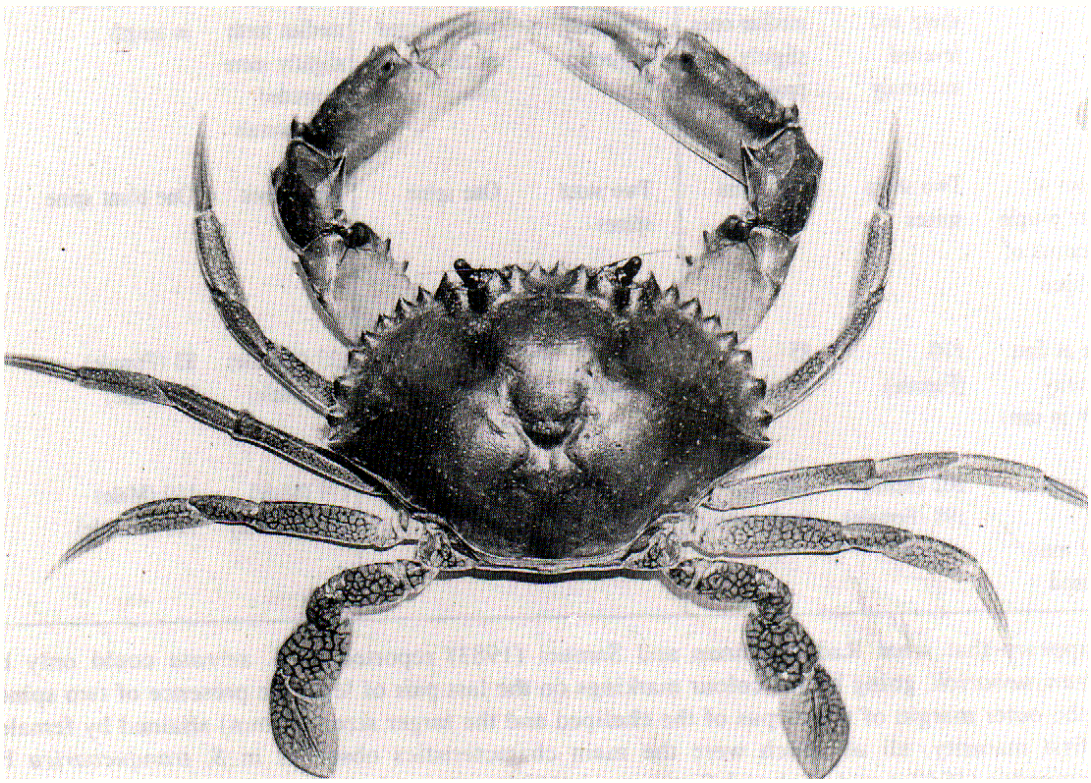
Colour/ Character	OBSERVATIONS BY					
	Kathirvel (1981)		Radhakrishnan & Samuel (1982)		Joel & Sanjeevaraj (1983)	
	S.oceanica	S.serrata	S.serrata	S.serrata serrata	S. tranqueharica	S. serrata
Colour on carapace	Light green	Dark green	Dark green	Dark green	Light to dark greyish-green	Ferrugenous brown to dark greenish brown
Polygonal marking areas	Present on chelipeds. all walking legs and swimming legs	Absent	Present on the last pair of walking legs and chelipeds	Absent	Absent exceptон abdomen of mature females	Absent
Shape of the carapace	Less convex	More convex and less convex	Unsmooth and less convex	Smooth and more convex	——	——
H' mark on carapace	Deep	Less deep	Deep	Less deep	——	——
Frontal teeth	Relatively sharp and levelled uniformly	Blunt and median ones slightly projecting out	Pointed and anteriorly projected	Not pointed and arranged in the same row	Sharp and median teeth slightly more protruded than laterals	Blunt and equal in length
Spines at outer margin of carpus of cheliped	Two sharp spines	One blunt tubercle	Two stout spines	One spine	Two spines	One blunt spine
Size at first maturity (CW in mm)	110 (Female)	85 (Female)	140 (Female)	98 (Female)	123 (Female) I 13 (Male)	83 (Female) 16 (Male)
Maximum size (CW mm) attained	202 (Male) 198 (Female)	120 (both sexes)	Not mentioned		179 (Male) 190 (Female)	1 IO (Male) 126 (Female)

It appears that what Radhakrishnan and Samuel (1983) reported as S. serrata could only be S. tranquebarica, going by the colour markings on the last pair of legs, the presence of two spines on the outer margin of the carpus of the cheliped and the larger size (140mm) attained by females at first maturity, all of which were the main characteristics observed in S. tranqueharica by Estampador (1949a) and Joel and Sanjeevaraj (1983). Also, the subspecies (S. serrata serrata) described by the same authors appears to be S. serrata, whose characteristics are well in agreement with those given by Estampador (1949a), Kathirvel (1981) and Joel and Sanjeevaraj (1983).

<<



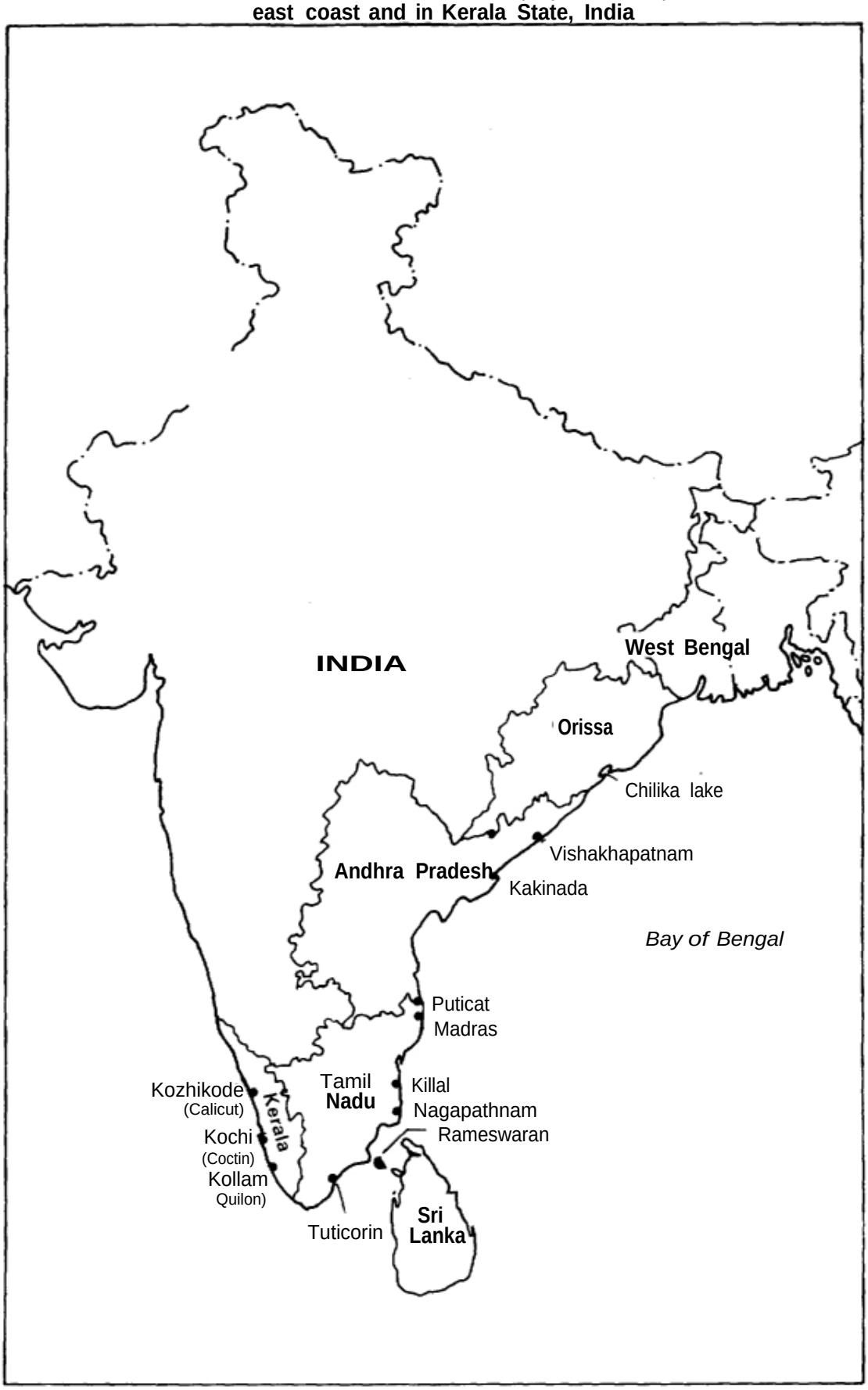
Scylla serrata (Forskol)



Scylla tranquebarica *(Fabricius)*

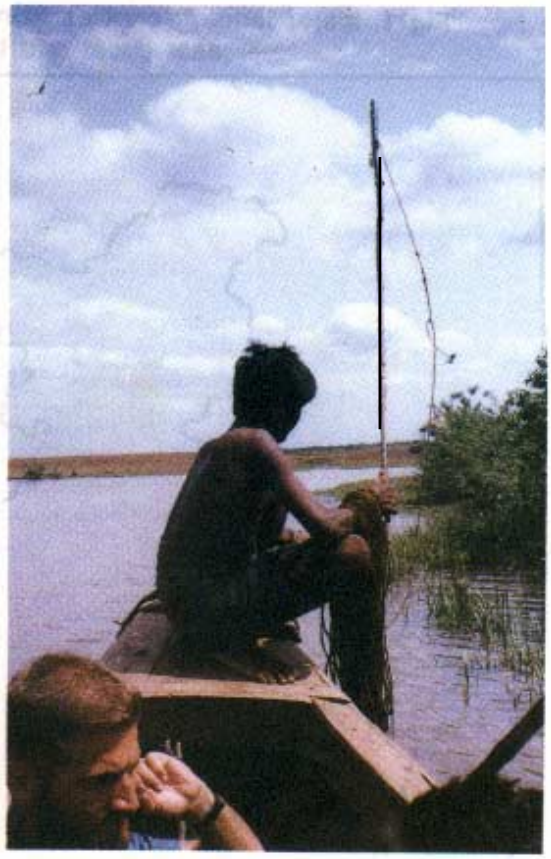
<<

Fig 1. Major landing centres of mud crab *(Scylla serrata)* **along the east coast and in Kerala State, India**

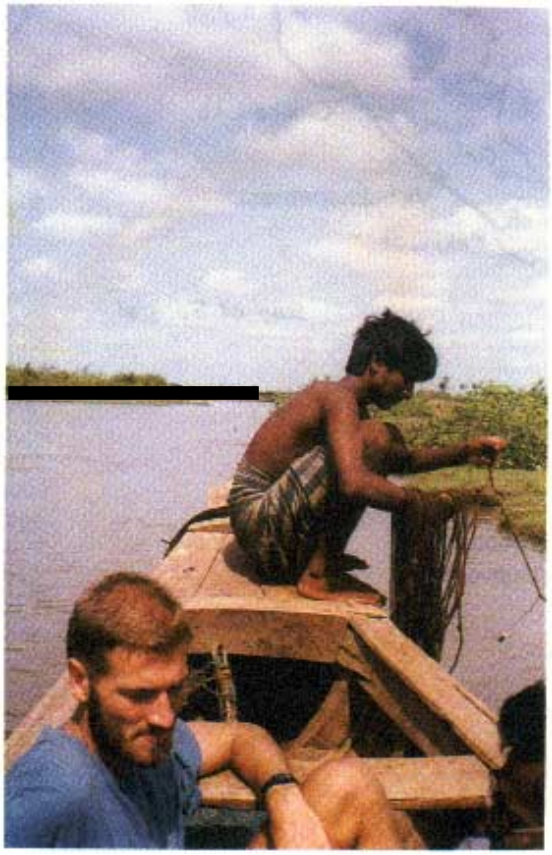


<<

Longlinc fishing for mud crab, Scylla serrata, *at Peddavalasala (Andhra Pradesh), India*



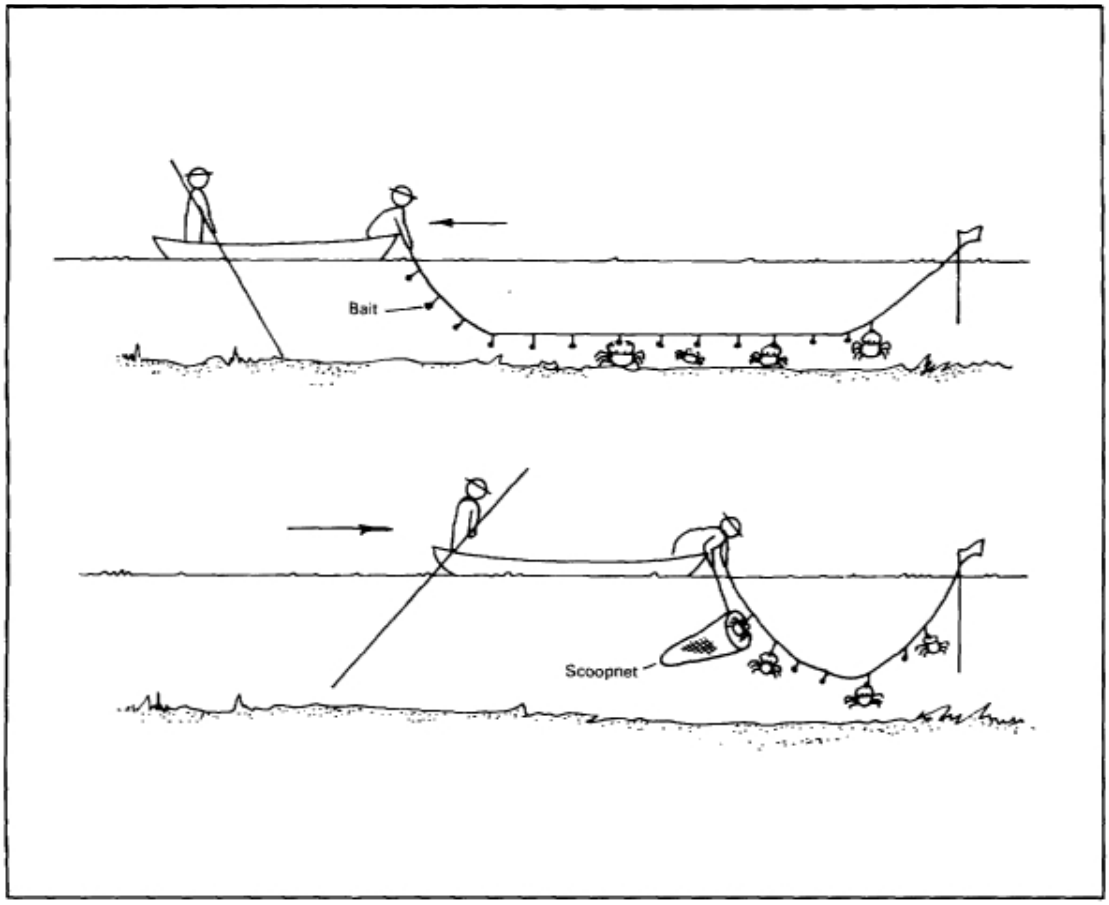
Longline being readied before being set



Longline being set

Collection of crab from the longline

Fig 2. Longline used in crab fishery



This gear is operated by two people. While one punts and manoeuvres the craft, the other lays the line, hauls it in and collects the crab. This gear is generally operated during the day.

The catch rate with longline varies with the season and the fishing grounds.

Longline fishing accounts for 47.3 per cent of the mud crab landed in Pulicat Lake (Srinivasagam, 1984).

During a crab fishing demonstration at Vadalanali Creek, near Peddavalasala, l6 crab, weighing in all about 0.5kg and of carapace width (CW) 4.5-10 cm each, were removed from a 300 m longline after it had been left at the bottom of the creek for 20 minutes. Dried eel was used as bait.

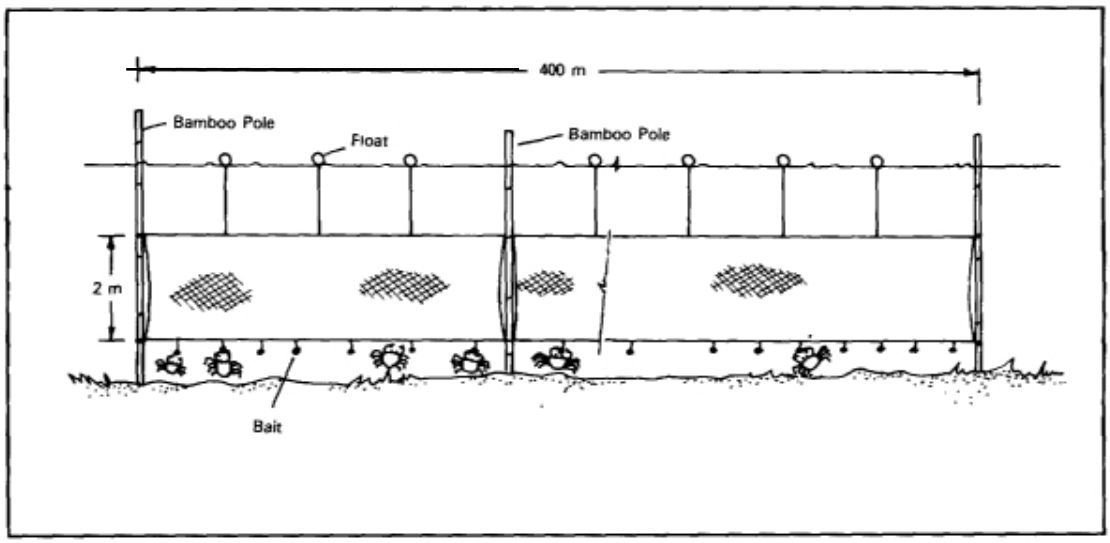
Hook-and-line: This consists of a single line made of nylon filament with a hook attached at its end. The line, with bait is cast into the water (or dangled in front of crevices) to attract the crab. As soon as a crab grabs the bait, the line is slowly hauled in and the crab collected with a scoopnet. This gear is operated in intertidal areas exposed during low tide and at 3-4 *m* depths when operated in water.

The bait used varies from place to place. At Haldi in West Bengal, fishermen claim to land between 15 and 20 crab of varying sizes a day using chicken heads as bait. The catch rates vary with season. Each line can land, on an average, ten large crab/day, but this could go up to even 25-30/day during peak season.

<<

Gillnets: Crab gillnets are mainly used in the Chilika Lake and the Killai estuary. In Chilika Lake. the gillnet (400m x 2m), locally called *noli jal* (see Figure 3). is made of sunhemp and has a mesh size of 10-15 cm. The nets are stretched between bamboo poles and kept without sinkers. The number of floats used depends on the water depth and the length of the net. Bait are hung at the bottom of the net. Crab attracted by the bait are caught by lifting the net at regular intervals.

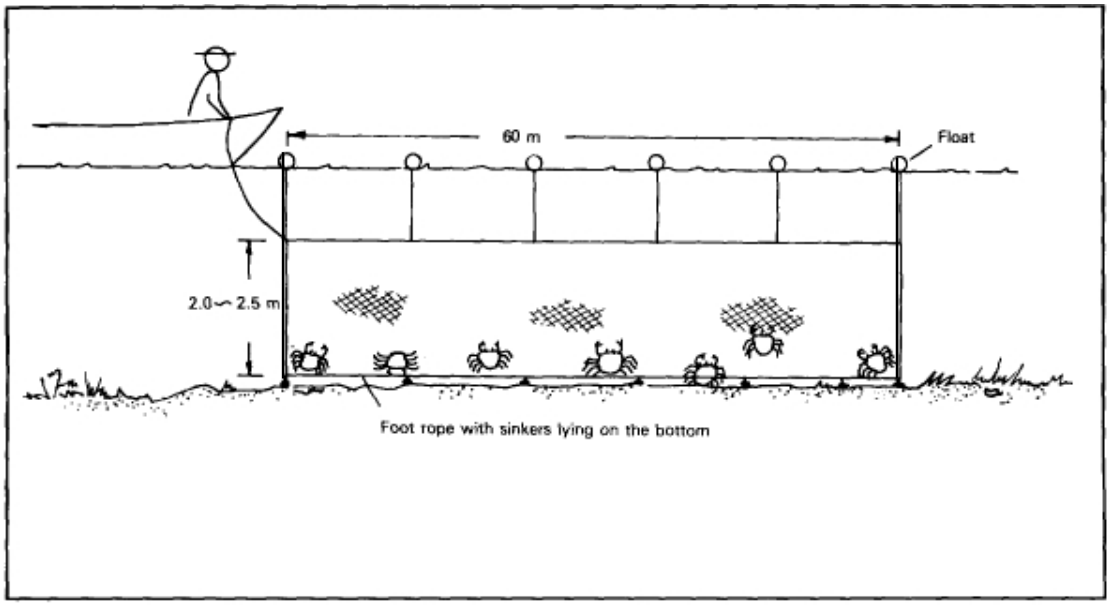
Fig 3. Crab net – *nail jal*



The gilinet used in the Killai backwaters is locally called *nandu valai* (see Figure 4). It is a small wallnet made of synthetic fibre (60 m x *2-2.5* m, with mesh size: 75 mm and head rope: 5 mm in dia.). Small wooden floats (25 x 7 x 3 cm) are attached at intervals of 1.5 m. The foot rope is 5 mm in diameter and has stone sinkers attached to it. These sinkers are tied opposite the floats and alternately. The foot rope rests on the bottom, while one end of the head rope is tied to the canoe. Fishing is conducted day and night by two fishermen. Every two hours, they collect the crab clinging to the mesh.

The gillnets are operated at depths of 2-4 m. The catches vary with seasons.

Fig 4. Crab net – *nandu valal*



<<

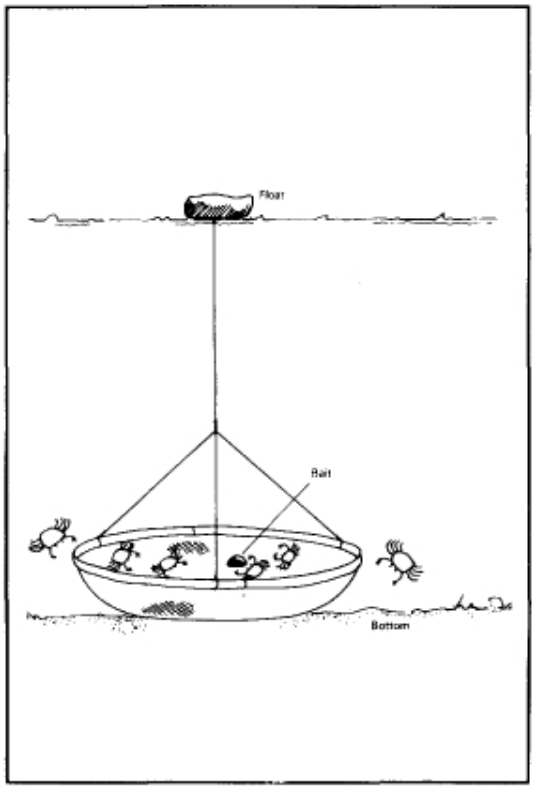
Crab traps: *Kankada khadia,* as they are locally called, are widely used in Chilika Lake. The trap is a simple, box type one, rectangular in shape and with a single opening on one side. It measures 45 x 30 x 25 cm and is made of bamboo strips of about 0.6 cm width separated from each other by about 2.5 cm.

The 25 x 10 cm opening is enclosed by a conical structure made of bamboo splits which project inside the trap. Bait consisting of shrimp or small fish are put inside each trap. The traps are placed on the bottom and generally tied to a pole, for easy spotting.

Fishing goes on day and night and the traps are lifted every 2 to 3 hours. Each team, 2- or 3-strong, operate 50-100 trap every day. Each trap on an average snares 3 or 4 crab/day. The traps are operated at I-3m depths.

Nandu katcha are traps mainly used in Pulicat Lake and the Killai backwaters in Tamil Nadu.

Fig 5. Crab trap — *katcha*



Each trap comprises a small bagnet made with a piece of nylon net of 70 mm mesh size attached to an iron ring of about 155-165 cm diameter (see Figure 5). The depth of the bag is about 20 cm. Bait, usually pieces of eel, skate or catfish are pierced with a wire, which is then placed across the ring. The ring has three bridles (60-80 cm long) and these are tied to a long rope, which is attached to a wooden float (25 x 7 x 3 cm). Line length varies from 4-6 m.

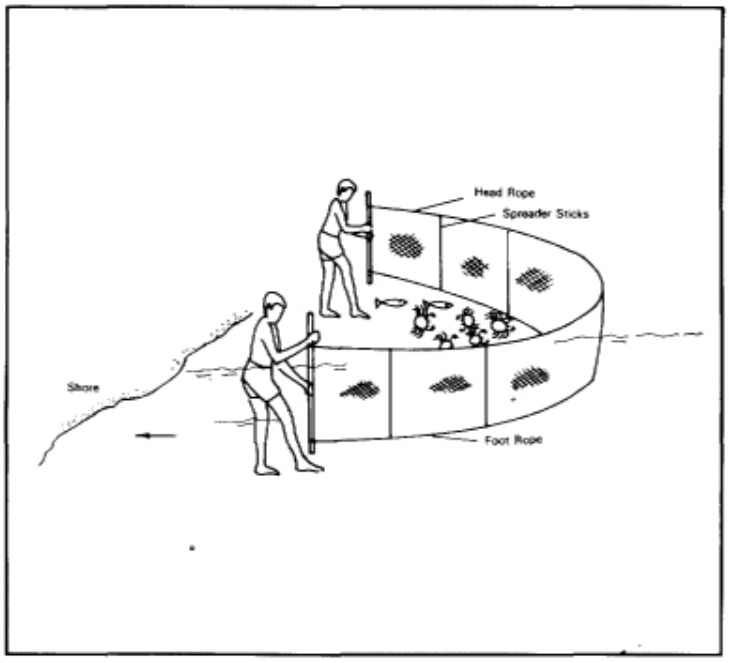
Each canoe carries 20-30 *katchas* and is operated by two fishermen. The traps are set at intervals of about Sm from one another and left in water for about an hour. They are then hauled up in quick succession.

Fishermen claim that each trap brings in 10-20crab/day. This trap is operated only during the day and at depths of 2-4 m.

Dragnet: These rectangular (8-12 m in length, 1-1.5 m in width) are used with about 8-12 spreader sticks. The length of each spreader stick is usually two-thirds of the width of the net (see Figure 6).

The net is dragged along the bottom, to the shore, by two people. This is not a selective gear and, hence, mud crab is landed along with other fish and shrimp. In Pulicat Lake, dragnets account for about two per cent of the S *serrata* landed.

Fig 6. Dragnet



<<

Castnets: These cone-shaped nets have mesh sizes varying from 15 mm at the apex to 5 mm at the bottom. The open end of the net has lead sinkers, enabling quick sinking. Mud crab are landed only as incidental catch by this gear, as it is generally used for shrimp and other bottom dwelling fish.

Apart from these gear, mud crab are also hand picked during low tide, especially in the mangrove areas. In West Bengal and Andhra Pradesh, iron rods, curved at one end are used to pull mud crab out from crevices and burrows along the shores of estuaries and mangrove areas.

Iron rods, curved at one end, are used in Andhra Pradesh, india, to pull out mud crab (Above, right and hellow)

CRAFT USED IN THE MUD CRAB FISHERY

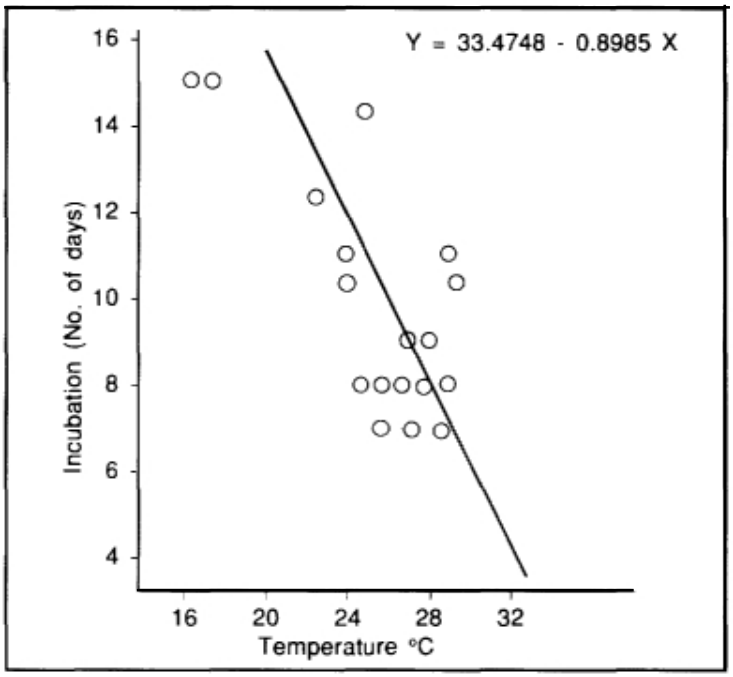
Wooden canoes are the most commonly used craft in the mud crab fishery. They are either planked or dugouts scooped from a singic log of wood. In Kcrala, small canoes of 4-6 m are used. They are either punted, using bamboo poles, or sculled with woodcn oars. Use of outboard motors is slowly becoming popular.

The main fishing craft used in Pulicat Lake, is known as the *padagu.* It is built with teak or sal wood planks nailed to wooden ribs. The craft's length varies betwccn 5 and 6.5 m and the boat is punted using a bamboo pole or sculled with wooden oars when there is no wind. Sail is used if the wind is favourable.

In the Killai backwaters, dugout canoes, locally called *kanna,* are used. Usually 6 m king and 0.5 m wide, they are punted using a bamboo pole or sculled with an oar.

Fecundity was recorded in the range of 1.5 to 2 million eggs and the size of eggs measured 280-390 m/dia. The mean temperature during the incubation period varied from 23 to 29°C and the salinity fluctuated between 32.2 and 36.8 ppt. The influence of temperature on the incubation period is well recognized: the higher the temperature, the shorter the period of incubation, resulting in faster embryo development in eggs. During summer, it took 8-10 days, as the mean temperature varied only between 28 and 29°C. Similarly, during winter, due to low temperatures around 24°C, the period of incubation extended 12-15 days. The readings of mean daily water temperature plotted against the number of days of incubation revealed an inverse relationship (Figure 1).

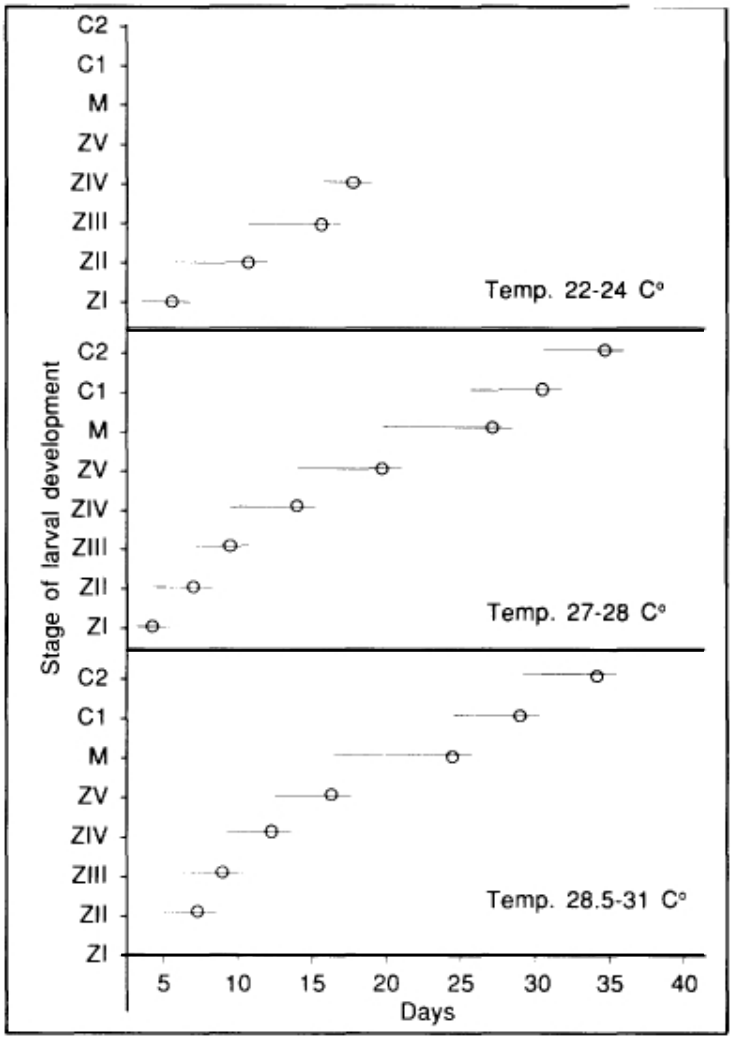
Fig. 1: The influence of temperature on incubation of berried female in the hatchery



LARVAL DEVELOPMENT AND REARING

Marichamy and Rajapackiam (1984) have described the morphological features and development process of various stages of larvae. There were five zoea stages, each of duration 3-4 days, and a megalopa stage of 8-11 days in the complete larval development of *S. serrata* (Figure 2).

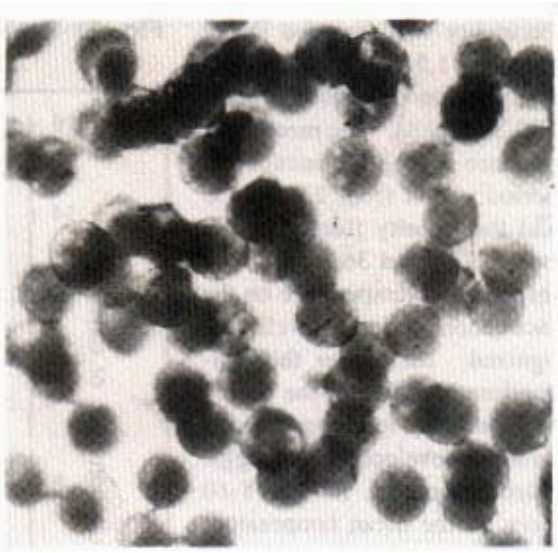
Fig 2. Stages of larval development



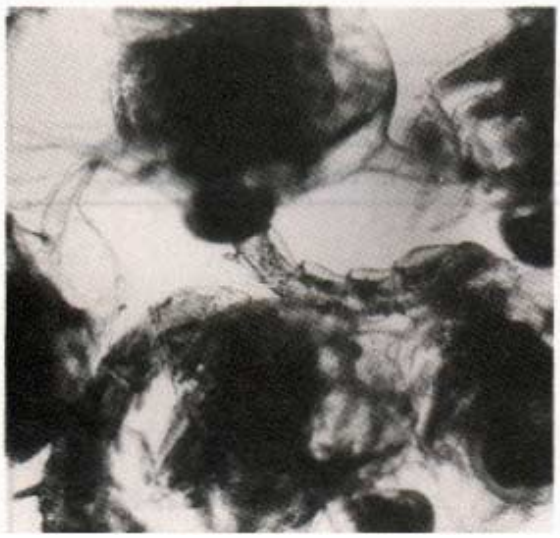
With subsequent metamorphosis, the first crab instar was obtained 26-31 days after hatching. Heavy mortality was recorded during the first, second and fifth zoea as well as in the megalopa stages. Bunches of nylon fibres were suspended in the rearing tank to serve as artificial weeds to which megalopa could cling. This arrangement increased the survival of megalopa to some extent. The first crab instar moulted into the second crab

<<

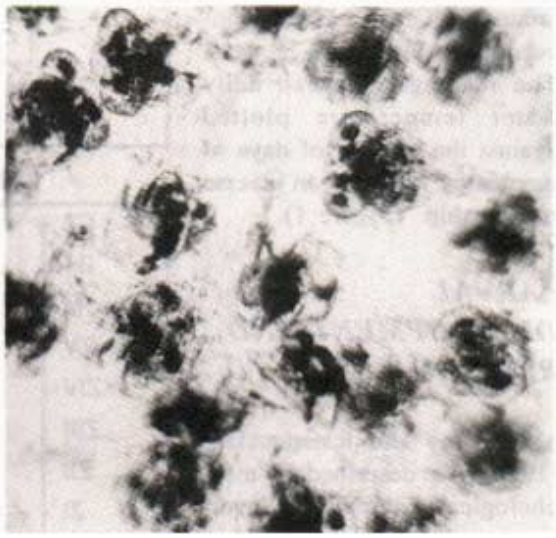
Berried Scylla serrata *in advanced stage of incubation*



Fully developed eggs with embryo

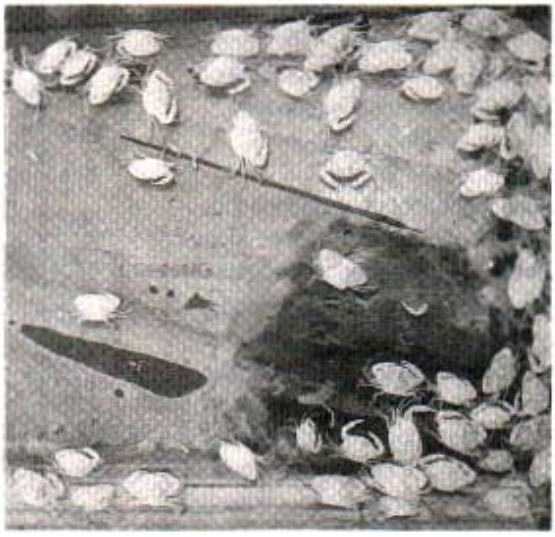


First zoea



Fifth *zoea*

Megalopa



Crab seed

Photographs taken during experiments on larval rearing and seed production of mud crab Scylla serrata *in Tuticorin, Tamil Nadu, India, by R. Marichamy and S. Rajapackiam of the CMFRI.*

<<

in five days. After the seventh moult, the carapace appeared greenish-grey and the crab became henthic.

Rotifers. *Brachinonus plicatilis* at a density of 150—200/mi. developed in *Chiorella* culture medium, constituted the food for the first three zoeal stages. Newly hatched *Arternia* nauplii were added to the diet when the larvae reached Stage Ill. The larvae in the later stages were fed exclusively with the nauplii of *Artemia salina* at a concentration of 15/ml Both crab larvae and the *Artemia* are positively phototactic and this was utilized to concentrate them in a well-lighted rearing tank, improving feeding efficiency. Maccrated clam and shrimp meat, as well as live copepods. were given to megalopa. Frozen *Artemia* were also fed. Bits of bivalve and shrimp meat were supplied to young crab which crawled along the bottom of the tank.

The hatchery-produced seed were stocked in coastal ponds for further growth. In addition. SO seed were selected for stocking in individual containers, so that their growth could be followed under laboratory conditions (Table 2). The moulting behaviour and progress in growth was observed up to 15 months, by which time the crab had attained 88 mm CW /110 g weight. The moulting frequency was delayed as the crab grew. The rate of increment was higher in smaller crab.

Table 2: Trends of growth observed in hatchery produced crab seed

No.of crab instar	Min.no.of days frurn hatching	No.of specimen	No.of days from preceding instar			Size of crab seed (mm CW)	Average mouli increment (mm)	Average increment	Weight inc rement	Average inc rement (g)	Average percentage increment
			Min.	Max	Mean						
I	24	50	-	-	7	3.5	-	-	0.004	-	-
2	27	50	-	-	3	5.2	1.7	48.6	0.022	0.018	-
3	31	48	3	4	4	7.5	2.3	44.2	0.062	0.040	-
4	37	46	5	7	6	9.9	2.4	32.0	0.123	0.061	98.4
5	45	43	7		8	12.8	*3.!*	31.3	0.257	0.134	-
6	54	40	9	10	9	16.1	3.3	25.8	0.527	0.270	-
7	66	41	11	3	2	20.0	3.9	24.2	1.022	0.495	94.0
8	78	36	11	4	12	25.0	5.0	25.0	2.000	0.978	95.7
9	92	37	13	15	4	31.2	6.2	24.8	3.950	1,950	97.5
10	107	34	13	16	15	38.0	6.5	20.8	7.800	3.850	97.5
11	127	32	14	22	20	45.0	7.0	18.4	13.850	6.050	77.6
I2	155	30	9	33	28	53.0	8.0	17.8	2 .200	8.350	60.3
13	187	28	23	38	32	62.5	9.5	7.9	36.600	14.400	67.9
14	223	25	28	40	36	75.2	12.7	20.3	62.360	26.760	75.2
IS	265	23	38	46	42	88.0	3.8	18,4	110.200	47.840	76.7

EFFECT OF HYDROLOGICAL CONDITIONS ON GROWTH AND SURVIVAL

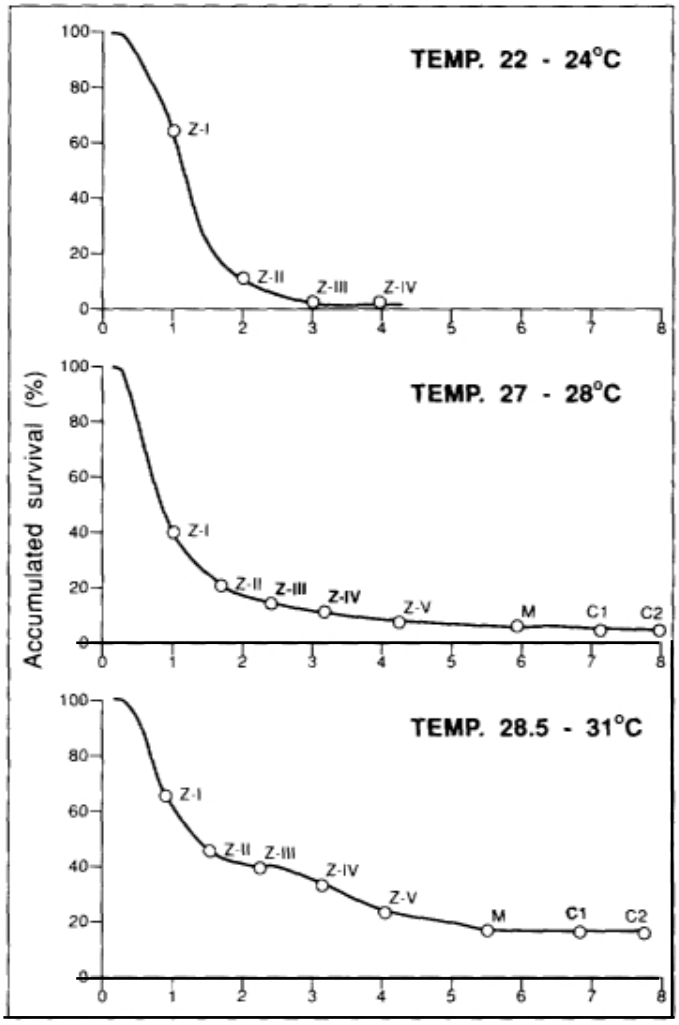
Temperature and salinity had a direct effect on the development of' larvae through metamorphosis. survival and production. A significant difference in the percentage survival of larval stock and growth can be seen in the experiments conducted in three different temperature regimes, ranging from 22-24°C to 28.5-3 1°C. Maximum production and fast growth, with an increased survival at each stage. was observed in Experiments 7 and 8 because of the higher temperature (28.5-31°C).

<<

The crab stage appeared on the 26th day after hatching (Figure 3).

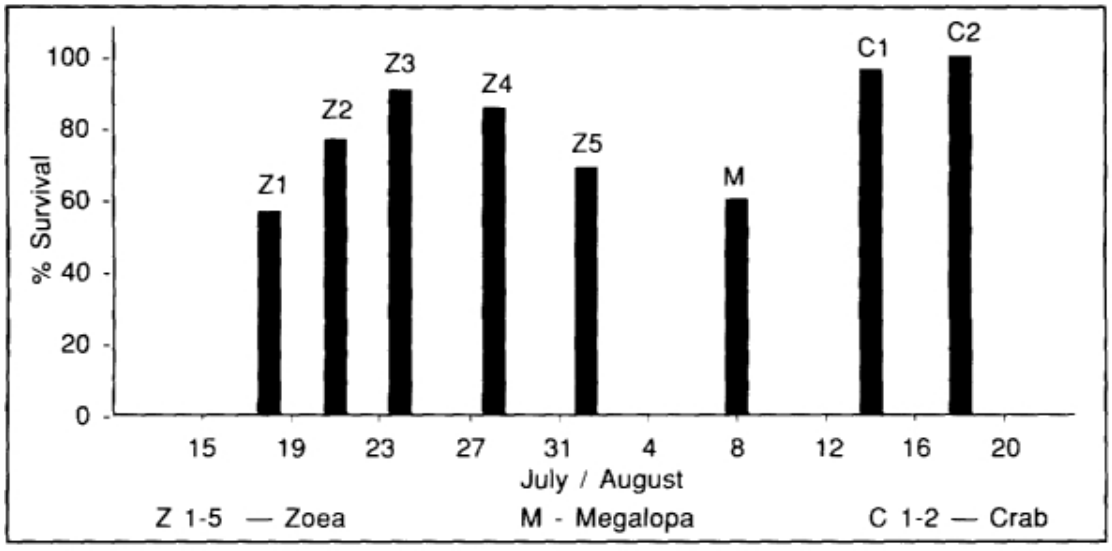
In the experiment conducted at 27-28°C, the intermoult period was prolonged and the survival rate was lower. Most metamorphosed to C 30 days after hatching. The larval rearing period was longer (35 days) with still less production at 25-26°C, as seen in Expt. 14 (Table 1). The role of temperature on the growth of larval stock can further be seen in the poor results of Expts. 11-13 carried out during the monsoon season. The water temperature ranged from 22 to 24°C. In these experiments, the survival of Z_1 to Z_4 gradually declined from 24 to 7 per cent. Moreover, it took more intermoult days and the stock was completely lost on the 17th day, without any further development or production. It would seem from this study that during cold weather, the temperature in rearing tanks would have to be raised and controlled to ensure a uniform production of crab seed.

Fig. 3. The influence of temperature on the survival of the larvae of *S.serrata*



The highest production of larval growth occurred at a mean salinity of 35 ppt in Expts. 7-9 and 15 (Table 1). In the rest of the experiments. survival was either poor or nil because of the lower salinity (32-33 ppt.). High salinity of about 36 ppt was also not suitable, as observed in Expts. 1-4. Generally, the survival of larvae varied in the different stages, although water quality appeared suitable (Figure 4). Unsuccessful moulting and cannibalistic behaviour of megalopa were major causes of poor survival.

Fig 4. Survival of larval stock in each stage of growth



<<

DISCUSSION

In the present study, a simple, inexpensive system has been designed and tested for mass rearing of mud crab larvae. The best survival level, 15 per cent, can be increased by improving the rearing tank structure using an upwelling system and maintaining the water temperature with thermostatically controlled heaters. Heasman and Fielder (1983) developed a system for thorough and continuous mixing of water in the rearing tank and achieved survival up to 30 per cent by increasing the feed concentration. Brick (1974) obtained a maximum larval survival rate of 41 per cent by adding Chlorella and antibiotics to culture media, thereby minimizing bacterial infection.

Japanese workers have perfected a reliable technique for large scale commercial production of the blue swimming crab, Portunus trituberculatus, but achieved only a 6 per cent survival rate with mud crab larvae. Scientists from the National Taiwan University observed a maximum production of 60 per cent of mud crab seed by rearing the larvae in water treated with sand filter, UV light and antibiotics. Their success has also been due to a variety of nutritive supplementary live feads, such as sea hare veligers, copepods, rotifers and Artemia nauplii, given to the larvae at different stages. In the present study, the early stages were fed with *Artemia* nauplii and copepods. Brick (1974) found better results with Artemia nauplii alone.

Ong (1964, 1966) maintained zoea at a mean temperature of 27.5°C. and salinity at 31 ±2ppt. DuPlessis (1971) did so at 24°C, Brick (1974) at 22°C and salinity in the range 33.0-34.5 ppt, and Heasman and Fielder (1983) at 27°C and 30 ± 2 ppt salinity. All of them reared megalopa larvae in a reduced salinity range of 26-28 ppt, as the post-larval stages are expected to have greater tolerance to reduced salinity and high temperature. This is reflected in the higher survival rate of later zoeal stages.

The present study indicates that the most suitable range of temperature for crab larvae, including the megalopa stage, is 28-31°C and salinity of around 35 ppt. It is significant to note that even though the salinity was maintained at the same rate, the duration of megalopa instars was only 7-9 days in a few experiments. However, an accelerated rate of growth and survival was noticed in trials made to rear megalopa in reduced salinity levels, of 27 ppt. The larvae of Syclla serrata from tropical areas may tolerate high temperatures and salinity more than those from other regions.

The success of shrimp farming, including the advance made in hatcheries, is largely due to the availability of technology in larval nutrition and micro-encapsulated diets. These new techniques should be applied in rearing the larvae of the mud crab, so that crab culture will become as practicable and profitable as shrimp culture.

REFERENCES

BRICK, R. W. 1974. Effects of water quality, antibiotics, phytoplankton and food on survival and development of larvae of *Scylla serrata*. *Aqua., 3: 231-244.*

Du PLESSIS, A. 1971. *A preliminary investigation into the morphological characteristics, feeding. growth, reproduction* and *larval rearing of* Scylla serrata *Forskal (Decapoda: Portunidae). held in captivity.* Fish. Dev. Corpn. of South Africa, Unpublished ms. 24 p.

EXRITOR, G. L. *1970. A report on experiments in the culture* of *the mud crab* (Scylla serrata). Proc. I.P.F.C., 14th Session, document IPFC/C70/Sym 46 I I p.

HEASMAN, M.P. and FIELDER, D.R. 1983. Laboratory spawning and mass rearing of the mangrove crab Scylla serrata (Forskal), from first zoea to first crab stage. *Aqua., 34: 303-316.*

HILL, B.J. 1974: Salinity and temperature tolerance of zoea of the portunid crab Scylla serrata. *Mar. Biol. 25:* 21-24.

———— 1975. Abundance breeding and growth of the crab *Scylla serrata* (Forskal) in two South African estuaries. Mar. *Biol.. 32:* 119-126.

MARICHAMY, R. and RAJAPACKIAM, *S. 1984. Culture of larvae of* Scylla serrata. Mar. Fish. Inf. Serv. T & E. Ser.. No 58: 13-15

————————, MANICKARAJA, M. and RAJAPACKIAM, S. 1986. Culture of the mud crab *Scylla serrata (Forskal)* in Tuticorin Bay. *IN: Proc. Symp. Coastal Aqua.* Part 4: I 176- I 182.

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

————————. 1966. Observations on the postlarval life history of *Scylla serrata* Forskal reared in the laboratory. Mal. *Agri. J. 45(4): 429-443.*

<<

PRELIMINARY STUDIES ON REARING THE LARVAE OF THE MUD CRAB *(Scylla serrata)* IN MALAYSIA

by Zainoddin Bin Jamari

of the National Prawn Fry Production and Research Centre. kampung Pulau Sayak, 08500 Kota Kuala Muda. Keduh. MALAYSIA

ABSTRACT

Larval rearing of the mud crab Scylla serrata was carried out in the NAPFRE hatchery. The developmental period from Z, C, took 25-28 days Feeding the larvae with Branchionus sp. ***and frozen*** Artemia *nauplii during the zoea stages gave a better survival rate than feeding* with live Artemia nauplii alone. broodstock of 350-520 g gave 800,000 - 2.0 million Z, *larvae. The hatching rate was close to 100 per cent. Feeding regimes are described in detail. A survival rate of up to 20 per cent has been obtained from Z, to C,.*

INTRODUCTION

Aquaculture production in Malaysia has increased significantly during the last decade. The main production, which includes cockle, tiger shrimp and fish, comes from brackishwaters. Technical advances and the overcoming of several constraints have been the reasons for the growth of aquaculture in Malaysia. However, a major problem has been the lack of seed supply for most of the cultured species. In the late Eighties, there were considerable advances in breeding technology for all important culture species, including tiger shrimp, sea bass and the giant freshwater prawn (Choo 1983; A1i ***et al*** 1985; Yaakob 1988; Zainoddin, in press). Artificial propagation of several other species is still not well developed.

Crab fattening is carried out in Malaysia in a limited way, using either ponds or cages (Abu Seman, 1983: Abdul Manan, 1979). The principal constraint in the expansion of this activity is lack of seed or stockable crab. Crab collected from the wild vary in size, age and with the seasons. Imported crab seed also fluctuates in price. This hinders the development of large-scale crab culture, although there is sufficient market demand. In an attempt to solve the seed supply problem, the Malaysian Department of Fisheries recently began experiments on larval rearing of crab. The main objectives of this effort were the improvement of hatchery technology and the large-scale production of crab. Crab larval rearing was initiated at the Fisheries Research Institute, Department of Fisheries, Malaysia in Glugor, Penang, where the successful larval and post-larval culture of *Scylla serrata* was carried out in the early 60s (Ong, 1964). This paper reports the results obtained from crab larviculture conducted at the Department of Fisheries, National Prawn Fry Production and Research Centre, in Kampung Pulau Sayak, Kedah.

MATERIALS AND METHODS

Hatchery design

A variety of tanks are used for larval rearing. Two types used by NAPFRE were: circular tanks with conical bottoms (2 t capacity) and those with a slope (10 t capacity). Both types were located indoors under transparent roofs.

Sea water supply and water quality

Sea water was pumped from the end of a 100 m jetty perpendicular to a muddy beach. The water was passed through a sand filter after settling overnight in receiver and sedimentation tanks. After

<<

passing through the sand filters, the water, now with reduced suspended materials, was pumped into gravity tanks, from where it flowed by gravity into the hatchery. The water quality parameters at the NAPFRE hatchery were :

Salinity	:	29 to 32 ppt
ph		8.0 8.7
D.O.		> 8.0 ppm
Temperature	:	28.5 · 32°C

Broodstock selection

Berried females of Scylla serrata were bought from gillnet fishermen whose fishing area was 5 · 6 n miles from the mainland. Only berried females with yellow and grey eggs were bought: broodstock with incomplete appendages were rejected.

The females with yellow eggs were kept in holding tanks with a stocking density of 10 pcs./10 t of water. Normally, the eggs of the berried females mature in 5 - 7 days. Some regressed after a few days, probably due to stress during transportation and handling. Squid was given twice daily as food.

The brookstock with grey eggs were transferred either to hatching tanks or direct to the rearing tanks, depending on the size of broodstock and the tank capacity used.

Hatching took place at 10 pm or between 5 and 8 am. The hatching time for Scylla serrata has been reported as between 7 and 8 am at 23°C and between 5 and 6 am at 27°C (Cowan 1984). The hatching rate was close to 100 per cent. This is similar to Portunus trituberculatus (Cowan 1984). During hatching, females were noticed swimming with legs twisted and their abdomens jerking up and down. This jerking action was presumably to disperse newly-hatched larvae.

The berried females of Scylla serrata (350 - 520 g) gave between 800,000 and 2,000,000 Z_1, while those of lesser weight (100 · 150 g) gave about 700,000 1,000,000 Z_1. Broodstock of 200 - 250 g can produce 800,000 - 1,500,000 Z_1 (Cowan 1984).

Larviculture

After hatching, the number of larvae was estimated and the larvae were transferred to rearing tanks. The stocking density ranged from 20-30/l. The diatom Skeletonema costatum was introduced in the rearing tanks at the rate of 5,000 - 8.000 cells/ml. Alternatively, Isochrysis sp. could also be used at the same rate. Isochrysis sp. has been used in the culture of P. trituberculatus (JASFFA, 1981). Larvae in the early zoeal stage fed with mixed diafoms have shown good survival, but do not moult (Simon 1974). However, development of the zoea stage can be accelerated when the larvae arc fed with mixed diatoms and rotifer (Branchionus sp). Ting (1980) used rotifer, *Chlorella* sp., *Spirulina* and *Artemia* nauplii as feed.

Larvae were fed twice daily, in the morning and afternoon. Feeding began four hours after newly hatched larvae were stocked in the rearing tanks. From Z_2 onwards. *Artemia* was fed exclusively in the afternoon (Table 1) Upon reaching the megalopa stage, two-day old *Artemia* nauplii, supplemented with artificial feed, were used When live rotifers were insufficient, frozen rotifers were used and supplemented with artificial feed during the zoeal stages. In the NAPFRE hatchery it was found that larviculture with Skeletonema costatum or Isochrysis sp. given in the early stages gave a better survival rate than those without microalgae. Simon 1974 found that feeding with *Artemiu* nauplii at more than 10/ml improved survival. From Z_2 · Z_4 frozen *Artemia* nauplii were used because live animals were more difficult for the zoea to catch; Artemia nauplii are active swimmers and move faster than the zoea themselves, especially during the early zoea stage.

<<

Table 1: Feeding regime practices in NAPFRE hatchery

Larval stages	Morning *(pcs/ml)*	*Afternoon (pcs/larvae)*	*Supplement* (g/ml)
Z_1	Rotifer 5-10	Rotifer 5-10/ml	Artifical feed. 3[a]
Z_2	Rotifer 5-10	Frozen Artemia 6	" 5[a]
Z_3	Rotifer 10-15	Frozen Artemia 10	" 7[a]
Z_4	Rotifer 20-30	Frozen Artemia 15	" 9[a]
Z_5	Frozen Artemia 10	Frozen Artemia 20	" 12[a]
M	2 days Artemia 10	2 days Artemia 40	" 15[a]
C	2 days Artemia 10	2 days Artemia>40m	" 15-20[b]

Note: **a = BMC (feed for shrimp larvae imported from Japan). Protein = 49%. fat = 31%, ash = 5.5% and moisture = 4.3 %**
b = SUTIMAL (feed for giant freshwater prawn) Protein = 55%. fat = 8%, ash = 7% and moisture = 5.5 %.
Z = zoea stage M = megalopa stage C = crab stage

The **number** of rotifers refers to the quantity of live Branchionus sp. given per ml of water in the culture tank. When the supply of live animals was inadequate, frozen rotifers were used as a supplement. The number of *Artemia* nauplii refers to the number of *Artemia* nauplii given to each crab larvae. The amount of artificial feed is the weight of feed given per million crab larvae.

Medication

Treflan at 0.7 to 10 ppm was added to control fungal growth. No other chemical was used.

RESULT AND DISCUSSION

Scylla serrata has five zoeal stages and one megalopa stage before metamorphosing into the first crab. It takes about 25 - 28 days to pass from the zoea through the megalopa to the first crab (C,) at 28°C - 30°C. with salinity at 25-30 ppt. Exposure to salinity below 17 ppt resulted in death, therefore zoea are not adaptable to estuarine regions (Brick 1974; Hill 1974; and Ong 1964). Dominisac and Dejasme (1974) found that the time needed from Z, to megalopa stage was 16 days and from megalopa to first crab stage another 8 days. In the NAPFRE hatchery, each substage of zoea took 2 - 4 days before moulting into the next substage. But in the megalopa, moulting occurred several times before the crab stage was reached. It is therefore suspected that there might be more than one substage in megalopa, but this is yet to be verified. The details of larval development are provided in Table 2.

Table 2: Days of interval metamorphose of crab larvae

Days	**1**	**5**	**10**	**15**	**20**	**25**	**30**	
Stages								
Z_1								Day **(3 - 4)**
Z_2		——						" **(4 - 8)**
Z_3								" **(7 - 12)**
Z_4				——				" **(10-16)**
Z_5					——			" **(15-20)**
M						——		" **(18 25)**
C								" **(25-28)**

Note: Z = zoea stage: M = megalopa stage; C = crab stage

<<

Survival and speed of development from Z_1 to C_1 were maximum at 27°C and when fed with ***Artemia*** nauplii at 30/ml (Heasman and Fielder 1987). Mortality was high (50 - 70%) between Z_1 and Z_3 stages. Sudden death occurred due to the inability of the larvae to moult. Zoea were killed occasionally by chitin-destroying bacteria attacking the carapace spine (Ting et ***al. 1981*).** The survival rate was high from Z_3 to megalopa stage (mortality: 10 - 20%). But from megalopa to first crab, cannibalism became serious and resulted in a significant drop in the population. Larvae that survived up to 19 days usually reached the megalopa stage. However, only a few metamorphosed into C_1. Megalopa have reportedly been observed attacking newly metamorphosed crab (Anonymous 1975). Also, the later metamorphosing crab are usually attacked by the earlier ones. In ***Portunus trituberculatus,*** the crab attack the megalopa. If a big percentage of megalopa metamorphose to the C_1 stage simultaneously, then cannibalism is likely to be reduced. The quality of newly-hatched larvae is also an important factor in determining the success of larviculture.

Feeding with rotifer and frozen ***Artemiu*** nauplii from Z_1 - Z_4 has shown better results compared to feeding with frozen ***Artemia*** nauplii alone. A combination of rotifers and frozen ***Artemia*** nauplii from Z_1 - Z_5 and 2-day-old ***Artemia*** nauplii for megalopa-crab stage gave better results. Rotifers are a good source of live feed for the early stages, but their culture is time-consuming and labour-intensive.

Live 2-day old ***Artemia*** nauplii were given from megalopa stage onwards because of their bigger size. Out of a total of 27 trials, 19 batches successfully produced C_1 and eight batches were abandoned due to mass mortality during the Z_2 to Z_4 stages as a result of unsuccessful moulting (Table 3).

Table 3: Summarized results of crab larval rearing

Culture number	Water volume (m ton)	Density travell1	Iso.[1] (/ml)	Skeleto..[2] (Iml)	Rotifer	Artemia nauplii	Formulated feed	Survival rate	Total Cl[3]	Crab per litre	Remarks
1	2	20	5,000		/	/		7.0	2,800	I	
2	2	20	5,000		/	/		5.5	2,200	I	
3	2	30		5,000	/	/		0.9	540	0	
4	2	30	5,000		/	/		6.0	3,600	2	
5	2	20	5,000		/	/		2.4	960	0	
6	10	20		5,000	/	/	/	0.0	0	0	died at Z
7	10	20	5,000		/	/	/	0.0	0	0	died atZ₂
8	10	20	5,000		/	/	/	0.0	0	0	died atZ₂
9	2	30	5,000		/	/	/	3.5	2.100	I	
10	2	30		5,000	/	/	/	2.0	I.200	I	
11	2	30	5,000		/	/	/	12.0	7,200	4	
12	2	30	5,000		/	/	/	4.0	2,400	1	
13	2	20	5,000		/	/	/	0.0	0	0	died at Z
14	2	20	5,000		/	/		0.0	0	0	died atZ
15	2	20	5,000		/	/		0.0	0	0	died at Z_3
16	2	20		5,000	/	/		3.5	1,400		
17	2	20	5,000		/	/		21.0	8,400	4	
18	10	20	5,000		/	/		4.0	8,000	I	
19	10	30	5,000		/	/		2.0	6,000		
20	10	20	5,000		/	/		0.0	0	0	died atZ
21	2	20	5,000		/	/		15.0	6,000	3	
22	2	20	5,000		/	/		2.5	1,000	1	
23	2	20	5,000		/	/		6.0	2,400	1	
24	2	30	5,000		/	/		6.8	4,080	2	
25	2	30	5,000		/	/		4.0	2,400	1	
26	10	20	5,000		/	/		0.0	0	0	died at Z
27	2	30	5,000		/	/		12.0	7,200	4	

1 *Iso.* = *Isochrysis sp.* *2Skelet.* = *Skeletonema sp.* Cl = crab stage

<<

Artificial shrimp or prawn feeds can be given as a supplement when there is a shortage of rotifers. From these experiments it appeared that when supplementary feed was given, the amount of rotifers could be reduced. Two types of artificial feeds are used in NAPFRE — BMC and SUTIMAL. BMC is from Japan and SUTIMAL is an artificial feed produced in NAPFRE for giant freshwater prawn larvae (Zainoddin and Yaakob, 1989). BMC of the size 50 to 100 µm was used from Z_1 to Z_2 and SUTIMAL, 150 µm to 300 µm was used from Z_3 to C_1. Frozen *Artemia* nauplii were given in the early stages because the zoea apparently could not catch the actively swimming *Artemia* nauplii. Excess of uneaten live *Arremia* nauplii in the tanks affect the water quality.

The high cannibalism during the C_1 stage and onwards is again a constraint in the nursery. Cannibalism can be as high as 60 per cent within a few days at a stocking density of 10 pcs/litre. Cannibalism continued even when enough food was provided. It may be reduced by lowering the stocking density to 5 pcs/litre. To reduce high mortality caused by cannibalism, direct stocking from hatchery to the pond is recommended.

REFERENCES

ABDUL MANAN JAIS. 1979. Mentemak ketam nipah. Kertas *Pengembangan Perikanan* Bil 60. Jabatan Perikanan Malaysia, Kuala Lumpur PL/33/79(1). (In Malay).

ABU SEMAN YATIM. 1983. Panduan mentemak dan menggemukkan ketam dalam sangkar. *Kertas Pengembangan Perikanan Bil* 82. Jabatan Perikanan Malaysia, Kuala Lumpur PL/33/R3(2). (In Malay).

ANON. 1975. Notes on the food preferences of Scylla serata Forskal. *Ann.* Rep. Inst. of Fish. Res. and Dev.. Mindanao State Univ., :121-122.

— 1981. Gazami Seed Production. *Tamano* Centre *Operations Report* 1981 Japan Sea Farm. Assn. Internal Rep. (In Japanese).

BRICK. R.W. 1974. Effects of water quality, antibiotics, phytoplankton and food on survival and development of larvae of *Scylla serrata* (Crustacea: Portunidae). *Aqua. 3.231-244.*

CHOO, P.S. 1983. Peneaid prawn larviculture technique in the Fisheries Research Institute. Penang. Malaysia. Paper presented at the Intl. Conf. on Dev. and Mgmnt. of Trop. Living Aquatic Res. August 2 · 5. 1983. Organized by Faculty of Fish. and Mar. Sci.. Agri. Univ. of Malaysia. Selangor. Malaysia.

COWAN, L. *1984. Crab farming* in *Japan. Taiwan and the Philippines.* Dept. of P. I. Brisbane, Qld

DOMINISAC. J.B. and DEJARME. H.E. 1984 Some observations on the reproduction and larval development of Scylla *serrata* Forskal. Tech. Rep. Inst. of Fish. Res. Dev., Mindanao State Univ. 57-64.

FUKUI. 1981. Gazami Seed Production. Operations Rep. II. Gazami Fukui Pref. Fish Farming Centre Internal Rep. (In Japanese).

HEASMAN, M.P. and FIELDER, D.R. 1983. Laboratory spawning and mass rearing of the mangrove crab. Scylla *serrata* (Forskal), from first zoea to the first crab stage. *Aqua.. 34 (3-4): 303-316.*

HILL, B.J. 1974. Salinity and temperature tolerance of zoea of the portunid crab *Scylla set-rata. Mar. Biol., 25(* 1): 21-24.

ONG KAH SIN. 1964. The early development stage of *Scylla* serrota Forskal (Crustacea Portunidae). reared in the laboratory. Proc. *IPFC* 11th session. Kuala Lumpur. IPFC 11(II): 135-146.

SIMON. C.M. 1974. Report on preliminary research on the rearing of the larvae of the crabs Scylla serrata Forskal and *Portunus* pelagicus. Tech. Rep. Inst. of Fish. Res. and Dev., Mindanao State Univ. pp 65-76.

TING. Y. Y.. LIN, M. M., LUO, W.S. and TSENG, B.S. 1981 Studies on the spawner rearing and reproduction of mud crab *Scylla serrata. China Fish. Aqua. 24:* I-7.

YAAKOB AHMAD, 1988 Temakan Udang Galah: Teknik Intensif dalam Sistem tertutup. Paper presented at Fish. Res. Sem., Dept. of Fish., Min. of Agri.. Malaysia. (In Malay).

ZAINODDIN. J. and YAKOB, A. 1989. Makanan rumusan larva udang galah · SUTIMAL. Paper presented at Fish. Res. Sem.. Dept. of Fish.. Min. of Agri.. Malacca. Malaysia, June 1989. (In Malay).

ZAINODDIN JAMARI, (In press). Teknologi pembenihan udang galah *(Macrobrachium resenbergii)* secara Ekstensif. Risalah Perikanan Bil. Jabatan Perikanan Kementerian Pertanian, Malaysia. (In Malay).

<<

CULTURE

<<

MUDCRAB FATTENING PRACTICES IN THE PHILIPPINES

by Daisy F Ladra
of the Bureau of Fisheries and Aquatic Resources, 860, Quezon Ave
Quezon City, Metro Manila 3008,
PHILIPPINES.

ABSTRACT

Mud crab fattening is a relatively new occupation in the Philippines. Efforts are being made to standardize techniques by private, small-scale, individual farmers. This paper describes the effort of the one such farmer, besides providing some basic information on other simple techniques used in the Philippines to fatten mud crab.

INTRODUCTION

Mud crab fattening is a relatively new practice in the Philippines. The technology has been pioneered by the private sector, primarily to meet the demands of the domestic and foreign markets by culturing marketable crab in a short span of time. Mud crab fattening pertains to culturing mud crab from 15 days to 1 month so that they put on additidnal weight after moulting. Ovigorous females are highly prized for their bright red roe. Fattening has also been resorted to by Filipino exporters to avoid confiscation of underweight mud crab, export of mud crab weighing less than 200 g being prohibited. However, due to limited baseline research studies in mud crab culture and fattening, practices vary widely in different parts of the country. The only documented technology verification studies on fattening in bamboo cages was conducted in Capiz by Joey and Sylvia de la Cruz of the Department of Agriculture, Roxas City.

This article describes some unique fattening practices being used in the Philippines.

MUD CRAB FATTENING PRACTICES

Early methods involved placing crab in holes along the seashore. The holes were covered and food was given as often as possible. The earliest recorded mud crab breeding and fattening project was by Catalino Catanoan of Bolinao, Pangasinan. His crab project was part of an integrated fish farm he tried out in this area with crab and milkfish. Tanks were constructed in his backyard, the mud crab breeding and nursery tank covering an area of 136 m^2 and the fattening tank covering an area of 41 m^2.

All sides of the tanks were cemented to prevent crab from burrowing. Drain pipes were provided in each tank to drain off foul water. Overhangs were positioned along the upper sides of the tank to prevent the crab escaping.

The water entering the tanks was fertilized and its depth maintained at 0.5 -1.0 m. About 1,000 animals were stocked, those of bigger size fattened, and the smaller ones cultured further. About ten berried crab were bought for breeding purposes and stocked in other tanks.

Feed was provided daily and consisted of kitchen leftovers, like rice, vegetables, fish and animal entrails, as well as swine manure from his piggery. During the rainy months, from May-October, about 2 kg of African snails were given.

The stock was periodically harvested to thin the tanks. Water was also changed, as often as possible, to prevent fouling.

<<

In all, 320 crab were harvested. each with an average weight of 950 g. Because this was purely a private experimental effort. no scientific data was maintained on the duration of culture, and the size and weight of the crab.

Mud crab fattening in fish ponds

NEW WASHINGTON. AKLAN

In New Washington, Aklan. mud crab fattening activities were initiated by fish pond owners using a series of crude trial and error methods. Small undeveloped ponds measuring 500 m^2 were utilized for fattening. Bamboo or plastic polyethelene netting was used as fencing material.

The ponds were prepared in similar fashion to milkfish and prawn ponds. After fertilization, crab weighing 150-200 g were stocked during the early mornings or late afternoons. The stocking rate was 2-3 crab/m‘ To prevent cannibalism and fighting amongst themselves, the tips of their pincers were cut off. Sometimes hollow blocks or old cans were placed at the pond bottom to serve as hiding areas for the crab.

The crab were fed three times a day at a rate of 5-8 per cent of bodyweight. Water was changed as often as possible to prevent fouling. The crab were fattened for 10-15 days and a growth increment of 110g/crab was achieved. After 15 days, the crab were harvested using crab liftnets.

PANQUIL BAY. MINDANAO

Panquil Bay in Mindanao is another mud crab producing region where mud crab fattening is widely practised. About 20 t of exportable mud crab are shipped every month from this area to Cebu or Manila.

Mud crab fattening is widely practised here because of financial assistance under the LEAD-Buklod Yaman Project of the Department of Agriculture. Assistance has been granted to four or five fishermen’s associations in this area. Each association has a membership of 25 fishermen.

The method of fattening in Panquil Bay differs from elsewhere. Instead of earthen ponds, square pens are used. These 2 x 2 x 1.5m pens, made with bamboo poles, are erected in the muddy, intertidal areas near the fishermen’s houses. In order to facilitate entry, exit and feeding, especially during high tides. there is a catwalk set up near the pens.

Crab weighing 150-300 g are fattened over 15-8-day periods. Chopped trashfish is given at 10 per cent hodyweight as feed twice daily. Crab liftnets are used to harvest the mud crab.

BASILAN PROVINCE

In Basilan Province. mud crab for fattening are penned underneath the homes of the Muslim fisherfolk. These houses are often constructed on stilts and the space underneath is fenced from top to bottom with chicken wire and discarded netting. There is an opening in the floor of the house through which trash fish. kitchen refuse and fruit peelings are dropped as feed. When the crab have attained the desired weight. they are harvested.

Mud crab fattening in bamboo cages

Mud crab fattening in bamboo cages is one of the technology verification studies tried out by Joey and Sylvia de la Cruz in Barangay Napapao, Ponteverdra Capiz. This project was conducted to provide a standard culture method for fattening crab.

<<

SITE SELECTION

Mud crab grow best in brackishwater, such as tidal flats, estuarine areas, bays and lagoons. Sheltered bays and coves are selected to protect the bamboo cages from strong winds and waves during adverse weather conditions. The water at such sites should be 0.5-lm deep. Areas with low salinities should be preferred, as saline water inhibits the growth of mud crab. Areas with sufficient crab for fattening as well as trash fish for feed should be considered. The area should also be accessible to the growers and target markets.

CAGE DESIGN

A modified bamboo cage (140 x 70 x 25 cm) subdivided into 18 compartments is fixed firmly by its comers to the substratum to prevent it from being washed away during inclement weather. The compartaments are covered with 140 x 70 cm split bamboo. Holes are provided in the compartment covers for feeding.

One advantage of using bamboo cages is that selective harvesting can be done. If the desired weight has not been attained, the crab could easily be returned to their compartments and fattened further.

STOCKING

About 18 crab can be stocked per unit. Stocking is done during the early morning or late in the afternoon. In Capiz, 185 crab, each of average weight 175 g. were stocked. The weight increase after 15 days was I 10 g.

FEED AND FEEDING

Mud crab are fed twice a day at 5 per cent bodyweight for 10-15 days. Feeds may be trash fish, soft-shelled snails, kitchen leftovers, mussel meat, animal entrails or almost any other kind of food.

CAGE MAINTENANCE

Periodic checks should be made during the culture period. Drifting seaweed, logs and other debris should be removed to facilitate easy circulation of water and prevent damage to the cages. After use, the crab cages should be lifted periodically and dried.

HARVEST AND HANDLING

After the fattening period, mud crab can be harvested individually by hand. The crab are then bound with straw or string to enable easy handling. A skilled labourer is hired to bind the pincers of the crab. Exposure of the crab to sun and wind should be avoided, as this may lead to weakening and eventual death.

<<

RESULTS OF TRIALS OF MUD CRAB *(Scylla serrata)* FATTENING

by L Bede D De Silva
of A E Aquatic Enterprises 98 Kol/upitiva Lane. Co/ombo .1.
SRI LANKA

ABSTRACT

Four crab fattening experiments were conducted during 199 1 Three of these used 4 x 4 x 1 m cement tanks and one was done in a 0.4 ha coverted shrimp pond. The first two trials in cement tanks were not successful. In the third trial in a cement tank, 34 crab were stocked and all were harvested after 62 days. Total weight increased from 7.9 to 13 kg. In the mud pond experiment. the average weight increase in 35 days was 96 g. Clam meat and abbatoir waste were used as feed.

INTRODUCTION

The ready market for mud crab in Singapore and the resources available for experimentation on our shrimp *farm* in Sri Lanka led to experiments in mud crab culture being conducted in the 75-acre farm at Pulichchakulama-Bathula Oya on the northwestern coast of Sri Lanka, approximately 100 km from Colombo.

The farm is operated according to international standards for the culture of *Penaeus monodon*, the black tiger shrimp, for export. Using these facilities, three experiments were conducted in cement tanks and a fourth in one of the shrimp culture ponds. This farm is bordered by a vast lagoon on its northeast and in these waters mud crab thrive.

METHODS AND MATERIALS

Si:e and nature of the culture tank

The mud crab fattening project commenced on the farm in June 1990 in two cement tanks *(5* x 5 x Im) with earthen bottoms and sea sand introduced into them. Rocks .(rubble) and deadwood were arranged in the tanks to create a near natural habitat for the animals. The bottoms were also of different levels. The tanks were partly covered during times of extreme light and heat. Brackish water from a canal leading to the lagoon was pumped into the tanks to a depth of about 0.66 m. The salinity of the water was 25-27 ppt.

First experiment

STOCKING

Twenty crab of assorted sizes and ages, weighing 3-4 kg in all, were introduced into each tank. They were water crab obtained from the commercial crab markets. Some of these crab had their claws tied to the body, or carapace, to restrict movement, while others had pegs in their chelae to facilitate handling. Before they were released into the tanks, they were untied and the pegs removed. This sometimes was a difficult exercise, as a worker incompetent in handling crab was vulnerable to attack.

BEHAVIOUR

The animals did not take much time to settle down when released. They moved freely through

<<

the crevices of the rocks from the upper tier to the lower one. They could be observed clearly. as the upper tier was only partly covered with water although the lower tier was totally covered. The animals were more active at night than during the day. even coming out of the water and resting on the rocks or on dead wood.

It was quite interesting to watch them moving on the sand or swiftly crisscrossing in the water, particularly when they noticed someone.

FEED

The animals were fed daily with offal and bones with meat. The meat was placed in the water either in cane baskets or hung. Leftovers had to be removed lest the water got contaminated. which could occur in a matter of a day. They were also fed with fresh fish, at no cost. caught from the nearby lagoon.

WATER QUALITY

Water was exchanged once a week and the tanks were cleared of any bones that may have been left over. The percentage of water discharge ranged from 30-40 per cent. The discharged water always had a very strong. offensive odour. Evidently water pollution was high. mainly due to wet food being introduced into the tank and allowed to remain for 4-5 hours, giving adequate time for the animals to feed at their own pace. Sometimes the bottoms of the tanks were washed with a hose to remove the muck that collected at the bottom and in the crevices. Maintaining water quality was not easy, but it is important.

MORTALITY

After about two months from the time the animals were introduced into the tanks, deaths occurred. Dying animals were noticed to be sedantry and inactive, not even keen on food. The rest of the animals were harvested in two or three instalments. The harvested animals were quite heavy and had gained in weight and size. They were found to be full of meat and the meat was very tasty.

Second experiment

The experiment was repeated in June 1991, after the tank bottom was cleaned. Twenty animals were introduced. The results were more or less the same, as we were not able to reduce mortality effectively.

The reasons for failure can be attributed to:

- Low level of water in the tanks.
- Rapid deterioration of the water quality.
- Production of toxic gases, consequent to poor water quality which resulted from the excretions of the crab and from rotting feed.
- Poor attention by incompetent staff with little or no technical knowledge.
- The cement tanks possibly not proving an ideal habitat.
- Pegging of the claws causing injury, which might have attracted bacterial or viral infection. (This view was expressed by an experienced fisherman.)

Experiment A: Cement tanks

A somewhat different arrangement was made in the same cement tank. A fresh bottom was laid with mud, seasand, rocks (rubble) and deadwood, and an undulating bottom and a water discharge device of 8 cm diameter were provided.

<<

Experiment B: Mud pond

A 0.4 ha growout pond for shrimp was converted for crab fattening. This mud pond was partitioned into three parts with wire mesh and the bottoms of each kept at three different levels. The entire pond was fenced or covered with wire mesh to prevent crab escapes. Rocks (rubble), deadwood and old tyres were placed in the pond to provide suitable rests or habitats for the animals. The objective was to provide an environment as close to nature as possible. The pond had its own 20 cm pump to supply it water and a drain sufficient to empty it in three hours.

Table 1: Stocking data in Experiments A and B

Date	No. Purchased	No. Stocked
A. Cement tank		
2.6	35	34
B. Mud pond		
5.6	SO	49
10.6	30	28
76.6	81	78
7.7	491	403
78.8	25	25
18.9	140	125

Each crab was tagged with a number, weighed and carapace measured before stocking.

After some time the tags were lost. The tagging was therefore abandoned. A different system of sampling was adopted from 26.6 onwards.

The crab were graded according to size into three categories before stocking. The smaller size were stocked in the shallow division while the larger went into the deeper section.

FEED & FEEDING

Wet food, namely fish, offal or clam meat was given the crab. Trash fish is freely available in the farm's discharge canals and in the neighbouring lagoon, while offal and clam meat were purchased. Feeding was done daily, either fish, offal or clam meat being given. Food was introduced into a number of cane baskets with wide mouths and placed in different places in the pond. Offal or tripe was hung. The leftovers were removed after about four hours.

The total quantity of feed in the mud pond varied according to changes in the density of crab. It averaged as follows ·

Offal	2 kg/day
Clam meat	**2** kg/day
Fish	4 kg/l00 animals per day.

The first preference seemed to be for clam meat and the second for offal or tripe.

We were not able to establish the Food Conversion Ratio (FCR), which is a vital economic factor.

WATER EXCHANGE

The mud pond was provided with an independent pump, 15cm diameter and a capacity of

<<

250 l/min. It also had a dam constructed with cement. concrete and mortar for efficient discharge of water and to empty the tank on the side opposite the inlet. The water level was maintained at about 60 cm. On very hot days, the level was increased. Water was discharged at least three times weekly, about 20-25 per cent being exchanged each time. The lowest sluice was opened during water changes to drain and clean out the pond bottom. Water contamination was very high in the case of the pond. Perhaps a low-cost, formulated feed might be the answer.

Crab appeared to like the water exchange. Activity increased with the fresh, cool incoming water.

SAMPLING

Sampling of crab to ascertain growth was neither easy nor pleasant. Most workers were reluctant to enter the tank or pond, fearing injury. However. random sampling was done with a great deal of effort.

Two methods were adopted. First, those crab that had been numbered at the time of stocking were weighed and measured. It was not easy to spot them as, in most cases, the numbers had been erased. This system of sampling had, therefore, to be abandoned.

The second method of sampling was somewhat similar to the method for sampling shrimp. Two lots of five animals each were caught from different places in each section and each lot was weighed separately and divided by the number of animals, to get the average weight. The average weight of the two lots was again added and divided by two to get a final average weight. This method was not reliable (Table 2).

Table 2: Results of Experiment B (mud pond)

	Stocking date	Avg.wt.at stocking (g)	Sampling date	Tot.wt. of five crab (g)	Avg.wt., (g)	wt. incr.. (g)
SAMPLE A	5.8	220	10.9	1650	330	110
SAMPLE B	"	230	"	1695	339	109

RESULTS

Two harvests were done. The cement tank which was stocked with 34 crab was harvested on August 2nd (62 days after stocking) and 31 crab recovered. Of them, five had lost their claws — one each. The average weight was 420 g.

The total weight of 34 crab stocked was	7.935 kg
Total weight of 31 harvested was	13.0 kg
Increase in weight	5.065 kg*

* Based on avg. stocking weight of 34 crab. increase in weight for 31 crab would he 5.9 kg appx

A partial harvest was made on August 8th from the mud pond. Forty animals were taken. The total weight of the harvest was 17.2 kg. In this instance it was difficult to ascertain average increase in weight as it was only a partial harvest.

* US $ 1 = SL Rs 40 appx. (1991)

<<

FINANCIAL EVALUATION

In view of the fact that these are the very initial experiments, a financial evaluation cannot prudently be made. However, the seed cost was 40 SL Rs*/kg and the feed cost was Rs.60. Other costs could not be worked out. The total weight harvested was 30.2 kg and when sold at a rate of 160 SL Rs./kg yielded SL Rs.4,832. The crab were sold on the local market. The export price varies between 6-8 $/kg F.O.B.

CONCLUSIONS

- Pond contamination is very high and pond bottom cleaning difficult.
- A dry. formulated feed would be preferable to a wet feed.
- Water exchange pleases the animals. Water should be discharged always from the bottom and it should be rapid.
- Animals should have all appendages at the time of stocking, therefore the selection of seed is imperative to cut costs.
- Restricted movement promotes rapid growth and minimizes cannibalism and squabbles which result in the loss of appendages.
- Ponds should be partitioned into small sections.
- Duration of fattening should not be unduly long to ensure cost-effectiveness.
- A more efficient system of sampling is required. The system of harvesting used here needed to be updated.
- Crab culture and fattening is profitable.

<<

POND CULTURE OF MUD CRAB IN SRI LANKA

by R P Samarasinghe, D Y Fernando and O S S C de Siha
of Andriez Mariculture Lid. Bangadeniya
SRI LANKA

ABSTRACT

Experimental culture of Scylla serrata was *done with* 2620 *crab. in a 0.39 ha pond.* at *Anciries: Manculiure Lid, Sri Lanka. The (lab were stocked in September 1989 and after* a *growout period of* 115 *days,* 1160 *marketable crab were harvested. Trash fish and shrimp head were used as feed. The apparent food conversion ratio was 1.5:1* **(dry** *weight basis). A possible income/ha of about SL Rs 85,000* was projected from the experience, in which case the pavhack period would be 1.2 years.*

INTRODUCTION

The mud crab, known as *Kalapu kakuluwa* in Sinhala, is a delicious sea food item. It is widely distributed in the estuaries and lagoons of several tropical and subtropical countries. Thailand, Malaysia. India. Sri Lanka, Indonesia, Bangladesh, Vietnam, the PhiJippines and Myanmar are the main producers of mud crab in Asia. According to market sources, there is a better price and greater demand for Sri Lankan crab in Singapore. Malaysia. Hong Kong and Taiwan. The edible *Kadol kakuluwa* or Mangrove Crab (very probably *S.serrata)* found in Sri Lanka's estuaries and lagoons is not exported. Its price is low even in the domestic market. The type that is exported is the *Kalapu kakuluwa* or Lagoon Crab (perhaps S. *oceanica).*

At present, most mud crab are captured from the wild. There is no crab culture or fattening farm in Sri Lanka. But, with crab fattening becoming popular in some Asian countries, like Thailand, the Philippines and Malaysia. some experimental work has been done in Sri Lanka on the propagation, fattening and pond culture of *S.serrata.* The culture techniques, however, have not been popularized among those engaged in coastal aquaculture. This could he due to the scarcity of seed (crablings) and the lack of technical knowhow.

Andriesz Mariculture Ltd.. the first intensive shrimp farm in Sri Lanka, in 1989 pioneered the propagation and culture of mud or lagoon crab. This could he the first step to the development of crab culture in the island. This paper presents some of the results of this experimental effort.

MATERiALS AND METHODS

Pond No.19 of Andriesz Mariculture's aquaculture project was selected for this trial. The particular pond was 3900 m2 and had earthen dykes and bottom. The depth of the pond was 1.8 m, while the gradient, or slope, of the dykes was steep to prevent the crab escaping.

initially there was much organic matter that had collected at the pond bottom as a result of culturing tiger prawn *(Penaeus monodon).* The pond bottom was, therefore, treated with 500 kg of quicklime (calcium oxide) and allowed to sun dry for about two months. Subsequently, the pond was filled with brackish water from the main saline water source for the farm. The pond water depth was maintained at 1.0-1.2 m throughout the culture cycle.

Crablings were bought from fishermen who had collected them by trapping and baiting. The bodyweight of the crablings ranged from 25 to 100 g each, with the average weighing about 50 g.

* US $ 1 = St. Rs 35 appx. (1989)

<<

The cost of each crabling was SL Rs 1.00. In all, 2620 crablings were stocked in the pond over a period of about two months.

The crablings were fed with chopped trash fish or shrimp heads, initially at a daily feeding rate of 10 per cent of the total biomass of the crab and, later, at 5 per cent.

Water renewal was not done regularly, except to replace evaporation losses. Artificial aeration was not provided as it was not needed. The dissolved oxygen level was always higher than 5 ppm.

Harvesting was done 1 15 days after the first stocking. The pond water was drained out completely and the crab were caught individually. After selecting the marketable animals, the smaller, soft-shelled and low quality crab were put back in the same pond. These animals were harvested ten days later, completing the experiment.

RESULTS AND DISCUSSION

The physico-chemical parameters of the rearing water are given in Table 1. A summary of the results is given in Table 2.

Table 1: Physico-chemical parameters of rearing water

	< WATER >				
Day of culture	*Depth (cm)*	*Salinity (ppt)*	*Temperature (°C)*	*pH*	*Transparency (cm)*
01	100	**29.0**	**29.5**	**8.2**	**60**
30	**120**	**32.0**	**30.0**	**8.5**	**40**
62	**120**	**24.0**	**29.0**	**8.7**	**30**
90	**110**	**28.0**			**25**
115	**120**	**22.0**	**28.5**	**8.6**	**25**

Table 2: Some important data on the culture cycle during this experiment

Pond area	3900m^2
No. of crablings stocked	**2,620**
Date of first stocking	**30.5.89**
Date of first harvesting	**25.9.89**
Total yield	**394.5 kg**
No. of crab harvested	**1160**
Average bodyweight at harvesting	**340 g**
Survival rate	**43.7%**
Culture period **from the first stocking**	**115 days**

Table 3: Feed consumption and feed conversion ratio

	Quantity (kg)	
Type of feed	*On wet weight*	**On** *dry* **weight***
Fresh shrimp heads	**740.0**	**185.0**
Trash fish	**1286.0**	**321.5**
Total	**2026.0**	**506.5**
Weight **gain during the culture period– 336.0 kg** (Total yield weight of crablings)		
FCR or AFCR**	**6.03: 1**	**1.50:1**

*** Assuming the dry weight is 25% of the wet weight.**
**** Apparent Feed Conversion Ratio (New M.B., 1987)**

Feeding was not a problem during the culture period because both the trash fish and fresh shrimp heads were well accepted. Table 3 provides data on feeding, while feed cost/kg of crab is computed in Table 4. The feed conversion ratio (FCR or AFCR) was 6.03:1 on fresh weight basis and 1.5: I on dry weight basis. The feed cost/kg of crab was SL Rs 14.92.

Table 4: Estimate of feed cost (in SL Rs)

Shrimp heads :	
740.0 kg @ Rs 1.00	**740.00**
Trash **fish :**	
1,206.0 kg @ Rs 4.00	**5144.00**
Total	**5884.00**
Total crab production	**394.5 kg**
Feed cost/kg of crab	
Rs 5884.00/394.5	**14.92**

<<

The animals rejected initially comprised 30 per cent of the population. They were restocked in the same pond and harvested after ten days, by which time most of them were marketable.

The survival rate of the crab in this experiment was 43.7 per cent. Mortality usually occurs due to cannibalism, but in this experiment, a considerable amount of mortality was experienced in the stocking stage. This 'initial mortality' could be due to the fact that, most of the time, the crablings were in a highly-stressed condition when delivered to the farm as a consequence of poor handling during collection and transport. It is therefore felt that the survival rate can be improved considerably through better collection, handling and transportation methods.

The cost analysis of this trial, given in Table 5, shows that the production cost was about Rs 47.85/kg. Farm gate price in 1989 was 90-100 SL Rs/kg for crab of 300 g and above. Therefore, a profit of SL Rs 42.15 could be obtained from I kg. According to this experiment, there was a profit of Rs 16,631.00 from the 0.39 ha pond which would give about SL Rs 42,500/ha/crop. With two culture cycles a year, possible profit could be as much as SL Rs 85,000.

Table 5: Financial analysis of the trial (in SL Rs)

1. Sales		35,505
(394.5 kg l@ Rs 90. 1crop)		
2 Fixed cost		
Land value (Rent on lease: Rs 6000/ha/year)		1,170
Depreciation on construction (10 B/year)		1,950
Depreciation on equipment (20 %/year)		1,750
	Subtotal	4.870
3. Variable Costs		
Seed cost (crablings) @ Re I each		2,620
Feed cost		5,884
Labour		2,000
Quicklime		1,500
Electricity/fuel		1,000
Miscellaneous expenses		1,000
	Subtotal	14.004
4. Total cost (2 t 3)		18,874
5. Income from 0.39 ha pond (I 4)		16.631
6. Estimated income from 1 ha pond with two crops per year		85,287

<<

Table 6 shows the estimated cash flow for the development of mud crab monoculture on a **new** 1 ha farm, including pond construction and equipment costs. Sales and variable costs are based on the experimental results and are extrapolated for two crops per year The project will make a net profit from the second year onwards and the payback period (for a one ha project) would be 1.22 years. Thus, it would appear that the monoculture of mud crab is profitable at a stocking density of 8.000/ha. Inflation is assumed to he 5 per cent annum over the five-year period.

Table 6: Five-year cash flow for 1 ha crab farm (in SL Rs)

Item	*Year* 1	2	3	4	5
1. Sales	182.076	191,180	200,739	210,776	221,315
2. Fixed costs					
Land cost					
(Rent on lease)	6,000	6.300	6.615	6,946	7.293
Pond construction	100,000	—	—	—	—
Water pump & tools	45.000				
Subtotal	151,000	6.300	6,615	6,946	7.293
3. Variable costs					
Seed cost	13,436	14,108	14,813	5,534	16,332
Feed cost	30.174	31,683	33.267	34.930	36,677
Labour	10.256	10,769	11,307	11,872	2,466
Lime	7.692	8,077	8,481	8.905	9,350
Electricity/Fuel	5,128	5,384	5,653	5,936	6.233
Miscellaneous expenses	5,128	5,384	5.653	5,936	6,233
Subtotal	71.814	75,405	79,174	83.133	87,291
4. Total costs (2 + 3)	222,814	81,705	85.789	90,079	94,584
5. Net cash flow (1 - 4)	(40.738)	109,475	114,950	120,697	126,731

<<

STATUS, CONSTRAINTS AND POTENTIAL OF MUD CRAB FISHERY AND CULTURE IN SRI LANKA

by **Chin How-Cheong and H P Amandakoon**
Aquaculture Division, Ceylon Grain Elevators Limited. Colombo 15. SRI LANKA

ABSTRACT

The large extent of shallow lagoons, tidal flats and swamps (appx. 40.000 ha) in Sri Lanka provides ideal habitats for mud crab. S. serrata. *The majority of the crab landings are from the Mannar, Kalpitiva and Negombo areas and 80 per cent of the catch are exported to Singapore and Malaysia. The crab fishing techniques are described in this paper. There are no known commercial crab culture facilities in operation in the island. Given the export potential, the possibility of lagoon cage culture of crab should he explored for further development*

INTRODUCTION

In Sri Lanka, brackishwater areas are approximately 120,000 ha in extent, out of which 40,000 ha are shallow lagoons, tidal flats and mangrove swamps (Figure 1). These areas are endowed with rich bottom fauna and flora which provide a good habitat for mud crab, S. *serrata.* The mud crab, or mangrove crab, locally called *Kalapu kakuluwa* or *Kadol kakuluwa* is known to occur abundantly in the estuaries, mangrove swamps, tidal flats and shallow lagoons (Pinto 1986). Little attention has been paid to the crab fisheries and crab culture in the past, but in view of the increased demand for crab in Southeast Asian countries, especially Singapore and Malaysia, this report was prepared reviewing the present status and future development potential of the crab fishery and crab culture.

Fig. 1 Mud crab production areas in Sri Lanka

CRAB LANDiNGS AND CRAB FISHERY

According to the FAO Year Book of Fishery Statistics, two important tropical Portunids,

<<

the blue swimmer, *Portunus pelagicus*, and the mangrove crab, *S. serrata.* dominate crab landings in India, Myanmar, Pakistan, Bangladesh. Malaysia, Vietnam and China. The 1972 landings of each of these species in the Indo-Pacific region was estimated to be in excess of 35,000 t or 10 per cent of the world production of crab (Haefner 1985). Besides being an important ocean resource, crab is also cultured. Taiwan produced 782 t of cultured mud crab in 1973 (Chen 1976).

Not much attention has been paid to the crab fishery in Sri Lanka and the total crab landing is not known due to inadequate catch statistics (Table 1).

Table 1: Coastal sector fish **production by varieties (in t)**

Fish varieties	*1980*	*1981*	*1982*	1983	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*
Seer	6,230	4.542	3.408	3.429	3,385	3.475	3.574	3.698	3,842	3,899
Paraw	10.049	0.325	8.273	6.080	7,887	8.096	8,327	8.616	8,552	9.085
Balaya	12.702	3.762	3,462	14,195	11,805	12,118	12,463	12.896	13.398	13,957
Kelawalla	6.907	7.663	8,484	9.137	6.542	6,716	6,907	7.147	7,426	7.536
Other bloodfish	8.666	11,402	12,715	8.629	6.135	6,298	6,477	6.702	6,963	7,066
Shark	8.406	9.793	6.639	8.868	6.177	6.34!	6,521	6.748	7.011	7,115
Skate	5.766	11,174	10,288	10.3 10	8.545	8,772	9,022	9.335	9,690	9,843
Rockfish	15.511	17,520	21.347	8.249	6.331	7.012	7,211	7,462	7,753	7,868
Shore seine varieties	81,513	77.346	82,714	45.073	27.467	27.682	28.466	29,460	31,368	31,064
Prawn	3.302	4.547	7.736	4.829	4,081	4.192	4.311	4,461	4,635	4.704
Lobster	204	589	636	571	577	592	608	629	654	663
Others	3.076	6,412	6.830	64.629	47.710	48,972	50.374	52.124	54,158	54.97!
Total	162.332	175.075	182.532	183.999	36.642	140.266	144.261	149.278	155,450	157,771

Source: Planning & Programming Division. Ministry of Fisheries

But based on customs export entry data, it is reliably estimated that more than 80 per cent of the crab catches are exported (Table 2). The export volume reached a peak of 977 t in 1985 and declined to a low of 43 t in 1990. The low quantity could be due to reduced fishing activity in major fishing areas due to unsafe local situations.

Table 2: Crab exports 1981-1990

Year	*Quantity (in* kg)
1981	5,219
1982	9.515
1983	58.340
1984	38.524
1985	976.636
1986	693.716
1987	283,292
1988	374.244
1989	439,903
1990	43.398

Source Sri Lanka Customs.

The fishermen engaged in the Sri Lankan crab fishery are professionals, though they may not spend the whole year crabbing. There are about 200 crab fishermen in the Negombo area and 150 crab fishermen in the Kalipitiya area. The main fishing craft used in the lagoon is known locally as *Oru*, a dugout wooden canoe between 5 and 6 m in length. Fishing is carried out either early in the morning or late in the evening, depending on the water condition and the location of the fishing area. Baited crab traps known as *Thattuwa*, are laid on the bottom at an average depth of 1.5-2 m and each is provided with a float to locate it. The bait used generally consists of skate, fish gills and, occasionally, cattle intestines. Each fisherman on an average lays 50 traps in an hour. After 20-30 minutes, the traps are lifted carefully, so as not to disturb the crab, and brought on board where the crab are retrieved by hand. The average catch per operator is 10-15 crab and up to a maximum of 50 crab per trip is possible.

Crabbing is done throughout the year except during the severe monsoon period. Catches are usually more during the morning and evening operations. Crabbing is best done when the water

<<

is turbid and almost stagnant, ie. when the tidal flow is minimal. Recently, dragnets have been introduced by some fishermen, They are usually efficient, but indiscriminate capture is bound to endanger stocks.

The major constraints of the crab fishery are

- High fishing pressure, causing drastic decline of crab.
- Local depletion of other fish stocks, causing natural food decline under intense fishing pressure.
- Deterioration in water quality. possibly retarding natural breeding processes.

CRAB CULTURE

Raphael (1972) reported preliminary pond culture trials of S. serrata in Sri Lanka with a survival rate of 36 per cent during an eight-month period. Subsequent experimental culture undertaken by the Government Pitipana Station showed less success because of high mortality due to cannibalism (Anonymous 1978). Numerous farmers have tried crab culture in net cages in the Negombo Lagoon (Samaranayake 1986), where juveniles were collected from the wild and fattened in cages using trash fish. Today, there are no known crab culture operations in the island on a commercial scale. Experiments carried out in one private farm with crablings fed on trash fish and shrimp head meal for 1 15 days have shown 44 per cent survival with an average weight gain of 200-300 g (Samarasinghe and Fernando, unpublished data 1991).

Crab breeding and hatchery technology, nutritional studies and crab feed development work are being carried out at our aquaculture research facility and will be intensified to commercial scale within the next three years.

The constraints of crab farming in Sri Lanka can be due to the following:

- Limited availability of juveniles caught from the wild.
- No commercial crab hatchery to provide seed stock.

  Non-availability of cheap commercial feed.
- Unavailability of land for crab culture.

  Various social, political and financial problems.
- Various government regulations and strict environmental control.

  High mortality and poor survival rates in existing culture system

  Wide variations in growth, making production control difficult.

MARKETING

Marketing of crab poses no problem, as they have a good demand in the local market as well as in the export market. Sri Lanka crab are preferred in Malaysia, Singapore and Hong Kong due to their excellent meat and taste. They command a premium price (4.40 US $*/kg) compared to those from Indonesia (1 .70-2.60 US $/kg) (Ferdouse 1990).

Daily catches. brought in in the morning or evening, are sold in the local markets. Good crab are selected, purchased and collected by the purchasing agents (middlemen) on the basis of body weight, prices being paid as follows:

300-500 gm	—	2.85 US $/kg (appx.)
Above 500 gm	—	4.28 US $/kg (appx.)

* US $ 1 = SL Rs. 40/- appx (199 1 |

<<

The pincers are tied with straw and the crab are packed in knitted bamboo baskets up to a maximum of 20 kg/basket. They are then transported to Colombo and airfreighted to Singapore, Malaysia etc. Mortality in non-stop airfreighting is usually 10- 15 per cent (Ferdouse 1990) and increases with the transit period. The export value and average selling price per kilo of live crab in Sri Lanka, from 198 1 to 1990, is tabulated in Table 3.

Table 3: Sri Lanka live crab export

Year	Value (US$)	Average price/kg (US$)
1981	6.184.95	1.18
1982	11,455.54	1.20
1983	61,525.92	1.16
1984	46,194.21	1.20
1985	1,196,872.90	1.23
1986	1049,580.62	1.51
1987	679,362.98	2.40
1988	973.319.33	2.60
1989	907.962.47	2.06
1990	114,803.75	2.65

Source. Sri Lanka Customs

Most of the crab are exported live, only limited amounts being used for crabmeat processing. The crabmeat processing is basically a hand-picking operation. The processing steps include weighing, cooking, picking and packaging.

Problems in crab marketing are as follows:

— Refusal by airlines to transport live crab due to traditional packing being messy.

Inconsistent supply of live crab due to unpredictable catch.

— Poor meat yield due to the moulting cycle.

— High mortality rate as a result of'mishandling and transport stress.

Competition from other species, such as Dungeness crab from the US Pacific coast, and other sources of supply at competitive prices.

CONCLUSION

Crab catches have fluctuated considerably from year to year. Over-exploitation of juveniles could be a major threat to the natural population (Samaranayake 1986). Domestic waste, urban sewage and increasing industrial affluents all contribute to the deterioration of water quality and the reduction of the crab population, as reported in Cochin, India (Devasia et al 1985). Aromatic petroleum hydrocarbons (Kulkarni and Masurekar 1983) and heavy metals such as mercuric chloride, arsenic trioxide and lead nitrate are toxic to mud crab (Krishnaja et al 1987).

Despite these constraints, the large extent of tidal flats, mangrove areas and lagoons in the Kalpitiya, Mannar and Batticaloa regions in Sri Lanka provide tremendous potential for crab culture. Extensive lagoon cage culture can be implemented with low biological or technical risks, and low capital and energy requirements. With the liberalization of the Sri Lankan economy, attractive incentives are offered by the Government to potential investors in commercial crab farming for export. In addition, crab culture would provide additional income for the coastal fishing folk and generate self-employment.

<<

REFERENCES

ANON. 1978. Master plan for *the development* **of** *coastal aquaculture* **in Sri** *Lanka.* **Min. of Fish., Sri Lanka.**

CHEN, T.P. 1976. *Aquaculture* **practice in Taiwan. Harwick Ltd. UK 130 p.**

DEVASIA, K.Y. and BALAKRISHNAN. K.F.C. 1988. Fishery of the Edible Crab, Scylla *serrata* **(Forskal) (Decepoda,** Brachyura) in the **Cochin** Backwater. IN: Harvest and Post-Harvest Technology of Fish. (Eds. Ravindran, K., Umnikrishnana, **N.. Nair. Perigreen, P.A., Madhaven, P.. Gopalakrishna** Pillai. **Panicker, A.A. and Mary Thomas) pp. 52-56.**

FERDOUSE, F. 1990. Live Crab'- a Malaysian favourite. INFOFISH Intl- **(6):55-57**

HAEFNER. Jr. P.A. 1985. The biology and exploitation of crabs. IN: *The Biology of Crustacean* **Vol. IO: Economic Aspects, Fisheries and Culture. (Ed.** Provenzano **Jr. A.J.). Academic Press, N.Y. p 1 I I-166.**

KRISHNAJA. A.P.. REGE. M.S. and JOHSHI, A.Q. 1987. Toxic effect of certain heavy metals (Hg. Cd,Pb, **As and Se) on the intertidal crab, Scy//a** *serrata Mar. Env. Res. 21:109-1* **19.**

KULKARNI. B.G. and MASUREKAR. U.B. 1983. Acute toxicity of some petroleum hydrocarbons to crab, Scylla serrata *Geobios.* **10(2):63-67.**

PINTO, L. 1986. Mangroves **of** *Sri* Lanka. **Nat. Res., Energy and Sci. Authority of Sri Lanka, 27 p.**

RAPHAEL. Y. I. 1972. Preliminary Report on the brackishwater pond culture of Scylla serrata **(Forskal) in Ceylon. IN:** *Coastal Aqua. in rhe Indo-Pacific Region* **p. 395.**

SAMARANAYAKE. R.A.D.B. 1986. Status and prospects for brackishwater aquaculture in Sri Lanka. J. Inland *Fish.* **Vol. 3 88-90.**

SAMARASINGHE. R.P. and FERNANDO, D.Y. (Unpublished data) 1991. Culture **of** *mud* carb **Scylla set-rata,** *in ponds.* **Andriesz Mariculture Ltd., Sri Lanka II.**

<<

MUD CRAB *(Scylla serrata* Forskal) FATTENING IN SURAT THANI PROVINCE

by Anuwat Rattanachote and Rachada Dangwatanakul
of the Surat Thani Coastal Aquacuirure Development Centre.
Kanchanadjt District. Swat Thani Province.
THAILAND

ABSTRACT

Mud crab (Scylla serrata *Forskal) fattening in Kanchanadit District. Surat Thani Province.* was *studied during January-February 1990. Two groups of post-moult crab, segregated by size, were maintained in eat-then ponds and fed with trash fish (at about 7-10 per cent of total hodvweight) for 20-30 days. The average size dark mud crab in the first group (which held medium-size crab) was about 11.87 cm, 456.69 g in the case of males and 10.84 cm. 241.65 g in the case of females, while that of white mud crab in this group was about 12.68 cm, 497.61 g (males) and 12.82 cm, 385.92 g (females). The average size of the second group, which consisted of the large-size crab, was about 12.35 c-rn. 519.94 g and 11.29 cm, 269.49 g respectively for male and female dark crab while, it was about 13.35 cm. 589.52 g and 12.81 cm, 387.85 g respectively tar male and female white mud crab. The catching rate was 85.20 per cent and the 1-ate of production output 93.77 per cent.*

INTRODUCTION

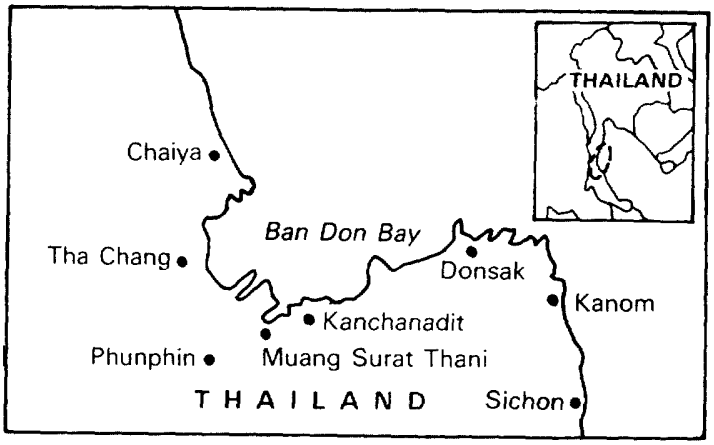
Mud crab *(Sc ylla serrata* Forskal) is a commercially important species of crustacean in Thailand, valued for its nutritional and organoleptic properties. It usually fetches a high market price. Ban Don Bay, Surat Thani Province, has abundant estuarine resources of shrimp, oyster, cockle, fish and crab. Local farmers have gained experience in mud crab cultivation and fattening over the past two decades. There is intensive mud crab culture in Kanchandit District, but it has not become a large-scale industry.

The objective of this study was to determine the range of size and the growth and survival rate of mud crab *(Scylla serrata* Forskal) maintained in earthen ponds. The culture method, cost and constraints are also discussed.

MATERIALS AND METHODS

A survey of mud crab fattening was conducted in Moo 4 Thumbol Takianthon, Kanchanadit District, Surat Thani Province (Figure 1) during January-March 1990. Mud crab numbering 1500 were sampled randomly to determine size, carapace width and fresh bodyweight. Vernier Calipers and a Centogram balance were used. The production of mud crab from ten ponds was repeatedly verified. Environmental parameters, such as salinity, temperature, pH, transparency and DO., were also observed whenever necessary.

Fig. 1 The study site located in Kanchanadit District, **Surat Thani Province**



<<

Fattening

Earthen ponds 500-800 m^2 and enclosed with bamboo poles, asbestos sheets or knotless net are usually used for mud crab fattening in Kanchanadit District. The cover is about 0.5 m over the pond. A bamboo screen about 1.0 m high placed above the sluice is used to prevent the crab escaping. Pond construction is shown in Figures 2 and 3.

Each pond is treated with lime (CaO or $CaCO_3$) at about 60-100 kg/rai* and exposed to the air for 5-7 days. It is then flushed with sea water two or three times before it is filled to 1.8-2 m depth. Water is changed daily by pumping or tidal effect.

Post-moult mud crab are stocked at a rate of about 3-5 pieces/m^2. They are fed with trash fish and horse mussel at 7-10 per cent of the total bodyweight once or twice a day. The culture period is 20-30 days.

Fig 2. Earthen pond enclosed with knotless net

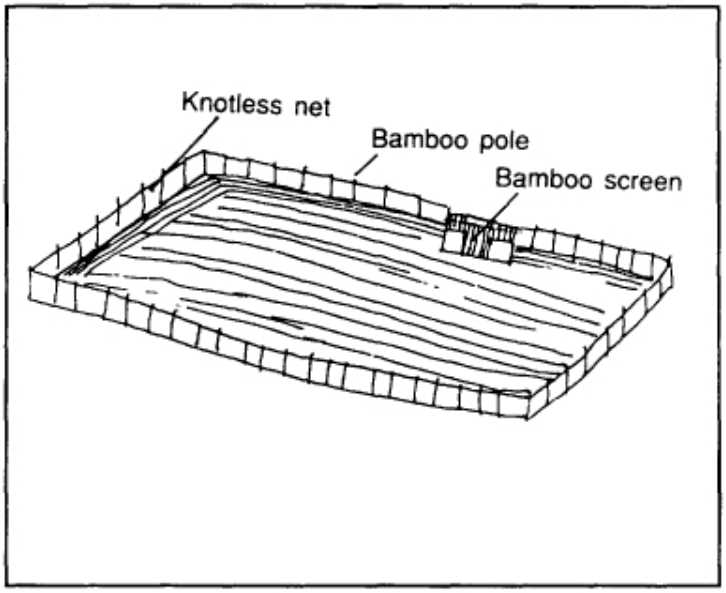
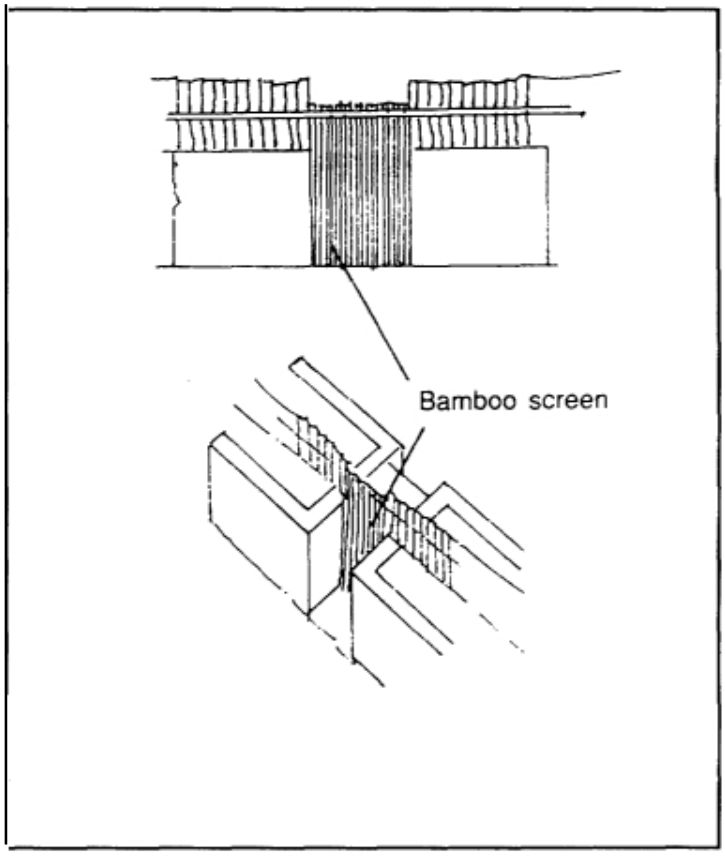


Fig 3. Bamboo screen in the sluice



Harvest methods

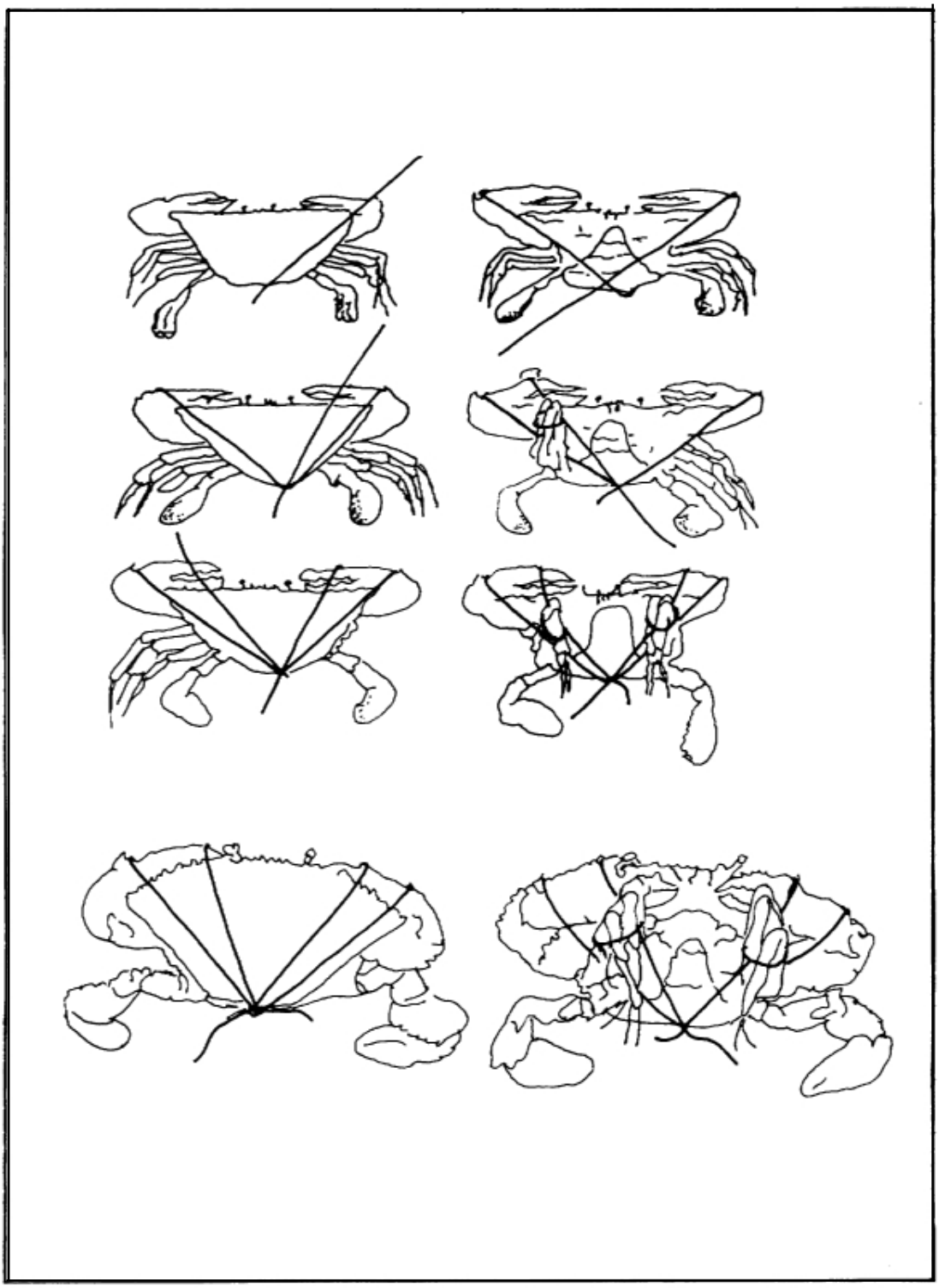
1. When the pond is refilled with sea water, the bamboo screen trap the crab. A tong-handled beam scoopnet is used to collect them. This method is followed before the main harvesting. It saves the crab from any possible damage. However, only a few crab can be caught.
2. When all the mud crab are to be harvested, a rake is used. After the pond is drained, the crab hidden in the muddy pond bottom are caught using this gear. Almost all the mud crab can be harvested with the rake, but this can be done only during the day, resulting in some damage to crab from sunlight exposure.
3. Crab hidden in holesare caught using a hook.

After collection, the mud crab are stocked in a tank (made of plastic, fibre glass or earthenware) filled with seawater, then tied with plastic line (Figure 4).

1 rai = 1600 m2

<<

Fig 4. Tying mud crab with plastic thread



<<

Environmental parameters

The mean values of the environmental parameters of the earthen pond for mud crab fattening are shown in Table 1.

Table 1: Environmental parameters of the earthen pond for mud crab fattening

Month	*Salinity (ppt)*	*Temperature (C)*	*DO.*	*pH* (ppm)	*Transparency (cm)*
1/90	23	28	6.2	7.8	35
2/90	25	30	6.1	7.6	32

RESULTS

Size distribution

The range of size of the post-moult mud crab fattened in the earth ponds in Surat Thani Province is shown in Table 2.

Table 2: Length and weight measurement of mud crab fattened in the earth ponds

Group		*Male*		*Female*	
		Length (cm)	*Weight (g)*	*Length (cm)*	*Weight (g)*
ID	Max	15.40	1000.00	15.73	595.00
	Min	9.4!	215.00	9.00	135.00
	Avg	11.87	456,69	10.84	241.65
1W	Max	15.64	990.00	14.90	610.00
	Min	10.30	230.00	9.76	190.00
	Avg	12.68	497.61	12.82	385.92
2D	Max	14.90	945.00	15.00	690.00
	Min	9.91	225.00	9.35	165.00
	Avg	12.35	*519.94*	11.20	269.49
2W	Max	16.77	1090.00	16.21	770.00
	Min	10.46	255.00	10.00	185.00
	Avg	13.35	589.52	12.81	387.85

ID and 1W = dark and white mud crab: medium size 2D and 2W = dark and white mud crab: large size

PRODUCTION

Catching rate was obtained as follows:

$$\text{Catching rate} = \frac{\text{No. caught}}{\text{No. stocked}} \times 100$$

The production rate was defined as

$$\frac{\text{Weight harvested}}{\text{Weight stocked}} \times 100$$

<<

The average catching rate of mud crab maintained in the earthen ponds, shown in Table 3, was 85.20 per cent while that of the production was 93.77 per cent.

Table 3: Production output and catching rate of mud crab maintained in an earthen pond

Replication	Month		Number	Catching rate (%)	Weight (Kg)		Production rate (%)
			Stock	Caught	Stock	Caught	
1	Jan.1990	296.00	228.00	77.03	122.00	103.90	85.15
2	Jan.1990	537.00	508.00	94.60	192.80	199.30	103.37
3	Jan.1990	515.00	490.00	95.15	216.60	219,60	101.39
4	Jan.1990	338.00	334.00	98.82	147.70	152.60	103.32
5	Jan.1990	433.00	360.00	83.14	163.30	145.60	89.16
6	Jan.1990	256.00	226.00	88.28	114.10	105.30	92.29
7	Jan.1990	427.00	405.00	94.85	145.60	153.50	105.43
8	Jan.1990	252.00	218.00	86.51	96.20	96.60	100.42
9	Jan.1990	258.00	219.00	84.88	112.70	90.90	80.66
10	Jan.1990	444.00	412.00	92.79	181.30	174.70	96.36
11	Feb.1990	276.00	231.00	83.70	126.30	112.40	88.99
12	Feb.1990	344.00	311.00	90.41	151.10	146.70	97.09
13	Feb.1990	335.00	217.00	64.78	122.10	91.20	74.69
14	Feb.1990	354.00	317.00	89.55	119.20	115.40	96.81
15	Feb.1990	218.00	205.00	94.04	102.80	101.20	98.44
16	Feb.1990	178.00	125.00	70.22	85.50	65.50	76.6!
17	Feb.1990	89.00	91.00	102.25	14.50	21.60	148.97
18	Feb.1990	133.00	78.00	58.65	51.00	39.90	78.24
19	Feb.1990	210.00	150.00	71.43	88.90	65.40	73.57
20	Feb.1990	199,00	165.00	82.91	52.00	43.90	84.42
	AVERAGE	304.60	264.50	85.20	120.29	112.26	93.77

Costs and earnings

The following estimates are made for an 800 m^2 pond. All costs are in Thai Baht.*

FIXED COSTS

Pond construction	12,000
Bamboo poles	2,400
Total	14,400

ECONOMICS

VARIABLE COSTS

These include seed stock, trash fish, wages and other miscellaneous costs. These amount to 8200-8700 Baht/crop if 100 kg of large crab are stocked for a fattening period of 20-30 days.

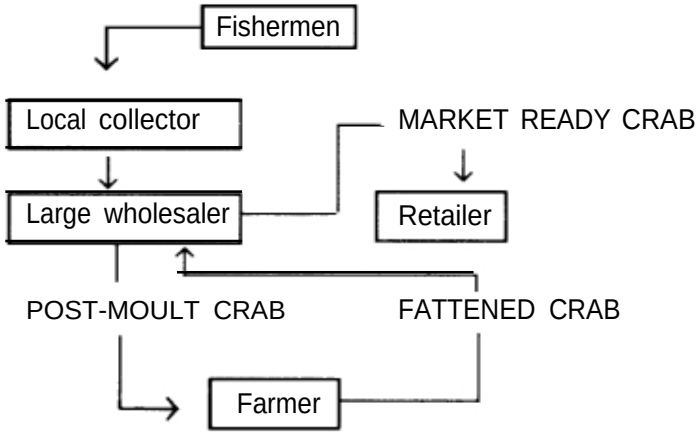
* US $ 1 = Baht 25 appx. (Feb 1990)

<<

REVENUE

Depending on the size composition of the harvest, revenue would be about 11,340 Baht, leaving a profit of 3140 to 3640 Baht. Depreciation on the pond and sluice gate has not been accounted for here, but is assumed to be relatively low.

Fig 5. The marketing channel of mud crab in Surat Thani Province



Prices on the local retail market depend on the size and condition of the crab, as shown in Table 4.

Table 4: Local market price of mud crab in Surat Thani Province

Quality	*Price (Baht)/kg*
Gravid female	90 - 160
Mid-sized male & female	65
Large males	120 - 130

CONCLUSIONS

Mud crab fattening in Surat Thani Province provides a good profit for local farmers. Gravid females in particular command a high price. However, this farming is still done only on a small scale. Culture areas and the number of farms fattening mud crab in Surat Thani Province are summarized in Table 5.

Table *5:* Culture **areas and number of crab fattening farms in Surat Thani Province.**

Location	1985		1990	
	Area (rai)	*Noof farms*	*Area (rai)*	*No. of farms*
Muang Surat Thani	70	1	-	-
Kanchanadit	11	2	2	5
ThaChang	80	1	-	-
Phunphin	20	2	18	1
Total	181	6	20	1

Source: Department of Fisheries of Thailand (1987) and the Surat Thani Coastal Aquaculture Development Centre (1990).

The data show that culture areas devoted to mud crab fattening have declined. This could be due to loss of natural resources.

<<

RECOMMENDATIONS

The insufficient supply of the post-moult mud crab for fattening in Surat Thani has directly affected aquaculture activities. This indicates that the natural stock of mud crab is now depleted, perhaps due to the following causes:

- The high demand of gravid female for consumption.
- Overfishing.
- Water pollution.
- Habitat destruction.

Due to the degradation of mud crab stocking in nature, the following are recommended:

- Artificial propagation to produce postlarva for restocking and supplying the farmers.
- Habitat protection.
- Research on spawning seasons. The knowledge of spawning season can be applied to fishing regulations during certain periods.
- Public awareness of the real situation and of aspects of conservation.
- Dissemination of mud crab culture techniques and introduction of market regulations.

<<

FORMULATION OF ARTIFICIAL FEEDS FOR MUD CRAB CULTURE: A PRELIMINARY BIOCHEMICAL, PHYSICAL AND BIOLOGICAL EVALUATION

by Chin How-Cheong, U.P.D. Gunasekera and H.P. Amandakoon
of the Aquaculture Division. Ceylon Grain Elevators Ltd. Colombo 15. SRI LANKA.

ABSTRACT

Two compounded diets were prepared in dry pellet for-m using various feed ingredients, including slaughter house and shrimp processing plant by-products. The experimental diets were analyzed biochemically for their nutrient content and water stability. The diets were fed to various size groups of mud crab (Scylla serrata) for biological evaluation. The results suggest that a compounded diet can be fed to mud crab to achieve a satisfactory growth rate. There was no significant difference in performance between groups fed with 35 per cent and 40 per cent protein levels. Crab fed with fresh clam (Meretrix casta) *had better feed conversion efficiency than experimental feed groups. The prepared diets were water stable, attractive. and consumed well by the crab.*

INTRODUCTION

Crab culture *(Scylla serrata)* has been practised in Kwang Tung Province in China from as early as 1891 (Tung and Sin 1991). Subsequently, commercial cultures were reported in the Philippines (Escritor 1970), Thailand (Varikul et al 1972), Sri Lanka (Raphael 1970) and India (Marichamy 1979). Polyculture of mud crab with milkfish was reported by Pagcatipunan (1972) in the Philippines and with *Gracilaria* in Taiwan (Loo 1979). Conventional feedstuffs used for crab culture were trash fish, clam and mussel meat, and gutted waste from fish processing plants (Chalyakam and Parnichsula 1978; Lijauco et al 1980; Bensam, 1986; Marichamy et al 1986). However, upto this day, no record on mud crab being fed artificial pelleted feeds can be found in the literature, unlike in the case of other species of crab, e.g. Chinese hairy crab, *Eriocheir sinensis, (Cheng et al 1989; Fan et al 1989) or blue crab, Callinectes sapidus. (Millikin et al 1980).* Since feed cost ranges from 50-70 per cent of total variable costs of production in aquaculture projects, it would be highly desirable to develop an efficient diet to improve profitability.

<<

MATERIALS AND METHODS

Composition and preparation of the feed

Two crab diets were prepared by making use of commercially available raw feed ingredients and processing plant by-products in the percentages given in Table 1. The diets were bound with Aquabind (0.5%) and wheat flour (10%) and labelled as CF- I and HM-2, respectively. A third diet, NF-3, consisted of whole fresh clam (Meretrix casta) purchased in frozen blocks from a local -seafood processor.

Table 1: Percentage composition of feed ingredients of different experimental diets (on dry matter basis)

CF-1 Ingredients	(%)	HM-2 Ingredients	(%)
Danish fishmeal	5.00	Shrimp head meal	30
Maldive fishmeal	5.00	Trash fish	30
Meat meal	2.00	Cattle intestine	30
Shrimp head meal	15.00	Wheat flour	10
Wheat bran	6.75		
Rice polish	19.65		
Soyabean meal	40.00		
L-lysine	2.00		
Dicalphos	2.00		
Cod liver oil	1.00		
Aquabind	0.50	NF-3	(%)
Vit. premix	1.00		
Mycocurb	0.10	Fresh clam	100

Biochemical Analysis

The diets were subjected to proximate composition determination of moisture, crude proteins, crude fats (Pearson 1976), crude fibre (Hastings 1976) and nitrogen-free extract, by using the methods of AOAC (Herwitz 1980). The percentages of ingredients in the three diets are presented in Table 2. The aminograms of feed samples were determined by Degussa Laboratory, Germany (Table 3).

Table 2: Proximate analysis of CF-1, HM-2 and NF-3

Composition	CF-1 (%)	HM-2 (%)	NF-3 (%)
Moisture	Il.8	8.4	78.8
C.Protein	35.6	39.9	15.4
C. Fat	5.2	8.3	1.0
C. Fibre	8.6	10.2	0.1
Silica	2.5	1.3	0.1
Ash	15.2	18.9	1.1
Ca	2.5	6.2	0.1
Salt	0.9	1.1	0.02
NFE	23.9	14.3	3.6

<<

Table 3: Amino acid composition* of the experimental diets

Amino Acid'	*CF-1*	*HM-2*	*NF-3*
Methionine	**1.78**	**I .54**	**2.25**
Cystiene	**1.15**	**I.45**	**1.57**
Methominet + Cystiene	**2.93**	**2.99**	**3.82**
Lysine	**2.93**	**2.99**	**6.84**
Threonine	**4.57**	**7.79**	**4.34**
Arginine	**4.29**	**6.26**	**6.6e**
Valine	**4.15**	**4.51**	**4.73**
Proline	**4.14**	**4.40**	**4.10**
Phenylalanine	**14.48**	**7.14**	**4.56**
Tyrosine			**4.14**
Tryptophan			**I.24**
Leucine	**4.95**	**6.49**	**7.20**
Isoleucine	**3.18**	**3.90**	**4.22**
Asparagine	**7.86**	**9.58**	**10.1 I**
Glutamine	**11.14**	**13.77**	**13.87**
Alanine	**4.75**	**4.68**	**6.10**
Histidine	**2.87**	**3.41**	**2.39**
Glycine	**5.02**	**4.94**	**5.17**
Serine	**3.21**	**4.02**	**4.88**

*gm AA/100gm CP

Physical evaluation

The pelleted diets were evaluated for water stability according to the method described by Lowe and Apelt (1985). The findings are given in Table 4. Five sizes of pellets of varying length and constant diameter (15 mm x 3.5mm, 20 mm x 3.5 mm, 20 mm x 3.5mm, 25 mm x 3.5 mm, 30 mm x 3.5 mm and 35 mm x 3.5 mm) were fed to two groups of crab (six animals per group) to evaluate the effect of pellet length and feed consumption time (Table 5).

Table 4: Water stability evaluation of crab feeds

	CF-1 (%)	*HM-2* 4
Water absorption (after 3 hours)	**35**	**25**
Floating particles (detaching particles after 3 hours)	**13.5**	**I I.2**

Table 5: Effect of pellet length on feeding time

Pellet size (mm)	Consumption time (sec)
I0 x 3.5	**16.60**
15 x 3.5	**30.75**
20 x 3.5	**14.25**
25 x 3.5	**18.25**
30 x 3.5	**16.20**
35 x 3.5	**44.50**

Biological evaluation

Preliminary feeding experiments were carried out for 120 days in six cement tanks divided into 18 pens, each of 2.4m^2 with a constant 0.83 m water level. Each pen was stocked with ten crab. The crab were fed with different diets at 5 per cent feeding level or ad libitum. Feeding was at 8.30 a.m. and 5.00 p.m. daily, with one-third being given in the morning and the remainder in the evening. Water intake was maintained and monitored daily for pH, temperature and salinity, and fortnightly for nitrite and ammonia.

<<

Each tank was aerated and salinity maintained at 28-32 ppt. throughout the experiment. The tanks were cleaned by siphoning faecal and other particulate matter and replacing the evacuated water. Crab growth **was assessed** at 30-day intervals by collecting and recording individual weight, total gain in biomass, total feed consumed and mortality rate, and 'T' tested to determine the significant differences in mean bodyweights. feed consumption, feed conversion ratio and protein efficiency ratio between groups fed with CF-1, HM-2 and NF-3 at the end of 16 weeks of trial.

RESULTS

Water stability and binding efficiency

The binding capability of wheat flour (10 per cent inclusion level) and Aquabind (0.5% inclusion level) was efficient. All sizes of pellets settled immediately and remained intact for more than six hours at a 28-32 ppt salinity. Leaching of nutrients from feed material into the surrounding water is an important factor. Water stability ensured minimal pellet disintegration from exposure to water and from manipulation by the crab during feeding. The binding texture did not affect the acceptability of the feed (Table 6). Pellet length between 20-30 mm showed optimal feeding time, while pellets exceeding 35 mm length broke during feeding.

Table 6: Crab feed attractability test

	CF-1	HM-2
	minutes	
Time taken by crab to reach target feed	7.66	10.39

Nutritive value

Biochemical analysis showed that the prepared diets had all major nutrients needed. Fish meal, shrimp head meal, clam meat and soyabean meal were good protein sources. Proteins and amino acids were the most important and expensive aspects of the diets and selecting the most suitable raw ingredients were a high priority item in formulating and processing the crab feed.

Biological evaluation of diets

The results of the feeding experiments (Table 7) showed that all the crab gained weight but the survival rate was low. Diet NF-3 (clam meat feed) showed better feed conversion efficiency ($P < 0.05$) than either CF-I or HM-2 at 5 per cent or ad libitum feeding levels. HM-2 feed when fed ad libitum achieved a significant biomass increase ($P < 0.01$) when compared to CF-I with 5 per cent feeding level. All treated groups showed no significant differences in protein efficiency ratio with CF-I, HM-2 and NF-3 feeds. Most of the crab moulted once, but cannibalism caused mortality in all pens. There was no significant difference in total survival with the different treatments (Table 7). Periodic decrease in feed intake or complete cessation of feeding occurred during Full Moon. However, a consistent increase in bodyweight with an increase in animal size was evident. The experiment indicated no significant difference in growth when fed ad libitum on 35 per cent protein (CF-I) or 40 per cent protein (HM-2) diet.

Table 7: Results of feeding experiments comparing the survival and growth of S. serrata fed diets of CF-l,HM-2 and NF-3*

Treatment (Feed level)	Initial biomass (gm)	Final biomass (gm)	Increase in biomass (gm)	Total feed consumed (gm)	Survival rate %	Average gain/crab (gm)	Feed conversion	Protein efficiency
CF-1 (5%)	594,92±21 19	1034.36±101.06	439.44±92.36	2226±667.97	23.7	2133.97	5.05	58.02
CF-1 (Ad lib)	591.86±8 115	1214.05±138.56	622.19±217.31	3231 .5±288.33	30.6	248.03	5.65	54.68
HM-2 (5%)	597.02±60.95	123 l .06±54.34	634.04±103.99	2560.5±285.95	32.5	203.5	4.09	62.05
HM-2 (Ad lib)	599.41±92.73	1334.19±120.38	744.78±52.64	29K4.5f379.7	35	215.51	4.01	62.89
NF-3 (Ad lib)	655.2±47.23	1553.95±382.13	898.69±334.89	3737.5±159	1 40	27 l .99	2.53	83.75

* Values are means ± SE of four replications

Statistical significance is denoted by a supplement letter ($P<0.01$ or $P>0.05$)

<<

DISCUSSION

In this experiment, use of wheat flour or Aquabind as binder produced good water stability of the pellet and physical integrity was apparent even after 24 hours of immersion. Sinking pellets arid good water stability are essential in crab feed, because the crab are bottom feeders and external mastication can cause pellet fragmentation and nutrient leaching. All three experimental diets were well accepted by the animals. As indicated in these experiments, shrimp head meal or cattle intestines from a processing plant could be utilized as a major raw feed ingredient. Previously published studies have suggested a wide range of food, including benthic invertebrates, mollusc, gastropods, bivalves, remains of fish and crustaceans (Hill 1979; Joel and Sanjeevaraj 1986).

A protein content of 35 per cent or more ensured a consistent increase in growth in all the experimental diets. Higher weight gain, survival rate and feed conversion ratios were observed on animals fed with NF-3 diet. Detailed amino acid analysis of all diets did not provide a ready explanation of the observed differences in growth rates (Table 3). The result may have been influenced by the physical characteristics of the pellets as well as the nutritional content of the diets. The amino acid requirement of S. serrata is unknown. During the trial, no differences in feeding activities were obvious between feeds.

High mortality due to cannibalism was a common problem in the experiments and this could have influenced the results. Mortality of crab due to cannibalism has been widely documented (Iversen 1986, Ryther and Bardach 1974, Costlow 1967).

In conclusion, good feed and high survival rate are of primary concern in commercial mud crab culture. Cheap raw materials of good nutritive value should be tested in different combinations to reach the optimum nutrient requirement of S. serrata. The diet compositions tried here have all the basic qualities of a good crab feed and can be further improved. An acceptable mortality rate would make mud crab culture a more profitable and stable business.

REFERENCES

BARDACH. J. E., RYTHER, J. H. and MCLANEY, W.O. 1974. ***Aquaculture: thr farming and husbandry of freshwater and marine organisms.*** **John Wiley & Sons, 335 p.**

BENSAM. P. 1986. A culture experiment on crab. Scylla serrata (Forskal) at Tuticorin during 1955-1977 to assess growth and production. IN: ***Proc. Symp. Coastal Aquu., 4: 1183- 1189.***

BHUIYAN, A.L. and ISLAM, M.J. 1981. Tolerance and distribution of Scylla ***serrata*** **in response to salinity of Karnafuly river estuary, Bangladesh.** ***J. of Agri. 6 (1):7-15.***

CHAIYAKAM, K. and PARNICHSUKA. P. 1978. Experiments on rearing ***Scylla serrata*** **in brackishwater pond and cement pond.** ***Ann. Rep..*** **Songkla Fish. Stn., Dept. of Fish., 72-89.**

CHENG, J.R., CHENG, Q.H., CHENG, X.M.. GAO, R.H. and PU, J.F. 1989. Preliminary studies on artificial feed for Chinese hairy crab, ***Eriocheir sinensis. Feed Research.*** **(12) 7-10. (In Chinese).**

COSTLOW, J.D. 1967. The effect of salinity and temperature on survival and metamorphosis of megalops of the blue crabs. ***callinectes supidus. Helgolander wiss. meereunters.*** **15:R4-97.**

COWEY, C.B. and TACON, A.G.J. 1983. Fish nutrition — relevance to invertebrates. IN: ***Proc.. of the 2nd Intl. Conf on Aqua. Nutr.*** **(Eds.) G.D. Pruder, C.J. Langdon and D.E. Conklin, Louisiana State Univ., Div. of Continuing Educ., Baton Rouge, LA. pp. 13-30.**

DESHIMARU, 0. 1982. Protein and amino acid nutrition of the prawn, ***Penaeus japonicus. IN: Proc.. of the 2nd Intl. Conf. Aqua. Nutr.*** **(Eds.) G.D. Pruder, C.J. Langdon and D.E. Conklin, Louisiana State Univ.. Div. of Continuing Educ., Baton Rouge, LA. pp. 106-123.**

DESHIMARU, O. and SHIGENO, K. 1972. Introduction to the artificial diet for prawn Penueus japonicus. Aqua.. I : 115- 133.

ESCRITOR, G.L. 1970. Observations on the culture of the mud crab, Scylla serrata. ***Coastal Aqua. in the Indo-Pucific Region,*** **FAO, 355-361.**

FAN, F.C., CHOU, C.H., WONG, Y.T. and YANG, R.S. 1989. Studies on artificial feed for Chinese hairy crab, ***Eriocheir sinensis. Feed Research.*** **(10) 12-1 4. (In Chinese).**

FE-LAVINA, A. 1979. Some indications of crab fattening. ***Asian Ayua..*** **Tigbaun, Iloilo, Phil.. 2:6.**

<<

FORSTER. J.R.M. 1975. Studies on the development of compounded diets for prawns. IN: Proc. *of the lst. Intl. Conf. on Aqua. Nutr* pp. 229-247.

HILL. B.J. 1976. Natural food, foregut clearance and activity of the crab *Scylla serrata. Mar Biol., 34 (2):* 109-116.

———— 1979. Aspects of the feeding strategy of the predatory crab *Scylla serrata. Mar. Biol., 55(3): 209-214.*

———— 1979. *Biology of the* crab Scylla serrata *in the Sr. Lucia system.* Trans. of the R. Soc. of South Africa. 4(1) 55-62.

IVERSEN, E.S. 1968. Farming in the edge of the sea. Fishing News Books. UK.. 301 p

JOEL, D.R. and SANJEEVARAJ. P.J. 1986. Food and feeding of the two species of Scylla (Portunidae: Brachyura). J. Mar. *Biol.Assn. Ind. 28* (I-2): 178-183.

LIJAUCO, M.M., PROSPERO. O.Q. and RODRIGUEZ, E.M. 1980. Polyculture of milkfish. Chanos and mud crab Scylla *serrata* at two stocking densities. Q. Res. Rep. SEAFDEC. Aqua. Dept. 4(4): 19-23.

LOO, T.C. 1979. Crab culture. IN: *Taiwan Aqua.. (N.N. Liang)* pp. 121-126. (In Chinese).

LOWE, R. and APELT. J. 1985. Investigation of the water durability of fish feed pellets, *Die muhle and mischfuttertechnik. Detmold.* 122.. (14) 181-184. (In German)

MARICHAMY. R. 1979. Culture of fishes in cages and pens along the coastal waters of India. Wkshp. on cage and pen fish culture. Iloilo. Phil.

MARICHAMY. R.. MANICKARAJA. M. and RAJAPACKIAM, S. 1986. Culture of mud crab Scylla serrata in Tuticorin Bay. IN: Proc. Symp. Coastal *Aqua.. 4:* I 176- I 182.

MARSHALL, S.M. and ORR. A.P. 1960. Feeding and nutrition. IN: *The physiology of crustacea. Vol. I. Metabolism and Growth.* Ed. T.H. Watermann. Academic Press. NY. P. 227-258.

MCCORMACK. G.B. 1989. An overview of invertebrate aquaculture in Australia. *Proc* 17. Univ. of Qld., pp. 19-83

MILLIKIN. M.R.. BIDDLE. N.. SIEWICKI, T.C., FORTNER. A.R. and FAIR, P.H. 1980. Effects of various level of dietary protein on survival. molting and frequency and growth of blue crab. Callinectes *sapidus. Aqua.* 19: 149-161.

PAGCATIPUNAN. R. 1972. Observations on the culture of alimango. Scylla serrata of Camarines Norte (Philipines IN: *Coastal Aqua in rhe Indo-Pacific Region.* p. 395.

RAPHAEL, Y.L. 1970. A preliminary report on the brackishwater pond culture of S. *serrata* (Forskal) in Ceylon. IN: Coastal *Aqua. in rhe Indo-Pacific Region.* p 395.

RYTHER, J. and BARDECH. J. 1968. The status and potential of acquaculture, particularly invertebrate and algae culture. U.S. Dept. Comm. Pb. 177-767. p. 261.

SIDEWELL. V.D. *I98 I. Chemical and nutritional composition of finfishes. whales. crustaceans. molluscs and their products.* NOAA Tech. Memo NMFS-I I. U.S. Dept. Comm.. Washington, D.C., 432 p.

TUNG. H.Y. and SIN. S.L. 1991. Feeds and feedings for fish, shrimp and crab. 109-110. (In Chinese)

VARIKUL. V.. PHURUPHOL. S. and HONGPROMYART. M. 1972. Preliminary experiments in pond rearing and some biological studies of S. *serrata* (Forskal). In: *Coastal Aqua. in the Indo-Pacific Region. 366-374.*

THE FATTENING AND CULTURE OF THE MUD CRAB *(Scylla serrata)* IN MALAYSIA

by P.C.Liong

of the National Prawn Fry Production & Research Centre. Department of Fisheries. Kampung Pulau Sayak 08500. Kota Kuala Muda. Kedah. MALAYSIA.

ABSTRACT

Fattening of the mud crab (Scylla serrata) *in floating net-cages and its culture in coastal ponds were first attempted in Malaysia in the late 1970s. Fattening involves a short holding of 2 to 14 days, of marketable size crab to obtain mature females and meat crab. and, hence. higher prices. with no growth involved For pond culture. under-sized crab are kept for several months allowing moulting and growth to take place. In both instances. trash fish is the major feed item, with fish offal used as a supplement by some farmers Fattening of crab is profitable because of the fast turnover low operating cost, high survival rate and good market demand for the end products. Survival in pond culture is generally lower as a result of cannibalism and escape. Unlike other brackishwater culture systems introduced in the 70s, both crab fattening and culture never quite took off in a big way. Inadequate supply of stackable crab, either local or imported.* **was** *a major constraint. It is hoped that the recent success in the larviculture of the mud crab by the NAPFRE Centre, together with future refinement of crab hatchery technology, would eventually contribute to the further expansion of this industry.*

INTRODUCTION

The successful introduction of floating net-cages for the culture of marine and freshwater fish species in the 70s resulted in the rapid growth of the culture system in Malaysia. Finfish, such as the bass, *Lates calcarifer,* estuarine grouper, *Epinephelus* sp. and the red snapper, *Lutjanus* sp., are preferred for culture in the marine environment. Culture and fattening of the mud crab, *Scylla serrata.* in brackishwater ponds and floating net-cages had also been attempted, but to a lesser extent, in the late 70s and early 80s (Abdul Manan 1979; Abu Seman 1983). While coastal aquaculture, such as the raft culture of mussel, has shown rapid growth in sheltered waters and low-lying coastal areas throughout the country, the fattening and culture of crab never quite took off and the number of enterprises remains limited. Inadequate supply of stockable crab has been a major constraint in the further expansion of the fattening and culture of crab in Malaysia (Ong 1983 & 1991).

CULTURE SYSTEM AND MANAGEMENT

Crab fattening, as carried out in floating net-cages and culture in coastal brackishwater ponds, are two distinct and different operations. Fattening involves holding of marketable size crab for 2-14 days to acquire certain desired biological characteristics that would enable them to fetch higher prices. During the fattening process, care is taken to prevent the crab from moulting. Because of the short holding period, the gain in weight is insignificant and usually does not exceed 5 per cent of the original weight. In pond culture, undersized crab are reared for a considerable length of time — up to six months allowing moulting and, hence, growth to take place. Culture of crab in floating cages (Abu Seman 1983) ceased after several unsuccessful attempts, apparently because of poor survival.

<<

Site selection

The requirements for crab fattening in the floating net-cages are rather similar to those for finfish culture. The areas have to be sheltered or protected from rough weather and should be relatively free from pollution. Most crab fattening farms are located beside finfish net-cages, as the farmers usually carry out finfish culture also. However, mud crab are euryhaline and relatively hardy compared to marine finfish (Cowan 1984; Davenport and Wong 1987). While the estuarine areas or river mouths are generally considered too risky for finfish culture operations, because of changing water quality (Liong 1979). quite a few crab fattening farms are located within river mouths.

Nearly all crab fattening projects are located in sheltered waters along the west coast of peninsular Malaysia. The states of Penang, Perak, Selangor, Malacca, and Johore are well-known for crab fattening operations (Figure 1, see facing page).

For pond culture, coastal low-lying areas which are subjected to tidal flushings are preferred. The water quality is rarely a problem in such projects as they are usually located outside urban centres. A small number of crab ponds are located in Kedah, Penang, Trengganu, Pahang and Johore.

Cage and pond construction and design

The floating net-cages used for mud crab fattening are basically similar to those used for marine finfish culture (Chua and Teng 1977). Wooden rectangular frames are floated on plastic drums. Polyethylene netting and rigid extruded plastic mesh are commonly used for the enslosure. Horizontal planks around the top edge of the enclosure prevent the crab escaping. Physical dimensions for the net enclosure are similar to fish cages: 3m x 3m x 2m. However, for some projects carried out in shallow coastal waters, the enclosures were 0.6m deep. The mesh size is 3-5 cm. In areas where the tidal current is strong, such as Pulau Ketam, off Selangor, the net enclosures are supported by rigid wooden frames to prevent them collapsing due to the strong current. Small rigid wooden frames, measuring 2m x 2m x 0.6m, with double layers of netlon for the sides and bottom, are also used by a few farmers. Parallel wooden beams are nailed together to form a frame and serve as a cover. Plastic floats attached to the upper frame provide the needed buoyancy. The frames are set in shallow water and secured to poles or anchors. Generally, no working space is provided. A typical crab fattening farm may have 40-200 cages.

Most farms take advantage of the availability of tidal exchange in low-lying areas for pond construction. Digging, which is minimal, provides soil for bund construction. The surface soil is left undisturbed so there is no need for levelling. A central island or mound of soil is usually provided for crab to burrow during moulting and to shelter at times of poor water quality. The bund is usually lined with asbestos sheets or planks to prevent escape. Tidal gates, or PVC piping, are provided for water exchange. Pond size varies from several hundred square metres to over a hectare. Bigger ponds are stocked by entrapment, but farmers practising true culture prefer smaller ponds.

Sources of seed stock

A small portion of the crab for fattening comes from local fishermen. However, most of the crab are imported from neighbouring countries, such as Thailand, Indonesia and Sri Lanka. Crab from Thailand come through Kuala Perlis, a fishing village in the northern state of Perlis, Port Klang in Selangor is the main point of entry for crab from Indonesia, while crab from Sri Lanka are usually airfreighted to Subang International Airport, Selangor. For fattening purposes, the minimum size accepted is 150 gm.

Pond operators depend on local fishermen for their supply of small crab. According to most culturists, there are two types of mud crab. Brown crab are the dominant type and occur mainly in the mangrove environment, while the green crab are found outside the mangroves in coastal waters. Green crab reportedly grow to a bigger size (Abdul Manan 1979). Imported crab are invariably of the brown type.

<<

Fig. 1 Culture/Fattening of crab in Peninsular Malaysia

<<

Fattening

A typical farmer practising crab fattening is a former fisherman. He also often functions as a middleman in the marketing of crab. He has some fishermen regularly supplying him with locally caught crab. While selecting seed, fully-mature gravid females and meat crab are set aside for immediate marketing. Newly-fertilized females are placed in separate cages for gonadal development, while unfertilized females and males with low meat content and poor texture are put into separate cages for fattening. Grading by the degree of shell hardness and size is also done. Shell hardness, though an arbitrary measure, is an indication of the meat content. Crab of the same size and with more or less the same degree of shell hardness are placed in the same cage to reduce cannibalism and facilitate harvest. The holding period depends on shell hardness in the case of meat crab.

Imported crab are similarly sorted, except there is no immediate marketing. Probably as a result of the long shipping time, a short conditioning of two or three days is considered necessary even for meat crab. This makes sense, as the crab may have been starved for several days. It is also reported that the short holding helps in getting rid of the undesirable odour of some of the imported crab.

Stocking density varies from 30 to 60 kg/cage, depending to a certain extent on the supply and depth of the net-cages. Feeding with trash fish is carried out daily. Adequate feeding of crab is considered important, because starving accelerates cannibalism. A few farmers supplement the trash fish feed with fish offal obtained from fish mongers who cut and fillet large size fish for marketing. Fish offal is also obtained from tunafish processing plants. For short-term storage of trash fish, sun-drying and salting have been attempted.

Pond culture

Pond culture of crab is mostly of a subsistence nature and is generally a part-time operation. The crab ponds are limited in number and are mainly scattered in the coastal low-lying areas. The ponds are generally small, the total water surface area in most projects being less than half a hectare. As stocking and harvesting are continuous operations, both stocking density and culture period are not precisely known. The culture period is most frequently cited as 2 3 months, but durations of I - 6 months are also reported. The culture period is dependent on the initial size of the crab stocked and the size desired at harvest. Precise growth data are not available, as crab of various sizes are stocked in the same pond on a continuous basis and partial harvesting is carried out from time to time. However, available data indicate that the growth of mud crab cultured in pens ranges from 1 .22 to 1.41 g/day (Chaiyakam and Parnichsuka 1977).

Harvesting and marketing

Visual selection of crab with the desired characteristics is done daily. Selected crab are harvested and tied individually for marketing. Most small farmers channel their products direct to local restaurants. Sea food restaurants in Johore catering to Singapore tourists are reputed to be the big buyers. However, the bigger farms may need to depend on middlemen to ensure greater efficiency in distribution. Some quantity, nearly all of them big size, mature females, the so-called premium grade, are exported to Hong Kong and Taiwan. Unlike other aquaculture products, crab ready for marketing cannot be held for long. Prolonged holding of matured gravid females may result in spawning and, hence, a drop in price. Spawned females are considered the equivalent of meat crab in pricing terms. Holding of meat crab leads to moulting and consequent cannibalism.

Survival of local crab during the fattening operation is reported to be over 90 per cent. For imported crab, however, survival is said to be 60-80 per cent. The higher mortality is due to stress during the long transportation and is more likely to occur on arrival or within the first two days of fattening operations. Some farmers sink some vegetation to provide shelter for the crab and, thus, reduce cannibalism.

<<

In pond culture, harvesting is done slowly. Pond farmers generally harvest only the larger crab (200 g and more), leaving the smaller ones to grow further.. Male crab, it is reported, grow to a bigger size. Crab over I kg in weight are caught occasionally in ponds. Harvesting is usually done with traps. Selection of crab for their desired biological attributes cannot be carried out as precisely as in the fattening operations, unless a cage is provided to hold them. Survival rate is 50 - 80 per cent. The lower survival, compared to the fattening operation, is a direct result of longer culture periods. Some crab manage to escape in spite of precautions taken.

Total annual production from the fattening operation for the whole country is estimated at 600 t. This does not reflect true biological production, as the bulk of the seed stock originates from neighbouring countries. Pond production is negligible — not more than 50 t/year.

Water management

Water exchange in the floating net-cages is maintained by free flow of water in and out of them. Maintenance expenditure of crab cages is minimal compared to fish cages, as a regular change to nets of larger mesh, as fish grow, is unnecessary. Biofouling of the net enclosure is minimal. The crawling of the crab along the nets probably helps to reduce fouling. Except for attached seaweeds, there is no fouling by barnacles or other organisms. Such organisms probably serve as an alternative food source for the crab. Net maintenance consists mainly of repairing and patching torn nets and periodical sun drying.

Water exchanges in crab ponds is by tidal exchange. The flow of water may be through some sort of a sluice-gate or conduit. There is usually a screen to prevent the escape of crab. The flow is maintained by gravity. and human interference is not needed. The farmers have little idea as to the percentage of water changed daily. Some ponds are so poorly constructed that they cannot be dried without pumping.

ECONOMIC ANALYSIS

The construction of cages is a major expenditure in floating-cage culture. A standard unit with four net-cages with floats and nets may cost around M$ 3,000. Depending on the size of the farm, the capital investment could be between M$ 30,000 and M$ 150,000. However, all cages need not necessarily be built simultaneously. There is usually a developmental phase, during which the number of cages is increased from time to time, based on the availability of funds and the supply of crab.

The major operating cost is the purchase of crab. The price varies from 4 M$/kg to 6 M$/kg, depending on the size. source and condition of the crab. Feeding cost is generally immaterial; trash fish can be purchased at 0.30-0.40 M$/kg, while fish offal can be obtained free of charge or at a nominal price. Assumming that a kilo of crab needs a kilo of trash fish or offal (which is an overestimate).the cost of feeding should be less than 10 per cent of the operating cost. For most family-run farms, there are no labour charges involved, though a few bigger farms may employ an extra hand at a cost of about 350 MS/month.

Meat crab are likely to be sold for 8-10 MS/kg, while gravid females fetch 12-15 M$/kg. Hence the profit margin is close to 100 per cent over the two-week period of the fattening operation.

For pond culture, the land involved is likely to be owned by the farmer or is leased at a nominal fee. The major capital expenditure is the pond construction, which may amount from several hundred to a few thousand dollars, depending on the pond size and the locality of the farm. Undersized crab (120 g or smaller) are cheap and can be obtained for l-2 M$/kg. Farmers operating crab ponds are generally coastal fishermen who are most likely to be self-sufficient in

---

• US $ I = M $ 2.75 appx (1991)

<<

trash fish. The harvest is likely to be sold for 6-8 M$/kg. While the profit margin may appear high, the total profit is not too impressive as a result of the small scale of the operation.

PROBLEMS AND PROSPECTS

Besides the shortage of stockable crab, supply of trash fish could occasionally be a problem as it is competed for with fish farmers and the fish meal factories. Actual physical shortages occur after any prolonged stormy weather, which prevents fishermen from going out, and during festival seasons when there is little fishing activity.

Poaching has been reported to be a problem. There is no substitute for someone being around throughout the day where security is at stake.

The tedious nature of the operation and the long lonely hours on the farms are also regarded as discouraging factors.

Fattening of crab is nevertheless lucrative, as the prices for crab with the right biological attributes are high, mortality is low and the turnover large. Purchase of stockable crab and trash fish consititutes the major operating expense. In spite of such advantages, the industry has grown relatively little over the past few years. The stagnation is a direct result of the factors mentioned above.

For pond culture, the profit is even higher, as a result of the low operating cost. However, the scale of operation is much smaller, and, hence, total returns, or net income, may not be too impressive.

With the expansion of the National Prawn Fry Production and Research Centre to include the artificial propagation of the mud crab, following the pioneering larviculture of Ong (1964). small quantities of crab seedlings have been produced and experimental pond culture of hatchery-produced seedlings has been initiated with the cooperation of several private farmers. It is hoped that continuing research will result in further refinements in the hatchery technology and large scale production of seedlings. While hatchery-produced seedlings are, obviously, unlikely to be of direct benefit to fattening operations, it is hoped that such seedlings could be transferred to cages for fattening purposes, thus enabling further expansion of the operation.

REFERENCES

ABDUL MANAN, J. 1979 Mcnternak ketam nipah. *Kertas Pengembangan Perikanan Bif* 60. Kemcnterian Pertanian Malayria. Kuala Lumpur.(In Malay).

ABU SEMAN. Y. 1983 Panduan menternak dan menggemukkan ketam dalam sangkar. *Kertas Pengembangan Perikanan* Bil X.?. Kementerian Pertanian Malaysia, Kuala Lumpur.(In Malay).

CHAIYAKAM. K. and PARNICHSUKA, P. 1977. Experiments on the rearing of mud crab, Scylla serrata Forskal *in bamboo* pens. Ann. *Rep.* Songkhla Fish. Stn. Text in Thai, the English abstract in Mud Crab Abs.. comp. by Brais Staff, SEAFDEC. Iloilo Phil.

CHUA. T.E. and TENG. S.K. 1977. Floating fishpens for rearing fishes in coastal waters, reservoirs and mining pools in Malaysia. *Fish Bull* No 20. Min. of Agri., Malaysia. Kuala Lumpur.

COWAN, *I.. 1984. Crab forming in Japan. Taiwan and the Philippines* Inf. Ser. Q184009 Dept. of P. I., Qld.

DAVENPORT. J. and WONG, T.M. 1987. Responses of adult mud crabs (Scylla serrata Forskal) to salinity and low oxygen tension. Comparative Biochem. and *Physiol.,* 86A(I) 43-47.

ONG KAH SIN. 1964. The early development stages of Scylla serrata Forskal *reared* ii *the laboratory Proc. IPFC 1 1th* Session. Kuala Lumpur. IPFC I I (II): 429-443.

1983 Development and management of aquaculture in Malaysia. Paper presented at the Intl. Conf. on Dev. and Mgmnt. of Tropical Living Aqua. Res., Aug. 2-S. 1983. UPM. Serdang.

_____ 1991. The status and progress of seafarming in Malaysia. Paper presented at rhe 4th Nat. Coordinators Meeting. Jan.9-12: 1991 Bangkok, Thailand.

<<

REARING OF MUD CRAB (Scylla Serrata)

by Suparp Prinpanapong
of the Extension Services for Small-Scale Fisheries in Ranong.
THAILAND
and
Thaweesak Youngwanichsaed
of the Surat Thani Coastal Aquaculture Centre. Surat Thani
THAILAND

ABSTRACT

Intermoulted (hard carapace) and post-moulted (soft carapace) dark mud crab were reared separately in ponds for two months using horse mussel as feed. The growth rate of the intermoulted crab was higher than that of the post-moulted ones. They grew from 99.46 to 204.20 g at harvest and 60.92 per cent survived. whereas the post-moulted crab grew from 99.66 to 178.07 g, with 51.45 per cent survival. Although a profit of Baht 547 resulted. it is recommended that the initial size of mud crab for stocking should be more than 120g if the best returns are to be obtained.*

INTRODUCTION

Two strains of mud crab are commonly stocked for culture in Thailand, the white mud crab, or Pu *Thong-lang.* and the dark mud crab, or *Pu Thong* Daeng (Chairatana 1988). Mud crab culture is carried out primarily in Surat Thani and Chandraburi provinces, where two culture methods are widely practised:

- **Fattening:** Thin mud crab (l-4 crab/kg) are fattened for IO-20 days to get a better price.

  Culture: Small crab (more than 5 crab/kg) are reared for one to several months until they reach marketable size after several moults.

Although a few culture trials have been tried out, the evidence is still insufficient to assess its success (Pattanaporn 1982). Hence, this experiment was conducted to replicate previous experiments in which the intermoulted and the post-moulted dark mud crab were stocked separately to prevent cannibalism.

The main objectives of this experiment were to observe the growth rate, calculate the survival rate and estimate costs and returns.

MATERIALS AND METHODS

Pond preparation

Two earthen ponds at Surat Thani Coastal Aquaculture Centre, one 800m^2 and the other 625m^2. were used. After removal of the bottom mud, the ponds were dried and limed, seawater was let in and crab were stocked.

* US $ 1 = Baht 25 appx. (1991)

<<

Stocking and feeding

Healthy dark mud crab averaging 50- 155 g bodyweight and 64-94 mm carapace width (CW) were brought to the Centre from Ranong for stocking. The intermoulted (hard carapace) and post-moulted (soft carapace) crab were separated by gently pressing their abdominal flaps and 650 of the former and 346 of the latter were released separately into the earthen ponds.

The bodyweight and carapace width were recorded individually.

The stocking densities were:

Pond No 1 (850 m^2)	:	650 intermoulted crab, 99.46 g average bodyweight and 77.78 mm average CW. were stocked at 0.6 crab/sq.m.
Pond No 2 (625m^2)	:	346 post-moulted crab, 98.66 g average bodyweight and 80.25 mm. average CW, were stocked at 0.6 crab/sq.m.

Water in each pond was changed 20 times/month during high tide, when the water level was high enough to be drained into the ponds. The crab were fed on horse mussel at 40 per cent of their bodyweight. Feeding was at dawn every day.

Water analysis

Salinity, temperature and pH were recorded daily using an ATAGO Salinity Refractometer, a mercury thermometer and a portable pH meter, respectively.

Growth determination and harvest

Thirty to fifty crab in each pond were sampled at monthly intervals and the bodyweight and carapace width of each individual recorded. The crab in both ponds were harvested and the experiment finished within two months of the stocking. The harvest was done as follows:

Most crab were harvested by a scoopnet while they were aggregating at the water inlet gate during high tide.

Afterwards, the ponds were drained and the remaining crab dredged out of the mud with a scoopnet and rake.

— Finally, the crab in holes were hooked out.

Data were recorded and costs and returns calculated.

RESULTS

Growth

Pond No.1: The carapace width of the intermoulted crab increased from 77.78 mm to 90.52 mm in the first month and to 95.60.mm at harvest in the second month. The bodyweight increased from 99.46 g to 156.20 g in the first month and to 204.20 g at harvest (Table !).

Pond No.2: The carapace width of the post-moulted crab increased from 80.25 mm to 87.50 mm in the first month and to 95.02 mm in the second month (harvest time). Bodyweight increased from 98.66 g to 138.60 g in the first month and to 178.07 g at harvest (Table 1).

<<

Table 1: Growth of intermoulted and post-moulted mud crab cultured in ponds for two months

			At stocking	1st month	At harvest
Pond No.1	CW	Avg. (mm.)	77.78	90.52	95.60
		Increment		12.74	17.82
	Bodyweight.	Avg. (g)	99.46	156.20	204.20
		Increment		56.74	104.74
Pond No.2	CW	Avg. (mm.)	80.25	87.50	95.02
		Increment		7.25	14.77
	Bodyweight	Avg. (g)	98.66	138.60	178.07
		Increment		39.94	79.41

Feeding and survival rate

Pond No.1: 120 buckets of horse mussel were used for feeding. The survival rate was 60.92 per cent, 396 of 650 intermoulted crab stocked being harvested.

Pond No.2: 60 buckets of horse mussel were consumed. The survival rate was 51.45 percent, 178 crab of the 346 post-moulted crab released being harvested.

On the whole. of the 996 crab stocked in the two ponds, 574 were harvested, a 57.63 per cent survival rate.

Water quality in both ponds was similar throughout the experiment and is shown in Table 2

Table 2: Water quality in the experimental ponds

		Temperature (°C)	Salinity (ppt)	pH
Pond No.1	Range	27.0 · 35.0	10 · 20	5.65 · 9.09
	Avg.	30.7	15	8.23
Pond No.2	Range	27.0 35.0	10 · 23	6.91 · 9.09
	Avg.	31.2	16	7.40

Observations

The more crab of 120- 150 g bodyweight stocked, the more crab of over 250 g that could be harvested. It is, therefore, recommended that the initial size of mud crab to be stocked be between 120-150 and 200 g, as they can gain substantial weight within two months.

There were some advantages when crab of different moults were stocked separately. The mortality of the soft carapace crab during the harvest was thereby reduced and their culture period could be prolonged so that they could gain weight.

<<

Cost and return

Variable costs (labour, depreciation and petrol excluded):

- 120 kg of crab stocked at 20 Baht/kg	=	Baht 2,400
- 180 buckets* of horse mussel at 11 Baht/bucket	=	Baht 1,980
- 3 rolls of plastic string at 25 Baht/roll	=	Baht 75
Total	=	Baht 4.455

* 1 bucket = 13 kg.

RETURNS

As some of the 574 crab harvested had soft or damaged carapaces, only 5 10 crab were sold for Baht 5,002 and a gross profit of Baht 547 earned.

CONCLUSION

1. **Healthy crab should be selected for stocking to reduce mortality during harvesting.**

2. **Optimal weight for stocking should be 120-200 g because crab of this size can gain a substantial weight and yield a reasonable return within two months. This discourages the catching of small crab lighter than 120 g (whose market price is low but for which the culture period has to be extended). This would also, indirectly, preserve the resource of small crab.**

REFERENCES

CHAIRATANA, C. 1988. Study of *mud* crab. Tech. Paper No.1/1988. Brackishwater Fish. Div.. Dept. of Fish.. Bangkok. Thailand. 43 p. (In Thai).

PATTANAPORN, U. 1982. Culture of mud crab (fattening aspect). Training Course on Coastal Aquaculture Techniques for Junior District Fisheries Officers of Small-scale Fisheries Development Project, November 23-26th. 1982. Brackishwatcr Fish. Div.. Dept. of Fish., Bangkok. Thailand. 7 p. (In Thai).

<<

A REVIEW OF EXPERIMENTAL CULTURE OF THE MUD CRAB, *Scylla Serrafa* (Forskal) IN INDIA

by S. Srinivasagam and M. Kathirvel
of the Central Institute of Brackishwater Aquaculture, Madras 600 028 INDIA.

ABSTRACT

Available literature on experimental farming of the species in India indicates an average monthly growth of 9 mm/10 g in laboratory tanks, 11 mm/19 g in cages and 14 mm/29 g in ponds. The survival rate ranges from 28 to 86 per cent. The estimated production rate is 494-600 kg/ha in monoculture and 690 kg/ha in polyculture with milkfish and mullet.

INTRODUCTION

Experimental culture of the mud crab, *Scylla serrata* (Forskal), has been tried in Australia (Heasman and Fielder 1983), India (Naidu 1955, Kathirvel 1980, Marichamy 1980, Marichamy *et al 1980* and 1986, Raman *et al* 1980, Anon. 1980-8 I, 198 l-82, 1983-84, 1984-85 and 1985-86, Natarajan and Thangaraj 1983, Marichamy and Rajapackiam 1984, Srinivasagam *et al* 1984 and Bensam 1986), Indonesia (Grino 1977), Malaysia (Ong 1964 and 1966), the Philippines (Arriola 1940, Escritor 1973, Pagcatipunan 1973, Lavina and Buling 1977, Motoh *et al* 1977 and Baliao *et al 1981).* South Africa (Du Plessis 1971), Sri Lanka (Raphael 1973), Taiwan (Nakano 1931-33, Chen 1976 and Chen 1990) and Thailand (Chaiyakarn and Pamichsuka 1977 and 1978, Varikul et *al 1973* and Suresh 1991). Major aspects of the culture in these countries included the use of both wild and hatchery seeds. Data pertaining to the experimental culture of mud crab in India are presented here.

EXPERIMENTAL CULTURE SYSTEMS

Experimental culture of mud crab was taken up in India at both laboratory and field levels to assess growth, survival and productivity. In the laboratory, aquarium tanks, mud and plastic tubs, and cement cisterns were used to rear *S. serrata* juveniles and adults. Perforated plastic containers and cages made of wood, nylon and metal frame were employed for the culture of juveniles and adults in the field.

Perforated plastic containers and cages were kept submerged in the upper level of the water column in the mud flat areas around Tuticorin and the shallow brackishwater areas of Pulicat Lake. Direct stocking of seed was also carried out in earthen ponds, where a chicken wire mesh fence was

<<

provided along the periphery of the pond to prevent escape of the cultured crab. The details of sizes of tanks cages and ponds used in the culture of mud crab are given in Table 1.

Table 1: Size of tank/pond, types of feed and water used for the culture of S. *serrata*

	Size of tank/cages in m. and ponds ha	Types of feed	Water Temp °C	Water Salinity (ppt)
Laboratory				
Aquarium tank (Kathirvel 1980)	0.6 x 0.3 x 0.3	Clam meal	28-32	22-30
Earthenware tubes	0.6 dia x 0.6 hi	Mussel meal & trash fish	27-31 26-30	26-30 24-28
Plastic pools (Srinivasagam *et al* 1984)			27-30	26-32
Field				
Perforated Jerry can (Srinivasagam *et a!* 1984)	0.6 x 0.3 x 0.45	Trash fish	27-32	14-18
Perforated plastic tub (Bensam 1986)	0.24 dia x 0.12 hi	- do -		35-45
Wooden box cage	2.0 x 1.0 x 0.3	- do -	25-28	32-42
Metal frame with synthetic twine webbing cage (Marichamy *et a!* 1986)	2.0 x 1.0 x 0.3 & 1.0 x 1.0 x 0.3	- do - - do -	24-29	28-37
Wooden box cage	2.0 x 1.0 x 0.3	- do -	26-32	16-20
Nylon *hapa*	3.0 x 2.0 x 1.0	- do -	28-32	28-34
Earthen pond (Srinivasagam MS)	0.007	- do -	27-32	28-34
Earthen pond (Marichamy *et a!* 1980)	0.12	- do -	24-29	28-40
Earthen pond (Anon, 1981-82)	0.42	- do -		

<<

Laboratory rearing

The details of stocking rate. size at stocking (carapace width — CW — in mm), growth and survival of S. serrata in monoculture trials under laboratory conditions are given In Table 2. Juveniles (17-60 mm) reared for 45-80 days at a stocking rate of 15-20/m.^{3} showed an average growth rate of 7 mm/month (Kathirvel 1980) and 9 mm/month (Srinivasagam et al 1984). The intermoult period varied from 20 to 28 days. In order to study the effect of removal of eyestalk on growth, mud crab measuring 26- 102 mm were subjected to unilateral eyestalk ablation. This resulted in better growth (10- 12 mm) and survival (71 - 100 per cent) at a higher stocking rate of 30-40/m^3. (Srinivasagam MS).

In the polyculture trials with other portunid crab. namely *Portunus pelagicus* and *Thalamita crenata.* the mud crab registered a monthly growth of 9 to 10 mm during 45 days rearing at a stocking rate of 12-18/m^3 (Table 2) (Srinivasagam et *al 1984).*

Table 2: Details of stocking rate, growth and survival of S. serrata in laboratory tanks

Type of tank	*Stocking rate (No/m^3)*	*Culture period (days)*	*Size at stocking Carapace width* Range (in mm)	Avg. size (mm)	Avg. wt (g)	*Avg. monthly growth size* (mm)	(g)	*Survival %*
Aquarium tank (Kathirvel 1980)	**20**	**80**	**17-29**	**24**	**3**	**7**	**3**	**85**
Earthenware rub (Srinivasagamet *al 1984)*	**15**	**45**	**25-60**	**45**	**12**	**9**	**13**	**67**
Earthen tub (Srinivasagam MS)	**30**	**60**	**26-50***	**30**	**3**	**12**	**13**	**71**
Cement cistern (Srinivasagam MS)	**40**	**37**	**35-102***	**69**	**62**	**10**	**21**	**100**

• Crab were subjected to unilateraleyestalk ablation

Field culture

Details of stocking rate, stocking size, growth and survival of *S. serrata* during monoculture and polyculture in cages and ponds are given in Tables 3, 4 and 5 (see overleaf). Mud crab (26- 127 g) reared in perforated plastic containers showed a monthly growth of 10-23 g in 8- 16 months' rearing, which took place in a salt pan area (Bensam 1986). When larger specimens (177 g) were reared for two months. Bensam (1986) noticed an increase of 44 g/month. Marichamy *et a/* (1986) reported a better growth (11- I2 mm/45-97 g) and survival (85-90 per cent) when the crab were reared in the metal frame cage with synthetic thread webbing for a period of six months.

<<

Table 3: Details of cage culture of S. serrata

Type of tank	Stocking rate No/m³	Culture period (days)	Size at stocking Carapace width Range (in mm)	Avg. size (mm)	Avg. wt (g)	Avg. monthly growth size (mm)	(g)	Survival %
Perforated	185	480		-	26	-	23	
plastic tub	185	420			76		12	
(Bensam 1986)	185	240			127		10	
	185	60	-		177		44	
Metal frame	17	180	51-59	55	25	11	51	90
with synthetic	17	180	61-69	65	48	12	45	85
twine webbing	17	180	72-79	75	71	11	97	85
(Marichamy *et al* 1986)								
Wooden box cage	4	40	38-60	46	12	14	17	50
(Srinivasagam MS)	4	40	34-68*	69	7	17	15	50
Nylon *hapa*	4	40	34-40	38	7	5	5	50
(Srinivasagam MS)	4	40	42-60*	50	14	18	17	50
	2	45	16-35	23	4	10	10	67
	2	48	31-46	40	22	9	12	50
	2	75	37-85	66	70	9	21	80
	2	60	38-61*	50	30	9	23	50

*Crab were subjected to unilateraleyestalk ablation

Table 4: Details of pond culture of S. serrata

Size of pond	Stocking rate (no/m²)	Culture period (days)	Size at stocking Avg. size (CW in mm)	Avg. wt (g)	Size at harvest Avg. size (CW in mm)	Avg. wt (g)	Survival %	Production (kg/ha)
0.12	Not	240	60	30	138	278	Not	494
(Anon.	mentioned						mentioned	
1989-81)	-do-	300	65	47	130	245	-do-	600
0.12	-do-	120	46	25	131	252	-do-	·
(Anon. 1983-84)								
0.12	-do-	270	19	1	137	378	-do-	·
(Anon. 1984-85)								
0.007	10,000	30	30	6	40	17	50	·
(Srinivasagam	-do-	45	44*	22	71	45	60	·
MS)	-do-	75	130	472	155	790	80	·

*Crab were subjected to unilateraleyestalk ablation

<<

Table 5: Details of polyculture of S. scrrata with other portunid crab and fish in different culture systems

Species	Stocking rate (No/m3 or (kg/ha)	Culture period (days)	Avg. size at stocking Size (CW in mm)	Weight (g)	Avg. monthly growth Size (CW in mm)	Weight (g)	Survival %	Production (kg/ha)
Laboratory Tanks (Srinivasagam et al 1984)								
S. serrata and	12	45	20	1	10	7	67	
P. pelagicus		45	22	1	11	2	67	
S. serrata.	18	45	51	22	9	10	33	
P. pelagicusand			65	13	10	9	33	
T. crenata			30	2	4	1	loo	
Field Plastic can (Srinivasagam et al 1984)								
S. serrata	60	45	51	20	12	20	67	
P, *pelagicus*			42	4	13	6	58	
Earthen Pond (Anon 1983-84)								
S. serrata		120	26	3	23	55	30	
C. chanos			Not mentioned					
(Anon. 1985-6)								
S. serrata	2.000	270	37	5	12	48		
L. macrolepis	10.000		38	–	19	9		
(Marichamy et al 1980)								
S. serrata	2.000	300	54	29	10	62	26	690
C. chanos	30.000		28	0.1	26	22	5	324
L. macrolepis	14.500		40	0.8	15	9	67	630

During the wooden box-type cage rearing over 40 days at a stocking rate of 4/m^3, the observed growth was 14 mm/17 g in the non-ablated crab and 17 mm/l5 g in unilaterally eyestalk ablated crab. At a stocking rate of 2-4/m^3, the growth pattern varied considerably among the ablated and non-ablated crab in nylon *hapa* rearing over 40-48 days. However, the weight increase was more when large-sized crab (67 mm/70 g) were reared for a longer period (75 days).

In pond culture, the rearing lasted for 4-10 months at Tuticorin and 30 to 75 days in the Pulicat Lake trials. Though the stocking details were not available for the Tuticorin trials, the monthly growth rate varied from 7 to 13 mm and 20 to 42 g over 8-10 months. In a short-term culture of four months, the monthly growth rate was higher (21 mm/57 g). The estimated production rate varied from 494 to 600 kg/ha (Anon. 1980-81, 1983-84 and 1984-85). In the short-term trials at Pulicat Lake, the stocking rate was 1 0,000/ha. The observed monthly growth rate was 10- 18 mm/ 1 1-15 g at 50-60 per cent survival in juveniles and 10 mm/127 g at 80 per cent survival in adults.

In the polyculture trials carried out in earthen ponds with milkfish *(Chanos* chanos) and mullet (Liza *macrolepis),* the mud crab recorded a survival rate of 26-30 per cent. The observed monthly growth rate was 10-23 mm and 48-62 g. A higher production of 690 kg/ha for mud crab was estimated (Anon. 1983-84 and 1985-86, Marichamy et al 1980). A production of 292-92 kg/ha/ 3 months (Chaiyakaran and Pamichsuka 1977 and 1978) has been reported from Thailand.

<<

Feeding trials

Studies on the food and feeding habits of wild S. serrata have shown that the main food items included the remains of crustacean (44.3 per cent), fish (22.3 per cent). mollusc (14.3 per cent) and others (19.1 per cent) (Kathirvel 1981, Prasad et al 1985). In one S. serrata rearing trial, Raman et al (I 980) tried sea grass *(Halophila* ovalis) and filamcntosus algae (Chaetomorpha sp. and Enteromorpha sp.) as feeds. Juveniles of mud crab (20-37 mm) fed only plant matter exhibited a growth rate of 6 mm/4g/month, which was equivalent to that of crab fed with equal proportions of plant matter and animal matter (trash fish and gastropod meat).

In another trial. artificial pelletised feeds were tested (Srinivasagam and Munawar Sultana MS). The first feed (No. 1) was made up of prawn meal, groundnut oil cake and rice bran (3:4:4). while the second feed (No.2) contained squilla meal and wheat flour (3:2). The third feed (No.3) was a mixture of fish head powder and wheat flour (2.5: 1). The feeds were offered at a rate of 5 per cent of total crab biomass stocked. Among the three. feeds tested Feed No.1 recorded a growth of 4 mm/8g/month during 35 days rearing of juveniles having an average size of 68 mm/48 g. The observations made by Raman et al (1980) and Srinivasagam and Munawar Sultana (MS) have indicated the possibility of utilizing plant matter and artificial feed for rearing of mud crab.

Broodstock maintenance

To obtain mature and berried females for breeding, adult crab of both sexes were stocked in earthen ponds and indoor tanks. The sizes of the specimens stocked were 80-175 mm for males and 70-170 mm for females. The male and female ratio at stocking was 2:3. The female crab were subjected to unilateral cyestalk ablation. The duration of broodstock rearing varied from 60 to 135 days. In the indoor tanks, premating embrace. copulatory moult and the mating process lasted 48 hours. A month after mating, berried crab were obtained from both the tanks and ponds. On one occasion, the same female crab became berried three times with an interval of one month between spawnings. Eyestalk ablation in S. serrata resulting in ovarian development has been reported by Rangnekar and Deshmukh (1968) and Simon and Sivadas (1978 and 1979).

Mating

Mating has been observed in cage-reared adults (Marichamy *et al* 1986) and in laboratory tank-held adults. Male and female were found paired together continuously for days. During this period. the male would climb over the female and clasp her with his chelipeds and walking legs. The pair separated on the verge of precopulatory moult. After the copulatory moult of the female, the male gently turned the female over on her back using his chelipeds. The female unfolded her abdominal flap and held the male in position. The whole process lasted for two days.

Spawning

The breeding behaviour of S. serrata under controlled conditions has been reported by Naidu (1955) and Marichamy and Rajapackiam (1984). Naidu has described the behaviour of a berried female of S. serrata under captivity, prior to the release of larvae. The eggs were yellow in colour at the time of capture and turned to black before the release of larvae in 14 days. The eggs measured from 280 to 380 mm in diameter, while the early (prezoea) and late first zoea larvae measured 1 .0 and I .4 mm in length, respectively. Marichamy and Rajapackiam (1984) have given an account of the spawning of a berried female. They observed the incubation period varying from 8 to 13 days. Before spawning, the egg mass became loosened and the release of larvae took place around 6 a.m. in most of the cases. The process lasted for two hours. A berried female measuring *140* mm released 2 million larvae. The size of berried females from the wild ranged from 93-175 mm (400-1000 g) and that of ablated females 135- 140 mm (340-700 g).

<<

Larval rearing

Marichamy and Rajapackiam (1984), who attempted larval rearing, offered diatoms for the first zoeal stage, live rotifers and frozen *Artemia* nauplii for the second and third zoeal stages and freshly hatched nauplii of *Artemia* for the last zoeal stages. The first and fifth zoea measured 1.2 and 3.5 mm in length, respectively. Each zoeal stage took 3-4 days to metamorphose into the next substage, while the megalopa took 8-l I days to attain the first crab stage. Srinivasagam (MS) offered the cultures of *Chaetoceros* sp., *Cnsinodiscus* sp., *Nitzschia* sp. and *Navicula* sp. to the first zoeal stage. Cultured *Amphiplura* sp.. prepared egg custard and green mussel meat suspension were fed to the second and third zoeal stages. Larvae were fed three times daily. Although the larvae were reared up to the second stage in most of the trials undertaken, only on one occasion did the larvae reach the third stage. The interval between substages was 3-6 days. In most of the trials, heavy mortality was observed during the second stage due to ciliate infestation.

Availability of wild seed

Hatchery trials undertaken in India for seed production so far are in the experimental stage. As such, field culture operations are dependent on wild seed. Information on the availability of S. *serrata* seed from major brackishwater bodies in India indicates a peak abundance during May-October along the southwest coast of India and December-June along the east coast of India (Jones and Sujansinghani 1952. Kathirvel 1980. Chandrasekaran and Natarajan 1987, Srinivasagam et al *1988).*

Transport of live juveniles and adults

Experiments conducted in the laboratory have shown that S. *serrata* juveniles (63-79 mm) could be kept alive for 2-18 days when packed with seawater-soaked marine algae, cotton and wood shavings (Vasudeo and Kewalramani 1960). A survival rate of 55-100 per cent has been recorded when crab of 50-120 mm collected from the wild were transported by road in open containers, without any packing, over a distance of 20-53 km for stocking in indoor tanks and culture ponds.

Salinity requirement for culture

S. *serrata* is known to occur in water bodies having a range of salinity from zero (Jones and Sujansinghani 1952) to 45 ppt (Nair et *al* 1974). The optimum salinity for best survival is not known. Seed crab (20-82 mm) were tested with and without acclimation in salinities of 4-51 ppt. It was found that juveniles of *S. serrata* could not survive at 6-48 ppt without acclimation and at 4 ppt even with acclimation. The lower survival rates (12.5-50.0 per cent) were recorded at 8-10 ppt without acclimation and at 51 ppt with acclimation (12.5 per cent survival). However, 100 per cent survival was recorded in the crab without acclimation at 16-45 ppt, which was further extended to 5-50 ppt with acclimated crab, indicating the euryhaline nature of the species.

Ponds

Due to their burrowing and nomadic habits, a considerable number of S. *serrata* were found in the prawn/fish culture ponds at Port Canning (de Man 1909), at Vypeen Island, Kerala (George et *al* 1969, George 1974), at Mannakkudy in the salt-pan areas (Suseelan 1975) and at Karwar (Prasad et al 1985). It is presumed that their entry into the ponds was either through the sluice gates or by crawling over the earthen dykes or by burrowing through the dykes. George et al (1968) and Prasad et al (1985) reported damage caused by *S. serrafo* to the earthen dykes of culture ponds because of their burrowing habits.

<<

CONCLUSIONS

Sufficient data are not available at present to assess the economic viability of mud crab culture. Further research and development on S. *serrata* are needed to assess the economic viability of its culture. The following aspects will have to be considered as priority areas in research and development programmes on this valuable seafood:

- Proper design and construction of culture ponds:
- Seed production through hatcheries;
- Formulation of artificial feeds;
- Polyculture with compatible fish;
- Suitable harvesting methods, and
- Live transport.

REFERENCES

ANON. 1980-81. 1981-82, 1983-84. 1984-85. 1985-86. *Ann. Rep.* CMFRI. Cochin.

ARRIOLA. F.J. 1940. A preliminary study of the life-history of *Scvlla* ***serrata*** (Forskal). *Phil J. Set..* 73 (4): 437-454.

BALIAO, D.D., RODRIGUEZ. E.M. and GEROCHI. D.P. 1981. Culture of the mud crab. *Scylla s('rrata* (Forskal)at different stocking densities in brackishwater ponds. Q. ***Res. Rep..*** SEAFDEC Aqua. Dept.. (5 (10-14).

BENSAM. P. 1986. A culture experiment on the crab *Scylla serrata* (Forskal) at Tuticorin during 1975-77 to assess growth and production. IN: *Proc. Symp. on Coastal* ***Aqua.*** Mar. Biol. Assn. Ind.Part 4: 1183-1189.

CHAIYAKARAN, K. and PARNICHSUKA, P. 1977. Experiments on rearing of mud crab *Scylla serrata* (Forskal) in bamboo pens. *Ann.* ***Rep.*** Songkhla Stn.. Dept. Fish.. p. 7289.

CHANDRASEKARAN. V.S. and NATARAJAN, R. 1987. Availability of juveniles of the edible crab *SeylIa serrala* (Forskal) in Pitchavaram mangrove, Southeastern India. IN: *Aqua. Europe* 87-Intl. Conf. and Int Exb.. Amsterdam. European Aqua. Soc., p. 20.

CHEN, T.P. 1976. Crab culture. IN: *Aqua. practices in Taiwan. Fishing News Books.* UK. pp. 123-128.

CHEN. 1.0. 1990. *Aquaculture in Taiwan.* Fishing News Books, UK. 273 p.

DE MAN, J.G. 1909. The fauna of brackishwater ponds at Port Canning. Lower Bengal. Decapoda Crustacea. with an account of a small collection from brackishwater near Calcutta and in the Dacca District, Eastern Bengal. *Rec. Ind Mus..* 2:211 - 231.

DU PLESSIS. A. 1971. A *preliminary investigation info the morphological characteristics, feeding, growth, reproduction and larval rearing of* Scylla serrata *(For.ckal) (Decapoda: Portunidae). held in captivity.* Fish. Dcv. Corpn. S. Africa. 24 p. (Unpublished).

ESCRTOR, G.L. 1973. Observations on the culture of the mud crab *&ylla serrata* (Forskal). Iv: *Coastal Aqua. in the Indo-Pacific region.* (Ed.)T.V.R Pillay. Fishing News Books, UK.. pp. 355-361.

GEORGE, K.V. 1974. Some aspects of prawn culture in the seasonal and perennial fields of Vypeen Island. *Ind. J. Fish..* 21 (1): 1—19.

GEORGE, M.J., MOHAMED. K.H., and PILLAI. N.N. 1968. Observations on the paddy-field prawn filtration of Kerala, India. *FAO Fish. Rep.,* (57) 2: 427-442.

GRINO. E. 1977. *Notes on the local importance of culturing* Scylla serrata *in Ak/an. Capiz and Ibodla Provinces.* SEAFDEC. Phil.

HEASMAN, H.P. and FIELDER. D.R. 1983. Laboratory spawning and mass rearing of the mangrove crab *Scy/la serrata* (Forskal) from first zoea to first crab stage. *Aqua.* 34: 303-316.

JONES, S. and SUJANSINGHANI. K.H. 1952. Notes on the crab fishery of the Chilka Lake. *J. Bombay Nat. Hist. Soc..* 51 (1):128-134.

KATHIRVEL. M. 1980. Abundance of portunid crab seeds in Cochin backwater. *Proc. Svmp. on Coastal Aqua..* Mar.BioI. Assn. Ind,, Abs. No. 94.

<<

KATHIRVEL. M. 1981. Present status of taxonomy and biology of *Scylla serrata* (Forskal). Wkshp. on Crustacean Biochem. and Physiol. CMFRI Univ. of Madras. pp. 1-13.

LAVINA. A.F.D. and BULING. A.S. 1977. The propagation of the mud crab *Seylla serrata.* (F) de Haan. Q. *Res. Rep..* SEAFDEC Aqua. Dept.. 2: 9-11.

MARICHAMY. R. 1980. Culture of fishes in cages and pens along the coastal waters of India. *Proc. intl. Wkshp. on pen culture offrsh.* SEAFDEC. Phil.. p. 41-44.

MARICHAMY. R. and RAJAPACKIAM. S. 1984. Culture of larvae of *Scvlla serrata.* Mar. Fish. Inf. Serv. T. & E. Ser., 58: *13-15.*

MARICHAMY. R.. SHANMUGAM. S. and RAJAPACKIAM. S. 1980. Polyculture experiment in coastal waters at Tuticorin. *Proc. Sem. on Coastal and Inland fish culture in Tamil Nadu.* Fish. College. TNAU, Tuticorin. pp. 241-248.

MARICHAMY. R.. MANICKARAJA. M. and RAJAPACKIAM. S. 1986. Culture of the mud crab *Scylla serrata* (Forskal) in Tuticorin Bay. *Proc. Svmp. on Coastal Aqua..* Mar. Biol. Assn. India. Part 4: 1176 -1182.

MOTOH. H.. PENA. D.D.L. and TAMPOS. E. 1977. Laboratory breeding of the mud crab, *Scylla serrata* (Forskal), through the zoea and megalopa stages to the crab stage. Q. *Res. Rep.* SEAFDEC Aqua. Dept., 1:14-18.

NAIDU. K.G. 1955. The early development of *Scylla serrata* (Forskal). de Haan and *Neptunus sanguinolentus* (Herbst). *Ind J. Fish..* 2 (1): 67-76.

NAIR. R.V.. BENSAM. P. and MARICHAMY. R. 1974. Possibility of marine fish culture in the salt pan area at Tuticorin. *Ind J. Fish..* 21 (1): 120-126.

NAKANO. S. 193 1-33. On culture of *Chanos chanos* (Forskal). *Penaeus monodon (Fabricius)* and *Scylla serrata* (Forskal) at Taiwan. Formosa. *Suisan Kol.* pp. 588-602. (In Japanese)

NATARAJAN. P. and THANGARAJ. G.S. 1983. Studies on the growth of edible crab *Scylia serrata* in brackishwater cage. *Proc. Nat. Sem. on Cage and Pen Culture.* Fish. College. TNAU. Tuticorin. pp. 107-110.

ONG KAH SIN. 1964. The early developmental stages of *Scylla serrata* (Forskal) (Crustacea: Portunidae) reared in the laboratory. *Proc. Indo-Pacific Fish. Council.* 10: 136-146.

1966. Observations on the post-larval life history of *Scvlla .cerrata* (Forskal) reared in the laboratory. *Malay. Agri. J..* 45: 429-443.

PAGCATIPUNAN. P. 1973. Observations on the culture of alimango. *Scvlla serrata.* at Camarine. *Norte (Philippines).* IN: *Coastal Aqua. in the indo.Pacific Region.* (Ed.) T.V.R. Pillay. Fishing News Books. UK.. pp. 362-365.

PRASAD. P.N.. HONNAVAR. R. and NEELAKANTAN. B. 1985. The mud crab *Scylla serrata* (Forskal) as a pest in the prawn culture fields adjoining Kali estuary. Karwar. *Seafood Export J.* 17 (16): 19-21.

RAMAN. K.. SRINIVASAGAM. S. and KRISHNAN. S. 1980. Preliminary studies on culture of portunid crabs. *Scylla serrata* and *Portunus pelagicus. Proc. Svmp.on inland Aqua..* CIFRI. Barrackpore, Abs. No. 111.

RAPHAEL. Y.I. 1973. A preliminary report on the brackishwater pond culture of *Scylla .cerrata* (Forskal) in Ceylon. IN: *Coastal Aqua. in the Indo-Pacific Region.* (Ed.) T V R Pillay, Fishing News Books. UK., p. 395.

RANGNEKAR. P.V. and DESHMUKH. RD. 1968. Effect of eyestalk removal on the ovarian growth of the marine crab *Scylla serrata* (Forskal). *J. Anim. Morphol.Phsiol..* 16(1): 15:116-126.

SIMON. J. and SIVADAS. P. 1978. Morphological changes in the development of ovary in the eyestalk ablated estuarine crab. *Scylla serrata* (Forskal). *Mahasagar* - Bull Nat. Inst. Oceanogr., 11 57-62.

SIMON. J. and SIVADAS. P. 1979. Histological changes in the oocytes of the estuarine crab, *Scylla serrata* (Forskal). after eyestalk ablation. *Mahasagar* - Bull. Nat. Inst. Oceanogr. 12: 11-16.

SRINIVASAGAM. S. and SULTANA. MUNAWAR (ms.). *On the growth of the mud (-nab* Scylla serrata (Forskal) *fed on ,nimal. plant and artificial peiletised feeds.*

RAMAN. K.. JOSEPH. K.O., ABDUL KADIR, P.M. and KRISHNAN, S. 1988. Prawn, crab and fish seed resources of four brackishwater bodies of Madras. *Proc. Svmp. on Tropical Marine Living Res.* Mar Biol. Assn. *Ind,* Abs. No 18.

SURESH. A.N. 1991. Crab fattening in Thailand. *Fishing Chimes.* 11 (4): 7-9.

SUSEELAN. C. 1975. The prawn culture practices in salt-pan reservoirs at Manakkudy near Cape Comorin. *Bull. Dept. Mar. Sci.* Univ. Cochin 7: 477-486.

VARIKUL. V.. PHUMIPHIL. S. and HONGPROMYART. M. 1973. Preliminary experiment on pond rearing and some biological studies of *Seylla serrata* (Forskal). IN: *Coastal Aqua. in the Indo-Pacific Region,* (Ed). T.V.R. Pillay, Fishing News Books, UK.. p. 366-374.

VASUDEO. R.B. and KEWALRAMANI, H.C. 1960. Transport of the common crab *Seylla serrata* in living condition. *Ind. J. Fish..* 7 (1) 169-173.

TRADE

<<

MUD CRAB STORAGE AND TRANSPORT IN AUSTRALIAN COMMERCE

by N C Gillespie
of the Queensland Department of Primary industries (QDPI).
Brihie Island Aquaculture Research Centre, Bribie Island. Queensland 4507. AUSTRALIA
and
J B Burke
ot the Queensland Department of Primary industries (QDPI). Southern Fisheries Centre.
Deception Bar, Queensland 4508.
AUSTRALIA.

ABSTRACT

Mud crab, usually packed in waved *cardboard cartons, are distributed in Australia using air and road transport. Since the mortality rate is high during such Transport. an attempt was made to find out what the ideal conditions for transport would he. Relative humidity of 95 per cent at 16-20 C were found to he optimal transport conditions. The use of ventilated, insulated polystyrene containers instead 0f cardboard ho.ves was also recommended.*

INTRODUCTION

About 600t of the mud crab *Scylla serrata* are harvested annually by commercial fishermen in Australia. A considerable proportion of this is caught in Northern Australia, in remote locations in the Northern Territory and the Gulf of Carpentaria, usually several hundred kilometres from the nearest major transhipment centre. Crab are transported alive from these production areas, which are thousands of kilometres away from the markets in southern Australia.

This paper describes techniques used in Australia for storage and transport of live mud crab over these long distances and provides details about the factors which influence survival of mud crab during transport.

HANDLING AFTER CAPTURE

Immediately after capture, the crab are bound with coarse twine to render their claws immobile. After servicing their traps, commercial fishermen either pack their catch immediately or, in more remote locations, store them under water until enough have accumulated for a full shipment (upto 200 crab), either by road or by light plane. These holding structures take the form of net-pens or floating steel cages. Some holding arrangements include the use of pumps and above-ground swimming pools established on the river bank. Some fishermen attempt to hold the crab out of water, keeping them moist by covering them with damp bags or mangrove leaves.

Packing for transport

Over the past 15 years, live mud crab have almost always been packed in waxed cardboard cartons. Crab that have been bound as described above are packed tightly into the carton in a vertical position, with their claws uppermost. Australian airline companies insist on the use of heavy-duty plastic liners, as leakages of blood or regurgitated digestive juices can severely damage aircraft. The liner is inserted in the carton first and several layers of newspaper placed in the bottom to absorb fluid lost by the crab. Ten to twelve kg of crab are packed to ensure availability of sufficient oxygen.

<<

The second group consists of baby crab of size 5-10 cm CW and weight 10-40 g each. Price for baby mud crab is 45-50 centavo/piece for females and IS-25 centavo/piece for males. In Aparri Cagayan, mud crab seedlings of 3 cm CW sold for 1.00P/pc, and in Coron and Talampulan, Palawan, juveniles sold at P 30.00/15-25 Pcs.

The third group comprises mature crab for fattening. They are bought in Banguil Bay in Cotabato and Capiz at IO P/piece. Male crab that have mated several times have very little meat and are sold for very low prices. To avoid this, mud crab are harvested and sold before September. Sometimes these crab are fattened in a month's time to fetch better prices.

Another group comprises exportable crab with CW exceeding 10 cm and weighing more than 200 g. FAO Law #I62 prohibits the export of live crab measuring less than 10 cm CW and weighing less than 200 g. Mud crab for export are classified into four different groups. based on weight, as follows :

Small mud crab	:	250-300g
Medium mud crab	:	300-500g
Large mud crab		500-850g each
Extra large		850g - I kg.

Mud crab for export should be clean and healthy. Before shipment, an application for shipment is made to BFAR. A permit, obtained for a fee of PSO, is attached to the shipment. Production is often insufficient to meet exporters' demands. In Capiz, for instance, buyers reported that only about 20 per cent of their demand is met.

Buying stations are usually set up by traders and brokers or middlemen. Agents who supervise the delivery and payment of the product may be salaried employees of these establishments or they may be paid on a commission basis. All buying stations are open at all times of the day, throughout the week. Most of the supply that goes to the different buying stations comes from nearby island barangays. Suppliers meet the handling, freight and transport costs, incurred from the landing site to the buying stations. Usually the buying stations are located in the municipality nearest the airport or port from which the crab are to be shipped.

Crab, individually trussed, are packed in bunches in baskets, boxes or other containers, depending on their volume. Most buying stations buy all the crab delivered to them, rejecting only weak and dead crab. A deduction from the agreed buying price is made for undersized crab. These small crab may be fattened by the traders or sold in Manila for the domestic market. No contracts and volume commitments are made by these traders to their suppliers.

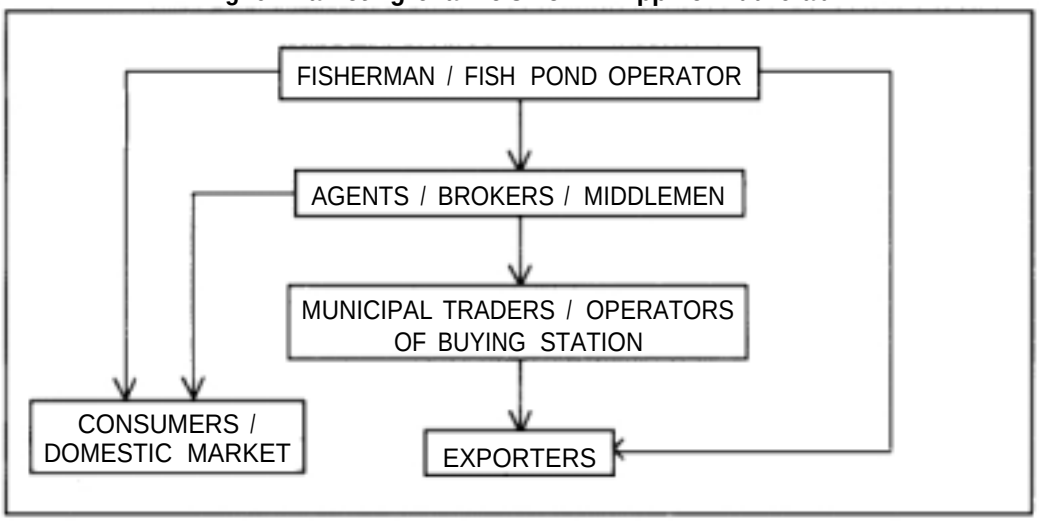
However, in some instances, advances. in the form of cash or kind, are given to gatherers to serve as incentives and assure supply. This usually happens when there is more than one buying station in an area and competition is very high. Most exporters usually get their supply from such stations. In some cases. the traders operating buying stations are also exporters. Holding pens are set up at the exporters' stations to prolong the shelf-life of the crab. Shortages in supply force most buying stations to hold their shipment until a desired volume for shipment is reached.

<<

Marketing channels

The trading pattern of the mud crab industry involves a series of intermediaries between the gatherer/supplier and the consumer or the exporter (Figure 3). This network plays an important role in the final pricing of the product; the greater the number of intermediaries, the higher the price of the crab.

Fig 3. Marketing channels for Philippine mud crab



A fish pond operator, or a big producer, usually has a shorter trading route than the fishermen who are small-scale suppliers. A progressive fish pond operator generally has the means to transport his produce and the confidence to establish links with traders and exporters. Therefore, he can sell directly to the large exporters in Cebu or Manila. On the other hand, the product of the small fisherman, particularly if he comes from island *harangays,* passes through a series of agents, brokers and traders before reaching the buying stations. Because the buying price is dictated by the exporters, the fisherman receives only a small part of the eventual price. A big chunk of the profit goes to the middlemen or brokers. Brokers act as middlemen between gatherers and wholesalers and between wholesalers and retailers. They act as financiers of the fisherfolk, when necessary. They may also operate buying stations. In remote areas, where market and consumer demand is low, gatherers sell the crab directly to consumers. Brokers generally sell to retailers or wholesalers in the public markets in Manila.

Transport practices

Mud crab juveniles of assorted sizes are placed in bamboo wicker baskets (called *hakag)* of 40cm x 50cm diameter. Three to five hundred juveniles 2.5 cms CL, with pincers tied are placed in each basket. The baskets are lined with mangrove leaves to ensure a favourable temperature and to minimize fighting among the crab. Some fishermen cut the tips of the pincers to prevent fighting.

Often the *hakag* are packed in larger containers made *of pandan* leaves, or wooden boxes *(hayong).* These larger containers are lined with mangrove leaves and regularly sprinkled with seawater to keep the crab moist and cool.

If crab are to be transported on inter-island vessels, they are placed in rattan baskets with a capacity of 60 kg/basket. The bottom and sides of the baskets are lined with mangrove leaves. Individually tied crab are arranged neatly inside the baskets and these are covered with plastic sheets and placed in the coolest part of the vessel.

<<

Crab are usually transported from the buying stations to Manila or Cebu by inter-island vessel or by domestic flights. Mud crab are placed in cartons lined with plastic sheets for air transport. The plastic sheets and cartons have ventilation holes. Crab may also be placed in polystyrene boxes with holes. Sometimes, outer cartons are required for air transport. Prior to packing, the crab are dipped in seawater to reduce mortality during air transport. Mortality during flight is usually 5-10 per cent, whereas during sea voyages it reaches 40 per cent.

Live crab should be handled minimally after capture. They should not be handled by their claws, as they readily shed them. Crab should also be protected from exposure to intense sun and wind.

While crab are being packed, they should be packed as close together as possible; spaces can lead to movement, fighting and damage. If mangrove leaves are not available, wet sawdust can be substituted and used at the bottom of the boxes.

Packing requirements for export are the same as for domestic air transport, except that the polystyrene boxes are usually smaller and contain 10 kg of crab. A cardboard carton can hold three polystyrene boxes containing 30 kg of crab. If polystyrene boxes are used, each is packed with 20-30 large crab.

Although mud crab are in great demand in foreign markets, they must arrive at their destination alive and in good condition. Most exporters now prefer to export crab weighing at least 300 g. Dead crab are chilled or cooked and sold at a lower price locally. Most exporters practise fattening to build up sufficient inventory for export. Cannibalism is prevented by feeding the crab 12-24 hours prior to shipment abroad.

One of the ways to prolong the shelf life of the mud crab is to pack them in polystyrene boxes with ice placed at the bottom of the box and chicken-wire mesh used to separate the crab from the ice. Mud crab kept in this manner have a 60 per cent better survival rate compared to those packed in bayong or pandan bags. For large shipments, it is best to put the crab in a cool area which has a temperature of 18-22°C.

Pricing

The great demand for mud crab in foreign markets has pushed the price to levels that domestic consumers cannot afford. In 1979, female crab were sold for 50-60 P/kg while for male crab the price was 25-45 P/kg. A survey conducted by the Department of Agriculture in 1986-87 revealed that the highest price observed for females crab was 105 P/kg in Capiz and lloilo in August, while male crab fetched a price of 60 P/kg. In Aklan, the lowest price for female crab was 72.50 P/kg for January-August while the buying price for male crab was 30 P/kg for the whole year.

By January-June of 1987, the highest average price for female crab in lloilo was 135 P/kg and 60 P/kg for male. The lowest price for female crab was 50 P/kg in Iloilo in April-June and for male crab 15 P/kg in May-June.

A recent survey conducted by the Marketing Assistance Group of the Department of Agriculture showed increases in retail prices of mud crab in Metro Manila. From 105 P/kg in 1987, mud crab are now sold for 120- 150 P/kg.

Prices vary among retail markets in Manila. For example, in October 1991, male crab were sold for 120- 150 P/kg and females for 220-250 P/kg. Assorted sizes commanded a price of 95-125 P/kg. On the other hand, the prevailing export price was 4 US $/kg. Taiwan buys mud crab from the Philippines at about 4-8 US $/kg while Hong Kong buyers pay 4 US $/kg.

Demand

There is limited quantifiable data on the local consumption of mud crab. However, interviews and surveys made by the Marketing Assistance Group, the agribusiness unit of the Department of

<<

Crab stored at 32°C also died earlier, due to dehydration. Many exhibited a tendency to regurgitate a black fluid, indicating that the animals were stressed.

It is apparent that optimum conditions for maintaining crab alive in air include saturated humidity, temperatures between 16°C and 20°C, and 95 per cent relative humidity.

Implications for storage and transport

As dehydration has such a significant effect on survival, handling conditions after harvest should be such that the crab are not subjected to drying winds. Exposure to direct sunlight for long periods also has a negative effect on survival.

The' mortalities associated with transport in waxed cardboard cartons could be substantially reduced if insulated polystyrene containers are used. While it is difficult to maintain a saturated atmosphere in them, because of the need to provide some ventilation, the improved temperature control afforded by the insulation would greatly reduce losses. Their adoption by industry is still resisted because of cost considerations.

CONCLUSIONS

- Mud crab are distributed live throughout Australia by air and road transport, usually packed in waxed cardboard cartons. But mortalities are common when these containers are used.

  There is data demonstrating that survival times up to ten days are possible at 16-20°C and 95 per cent relative humidity.

  Maintenance of these conditions requires packaging in insulated polystyrene containers, but these practices are not yet in commercial use in Australia.

<<

TRADE AND MARKETING PRACTICES OF MUD CRAB IN THE PHILIPPINES

by Daisy F Ladra
of the Bureau of Fisheries and Aquatic Resources. 860. Arcadia Building Que:on Ave.. Quezon Metro Manila 3008. PHILIPPINES
and
Jeff C Lin
President/General Manager the Shining Sea Export Trading 7 Sunset Drive Sunset Village, Tambo, Paranaque Metro Manila. PHILIPPINES

ABSTRACT

The mud ciab fishery in the Philippines involves more than 50.000 fishermen. Production has increased from 1747 tin 1983 to 2367 tin 1990. The fishery supplies both the domestic and overseas rnarket.c. Taiwan is the most important export market, hut Taiwanese purchases have been negatively affected by red tide scares. Aquaculture production of mud crab has increased from 924 t in 1983 to 1135 tin 1990. The market includes seed crab, ovigorous females and market size males. A brokerage system has developed to supply these markets. Transport mortality is 5-40 per cent depending on the mode of transport. Mortality can he reduced by better handling and packing, particularly with the use of ice in insulated and ventilated plastic foam containers. Roth fattening and culture should expand, given the strong demand and large expanse of brackishwaier ponds in the Philippines.

INTRODUCTION

Mud crab are widely distributed in the Philippines and are easily available in the markets throughout the year. This crustacean, considered a delicacy, is an important fishery in the country. 'Red claw' and green claw' varieties are found. Most fishpond operators prefer the 'red claw' because it exhibits a faster growth rate and is stress-tolerant.

Mudcrab gathering, culture and fattening provides income and livelihood to many Filipinos. In fact, in Region VI (see Figure 1 overleaf) alone, about 50,000 fishermen are dependent on mud crab for their livelihood. What was considered as a minor fishery product before is now an export commodity and a foreign exchange earner.

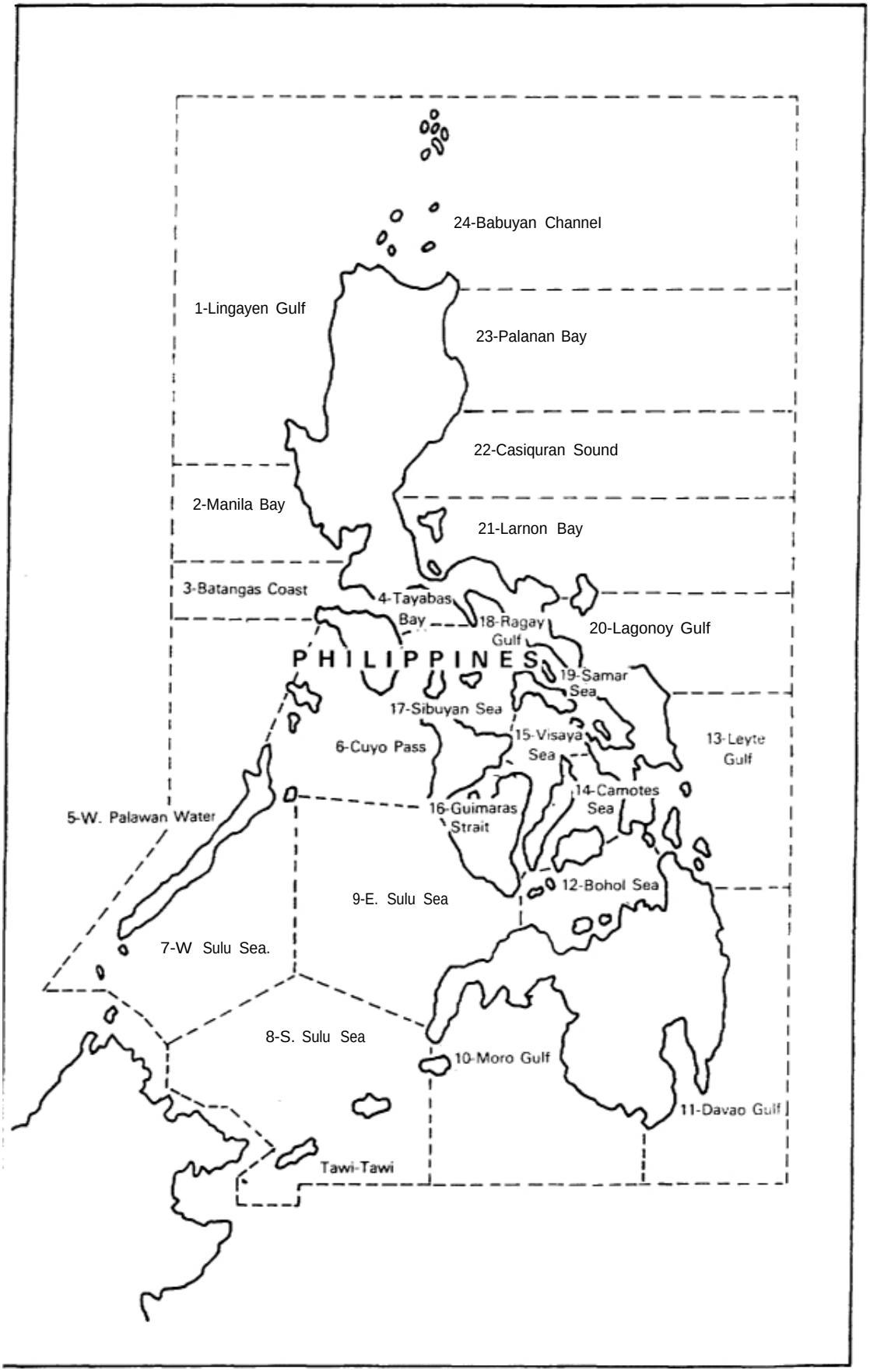
The development of the mud crab industry has, however, been quite slow, compared with other exportable commodities like tuna and shrimp. One reason for this is the lack of government attention to research and baseline studies that could provide information helpful to the development of the industry.

Mud crab being a supplementary crop from brackishwater milkfish and shrimp ponds, it has virtually been overlooked as a potential species for culture. Some fishpond operators even consider mud crab a nuisance because of their burrowing habits which cause extensive damage to pond dykes.

But with the increase in prices and demand from both domestic and foreign markets, the attitude towards mud crab has been changing. A series of experiments conducted on a trial and error basis was initiated by fishpond operators and gatherers who sought to get better yields in a shorter time. This has triggered the development of mud crab polyculture and fattening projects in the Philippines.

<<

Fig. 1 Locations of fishing grounds in the Philippines



<<

DOMESTIC PRODUCTION

Mud crab, like any other aquatic product, exhibit seasonality. They are abundant during the rainy months (May-September, which also happens to be the breeding season. The peak breeding month is July. Crab fry are stocked in fish ponds from the last week of May to the first week of June. Harvest occurs in September. The second stocking period is from the second week of September to the first week of October, with the harvest in January.

Although mud crab can he found all over the country. the major mud crab producing areas are Cagayan Province. Bataan, Pangasinan, Bulacan. Pampanga. Cavite, Palawan, Mindoro, Quezon, Camarines Norte. Sorsogon. Masbate. Negros Oriental and Occidental, Barotac Nuevo and Dumangas in Iloilo, Guimaras, Aklan and Capiz. Guian in Eastern Visayas. Zamboanga and Basilan, and Cotabato. particularly the coastal communities in Panguil Bay (see Figure 1).

The Philippines fishing industry is divided into the commercial, marine municipal fishery. inland municipal fishery and aquaculture sectors. The supply of live crab comes from the last-named three sectors. The marine municipal fishery involves artisanal fishing using small craft or *buncos* of not more than 3 t gross. It is active mostly in shallow coastal waters. Adult mud crab that migrate to the sea to reproduce are fished from these areas by using different fishing gear, such as fish corrals, crab liftnets fishpots and pushnets.

Mud crab also inhabit the muddy bottoms of estuarine areas and tidal rivers along the shore in mangrove areas and river mouths. These inland municipal waters are where sizeable quantities of mud crab gather.

Domestic production of mud crab in the Philippines from the different sectors is shown in Table 1 and Figure 2. However, production has been rather erratic between 1983 and 1990. Of the three sectors, aquaculture consistently contributed the largest share to the total production from 1986-1989 4.734 t or an average of 1.1 84.5 t/year.

Fig 2. Mudcrab production 1983-90

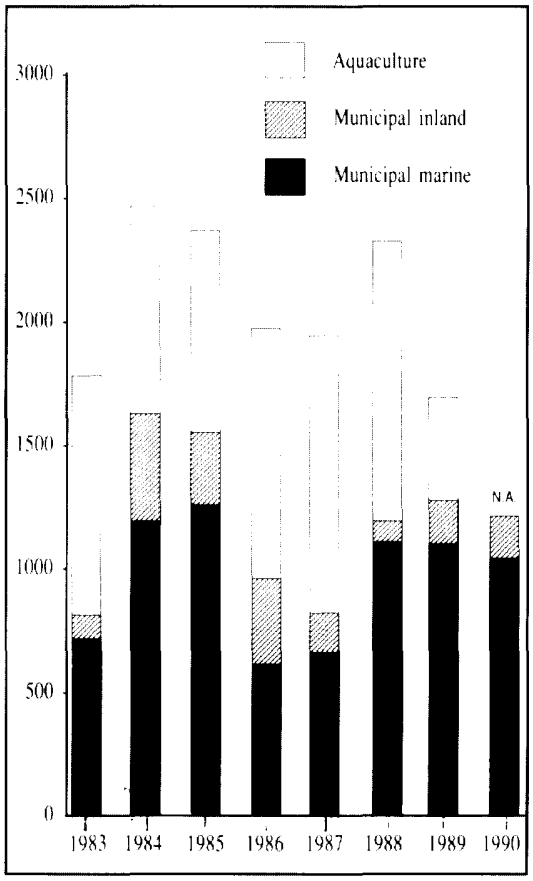


Table I: Mud crab production by sector in the Philippines 1983-1991

Sector \ Volume (t) Year	1983	1984	1985	1986	1987	1988	1989	1990
Total	747	2462	2374	972	1959	2311	709	NA. *
MUNICIPAL								
A. Marine	688	1255	1297	637	613	1113	099	1056
B. Inland	35	374	244	301	224	62	68	79
Total	823	629	541	938	837	1175	1267	235
AQUACULTURE								
Brackishwater fish ponds	924	833	833	1034	1122	1136	442	NA.

*NA. Not available

<<

Comparisons of 1983- 1990 sectoral production data shows that brackishwater fish ponds registered a high growth rate of 26.94 per cent in 1989. The substantial increase in the share of aquaculture is indicative of aquaculture very likely becoming the primary source of supply, especially with the technology of fattening gaining acceptance by many artisanal fishermen and fish pond operators.

The high production of live crab from the brackishwater fish ponds is due to the abundance of fish ponds in the country. which now occupy 210.700 ha (1989). Yet mud crab account for only 0.34 per cent of the total catch of all species harvested from fish ponds as part of the extensive development of brackishwater culture in the Philippines. The main products are milkfish (83.14%). tiger shrimp (10.01%), tilapia (5.84%'), white shrimp (0.82%) and endeavor shrimp (0.21%).

The average annual production of mud crab from the municipal sector from 19X3-1990 was 1,089 t. The yearly growth rate was 3.14 per cent. The decrease in production from 1984 to 1987 may be attributed to deteriorating conditions in the municipal waters due to periodic outbreaks of algal blooms or red tide, destructive methods of fishing and indiscriminate use of chemicals.

The municipal inland sector has been the lowest contributor to production (Table I). The low production from this sector may be attributed to the rapid destruction of tidal flats, estuarine areas and river mouths which were converted to fish ponds. There has been a rush to join the fish pond business in the last few years, stimulated by high shrimp prices. Another reason is the low catching efficiency of traditional fishing gear. Further, mud crab gathering is a well-kept secret among fishermen to avoid others from encroaching upon their fishing ground and depriving them of their livelihood. It involves skill. patience, and experience to determine the hiding places of mud crab.

MARKETING

Mud crab marketing practices vary in different parts of the country, but in all cases the crab are marketed live. Females with mature ovaries are particularly expensive. Mud crab are sold in the market year-round, but, generally, those found in the domestic markets are grouped in mixed sizes and are smaller than exportable crab. Mud crab sold in restaurants are 250g and above (Table 2 see facing page). Prices may vary with markets and seasons. Usually, during the Christmas season, the price is relatively high because of the increased demand.

There is a market for both male and female crab with or without ripe gonads. Experienced farmers can tell whether the ovaries are full by examining the crab against the light and also by pressing its shell to feel if the crab is firm and full.

Mud crab sold in the Philippines can be classified into three major groups. Mud crab seed are for stocking in fish ponds for culture and are gathered from February to April. Mud crab of 15-18 pcs/kg are utilized for culture. In six months, they attain a carapace width (CW) of 12- 15 cm and weigh 200-250 g each, fetching a farmgate price of 60-75 P*/kg.

*** US $ 1= Peso 27 appz (1991)**

<<

Table 2: Marketing practices for live crab in Metro Manila, July 1991

Source of information	*Quantity reqd/day*	*Buying price/kg (P)*	*Preferred si:e*	*Terms of payment*	*Source of supply*	*Problems encountered*
Restaurant 1				C.O.D.	Farmer's Market, Cubao, Quezon City	Low demand
Restaurant 2	10 kg	120/kg	600 g/kg	C.O.D	Cavite, Pampanga Cotabato	
Restaurant 3	8 kg			C.O.D	Farmer's Market. Cubao	
Restaurant 4	5 kg	110/kg	Big	C.O.D	. do .	
Restaurant 5	20-30 kg	240	250-500 g	7 days		Low supply
Restaurant 6	50*	100/kg	400g/kg	17 days	Seaside Market	Low supply during lean months
Restaurant 7	25*	110	Small-Medium, Big	C.O.D	Masbate, Bicol Iloilo	
Restaurant 8	10*	100.00/kg	Big	C.O.D	Trader	
Hotel 1	10*	100-150/kg	200g/pc	C.O.D	Farmer's Market, Cubao	
Hotel 2	20*	100-120/kg	Medium-Big	C.O.D	Trader	
Supermarket (Grocery)				C.O.D	Farmer's Market, Cubao	
Supermarket				7 days	Trader	
Restaurant	10kg	90/kg	Small-Medium. Large	7-15 days	Zamboanga del Sur	
Restaurant	2 kg	130-150/kg.	400g/pc	C.O.D	Seaside Restaurant	
Restaurant	5 kg	120-150/kg	Big/Female	C.O.D	Seaside Market	
Restaurant	15 kg	220/kg	4pcs/kg	7 days	Seaside Market	
Restaurant	2 kg	80/kg	3-4pcs/kg	7 days	. do .	
Supermarket					Trader	
Hotel	5 kg	120	Big 350-800/pc	15 days	RGA Resources	
Restaurant Seafood market .	76 kg	150-200	3pcs/kg	7 days	Seaside Market	
Hotel	17kg	120-190/kg	4pcs/kg	15 days	-do .	
Hotel	10 kg	120-200/kg	3pcs/kg	30 days		
Hotel	10 kg	200/kg	3pcs/kg	-do .		
Restaurant	80 kg	100-130/kg	2 pcs/kg	7 days	Bataan, Pangasian Samr, Mindanao	

* Numbers

Filipinos consume an average of 30-100 kg of mud crab a day in Quezon City alone

while male mud crab were selling for 150 P/kg (CW 16 cm) in Quezon City.

<<

Crab transported in this way are exposed to variable temperature conditions. While most arrive in southern markets, such as the Sydney Fish Market, in good condition, mortalities can be as high as 30 per cent, but are more commonly less than 10 per cent.

Wholesale or retail storage

Almost all restaurants and wholesale outlets for crab now have re-circulating holding, or display, tanks, with biological usually with temperature controlled at around 18°C.

FACTORS AFFECTING SURVIVAL OF CRAB DURiNG AIR TRANSPORT

We have, using a temperature controlled humidity chamber, examined the effect of humidity and temperature on the survival of mud crab in the air. Mud crab were obtained from commercial fishermen and kept in seawater for several days before being tested. Survival, weight loss and behaviour were noted during each experiment. Tables I and 2 show the results of these investigations.

Table 1: Effect of temperature on survival of the mud crab in air and weight loss until death at *95* per cent relative humidity

Ternpera floe C	n	*Mean survival time (days)*	*Mean weight loss at death (% of hodvweight)*
12	16	1046 ±46 *	8.29 ±68
16	18	10.77 ±48	9.93 ±30
20	15	9.73 ±44	10.72 ±31
24	3	6.53 ±33	10.37 ±47
28	7	6.70 ±38	10.51 ±28
32	17	6.05 ±26	8.57 ±37

* Relative error

Table 2: Effect of humidity on survival of mud crab in air at 20°C

Relative humidity	n	*Mean survival in days*
77	17	3.17 ±21 *
86	19	3.73 ±20
95	15	9.73 ±44

* Relative error

It can be seen that relative humidity had a major impact on survival times. Weight loss in less than a saturated atmosphere was quite rapid and, as can be seen in Table I, crab became moribund and died after losing about 10 per cent of their body weight through dehydration. At 77 per cent relative humidity, this point is reached in 3.1 days.

Temperatures below 20°Csignificantly enhanced survival time relative to those of 24°Cand above. Crab stored at 12, 16 or 20C survived for about ten days, whereas crab only survived 6-7 days at higher temperatures.

It was apparent that at 12°C and 32°C survival was affected by temperature stress as well as dehydration. At 12°C, the crab were almost totally immobile and several died due to dehydration. It would seem that I2°Cis very close to the lowest temperature tolerated by these animals, so should not be used in commercial practice.

<<

Agriculture, reveal that the major consumers of live crab are exporters, hotels and restaurants. A survey of 15 restaurants, six hotels and four supermarkets in Metro Manila showed a consumption of about 11,916 kg/month of live crab. Quezon City consumption was 30-100 kg/day.

EXPORTS

Export of live mud crab from the Philippines between 1987 and June 1991 was 1,289 t an average of 287 t/year. Of the total production of *1,959* tin 1987, only 4.1 per cent was exported. In 1988, the Philippines exported *5.43* per cent and in 1989 9.22 per cent (Table 3, and Figure 4).

The major markets for the Philippine mud crab are Taiwan, Hong Kong, Guam, Japan and the USA. Minor markets are Singapore, Brunei, Germany, Korea and other neighbouring countries (See Table 4 and Figure 4). Since 1987, Taiwan has been the biggest buyer of mud crab from the Philippines. It took 98.63 per cent of all exported mud crab. In 1988, this decreased somewhat to 82.47 per cent while Hong Kong took 9.6 per cent and Guam 6.7 per cent.

Table 3: Live mud crab exports 1987-1991

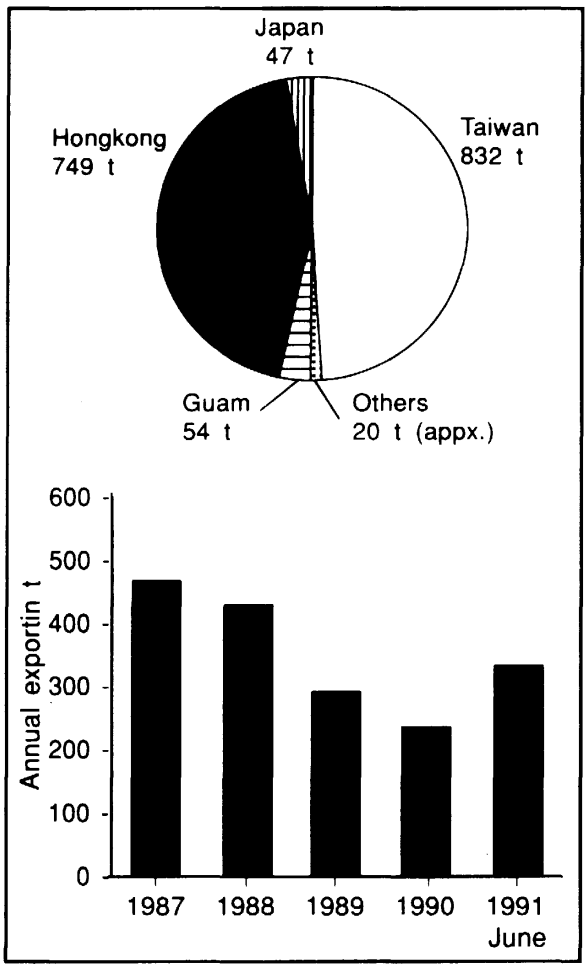
Year		*Volume (t)*	*Value (P 1000's)*
1987		477	383
1988		426	335
1989		294	277
1990		240	226
1991	Jan-Jun	329	361

Table 4: Live mud crab export markets 1987 - June 1991 by country

Country	*Volume of imports (t)*
Taiwan	850
Japan	47
Hong Kong	749
Saipan	5
Guam	54
U.S.A	9

Note Small amounts, of less than 1 t to each, were **exported** to Malaysia. Germany, Korea. Israel. Brunei and Singapore.

Fig. 4: Live mudcrab exports 1987 - June 1991



In 1989, there was a drastic change in international trading for mud crab. Hong Kong displaced Taiwan as the primary market. Taiwan purchased only 6.2 per cent of exports, while Hong Kong absorbed 81 .49 per cent. One reason for this was that the Taiwanese restricted the entry of Philippine mud crab due to the widespread incidence of toxic algal bloom (or red tide). Hong Kong re-exported much of these crab to Taiwan. However, mortality was markedly high during this period, from the normal 10 per cent to as high as 40 per cent.

Immediately before the red tide scare, Taiwan was buying an average of 35.6 t/month. But after 1987, Hong Kong increased its imports five-fold, while Taiwan's decreased. The decrease in Taiwanese imports could also be attributed to low market demand and changes in consumer preferences, but during the first half of 1989, Taiwan's imports increased again to 3.5t/month.

REFERENCES

ANON. Fattening mud crabs *Scylla serrata* in bamboo cages. ***Fish. Extension Rep..*** Dept. of Aqua. Phil.

Fisheries Statistics ***1985-1990,*** **Bur. of Fish. and Aqua. Res., Phil.**

BALIAO, D. 1983. The culture of almango and bangur in brackishwater ponds. *Modern Fish Farm.* **A magazine for aquaculture by Federation of Aqua. pp 29.**

CANEU, MURIEL. 1991. Exportation of mud crab. Personal Interview.

LEGAPI, A. 1990. *A guide for* **fish** *handling, marketing and* ***distribution.*** **BFAR Extension.** # 9 **28p.**

<<

EXTENSION, CREDIT AND ECONOMICS

<<

POND CULTURE OF MUD CRAB (Scylla serrata): AN ECONOMIC ANALYSIS

by Giselle P B Samonte and Renato F Agbayani,
Aquaculure Department, Southeast Asian Fisheries Development Center,
P 0 Box 256, Iloilo City 5000.
PHILIPPINES

ABSTRACT

The study compares the profitability of mud crab pond culture with existing crab fattening practices in Iloilo.

Monoculture of Scylla serrata *at stocking densities of 5.000, 10.000. 15,000 and 20,000 pcs/ ha are compared for economic feasibility. Highest return on investment, return to equity, and shortest payback period* were *obtained from a stocking density of 5000/ha. Production cost ranged from 35.78 P/kg. at 5000/ha stocking density to 55.05 P/kg at 20,000 stocking density. Partial budgeting showed that no incremental benefit accrued from increasing the stocking density to 10,000/ha. Discounted economic indicators. such as net present value, benefit-cost ratio and internal rate of return, were also highest at 5,000/ha stocking density.*

INTRODUCTION

As an important commercial seafood, mud crab commands a high price in the domestic and export markets of the Philippines. Current prices of mud crab in Iloilo range from 80-140 P*/kg. Female crab command higher prices (150-200 P/kg) than male crab (60-80 P/kg).

In 1987, municipal, marine and inland fishery production of mud crab in the Philippines was 6 13 t and 224 t respectively (Centre for Research and Communication, 1989). Mud crab are caught in the extensive mangrove swamps and estuarine waters using gillnets, baited traps, fish traps and hooks (Cowan 1984; Motoh 1983). The culture of mud crab in ponds is becoming popular.

The objective of this study was to determine the economic feasibiliity of the pond culture of mud crab at various stocking densities.

METHODOLOGY

Technical data used in the economic analysis of the monoculture of mud crab *(Scylla serrata)* were derived from the experiment of Baliao *et al* (1981) conducted at the Southeast Asian Fisheries Development Center's Leganes Research Station. An updated comparative economic analysis was performed on the monoculture of mud crab *(Scylla serrata)* at stocking densities of 5000; 10,000, 15,000 and 20,000 juveniles/ha with two crops/year. Calculations are presented on a per hectare basis, using Philippine cost prices as of August 1991.

* US $ 1= P: 27 appx **(mid-1991)**

<<

The economic feasibility analyses were based on the formulae of Shang (198 1). Economic indicators, such as return on investmnet (ROI), return on equity (ROE), and payback period, were determined. ROI was computed by dividing net income after tax by the total investment, ROE by dividing net income after tax by owner's equity and the payback period by dividing the total investment by the sum of the net income after tax and annual depreciation. Five-year cash flows were discounted at 10 per cent to determine the net present value (NPV), benefit-cost ratio (BCR) and internal rate of return (IRR). NPV was computed by subtracting discounted costs from discounted revenues, BCR by dividing discounted revenues by discounted costs and IRR by using a Lotus computer programme.

For comparison, identical capital outlay and depreciation were used for each stocking density. The acquisition cost of land was not included as the study assumed that existing milkfish/shrimp ponds would be used. Working capital was equivalent to the variable costs plus repairs and maintenance costs, and caretaker's salary during the first crop. A 50:50 debt/equity ratio was used.

RESULTS AND DISCUSSION

Investment, costs and returns

Mean weight, percentage survival, relative growth increment, gross production and feed conversion values for the different stocking densities are shown in Table 1. Capital outlay and annual depreciation for a 10ha monoculture crab farm was P64,020 and P16,618 respectively (Table 2 facing page). Investment requirement for a l-ha crab monoculture ranged from P88,201 for 5000/ha stocking density to P1 l 1,484/ha for 20,000/ha stocking density (Table 3 facing page). investment consisted of capital outlay and working capital for one crop.

Table 1: Stock and harvest data for mud crab (S.serrata) monocultured at four stocking densities in 100 m^2 ponds.

Treatment	*Stocking density (1100m^2)*	*Harvest1100 m^2*			*Relative growth increment (g/day/crab)*	*Feed conversion value*	*Cross production (kg/ha/crop)*
		Number recovered	*Average wt.(g)*	*Percentage survival*			
1	50	44	*231.60*	*88.00*	*2.28*	*1.72*	*1.019.04*
II	100	*52*	*196.63*	*52.00*	*1.89*	*2.16*	*1,022.48*
III	150	*57*	*171.11*	*38.00*	*1.61*	*3.85*	*975.33*
IV	*200*	*62*	*178.11*	*31.00*	*1.69*	*4.04*	*1.104.28*

Source : **Baliao et al [198 1]**

<<

Table 2: Capital investment and annual depreciation for a 1-ha crab monoculture farm

Capital outlay	*Quantity*	*Unit cost (P)*	*Total cost (P)*	*Economic life (years)*	*Annual depreciation (P)*
Pond development			50,000	5	10,000
Perimeter fencing					
Bamboo poles (pcs)	150	22	3,300	2	1,650
Banata fabrication (pcs)	110	20	2,178	2	1,089
Nylon monofilament	17	105	1,777	2	888
Nails (kg)	4	17	66	2	33
Plastic sheet (rolls)	5	176	880	2	440
Construction of mounds (units)	100	44	4,400	2	2,200
Caretaker's hut*			1,100	5	220
Tools and equipment*					
Digging blade	2	165	66	5	13
Bolo	2	66	26	5	5
Spade	1	204	41	5	8
Scoopnet	2	55	22	2	11
Traps. bamboo	8	22	35 **	2	18
Basins, 20 li	2	105	42	3	14
Pails. 10 li	3	39	23	3	8
Pails. 60 li	2	160	64	3	21
Total			64.020		16,618

*Aflocated to 5 ha: 5-ha allocation calculated for 1-ha

Table 3: Investment requirement and debt-equity ratio for 1-ha crab monoculture at various stocking densities

Investment	*Stocking Density*			
	5000	10000	15000	20000
Capital outlay	64.020	64.020	64,020	64,020
Working capital * for one crop	24:181	29.443	40.624	47,464
Total investment	88.201	93.463	104,644	111,484
Debt (50%)	44,100	46,731	52,322	55,742
Equity (50%)	44,100	46,731	52,322	55,742

* Working capital includes variable **costs, repairs and maintenance costs, and caretaker's salary**

<<

Comparative costs and returns of the different stocking densities are shown in Table 4. Annual net income after tax was highest at P58,583/ha at a stocking density of 5000/ha and decreased as stocking density increased. A socio-economic study conducted by Lapie and Librero (1979) in the Philippines showed that a crab monoculture farm produced 339 kg/ha with net farm income of 1888 P/ha.

Table 4: Costs and returns for a 1-ha crab monoculture at various stocking densities

Item	Unit Cost	5,000		10,000		15,000		20,000	
		Quantity	Total	Quantity	Total	Quantity	Total	Quantity	Value
1. **REVENUE (kg)**	80.00	1,019	81.523	1,022	81.798	975	78,026	1,104	88.343
2. **VARIABLE COSTS**									
Chicken manure (kg)	0.66	1,000	660	1.000	660	1,000	660	1,000	660
Crab juveniles(pc)	0.55	5.000	2.750	10,000	5,500	5.000	8.250	20.000	.000
Trash fish (kg)	5.50	1,753	9,640	2.209	12.147	3,755	20.653	4.461	24.537
Labour (manhours)	5.50	.000	5,500	1.000	5,500	1.000	5.500	1.000	5.500
Marketing expenses (2%)			1.630		1,636		1.56		1.767
Subtotal			20,180		25,443		36,624		43,464
3 **FIXED COSTS**									
Repairs and maintenance			1,600		.600		1,600		.600
Interest			3,969		4,206		4,709		5,017
Depreciation			8,309		8,309		8,309		8,309
Caretaker's salary- P400/month/ha			2,400		2,400		2.400		2,400
Subtotal			16,278		16,515		17,018		17,326
4. **TOTAL COSTS (2+3)**			36,458		41.958		53.642		60,790
NET INCOME									
5. Net income before tax (per crop) (1-4)			45.065		39.840		24,384		27,553
6. Net income before tax (2 crops/yr)			90,130		79,680		48,768		55,106
7. Tax (35%)			31,545		27,888		17,069		19,287
8. Net **income after tax** (2 crops/yr) (6-7)			58,585		51,792		31,689		35,819
Return on investment (RUI)			66%		55%		30%		32%
Return on equity (RUI)			133%		111%		61%		64%
Payback period (year)			1.17		1.37		2.17		2.13

<<

Net income from three crab fattening farms in Balasan, Iloilo, averaged 39,074 P ha/year (Table 5). The production cost ranged from 31 P/kg to 86P/kg. Average Return on Investment was 64 per cent.

ROl, Return on Equity (ROE) and payback period also showed the same trend. ROl was 66 per cent **for 5000/ha. Agbayani *et* al (1990) obtained ROl at 124 per cent for the same stocking density with three crops per year. Seville (1987) obtained ROl of 44 per cent for a 500 m² crab farm stocked with 3** crab/rn2.

Table 5: Costs and returns of crab fattening in ponds in Balasan, Iloilo

Item	1	2	3	Average
Farm area (m^2)	1.000	7,500	2.500	3.667
Fattening period (days)	15	30	15	20
RETURNS				
Avg. weight (g/crab)	188	500	833	507
No. of crab harvested	40	100	48	63
Production (kg)	8	50	40	33
Selling price (P/kg)	95	100	110	102
1. **Total returns**	714	5000	4398	3,371
COSTS				
Stocking (165 g avg. size)				
Density (pcs)	40	130	50	73
Cost of crabs (P/pc)	6	8	6	7
2. **Total cost of seed (P/crop)**	240	1,040	300	527
Feeding (kg/day)	5	6	12	8
Cost of feed (P/kg)	2	2	4	3
Cost of feed/day (P)	10	12	42	21
3. **Total cost of feed (P/crop)**	150	360	630	380
Labour mandays	8	IS	8	10
Opportunity cost of labour	40	40	40	40
4. **Total labour cost**	300	600	300	400
5. Total cost (P/crop) (2+3+4)	690	2,000	1,230	1,307
6. Net income per crop (P) (1-5)	24	3,000	3,168	2,064
7. Number of crops/year	24	12	5	14
8. Net **income/year (P) (6** x 7)	576	36,000	15,840	17,476
PER HECTARE:				
Stocking density (pcs/ha)	400	173	200	258
Net Income(P/ha/year)	5,856	48,000	63,365	39,074
Cost per kg	86	40	31	52
Return on Investment*	4%	95%	93%	64%

* Investment includes cost of fencing materials.

<<

Feed and labour were the major cost items for crab monoculture at 5000/ha stocking density. At 10.000-20,000/ha stocking densities, cost offeed and juveniles comprised a larger portion of production costs. This is consistent with the increasing FCR as stocking density increases. Average **production cost ranged from** 35.78 P/kg at 5000/ha to 55.05 P/kg at 20,000/ha (Table 6).

Table 6: Comparative cost indicators of production for a 1-ha crab monoculture (1 crop)

Item	Stocking density 5000	10000	15000	20000
Average feed cost (P/kg)	9.46	11.88	21.18	22.22
Average juvenile cost (P/kg)	2.70	5.38	8.46	9.96
Average labour cost (P/kg)	5.40	5.38	5.64	4.98
Average marketing cost (P/kg)	1.60	1.60	1.60	1.60
Average cost of debt (P/kg)	3.89	4.11	4.83	4.54
Average variable cost (P/kg)	19.80	24.88	37.55	39.36
Average total cost (P/kg)	35.78	41.04	55.00	55.05

Feasibility analysis

Partial budgets of crab at 5000/ha and 10,000/ha stocking densities showed that cost of crab juveniles, trash fish and marketing expenses increased by P5,263 (Table 7). This resulted in a decrease of P4,988 in net benefit, indicating that no incremental benefit accrued from increasing the stocking density to 10.000/ha.

Table 8 shows the discounted economic indicators for a 1-ha crab monoculture farm at the **four stocking densitites. The NPV gives the** net worth of the project for **its entire project** life and was highest at P149.331 for 5000/ha stocking density. The BCR indicates the cost efficiency of the project. Stocking at 5000/ha was more cost effficient compared to stocking **mud crab at 10,000/ha, as indicated by the**

Table 7: Partial budget for a 1-ha crab monoculture at 5000 and 10,000 stocking densities

	5,000	10,000
Revenue	81,523	81,798
Variable costs		
Crab juveniles	2,750	5,500
Trash fish	9,640	12,147
Marketing expense	1,630	1,636
Total	**14,020**	19,283
Marginal revenue	275	
Marginal cost	5,263	
Net benefit (decline)	(4,988)	

Table 8: Discounted economic indicators for 1-ha mudcrab monoculture at various stocking densities (10% discount rate)

Item	5000	10000	15000	20000
Discounted revenue	676,739	679,021	647,709	733.348
Discounted cost	527,408	573,147	657.665	746.060
Discounted net cash flow	149.331	105,873	(9,956)	(12,712)
Net present value	149,331	105,873	(9,956)	(12,712)
Benefit cost ratio	1.28	1.18	0.98	0.98
Internal rate of return	365.23%	162.02%	1.36%	—0.91%

<<

higher BCR derived from stocking at 5000/ha. The IRR represents the return over the life of the project to the resources engaged in the project. Highest IRR *(365* per cent) was obtained from 5000/ha stocking density. The discounting method showed that stocking at 15,000/ha and 20,000/ha was not economically viable.

CONCLUSION

The monoculture of mud crab in brackish water ponds is economically feasible at stocking densities of 5000/ha and 10,000/ha. Pond owners may diversify their business by allocating portions of their ponds to mud crab culture. Further research on improved pond management and polyculture systems should be pursued.

REFERENCES

AGBAYANI. R.F.. BALIAO. D.D. SAMONTE. G.P.B.. TUMALIUN, R.E. and CATURAO. R.D. 1990. Economic feasibility analysis of the monoculture of mud crab *(Scylla serrara)* Forskal. *Aqua.* 91:223-231.

ANON. 1989. *Philippine Agribusiness Faethook and Directory.* 89/90. pp. 154-157. Centre for Rese. and Communication.

BALIAO. D.D.. RODRIGUEZ. E.M. and GEROCHI. D.D. 1981. Culture of the mud crab *Scylla serrata* (Forskal) at different stocking densities in brackish water ponds. *Q. Res. Rep.* SEAFDEC Aqua. Dept.. *5(1);* lO – 14.

COWAN. L. 1984. Cultivation of crab *(Scylla Serrata)* to market size in the Philippines. IN: *Crab farming in Japan, Taiwan and the Philippines.* Inf. Ser. QI 84009, Dept. of P.I.. Old. pp. 63-70.

LAPIE. L.P. and LIBRERO. A.R. 1979. *Crab farming in the Philippines:a socio-economic study.* Res. Paper Ser./ Socio-economic Survey of the Aqua. Industry in the Philippines. No.21 Los Banos, Laguna, SEAFDEC-PCCARD Res. Prog. *56* p.

MOTOH. H. 1983. Traditional devices for capturing crab used in the Philippines today. *Researches on Crustacea (12):45-53.*

SEVILLE. S.V.. BARCENAS. L.A. and GRABOSO. R.P. 1987. Mud crab culture. *Reaehout,* 6(1):6-7.

SHANG. Y.C. 1981. *Aquaeulture Economics: basic concepts and methods of analysis.* West-View Press, USA, 153 p.

ANNEXURES (see over)

<<

ANNEXURE I

Loan amortization schedule for 1-ha crab monoculture

Stocking density	*Initial loan*	*Year*	*Annual payment*	*Interest (18%)*	*Principal*	*Balance*
5000	44,100.28	1	14,102.29	7938.05	6,164.24	37,936
		2	14,102.29	6,828.49	7,273.81	30,662
		3	14,102.29	5,519.20	8,583.09	22,079
		4	14,102.29	3,974.25	10,128.05	11,951
		5	14,102.29	2,151.20	11,951.10	0
10000	46,731.48		4,943.69	8,411.67	6,532.03	40,199
		2	14,943.69	7,235.90	7,707.79	32.492
		3	14,943.69	5,848.50	9,095.19	23,396
		4	14,943.69	4,211.37	10,732.33	12,664
		5	14,943.69	2,279.55	12,664.15	0
15000	52,321.53	1	16,731.27	9,417.88	7,313.39	45,008
		2	16,731.27	8,101.47	8,629.80	36,378
		3	16,731.27	6,548.10	10,183.16	26,195
		4	16,731.27	4,715.13	12,016.13	14,179
		5	16,731.27	2,552.23	14,179.04	0
20000	55,741.99	1	17,825.05	10,033.56	7,791.50	47,950
		2	17,825.05	8,631.09	9,193.96	38,757
		3	17,825.05	6,979.18	10,848.88	27,908
		4	17,825.05	5,023.38	12,801.68	15,106
		5	17,825.05	2,719.08	15,105.98	0

Interest Rate **0.18;**
Payable Period *5* **years;**
Grace Period **None;**
Conversion Rate **0.3198**

<<

ANNEXURE II

Five-year cash flow for a 1-ha crab monoculture at various stocking densities (2 crops/year)

	5000 crab/ha					10,000 crab/ha				
Item	YI	Y2	Y3	Y4	Y5	YI	Y2	Y3	Y4	Y5
Revenue	163,046	171.199	179,759	188,747	198,184	163,596	171,776	180,365	189,383	198,852
Capital cost	64.020	0	13,923	148	0	64.020	0	13,923	148	0
Operating cost										
Chicken manure	1,320	1,386	1,455	1,528	1,604	1,320	1,386	1,455	1,528	1,604
Crab juveniles	5.500	5.775	6,064	6.367	6,685	11.000	11,550	12,128	12,734	13,371
Trash fish	19,280	20.244	21,256	22,319	23.435	24,294	25.509	26,784	28,123	29,530
Labor	15.800	16,590	7.420	18.290	19,205	15,800	16,590	17,420	18,290	19,205
Marketing expenses	3.261	3.424	3.595	3.775	3.964	3,272	3,436	3,607	3,788	3,977
Repair & maintenance	3.201	3,361	3.529	3,706	3,891	3,201	3,361	3,529	3.706	3,891
Interest	7.938	6,828	5,519	3,974	2,151	8,412	7,236	5,848	4,211	2,280
Tax	57.06	59.920	62.916	66,061	69,364	57,259	60,122	63,128	66,284	69,598
Subtotal	113,366	117,528	121,754	126,021	130,300	124,557	129,189	133,899	138,664	143,455
Total cost	117,386	117,528	135,677	126,169	130,300	188,577	129,189	147,822	138,812	143,455
Net cash flow	(14,340)	53.670	44,081	62,578	67.884	(24,981)	42.587	32,542	50,571	55,397

	15,000 crab/ha					20,000 crab/ha				
Item	Yl	Y2	Y3	Y4	Y5	Y1	Y2	Y3	Y4	Y5
Revenue	156.052	163,855	172,048	180.650	189,683	176,685	185,519	194.795	204.535	214,762
Capital cost	64.020	0	13.923	148	0	64.020	0	13,923	148	0
Operating cost										
Chicken manure	1,320	1.386	1.455	1,528	1,604	1,320	1,386	1,455	1,528	1,604
Crab juveniles	16,500	17,325	18,191	19,101	20,056	22,000	23,100	24.255	25,468	26,741
Trash fish	41.305	43,370	45.539	47.8 16	50.207	49,074	51,528	54,104	56,810	59,650
Labor	15,800	16.590	7,420	18,290	19,205	15,800	16,590	17,420	18,290	19,205
Marketing expenses	3,121	3.277	3,441	3,613	3,794	3,534	3,710	3,896	4,091	4,295
Repair & maintenance	3,201	3,361	3,529	3,706	3,891	3,201	3,361	3,529	3,706	3,891
Interest	9,418	8,101	6.548	4,715	2,552	8,034	8,631	6,976	5 023	2,719
Tax	54,618	57,349	60,217	63,228	66,389	61,840	64,932	68,178	71,587	75,167
Subtotal	145.283	150760	156,340	161,996	167,698	166,802	173,238	179,814	186,503	193,272
Total cost	209,303	150.760	170,263	162,144	167,698	230,822	173,238	193,737	186,651	193,272
Net cash flow	(53.250)	13.095	1.784	18,506	21,985	(54,137)	12,281	1,058	17,884	21,489

<<

ANNEXURE III

Discounted cash flows for crab monoculture

(at 5,000/ha)

Year	*Revenue*	*Cost*	*Net factor*	*Discount factor 10.00%*	*Discounted revenue*	*Dis counted cost*	*Dis counted net cash flow*
I	163,046	177,386	(14,340)	0.9091	148.224	161,260	(13,036)
2	171,199	117,528	53,670	0.8264	141,487	97,131	44.356
3	179,759	135,677	44,081	0.7513	135,055	101,936	33,119
4	188,747	126,169	62.578	0.6830	128,916	86,175	42,741
5	198,184	130,300	67,884	0.6209	123.057	80.906	42,151
Total	900.935	687.060	213,873		676,739	527,408	149.331

(at 10,000/ha)

Year	*Revenue*	*Cost*	*Net factor*	*Discount factor 10.00%*	*Discounted revenue*	*Discounted cost*	*Discounted net cash flow*
1	163,596	188,577	(24,981)	0.9091	148,724	171,433	(22,710)
2	171,766	129,189	42,587	0.8264	141,964	106,768	35,196
3	180,365	147,822	32,542	0.7513	135,511	111.061	24,450
4	189,383	138,812	50,571	0.6830	129,351	94,811	34,540
5	198,852	143,455	55,397	0.6209	123,472	89,074	34,397
Total	903,962	747,855	156,107		679,022	573,147	105,873

(at 15 000/ha)

Year	*Revenue*	*Cost*	*Net factor*	*Discount factor 10.00%*	*Discounted revenue*	*Discounted cost*	*Discounted net (ash flow*
1	156,052	209,303	(53,250)	0.9091	141,866	190,275	(48,410)
2	163,855	150,760	13,095	0.8264	135,417	124,595	10,822
3	172.048	170,263	1,784	0.7513	129,262	127,921	1,341
4	180,650	162,144	18,506	0.6830	123,386	110,747	2,640
5	189,683	167,698	21,985	0.6209	117,778	104,127	13,651
Total	862,288	860,168	2,210		647,709	657,665	(9,956)

(at 20 000/ha)

Year	*Revenue*	*Cost*	*Net factor*	*Discount factor 10,00%*	*Discounted revenue*	*Discounted cost*	*Discounted net cash flow*
1	176,685	230,822	(54,137)	0.9091	160,623	209,838	(49,215)
2	185,519	173,238	12,281	0.8264	153,322	143,172	10,150
3	194,795	193,737	1,058	0,7513	146,353	145.558	795
4	204,535	186,651	17,884	0.6830	139,700	127,485	12,215
5	214,762	193,272	21,489	0.6209	133,350	120,007	13,343
Total	976,296	977,720	(1,425)		733,348	746,060	(12,712)

<<

MUD CRAB FATTENING TECHNOLOGY TRANSFER TO THE SMALL-SCALE FISHERFOLK OF RANONG PROVINCE, THAILAND

by Hanne Kristensen,
Socio-Economist of the Bay of Bengal Programme, 91 St.Mary's Road, Ahhiramapuram, Madras 600 018. INDIA

ABSTRACT

As part of the Bay of Bengal Programme's extension activities with small-scale fisheries, attempts have been made in Ranong, Thailand, to transfer the technology of mud crab fattening and culture to small-scale local fishermen. The trials failed because of the following problems that had not been properly assessed before they were introduced.

- *Unfavourable environmental conditions.*
- *Seed stock shortages.*
- *Inadequate training.*
- *Untimely financing.*
- *High investment cost and high risk.*

INTRODUCTION

In connection with the project 'Extension Services for Small-Scale Fisheries in Ranong'. jointly introduced by the Department of Fisheries, Thailand, and the Bay of Bengal Programme, trials were carried out to transfer to the small-scale fisherfolk in Ranong Province, south Thailand. the technology of fattening and culture of mud crab (*Scylla serrata*)

This project, started in 1987, will continue until the end of 1992. The Project's activities can be broadly classified as:

Adapting, demonstrating and extending fisheries technologies, such as aquaculture (oyster culture, shrimp and fish cage culture, green mussel and crab fattening).

introduction of improved fishing gear (crab and squid traps).

Processing.

Facilitating credit (establishment of revolving funds).

Promoting income generation for women in fisherfolk communities.

Improving fisherfolk access to social services provided in co-operation with other agencies.

Overfishing has been responsible for the problems of the fisherfolk in the province. In response, considerable effort has gone into trials with different types of aquaculture activities as a possible alternative or to supplement the reduced revenues from the capture fishery. In the light of the successes with crab fattening reported from Chantaburi and Surat Thani Provinces. it was decided to test its feasiblity in the Ranong area.

Small crab were already being caught in the area, but market prices were relatively low. It was envisaged that value could be added by culture and, thus, improve earnings.

<<

AN OUTLINE OF THE EXTENSION PROCESS

In early 1988, 13 fisherfolk from eight villages throughout the Province were selected by the Provincial Fisheries Officer and the village leaders. The criteria for selection were that the participants would already be engaged in catching crab, have access to land and were living in villages with extensive crab catching enterprises.

The participants were initially trained in the technology during a study tour to Surat Thani on the west coast of Thailand. This was followed with a one-day workshop at the project office in Ranong. Project staff thereafter provided on-site training during their monthly visits.

The methods for culture and fattening and the type of earthen ponds promoted were quite similar to those in the Surat Thani area. (See Anuwat Rattanachote and Rachada Dangwatanakul 1991.)

It was originally planned to procure bank credit for the fisherfolk, as very few of them could afford the relatively high investment costs. However, the banks refused to extend credit as the participants could not provide any kind of collateral acceptable to them.

In order to implement the scheme, the project therefore decided to give limited support to each of the fisherfolk as an incentive to start the activity. For various reasons, it was not until quite late in the project cycle (February 1989) that each of the 13 fisherfolk received Baht 5000* and signed an agreement to repay the amount, into a village revolving fund, within a year. The participating fisherfolk were organized into a group which planned to hold monthly meetings at each other's culture sites in rotation, in order to share their learning and experience.

By July 1989, only five of the members had actually taken up the activity. Two were fattening females for eggs, two were culturing small crab, and one did both. All the participants used earthen ponds of sizes varying between 210 and 304 m^2. One culturist owned three ponds, while the other four had one each. The remaining eight group members had not yet started due to an insufficiency of funds and the very late distribution of even that.

In August, at the peak of the rainy season, the active members were urged to stop their work, as the Provincial Fisheries Officer's previous experience had shown that frequent salinity drops caused high mortality among the crab. The risk of flooding of ponds and subsequent escape of the crab from them was also very high.

In November, at the beginning of the dry season, the Project urged the members to take up the activity again. Repayments to the revolving funds had been very poor, in spite of continued efforts by the Project staff to recover the loans. It was felt that this failure might have serious negative effects in the villages, as other fisherfolk in the same villages had received similar loans from revolving funds for other Project activities.

During the 1991 season, the same five fisherfolk continued their activities, but once again they faced several problems. such as shortage of crab for fattening, and low market prices. Some of the participants who had refused to take up the activity stated that the long rainy season, during which activities had to be stopped, rendered it questionable whether the total earnings justified the effort and investment.

The total repayment of the loans till June 1991 was only 54 per cent and this was repaid by ten of the members. This has been poor compared to repayments of other revolving funds and loans given by the Project.

It was, therefore, decided after three years of trials of crab fattening that it was time to stop. It had become obvious that this technology faced more problems and was more risky than had been envisaged at the beginning. The high investment cost and risk could only be borne by the better-

* US $ 1 = 25 Baht appx. (1989)

<<

off fisherfolk in the community. But though the Project failed, some important experience was gained from the problems that arose and the constraints that were encountered.

The main problem areas pointed out below might serve to illustrate the interrelated factors that need to be considered prior to promotion of crab fattening among small-scale fisherfolk in a given area:

- From the start of the Project, the feasibility of the culture itself was more or less taken for granted, as crab fattening was already being done with great success in other coastal areas in Thailand and abroad. Specifically, the positive experience from nearby Surat Thani served as a model, and all studies made during the trials were conducted there. The very limited number of culture operations in the Ranong area hardly offered a sound basis for generalization. However, the situation in Ranong differs in many crucial aspects from that in Surat Thani.

- The rainy season in Ranong province is very long — about eight months — during which there is very heavy rainfall. Further, the land is hilly, causing flooding of rivers and the low areas along the coastline. This resulted in severe problems for the crab culturists. The ponds were repeatedly flooded, allowing crab to escape. Low water salinity and silting caused high mortality of stocked crab. The only solution to this problem was discontinuation of activities during the height of the rainy season, making the culture period shorter than that elsewhere. This, in turn, reduced return on investment, as yearly depreciation costs were pretty much the same everywhere.

- Tidal differences in Ranong are higher (3 - 4 m) than in Surat Thani (l-2 m). The earthen ponds had therefore to be constructed with higher dykes, which, in turn, posed severe difficulties in ensuring proper exchange of water. During neap tide, this was possible only with pumping. The combination of heavy rainfall and insufficient water exchange accounted for sudden and drastic drops in salinity. Apart from culture problems, these conditions also resulted in considerably higher investment on the construction of ponds as well as the necessary equipment.

- Special environmental conditions also constrained other culture trials the Project has been engaged in, such as oyster, shrimp and fish cage culture. In all these cases there was a much higher degree of risk than at other locations with more stable climatic condition and more easily controllable environments.

RESOURCES

Seed supply

Many of the participants experienced difficulties in getting a sufficient supply of crab, including seed for culture as well as larger males and females for fattening. Some participants gave this as their reason for giving up the activity. Throughout the Project, the potential of the crab resources in the area to sustain further expansion was routinely discussed. Though these discussions was mainly in connection with the possibility of introducing a more efficient crab trap, the problem also had implications for the fattening scheme. A study of the resource base, including speculation as to whether the Ranong crab are another variety of *Scylla serrata*., is being made, but no final conclusion has been reached. It does, however, seem that the resource is being overexploited.

Feed supply

It proved difficult to get sufficient trash fish, especially during neap tides. As a consequence, the growth rates in the cases of some of the crab was very low and some of the participants could get only low returns on their investment. The sustainability of the trash fish resource is also a cause

<<

for concern. Trash fish consists not only of low-value fish, but also of juveniles of many valuable species.

CULTURE vs. FATTENING

It had been assumed that culture as well as fattening would be possible in the area. The holding of female crab until development of gonads proved to be the most economically feasible technique. Still, special attention had been paid to promoting the rearing of small crab to marketable size, considering the low prices paid by dealers for small size wild crab and the potential danger to the resource as a consequence of more intensive catching of female crab.

However, the growth rates of cultured crab did not seem to live up to expectations. A test of the growth rate of Ranong crab cultured at the Surat Thani Brackishwater Fisheries Centre was carried out (Pripanapong and Youngvanitset 1991). The result showed that the rearing time for very small crab under 150 g was too long. Crab beyond this size had fair growth rates and reached marketable size in about two months' time, although the profits were not good. Given the adverse environmental conditions in Ranong, it is even less likely that crab fattening could be profitable there.

ECONOMY AND MARKETING

During the Project, a cost/benefit analysis was carried out in Surat Thani showing that the enterprise was indeed economically viable (Hanvivatanakit 1990). This study was made at a rather late stage and was not combined with a comparison of the specific conditions in Ranong, such as the higher investment costs, the shorter season when culture or fattening is possible, the risks involved, and the differences in marketing patterns.

Due to differences in grading, the prices of marketable crab are different in Ranong, giving an overall lower net income from the enterprise. Further, adding to the problems the Ranong culturists face, getting sufficient supplies of small crab, is the thriving crab culture and fattening business in Surat Thani, which has created a special market for small crab in other areas of Thailand. Many fish traders from Ranong District are a part of a larger market chain that dominates the trade in small and culturable crab. Consequently, in Ranong, it is difficult to buy small crab, and, more importantly, the fisherfolk selling crab are obliged to deliver their total catch, not just the part of it that is marketable to consumers.

EXTENSION METHODOLOGY

Selection of participants

One of the main reasons why the Project, in spite of the financial assistance given, managed to motivate only a few of the actual participants in the scheme to take up culture and fattening trials is that some of them were not seriously interested in the technology. Due to the relatively high investment costs, the risks involved and the necessity of possessing land, it was clear that an approach had to be made only to the better-off fisherfolk in the local communities. However, many of these fisherfolk were engaged in several other more profitable activities, and, as soon as the problems became obvious, they lost interest.

Training and follow up

The poor results might have been prevented with more comprehensive training and closer follow-up work than what was actually done. The necessary knowledge and skills to take precautions against cannibalism, avoid improper feeding and loss of crab due to continuation of activities during the peak rainy season were, apparently, not imparted to the participants.

<<

Credit

Due to the high investment costs, some source of credit or funding is necessary to enable most fisherfolk to start such an activity. As procurement of bank credit proved impossible, the Project decided to, provide some assistance towards the total cost involved, which, for some participants, amounted to around Bht. 30,000. (The cost and returns study from Surat Thani indicated an average of Bht. 42,000 as the necessary investment cost, including land costs. The average loans taken were Bht., 8,500. Rattanachote and Dangwatanakul (1991) gave Bht. 14,400 for pond construction alone). This definitely constituted one of the major reasons why the fisherfolk in Ranong could not pursue this activity.

Due to reasons beyond the control of the Project, financial support was given at a very late stage, in the optimal season for culture. This caused further loss of interest among the fisherfolk.

CONCLUSION

The main lesson for the Project has been that even though a technology is well-proven in one area, transfer of it to another must be carefully done. It is vital to carry out thorough preparations during the demonstration phase.

Given that the technology had been relevant to the fisherfolk, and had not stressed the resource, it would probably have been possible to solve the above problems with the extension methodology, given time.

REFERENCES

HANIVVATANAKIT. PANIPA. | 1990). Cost and returns of carb fattening in Surat Thani *Province.* Bay of Bengal Programme. Madras.

PRIPANAPONG. SUPARP. AND YOUNGVANITSET. THAWESAK. (1991). Rearing of mud crab Scylla serrata. Bay of Bengal Programme. Madras. 199 1.

RATTANACHOTE, ANUWAT. and DANGWATANAKUL, RACHADA. (1991). Mud crab Scylla serrata *fattening in Surat* Thani *Province.* Surar Thani Coastal. Dev. Centre.

<<

Abbreviations of Journal Titles and Publishers

Abbreviated Title	Complete Title
Adv. Mar. Biol	Advances in Marine Biology
Agri. Pak	Agriculture Pakistan
All. Univ. Stud.	Allahabad University Studies
All Ind. Symp. on Invert. Repn.	All India Symposium on Invertebrate Reproduction
Am. Zoo.	American Zoologist
Ann. Rep., Cent. Inland Fish. Res. Inst., Barrackpore	Annual Report, Central Inland Fisheries Research Institute, Barrackpore
Ann. Rep., Mindanao State Univ. Inst. Fish. Res. Dev	Annual Report, Mindanao State University Institute of Fisheries Research and Development
Ann. Rep., Shizuoka Prefect. Fish. Expt. Stn.	Annual Report, Shizuoka Prefecture Fisheries Experimental Station
Ann. Rep., Songkhla Fish. Stn., Dept. Fish.	Annual Report. Songkhla Fisheries Station, Department of Fisheries
Ann. Rep., Fish. Res.	Annual Report. Fisheries and Resources
Asian Aqua.	Asian Aquaculture
Asian Mar. Biol.	Asian Marine Biology
Aust. Fish.	Australian Fisheries
Aust. J. Mar. Fshw. Res.	Australian Journal of Marine and Freshwater Research
Aquabusiness Project Dev. and Mgmnt.	Aquabusiness Project Development and Management
Bangla. J. Agri.	Bangladesh Journal of Agriculture
Biophys. J.	Biophysics Journal
BJDR Dierk.	Bijdragen tot de dierkunde, Leiden
Br. J. Nutr.	British Journal of Nutrition
Bull. Dept. Mar. Sci.	Bulletin of the Department of Marine Science
Bull. of Taiwan Fish. Res. Inst.	Bulletin of the Taiwan Fisheries Research Institute
Cell Tiss. Res.	Cell Tissue Research
China Fish. Monthly	China Fisheries Monthly
Ceylon J. Sci. (Biol. Sci)	Ceylon Journal of Science. (Biological Sciences)
Chromosome Inf. Serv.	Chromosome Information Service
CMFRI Newsl.	Central Marine Fisheries Research Institute Newsletter
Comp. Biochem. Physiol. (A. Comp. Physiol.)	Comparative Biochemistry and Physiology. Part A. Comparative Physiology
Comp. Biochem. Physiol. (B Comp. Biochem.)	Comparative Biochemistry and Physiology. Part B. Comparative Biochemistry
Dept. of P. I.	Department of Primary Industries.
Dev. Comp. Immunol.	Development in Comparative Immunology
Dept. of Zoo.	Department of Zoology
Dept. of Agri. and Natl. Res.	Department of Agriculture and Natural Resources
Fish. Res. Ann. Rep. Fish. Div. (Papua New Guinea)	Fisheries Research Annual Report., Fisheries Division (Papua New Guinea)
Fish. Res. J. Phil.	Fisheries Research Journal of the Philippines
Fish Farm. in the Phil.	Fish Farming in the Philippines
Fish Tech., Soc. Fish. Tech.	Fisheries Technology, Society of Fisheries Technologists
Food Tech. Aust.	Food Technology in Australia

<<

Guam. Aqua.	Guam Aquaculture
Ind. J. Exp. Bio.	Indian Journal of Experimental Biology
Ind. J. Fish.	Indian Journal of Fisheries
Ind. J. Mar. Sci.	Indian Journal of Marine Sciences
Ind. J. For.	Indian Journal of Forestry
Ind. J. Physiol. All. Sci.	Indian Journal of Physiology and Allied Sciences
Ind. J. Zoo.	Indian Journal of Zoology
Inst. Fish. Res. Dev.	Institute of Fisheries Research and Development
Intl. J. Invert. Repn.	International Journal of Invertebrate Reproduction
Intl. Symp. on Utlz. of Coastal Ecosystems	International Symposium on Utilization of Coastal Ecosystems
Japan Sea Farm. Assn.	Japan Sea Farming Association
J. Anim. Morphol. Physiol.	Journal of Animal Morphology and Physiology
J. Asia. Soc. Bengal	Journal of the Asiatic Society, Bengal
J. Bio. Chem.	Journal of Biological Chemistry
J. Biol. Sci.	Journal of Biological Sciences
J. Bombay Nat. Hist. Soc.	Journal of the Bombay Natural History Society
J. Comp. Physiol.	Journal of Comparative Physiology
J. Expt. Biol.	Journal of Experimental Biology
J. Expt. Mar. Biol. Ecol.	Journal of Experimental Marine Biology and Ecology
J. Expt. Zool.	Journal of Experimental Zoology
J. Fish. Dis.	Journal of Fish Diseases
J. Inland Fish. Soc. Ind.	Journal of the Inland Fisheries Society of India
J. Mar. Fish. Res	Journal of Marine Fisheries Research
Man. of Res. Methods for Mar. Invert. Repn.	Manual of Research Methods for Marine Invertebrate Reproduction
Mal. Agri. J.	Malaysian Agricultural Journal
Mar. Biol.	Marine Biology
Mar. Env. Res.	Marine Environmental Research
Mar. Biol. Assn. of Ind.	Marine Biological Association of India
Off. of Env. and Conserv.	Office of Environment and Conservation
Pak. J. Sci. Industrial Res.	Pakistan Journal of Science and Industrial Resources
Papua New Guinea Agri. J.	Papua New Guinea Agricultural Journal
Phil. J. Sci.	Philippine Journal of Science
Proc. IPFC	Proceedings of the Indo-Pacific Fishery Commission
Proc. Zoo. Soc., Calcutta	Proceedings of the Zoological Society, Calcutta
Proc. of the Symp. on Coastal Aqua.	Proceedings of the Symposium on Coastal Aquaculture
Proc. of the 1st Aust. Shellfish Aqua. Conf	Proceedings of the First Australian Shellfish Aquaculture Conference
Proc. of the Intl. Wkshp. on Pen and Cage Culture	Proceedings of the International Workshop on Pen and Cage Culture
Proc. Ind. Academy Sci.	Proceedings of the Indian Academy of Sciences
Progress in Invert. Repn. Aqua.	Progress in Invertebrate and Reproduction and Aquaculture
Q. Res. Rep., SEAFDEC Aqua. Dept	Quarterly Research Report, Southeast Asian Fisheries Development Centre Aquaculture Department

<<

sci. Cult.	Science Culture
Seafood Export J.	Seafood Export Journal
Symp. P. 1st Bangla. Sci. Conf.	Symposium paper, First Bangladesh Science Conference
S. A. J. Zoo.	South African Journal of Zoology
SEAFDEC	Southeast Asian Fisheries Development Centre
Tech. Rep., Mindanao State Univ. Inst. Fish. des. Dev.	Technical Report, Mindanao State University Institute of Fisheries Research and Development
Tech. Rep., N.Z. Mar. Dept. Fish.	Technical Report. New Zealand Marine Department of Fisheries
Thai Fish. Gaz.	Thai Fisheries Gazette
Trans. Mycol. Soc. Japan	Transactions of the Mycological Society of Japan
Trans. R. Soc. South Africa	Transactions of the Royal Society of South Africa
U. P. Home Econ. J.	University of the Philippines Home Economics Journal
Wkshp. on Mar. Invert. Repn.	Workshop on Marine Invertebrate Reproduction
Z. Mikrosk. Anat. Forsch	Zeitschrift fuer Mikroskopisch Anatomische Forschung
Z. Vgl. Physiol.	Zeitschrift fuer Vergleichende Physiologie
Zoo. J. Linn. Soc.	Zoological Journal of the Linnean Society

OTHER ABBREVIATIONS USED

Annex.	Annexure
Ag.	Agency
Anat.	Anatomy
Acad.	Academy
Abs.	Abstract
Bklt	Booklet
Bur.	Bureau
Br.	Branch
Cult.	Culture/Cultural
Curr.	Current
Comm.	Commerce
Commn.	Commission
Comp.	Compiled/Compilation
Corpn.	Corporation
Chem.	Chemical
coop.	Cooperative
Div.	Division
Dir.	Director
Educ.	Education
Edn.	Edition
Ed.	Editor
Exb.	Exhibition
Fr.	French
Ger.	Germany
Inf.	Information
Lab.	Laboratory
Metab.	Metabolisim
Ms.	Manuscript
Mus.	Museum
Natl.	Natural/National
Nutr.	Nutrition/Nutrient
No.	Number
Oceanogr.	Oceanography
Proj.	Project
Prog.	Programme
Plan.	Planning
Pol.	Pollution
Pdct.	Productivity
Pub.	Publication/Published
P.	Page/Total page
pp.	Pages
Rev	Review
Spl.	Special
Ser.	Series
Sem.	Seminar
Sur.	Survey
Stn.	Station
Suppl.	Supplement
Toxicol.	Toxicology
Trng.	Training
Trop.	Tropical
Vol.	Volume

<<

PUBLICATIONS OF THE BAY OF BENGAL PROGRAMME (BOBP)

The BOBP brings out the following types of publications:

Reports (BOBP/REP/...) which describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and subprojects in member-countries for which BOBP inputs have ended.

Working Papers (BOBP/WP/...) which are progress reports that discuss the findings of ongoing BOBP work.

Manuals and Guides (BOBP/MAG/...) which are instructional documents for specific audiences.

Information Documents (BOBP/INF/... which are bibliographies and descriptive documents on the fisheries of member-countries in the region.

Newsletters *(Bay of Bengal News)* which are issued quarterly and which contain illustrated articles and features in non technical style on BOBP work and related subjects.

Other publications which include books and other miscellaneous reports.

A list of publications in print follows. A complete list of publications is **available on request.**

Reports (BOBP/REP/...)

23. *Summary Report of BOBP Fishing Trials and Demersal Resources Studies in Sri Lanka.* (Madras. March 1986.)
24. *Fisherwomen's Activities in Bangladesh : A Participatory Approach to Development.* P Natpracha, (Madras, May 1986.)
25. *Attempts to Stimulate Development Activities in Fishing Communities in Adirampattinam. India.* P Natpracha. V L C Pietersz. (Madras. May 1986.)
26. *Report of the Tenth Meeting of the Ath'isorv Committee.* Male. Maldives. 17-18 February 1986. (Madras. April 1986.)
28. *Small-scale Aquaculture Development Project in South Thailand:* Results *and Impact.* E Drewes. (Madras. May 1986.)
29. *Towards Shared Learning: An Approach to Non-formal Adult Education ft)r Marine Fisherfolk of Tamil Nadu. India.* L S Saraswathi and P Natpracha. (Madras. July 1986.)
30. *Summary Report of Fishing Trials with Large-mesh Drifinets in Bangladesh.* (Madras. May 1986.)
31. *In-service Training Programme ftr Marine Fisheries Extension Officers in Orissa, India.* U Tietze. (Madras, August 1986.)
32. *Bank Credit fir Artisana! Marine Fisherfolk of Orissa. India.* U Tietze. (Madras. May 1987.)
33. *Non-formal Primary Education for Children of Marine Fisherftlk in Orissa. india.* U Tietze and Namita Ray. (Madras, December 1987.)
34. *The Coastal Set Bagnet Fishery of Bangladesh — Fishing Trials and Investigations.* S E Akerman. (Madras. November 1986.)
35. *Bracki.shwaier Shrimp Culture Demonstration in Bangladesh.* M Karim. (Madras, December 1986.)
36. *Hilsa Investigations in Bangladesh.* (Colombo. June 1987.)
37. *High-Opening Bottom Trawling in Tamil Nadu. Gujarat and Orissa, India : A Summary of Effort and impact* (Madras. February 1987).
38. *Report of the Eleventh Meeting ofthe Advisory Committee.* Bangkok. Thailand. March 26-28, 1987. (Madras, June 1987.)
39. *investigations on the Mackerel and Scud Resources of the Malacca Straits.* (Colombo, December 1987).
40. *Tuna in the Andamun Sea.* (Colombo, December 1987)
41. *Studies of the Tuna Resource in the EEZs of Sri Lanka and Maldives.* (Colombo, May 1988)
42. *Report of the Twelfth Meeting of the Advisory Committee.* Bhubaneswar, India, 12-15 January. 1988. (Madras, April 1988).
43. *Report of the Thirteenth Meeting of the Advisory Committee.* Penang, Malaysia, 26-28 January. 1989. (Madras, March 1989).
44. *Report of the Fourteenth Meeting of the Advisory Committee.* Medan, Indonesia. 22-25 January. 1990. (Madras, April 1990).
45. *Report of the Seminar on Grailaria Production and Utilization in the Bay of Bengal Region.* (Madras. November 1990).
46. *Exploratory Fishing for Large Pelagic Species in the Ma/dives* R C Anderson and A Waheed, (Madras, December 1990.)
47. *Exploratory Fishing for Large Pelagic Species in Sri Lanka.* R Maldeniya and S L Suraweera. (Madras, April 1991.)
48. *Report of the Fifteenth Meeting of the Advisory Committe3.* Colombo, Sri Lanka, 28-30 January, 1991. (Madras, April 1991).
49. *Introduction of New Small Fishing Craft in Kerala.* O Gulbrandsen and M R Anderson. (Madras, January 1992.)
50. *Report of the Sixteenth Meeting ofthe Advisory Committee.* Phuket, Thailand, 20-23 January, 1992. (Madras, April 1992.)
51. *Report of the Seminar on Mud Crab Culture and Trade in the Bay of Bengal Region.* November 5-8. Surat Thani, Thailand. (Madras. September 1992.)
52. *Feeds ftr Artisanal Shrimp Culture in India — Their Development and Evaluation.* (Madras, November 1992.)

Working Papers (BOBP/WP/...)

27. *Reducing the Fuel Costs of Small Fishing Boats.* **O Gulbrandsen. (Madras, July 1986.)**

<<

38. *Credit for Fisherfolk : The Experience in Adirampattinam. Tamil Nadu. India.* R S Anharasan and O Fernandez. (Madras. March 1986.)

42. *Fish Trap Trials in Sri Lanka.* (Based on a report by I Hammerman). (Madras, January 1986.)

43. *Demonstration of Simple Hatcher Technology for Prawns in Sri Lanka.* (Madras. June 1986.)

44. *Pivoting Engine Installation frr Beachlanding Boats.* A Overa, R Ravikumar. (Madras. June 1986.)

45. *Further Development of Beachlanding Craft in India and Sri Lanka.* A Overa. R Ravikumar. O Gulbrandsen. G Gowing (Madras, July 1986.)

46. *Experimental Shrimp Farming in Ponds in Polekurru. Andhra Pradesh. India.* J A J Janssen. T Radhakrishna Murthy. B V Raghavulu and V Sreekrishna. (Madras. July 1986.)

47. *Growth and Mortality of the Malaysian Cockle.* (Anadara granosa) *under Commercial Culture : Analysis through Length-frequency Data.* NG Fong Oon. (Madras. July 1986.)

48. *Fishing TriaLs with High-Opening Bottom Trawls from Chandipur, Orissa. india.* C Pajot and B B Mohapatra. (Madras. October 1986.)

49. *Pen Culture of Shrimp by Fisherfolk : The BOBP Experience in Killai. Tamil Nadu. India.* E Drewes. C Rajappan. (Madras, April 1987.)

50. *Experiences with a Manually Operated Net-Braiding Machine in Bangladesh.* B C Gillgren. A Kashem. (Madras, November 1986.)

51. *Hauling Devices for Beachlanding Craft.* A Overa, P A Hemminghyth. (Madras, August 1986.)

52. *Experimental Culture of Seaweeds* (Gracilaria Sp.) *in Penang. Malaysia.* (Based on a report by M Doty and J Fishcr). (Madras, August 1987.)

53. *Atlas of Deep Water Demersal Fishery Resources in the Bay of Bengal.* I Nishida and K Sivasuhramaniam. (Colomho. September 1986.)

54. *Experiences with Fish Aggregating Devices in Sri Lanka.* K T Weerasooriya. (Madras, January 1987.)

55. *Study of Income, indehtedne.ss and Savings among Fisherfolk of Orissa. india.* T Mammo. (Madras, December 1987.)

56. *Fishing Trials with Beachlanding Craft at Uppada. Andhra Pradesh. India.* L Nyberg. (Madras, June 1987.)

57. *identifying Extension Activities for Fisherwomen in Visakhapatnam District. Andhra Pradesh, India.* D Tempelman. (Madras, August 1987.)

58. *Shrimp Fisheries in the Bay of Bengal.* M Van der Knaap. (Madras. August 1989.)

59. *Fishery Statistics in the Bay of Bengal.* T Nishida. (Colombo, August 1988.)

60. *Pen Culture of Shrimp in Chilaw. Sri Lanka.* D Reyntjens. (Madras, April 1989.)

61. *Development of Outrigger Canoes in Sri Lanka.* O Gulbrandsen, (Madras, November 1990.)

62. *Silvi-Pisciculture Project in Sunderhans. West Bengal : A Summary Report of BOBP's assistance.* C L Angell. J Muir. (Madras, September 1990.)

63. *Shrimp Seed Collectors of Bangladesh.* (Based on a study by UBINIG.) (Madras. October 1990.)

64. *Reef Fish Resources Survey in the Maldives.* M Van der Knaap. Z Waheed, H Shareef and M Rasheed (Madras. April 1991.)

65. *Seaweed* (Gracilaria Edulis) *Farming in Vedalai and Chinnapalam. india.* Ineke Kalkman, Isaac Rajendran and Charles L Angell. (Madras, June 1991.)

66. *improving Marketing Conditions for Women Fish Vendors in Besant Nagar. Madras.* K Menezes. (Madras, April 199 1.)

67, *Design and Trial of ice Boxes for Use on Fishing Boats in Kakinada. india.* I J Clucas. (Madras, April 1991.)

68. *The By-catch from indian Shrimp Trawlers in the Bay of Bengal: The potential for its improved utilization.* Ann Gordon. (Madras, August 1991.)

69. *Agar and Alginate Production from Seaweed in india.* J J W Coopen. P Nambiar. (Madras, June 1991.)

70. *The Kattumaram of Kothapatnam-Pallipalem. Andhra Pradesh. India — A survey of the fisheries and fisherfolk* Dr K Sivasubramaniam. (Madras, December 1991.)

71. *Manual Boat Hauling Devices in the Maldives.* (Madras. November 1992.)

72. *Giant Clams in the Maldives — A stock assessment and study of their potential for culture.* Dr J R Barker. (Madras, December 1991.)

73. *Small-scale Culture of the Flat Oyster* (Oyster folium) *in Pulau Langkawi. Kedah. Malaysia.* Devakie Nair and Bjorn Lindeblad. (Madras, November 1991.)

74. *A Study of the Performance of Selected Small Fishing Craft on the East Coast of india.* Gardien El Gendy. (Madras. August 1992.)

75. *Fishing Trials with Beachlanding Craft at Thirumullaivasal, Tamil Nadu. india 1989-1992. C* Pajot. (Madras, November 1992.)

76. *A View from the Beach — Understanding the status and needs of fisherfolk in the Meemu. Vaavu and Faafu Atolls of the Republic of Maldives.* The Extension and Projects Section of the Ministry of Fisheries and Agriculture, The Republic of Maldives. (Madras, June 1991.)

77. *Development of Canoe Fisheries in Sumateria, indonesia.* O Gulbrandsen and C Pajot. (Madras. April 1992.)

78. *The Fisheries and Fisherfolk of Nias island. Indonesia. A description of the fisheries and a socio-economic appraisal of the fisherfolk.* Based on reports by C Pajot and P Iownsley. (Madras, December 1991.)

79. *Review of the Beche De Mer (Sea Cucumber) Fisher in the Maldives.* Leslie Joseph. (Madras, April 1992.)

80. *Reef Fish Resources Survey in the Maldives — Phase Two.* R. C Anderson, Z Waheed and A. Arif. (Madras, April 1992.)

81. *Exploratory Fishing for Large Pelagic Species in South indian Water.* Jean Gallene and Robert Hall. (Madras. November 1992.)

82. *Cleaner Fishery Harhours in the Bay of Bengal.* R Ravikumar (Madras, April 1992.)

83. *Survey of Fish Consumption in Madras.* Marketing and Research Group, Madras, India. (Madras, October 1992.)

Manuals and Guides (BOBP/MAG/...)

1. *Towards Shared Learning : Non-formal Adult Education for Marine Fisherfolk. Trainers' Manual.* (Madras, June 1985.)

2. *Towards Shared Learning : Non-formal Adult Education for Marine Fisherfolk. Animators' Guide.* (Madras. June 1985.)

3. *Fishery Statistics on the Microcomputer : A BASiC Ver.sion of Hasselblad's NORMSEP Program.* D Pauly, N David. J **Hertel-Wuiff.** (Colombo. June 1986.)

4. *Separating Mixtures of Normal Distributions : Basic programs for Bhattacharya's Method and Their Application for Fish Population Analysis.* H Goonetilleke and K Sivasubramaniam. (Madras, November 1987.)

5. *Bay of Bengal Fisheries Information System* (BOBFINS): *User's Manual.* (Colombo, September 1987.)

8. *Extension Approaches to Coastal Fisherfolk Development in Bangladesh: Guidelines for Trainers and Field Level Fishery Extension Workers.* Department of Fisheries, Ministry of Fisheries and Livestock, Government of Bangladesh and Bay of Bengal Programme. (In Bangla) (Bangladesh, July 1992.)

10. *Our Fish. Our Wealth.* A guide to fisherfolk on resources management. — In 'comic book' style (English/Tamil/Telugu). Kamala Chandrakant with K Sivasubramaniam and Rathin Roy. (Madras, December 1991.)

Information Documents (BOBP/INF/...)

9. *Food and Nutrition Status of Small-Scale Fisherfolk in India's East Coast States : A Desk Review and Resource investigation.* V Bhavani. (Madras. April 1986.)

10. *Bibliography on Gracilaria — Production and Utilization in the Bay of Bengal.* (Madras, August 1990.)

11. *Marine Small-Scale Fisheries of West Bengal : An Introduction.* (Madras, November 1990.)

12. *The Fisherfolk of Puttalam. Chilaw. Galle and Matara — A study of the economic status of the fisherfolk offour fisheries districts in Sri Lanka.* (Madras. December 1991.)

13. *Bibliography on the Mud Crab Culture and Trade in the Bay of Bengal Region.* (Madras, October 1992.)

Newsletters *(Bay of Bengal News)*

Quarterly

Other Publications

Artisanal Marine Fisherfolk of Orissa : Study of their Technology. Economic Status. Social Organization and Cognitive Patterns. U Tietze. (Madras, December 1985.)

Studies on Mesh Selectivity and Performance : The New Fish-cum-Prawn Trawl at Pesalai, Sri Lanka. BOBP/MIS/3. M S M Siddeek. (Madras, September 1986.)

Motorization of Dinghy Boats in Kasafal. Orissa. BOBP/MIS/4. S Johansen and O. Gulbrandsen. (Madras, November 1986.)

Helping Fisherfolk to Help Themselves : A Study in People's Participation. (Madras, 1990.)

For further information contact:

The Bay of Bengal Programme, Post Bag No. 1054, Madras 600 018, India.

Cable : BAYFISH Telex: 41-8311 BOBP Fax: 044-836102

Telephone: 836294, 836096, 836188