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

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ABSTRACT

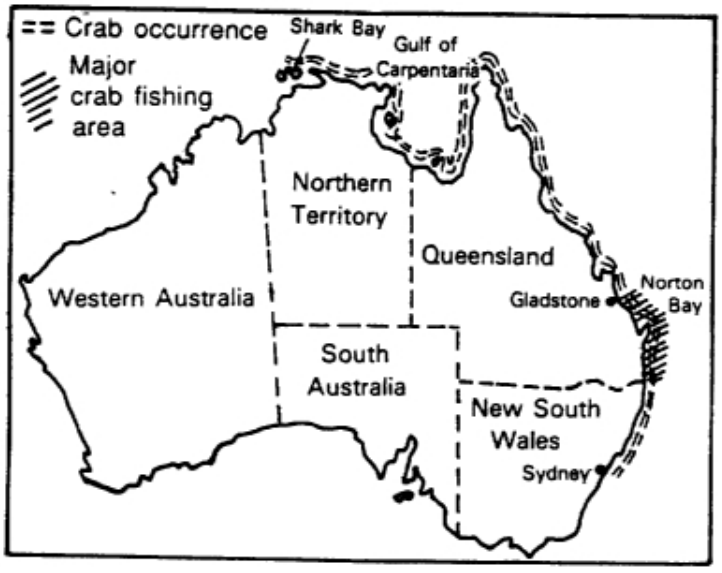
The annual commercial catch of mud crab in Australia is 600 t. These crab are caught by professional crabbers, fishermen taking crab as a supplementary catch and recreational fishermen. There are about 220 professional and secondary crabbers operating in Queensland. Baited pots are the predominant gear. 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 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 -20°C, 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

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*** 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 lO-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.

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AN OVERVIEW OF THE MUD CRAB FISHING GEAR IN THE PHILIPPINES

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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.

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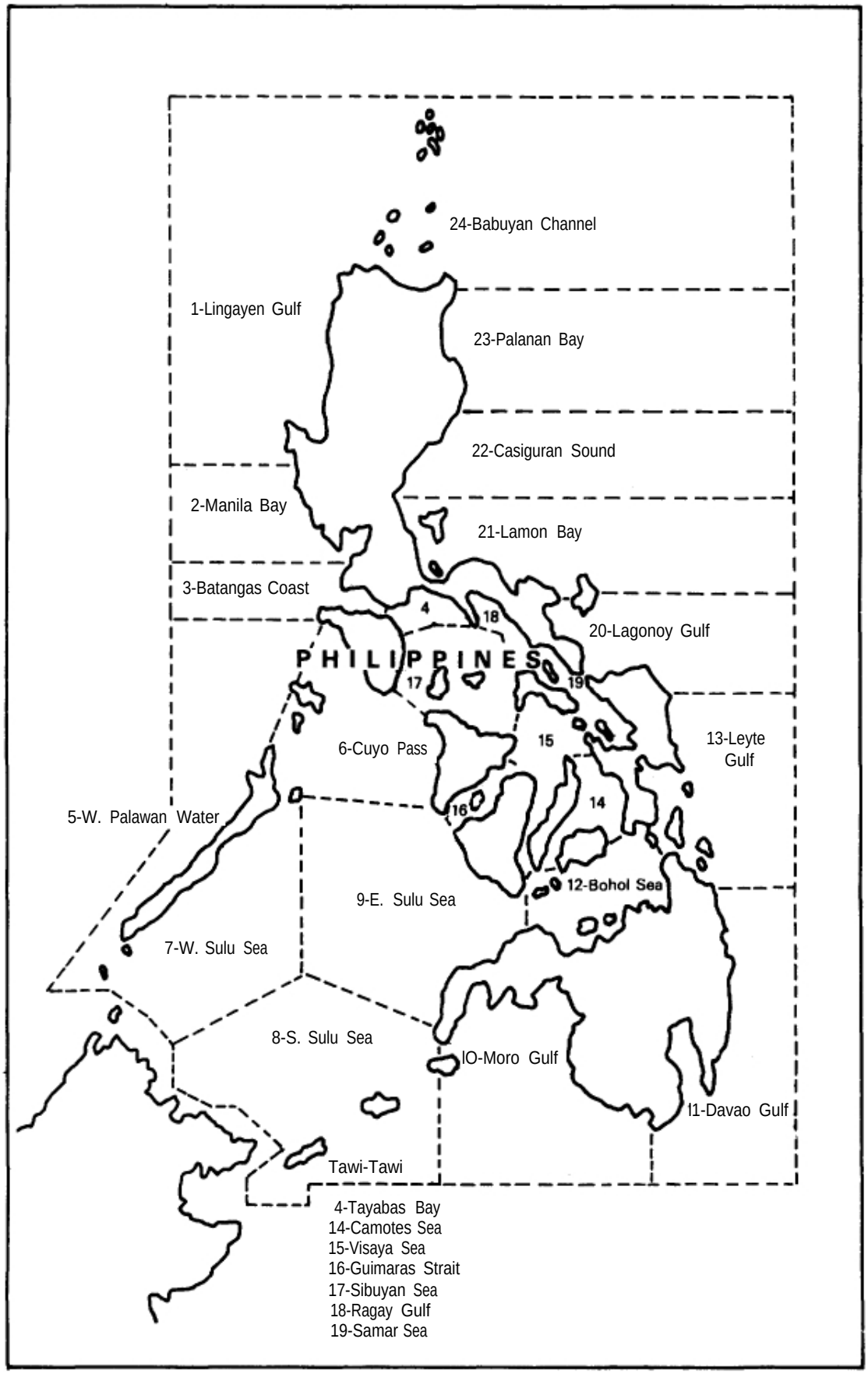
Fig. 1 Locations of fishing grounds in the Philippines



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	-	1	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.

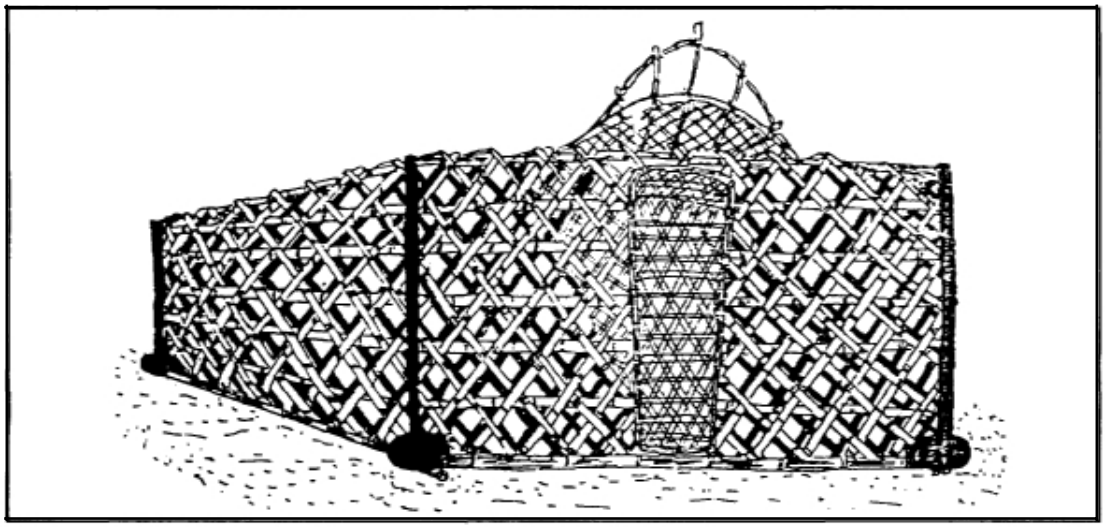
FISHING GEAR

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

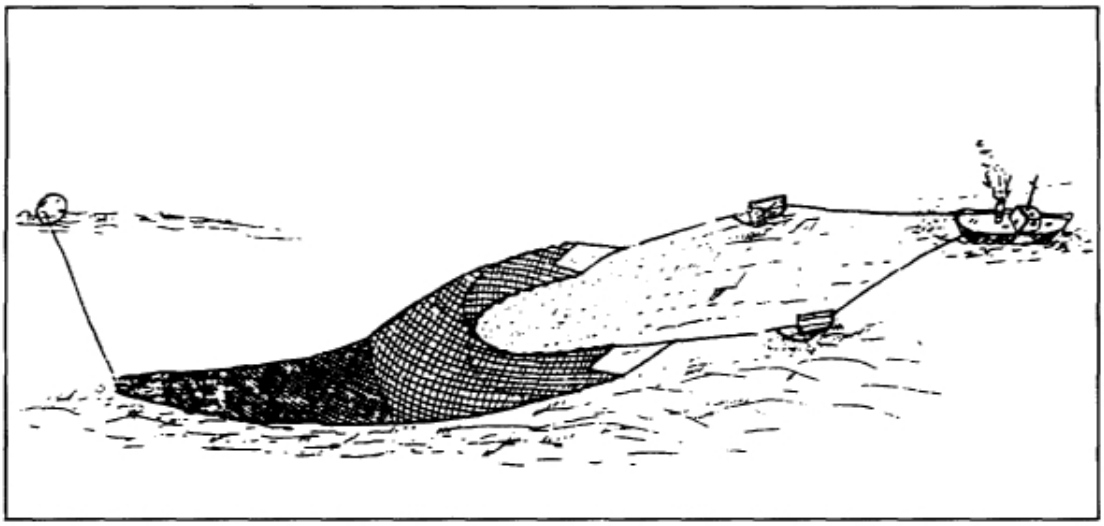
The castnet *(data* or *lava* in the local dialect) isac onical net made of fine meshed netting of 20—30 knots mesh size Artisanal fishermen use a net 8-lt) in in mouth circumference. It is usually operated by one man. In deeper water, a *bancd* or raft, has to he used. The net is cast into the water 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

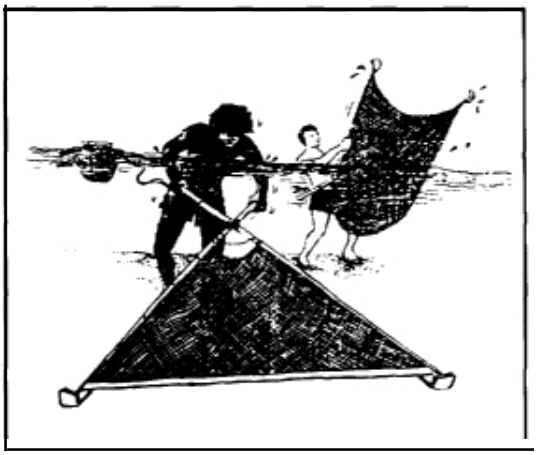
Trawls are nets made in the form of a conical hag. with the mouth kept open by otter boards. The entire gear is operated by towing over the bottom of the sea to capture demersal species (Figure 4).

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.

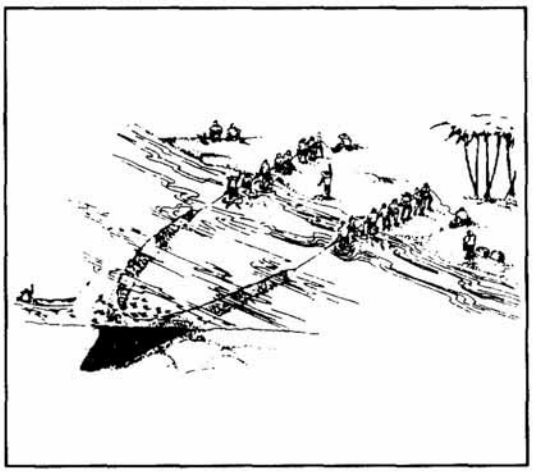
Fig 5. Shallow water push net



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 6. Beach seine



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

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.

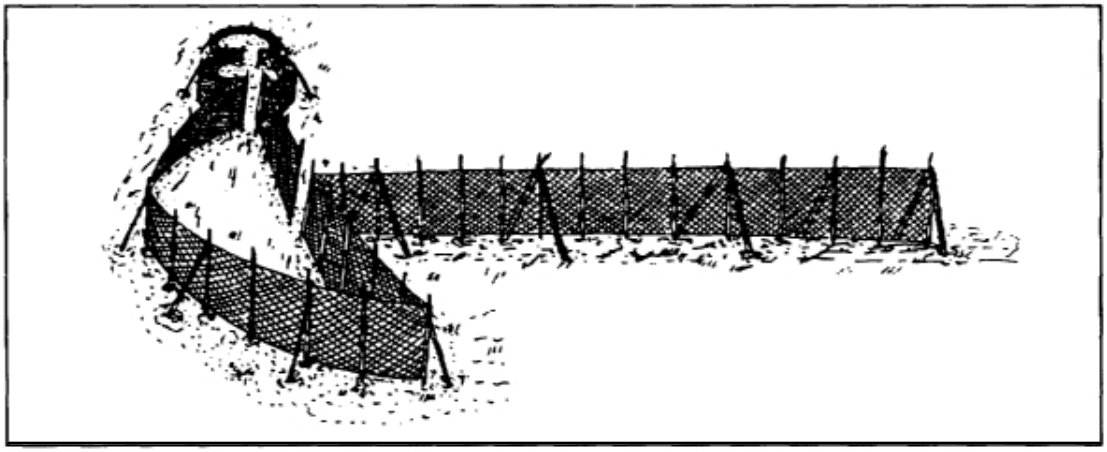
The seine is operated during the day in the shallow waters ot coves, bays and coastal areas. Sometimes the gear is operated during late afternoons and evenings.

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).

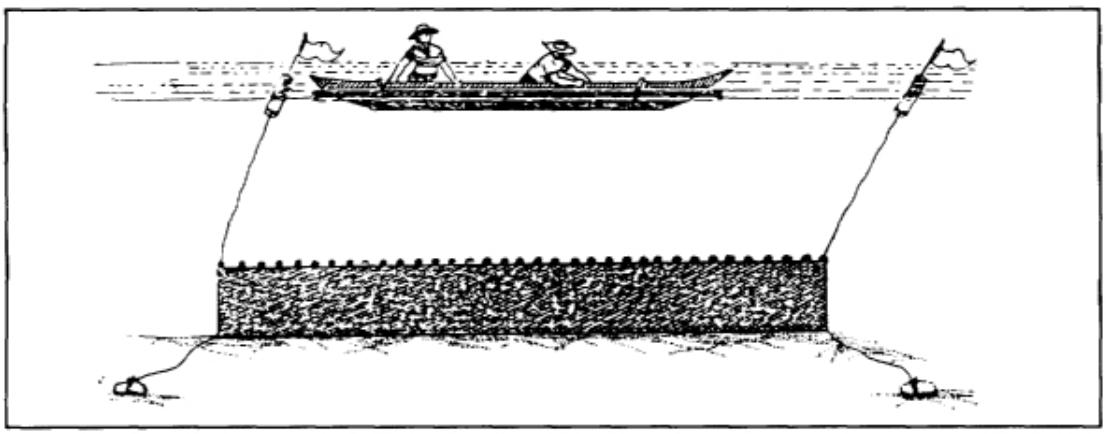
Fig 7. Fish corral



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)

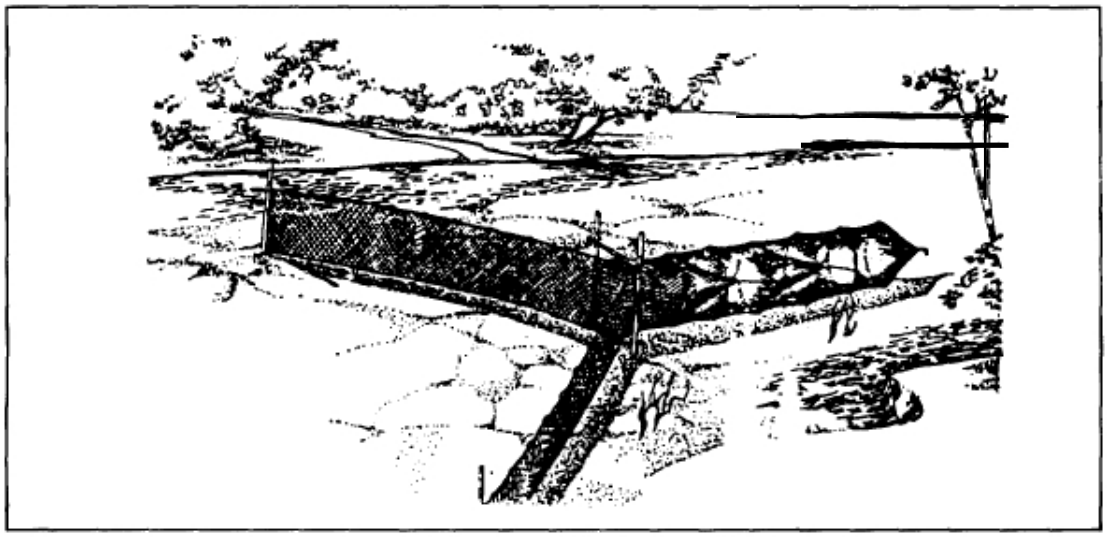
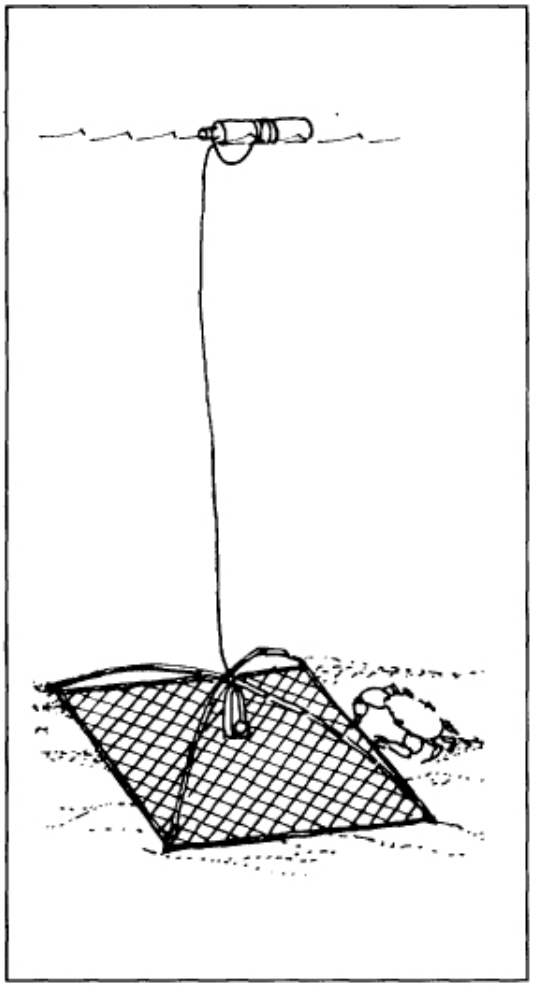


Fig 10. Crab liftnet



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.

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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

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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 1- 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 Patel 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 1, Chhapgar 1962 and Rao

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* 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)				
KiIlai 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
III · 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.

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MUD CRAB — A POTENTIAL AQUA-RESOURCE OF BANGLADESH

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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).

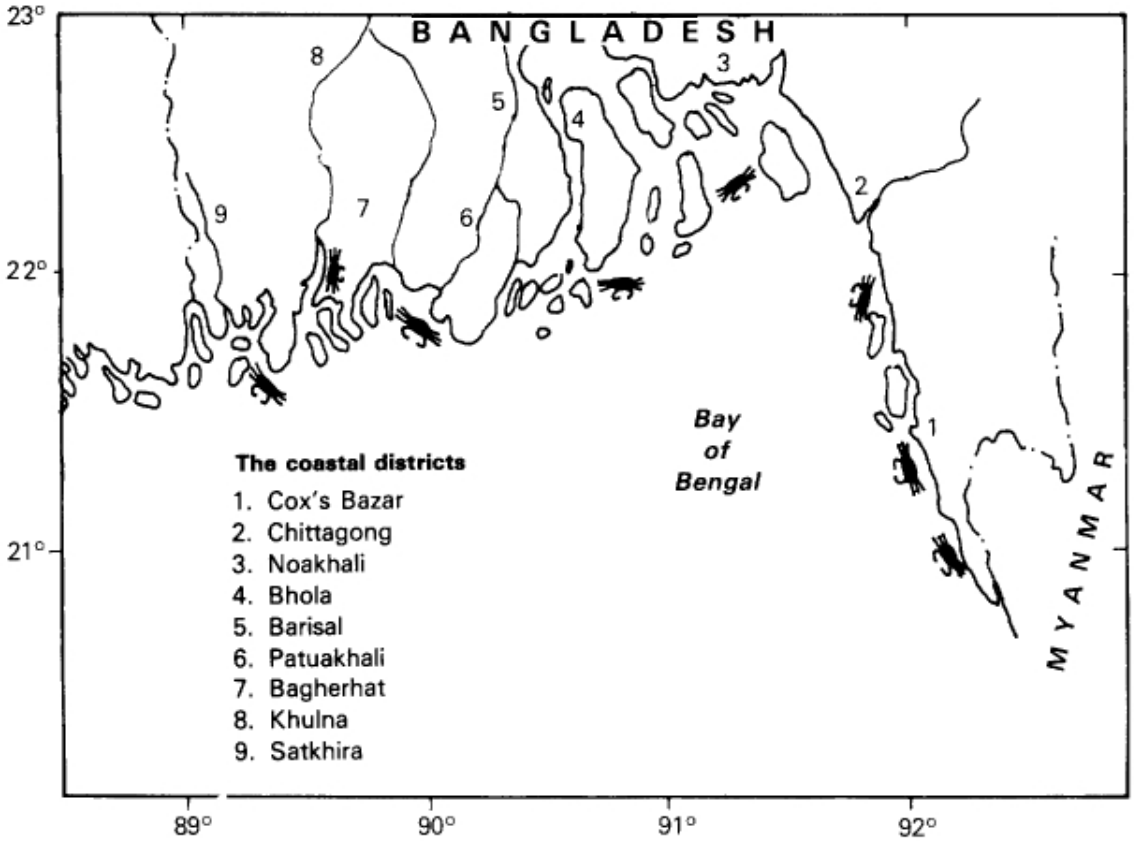
Estampador (1949) reported three species of the genus *Scylla,* namely *S.serrata* (Forskal), *S.oceunica* (Dana) and *S.transquebarica* (Fabricius). and one new variety *S.serrata* var. *paramamosain*

(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 ¦ I = 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 $ ¦ = 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:

i. 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.

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