Final report

Culture of mud crab (Scylla sp.) and swimming crab (Portunus pelagiucs) in Phu Quoc Archipelago

I. Introduction

The mud crabs *Scylla* spp., are *Portunid* crabs which are distributed throughout the Indo-Pacific region, typically found associated with mangroves, especially in estuaries and sheltered muddy coastal habitats. They are considered one of the most commercially important species for fishery and aquaculture, supporting artisanal, small-scale fisheries as well as supplies of juveniles for pond culture. However, the production of mud crabs has recently declined due to both over-fishing and aquaculture activities. In some areas, expansion of the shrimp culture industry, mangrove forests have been substantially destroyed, resulting in loss of habitat for these species with consequent decline in fishery production.

Aquaculture of mud crabs may offer potential to compensate for these losses. Artificial production of mud crabs could help mitigate pressure on fishery resources. However, due to the low level of success in hatchery production of mud crabs, fisheries are still playing a very important role in supporting aquaculture. Consequently, Sivasubramaniam (1992), Fortes (1999) and Cholik (1999) all report that seed supply for pond culture relies on wild caught juveniles. Proper management of fisheries is an important component of aquaculture development.

In an attempt to reduce exploitation of the natural resources and in the other hand to improve livelihood of the farmers in Phu Quoc Island, a study was made to introduce a well-established model of mud crab culture in this area. In the first

step, wild crabs can be used to establish the culture model. Once the model is working promisingly, introduction and application of hatchery-reared crabs may be implemented. In the first trial 2 kinds of crabs were cultured including mud crab (*Scylla* sp.) and swimming crab (*Portunus pelagicus*).

II. Establishment of culture models

1. Training on mud crab culture

A training course was held to train farmer techniques for culture of mud crabs. Total farmers participated in the training was 15. The course was introduced all knowledge related to mud crab culture including general biological characteristics of mud crab, status of mud crab hatchery, techniques of nursery, status of culture and different culture techniques such as fattening culture, soft shell culture, mangrove-crab integrated culture, etc… Common diseases in crabs and treatment methods were also mentioned. The farmers were also provided documents for consultancy.

2. Site selection, pond design and culture methodology

A survey was made to select suitable sites for setting up mud crab and swimming crab culture models. For swimming crab culture, a site at the sea fringe in Cay Sao Hamlet, Ham Ninh Village was considered. A cage was designed with size of 11 m wide and 22 m long to confine the crabs. At the bottom an iron chain was anchored 40 cm deep into the substrate to prevent crab escapes. Net surrounded had a mesh size of 20 mm to allow water passing through and prevent crab loss. The cage was positioned 150 m far from the bank on the stone mounts area. The height of net above water surface was 30-50 cm. The cage was regularly checked to ascertain its firmness and safety.

Crab juveniles were purchased from fishermen. Those with size of 15 g and undamaged were selected for culture. Crabs were stocked in the cage at a density of 5 ind./m^2. The crabs were fed with trash fish purchased from fishing boats at a

feeding rate of 5% body weight except the first 10 days with 10%, once in the afternoon at 5-7 pm. Crabs were checked for growth after 1.5 months of culture. During the culture period, some water parameters such as temperature, pH and salinity were checked regularly. Water was monitored dependently on tide. Natural food may be supplemented through the tidal water.

In Le Bat Hamlet, Cua Can Village, two ponds were selected for mud crab culture. The area of each pond was 4000 m^2. The ponds were designed with surrounding trenches with 1 m deep and 2.5 m wide. Water depth maintained at the middle field was 30-40 cm. During the pond preparation, 100 kg of lime was applied and the ponds were dried for 3 days before water was filled. A nylon fence surrounding the pond dikes was installed to protect escaping of crabs.

Wild crabs juveniles of 20-30 g were purchased and stocked at density of 1000 crabs per pond. The chosen crabs were relatively uniformed and active. Two species of crabs (*Scylla paramamosain* and *S. olicavea*) were stocked together, in which *S. olivacea* accounted for 85-87% of the population. The crabs were fed with trash fish at 5-10% of body weight once a day at 5-7 pm. Trash fish were chopped in small pieces and distributed around the trenches and spread over the field. The farmers were adviced to check the feed fed to ascertain not over or underfeeding. Regular sampling to estimate individual weight and subsequently the amount of feed. Water exchange was implemented every 5-7 days with 30% of total volume each. Similarly, temperature and pH was checked twice a day, while salinity was only measured occasionally when sampling. Daily observation was suggested to follow up the status of crabs as well as security, especially when crabs reached the marketable sizes.

Before stocking, crabs were measured carapace width and weight to get initial size for calculating growth rate. Survival rate was estimated at the end when harvest.

At harvest all crabs were individually counted for each species and production was recorded.

3. Results

3.1. Swimming crab culture

The culture was maintained for 110 days. Maximum temperature recorded at the culture site was 30^{o}C in the morning and 33^{o}C in the afternoon. Temperature was relatively stable during the culture period (Figure 1). pH was rather stably high at 8.8. Similarly, salinity was not fluctuated and maintained at a range of sea water (26-30 ppt). All these parameters were suitable for growth of swimming crabs.

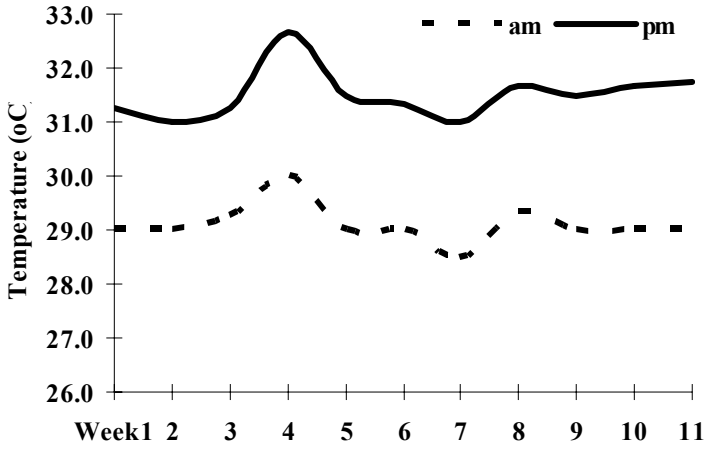

Figure 1: Fluctuation of temperature at the swimming crab culture area on the sea.

Initial weight (W) and carapace width (CW) of crabs at stocking were 16.2 g and 45.6 mm, respectively. The crabs attained the final weight and CW at harvest of 108.2 g and 90.1 mm, respectively. Consequently, the crabs obtained a growth rate of 12 mm carapace width (CW) per month and 0.85 g per day. There was no difference in growth rate between male and female crabs. Figure 2 showed that

male and female crabs had similar growth both in weight and size (carapace width).

Survival of swimming crabs after 3 months was relatively high with 69.2%. Total biomass harvested was 930 kg. In average an estimated net profit was 2.5 million VND.

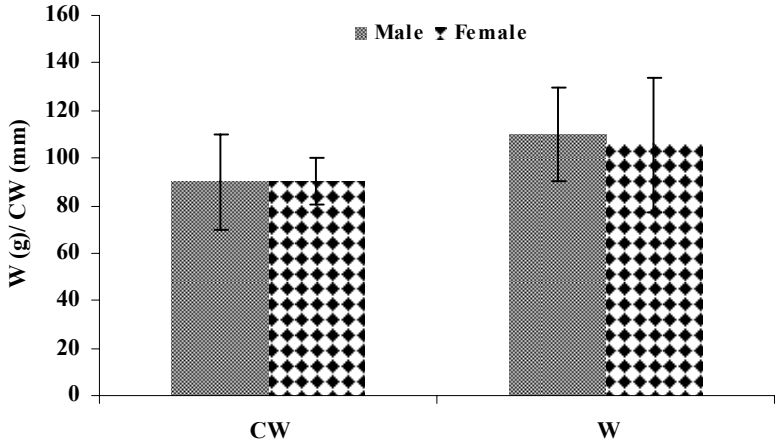

Figure 2: Growth of male and female swimming crabs

2. Mud crabs

Two ponds of mud crabs were strictly monitored. Temperature measured in pond 1 was slightly lower than that in pond 2 (Figure 3). Lower temperature was recorded early in October ranging from 26-27 ^{o}C in the morning whereas highest temperature occurred in September in the afternoon, up to 33.7 ^{o}C.

pH was relatively stable and ranged from 7-8 which was suitable for crab growth. Salinity was different between two ponds especially during the end of the culture period. Salinity was lower in the pond 1 and did not exceed 10 ppt over the culture duration. Whereas salinity in pond 2 was increasing up to 20 ppt at the end of the culture (Figure 4).

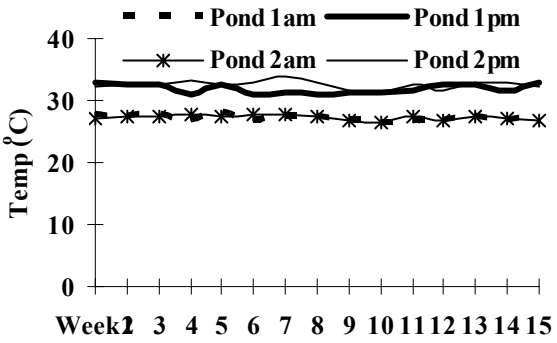

Figure 3: Temperature recorded in two ponds of mud crabs

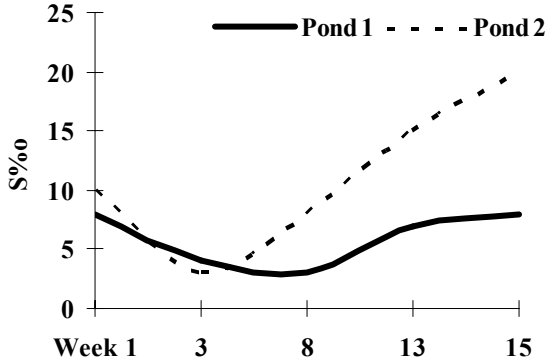

Figure 4: Salinity measured in two ponds of mud crabs

Water clarity was also monitored in both two ponds during the culture period. In marine aquaculture, shrimp or crab culture, the best water clarity should be maintained at 25-40 cm. Figure 5 showed that water clarity was in the suitable range from 26-40 cm. If it is lower than 20 indicating low water quality with high density of algae, whilst if water clarity is greater than 40 indicating signs of poor development of algae and natural food.

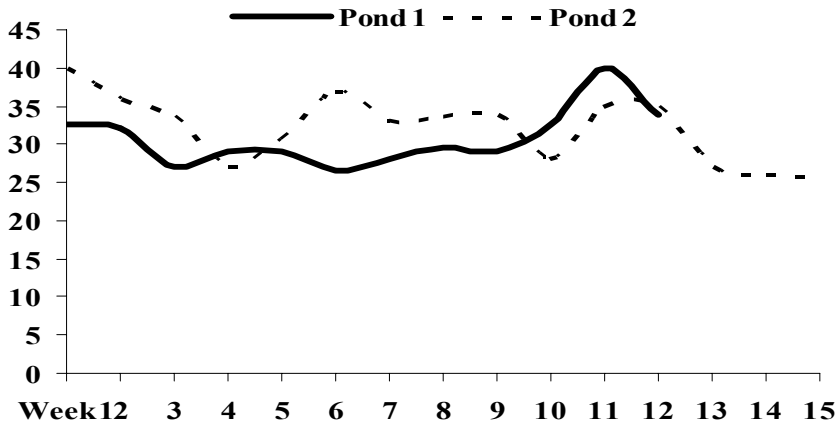

Figure 5: Water clarity measured in 2 ponds during the culture period.

Scylla olivacea dominated over *Scylla paramamosain* with a ratio of 7:1. Unlike in the mainland area *S. paramamosain* is predominant in the crab population, *S. olivacea* is dominant in the west coast where influenced by the population from

Thailand. According to the recent revised version on taxonomy, Keenan et al (1998) confirmed four species of Scylla exist over the world. In Vietnam, especially in the Mekong Delta only two species present, *Scylla paramamosain* and *S. olivacea*. Among these, *S. paramamosain* is the dominant species accounting for up to 95% of the mud crab population. However, in the west coast the opposite is true as the population may be merged with the one from Thailand where *S. olicavea* is dominant. Therefore, it is not surprise that wild population of mud crab in Phu Quoc is predominant by *S. olivacea*.

After a period of 110 days, crabs attained an average size of around 300 g in weight and 110 mm CW. There was no significant difference in growth between two species but between males and females (Table 1). Males grew faster than females especially in weight. Overall growth rates obtained were 2.4 g/day and 0.5 mm/day regardless of sex. Growth rates of crabs in two ponds were similar though salinity in the second pond was higher and more fluctuated. Most of crabs attained the marketable sizes (250-300 g) at harvest.

Table 1: Difference in growth, especially weight between males and females of mud crab *Scylla olivacea* in two culture ponds

		At sampling		**At harvest**	
		CW (mm)	**Weight (g)**	**CW (mm)**	**Weight (g)**
Pond 1	Males	88.8 ± 6.7	157.7 ± 33.4	107.0 ± 10.0	327.4 ± 75.5
	Females	84.7 ± 4.9	129.8 ± 29.7	105.8 ± 6.4	265.4 ± 67.7
Pond 2	Males	88.9 ± 5.0	163.8 ± 30.5	103.4 ± 6.6	307.7 ± 77.1
	Females	85.9 ± 4.3	137.4 ± 22.0	103.9 ± 9.6	273.6 ± 81.6

After more than 3 months of culture, a proportion of gravid females of around 10% was recorded. Gravid crabs are considered the best quality grade with highest prices. A total production of 248 kg and 259 kg was obtained from two ponds, respectively (Figure 6). Survival of crabs was very high, up to 85% which is normally rare among crab farming systems (Figure 7). Production and survival

rate of crabs in two ponds were very closed to each other. This indicated that the trial models are working well and promisingly applicable.

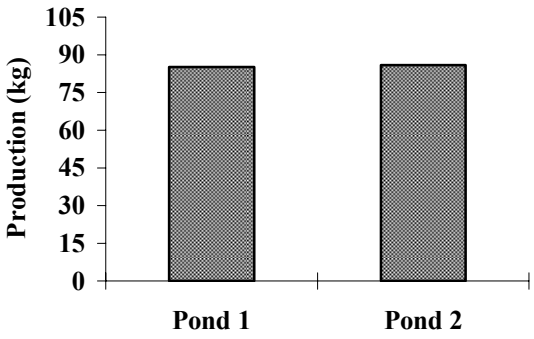

Figure 6: Survival of crabs recorded at two ponds at harvest

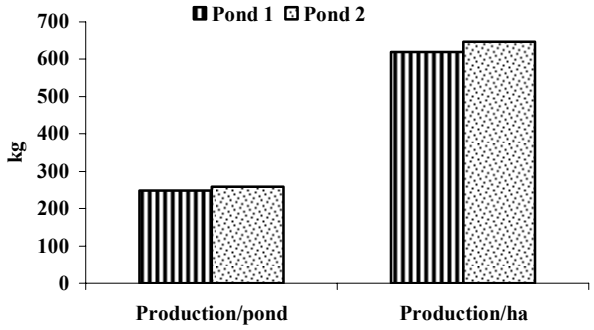

Figure 7: Production of crabs in two ponds calculated per pond and per ha.

According to the final calculation, after deducting all costs including seeds, feed, fuel for water pumping, etc… net profit obtained was estimated about 10-15 million VND per pond of 4000 m^2. Thus, if stocking with low density like in this case (1 crab/4 m^2 or 0.25 ind./m^2) one ha of water surface may expect to obtain a yield of 625 kg/ha and a net profit of 40-50 million VND/ha.

Among two species of mud crabs, *S. olivacea* grow slowly than *S. paramamosain*, according to Vu Ngoc Ut (2002), *S. paramamosain* could attain a growth rate of 25 mm CW/month. Regarding to stocking density, the author also found that stocking density is inversely proportional to survival rate, particularly above 3 ind/m^2. The best stocking density applied for *S. paramamosain* is 0.1 -1 ind./m^2. *S. olivacea* is more aggressive than *S. paramamosain*, therefore higher density should be taken into consideration to make sure obtaining reasonable survival and production. In terms of growth, *S. paramamosain* grow faster than *S. olivacea*. Introduction of *S. paramamosain* could improve production and faster culture

cycle in Phu Quoc Island. However, this species prefer lower salinity compared to *S. olivacea* which grow best at higher salinity.

At the time that hatchery-reared crabs are not available in Phu Quoc or not sufficiently supplied from the mainland areas, wild juveniles can be used either directly from the Island or mainland's sources. Regardless of sources, crabs are still the indigineous species which are not of concern of contamination.

Generally, trial models have revealed a promising result to expand the culture of mud crabs and swimming crabs in Phu Quoc, in one hand to improve income of farmers/fishermen and in the other hand, especially when hatchery-reared crabs are available, contribute to reduce over-exploitation of natural resources around the islands.

4. Conclusions and recommendations

Final results obtained from the trial culture models of mud crab and swimming crab indicated that culture of these two are potentially developed in Phu Quoc. According to the cannibalistic characteristic of mud crab, stocking density should not be higher than 1 crab per m^2. The best stocking density is 0.5 ind. per m^2. However, higher density could be properly working when substrates are installed to assure enough refuges for crabs to prevent cannibalism especially when molting. Water should be maintained to exchange frequently to provide fresh and good quality. Feeding is one of the most important factors affecting growth and survival of crabs. Overfeeding or underfeeding is either directly affect growth and production cost as well as water quality, therefore need to be monitored properly. The preferable feed of crab in low stocking density ponds is trash fish.

Culture models of mud crab and swimming crabs can be applied extensively in Phu Quoc where favourable conditions for crabs are met (salinity from 5-30 ppt, pH: 7.5-8.5, water exchange available and access of feed source. Proper construction of ponds should be considered as discussed above to ascertain the

production. With this small scale, most of the farmers in Phu Quoc can operate themselves a mud crab pond to help improve their income as well as increase mud crab or swimming crab production in Phu Quoc. This will help mitigate overexploitation of big crab that could be in the reproductive stages to avoid loss of potentially big population. In the near future, hatchery-reared crabs can be used for grow-out ponds, the aim of resource protection and conservation will be complete.

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Several photos of crabs models on Phu Quoc island

Photo-1: Two mud crab species: *Scylla paramamosain* (left) and *S. olivacea* (right) , cultivated at Cua Can village – Phu Quoc island.

Photo-2: Mud-crab pond in Cua Can village (Left) and **Checking growth of swimming crab** in Ham Ninh village (Right)

Photo-3: Swimming-crab cultivation model, off shore of HamNinh village