MOLLUSC CULTURE SYSTEM AND ENVIRONMENTAL CONDITIONS IN CAN GIO DISTRICT, HO CHI MINH CITY, VIETNAM.

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ABSTRACT

Environmental conditions and current culture systems of the clams *Meretrix lyrata* Sowerby and blood cockle *Anadara granosa* Linnaeus were studied. The sea bed (sand and mud), which can be used to culture clam and blood cockle constitute 1,386 and 717 hectares respectively in the Can Gio district. This study was based on 2 farms for clam and 3 farms for blood cockle. Samples of clam, cockle, water and substrate of culture beds were collected and analysed monthly to determine the growth rate in relation to environmental conditions at the farms. The growth rates of clams were not significantly different during the study, although the soil texture of these two farms was significantly different. Growth rates of blood cockle were significantly different except in one case. The growth rate of blood cockle might be related to the clay and organic matter contents of the culture beds. In economic terms, very good return was gained from molluscs farming. Profits per hectare per year were 1,439 and 2,519 US$, and profit margins were 59.8% and 40.8% for clam and blood cockle respectively.

INTRODUCTION

Vietnam has a long coastline (3,200 km) with many areas suitable for culture of molluscs. In the past, molluscs were harvested for domestic consumption, but lately they have been cultured to satisfy demands from the rapidly increasing population and export. Vietnam has a great potential for aquaculture of many commercial molluscs species, such as oyster, mussel, blood cockle and clam. However, only clams (*Meretrix meretrix* in the North and *Meretrix lyrata* in the South) and blood cockle (*Anadara granosa*) have been cultured recently. In Can Gio district, clam culture started in 1993 and blood cockle culture in 1995. However, limited studies on mollusc biology and financial problems have hampered development of the aquaculture industry in Vietnam. Thus, research on environmental conditions and improvement of current clam and blood cockle culture systems could help local people to select appropriate farming sites and to increase productivity.

MATERIALS AND METHODS

Field measurements

Can Gio district was selected for the study since clam and blood cockle cultures have just recently developed in the district. The Division of Agriculture and Rural Development provided information on culture areas and current culture systems. The most important consideration for selection of farms was the size of clams and cockles at the time the study was initiated. As the study period coincided with harvesting season in the district, most clams and blood cockles had marketable sizes, which were not suitable for a grow-out study. However, there were two clam farms in Can Thanh commune and three blood cockle

farms in Long Hoa commune with small sized bivalves. These five farms were selected for the study. A pole was rammed down to mark the point for sample collection in each farm. Farmers often stocked small size clam or blood cockle in a small areas within their farms for better management. Samples of clam, blood cockle, water, and sediment were collected and analysed monthly to determine growth rate in relation to environmental conditions. Sampling was carried out at each farm when the water level was high. Three water samples were collected using a water column sampler within a 3-m radius of the marking pole. DO, water temperature, pH, and salinity were measured *in situ* and the average value of three measurements recorded. Water samples were stored in plastic bottles in an ice-box during transport to the laboratory. The samples were analysed for chlorophyll-a, total suspended solids (TSS) and total volatile suspended solids (TVSS). Sediment pH was measured at 3 spots around the marked poles. Samples of clams, blood cockles and substrates were also collected at these points when the culture beds were exposed.

Length and weight of 30 individuals of clam or blood cockle were measured from each farm using sliding callipers and an electronic balance with accuracy of 0.05 mm and 0.1 g respectively. Comparison of growth performance at the end of the study was based on percentage growth in length due to the differences in initial length of blood cockles in three selected farms termed A, B, and C. Growth was calculated by the following equation:

$$\text{Growth in length (\%)} = \frac{\text{Final length - Initial length}}{\text{Initial length}} \times 100$$

Mud substrate samples were collected from the upper 3 cm surface and stored in plastic bags in the ice-box before analysis of soil texture and organic matter.

Economic survey

Baseline information on current culture area, local natural conditions, maps, status of research and culture techniques, land lease policy was provided by Division of Agriculture and Rural Development of Can Gio district. Meetings and discussions with representatives from Can Gio's People Committee and farmers of Long Hoa commune were also carried out to get more detailed information on the above aspects to verify the accuracy of all secondary data collected at Division of Agriculture and Rural Development.

Primary data were collected from interviewing local farmers with a prepared questionnaire. Seven clam farms and seven blood cockle farms located in Can Thanh and Long Hoa communes were selected for interviews. Data related to the culture system as well as the economic aspects of each farm were collected along with the questionnaire.

Data collected during the study on growth performance, environmental conditions, soil texture, etc. were analyzed using multiple range analysis of variance and one way ANOVA to determine and compare growth performance in relation to water quality, soil texture and soil organic matter content. The comparison between clam and blood cockle farms were done separately since they were different species. The economic analysis on profit, profit margin, etc. was also done separately for clam and blood cockle farms.

RESULTS AND DISCUSSION

Description of clam and blood cockle culture area

In Can Gio district, sandy and muddy flats suitable for culturing clam and blood cockle culture, constitute 1,386 and 717 ha respectively. Table 1 shows the distribution of culture areas for clam and blood cockle culture among seven communes in 1997.

A total of 85.7% of the sandy flats was

leased for clam culture and 70.0% of the mudflats for cockle culture. In fact, the real culture areas were lower than the above data since most farmers did not utilize all their permitted farming area. A major problem was shortage of seed supply. Since 1994 seed production has been reduced rapidly due to indiscriminate seed harvesting and environmental pollution. Furthermore, culture areas have increased considerably in size because of the potentially high profits from mollusc culture. The combination of these two factors has resulted in seed prices, which increased 2-10 times compared to 2-3 years ago. Since the demand is always higher than supply, competition tends to increase among farmers to get seed.

Growth performance of clam and blood cockle in relation to sediment texture, soil organic matter composition and water quality

Table 2 shows a comparison of growth of clams and cockles in terms of length increments during a 4-month period from January to April. The initial length of clams

Table 1. The distribution of sand and mudflat areas and areas used for clam and blood cockle culture in 1997. (Source: Buu, 1998).

No	Commune	Clam		Blood cockle	
		Sandy area (ha)	Culture area(ha)	Mudflat area (ha)	Culture area (ha)
1	Binh Khanh	0	0	0	0
2	An Thoi Dong	0	0	30	0
3	Ly Nhon	83	40	100	85
4	Thanh An	0	0	150	30
5	Can Thanh	805	780	17	0
6	Long Hoa	498	368	390	356
7	Tam Thon Hiep	0	0	30	2
Total		1,386	1,188	717	473

Table 2. Shell lengths (cm) of clams in two farms (A and B) and blood cockle in three farms (A, B and C) from January to April, 1998. Monthly means of 30 individuals.

Species	Farm	Length (cm) (Mean ±SE)			
		January	February	March	April
Clam	A	1.65 ± 0.02	2.07 ± 0.02	2.19 ± 0.02	2.53 ± 0.02
	B	1.61 ± 0.03	1.95 ± 0.03	2.20 ± 0.02	2.48 ± 0.02
Blood cockle	A	2.24 ± 0.02	2.32 ± 0.03	2.36 ± 0.02	2.42 ± 0.02
	B	2.16 ± 0.02	2.22 ± 0.02	2.24 ± 0.02	2.35 ± 0.01
	C	1.78 ± 0.03	2.11 ± 0.03	2.14 ± 0.02	2.36 ± 0.02

Table 3. Granulometrics and % of organic matter of sediments in two clam and three blood cockle farms.

Species	Farm	Sand (%)	Silt (%)	Clay (%)	Organic matter (%)
Clam	A	96.21	1.77	2.03	1.18
	B	85.28	11.70	2.77	1.10
Blood cockle	A	40.76	38.84	20.41	4.33
	B	41.29	38.23	20.62	4.25
	C	33.50	41.79	24.72	5.30

in the two farms were not different (P> 0.05). The initial lengths of cockles did not differ between farm A and B but differed between farm A and C, and between farm B and C (P<0.05).

Clams and cockles live buried in the sediment, which constitutes an important factor for their growth. If the proportions of sand, silt, and clay are suitable in culture beds, the bivalves will grow well and maintain a high survival rate. Otherwise, slow growth rate and high mortality will occur. The content of organic matter in the sediment is also important as clam and cockle feed on detritus with associated microorganisms. According to Chuong and Phung (1994a,b), detritus comprised 75% and 93% in the digestive tracts of clam and cockle respectively. A high organic matter content in the soil is often associated with fast growth of clam and cockle.

Table 3 shows sediment texture and the content of organic matter in sediments of the culture areas. The content of organic matter did not differ (P>0.05) concerning the two clam farms, but the sediment compositions were different (P<0.01 for sand and silt content, and P<0.05 for the clay content). However, growth rates of clams from the two farms were not different (P>0.05). Even though the sediment parameters were different they were still within a range, which could support normal growth of the clams.

The composition of sand and silt did not differ among the three cockle farms (P>0.05), while the clay and organic matter contents were significantly different between farm A & C, and farm B & C. As mentioned above, growth of blood cockle was different between farm A & C and farm B & C and these differences might be related to the clay and organic matter contents of the sediments.

Table 4 shows the water quality parameters : salinity, pH, sediment pH, DO, total suspended solids (TSS), total volatile suspended solids (TVSS), chlorophyll-a concentration, and water temperature. The salinity, pH, sediment pH, DO, and water temperature did not fluctuate greatly during the study period and they were within a suitable range for normal growth of both clam and cockle. Statistically, TSS, TVSS and chlorophyll-a were not different between two clam farms (P>0.05). The water quality and organic matter composition did not result in a different growth rate of clams in the two farms.

The TSS, TVSS and chlorophyll-a were not different between the cockle farms A & B and farm B & C (P>0.05). The only significant differences were found in TSS

Table 4. Highest and lowest values of water quality parameters measured from January to April 1997 in two clam and three blood cockle farms.

Species	Farm	Salinity (ppt)	Water pH	Sediment pH	DO
Clam	A	32-34	8.3-9.3	6.9-7.0	6.92-7.30
	B	30-34	7.9-9.4	6.9-7.4	7.01-7.40
Blood cockle	A	23-32	8.4-8.6	6.7-6.9	5.14-6.97
	B	20-30	8.1-8.5	6.5-6.9	6.18-6.39
	C	23-28	8.0-8.5	6.5-6.9	5.46-6.06
		Water temp. (°C)	TSS (mg/L)	TVSS (mg/L)	Chlorophyll-a (mg/m^3)
Clam	A	28.0-32.1	376.0-696.0	54.7-138.7	5.091-8.019
	B	28.4-34.6	412.0-707.3	60.0-162.0	5.346-8.910
Blood cockle	A	27.6-29.2	328.0-481.3	48.7-120.0	2.673-8.910
	B	28.0-30.1	328.0-462.0	37.0-137.3	4.455-12.474
	C	28.5-29.8	327.3-716.7	51.3-165.3	6.237-13.365

and chlorophyll-a between farm A and C ($P<0.05$). The different growth rates of cockles in farm A and C might be related to these differences in combination with the observed differences in sediment texture and organic matter contents (Table 3).

Financial analysis of clam and blood cockle farming

Financial analysis of clam and blood cockle farming in Can Gio district was done separately. Normally, each household was permitted to lease 3 ha of sandy sea bed for clam culture. Due to small culture areas, local farmers usually grouped ten households and managed the culture activities together. Normally, all farmers invested equal amounts of money and profit was divided equally among them. If a farmer could not invest as much money as requested, other farmers might invest more and profit was computed based on the investment of each farmer.

Cost breakdown

During the study, seven groups of clam and seven groups of blood cockle farmers were interviewed to get information and data on economics. The calculation and analysis were based on total operating cost of the whole culture period and mean values were used. The Figures 1 and 2 show that in both clam and blood cockle farms, seed cost comprised the highest cost. Up to now, seeds have only come from the nature. Harvesting cost also comprised a high proportion in total operating cost. In clam farming, this value was much higher than that of cockle farming since clams were harvested by hand picking. Cockle harvest was mechanised using a motor boat pulling a dredge. Therefore, the clam harvesting method should be improved in the future. Clam and cockle farming required a fairly high investment. Total operating cost per hectare per year were US$ 967 and US$ 3,662 for clam and cockle farms respectively. These investments were high as compared to capital availability of local

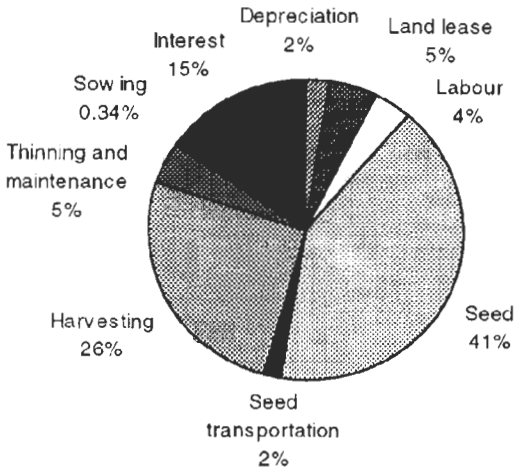

Figure 1. Cost breakdown of clam farm.

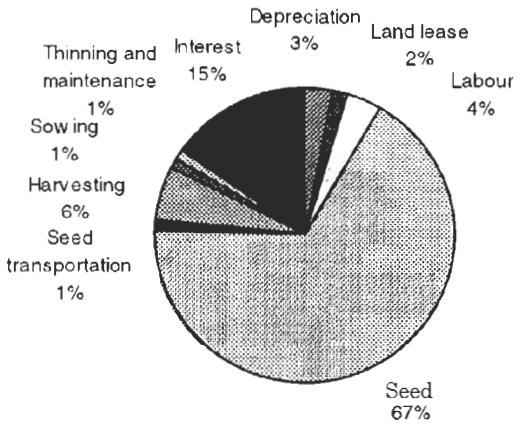

Figure 2. Cost breakdown of blood cockle farm.

farmers. Thus, all of them had to obtain loans from banks. The loan period was only one year and the interest 1.4% per month. Thus, the bank interest comprised a high proportion of the total operating cost (15.2% for clams and 15.5% for cockles). The government should extend the loan period and reduce the interest rate for local farmers to encourage them to invest in bivalve farming in the future.

Table 5. Costs and revenues of clam and blood cockle farming.

No	Items	Clam farming	Blood cockle
1	Break-even price	US$ 0.05/kg	US$ 0.37/kg
2	Net profit per ha per year	US$ 1,439	US$ 2,519
3	Ratio net profit and operating cost	148.8%	68.8%
4	Profit margin	59.8%	40.8%

Table 5 shows the costs and revenues of clam and cockle farming. Although the profit per hectare per year of clam farming was lower than that of cockle farming, the ratio between net profit and total operating cost was much higher for clams than for cockles (148.8% against 68.8%). This means more profit can be gained from clam farming than from blood cockles. Clam farming has, therefore, been more attractive than cockle farming in the district.

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