OBSERVATIONS AND NOTES ON THE CULTURING AND SETTLING CHARACTERISTICS OF THE GREEN MUSSEL, "TAHONG", *MYTILUS SMARAGDINUS*, IN THE PROVINCE OF CAPIZ

DANIEL KRIPPENE

INTRODUCTION

The culture of green mussels, "tahong", (*Mytilus smaragdinus*), is not considered a new mari-culture concept, as such practice has been in use in Bacoor Bay, Cavite, for the last 20 years. However, there had been little improvement in culture techniques and no new culture waters were identified until the Municipality of Sapian began its first experimental project two years ago using a new rope method which was introduced by B.J. French, a Peace Corps Volunteer. Information regarding the bivalve itself and the conditions under which it is cultured are still not available.

The succeeding discussions represent the findings based on one-year observation of various methods of mussel culture. The settlement relationship in these methods, the indigenous population existing in areas outside Sapian Bay, farm operations, production potentials, and general notes on aspects affecting or related to green mussel culture after tahong farming was introduced in the Province of Capiz.

Sapian, Capiz, has proven its ability to support intensive shallow water mussel culture. There are other areas in Capiz exhibiting natural populations that may be feasible for culturing practices after performing the chronological development procedures already experienced by the Sapian region.

DEVELOPMENTAL HISTORY

Before culturing practices for mussels became known in Capiz, Bacoor Bay, Cavite was the only place actively practising mussel culture. For years, mussel populations in Capiz existed on whatever substrate was available in suitable areas, these often being man-made fishtraps (salurans) and the like. The local fishermen gathered the mussels for local consumption. But "tahong", was an unknown word

throughout most of the province. Barely three years ago did recognition of these prolific shells occur.

The first pilot farm was erected by the municipality of Sapian and the provincial development staff of Capiz, using a new rope method introduced by Mr. Bruce French in Sapian River in September 1974. After its initial success, the municipality began outlining the procedures as a potential sea-farming industry and imposing the first conservation measures (some still pending approval of the Department of Natural Resources). It was in October 1975 that the author was assigned in a pilot program in shellfish extension of the Bureau of Fisheries and Aquatic Resources (BFAR) for the province of Capiz.

In November-December 1975, F.J. Elizalde erected the first privately-owned mussel farm, occupying one hectare (50m x 200m) and using the new rope method. This project became a major observation site for the results mentioned in the text. F.J. Elizalde also performed a market survey using stock from the original municipality project, making a sizable profit for the municipality.

The Bureau of Lands surveyed the main Sapian River area for the availability of small farms, leaving all areas north of the municipality project for large-scale farms (Map 2). A total of 162 small farms, 250 sq m (25m x 10m) each were marked out. The Development Bank of the Philippines (DBP) approved a loan profile for these lots, using either the rope or the bamboo method. However, most fishermen chose the bamboo method for reasons described in the text. It was advised that only 20-30 farms be erected at first until a stable breeding population is established, but unfortunately with the popularity of mussels, the number of farms increased to nearly 80. It is hoped there will be enough spatting in the forth-coming months to make their efforts worthwhile.

In the effort to identify other existing culturable population, pilot projects were set through the assistance of the municipality of Roxas City (Map 3), as well as periodic surveys of man-made structures in the various areas of Capiz. The Southeast Asian Fisheries Development Center (SEAFDEC) is currently engaged in reproductive studies of these mussels and is maintaining two raft structures near the Sapian municipality project. They are also experimenting with new clutch materials hanging from the raft structure. The Department of Natural Resources (DNR) set up an experimental farm in Tinagongdagat Bay near Bo. Bandan, Pres. Roxas. Unfortunately, the results of the experiment in this area were not very encouraging.

DESCRIPTION OF AREAS

Maps 1-a and 1-b indicate those areas in Capiz supporting indigenous population on salurans (fishtraps) or pilot projects indicate stable populations as discussed later.

Sapian River region (Map 2) exhibits comparatively the highest degree of prolificacy. The area of culture is limited to the main channel, as over one-half of the river (northwest bank) is exposed at low tide, composed mostly of sand. The main channel ranges from one foot to 15 feet deep at low tide, the bottom composed of soft black mud mixed with sand. The salinity is generally high most of the year, as there are few freshwater sources. Occasionally though, the salinity will drop to 1.5-1.8% during heavy rains. Temperature normally ranges from 28-31°C. The culture area extends just past the mouth of the river, populations thinning out markedly after a certain point. There are isolated populations in Basiao.

Ayagao Bay is very similar to Sapian, except for a larger freshwater source. This area resembles a bay, but most of the water area disappears at low tide, leaving only a main channel similar to Sapian. It may be a reason for the isolation of dense populations of mussels in the upper section of the bay. The indications are very favorable for culture, but existing populations are fewer compared to Sapian.

Pilot projects were erected in several areas in the Capiz Bay areas (Map 3). These projects were to test the settlement of mussels within the areas indicated with periodic surveys of settlement on fishtraps in most river areas of Capiz. Of the areas that gave evidence of mussel populations, the settlement was usually just inside river mouths, the sediment composed of soft mud mixed with sand characteristic of main channels, with a restricted freshwater source.

Panay River has several outlets to the sea; one in Barra, Roxas City; one in Punta Cagon, Roxas City with tributaries serving numerous tidal estuaries and fishponds; and another in Pontevedra River that receives most of the inland freshwater. This latter outlet is subject to freshwater flooding during heavy rains, a fate Barra and Punta Cagon do not experience.

Tinagongdagat Bay supports a small population despite its great freshwater influx. A recent harvest figure from the DNR experimental one-hectare farm showed a total of about 2½ mt after one year.

It was reported that occasional flooding from Pontevedra River after heavy rains kills even the oyster populations.

There is practically no industrial development in Capiz, except for two sugar centrals. The only pollutant is the widespread use of toxic pesticides and poisons in fishponds and ricefields near the rivers. In some areas, there is an occasional danger period for cholera during dry months, but such is rarely considered a problem in the Sapian Region.

THE CULTURE METHODS

Use of Rope as Clutch

The technique of mussel culture first introduced to Sapian made use of one-half inch blue polypropylene rope, constructed to form a unit composed of about 40 m of rope (Figure A). This unit was suspended between two vertical bamboo poles spaced three meters apart parallel to the current, two meters deep below spring low tide (French, 1975). Both the municipality of Sapian and F.J. Elizalde used this method.

When the farms were completed, the appearance of mussel spat first became apparent on the bamboo poles (see Bamboo as Clutch). Those ropes that were filled with mussels, were usually those closest or inside the mainstream of the river where it was deepest and where currents were fastest. Only after these poles and ropes were filled, did spatting occur in significant quantities to those units close to shore. Even so, the shoreline units generally produced less, some remaining empty or exhibiting sporadic clumps.

In comparison, the same polypropylene rope three to four meters long, hung from the caretakers raft and weighed bi-weekly. These singular raft ropes were disappointing, the best having sporadic clumps if any at all. Abaca rope was also used, but it deteriorated rapidly.

Production on those units that did fill completely had a remarkable average of 200 kg/unit, some had even more. Those that did not produce as well ranged from 50-150 kilos per unit (see Table 2). The raft ropes only had 10-15 kilos at the most, many had much less.

After the ropes were cleaned and dried, they were placed back in the water for the next crop.

DISCUSSION

At this point, there may be a question as to the preference of blue polypropylene as a clutch type. According to Tortell (1975), similar mussel species was spatted according to the type and colors of rope used. It was shown that mussels preferred a dark substrate as compared to light. It was observed that the first appearance of spat on the F.J. Elizalde Farm occurred on the black painted barrels supporting the raft. Lutz (1974) stated that the more "hairy or flexible" the rope, the more suitable it is as a clutch.

Unfortunately, the polypropylene in use was light blue and rather stiff. Tortell suggested the use of a filibrated black polypropylene or similar polymer, as it offered these preferable characteristics, but these materials were unavailable locally. One-inch thick coir rope was successful in Europe, but longevity cannot compare with polymer ropes, which is an important consideration for commercial feasibility. We noticed though, after harvesting the first crop from the units, the now used ropes definitely showed a marked improvement in being "hairy", as well as being more flexible. It is our hope that perhaps these seasoned units would be more suitable for spat collection when dried and reused.

The location of the ropes seemed significant. The heavy yields in those areas of the mainstream would seem to indicate the over-abundance of larvae seeking settling sites within this area. Although the larvae were capable of mobility, being planktonic, they were still directly influenced by current patterns. They were a gregarious species. The author's observations showed a definite settling attraction to substrates already exhibiting clusters of previously-settled mussels. Low production on the singular raft ropes might be due to its isolated position, as compared to the greater surface areas of close-quartered units and poles.

Not to be taken lightly, the use of rope units did facilitate easy harvesting, as the units were easily removed from the supporting poles and taken to a better place for removal and packing.

CONCLUSION

Despite the problems of polypropylene, as discussed, the production figures still deem it feasible for large-scale farms. No doubt, other polymer types mentioned and a darker color may improve the

potentials, but their unavailability at this time rendered them ineffectual. Considering the cost of polypropylene and the problems encountered, it should not be used for small farms unless these farms are located in the ideal places mentioned and the farms operate for long periods that they take advantage of the longevity of polypropylene.

Bamboo as Clutch

Bamboo has been used for decades in local fishtraps and other apparatus. It was on these poles that populations of mussels existed in a great majority. Bamboo was used as a structural component for the rope method described, as well as a clutch type itself.

A modified bamboo method for small farms is in use now in lieu of the expensive rope method. The method basically consists of vertical bamboo poles spaced one meter apart with four horizontal cross-pieces set below low tide, tied at 50-centimeter intervals, all parallel to the current. This method was made to fit the DBP loan profile for the "250-square-meter" lots available (Figures A, B, and C).

Bamboo poles were usually the first item to collect natural mussel spat after conditioning. This generally entailed the growing of barnacles on the pole before the settling of spat. The entire pole would usually be covered with mussels below spring low tide, and about one foot above this level. All bamboo poles that were set in the farms produced the same quantities of mussels per unit area (depending on depth) with only slight variation. That is, those in the mainstream of the river produced just as well as those near the shore. Production decreased only on a few horizontal poles set just below spring low tide due to the settling of oysters. The growth of mussels was also considerable underneath the caretakers raft which was made of bamboo.

Production figures were very stable from one pole to another, generally about 50 kg per three to four meters. Harvesting bamboo poles was by no means as easy as ropes, the mussels had to be removed underwater by divers and placed in baskets. Once the pole was cleaned of mussels and the pole surface was smooth, most of the barnacles that initially grew on it would be killed because of the increased growth of mussels. The estimated life of a good bamboo pole (first and second class) is about one to one and a half years.

DISCUSSION

The presence of barnacles on bamboo seems to be critical, as mussels rarely attach without them. This was cited by French (1975) as the need for "rough surfaces" by the settling spat. This is further supported by the absence of barnacles after harvest. Again, there may be a color or shading relationship involved, as a barnacle-encrusted pole appears dark grey. This should not be interpreted as a direct attraction relationship of mussels to barnacles, due to successful spatfall on ropes, rocks, and other substrates in the absence of barnacles.

The disadvantage of using bamboo poles compared to ropes is the difficulty of harvesting poles. Divers must be employed for underwater work, and this requires more time and extra labor to obtain the same quantities grown on ropes. But for small farms, as in the 250 sqm lots mentioned, this should not pose a problem.

CONCLUSIONS

Bamboo poles offer a more stable producing clutch type in all culturable areas, compared to ropes which are sometimes undependable, (it is not advisable to use rope in a small lot positioned near the shoreline). Moreover, bamboo is a commodity which fishermen operating small farms are familiar with. For those people needing financial assistance, bamboo offers the cheapest and most dependable clutch available. However, it is not recommended for large farms (say one-half to one hectare) to use bamboo exclusively, as the number of poles required and the cost of labor to maintain, harvest, and replace poles will be phenomenal.

Other Methods and Clutch Types

Generally speaking, mussels will attach to just about anything: coconut husks, shells, metal frames, and rocks, to mention a few. Culture methods are devised to attain maximum production per unit area without creating adverse conditions affecting the culture area. Ryther and Bardach (1972) described several rack and raft methods possible for mussel culture.

Floating rafts make use of single suspended ropes ranging from two to four m deep. Sometimes, other clutch types (as above) are added to increase the surface area. It was observed, however, that there is some doubt as to the efficiency to attract natural spat, with or without added clutch varieties. With ropes holding shells, husks, and rocks, the mussels clamp to these clutch types, rarely in between. Here, production per unit area in raft culture has yet to compare with those methods being used at present. Experimentation is still in progress and the feasibility of raft culture has yet to be fully determined.

An advantage of floating rafts rests in its structural efficiency. One of the major problems of pole or pole/rope culture is the damage caused annually by currents and other factors (see Special Problems) There is also an indication of excessive build up of pseudofeces and silt around the bamboo structures. Raft culture does not experience these problems. Rafts may also provide an easy means for transplanting to other areas (see Transplanting).

Special Problems

Although bamboo poles are expected to last at least a year, structural damage often occurs when the currents are running strong. It is assumed that some poles will be weaker than others, deteriorating more rapidly. In the large farms using the rope method, holes are punched in the hollow sections of each bamboo pole to reduce bouyancy and facilitate easy setting. There is a type of crab that uses these holes as a refuge. As the crab grows, the holes become large. This, along with the natural deterioration of the pole inside and outside, causes weak points in almost all areas of the project. When one pole breaks, the others in the row lean and sometimes the caving in of entire sections occurs, causing the loss of mussels which are buried in the soft mud. So, this practice has proved to be ineffective, thus should be avoided.

The procedure before with the rope method is the supporting of the vertical poles (each three meters apart) with perpendicular and horizontal braces above the high tide level every fifth pole across the entire width of the farm, each row supported by the other. Because of the wide spacing between poles (three meters) in the rope method, there are not enough braces to effectively reduce the stress during fast currents. Therefore, it is suggested that these bracings be increased to every other vertical pole, at least in the sections nearest the mainstream. The use of good quality bamboo (first and second class) for vertical poles will also reduce the stress factor. The modified bamboo method should not be a problem, as the vertical poles are spaced closer together (one meter) with the added support of the four horizontal crosspieces.

Because of the great quantities of pseudofeces produced by the mussels, there is a "sand dune effect" of sorts building up mounds under the rope units and around the bases of poles. It is not uncommon to see those mussels growing near the bottom just to be buried later on as the "dunes" build up. Just how much or how far these mounds are built up is not known, but this build-up does not happen in all areas of the farms. As it appears, the dunes may shift from one section to another. Our main concern here is the bamboo pole method with its closely spaced poles. Although these farms are constructed to go with the current to reduce resistance, the strong currents may create eddies between farm rows. This will bear careful observation, lest we create islands or silt bars.

HARVESTING AND PACKING

According to French (1975), two harvests per year were the original estimate, based on the peak spawning seasons in February-March, and September (see Spawning). The marketable sizes were based on a minimum of five-month-old mussels ranging from six to seven centimeters or sometimes larger. The F.J. Elizalde Farm started in the first week of January 1976, and was expecting to harvest the following June. Unfortunately, due to the varied sizes gathered as a result of continual settlement and late spatting (Table 1), harvesting had to wait until August and September when the smaller mussels would be large enough to be marketably acceptable. Sorting was attempted and a special submersable raft was constructed as a holding structure in which the smaller mussels were placed to grow longer. The mussels had to be consistently larger, since sorting operation was laborious and time-consuming. Harvesting season in a large farm from September to November, for example, would not be completed, so one harvest per year now seems more feasible. However, two harvests or crops per year for small farms seem impossible if the farms were constructed in time to catch the peak seasons, and are able to harvest and market in time for the next season. This depends on the marketing situation, as successful farming does not always guarantee successful marketing. In this type of culturing enterprise, if the market is unacceptable at the time of scheduled harvest, unlike fishponds, there is a need to wait until things improve.

Packing mussels for shipment to various markets must be done to keep the mussels cool and moist at all times. If the harvested mussels are exposed to any form of heat, deaths occur in a very short time. If these conditions are met, the mussels should live for 30 hours or so out of water with little mortality rate. Any container may be used for shipping mussels, but the most economical is the sack (feeds sacks, sugar sacks, etc.).

When harvesting from ropes or poles, it is easiest to use floating rafts since they can be constructed to fit in-between the rows. The conventional rafts used in Sapian are made of closely-tied bamboo poles about nine meters long, with a flooring of bamboo slats (Figure D). Harvesting during a cool day is advisable, but not always possible. After harvest, the mussels are not always packed or transported immediately. In these cases, the same harvest raft can be submerged by placing rocks, water filled barrels, or similar heavy objects to create an improvised "holding raft," leaving the harvested mussels underwater where they will live indefinitely until needed. (Note: the more bamboo poles used to make the raft, the harder it is to sink the raft to the desired depth). An added advantage of packing mussels in sacks is the ability of packed sacks to make use of the submersed rack until ready to ship.

When transporting on land, the use of tarpaulins or tent-like structures is suggested to avoid sun exposure. An occasional splashing of sea water on the sacks helps keep them moist, thus cools them. Use of styrofoam containers may be better for excessive overland transportation, but this will increase the weight when transporting by air. The use of ice or refrigeration is detrimental since it causes deaths.

SPAWNING AND SETTLEMENT

Stable populations are those areas that indicate strong settlement of mussels within a defined water area at least twice a year. As mentioned previously, the variation of sizes harvested from bamboo poles means that constant spawning occurs throughout the year in the Sapian Region, with peak settlements in February and March. Those small farms constructed last June and July exhibited substantial settlement on bamboo poles in August and early September, while those farms erected in late August have yet to see any.

The results of the pilot projects located in Panay and Talon Rivers, and Ayagao and Pilar Bays differed from those of Sapian. A survey of these areas in late March showed a more consistent size variety indicating a heavy settlement during December and January. A recent survey of the same areas (September) supported settlement in Panay River near Barra and Ayagao in early August. The Talon River project failed to produce at all.

A survey of bamboo poles in the open bay regions outside Bo. Barra, Ayagao Point, and Pilar last November 1975 showed a rather large number of mussels (which were harvested by the local fishermen shortly after). Two pilot projects were erected in an open bay region near Barra and Culasi Port (Culasi was destroyed), but they failed to attract any settlement.

In all areas surveyed, the majority of settlement occurred inside tidal rivers or river mouths not subject to heavy influxes of freshwater. Rarely did the population extend to open bays.

DISCUSSION

Our observations basically coincide with the original survey performed by B.J. French. Even though there exists constant spawning, there is enough evidence to show there are definite peak seasons in March and September. This, of course, pertains only to the Sapian Region.

It is obvious the spawning patterns vary among localities, as each area is subject to different environmental conditions. According to Lutz (1974) on *Mytlus edulis*, the peaks in spawning are not always followed by peaks in settlement, the latter being largely a function of larval survival and the presence of suitable substrates as well as successful fertilization. This would certainly help account for the differences in settlement observed in the other areas mentioned. The position and number of viable breeders may also play a key role.

It is not unusual to occasionally spot mussel growth on bamboos in open bay areas that normally do not support stable populations, as the metamorphozing larvae that are ready to settle are often subject to the strong currents. But it stands to reason that with the influences capable of affecting population dispersion if such areas were generally suitable for mussel growth, constant populations would be present, as these open areas have a large variety of suitable substrates. The

presence of stable populations in Panay River near Barra may seem extraordinary considering its freshwater sources. Panay River, though, is unusual in itself, as described earlier.

After a one-year attempt to culture mussels in Tinagongdagat Inlet near Bo. Pandan, Pres. Roxas, the DNR project reported only 2½ metric tons of total harvest using intensive bamboo culture. Pontevedra River may very well be the cause. The pilot project erected in Bo. Butacal, Panay, which is nearer to the sea, indicated a greater settling density. These production figures of the DNR project may not be conducive to commercial feasibility. Moreover, they show that not all areas will support a culture endeavor, although a small number of mussels exist.

The survey, so far, shows that only Ayagao Bay and possibly the Panay River sites near Barra are attracting strong settlements twice a year. The other areas have shown strong settlements at least once a year. However, one year is not enough to accurately assess the commercial feasibility of these areas, as the small pilot projects do not assure accurate statistics on mussel settlement, considering the many variables that affect the presence of mussels. Periodic monitoring of fishtraps is not always dependable since the local fishermen always harvest in great amount. Besides natural factors, overharvesting pressure may cause inefficient spawning and sporadic settlement.

Some basic information regarding spawning habits of mussels are still unavailable. The SEAFDEC is still studying mussel reproduction.

BREEDING POPULATIONS

The success of mussel populations depends on the number and condition of breeders that produce viable larvae. This study shows that existing populations are/or will be endangered by the constant pressure of the non-selective gathering by the local inhabitants. For example, there is a strong evidence on the claim that mussel populations inside the Ayagao Bay area have been steadily declining. Even the Sapian area, with its intensive culturing practices and conservation awareness, still sees an unrelenting gathering of mussels due to their recent popularity.

To aid in building up a breeding stock, it is suggested (required by the municipality of Sapian for those culturing in their area) that at least 5-10% of cultural mussels be reserved for breeders, or stocks be built in suitable areas. These mussels will be allowed to mature for reproduction. It is assumed that the larger the animal, the greater the quantity produced. However, it is also reasonable to assume the occurrence of menopause when the mussels reach a certain age or size. Periodic gonadal studies of the breeding stocks will determine their usefulness as breeders before the need to replace them with a fresher stock arises.

The projects in Sapian generally using bamboo poles were originally settled. For those using polypropylene ropes, leaving a few rope units unharvested would certainly last. But as the mussels get larger, the small surface area of the rope loses its efficiency, and the mussels often drop or slide off. Use of pegs may alleviate this problem, but the units have to be transferred to newer supporting poles periodically. The poles may be broken and the mussels may be buried in the mud because bamboos are weak to hold the heavy mussels. France makes use of the "bouchet method," in which mussels are wrapped around a pole with a net until they are reattached to the pole (Ryther and Bardach, 1972). Betel nut poles (bunga) will last longer, but their use is time-consuming and involves extra capital for netting, especially when working with large quantities.

A less costly but more permanent breeder structure is a type of submerged racks made of betel nut poles. These racks are filled with mussels on both sides, placed just off the mud bottom by .5-1 m (Figure E), and constructed in such a manner that they fit in-between rows of the farm. Each rack should be well marked and never placed where it will be a hazard to boats.

TRANSPLANTING

Transplanting may be interpreted in two ways: 1) the transfer of viable breeder stocks to an area in order to produce the settlement of a natural population; or 2) the transfer of small mussels to the so-called "fattening waters" to reach the marketable size, so as to make maximum use of the limited settling areas. The second proves more feasible.

Last December, about 200 kg of eight-month-old mussels were transplanted in an open bay near Padre Burgos, Quezon Province. According to Dr. Dodi Carlos of the Luzonian Marine Biological Station, occasional gonad studies showed negative development of sex products,

although general growth was remarkably good. This fact may not yet be concluded since there may be an adjustment period and/or lack of environmental stimuli. In addition, the studies are still continuing. The author believes that transplanting to areas not indigenous to these mussels for the purpose of introducing them as a natural population would seem entirely unfeasible at this time. There were no data regarding such ventures. The quantities needed for successful spawning, if spawning occurred at all, and many of the factors affecting successful settlement to the desired area were virtually unknown. This would be an interesting research project, but for commercial purposes, attention was focused on those areas supporting natural populations.

Transfering small mussels to wide-open bay areas may very well improve the production potentials of the limited settling area. When the clutch unit filled with mussels is removed, the settling area becomes an available space that can be utilized several times a year as settling continues. Floating rafts supply the easiest means of transfer, as the structures are easily maneuvered. The Bouchet Method described earlier is popular in Europe, but involves a lot of labor, and is costly. Ropes facilitate easy transfer if originally settled upon. However, when filled ropes are jostled excessively, mussels have the tendency to drop. Use of pegs may help. Guards may be hired to avoid this. These people may look after the strength of the structures that hold the mussels in place.

REPLACING BAMBOO POLES

Bamboo poles are most often very deeply embedded in the soft mud, and because they become obsolete after harvest, they must be removed. In the past, this practice was not given concern since this job was extremely difficult, so the poles were just left where they were. But with the great number of bamboo poles now present in Sapian, a method must be devised to efficiently remove them.

It is suggested that the poles be cut at the mud level, but the stumps still remain, and the procedure seems laborious. There is a need for a crane and barge since this machine would always be in demand for many jobs like levelling fishponds and other construction purposes. However, this would mean large capital. A temporary solution therefore may be the hiring of large boats, like trawlers which are fitted with cranes. But still these boats may not be advantageous for they operate only at high tides because of shallow waters, so the fees may be very high.

It is suggested that a prototype for an improvised crane be used. This consists of block and tackle on a quadrapod, and rests on bamboo rafts made of at least 20-25 poles for stable bouyancy.

COMPETITIVE, FOULING AND COMMUNAL ORGANISMS

Barnacles cannot really be considered fouling organisms since their presence is beneficial to settling mussels on bamboo. Sponges are not a problem in Sapian, but are found on several of the pilot projects, notably Talon River and the open bay areas. Colonial hydroids are particularly a problem in all areas of Capiz, for mussels rarely attach to the surfaces they occupy although they do not harm those already attached.

In January and February, all the projects were virtually covered with an encrusting bryozoan. However, settlement or growth of mussels was unaffected for after two months they disappeared. Later, colonial tunicate followed and grew on mussels and structures in which remnants were still present. Seaweeds floating with the strong currents were constantly getting tangled in the structures.

Most competition for clutch surfaces (not regarded as fouling) were usually made by other bivalve mollusks. Several species of *Crassostrea* oysters (*iradalei, malabonesis, palmipes, amasa*) were generally found on all poles and ropes, and made up a considerable secondary product. *Pteria* and *Pinctada* species were also found in abundance, along with an occasional brown mussel (*Modiolus metcalfei*).

Both large and small mussel farms created an artificial reef of sorts, providing refuge for a wide variety of marine organisms. Fish were constantly grazing between the rows, and fishing became a profitable pastime for caretakers. Crustaceans were many, as amphipods, shrimps, crabs, and lobsters. There were few echinoderms, sometimes, the black spiny sea urchins were also found in areas near the bay. Species of *Meretrix* blood clams were commonly found in the soft mud near the projects, as well as the *Modiolus* brown mussels. Gastropods were also numerous. A great variety of other marine organisms were also present.

CONCLUSION

The potentials of mussel culture in Capiz are now more clearly defined, as much of the preliminary groundwork is already performed. It is our hope that the on-going research will supply some of the basic reproductive patterns, and an improved clutch unit capable of greater production and structural efficiency that can match the initial capital investment of those techniques being used at present. In the areas indicating natural populations, a chronological development strategy is needed to fully determine production potentials. This would probably ensure the establishment of a stable breeding population and conservation. Municipalities interested in mussel culture in their waters exhibiting mussels may wish to set up small farms (¼-½ hectare) in the same manner as Sapian had started.

Capiz is gifted in having extensive mussel populations in most river mouth areas, a factor Luzon does not seem to possess. It is believed that with the proper attitude and the culturing techniques available, Capiz can become the shellfish capital of the Philippines.

ACKNOWLEDGMENTS

The author wishes to thank the F.J. Elizalde Tahong Farm for its unselfish assistance in our efforts to study these mussels; Mayor Orillos and the municipality of Sapian for their concern of the ecology; the provincial development staff of Capiz; the municipality of Roxas City for the construction of the pilot projects; and all the people of the Province of Capiz who became involved in the industry itself.

LITERATURE CITED

BARDACH, JOHN E., JOHN H. RYTHER and WILLIAM O. MCLARNEY.
1972 Aquaculture — the farming and husbandry of fresh-water and marine organisms. N.Y., Wiley-Inter-Science.

FRENCH, BRUCE J.
1975 Tahong: An old shellfish with new potentials. (Rope method and feasibility study).

LUTZ, RICHARD A.
1972 Raft cultivation of mussels in Maine waters; its practicability, feasibility, and possible advantages. University of Maine at Orono.

TORTELL, PHILIP.
1975 An inquiry into the biology and farming of the mussels *Mytilus smaragdinus* and *Modiolus metcalfei* in the Philippines. (First Interim Report). SEAFDEC. Nov. 1975.

TABLE 1

Size Percentages Based on a Total Sample of 2,876 From One Bamboo Pole on July 7, 1976.*
(six months after first appearance of mussel spat)

7.0-8.0cm (January Settlement)	.2781%
6.5cm	2.0862%
6.0cm	8.9360%
5.5cm	17.6981%
5.0cm	26.9123%
4.5cm (March Settlement)	22.4269%
4.0cm	15.1947%
3.5cm	6.1543%
3.0-1.0cm	2.3991%

* from Sapian River

TABLE 2

Update of Costs, Production, and ROI

Cost of Materials (Capiz Province, 1976)

1) Bamboo *
   — first and second class poles: ₱8.00-10.00/pole (assume ₱10)
   — third and fourth class poles: ₱5.00-8.00/pole (assume ₱7)
2) Nylon Monofilament: ₱24.00-28.00/kilogram (all sizes)
3) Polypropylene Rope (½ inch diameter) **
   — approx. ₱400.00/roll of 175 meters
   — each 40 unit costs approx. ₱85.00-90.00 excluding labor (assume ₱90)

Production ***

1) Bamboo: averages 30-50 kilograms/3-4 meters of pole.
2) Rope:
   a) average low: 100 kg/40m unit (Average Mean of 50-150 kg recorded harvest)
   b) average high: 200 kg/40m unit (AM of 150-250 kg)

ROI per Unit

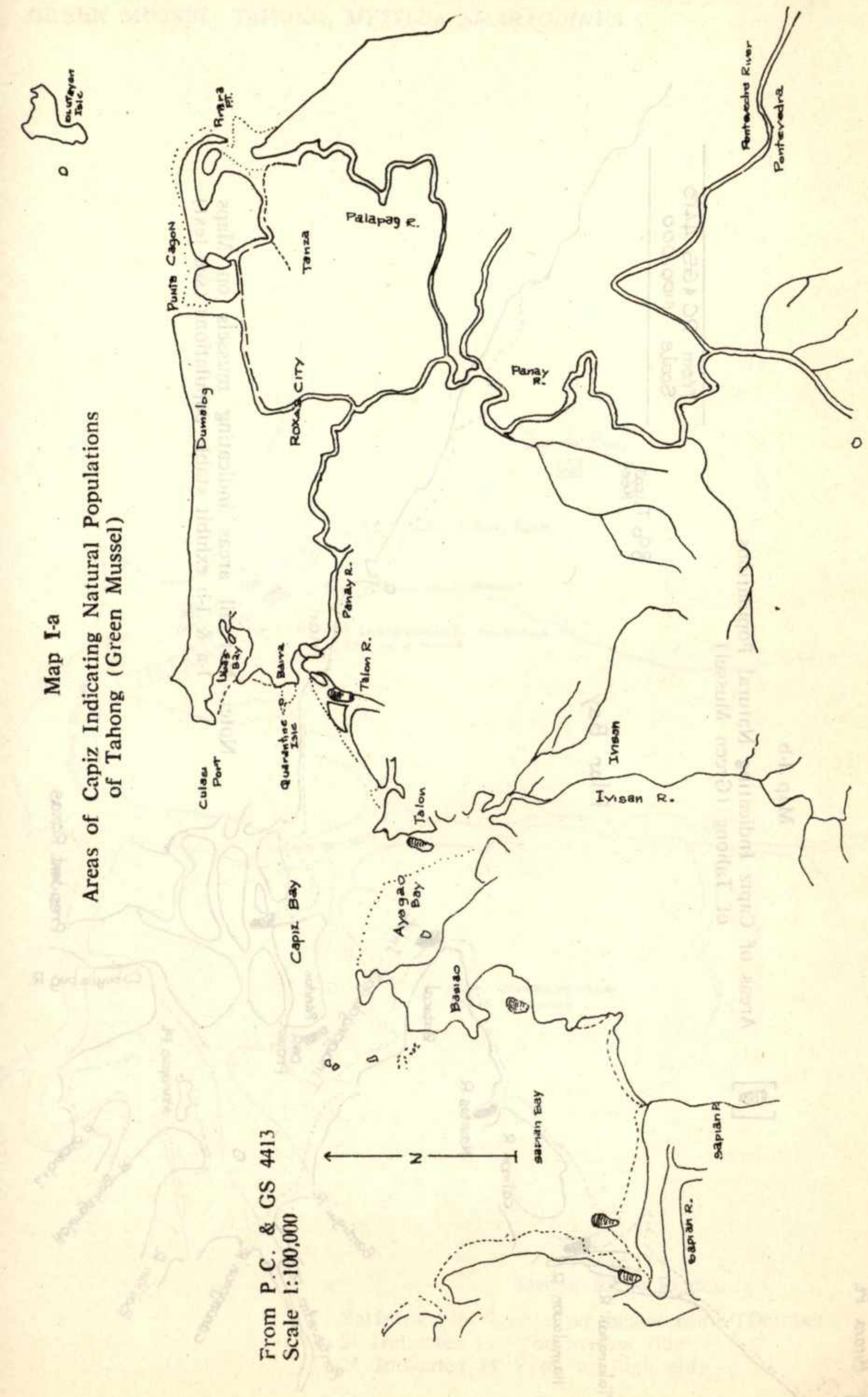
Gross Sales in Pesos (per kg)

	1.50	2.00	2.50	3.00	3.50	4.80	4.50
Bamboo Poles @ ₱10/pole	35-75	50-90	65-115	80-140	95-165	110-190	125-265
Bamboo Poles @ ₱7/pole	38-78	53-93	68-118	83-143	98-168	113-193	128-268
Rope (low) @ ₱90/unit	60	110	160	210	260	310	360
Rope (high) @ ₱90/unit	120	220	320	420	520	620	720

* Price depends on market locality and size of order. With the recent rise in demand, prices could continue to rise. Figures do not include transporting.

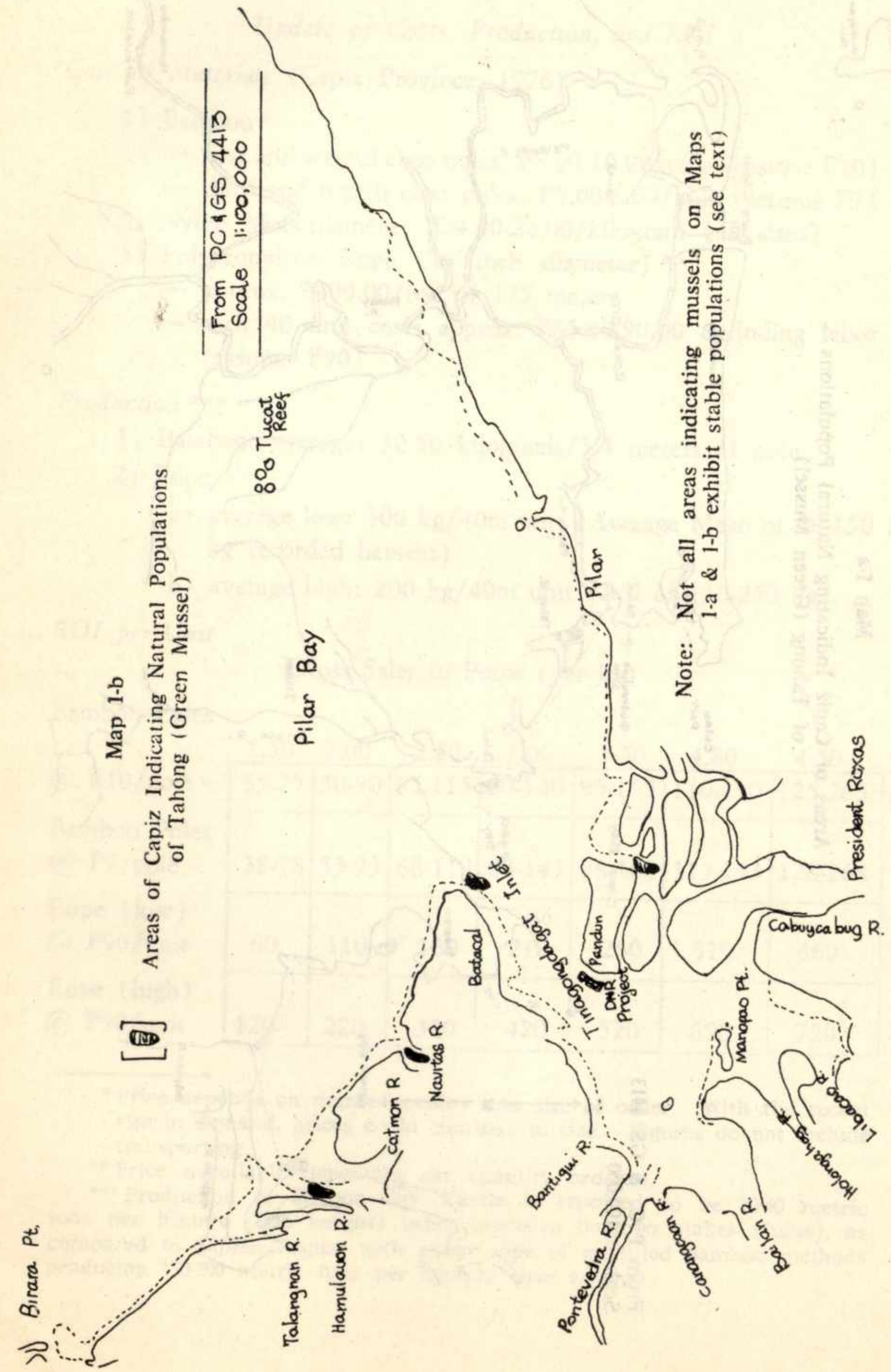
** Price negotiable depending on quantity ordered.

*** Production in Bacoor Bay, Cavite is reported to be 30-40 metric tons per hectare (live weight) using intensive bamboo stakes (tulus), as compared to Sapian Region with either rope of modified bamboo methods producing 150-200 metric tons per hectare (live weight).

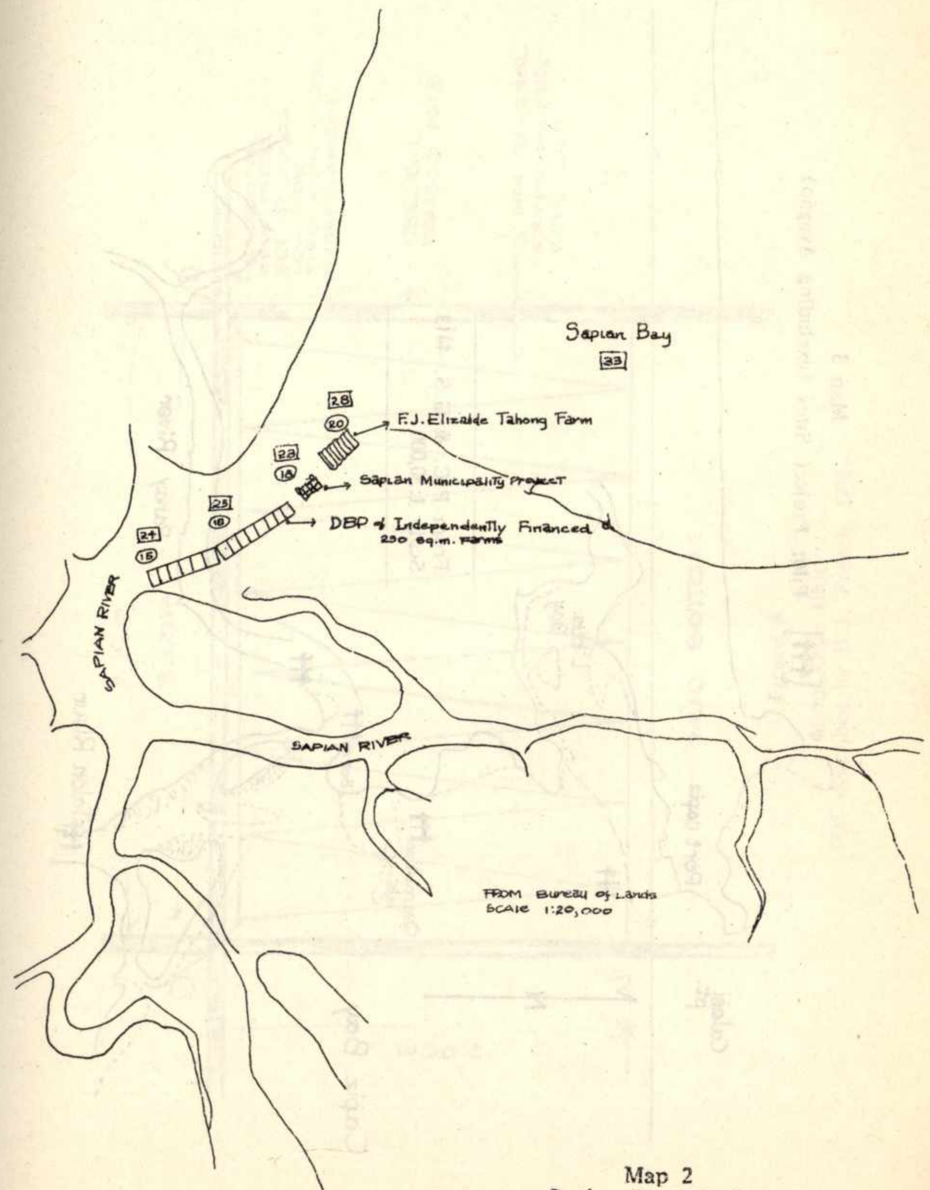


Map I-a
Areas of Capiz Indicating Natural Populations of Tahong (Green Mussel)

From P.C. & GS 4413
Scale 1:100,000

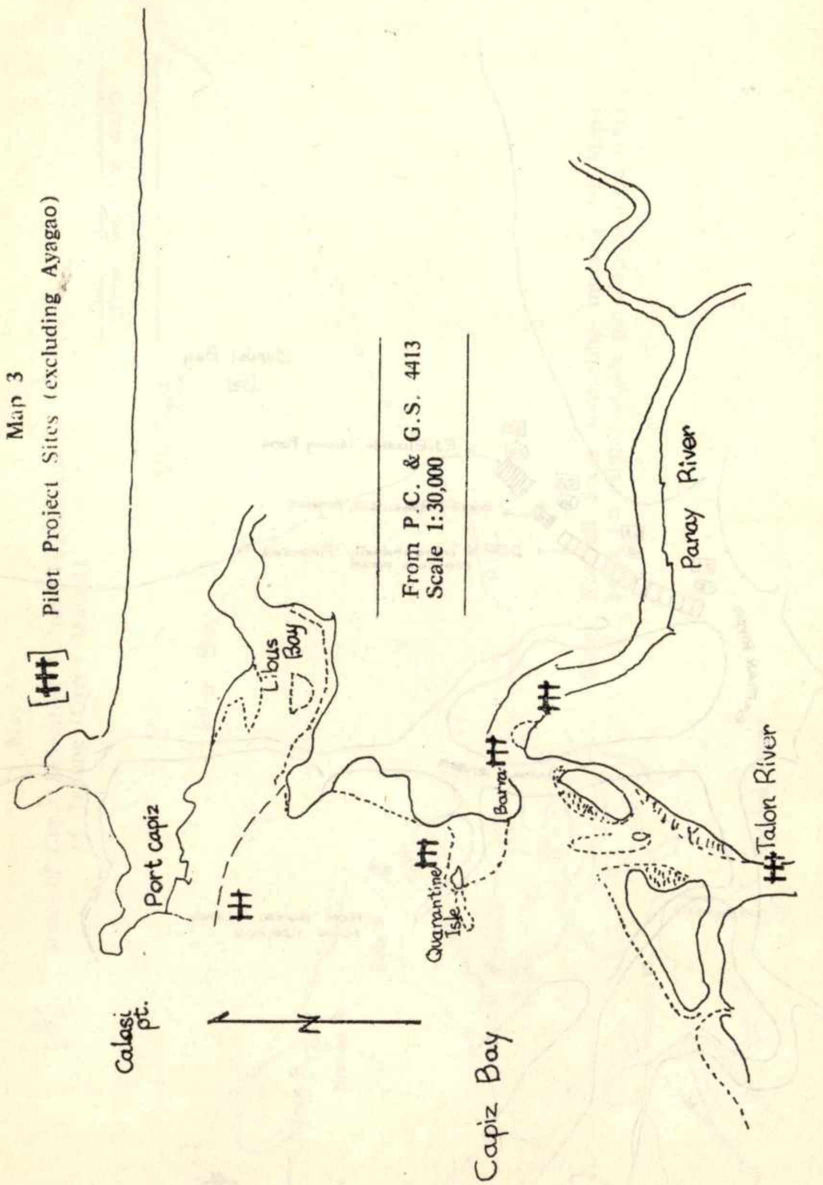


Map 1-b
Areas of Capiz Indicating Natural Populations of Tahong (Green Mussel)



Map 2
Sapian River Region

Salinities in °/oo after heavy rains (October)
15 Indicates 15 °/oo at low tide
24 Indicates 24 °/oo at high tide



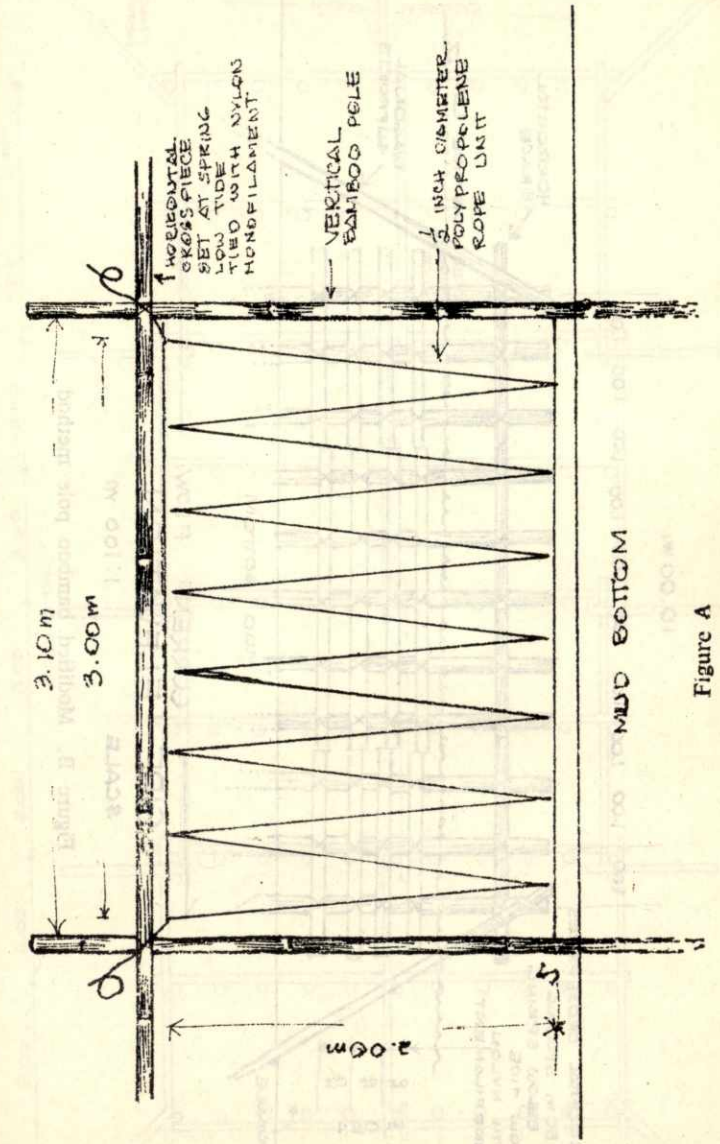


Figure A
40 m Rope Unit
(OS described by B.J. French, 1975)

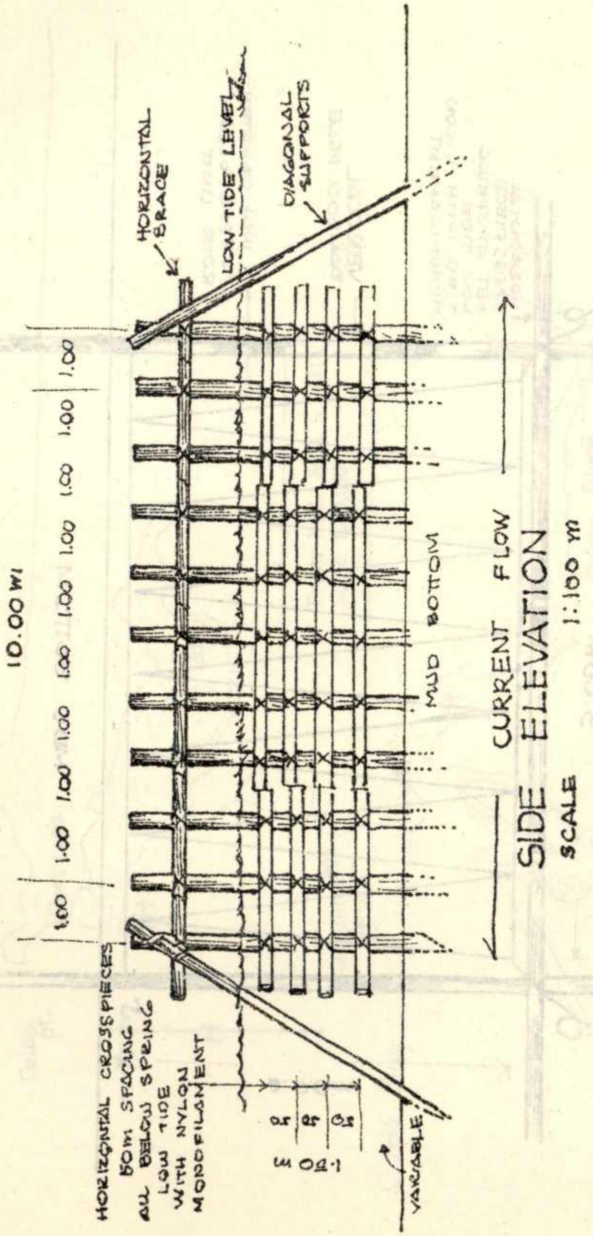


Figure B. Modified bamboo pole method

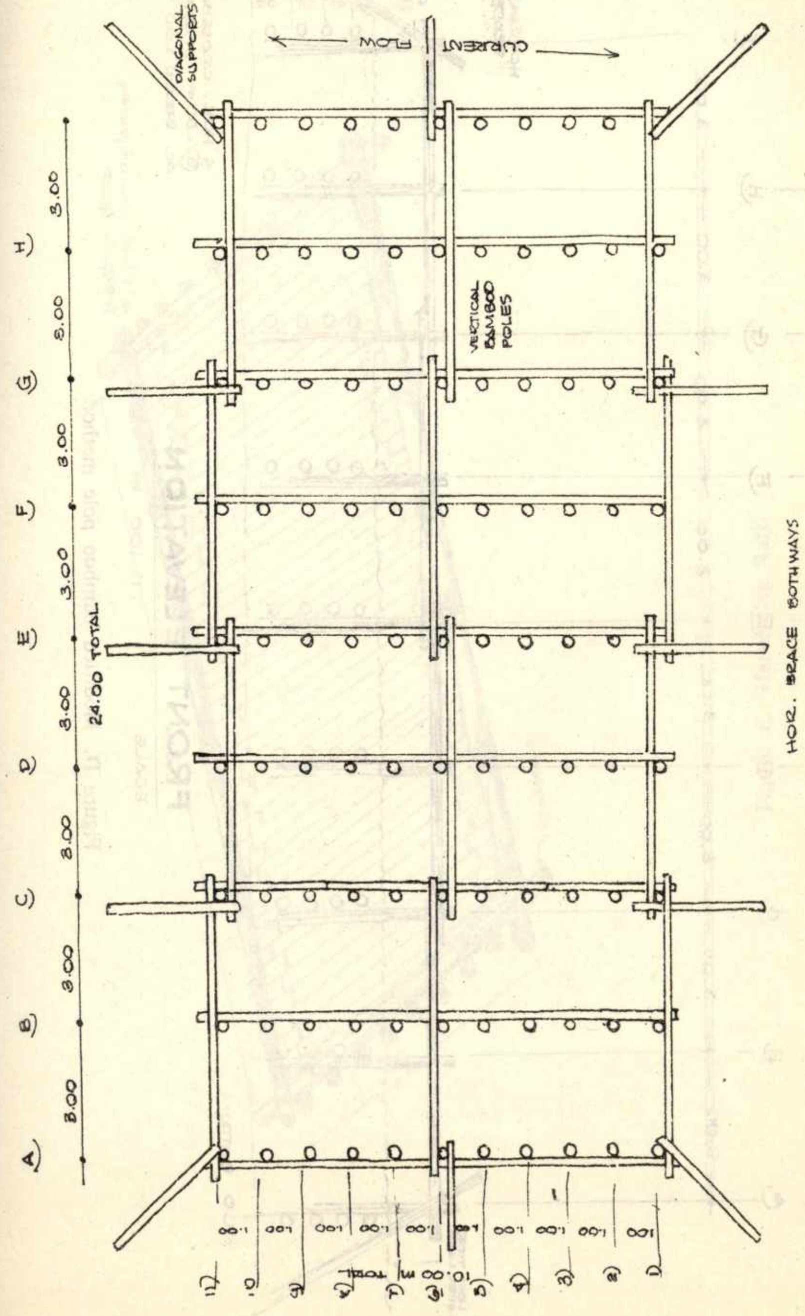


Figure C. Modified plan of a bamboo pole method

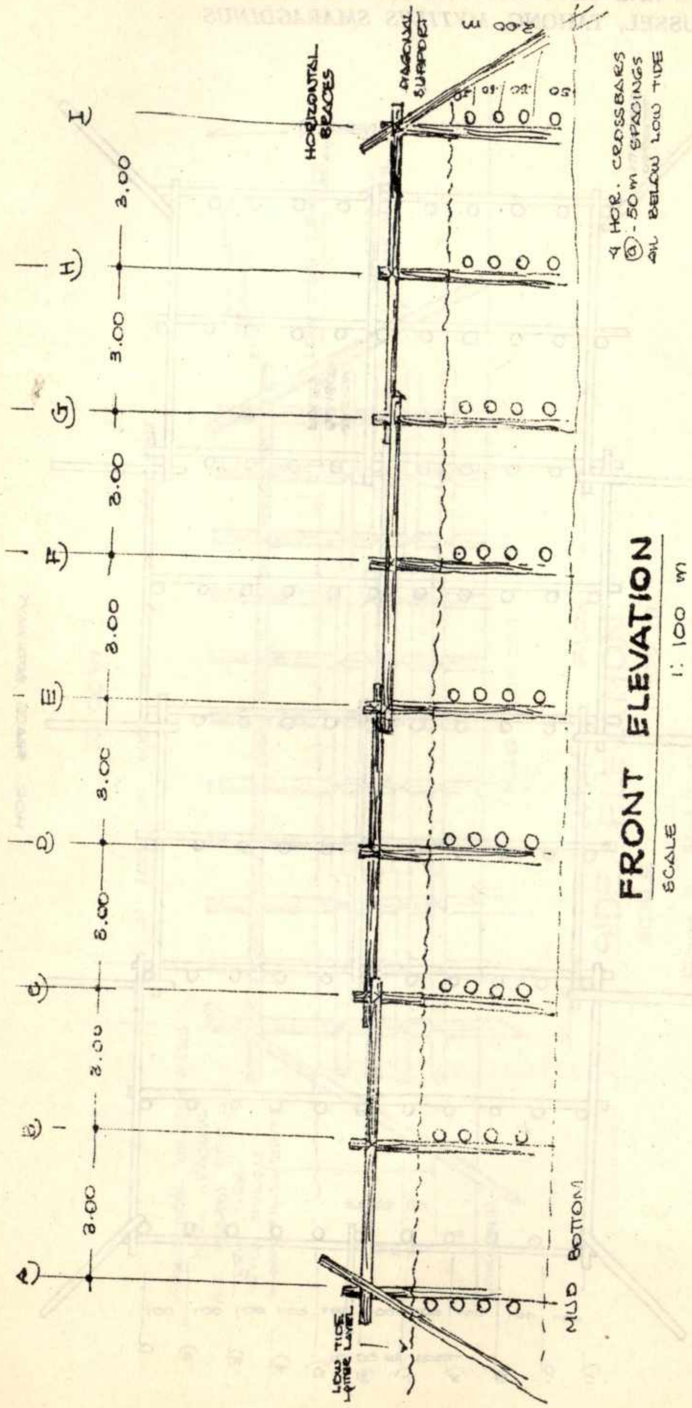


Figure D. Modified bamboo pole method

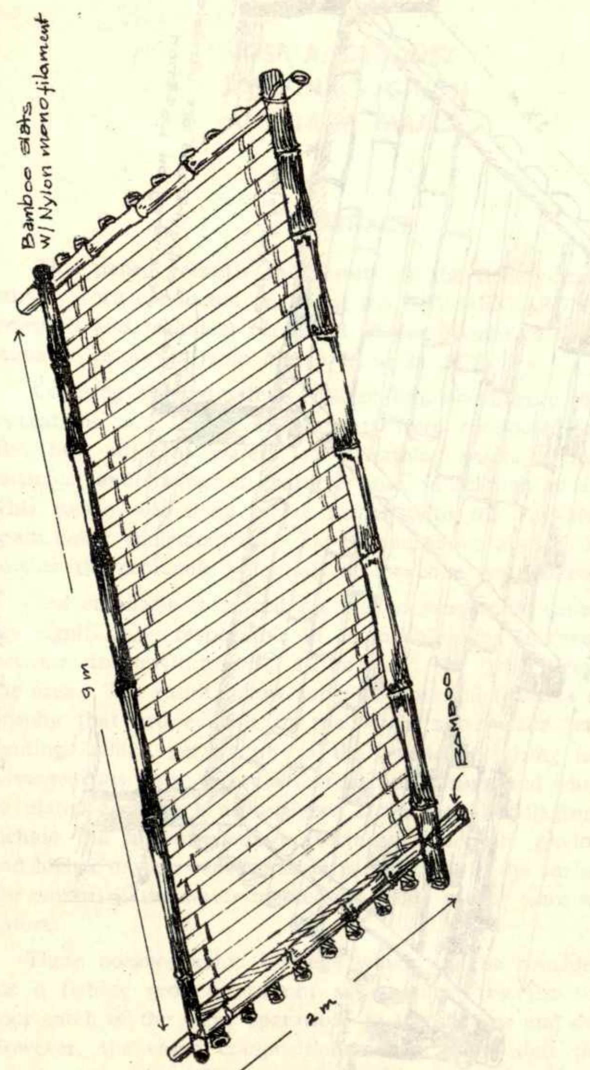


Figure E. Harvesting Raft

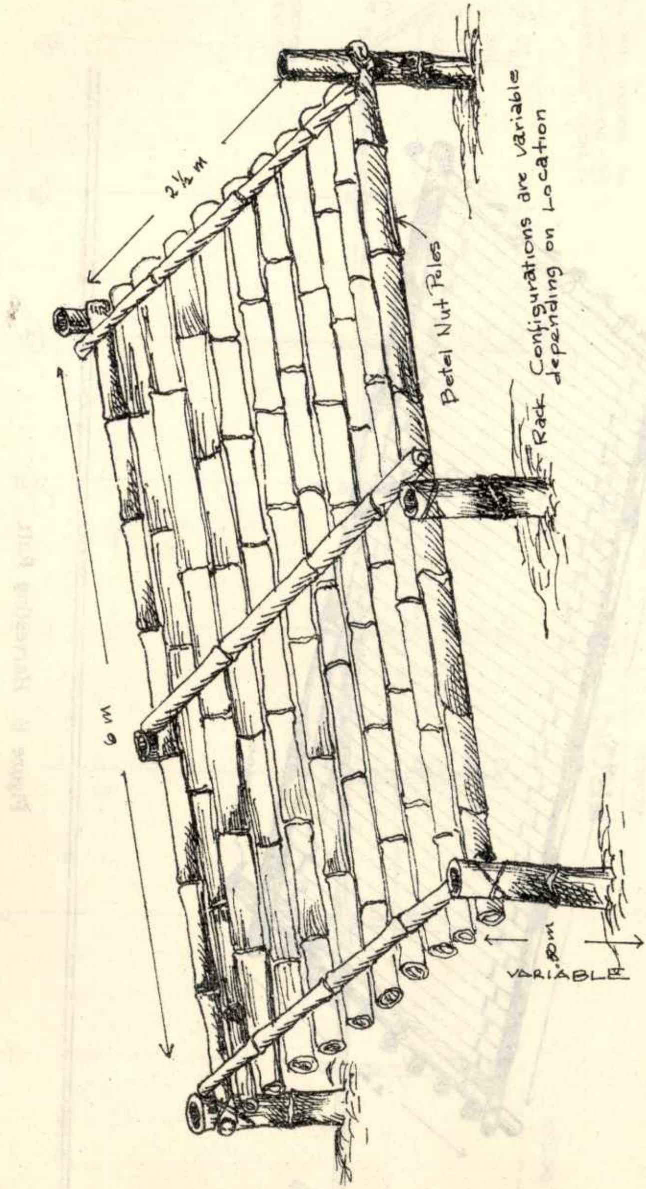


Figure F. Breeder Rack