(AF) 51—76

REPORT ON PREFEASIBILITY MARINE CULTURE SURVEY IN INDONESIA

April 1976

JAPAN INTERNATIONAL COOPERATION AGENCY

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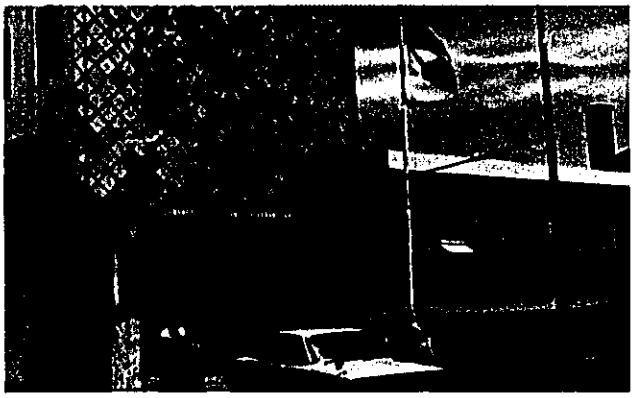
Pre-survey arrangements at Direktorat Jenderal Perikanan, Departemen Pertanian.



Lem. Penelitian Perikanan Laut (Marine Fisheries Research Institute), J1, Krapu 12, Jakarta-Kota, Jakarta.

Dinas Perikanan, Kabupaten Lampung.

Shellfish distribution survey on the west coast of Ratai bay at low tide.

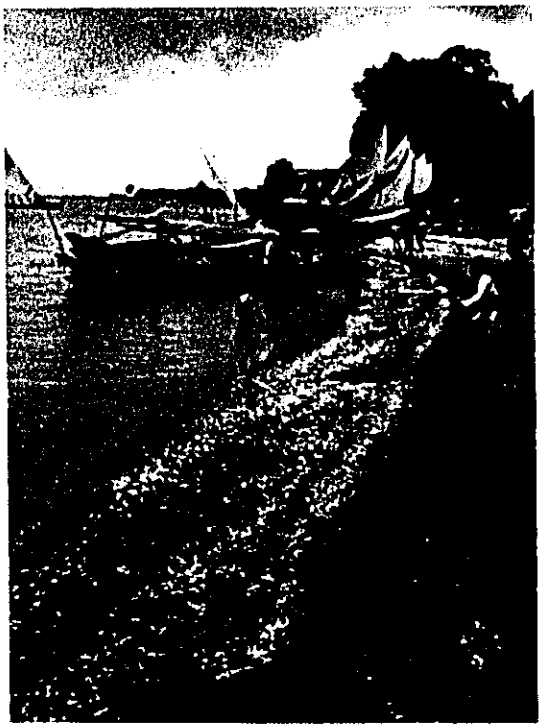
Fishing port at Telukbetung, Kabupaten Lampung.

Fish market at Telukbetung (1).

Fish market at Telukbetung (2).

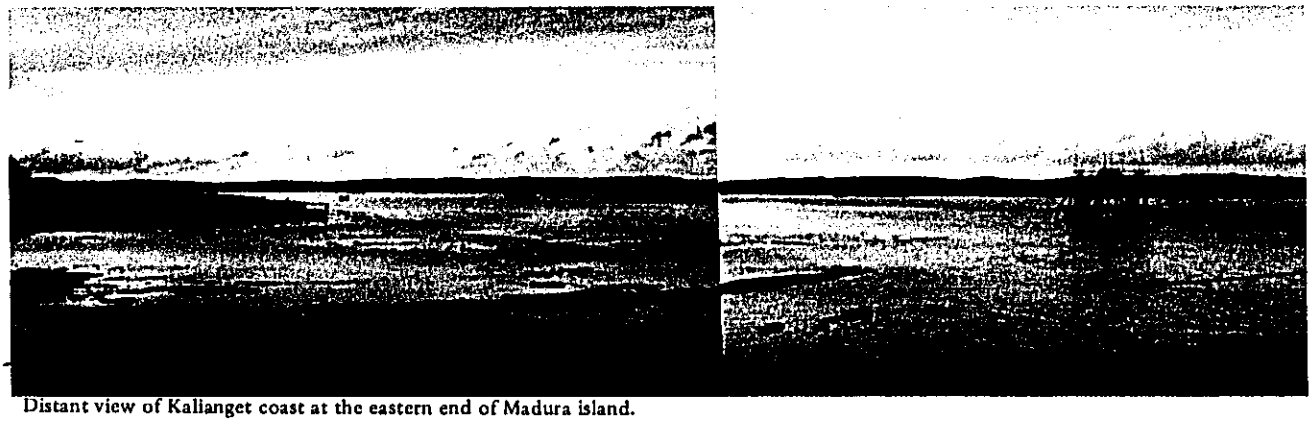
Bagan set in Lampung bay.

General view of Lampung bay (day and night); lights of Bagan lamps are seen in the night view.



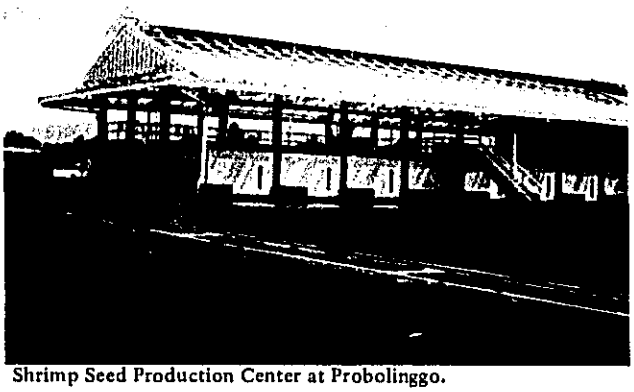
Beach in Kenjeran area; abundant shells are seen.

South coast of Madura island.



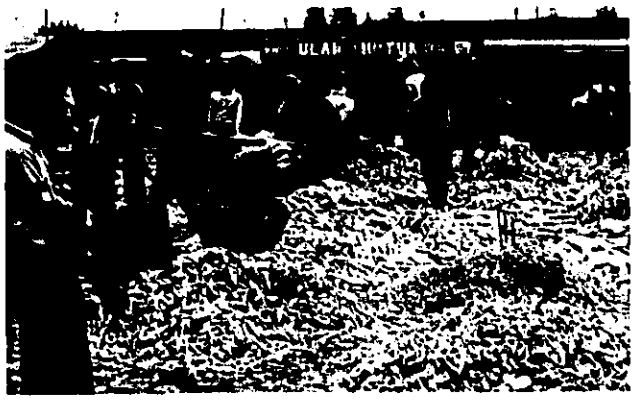
Distant view of Kalianget coast at the eastern end of Madura island.

Drying of salted fishes at Muncar.



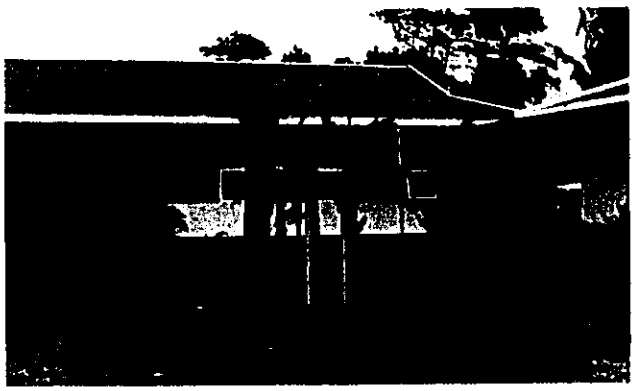
Shrimp Seed Production Center at Probolinggo.

Fish market at Semarang (1).

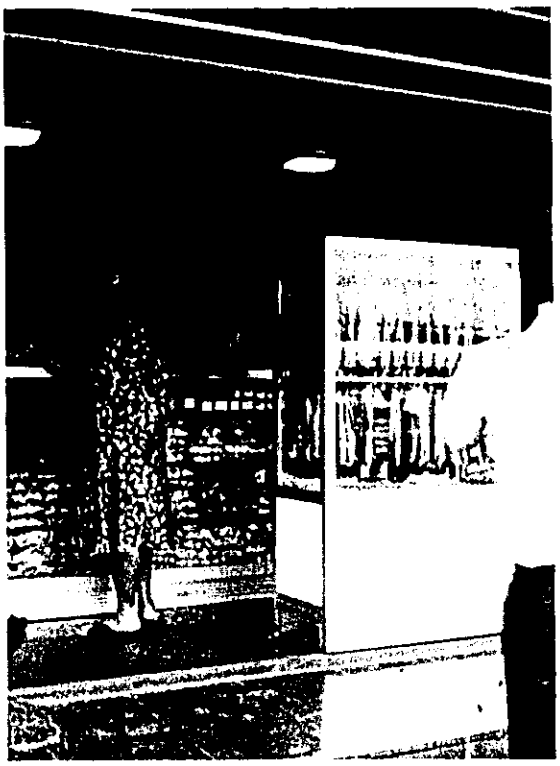


Fish market at Semarang (2).

Dinas Perikanan of Central Java Province, Semarang.



FAO/UNDP Shrimp Culture Research Institute at Jepara, Central Java.

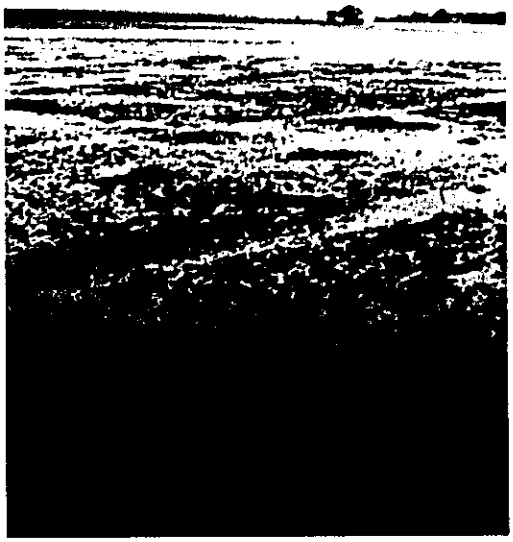


A cured fish store at Sidoarjo.

Garr (shellfish collecting gear) in Kenjeran area.

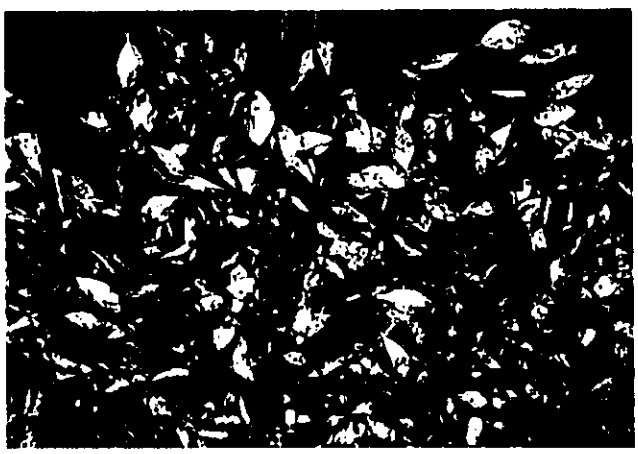
View of Benoa bay, Bali island.

P.T. Perikanan Samodra Besat, Benoa bay.



Tideland in Benoa bay, Bali island.

Drepam ds, spp.



Leiognathids.

Scowferowors sp. Polyenemus SP.

Pniacanthids

Clupeoids　　Platjcephalids

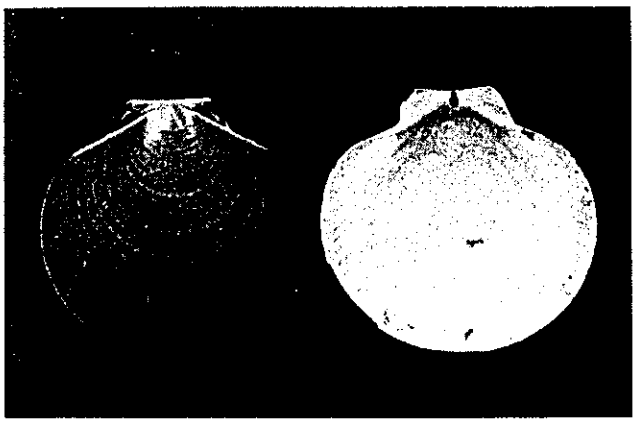
Ariids　－1

Ariids　－2

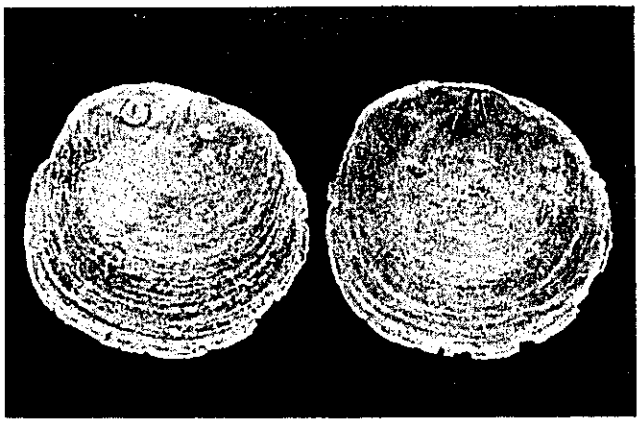
Cyuoglossids.

Stnomatids.　　Carangids.　　Carangids.

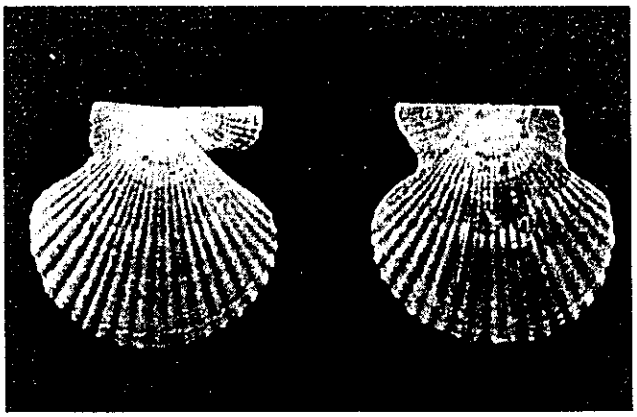
Spiuepherids　　Scianids.



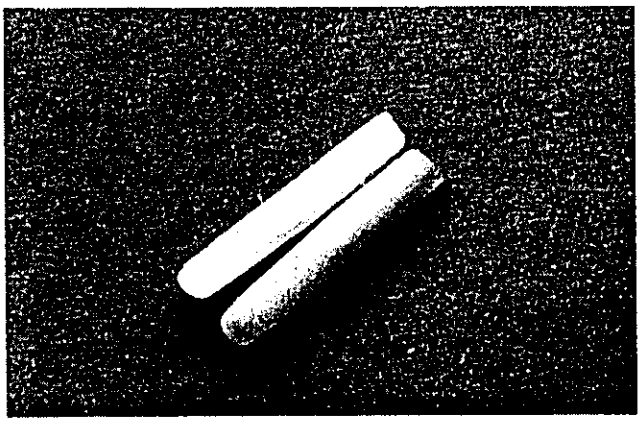
Amusium pleuronectes



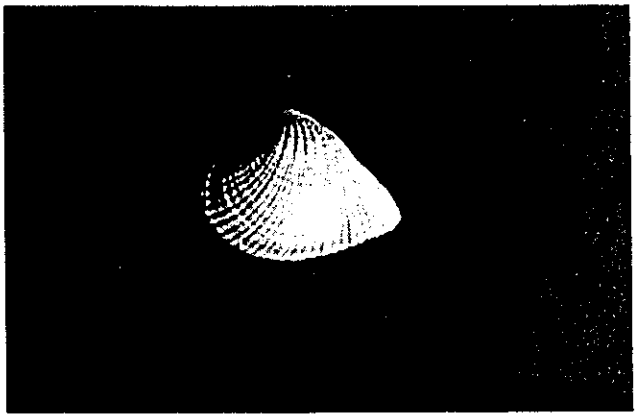
Placuna placenta



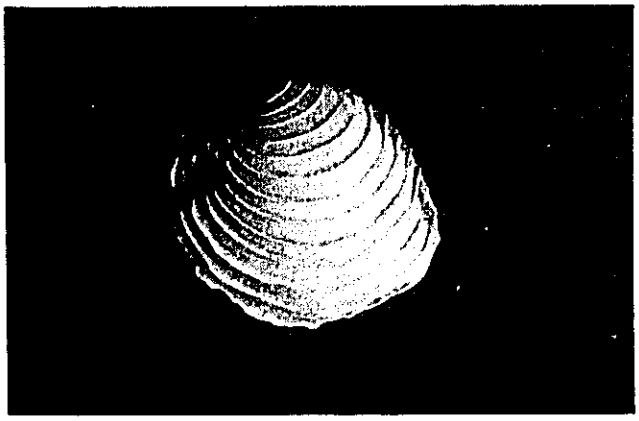
Chlamys sp.



Solen lamarckii

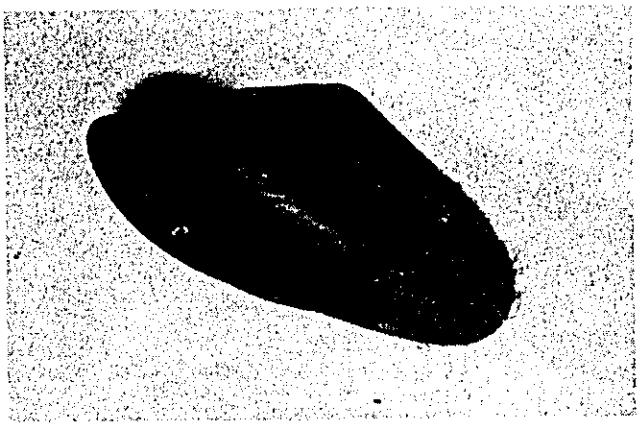


Anomalodiscus squamosus



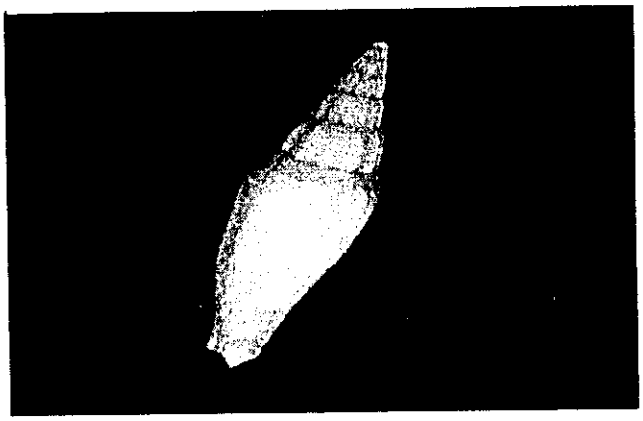
Placamen calophylla

Barbatis multivillosa

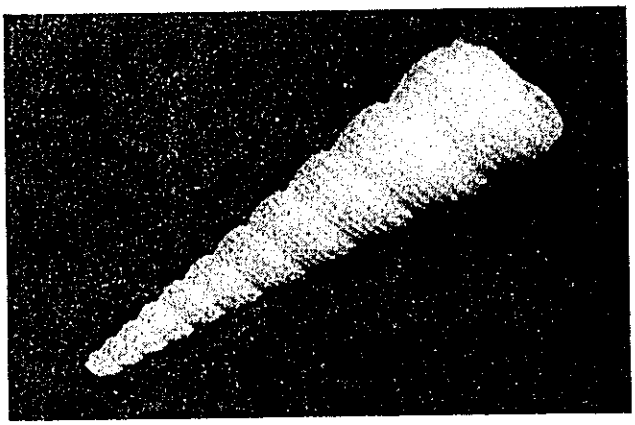


Modiolus agripedus

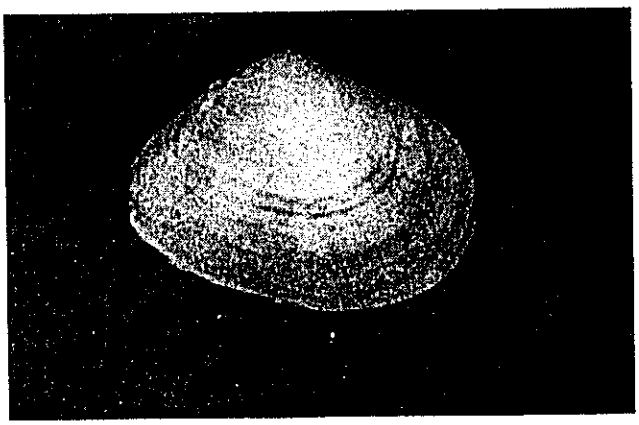
Eunaticina papilla



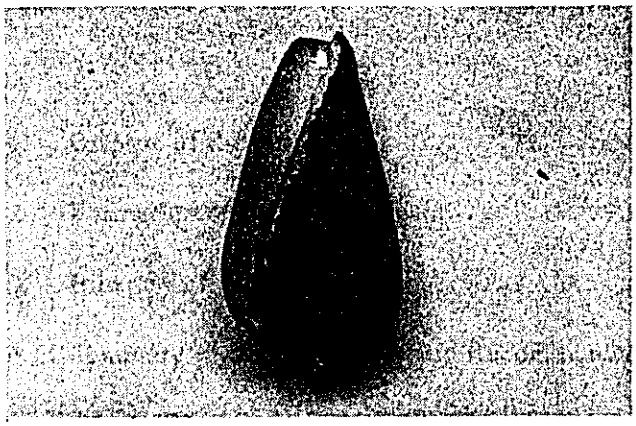
Vexillum sp.



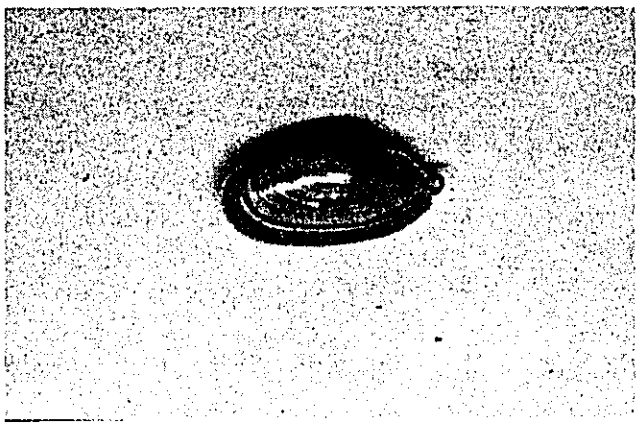
Turritella terebra



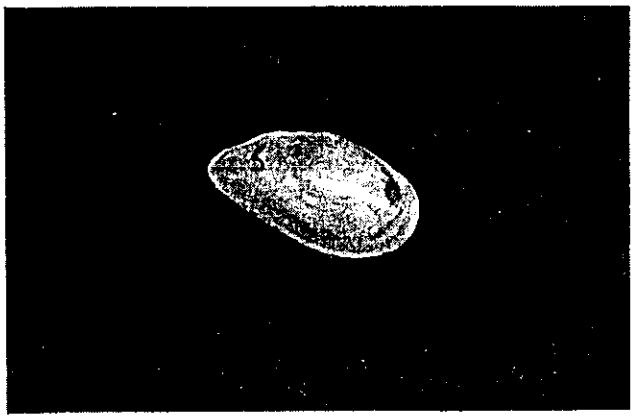
Semele sp.



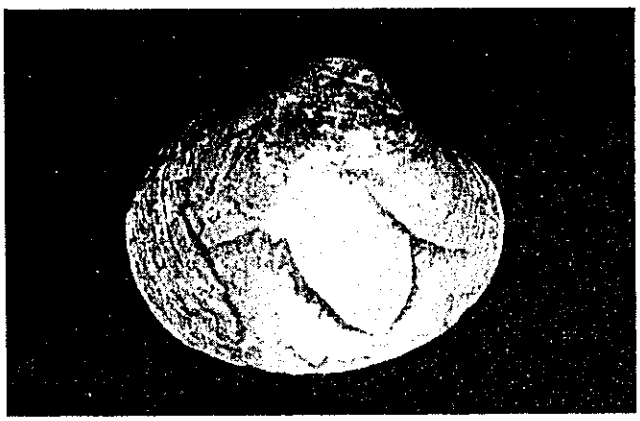
Phasmaconus radiatus



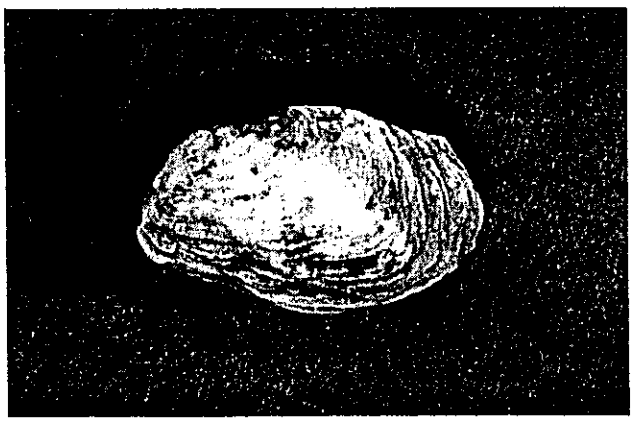
Semele sp.



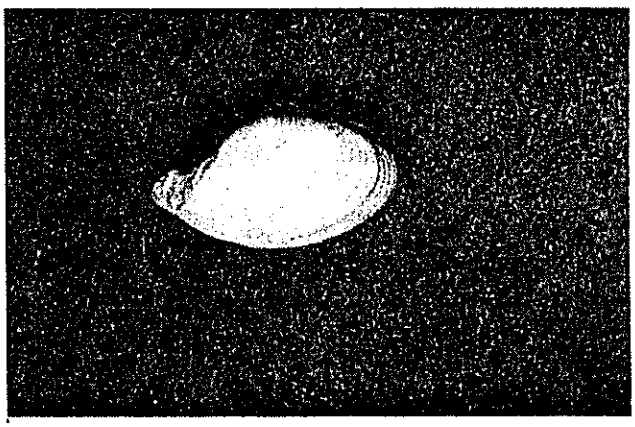
Moerella sp.



Livoconcha fastigiata



Trapezium liratum



Solidicorbula formosensis

CONTENTS

1. Purpose of the Survey

The prime objective of the present survey was to increase the production of fishes and shellfishes by marine culture in the coastal waters of Indonesia. To attain this objective, the survey was conducted in Lampung Bay of Sumatra island and in the coastal waters of Java island (including Madura and Bali islands) for the following specific purposes.

a. Selection of suitable species of fishes, shellfishes and seaweeds, and determination of suitable locations for their marine culture.

b. Collection of environmental data necessary for the selection of suitable locations of marine culture.

c. Study on the possiblites of technical development for commercial or small-scale introduction of adequate marine culture of suitable species.

2. Formation of the Survey Team

Name	Assignment	Affiliation
Takeichiro KAFUKU	Leader, Overall control	Chief of Pisciculture Department, Freshwater Fisheries Research Laboratory, Fishery Agency
Kunihiko FUKUSHO	Fish culture	Propagation and Culture Laboratory, Nagasaki Prefectural Fisheries Experiment Station
Joji OGAWA	Shellfish culture	Overseas Fisheries Cooperation Fund
Takashi TOKUTAKE	Liason and coordination	Forestry Development Cooperation Department, Japan International Cooperation Agency

3. Itinerary of the Survey

The survey was conducted in areas along the southwestern coast of Sumatra island, northwestern coast of Java island and southern coasts of Madura and Bali islands (See Fig. 1), according to the itinerary shown below.

Fig. 1. Indonesia and its vicinities

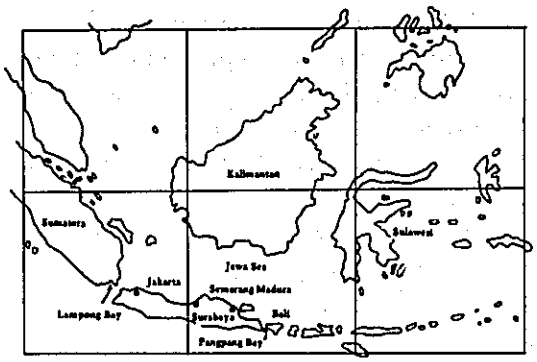
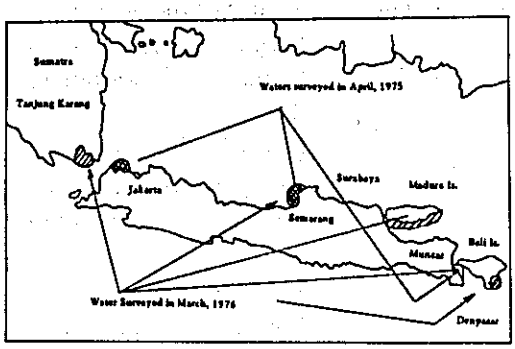


Fig. 1'. Waters surveyed areas



Date	Day	Trip and Place of Visit	Description
Feb.	26 Thu.	Tokyo – Jakarta	
	27 Fri.	Direktorat Jenderal Perikanan	Arrangements with the Indonesian government for the schedule and details of the survey
	28 Sat.	- ditto -	Rearrangements for the survey schedule, followed by the visit to the Marine Fisheries Research Institute for inspection and collection of data regarding the general fisheries condition in Indonesia
	29 Sun.		Holiday
Mar.	1 Mon.	Jakarta – Telukbetung; Dinas Perikanan of Lampung Province, and fish market and fishing port piers at Telukbetung	Visit to Dinas Perikanan of Lampung province for arrangements for the particulars of the survey, followed by the inspection of fishing port piers and fish market at Telukbetung
	2 Tue.	Fish market, and Dinas Perikanan of Lampung Province	Visit to the fish market early in the morning for survey of its activities and the species of landed fishes and shellfishes, followed by the visit to Dinas Perikanan of Propinsi Lampung to collect the data on general fisheries condition in Lampung Bay (e.g., fishing gear, species of landed fishes and shellfishes, numbers of fish markets and ice manufacturing plants, number of fishermen, ocean current, tidal data, market price and consumption of fishes, size and number of fishing vessles, etc.), and an on-land survey of the geology, topography, fauna and flora of the west coast of Lampung Bay.
	3 Wed.	Lampung Bay	Survey of transparency, pH, specific gravity, temperature, etc. of sea water and sampling of fishes by trawl net operation in Ratai Bay on the western side of Lampung Bay aboard a 7-ton boat of Dinas Perikanan of Lampung province

Date	Day	Trip and Place of Visit	Description
Mar. 4	Thu.	Tulukbetung – Lab. Maringgai	Visit to Lab. Maringgai facing Java Sea for inspection of fisheries and collection of relevant data
5	Fri.	Entrance of Lampung Bay	Visit to Pasarang island for observation of fishermen's work and fish drying yards
		Dinas Perikanan of Lampung province	Submission of survey results to Dinas Perikanan and discussion
6	Sat.	Entrance of Lampung Bay	Same survey and trawl net sampling operation as conducted on March 3
7	Sun.	Tulukbetung – Jakarta	Completion of the survey in Lampung Bay and return to Jakarta
8	Mon.	Direktorat Jenderal Perikanan	Courtesy call paid to Director Iman Sardjono of Direktorat Jenderal Perikana, with explanation on the results of survey in Lampung Bay survey schedule; Preparations for the survey in coastal waters of Central and Eastern Java.
9	Tue.	Jakarta – Semarang	Visit to Shrimp Culture Research Institute Java Area at Semarang to provide explanation on the survey schedule and particulars and to collect data on general fisheries condition in Central Java, followed by the inspection of fish markets and a shrimp freezing plant
10	Wed.	Semarang – Jepara	Visit to Fisheries Experiment Station (established with FAO's cooperation) for inspection and collection of data on the general fisheries condition in Jepara area
11	Thu.	Semarang	Inspection of Freshwater (paddyfield) Seed Production Center, Ngrajeg
12	Fri.	Semarang – Surabaya	Visit to Dinas Perikanan of Western Java Area at Surabaya to collect data on the general fisheries condition in Western Java area including Madura island and Baniwangi
13	Sat.	Surabaya – Kenjeran coast (north)	Survey of shellfishes, observation of fishing gear available on the market, and interviews with fishermen
		Surabaya – Sidoarjo coast (south)	Inspection of fish markets
14	Sun.	Surabaya – Madura island	Trip to Madura island by a ferry boat for collection of data on the fisheries of the island and a survey of shellfishes in near Pamekasan (fishing village)
15	Mon.	Madura island – Surabaya	Collection of general fisheries data at Dinas Perikanan of Madura island, survey in several places on the east coast of Madura island, and return to Surabaya

Date	Day	Trip and Place of Visit	Description
16	Tue.	Surabaya – Kenjeran	Visit to Dinas Perikanan of Eastern Java Area at Surabaya for submission of survey results covering Eastern Java area excluding Baniwangi, followed by discussion with the staff of Dinas Perikanan; Interviews with fishermen in Kenjeran area on fishing gear and shellfishes
17	Wed.	Surabaya – Baniwangi	Inspection of the retail market and landed fish volume in Surabaya city; observation of Fisheries Training Center of Dinas Perikanan of Eastern Java Area and Shrimp Seed Production Center at Probolingo on the way to Baniwangi
18	Thu.	Baniwangi – Pangpang Bay	Survey of Pangpang Bay along its coast, inspection of dried and fish (drying and salting yards) at Muncar, and collection of general fisheries data at Dinas Perikanan of Baniwangi Area
		Baniwangi – Bali island	Sailing to Bali island by a ferry boat
19	Fri.	Denpasar	Visit to Dinas Perikanan of Bali island for discussion on the schdule and particulars of survey on the island and for collection of general fisheries data, followed by the survey of Benoa Bay in the south and inspection of the freezing plant of Samodra Besar
20	Sat.	Northern coast of Bali island	Inspection of the northern coast of Bali island
21	Sun.	Denpasar	Inspection of sea ornamental fish company in Sanur
22	Mon.	Benoa bay, Bali island	Survey of Benoa Bay conducted again
23	Tue	Denpasar – Jakarta	Completion of the field survey and return to Jakarta; preparation of the interim report for submission to the Indonesian government
24	Wed.	Direktorat Jenderal Perikanan and Marine Fisheries Research Institute	Preparation of the interim report and arrangement of sampled fishes and shellfishes
25	Thu.	Direktorat Jenderal Perikana	Presentation of the interim report to Director General Iman Sardjono
26	Fri.	Jakarta – Tokyo	Return to Tokyo

4. Summary of Survey Results and Recommendations

(1) Fundamental Approach to the Survey

In complying with the request of the Indonesian government, it was considered necessary to study the possibility of providing assistance under the project cooperation system, one of JICA's international cooperation methods, in order to ensure the smooth future development of marine culture in Indonesia. Accordingly, the survey was conducted with prime consideration given to the feasibility of promoting the production of respective selected species under a marine culture project.

The survey team was instructed to act on the directions from JICA in the event of any discrepancy of opinion between the Indonesian government and the team regarding any important part of the scope of cooperation, and to adjust the minor details of the survey on the responsibility of its leader after consultation with Mr. Masao Akai, a Japanese fisheries expert stationed in Indonesia.

Prior to its departure from Japan, the team made studies on the existing state of fisheries in Indonesia and marine culture in tropical countries (data of which are shown in the reference), which led to the following inferences.

(Shrimps, crabs and turtles were excluded from the scope of the present survey)

(2) Fish Culture

Japanese cultural techniques in which feed is supplied at a high rate as in floating netcage culture are not applicable in Indonesia for economic reasons except in few limited places. In developing countries, it is not advisable to plan marine culture for production of carivorous fishes. Species suited to marine culture are rabbit fish (*Siganus spp.*) which is abundantly found in coral reef waters and feeds on seaweeds and detritrous feeders such as mullet (*Mugil spp.*) which are found in abundance in brackish waters.

For the purpose of the planned maricultural development, it is advisable to utilize the fishponds which are left idle at present due to the shortage of seeds of milk fish (*Chanos chanos*) [for instance these fishponds can be used for culture of sharp nose molly (*Molliensis sp.*), a bait fish for bonito angling, or other suitable species], and to introduce pen culture method which can be practised in shallow waters rich in nutrient using bamboos and nets (e.g., milk fish culture in the Philippines).

(3) Shellfish Culture

On the strength of the previous survey report in which the poor growth and fattening of oysters in tropical waters is pointed out, oyster culture in Indonesia is regarded not very promising. It is considered that priority should be given to ark shell (*Anadara spp.*) which enjoys a heavy demand in Java island as well as to mussel (*Mytilus spp.*) and Asian moon scallop (*Amusium spp.*), though the latter two are not mentioned in the previous report.

On the basis of the above inferences, the following two points were confirmed as the fundamental approach to the survey.

1) The inferences will be checked, corrected or discarded with the progress of the field survey.

2) In carrying out a technical development scheme in a developing country, it is not desirable to attach importance only to the technological aspect without regard to the related industrial fields. In studying the possiblity of marine culture development in Indonesia, therefore, due account must be taken of the inland brackish water areas because the country's coastal waters are affected by fresh water intrusion during the monsoon season.
However, under the research administration system of Indonesia, brackish water areas subject to the inflow of inland water are regarded as fresh water areas which fall under the jurisdiction of the Inland Fishery Research Institute, whereas coastal brackish water areas are regarded to fall under the jurisdiction of the Marine Fisheries Research Institute. Careful consideration should be given to this administrative distinction in conducting the survey.

4-1 Summary of Survey Results

A basic survey was conducted during the period from February 26 to March 26, 1976 in areas along the southwestern coast of Sumatra island, northern coast of Java island and southern coasts of Madura island and Bali island to select suitable locations of marine culture. Sea water temperature, specific gravity, pH value, transparency, etc. were obtained by actual measurement in Lampung Bay along the southwestern coast of Sumatra island; Data of other survey areas were collected by interviews with the staffs of local Dinas Perikanan and fish markets, fishermen and consumers or by observation conducted with the cooperation of Indonesian counterparts.

4-1-1 Fishes

The existing fishfarms are operated for production of the species which enjoy a heavy demand and a high market price. Since most of them are carnivorous fishes, bait fishes are limited to those which are inexpensive, abundant and stabilized in catch. In Japanese marine culture, the bait fish requirement for each 1 kg increase of cultured fish ranges from 7 to 15 kg and the market price of cultured fish is required to be 20 to 30 times as high as the price of bait fish. The following is a brief a account of the study made from this viewpoint on the species suited to marine culture and the price of bait fish.

(1) Promising Species

Though their prices are subject to regional fluctuation, the most important species are scombroid fishes, *Scomberomorus spp.*, *Stolephorus spp.*, *Clupea spp.* and *Rastrelliger sp.* Other species enjoying a high market price are *Lutijanns spp.*, *Arius spp.* and *Epinepheulus spp.* As no adequate culture method has yet been established for scombroid fishes (incl. *Scomberomorus spp.*), *Sardinela sp.* and *Clupea spp.*, the species suited for future marine culture will be *Epinepheulus spp.*,

Lutijanns spp. and Arius spp.

(2) Bait Fish

Notable among the bait fishes available in Indonesia are *Leiognattus sp.* and *Sardinela sp.* which are both inexpensive. Although these two species are important materials of cured or canned products, their stable supply is not ensured. A price comparison between the cultured species and the bait fishes disclosed that the former are higher by only several times. If no greater price difference can be expected, culture of any species will entail economic instability unless a very favourable location is lelected. The payability of the special culture methods followed in Japan is based on the fact that the price of fishes varies largely by species and live fishes sell well at a high price. Therefore, direct introduction of Japanese culture techniques is not considered practicable at least for sea fishes.

(3) Future Course of Development

The milk fish culture in Indonesia is known as an accumulation of traditional techniques and knowledges. While these techniques should naturally be improved to turn the milk fish culture into a modern and rational culture system exhibiting a high productivity, what is basically required for the planned marine culture development is to promote the culture of omnivorous and herbivorous fishes which hardly call for the supply of animal protein feed, such as *Mugil spp.*, black sea bream, and Rabbit fish or *Siganid spp.* In order to culture these fishes in the extensive brackish water areas of Indonesia, this method may be suitable for the pen culture method is commendable rather than the floating netcage culture. If the culture of carnivorous fishes such as *Lates carcarifer* is desired, mixed culture with *Telapia mossambica* as bait fish should be planned.

(4) Suitable Locations for Marine Culture

1) One of small bays found along the south coast of Lampung Bay, Ratai Bay is exceptionally suitable place in Indonesia to the floating netcage culture, especially of *Lates carcarifer, Epinepheulus spp.* and *Lutijanns spp.* These bays are favourably conditioned for marine culture because of their proximity to Jakarta which is a huge consumer area, but prior study should be made on the price of bait fishes which will be supplied by the Bagang operators in Lampung bay.

2) Small bays in the east coast of Madura island, specially Kalianget bay, have shoals extending to a great distance from the beach and embrace stagnant water areas. Pen culture of milk fish utilizing the "Sero" techniques is promising in these bays particularly because they are close to Surabaya city and the milk fish seed fishing ground is in the vicinity (Fig. 2).

3) Benoa bay of Bali island is mostly covered with coral reefs, but a relatively stagnant water area with a depth of more than 2 m and sandy mud bottom is found inside the jetty at the innermost recess. Pen culture of milk fish in this area is considered promising because milk fish seeds can be caught with relative ease along the northern coast of Bali island and the consuming area, Denpasar, is not far.

Fig. 2. Sero (Guiding Barrier)

Local stationary fishing gear, SERO, mainly operated near the estuary

4) Terima Baai Bay facing Java Sea is situated in the northwestern end of Bali island and abounds in marine fishes for ornamental use. The bay is considered suited for culture of such ornamental fishes.

4-1-2 Shellfishes

(1) Promising Species

Generally speaking, the shellfish consumption is extremely low, although bivalves were noted to be consumed in all survey areas. This is due not to the palate of Indonesians but to the delayed development of shellfish fishery and resulstant absence of collecting gear. The only shellfish collecting gear observed by the team was "Garr", a simple ark shell collecting gear used in the neighbourhood of Surabaya.

What must be done in the coming few years is therefore to extend improved collecting gears and techniques among fishermen and increase the production and consumption.

As a result of the previous and present surveys, it is known that Indonesian coastal waters abound in a diversity of shellfishes, of which the following species are considered suited to culture.

Edible shellfishes:

Ark shell – *Anadara sp.* (See Fig. 3)
Clam – *Gafrarium tumidum*
Asian moon scallop (Simping) – Amussium pleuronectes (See Fig. 4)

Shellfish for ornamental use:

Window pan shell – *Placuna placenta*

Experimental culture of these useful species should be undertaken in selected places to obtain their basic biological data.

Fig. 3. *Anadara spp.*

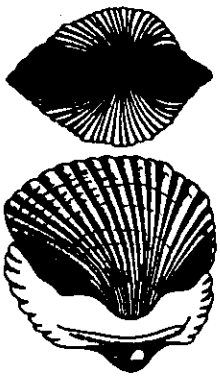
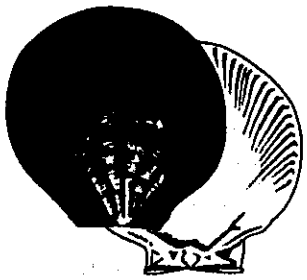


Fig. 4. *Amusium spp.*



Oyster Culture: It is said oysters are not suited to culture in tropical waters because of their poor fattening, and this was evidenced by the previous and present surveys. Whether this poor fattening is caused by the tropical environment or the biological characteristics of oysters themselves is not known yet. At any rate, it is not advisable to embark upon oyeter culture in the face of such adverse condition. Collection of relevant data should be continued for further studies and preparations.

(2) Locations Suited for Shellfish Culture

Areas considered to deserve development effort from the biological and geographical point of view are Lampung area (Sumatra), Surabaya area, and Madura strait area including Surabaya coast.

1) Lampung Area

This area is situated in the southwestern end of Sumatera island and favoured by its proximity to Jakarta. The sandy and silty shoal extending from the innermost recess of the bay along the east coast provides an excellent environment for the growth of ark shell. Extensive ark shell culture in this shoal will be possible.

2) Surabaya Area

In this area, the catch is consumed either when fresh or after dried and the distribution mechanism is fairly consolidated. It is hoped that the existing fishing industry in the area will be further developed by improving fishing boats and introducing more efficient fishing gear. Asian moon scallop is ecologically similar to Japanese scallop (*Patinopecten yessoensis*) so that it will be possible to apply the latter's culture method. Window pan shell (*Placuna placenta*) is valuable not only for ornamental use but also because it is edible and capable of extensive culture. It is one of the shellfishes expected to be produced by culture in future.

4-2 Recommendations

4-2-1 Fish Culture

(1) Considering the probable difficulty in securing the supply of bait fish and the small price gap between the prospective culture fishes and bait fish, it is not desirable to introduce Japanese culture methods such as floating netcage culture which is applied for production of carnivorous species like red sea bream (*Pagrus major*) and yellow tail (*Seriola quinqueradiata*).

For future development of marine culture in Indonesia, priority should be given to species like *Mugil* fish, *Siganid* fish and black sea bream which can all be cultured without supplying animal protein feed. An improved pen culture method incorporating the prevailing "Sero" fishing techniques may as well be introduced. It must be noted, however, that if this method is employed for milk fish culture, the seed stocking for production increase is prone to be augmented as was the case with Laguna de bay in the Philippines and aggravate the seed shortage which is already acute in Indonesia.

The planned development of marine culture should preferably started with the biological research and experimental culture of selected species.

(2) In order to secure the supply of animal protein which is now in heavy demand, the Indonesian government is urged to exert effort to increase fish production not only by marine culture but also by inland fresh water culture of unexploited resources such as mullet seeds available along coastal lines and particularly in brackish water areas.

While milk fish is the most important cultured species in Indonesia, it is known that its production has been on the decline in the last several years due to the shortage of seeds. The situation calls for the selection and production of a suitable species which can economically substitute for milk fish in the event of shortage of milk fish seeds as well as for the experimental culture of such species in idle fishponds.

(3) The shellfish consumption is low and the development of collecting gear is delayed, except that simple gear are used in Jakarta and Surabaya areas. For future development of shellfish fishery, improvement of fishing boats and introduction of efficient gear should be enhanced in these two areas where the consumption of shellfishes is relatively large, with endeavours also made for collection of basic data of promising species (such as distribution and spawning season) and for their accelerated production.

(4) Since the survey period was short and coincided with the wet season which recorded an unusually heavy rainfall, the team was not able to build up conclusions on all sufficient data and evidences. For instance, *meretrix spp.* and *mytilus spp.* could not be observed during the survey period, although their abundance had been reported by the Indoneian side. It is therefore necessary to conduct another survey during the dry season to arrive at a sounder and more comprehensive conclusion.

(5) Locations suited for marine culture under a project should be selected from among the

areas covered by the present survey, regardless of whether a comprensive survey will be conducted at a future date. In this case, the population of cities in the neighbourhood of the prospective locations, availability of hospitals, educational institutions, international fisheries research institutes and transport means as well as the relationship with the consuming areas should be studied in anticipation of the establishment of research institutes and future industrial development. For the purpose of balanced future industrial development, it is advisable to clarify the local characteristics by selecting a single species for each location and from this point of view, it is possible to propose one shellfish culture project area and two fish culture project areas from among the areas covered by the present survey.

4-2-2 Kenjeran

Kenjaern area has a flat coast inhabited by many different species of shellfishes. It faces Selat Madura and the coast of Madula island which both abound in important shellfishes. Selection of Kenjeran as the shellfish culture project area can be justified by the presence of fishermen earning a livelihood by shellfish fishery, proximity to Sidoaljo where shellfish processing has been conducted for many years, and proximity to Surabaya which is a large consuming area.

Species suited for culture in this area are ark shell and window pan shell available on Kenjeran coast and ark shell found on the southern coast of Madura island. If the project is implemented in this area, it is possible to conduct a preliminary survey for culture of Asian moon scallop, a very promising species expected to hold an important place in the future shellfish culture industry. Further, cooperation in the field of researches can be obtained from Dinas Perikanan of Surabaya West Java Area.

Since Kenjeran area is very extensive, implementation of the project in this area should be preceded by a further detailed survey to obtain more concrete and sufficient data and grasp the seasonal fluctuation of environmental conditions.

4-2-3 Bali Island

By virtue of the presence of Denpasar, an international tourist resort, there is a clear-cut distinction between consumption and production in Ball island, so that the culture of fishes and shellfishes on the commercial basis is promising and involves no difficulty.

However, since the area selected during the present survey is not extensive enough, the whole Benoa bay and the outer coastal area should be surveyed for selection of a wider project area. Species suited for culture in Benoa bay are *Anadara spp.*, milk fish for pen culture in the inner recess of the bay, and rabbit fish (*Siganus spp.*) found in abundance in the coral reef area of the bay.

There are two facts which are not directly related to the purpose of the present survey but deserve attention: Bali island produces large volumes of fishes for ornamental use, and Denpasar is an international resort place favourably conditioned as the market of such fishes.

4-2-4 Lampung

Ratai bay which is in the southern coast of Lampung bay of Sumatra island is the only area suited to floating netcage culture. A miscellafishes caught by countless Bagans in Lampung bay are available as bait fishes, it can be said that Ratai bay is provided with the basic condition for floating netcage culture of carnivorous fishes. It is to be noted, however, that fishes caught in Lampung bay are getting smaller and smaller in size due to the reckless fishing of fries by some 2,500 set Bagans using fish lamps. Fish resources in Lampung bay are now at stake due to set Bagan fishery. If miscellaneous fishes including fries are to be used as bait fish, the use of set Bagan, a prohibited gear, will be encouraged contrary to the purpose of the project. The following two conditions should therefore be fulfilled before putting the project into execution.

1) Restraint should placed on the scale of set Bagan fishery and measures should be taken to promote small fixed net fishery. In order to secure the supply of miscellaneous bait fishes for floating cagenet culture, fixed net fishery should be encouraged by all incentive measures.

2) Ratai bay is at about two hours' distance by boat from Lampung city. A dwelling site and research facilities should therefore be provided preferably within the compound of the Brackish Water Culture Exeripment Station at Palm Batmanyan.
Species suited to culture are *Lates carcarifer, Lutijanus spp.* and *Epinepheulus spp.* which are all found in abundance in Lampung bay.

To summarize the results of the present survey, highest priority can be given to shellfish culture in Kenjeran area, second priority to fish and shellfish culture in Benoa bay of Bali island, and third priority to floating netcage culture in Ratai bay. But this priority order should not be construed as final because all the three areas have their own merits and demerits and nothing definite can be said at the moment about their future prospect. Accordingly, a further detailed survey should be conducted for selection between the three proposed areas. For this purpose, two experts specialized in fish and shellfish culture respectively should be sent to Indonesia on a long-term basis. They will be required to be stationed at Marine Fisheries Research Institute at Jakarta and collect the necessary data to determine which of the three areas is best suited for marine culture development under a project. If they find any other sites suited to marine culture development, they should investigate such sites and collect the relevant data.

5. References

(1) Interim Report

(2) Comments on Important Species

a) Milk Fish

b) Rabit Fish and Mullet

c) Window Pan Shell and Asian Moon Scallop

d) Fishes for Ornamental Use

(3) Previous Survey Report (1975)

(4) Bibliography

I. Interim Report

March 31, 1976

First Admiral Iman Sardjono
Director General of Fisheries

Dear Sir,

I would like to enclose the papers of English translation of Preliminary Survey Report on marine culture made by Dr. Kafukus Survey Team, J.I.C.A.

For the following up of the development of marine culture, on my opinion, making field survey same as this in the coming dry season is recommendable because rainy season this year is much severer than usual.

Sincerely yours,

Masao Akai
Chief of Advisory Team

c.c. Col. A. T. Wignjoprajitno
Secretary of Director General
of Fisheries

Mr. V. Soesanto
Director of Fisheries Resources

Mr. N. Unar
Director of L.P.P.L.

Mr. K. Uesugi
First Secretary of the
Embassy of Japan

Mr. S. Tsurumi
Chief of J.I.C.A. Office,
Jakarta

Preliminary Survey Report

on Favorable Area and Favorable Species for the Marine Culture of Fish and Shellfish

(March 25, 1976)

J.I.C.A. Experts
(Chief) T. Kafuku, D.Sc
K. Fukusho
J. Ogawa
T. Tokutake

CONTENTS

Foreword:

In compliance with the request of the Government of Indonesia, we conducted fundamental survey in order to find out the favorable areas and favorable species for the marine culture of fish and shellfish. The survey areas were southern coast of Sumatra, northern coast of Java, southern coast of Madura and Bali Island, and the term was from the 1st of March, 1976 to the 23rd of March, 1976.

Through the survey, in Lampung Bay, southern coast of Sumatra, we measured water temperature, specific gravity, pH, transparency of sea water and in most part of other survey areas, observed sea condition and made hearing survey from persons concerned at regional fisheries office and fish market along with fishermen and consumers.

I. Outline of the Findings

1) Marine culture of fish

A) Favorable species

In existing marine culture, speaking generally, the objective fishes are much in demand and expensive. Further, most of them are carnivorous, therefore, cheap fishes that supplied condition is large in amount and stable are served as food for the objective fish.

Consequently, we made a survey of fish price, and in the result, although regional differences are found, Scombroid fishes, Scomberomorus spp., Stolephorus spp., Clupeid fish, Rastrelliger sp. are important and otherwise, Lutijanus spp., Arius spp., Epinepheulus spp. have high market value. Among these, Epinepheulus spp., Lutijanus spp., Arius spp. are considered objective fish for existing culture method because breeding methods of Scombroid fishes (including Scomberomorus spp.), Sardinela sp., Clupeid fish have not been established yet in the world.

However, even if the culture of objective fish be carried out, there is a fear for maintaining economic advantage otherwise using considerably suitable area owing to the following factors:

(a) Although some cheaper species such as Leiognathus sp. and Sardinela sp. are worth notice for food of cultured fish and also suitable for raw material of saled-dry or canned fish, etc., they are in unstable supply in the market.

(b) Price difference between cultured fish and food fish shows only about several times.

In Japan, for your information, the difference reaches 20 – 30 times and in case increasing one kilo-gramme of cultured fish, 7 – 15 times quantity of food fish is needed.

That is, a specialized culture method is able to find own way only in the present instance such as Japan, where live-fishes are valued and the price variation of fish is widely different.

In Indonesia however, at least on marine fish, it is not suitable to introduce culture method being adopted in Japan without any modification.

On the other hand, in culture of milk fish, tranditional technics and information have been accumulated in Indonesia. Therefore, it is needless to say that rising productivity and improving culture management of milk fish are urgent business in the fisheries circle.

Further, it seems that the culture of omnivorous and herbivorous fish such as Magilid fishes, Black sea breams and Siganid spp. should be taken into consideration because in this case, animal protein food is practically not needed.

Besides, it also seems that the pen culture of Mugilid fish and Sea bass making good use of vast brackish water zone and mixed culture of Tilapia mossambica aiming at rearing food fish for Lates carcarifer, carnivorus fish are recommendable.

B) Favorable area

a) Among small bays situated at the sourthern part of Lampung Bay, especially Rata Bay seems favorable for the floating cage culture of Lates carcarifer, Epinepheulus spp. and Lutijanus spp. Further, Jakarta is not so far, so, Rata Bay has a good condition of location.

b) Small bays in eastern part of Madura, especially Kalianget Bay not far off from the eastern extremity of Madura, seems favorable for the pen culture -- applying technics for constructing "sero" -- of milk fish because in the neighborhood of this area, there are collecting areas of the fry and consuming area of Surabaya.

c) In Benoa Bay, Bali Island, most of its bottom substance are formed by coral reef but partially sundy-mud with the depth of more than 2 meters. In this area, pen culture of milk fish seems promising because the fry of milk fish is easily caught along the northern coast of Bali Island, and Denpasar, consuming area, is close at hand.

d) In Bali Island, Terima Bay facing Java sea is situated nearby western extremity and seems favorable for the pen culture of tropical ornament fish.

2) Marine culture of shellfish

A) Favorable species

Throughout the survey area, utilization level of shellfish is still very low, however, the bivalves is most popular as food.

Accordingly, shellfish fishing is nearly in undeveloped stage with the exception of

Anadara fishing in the vicinity of Surabaya using simple gear named "garu".

Judging from beforementioned situation, immediate measures to be taken are to increase production and to promote consumption through generalization of fishing gear and method.

In parallel with this, it is essential to make basic and experimental research on useful shellfish in each favorable area.

In the survey this time, we observed many species of shellfish and among others, consider four species mentioned under favorable ones for the culture.

Food shellfish	Blood shell	Anadara
	Clam	Gafrarium tumidum
	Simping	Amussium pleuronectes
Ornament shellfish	Window pan shell	Placuna placenta

Further, we refer to oyster. Generally speaking, oyster is considered unsuitable species for culture in tropical zone as pointed out in Dr. Arakawas report due to the unfavorable condition for fattening. Our views are same as this and it is not clear that such a lean fattening is caused by tropical environment or by biological characteristics of oyster itself.

B) Favorable area

From the biological and economical point of view, we consider that the areas of Lampung in Sumatra and Surabaya including Madura strait are fishing grounds to be developed in the future.

a) Lampung and its vicinity

The location of this area has a advantage of existing Jakarta, the largest consuming area in Indonesia and in particular, eastern coast from the inner most recess of Lampung Bay where sandy-mud and shoal beach are found is suitable for the living of Blood shell and there, extensive culture seems possible in the future.

b) Surabaya and its vicinity

We consider that Surabaya and its vicinity is the most flourishing area of Anadara fishing. Most of Anadara meat are consumed in the form of fresh or dry and their marketing route has been settled in some degree. In the future, it is desirable to develop existing fishing through motorization of fishing boat and introduction of more effective fishing gear.

Simping is a similar species in ecology to Patinopecten yesoensis produced in Japan, therefore, culture method of Patinopecten yesoensis may be adopted in Indonesia.

Further, Window pan shell seems a hopeful species to be cultured in the future since

it has a high value as ornamental goods.

II. Suggestion

Based on our findings stated earlier, we would like to suggest following subjects:

1) Marine culture of fish

It is not advisable for the marine culture of fish in Indonesia to introduce same method being adopted in Japan without any modification expecting in case trying it in extremely suitable area because obtaining food in stable condition is in difficulty, and price difference between cultured fish and food fish is only several times.

Therefore, the culture method of fishes that need not take animal protein food such as Mugilid fish, Siganid fish and Black sea bream should be paid attention in Indonesia. In this case, we consider that a pen culture modifying "sero" is recommendable. However, in case of pen culture, the stocking fry is liable to reach much amount aiming at the increase of production as seen in Lagua de Bay, Philippine and there is a fear of the fry become short condition.

Generally speaking, it is desirable for the development of marine culture to begin with the accumulation of the result in biological research and fundamental experiments concerning objective fishes.

2) Marine culture of shellfish

It seems that the consuming level of shellfish, on the whole, still remains very low, however, only in the area neighboring both Jakarta and Surabaya, we could observe the fishing of shellfish with simple gear.

Therefore, we consider that the increase of production through motorization of fishing boat and introduction of effective gears, and keeping pace with this, the accumulation of fundamental information concerning distribution and spawning season, etc. of hopeful species are essential for the future development of shellfish culture.

3) Utilization of unexploited resources

We consider that from the view point of increasing national animal protein intake, the Government of Indonesia should take the measures for the increase of fisheries production through not only the development of marine culture but also the utilization of unexploited resources that inhabit around coastal zone especially inhabit in brackish water area making good use of fresh water area located in inland part.

Furthermore, the culture of milk fish, the most important undertaking in fisheries circle, has been threatened with risky condition due to the fry shortage for these several years.

Therefore, it seems essential to find out suitable fish species for the substitution of milk fish and to try incidental experiments using "tambak"/ fish pond in order to make preparation for such situation.

III. Supplementary Note

Our findings through the survey are tentatively summarized as stated above, however, there is a fear that our views are attributed to the one-sided observation because the term of survey was about one month and in rainy season severer than usual.

Therefore, we consider that making a survey same as ours in the coming dry season is indispensable for the purpose of drawing overall conclusion.

IV. Acknowledgement

Taking this opportunity, we would like to express our heartfelt appreciation to the officials concerned including D.G.F., L.P.P.L. and regional fisheries office, and to local fishermen whose unlimited cooperation has been most valuable in the execution of our survey.

2. Comments on Important Species

(1) Milk Fish

Milk fish is, so to speak, the national fish of Indonesia and the history of its culture is very long. Taiwan, the Philippines and Indonesia are the main countries engaged in milk fish culture. The average annual production of cultured milk fish per ha (June to August) is more than 2 tons in Taiwan, 600 ~ 800 kg in the Philippines and 300 kg in Indonesia. The low production level in Indonesia is ascribable, for one thing, to the fact that the country is very extensive and the average production per unit area of fishfarm is inevitably made smaller than in other countries. However, there is a more material reason: while fertilization techniques are well developed and emphasis is placed on fishfarm management in Taiwan, the Indonesian culture is extensive and resorts to the traditional method in which no rational consideration is given to the fishfarm design. To effect necessary improvement to the current cultural practice, a survey is now conducted with fund provided by the World Bank.

The first consideration in the culture of milk fish is to secure the supply of seeds. Since milk fish never lay eggs in fishfarms, seeds caught in coastal waters are transferred to fishfarms but their catch fluctuates hevily from year to year. With the growing demand for milk fish observed in recent years, the producing countries are now faced with a pressing shortage of seed supply. Particularly in Indonesia, a chronic shortage has continued for the last several years. In Java island, for instance, the annual seed requirement is 493 million and it is estimated that only 84% of this total requirement can be supplied. As a consequence, an estimated 17,000 ha out of the total fishfarm area of 55,600 ha is left idle in the seed-short Central and Western Java. Unlike Eastern Java which is relatively rich in seed supply, Western Java suffers an extremely low production and embraces an extensive idle farm area. To cope with this situation, seeds are transported by air from Lombok and Sulawesi to Jakarta to supply them to Western Java, but there is no guarantee that the chronic seed shortage in Western Java can be solved.

In Central Java, extensive mullet culture by stocking used to be conducted when the supply of milk fish seeds was short. In recent years, however, shrimp has emerged as a major by-product of milk fish farm operation and an important source of fishermen's income. As a result, technical development in the monoculture of shrimp and mixed culture with milk fish is desired and the fundamental approach to fill this desire is made within the framework of the fishfarm improvement project implemented with the financial aid of the World Bank and the development researches conducted by FAO/UNDP at Jepara. It is to be pointed out, however, that the fishfarm utilization for shrimp culture alone involves a risk. Researches should be conducted to find a number of other species suited for culture in milk fish farms.

In the field of fresh and brackish water culture of milk fish, a notable development has recently been attained in Lagna de bay in the suburbs of Manila, the Philippines. Specifically, a production of nearly 10 tons per ha was recorded by pen culture using bamboos and nets in Lagna de bay which is a purely fresh water lake. The pen culture adopted in this lake differs from the conventional milk fish culture method in that the water depth is as large as about 2 m as compared with 30 cm of most existing farms. The pen culture method is worthy of notice as it can be applied not only in fresh water but also in brackish water. However, it is liable to

aggravate the prevailing shortage of seeds because the fishermen tend to stock fries in increasing numbers to accelerate the production (the number of stocked fries per ha is 4,000 in Indonesia at present but it is as large as 40,000 in Lagna de bay).

(2) Mullet and Rabbit Fish

Selection of species for future fish culture in tropical brackish waters should be made from the economical as well as biological point of view. Censidered from the economical point of view, the selected species should have a high market value. And considered from the biological standpoint, high-yielding fishes differentiated into many species should be selected. The captioned two fishes deserve attention as filling these two requirements.

(Rabbit Fish)

Rabbit fish is tasty and has a high market value. It inhabits near coral reefs and is available in many differentiated species which mostly feed on seaweeds. Hence, it is suited to culture in tropical waterts where the supply of animal protein feed is difficult. Culture of this fish proved successful in Japan but not on the commercial basis because of the low water temperature in winter. Apart from this attempt in Japan, basic studies were conducted in 1970 by Hebrew University, Israel, on the culture of *S. rivalatus* which inhabits in Red Sea and Mediterranean Sea and is reported to grow to have a full length of 40 cm and a weight of 500 g. Culture of this species is also attempted by Siganid Mariculture Group organized by the Micronesian Mariculture Demonstration Center in Palau, the Caroline Islands, in collaboration with the Oceanographic Research Institute, Hawaii. Considering the large rabbit fish production in Indonesia, these research efforts for culture of *Siganid* deserve the attention of Indonesian fisheries authorities. At present, 10 species of siganid group are reported by Mr. B.S. MARTOSEWOJO ETAL in "Marine Research in Indonesia (1975)".

(Mullet)

Mullet is produced in large quantities in Indonesia. One of the advantages of this fish is that it is a detritous feeder and can therefore cultured in tropical waters. There has arisen a growing interest in the culture of mullet since China and Israel succeeded in increasing its production by collecting sea-born fries and stocking them in inland lakes after acclimatiging them to fresh water.

Recent researches conducted in different countries for mullet culture are as outlined below.

The success of artificial seed production by hormone injection attained in Taiwan in 1960 was followed by the same success in Hawaii (Oceanographic Research Institute) and India. Mixed culture with carp in fresh water is conducted in Nigeria, and monoculture in fresh water in India. A noteworthy production of 2,400 kg/ha/year was attained by experimental monoculture at Central Inland Fisheries Research Institute at Kakdwip, West Bengal.

The number of species belonging to Indonesian mullet group is said to be 20 (Weber

and de Beaufort, 1922) or 4 ~ 5, but it is not ascertained yet Of these species, those which grow to have the largest weight within the shortest period should be identified and selected. In brackish water areas of Indonesia, mullet is a subsitute for milk fish when the supply of the latter's seeds is short, so that it is valued low and very cheap. However, if its production by stocking or culture in inland waters is materialized, mullet will be given a higher evaluation.

(3) Window pan shell and Asian mo

Window pan shell, popularly known as Kapis in Phillipines, is commercially propagated in the mud bottom zone tidal of east coast of Manila Bay and Baccor Bay.

The transparent shell is a good material to make a lampashade, a tray or an ornametal goods as the souvenires of Philippines. Therefore, the technological practices have been carried on for many years as the side work of fishermen. Moreover, the meat is used for food. They distribute from the tidal flat to the depth of 100 m depth along the shore line, but in general these sedimentary bivalve are favorably raised in shallow estuarine lagoons, covered with blue mud sediments together with an oyster.

Usually, kapis culture is carried out as follows. At first, they gathered kapis seeds ranging 25 – 40 mm in diameter from the spawning grounds and spreading them in shallow estuarine area enclosed by bamboo. Kapis larvae have a free swimming stage at the bigining of the early life cycle. After that, they usually lay on mud bottom. The growth rate is quite rapid. They can grow 55 – 77 mm in diameter within a year, 133 mm in the second year and matured in 3rd years. The meat ranging 12 – 13 cm in diameter has one centimeter thickness. The spawning season in Bacor Bay, seems to be from May to June. In 6 to 12 months, they reach to 140 mm in diameter in average and are ready to be harvested. After harvesting them, they are classified 4 degrees, from the point of quality. Some are send to window pan shell factory or exported to the foreign countries.

The bivalve feeds detritas settled on mud bottom and also feeds on living diatoms, dinoflagerats, copods, etc.

Following Asian moon scalop is also a useful vivalv, delicious and expensive one. They are caught by small trawls alon the west coast from Taichung to Pingtung in Formosa and also some part of Philippines but their biology are not elucidated yet. Therefore, no country has been cultured them in artificial condition, but culture of simping belongs Pectinidae is not so difficult with some ideas of Japanese pecten shell culture technique.

(4) The Ornamental Sea Fish

According to the report of F.A.O., recently ornamental fishes including salt water fish are becoming important exporting item of developing countries. In 1973, U.S.A., the biggest importer of ornamental fish obtained them from Eastern Asia (69.15%) and Latain (27.14%), two main regions of the world. Among the Asian countries, the major supplies were Hongkong (23.42%), Singapore (12.50%) and Thailand (18.82%). But Taiwan (6.0%), the Philippines (5.39%) and Indonesia (1.69%) still show evidence of an increasing development of their ornamental fish export potential.

Although ornamental fish imports into U.S.A. (1973) formed almost 99% of freshwater fish and 1% of wild-caught saltwater fish in total, recently aquaculturerists have a tendency to show an interest about sea ornamental fishes owing to the development and spread of sea fish aqualium equipments.

Under such circumstances, a saltwater fish fauna of potential interest to the trade are forcused on (I) Caribbean Sea (2) Indo-Pacific (3) Red Sea. According to the potential of price lists supplied by the dealers in saltwater fish, 23 families of greatest potential interest to the hobbyst are pointed out.

Fortunately, more than half of that families live in intertidal zones up to a depth of approximately 30 m of Indonesian coast (Dwiponggo, 1974), especially Bali Island. Therefore, we should pay attaintion to the situation of Denpasar, international tourist town of Bali Island which is very convenient for international trading. In order to fulfil the condition of international trading market, the Government should bring up companies and make some facilities. They say that a company should always hold more than 100 different species of saltwater fish. and also the Government must be adopted proper restriction upon unproper fishing method, fishing places and time in order to protect natural resources of wild sea ornamental fish.

One more important problem is how to reduce mortality during transportation, carring out by dealers from fishing places to the market place. The Government should be checked the mortality during these transportation and also teach them better techniques of transportation.

These techniques and regulation will become useful experiences for sea fish culture which will carried out in near future.

Table of Exported Ornamental Fishes

Freshwater fish	Saltwater fish
Macrones sp.	Amphiprion percula
Leioassis stenomus	Abudefduf biocellatus
Pseudotropius moulenburghae	Chromis caeruleus
Tetraodon reticularis	Cholmon rostratus
Lusiosoma setigerum	Parachaetodon ocellatus
Zenarhopterus ectuntio	Pomacanthus semicirculatus
Puntius tetrazona	Pygoplites diacanthus
Botia macracanthus	Centropyge bicolor
Puntius schwanenfeldi	C. tibicen
Cryptopterus bicirrhis	Zanclus cornutus
Botia hymenophysa	Zebrasoma veliferum
Cryptopterus cryptopterus	Paracanthurus teuthis
Betta picta	Acanthurus lineatus
B. splendens	Balistes flavimarginatus
Balantiochilus melanopterus	Odonus niger
Puntius fasciatus	Balistoides conspicilium
Rasbora trilineata	Hippocampus kuda
Rasbora spp.	Aeoliscus strigatus
Chela oxygastroides	Pterois volitans
Hampala macrolepidota	Apogon bifasciatum
H. ampalong	Lactoria cornuta
Epalzeorhynchus kallopterus	Chromileptis altivelis
Sphaerichthys osphromonoides	Myripristis murdjan
Trichogaster microlepis	Holocentrus rubrum
Labeo chryspekadion	Coris greenovii
Trichogaster leeri	C. gaimard
T. trichopterus	Novaculichthys taeniurus
Toxotes jaculator	Gomphosus varius
	Anampses meleagridis
	Halichoeres nigriscans
	Hemigymnus melapterus
	Thallasoma lunare
	Bodianus mesothorax

Source. Direktorat Jenderal Perikanan (1974)

Export Value by Country of Deslination (1971)

Country of destination	Value (U.S.$)	Percent
1. AMERICA		
U.S.A.	3,676	12.67
2. ASIA		
Hong Kong	1,511	5.21
Japan	483	1.66
Singapore	12,476	43.02
3. AUSTRALASIA		
Australia/Oceania	75	0.26
4. EUROPE		
Belgium/Luxembourg	513	1.77
Fed. Rep. of Germany	4,096	14.12
France	170	0.59
Italy	380	1.31
The Netherlands	2,764	9.53
U.K.	150	0.52
5. OTHER COUNTRIES	2,674	9.22
Total	28,998	

Export Value by Year

Year	Volume (kg)	Value (U.S.$) [a]
1968	23,106	32,870
1969	41,659	19,963
1970	96,585	34,171
1971	100,037	28,221
1972	190,000	37,000
1973 [b]	286,000	56,000
1974 [c]	181,000	28,000

Notes: 1. Prepared from Fisheries Statistics of Indonesia, 1972 (Direktorat Jenderal Perikana, 1973) and private communication with Direktorat Jenderal Perikanan.

2. a - FOB price
   b - Temporary price
   c - Up to August 1974

(All tables are from D.A. Conroy 1975, FIRS/C335)

Report on Marine Culture Survey in Indonesia
(March 28 – April 17, 1975)

Their representative marine culture experts,

by Dr. Yoshimitsu ARAKAWA,
Mr. Hiroshi OKADA

CONTENTS

I. Introduction

At the request of the Indonesian Government, the Japan International Cooperation Agency dispatched Dr. Arakawa and Mr. Okada, who conducted marine culture surveys along the north coast of Java for three weeks from March 28 to April 17, 1975. The tasks assigned to them were as follows:

- to undertake surveys for identification of suitable locations for the development of specific culture according to the ecological conditions;
- to introduce suitable methods of culture to be developed;
- to introduce the design of equipment required;
- to introduce and eventually to make experimentation for seed collection for certain marine culture; and
- to look for possibilities for the development of culture of edible fish, clam (cockle) or crustaceans, and seaweed.

Although it is hard to give the marine potential the once-over, discussions are made here, based on the findings of the survey and in consideration of the natural environments and socio-economic background there, for the measures that are considered agreeable to the development of marine culture.

The survey team should like to express its great indebtness the Indonesian Government, officials and the many individuals for their unlimited cooperation and assistance and warm hospitality extended to the team during its stay in Indonesia. The survey team's debt is particularly great to the officials of the Marine Fisheries Research Institute and the Direktorat Jenderal Perikanan Departemen Pertanian.

II. Summary

The north coast of Java Island standing on the Java Sea is climatically favoured throughout the year, has a great expanse of shallows and tidelands of fertile sandy silt which provide favourable breeding conditions for commercially valuable fishes and shellfishes, inter alia Bivalvia, lobsters, shrimps, and mullets.

Off the coast are islanded waters with abundance of coral reefs and calm lagoons which are eligible as habitats, sanctuary or culture ground for pearl oysters, edible and ornamental fishes, sea turtles, etc.

In addition, there are many resources of commercially valuable fishes and shellfishes left untapped.

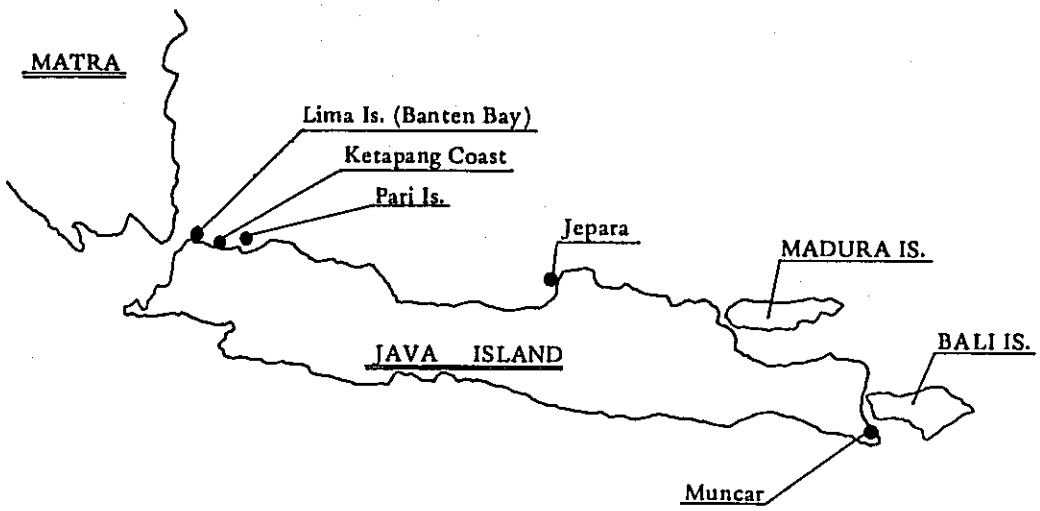
Without counting much on painstaking development of agriculture, these will be harnessed to raise marine outputs more than at present if demand stimulates the effort for fishing, improvement of fishing gears and methods or if the fishing grounds are operated properly.

III. Survey Areas and Itinerary

April 1, 1975	Ketapang Coast, Mauk, West Java
April 2, 1975	Lima Island, Banten Bay, West Java (LPPL oyster farm)
April 4 – 5, 1975	Pari Island, West Java (LPPL oyster farm, hawksbill farm)
April 9, 1975	Jepara, Central Java (UNDP crustaceans research facilities)
April 12, 1975	Muncar, Pangpang Bay, East Java

The investigations were made at the site stated above as to topography, related piscicultural facilities, marine conditions, bottom nature, fauna flora, etc.

Fig. 1. Survey Areas



IV. Findings

1. Ketapang Coast

General view:

Here, the shoal extends to a great distance and exposes a great expanse of tidelands when the tide is down.

The rivers teeming into the shoal are bringing about quantities of floating mud; the tidelands are provided with a couch of soft mud of as deep as 20 cm. This iron-rich soft mud is suitable as a habitat of Bivalve, particularly as breeding and culture grounds of Arcidae.

As regards the transplantation and culture of *Tegillarca granosa*, the Indonesia Marine Fisheries Research Institute has been making studies since 1976 and has already raised substantive results.

Marine conditions and bottom nature:

St. 1 (approx. 300 m off the estuary)

Transparency:	0.3 m
Bottom nature:	Top layer (0 – 10 cm), floccules Middle layer (10 – 15 cm), iron-rich blackish hard sandy mud Bottom layer (15 cm –), grey sandy mud No stink

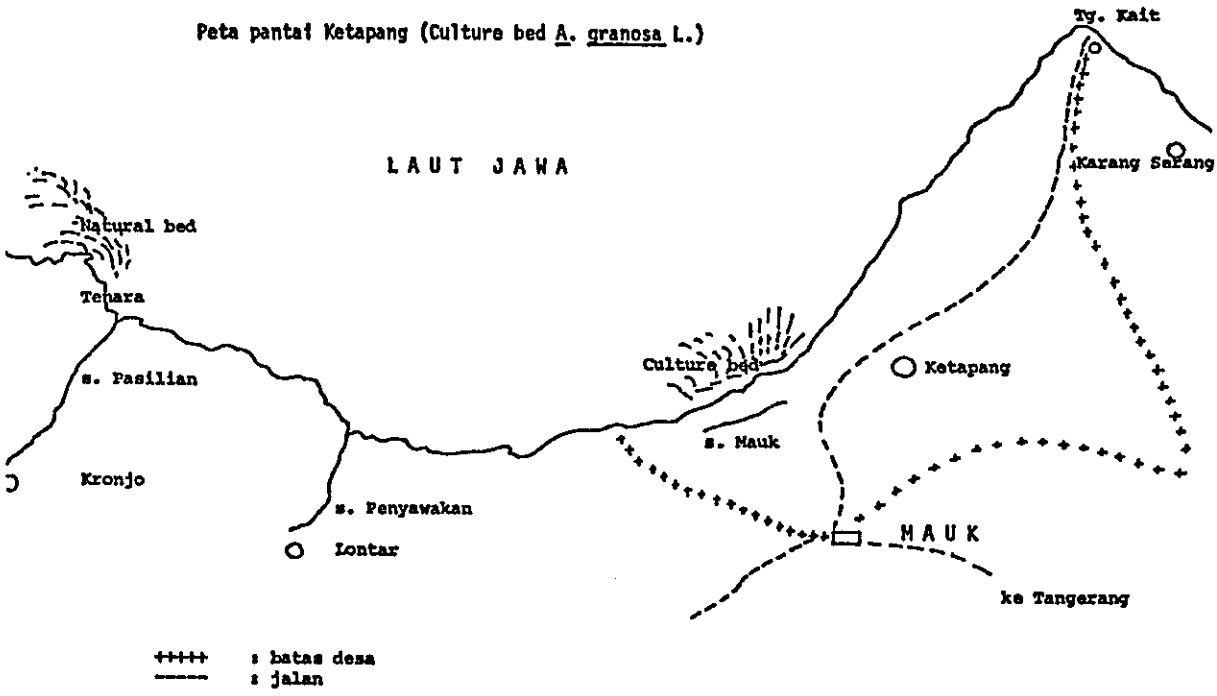
St. 2 (approx. 500 m off the estuary)

Specific gravity:	1.0207 (surface)
Water temperature:	26.2°C (surface)
Bottom nature:	Top layer (0 – 10 cm), iron-rich blackish mud Bottom layer (10 cm –), grey sandy layer No stink

St. 3 (approx. 800 m off the estuary)

Transparency:	0.4 m
Bottom nature:	Top layer (0 – 8 cm), floating mud Middle layer (8 – 18 cm), iron-rich blackish mud Bottom layer (18 cm –), grey sandy mud No stink

Fig. 2. Ketapang and Its Vicinities



Fauna (shellfishes):

GASTROPODA

	Planaxis sulcatus	(Planaxidae)
	Clyepomosus petrosus	(Cerithidae)
	Clyepomosus coralium	(Cerithidae)
	Clyepomosus batillariaeformis	(Cerithidae)
*	*Paratectonatica tigrina*	(Naticidae)
*	*Mancinella mutabilis*	(Muricidae)
	Euplica versicolor	(Pyrenidae)
**	*Pictocolumbella acellata*	(Pyrenidae)
	Nassarius coronatus	(Nassariidae)
	Plicarcularia bellula	(Nassariidae)
	Plicarcularia leptospira	(Nassariidae)
	Zeuxis crenulatus	(Nassariidae)
	Lophiotoma marmoratum	(Tarridae)

BIVALVE

***	*Tegillarca granosa*	(Arcidae)
**	*Placuna placenta*	(Placunidae)
***	*Pitar exicsa*	(Veneridae)
***	*Meretrix lyrata*	(Veneridae)
***	*Marcia ceylonensis*	(Veneridae)

* Enemy, ** Ornamental, *** Edible

Comments:

The site is alive with natural seeds of *Tegillarca granosa*; overpopulation resulting from less catching efforts seems likely to have checked the growth. At present, it is preferable to avoid the overpopulation and make the most of the resources by planned and rationalized catching and operation of fishing grounds rather than to push forward culture. It will be feasible to transplant and breed *Tegillarca granosa* at suitable places along Kenpang Coast with Tenara Natural Bed as center, if the following conditions are provided:

1) Where the seaweeds will not grow;
2) Where the seabed shows itself at low tide;
3) Where fresh water mixes with sea water (e.g., around estuary); and
4) Where soft mud is present 15 to 30 cm deep.

For those places which are less influenced by fresh water and have less muddy components, Veneridse (*Meretrix lyrata, Marcia ceylonensis*) will grow well.

Gears suitable for harvesting commercially vauable Bivalvia are suggested in Figs. 3

through 5. If these implements are fully used in a planned way, the catches will be increased, and at the same time the resultant cultivation of seabed will improve the habitat for clams to enhance the marine productivity.

Fig. 3. Shallow-water Dredge for Edible Clams
(*Venerupis, Meretrix & Mactra*, etc.)

Shallow water dredge for edible clams,
Venerupis, Meretrix & Mactra.

Handle length: 1.5 m

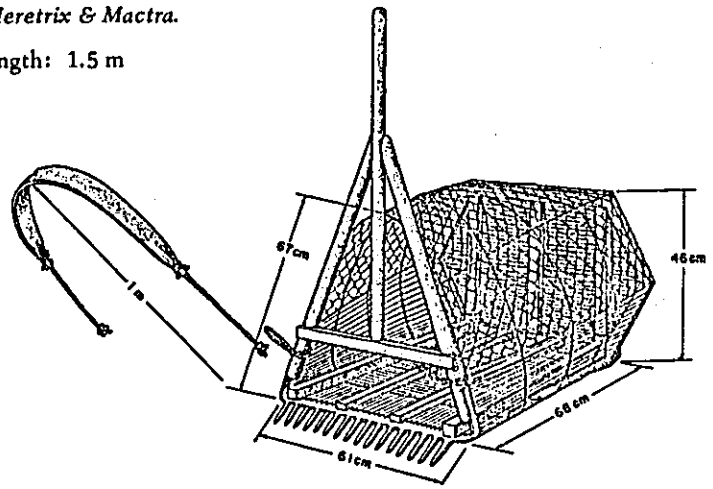
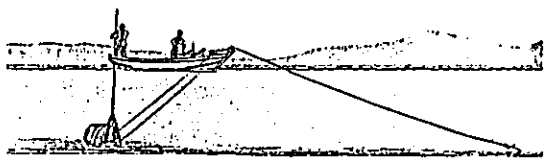


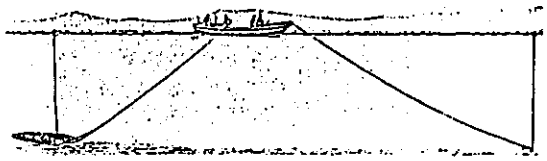
Fig. 4. Clam Harvesting Methods

A. In Shallow Water

B. In Water of Medium Depth

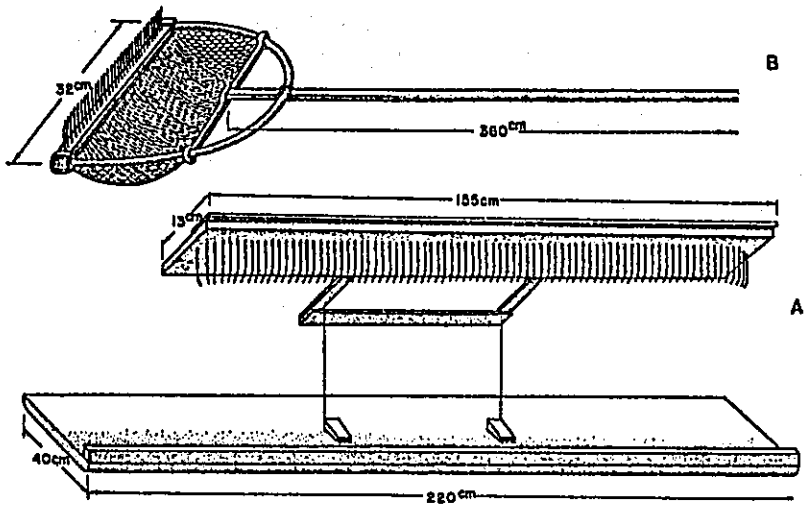


C. In Deep Water



A. In shallow water (around 1 m deep), B. In water of medium depth (2 - 3 m), C. In deep water

Fig. 5. Collecting Gear for *Anadara Granosa*



Use:

Kneel down on one knee on the skiing board (Fig. 5–A), and kick the mud by the other foot to run about on the tidelands. While travelling on the tidelands, collect the clams by a small-shanked rake (Fig. 5–B).

2. Lima Island

General view:

Lima Island is made up of coral reefs, and its shores have well-developed fringing reefs. Since 1972, the Indonesia Marine Fisheries Research Institute has conducted seedage test of Bombay oyster ((?) *Crassostrea culculata** (?)) and *Ostrea* c.f. *circumpicta*** near Karangantu in the recesses of Banten Bay. As of April 1975, the raft hanging method of oyster culture was in progress in the waters near Lima Island, but the fatteness of oysters generally seemed to be not good. High transparency shows less suspended solids.

Marine conditions and bottom nature:

St. 1 (approx. 300 m off the estuary of Karangantu Canal)

Transparency:	smaller than 1.5 m
Water temperature:	29.7°C (surface)

* So called as they abound around Bombay, India. Also seeable in Japan. Not so revered.

** This species has much in common with *Crassostrea belcheri* (to be explained later on) in both appearance and distribution, but is viviparous.

Specific gravity:	1.0259 (surface)
Bottom nature:	Top layer (0 – 7 cm), soft brown floating mud
	Bottom layer (7 cm –), grey mud
	No stink

St. 2 (approx. 1,000 m seaward of St. 1)

Transparency:	1 m
Water temperature:	29.4°C (surface)
Specific gravity:	1.0267 (surface)
Bottom nature:	Much floating mud
	0 cm – : Grey mud with shell fragments
	No stink

St. 3 (Rfat type oyster bed near Lima Island)

Transparency:	2.8 m
Water temperature:	29.3°C (surface)
Specific gravity:	1.0268 (surface)
Bottom nature:	0 cm – : Grey sandy mud
	No stink

Fauna (shellfishes):

GASTROPODA

	Tectus triserialis	(Trochidae)
***, **	*Tectus niloticus*	(Trochidae)
**	*Tectus conus*	(Trochidae)
	Lunella cineraea	(Turbinidae)
	Theliostyla laveilirata	(Neritidae)
	Theliostyla squamulata	(Neritidae)
	Amphinerita polita	(Neritidae)
	Ritena signata	(Neritidae)
**	*Telescopium telescopium*	(Potamididae)
**	*Terebralia palustris*	(Potamididae)
	Terebralia sulcata	(Potamididae)
	Clypeomorus coralium	(Cerithidae)
***, **	*Laevistombus canarium turturella*	(Strombidae)
**	*Lambis lambis*	(Strombidae)
**	*Erosaria miliaris inocellata*	(Cypraeidae)
**	*Erronea errones*	(Cypraeidae)
*	*Morulina concatenata*	(Muricldae)
**	*Rhizoconus vexillum*	(Conidae)

BIVALVIA

	Arca terebra	(Arcidae)

	Barbatia bicolorata	(Arcidae)
	Barbatia multivillosa	(Arcidae)
**	*Anadara antiqua*	(Arcidae)
	Modiolus agripetus	(Mytilidae)
	Isogonum isogonum	(Isognomonidae)
	Malleus daemoniacus	(Malleidae)
**	*Comptopallium radula*	(Pectinidae)
**	*Fimbria fimbriata*	(Fimbriidae)
	Chama ambiqua	(Chamidae)
	Chama brassica	(Chamidae)
***, **	*Regozara flavum*	(Cardiidae)
***, **	*Tridacna crocea*	(Tridacnidae)
***, **	*Tridacna squamosa*	(Tridacnidae)
***	*Gafrarium tumidum*	(Veneridae)
	Gafrarium disper	(Veneridae)
**	*Pitar striatum*	(Veneridae)
**	*Tapes lirata*	(Veneridae)
***	*Pteriglypta clathrata*	(Veneridae)
	Atactodea striata	(Mesodesmatidae)
	Lutraria arcuata	(Mactridae)
	Semele carnicolor	(Semelidae)
	Tellinella staurella	(Tellinidae)
***	*Cyclotellina remies*	(Tellinidae)
***	*Asaphis dichotoma*	(Psammobiidae)

** Ornamental, *** Edible

Comments:

The waters having coral reefs developing usually have an annual average transparency of more than 20 m and also a considerably rapid current. Such places are not suitable for oyster culture because of deficiency in suspended solids and phytoplankton the oysters feed on.

Instead, it is recommended to use the rack method on the tidelands near the estuary which are influenced by turbid, nutrient freshwater. (See Figs. 6 & 7)

Fig. 6. Lima Island and Its Vicinities

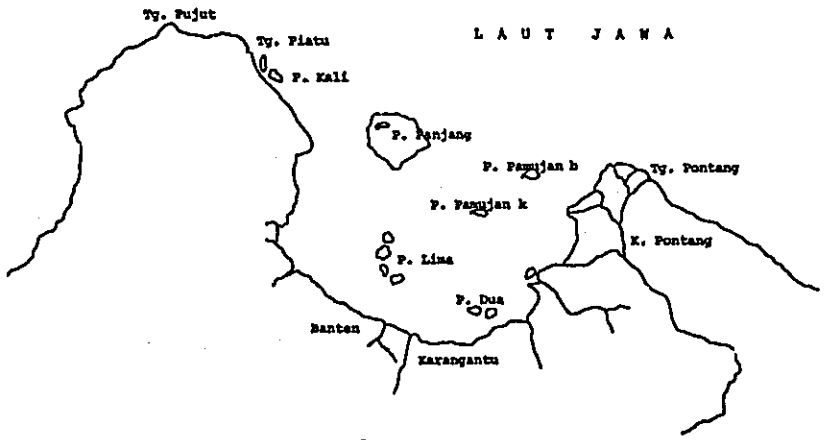
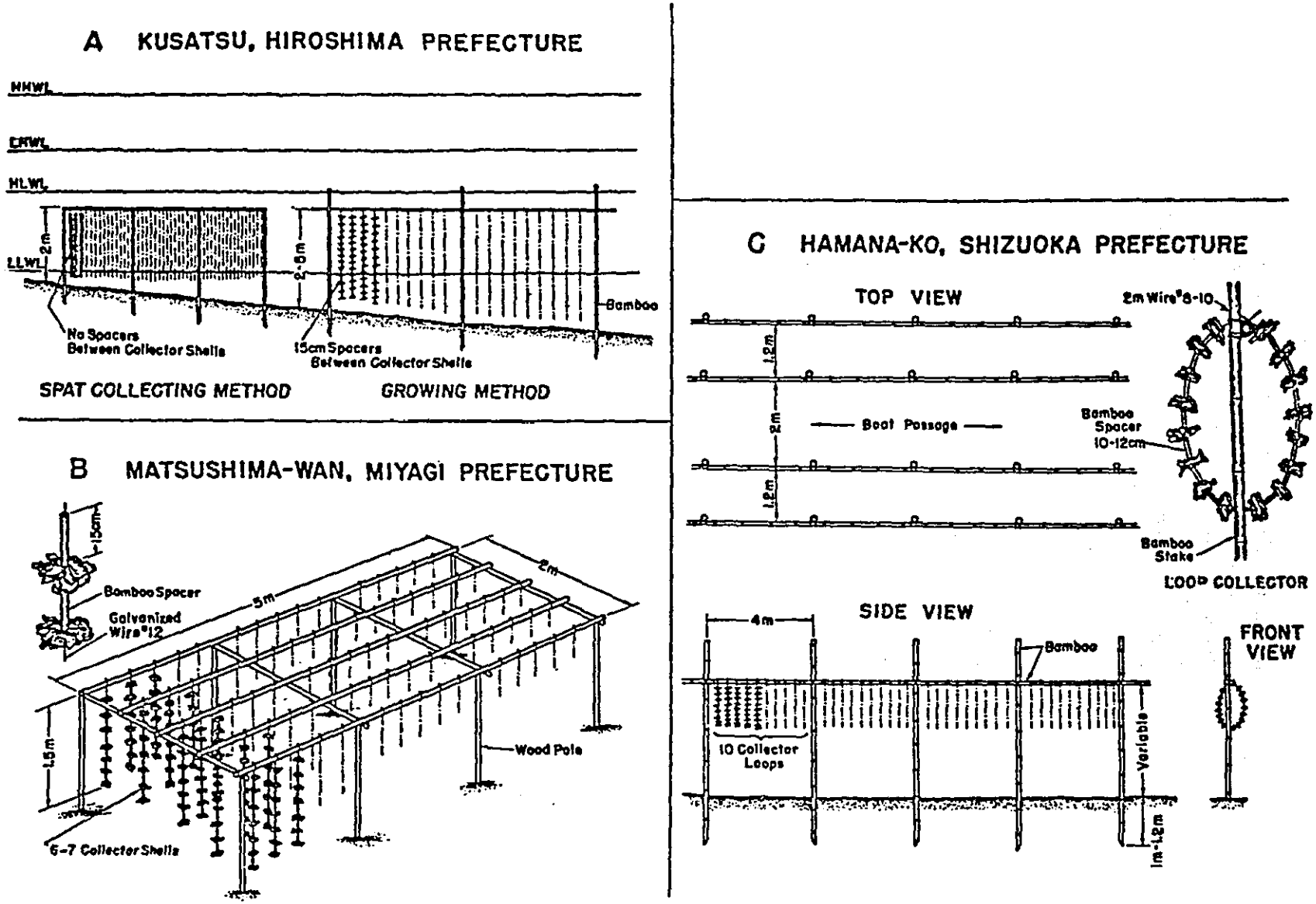


Fig. 7. Rack Method of Oyster Culture on Tideland



So far, the commercially viable oyster farms known to the world have been found in comparatively high latitudes from temperate to sub-frigid zones, and there has been no reporting successes in the tropical zones.

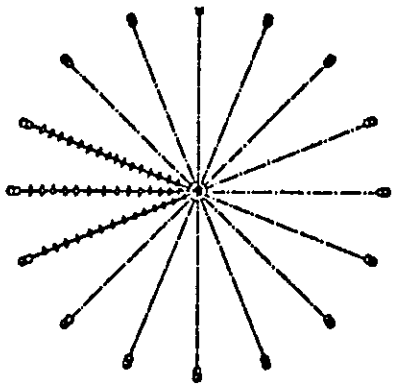
This is because the water temperatures are as high as 30°C throughout the year to permit of no chance for oysters to grow plump.

In order to cope with this problem, the following measures will be necessary:

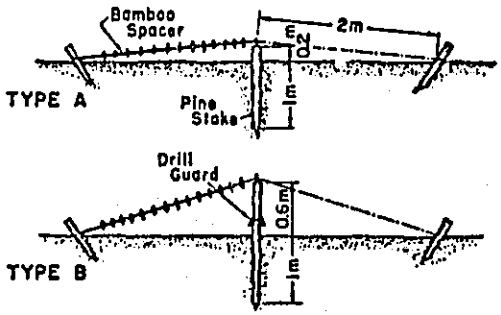
1) Transplantation to waters of different environmental conditions to check the changes in fatness by season and by environment and also to check for the marginal level of fattening.
2) Identification and culture of species which are edible and grow fat even in tropical zones (e.g., *Crassostrea belcheri* and the like)
3) If oysters with estable fatness can be raised in Indonesia, there will be no problem in spat collection. Then Indonesia might be an important looked-for supplier of spats to Australia and New Zealand which have been distressed with chronic shortage of spats in recent years.

Fig. 8. Umbrella Method of Oyster Culture on Tideland of Shoaling Beach

Top View



Side View



Topographically and climatically, Banten Bay and its vicinities are considered eligible for a spat collecting ground. It is worth investigating the spawning period, larval, distribution and implantation of young oysters.

3. *Pari Island*

General view:

This is an island made up of coral reefs impounded by atolls, and is rich in biota. Calm throughout the years, the waters in the lagoons will be tamed for multi-purpose projects, including the breeding and culture of fishes and crustaceans. In support of this, the Marine Fisheries Research Institute has implemented plans for raft method of oysterage and installation of artificial fishing reefs for raising sea turtles like hawksbill.

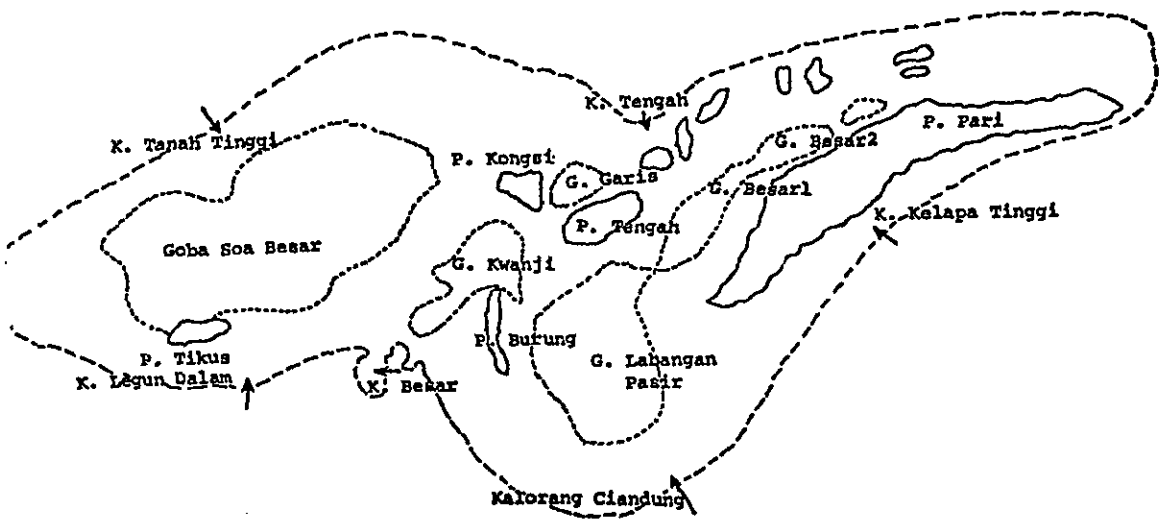
On the tidelands, *Anadara antiqua* (Arcidae) and *Pitar striatum* (Veneridae) are noticed and on the roots of Mangroves, edible Bivalvia, including Prestostrea, inhabit.

Marine conditions and bottom nature:

St. 1 (near oyster bed in the lagoon)

Transparency:	smaller than 3.3 m
Water temperature:	28.7°C (surface)
Specific gravity:	1.0254 (surface)
Bottom nature:	Grayish white fine sand
	No stink

Fig. 9. Pari Island and Its Vicinities



Fauna (shellfishes):

GASTROPODA

**	*Trochus maculatus verrucosus*	(Trochidae)
**	*Trochus fenestratus*	(Trochidae)
	Chrysostoma paradoxum	(Trochidae)
	Astralium calcar	(Turbinidae)
	Theliostyla albicilla	(Neritidae)
	Amphinerita insculpta	(Neritidae)
	Ritean signata	(Neritidae)
	Littoraria scabra	(Littorinidae)
	Terebralia palustris	(Potamididae)
	Terebralia sulcata	(Potamididae)
	Rhinoclavis asperum	(Cerithidae)
	Rhinoclavis vertagus	(Cerithidae)
	Cerithum columna	(Cerithidae)
**	*Canarium urceum*	(Strombidae)
**	*Canarium labiatum*	(Strombidae)
**	*Gibberulus gibberulus gibbosus*	(Strombidae)
**	*Harpago chiragra*	(Strombidae)
*, **	*Polinices vavaosi*	(Naticidae)
*, **	*Polinices pyriformis*	(Naticidae)
**	*Cypraea tigris pardalis*	(Cypraeidae)
**	*Cymatriton nicobaricus*	(Cymatiidae)
	Gutturnium muricinum	(Cymatiidae)
	Bursa tuberosissima	(Bursidae)
*, **	*Muricodrupa fiscellum*	(Muricidae)
*	*Cronia margariticola*	(Muricidae)
	Pollia proteus	(Buccinidae)
	Nassarius coronatus	(Nassariidae)
	Nassarius coronulus	(Nassariidae)
	Zeuxis crenulatus	(Nassariidae)
	Zeuxis margaritiferus	(Nassariidae)
	Volema myristica	(Galeoidae)
**	*Pterygia dactylus*	(Mitridae)
	Milda ventricosa	(Pyramidellidae)
	Longchaeus	(Pyramidellidae)

BIVALVIA

	Barbatia bicolorata	(Arcidae)
***	*Anadara antiqua*	(Arcidae)
	Pinna muricata	(Pinnidae)
***	*Atrina vexillum*	(Pinnidae)
	Isogonum isogomum	(Isognomonidae)

	Isogonum acutirostris	(Isognomonidae)
	Malleus daemoniacus	(Malleidae)
**	*Pinctada margaritifera*	(Pteriidae)
**	*Spondylus ducalis*	(Spondylidae)
	Dendostrea folium	(Ostreidae)
(***)	*Saxostrea mordax*	(Ostreidae)
***	*Prestostrea hyotis*	(Ostreidae)
***	*Prestostrea sinensis*	(Ostreidae)
	Codakia tigerina	(Lucinidae)
	Codakia paytenorum	(Lucinidae)
	Chama iostoma	(Chamidae)
***	*Regozara flavum*	(Cardiidae)
**	*Fragum unedo*	(Cardiidae)
***, **	*Tridacna gigas*	(Tridacnidae)
***, **	*Tridacna crocea*	(Tridacnidae)
***, **	*Hippopus hippopus*	(Tridacnidae)
***	*Gafrarium tumidum*	(Veneridae)
***	*Pitar striatum*	(Veneridae)
**	*Tapes literata*	(Veneridae)
***	*Pteriglypta puerpera*	(Veneridae)
***	*Pteriglypta clathrata*	(Veneridae)
	Atactodea striata	(Mesodesmatidae)
	Davila planum	(Mesodesmatidae)
	Quadrans garadia	(Tellinidae)
	Quidnipagus palatum	(Tellinidae)
**	*Tellinella virgata*	(Tellinidae)
**	*Tellinella staurella*	(Tellinidae)
***, **	*Cyclotellina remies*	(Tellinidae)
***	*Asaphis dichotoma*	(Psammobiidae)

* Enemy, ** Ornamental, *** Edible

Comments:

It will be possible to apply the raft method of culture for raising *Pinctada margaritifera, P. fucata, P. penguin* and similar pearl oysters and sponges.

Floating netcage culture of Serranidae and Scaridae and other edible and ornamental fishes which take to coral reefs as a hive will also be feasible by making use of part of rafts.

It is also suggested to raise Hawksbill turtles (for ornamental and handicraft use) and Green turtles (for food) in crawls in part of shoal.

It is also worth investigating the feasibility of spat collection of *Pinctada margaritifera* and *P. penguin* and similar large-sized pearl oysters in the lagoons. If possible, their culture will be promising.

Since the lagoons are inhabited by large sea turtles, the nearby tidelands hold potential as a spawning ground and an intensive hatchery for breeding.

4. Jepara Coast

General view:

Here, an experimental station under UNDP was established around the end of 1974, and a plan for the pond culture of crustaceans is in progress by making use of the places where salt farms once prospered. Here is a fertile shoaling beach, and the breeding of Mugilidae, Ostreidae and Arcidae, in addition to crustaceans, will be promising.

Marine conditions and bottom nature:

St. 1 (approx. 100 m off the estuary)

Transparency:	less than 1 m
Water temperature:	approx. 30.5°C (surface)
Specific gravity:	1.0244 (surface)
Bottom nature:	Much floating mud
	0 – 7 cm: Brown floccules
	7 cm – : Blackish brown sandy mud containing iron
	No stink

St. 2 (500 m off the estuary)

Transparency:	less than 1.5 m
Water temperature:	30.4°C (surface)
Specific gravity:	1.0261 (surface)
Bottom nature:	Much floating mud
	0 – 10 cm: Light brown mud
	No stink

Fauna (shellfishes):

GASTROPODA

	Crysostoma paradoxum	(Trochidae)
	Angaria atrata	(Angariidae)
*	*Canarium urceum*	(Strombidae)
**, *	*Polinices vavaosi*	(Naticidae)
**, *	*Polinices pyriformis*	(Naticidae)
*	*Eunaticina papilla*	(Naticidae)
	Gyrineum elegans	(Bursidae)
*	*Murex trapa*	(Muricidae)

*	*Cronia margariticola*	(Muricidae)
**	*Vexillum rugosum*	(Mitridae)
**	*Vexillum balteolatum*	(Mitridae)
	Milda ventricosa	(Pyramidellidae)
	Cassidula nucleus	(Ellobiidae)

BIVALVIA

	Barbatia multivillosa	(Arcidae)
***	*Anadara antiqua*	(Arcidae)
***	*Anadara crebricostata*	(Arcidae)
***	*Tegillarca granosa*	(Arcidae)
***	*Tegillarca nodifera*	(Arcidae)
	Anomia chinensis	(Anomiidae)
**	*Placuna placenta*	(Placunidae)
***	*Pretostrea hyotis*	(Ostreidae)
	Cycladicama oblonga	(Ungulinidae)
	Chama iostoma	(Chamidae)
***	*Gafrarium tumidum*	(Veneridae)
	Pitar lineatulum	(Veneridae)
***	*Katelysia japonica*	(Veneridae)
***	*Marcia ceylonensis*	(Veneridae)
	Anomalocardia squamosus	(Veneridae)
	Latona faba	(Donacidae)
	Tellinides timorensis	(Tellinidae)
	Psammobia rabiata	(Psammobiidae)
	Psammotelling ambigua	(Psammobiidae)

* Enemy, ** Ornamental, *** Edible

Comments:

The fattening of oysters is considered feasible because of easy control over water quality and feed, and it will be worth trying pond culture of crustaceans and Ostreidae.

5. **Muncar (Pangpang Bay)**

General view:

Muncar is a calm inlet surrounded by lands and facing open to the north. The waters in the eastern pocket of the inlet are deep, while the southern and western coasts form a shoaling beach, which is transformed into a great tideland at low tide. There are rivers running into the inlet.

Among other places so far investigated, the inlet is considered best suited to the

oysterage. At places in the inlet, there are colonies of wild oysters, but they all are small in size.

On the tideland in the west of the inlet, there live large-sized short-necked clam-like *Katelysia hiantina* (Veneridae), the breeding of which will also be hopeful.

Marine conditions and bottom nature:

St. 1 (approx. 400 m east of Muncar Fishing Port)

Transparency:	1.5 m
Water temperature:	31.2°C (surface)
Specific gravity:	1.0254 (surface)
Bottom nature:	0 – 5 cm, black sandy mud, a little hard Odorous

St. 2 (approx. 1,500 m east of Muncar Fishing Port)

Transparency:	1.5 m
Water temperature:	31.2°C (surface)
Specific gravity:	1.0253 (surface)
Bottom nature:	Much floating mud (25 cm) 0 – 5 cm: Blackish brown mud 5 cm – : Black mud Odor of hydrogen sulfide

Fauna (shellfishes):

***	*Atrina vexillum*	(Pinnidae)
**	*Pinctada fucata*	(Pteriidae)
***	*Gafrarium tumidum*	(Veneridae)
***	*Katelysia hiantina*	(Veneridae)

** Ornamental, *** Edible

Comments:

The deep waters in the east of the inlet are well situated for the raft method of oysterage. The water itself seems likely to be entrophic. If spats can be collected, the oysterage will be promising. It is therefore necessary to conduct tests on spat collection and fattening.

Another condition that favours this site is that the markets like Bali Island are within easy reach, just ahead of a waterway.

Fig. 10. Muncar (Pangpang Bay) and Its Vicinities

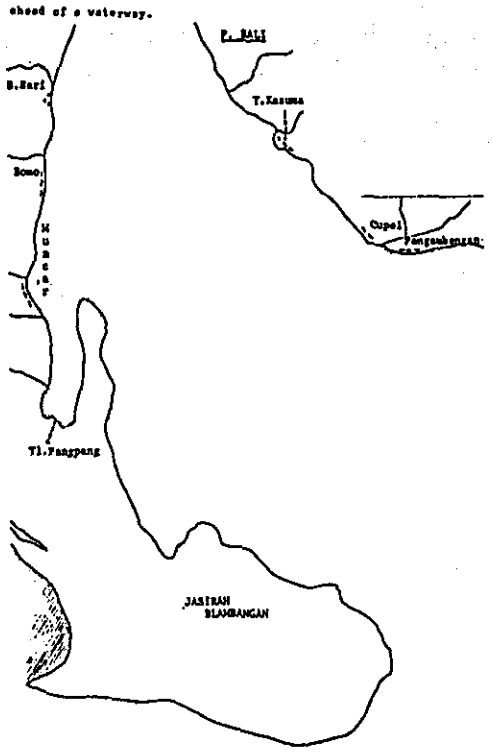
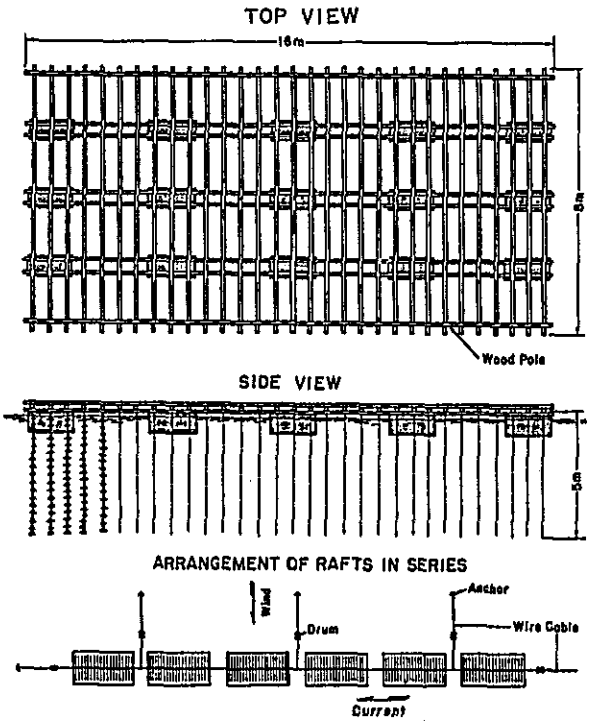


Fig. 11. Raft Hanging Method of Oyster Culture



V. Recommendations

1. Not only the development of culture, but is it important to improve the fishing boats and fishing gears, to operate the fishing grounds efficiently in a planned way for the purpose of making the most of untapped sea food resources in order to raise the marine productivity.

2. The technological development should not be limited to marine culture alone, but should be closely linked to socio-economic backgrounds. Namely, the improvement and amplification of economic distribution structure (markets, cold chain system, etc.) and of processing and storage techniques will stimulate the demand for marine products and give the fishery major incentives to the promotion of catching and development of culture.

3. Efforts should also be made to rear up staff engineers for marine culture, to improve and amplify the marine culture research organs, to enlist more of younger researchers and to invest in the research activities much more money.

VI. Appendix

** List of Molusca Collected from Various Regions along the North Cost of Java, Indonesia (March 28 – April 17, 1975)

	Sites of Collection				
	Lima Is. (Banten Bay)	Keta-pang (Mauk)	Pari Is.	Jepara	Muncar (Pangpang Bay)
MOLLUSCA					
Castropoda					
Trochidae					
Trochus (Trochus) maculatus verrucosus (Gmelin, 1970)			(1)		
Trochus (Trochus) fenestratus (Gmelin, 1971)			(1)		
Tectus (Tectus) triserialis (Lamarck, 1820)	(2)				
Tectus (Rochia) niloticus (Linne, 1767)	(1)				
Tectus (Rochia) conus (Gmelin, 1790)	(1)				
Chrysostoma paradoxum (Born, 1780)			(2)	(1)	
Angariidae					
Angaria atrata (Reeve, 1843)				(1)	
Turbinidae					
Lunella cineraea (Born, 1798)	4				
Astralium (Astralium) calcar (Linne, 1758)			2		

	Sites of Collection				
	Lima Is. (Banten Bay)	Keta-pang (Mauk)	Pari Is.	Jepara	Muncar (Pangpang Bay)
Neritidae					
Theliostyla laevilirata (Soweby, 1914)	1				
Theliostyla squamulata (Recluz, 1842)	(1)				
Theliostyla albicilla (Linne, 1758)				1	
Amphinerita insculpta (Recluz, 1842)				3	
Amphinerita polita (Linne, 1758)	3				
Ritena signata (Lamarck, 1822)	(2)			(2)	
Littorinidae					
Littoraria scabra (Linne, 1758)				1	
Planaxidae					
Planaxis sulcatus (Born, 1778)		2			
Potamididae					
Telescopium telescopium (Linne, 1758)	(1)				
Terebralia palustris (Linne, 1767)	(1)			2	
Terebralia sulcata (Born, 1780)	(1)			14	
Cerithidae					
Clypeomorus petrosus (Wood, 1828)	1	4			
Clypeomorus coralium (Kiener, 1834)		13			
Clypeomorus batillariaeformis (Habe & Kosuge)		3			
Rhinoclavis asperum (Linne, 1758)				(4)	
Rhinoclavis vertagus (Linne, 1767)				13	
Cerithium columna (Sowerby G. B. II., 1825)				(2)	
Strombiidae					
Canarium labiatum (Roding, 1798)			(2)		
Canarium urceium (Linne, 1758)			2(7)	(4)	
Gibberulus g. gibbosus (Roding, 1798)			(2)		
Laevistrombus canarium turturella (Roding, 1798)	13				
Harpago chiragra (Linne, 1758)			1		
Lambis lambis (Linne, 1758)	1				
Naticudae					
Paratectonatica tigrina (Roding, 1798)		(1)			
Polinices vavaosi (Reeve, 1843)			(3)	(1)	
Polinices pyriformis (Recluz, 1844)			1	(1)	
Eunaticina papilla (Gmelin, 1791)				(1)	
Cypraeidae					
Cypraea tigris pardalis (Shaw, 1909)			2		
Erosaria miliaris inocellata (Gray, 1825)	(1)				
Erronea (Erronea) errones (Linne, 1758)	(1)				
Cymatiidae					
Cymatriton nicobaricus (Roding, 1798)			2		
Gutturnium muricinum (Roding, 1798)			(2)		

	Sites of Collection				
	Lima Is. (Banten Bay)	Keta-pang (Mauk)	Pari Is.	Jepara	Muncar (Pangpang Bay)
Bursidae					
Gyrineum elegans (Sowerby G. B. II, 1820)				(1)	
Bursa tuberosissima (Reeve, 1844)			1		
Muricidae					
Murex trapa (Roding, 1798)				(1)	
Mancinella mutabilis (Link, 1806)		(1)			
Morulina concatenata (Lamarck, 1822)	(1)				
Muricodrupa fiscellum (Gmelin, 1791)			(2)		
Cronia margariticola (Broderip, 1833)			(1)	(1)	
Pyrenidae (Columbellidae)					
Euplica versicolor (Sowerby G. B. I, 1832)		(1)			
Pictocolumbella ocellata (Link, 1807)		1			
Buccinidae					
Pollia proteus (Reeve, 1847)				(2)	
Nassariidae					
Nassarius coronatus (Bruguiere, 1929)				(1)	
Nassarius coronulus (A. Adams, 1852)		(2)			
Plicarcularia bellula (A. Adams, 1852)		(1)			
Plicarcularia leptospira (A. Adams, 1852)		(1)			
Plicarcularia globosa (Quoy & Gaimard, 1832)		(1)		2	
Zeuxis crenulatus (Lamarck, 1799)		(9)		1	
Zeuxis margaritiferus (Dunker, 1846)				(1)	
Galeoidae					
Volema myristica (Roding, 1798)				5(3)	
Mitridae					
Pterygia (Pterygia) dactylus (Linne, 1758)			(1)		
Vexillum (Vexillum) rugosum (Gmelin, 1791)				(3)	
Vexillum (Vexillum) balteolatum (Reeve, 1844)				(1)	
Turridae					
Lophiotoma marmoratum (Link, 1807)		(2)			
Conidae					
Phizoconus vexillum (Gmelin, 1788)	(1)				
Pyramidellidae					
Milda ventricosa (Gmelin, 1791)			2	(1)	
Longchaeus eburnea (Laseron, 1959)			(1)		
Ellobiidae					
Cassidula nucleus (Gmelin, 1791)				(1)	

	Sites of Collection				
	Lima Is. (Banten Bay)	Keta-pang	Pari Is.	Jepara	Muncar (Pangpang Bay)
Achatinidae					
Achatina fulica Ferussac					
Bivalvia					
Arcidae					
Arca terebra (Iredale, 1939)	(1)				
Barbatia (Ustularca) bicolorata (Dillwyn, 1817)	(7)		(1)		
Barbatia (Ustularca) multivillosa (Iredale, 1939)	(1)			(1)	
* *Anadara antiquata* (Linne, 1758)	(2)		17	(1)	
Anadara crebricostata (Reeve, 1844)				(2)	
* *Tegillarca granosa*		1(6)		(4)	
Tegillarca nodifera (v. Martens, 1860)				(1)	
Mytilidae					
Septifer (Septifer) bilocularis (Linne, 1758)				(1)	
Modiolus (Modiolus) agripetus (Iredale, 1939)	1				
Pinnidae					
Pinna (Quantulopinna) muricata (Linne, 1758)			2		
Atrina (Atrina) vexillum (Born, 1778)			1		
Isognomonidae					
Isogonum (Isogonum) isogomum (Linne, 1758)	(1)		2		
Isogonum (Parviperna) acutirostris (Dunker, 1848)			1		
Malleidae					
Malleus (Parimalleus) daemoniacus (Reeve, 1858)	(5)		(2)		
Pteriidae					
** *Pinctada margaritifera* (Linne, 1758)			3		
** *Pinctada fucata* (Gould, 1850)					
Spondylidae					
Spndylus (Lamilda) ducalis (Roding, 1798)			3		
Pectinidae					
Comptopalluim radula (Linne, 1758)	(1)				
Anomiidae					
Anomia chinensia (Philippi, 1849)				(4)	
Placunidae					
** *Placuna placenta* (Linne, 1758)		(2)		(5)	

	Sites of Collection				
	Lima Is. (Banten Bay)	Keta-pang (Mauk)	Pari Is.	Jepara	Muncar (Pangpang Bay)
Ostreidae					
Dendostrea folium (Linne, 1758)			10		
* *Saxostrea mordax* (Gould, 1850)			3		
* *Pretostrea hyotis* (Linne, 1758)			(2)	(1)	(1)
* *Pretostrea sinensis* (Gmelin, 1793)			(1)		
Ungulinidae					
Cycladicama oblonga (Hanley, 1842)				(1)	(1)
Lucinidae					
Codakia tigerina (Linne, 1758)			2		
Codakia paytenorum (Iredale, 1927)			1		
Fimbriidae					
Fimbria fimbriata (Linne, 1758)	(1)				
Chamidae					
Chama (Chama) ambigua (Lischke, 1870)					
Chama (Chama) brassica (Reeve, 1846)	1(1)				
Chama (Chama) iostoma (Conrad, 1837)			(1)		
Chama (Chama) sp.	(2)				(1)
Cardiidae					
Regozara flavum (Linne, 1758)	24(1)		3		
Fragum unedo (Linne, 1758)			6		
Tridacnidae					
** *Tridacna (Tridacna) gigas* (Linne, 1758)			(2)		
Tridacna (Chametrachea) crocea (Lamarck, 1918)	2		3		
** *Tridacna (Flodacna) squamosa* (Lamarck, 1819)	(1)				
** *Hippopus hippopus* (Linne, 1758)			(2)		
Veneridae					
Gafrarium tumidum (Roding, 1798)	14(2)		1	(2)	2
Gafrarium disper (Dillwyn, 1817)	1				
* *Pitar (Pitarina) striatum* (Gray, 1855)	3		13		
Pitar (Pitarina) eixcsa (Gmelin, 1791)		(1)			
Pitar (Hyphantosoma) lineatulum (Sowerby, G. B. II, 1854)					
Meretrix lyrata (Sowerby, 1851)		(4)			
* *Katelysia (Hemitapes) hiantina* (Lamarck, 1818)					8
Katelysia (Hemitapes) japonica (Gmelin, 1791)				(3)	
Marcia ceylonensis (Sowerby, 1867)		(1)		(3)	
Tapes literata (Linne, 1758)	(1)		2		
Anomalocardia (Anomalodiscus) squamosus (Linne, 1758)				(5)	
* *Pteriglypta puerpera* (Linne, 1758)			5		
* *Pteriglypta clathrata* (Deshayes, 1854)	(4)		3(2)		
Mesodesmatidae					
Atactodea striata (Gmelin, 1791)	(1)		1		
Davila planum (Hanley, 1843)			(1)		

	Sites of Collection				
	Lima Is. (Banten Bay)	Ketapang (Mauk)	Pari Is.	Jepara	Muncar (Pangpang Bay)
Mactridae					
Lutraria (Psammophila) arcuata (Reeve, 1854)	(1)				
Donacidae					
Latona faba (Gmelin, 1791)				(13)	
Semelidae					
Semele carnicolor (Hanley, 1845)	1				
Tellinidae					
Quadrans garadia (Linne, 1758)			(2)		
Quidnipagus palatam (Iredale, 1929)			(27)		
Tellinella virgata (Linne, 1758)			(3)		
Tellinella staurella (Lamarck, 1818)	(1)		5(2)		
Cyclotellina remies (Linne, 1758)	(12)		(5)		
Tellinides timorensis (Lamarck, 1818)				(12)	
Psammobiidae (Asaphidae)					
* *Asaphis dichotoma* (Anton, 1838)	4(5)		(7)		
Psammobia rabiata (Dunker, 1845)				(5)	
Psammotellina ambigua (Reeve, 1857)				(2)	

* Edible, ** Ornamental,
Numerals indicate number of collected specimens alive.
Numerals in parenthesis indicate number of collected specimens dead.

** List of Crustacea Collected from Various Regions along the North Coast of Java, Indonesia (March 28 – April 17, 1975)

	Sites of Collection				
	Lima Is. (Banten Bay)	Ketapang (Mauk)	Pari Is.	Jepara	Muncar (Pangpang Bay)
ARTHROPODA					
Crustacea					
Balanidae					
Balanus amphitrite amphitrite (Darwin, 1854)				(1)	
Balanus concavus (Bronn, 1831)	(5)			(10)	
Balanus variegatus variegatus (Darwin,)	(12)		(2)		(11)
Balanus sp.				(1)	
Diogenidae					
Calcinus laevimanus (Randall, 1840)			7		
Clibrnarius striolatus (Dana, 1852)			11		
Clibrnarius cruentatus (H. Milne Edwards, 1848)			?		

(Balanidae: identified by Dr. Huzio Utinomi, Diogenidae: identified by Dr. Sadayoshi Miyake)

** **Explanation of Plates**

Commercially valuable or noxious shellfishes collected from various localities of north coast of Java, Indonesia (March 28 – April 17, 1975)

Edible shellfishes

1. *Tegillarca granosa* (Kerang darah)
2. *Anadara crebricostata*
3. *Anadara antiquata* (Kerang gelatik)
4. *Pretostrea hyotis* (Tiram)
5. *Pretostrea sinensis* (Tiram)
6. *Saxostrea mordax* (Tiram)
7. *Dendostrea folium* (Tiram)
8. *Crassostrea cuculata* (Tiram, Bombay oyster)
9. *Atrina vexillum*
10. *Katelysia hiantina*
11. *Marcia ceylonesis*
12. *Gafrarium tumidum*
13. *Meretrix lyrata* (Lyrate asiatic hard clam)
14. *Pteriglypta puerpera* (Purple venus)
15. *Pteriglypta clathrata*
16. *Pitar striatum*
17. *Regozara flavum*
18. *Asaphis dichotoma* (Rayed cockle)

Shellfishes for ornamental use

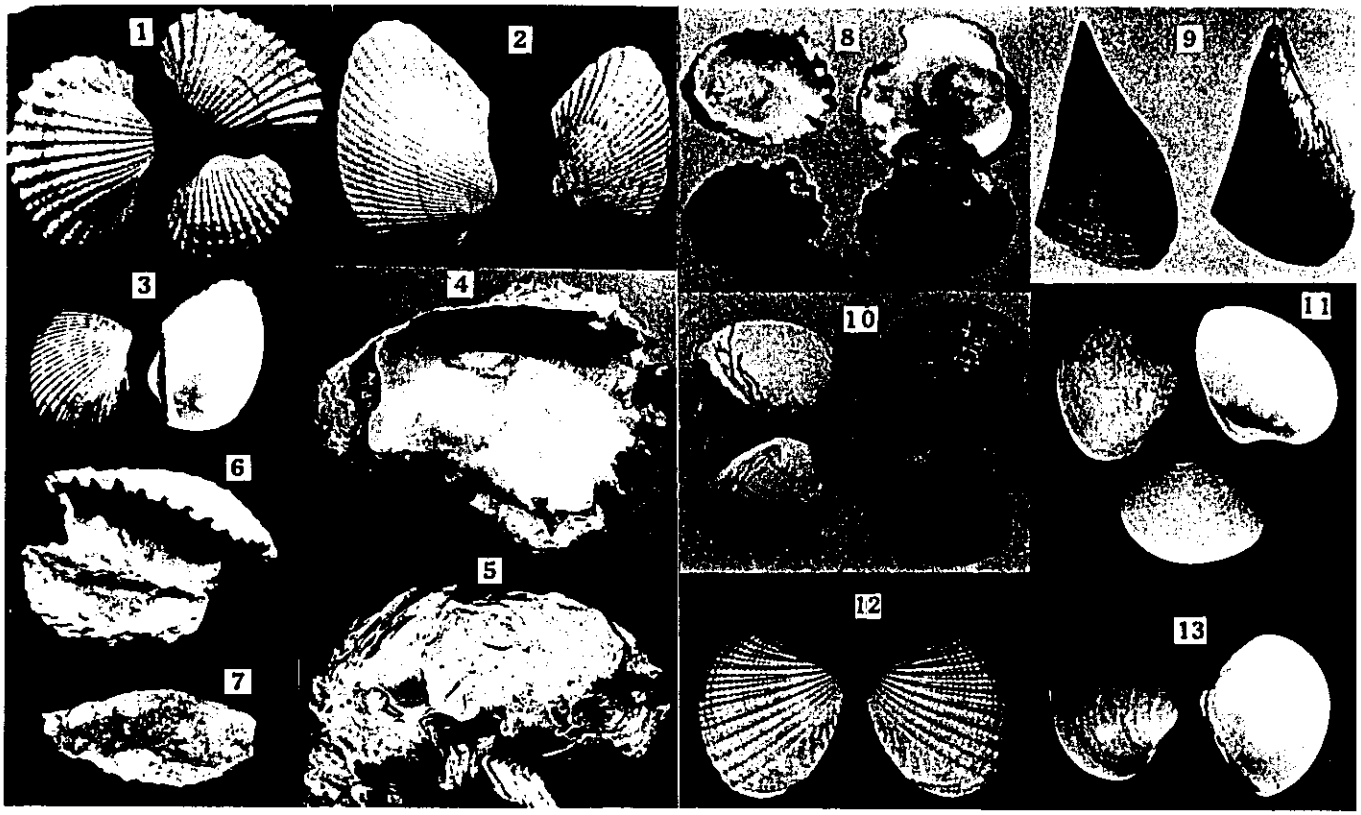
19. *Harpago chiragra* (Dorsal view)
20. *Harpago chiragra* (Ventral view)
21. *Lambis lambis* (Spider shell)
22. *Phizoconus vexillum*
23. *Trochus niloticus* (Lolak/Kerang susu, Commercial top)
24. *Cypraea tigris pardalis* (Tiger cowrie)
25. *Laevistrombus canarium turturella*
26. *Murex trapa* (Triple spine murex)
27. *Placuna placenta* (Window shell)
28. *Comptopallium radula*
29. *Pinctada margaritifera* (Kerang mutiara, Black lip pearl oyster)
30. *Pinctada margaritifera* (Kerang mutiara, Black lip pearl oyster)
31. *Pinctada fucata* (Japanese pearl oyster)
32. *Spondylus ducalis* (Northern thorny oyster)
33. *Codakia paytenorum* (Payt en's codakia)
34. *Codakia tigerina* (Pacific common codakia)
35. *Fragum unedo* (Strawberry cockle)
36. *Tridacna crocea* (Boring clam)

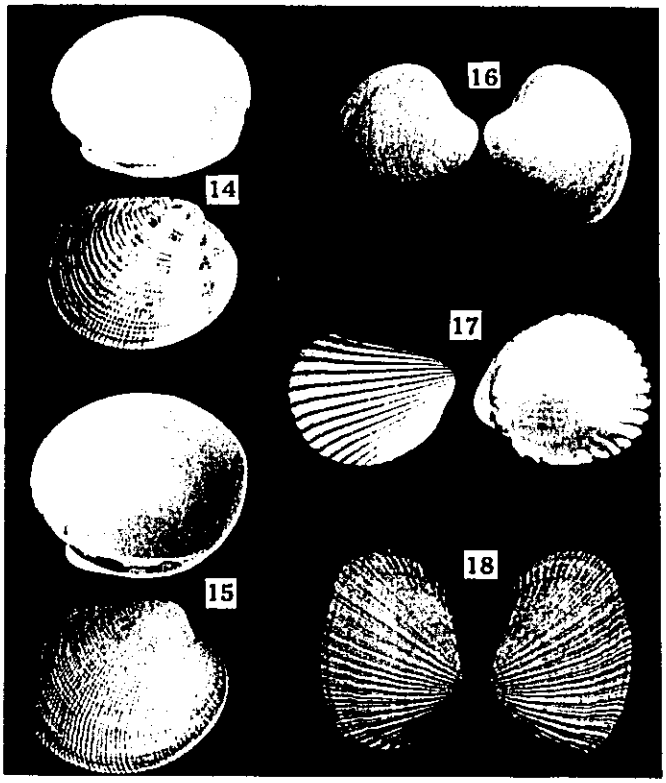
37. *Tapes literata* (Lettered tapes)
38. *Tellinella staurella* (Little bag tellin)

Noxious shellfishes

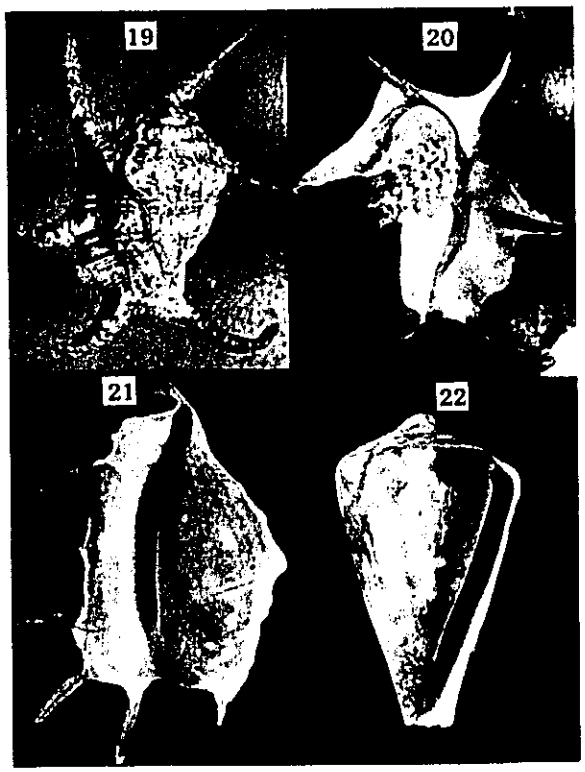
39. *Polinices vavaosi*
40. *Polinices pyriformis*
41. *Paratectonatica tigrina* (Tiger moon shell)
42. *Morulina concatenata*
43. *Cronia margariticola*
44. *Mancinella mutabilis*
45. *Achatina fulica* (Agate shell)
46. *Balanus concavus*
47. *Balanus variegatus*

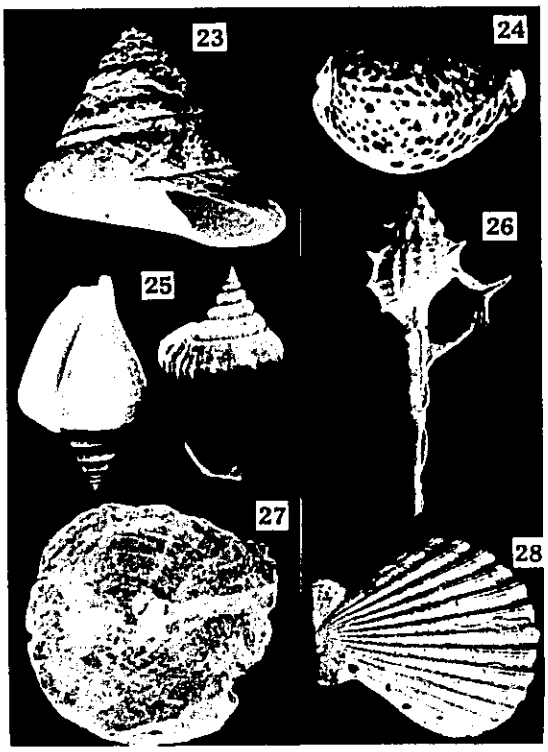
Edible shellfishes (No.1 – No.18)

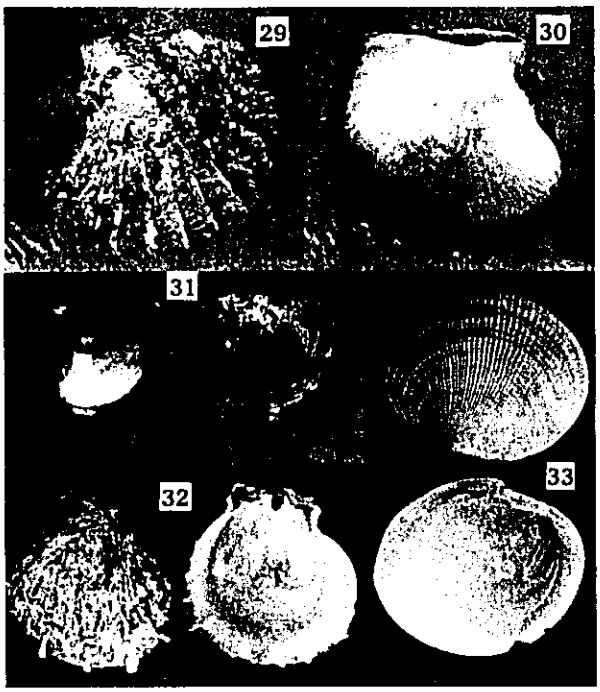


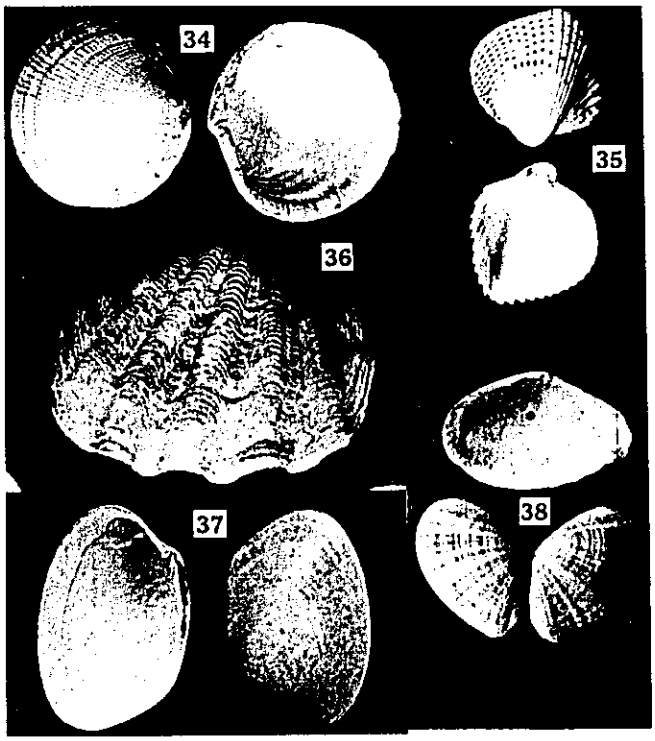


Shellfishes for ornamental use (No.19 – No.38)

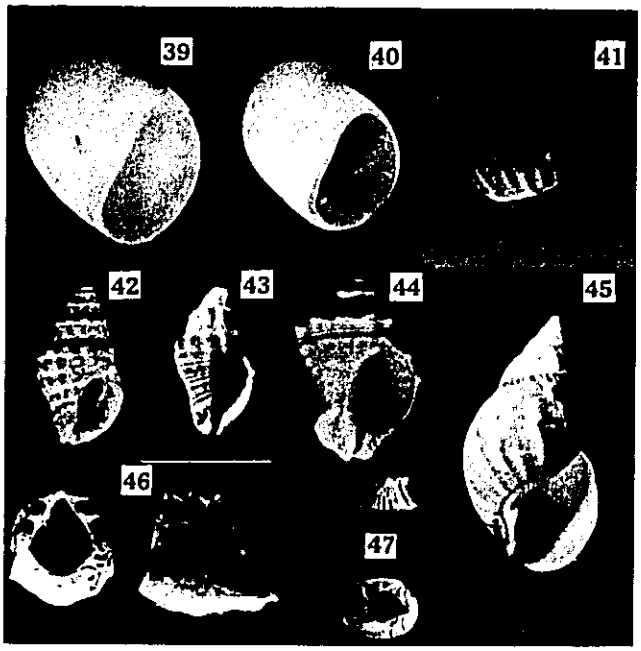








Noxious shellfishes (No.39 – No.47)



Summary Report

on Marine Culture in Northern Coast of Java Island

(April 16, 1975)

J.I.C.A. Experts

D. S. c. Y. Arakawa
H. Okada

CONTENTS

Foreword

In compliance with the request of the Government of Indonesia, we conducted field survey in suggested areas suitable for marine culture in northern coast of Java Island for the period between 29th March and 16th April.

It is next to impossible for us to draw a detailed conclusion since our survey period was less than three weeks. Therefore, our impressions through the survey are tentatively summarized as follows:

I. Outline of the Findings

1) General views

Generally speaking, in northern coast of Java Island, fertile sandy-mud, muddy shoal and dry beach are found covering a wide area.

Therefore, these areas form suitable conditions for the propagation of fish and shell-fish used for food, especially of Bivalves, Crustaceans and Mussels.

Besides, the sea areas around islands where coral reefs grow form suitable conditions making use of calm inlet in lagoons for the propagation and reservation as well as cultivation of Pearls mother shells, food or aquarium fishes and Turtles.

2) Regional views

a) Banten Bay and its vicinity

Regional survey was conducted on the 2nd of April. This area is considered suitable for the culture of Bivalves and Crustaceans.

In the water around Lima Island, a off-shore island, raft hanging method of oyster culture has been carried out, however, sea area where its average transparency reaches about twenty meters through a year and coral grows naturally is not suitable for the growth of oyster owing to the shortage of feed.

We consider that the vicinity of estauries where its turbidity shows higher is more suitable for the fattening of oyster rather than said area.

b) Ketapang (Mauk) coastal area

Regional survey was conducted on the 1st of April. In this area, detritus is abundant and sea bottom consists of fine sand including iron component in plenty. Therefore, the area is

suitable for the propagation of Bivalves, however, owing to over-crowded distribution, their growth is not in good situation.

Under such conditions, the improvement of collecting method (for example, adoption of dredge net) and proper utilization of propagation area are recommendable.

c) Paris Island and its vicinity

Regional survey was conducted on the 4 - 5th of April. This area is surrounded by atoll and calm throughout a year.

In the area, multipurpose utilization for the marine culture such as raft culture of Margaritafera margaritafera, Ptria penguin, P. fucata var.; net cage culture of food fish (Yellowtail, Epinephelus); and the culture of aquarium fish, Turtles, Spong is considered feasible.

d) Djepara coastal area

Regional survey was conducted on the 9th of April. As a project of U.N.D.P., a experimental institute was established in July, 1974 and the pond culture of shrimps is being promoted making use of abolished salt farms.

In this area, the culture of Mullet, Oyster and Quahog (anadara spp.) is also considered promising. Among others, for the hastening of oyster's fattening, the pond culture is considered a experimentation worthy of trying because in this case the control of water quality and feed supply is easily operated.

e) Pangpang Bay and its vicinity

Regional survey was conducted on the 12th of April. This area is a calm inlet facing north and surrounded by the land.

We could observe the cluster of wild oyster, however, all of them were small size.

We regard the Pangapang Bay and its vicinity as the most suitable area among surveyed spots in Indonesia for oyster culture considering existence of a river pouring into the Bay.

Besides, large-sized Venerupis sp. inhabits western dry beach and its propagation is also considered feasible.

II. Supplementary Note

From world-wide view point, until now, the areas where oyster culture has been carried out are limited within higher latitudinal zone from temperate zone to subarotio zone and while, at tropical areas in lower latitudinal zone, the researchers have failed to realige the antici-

pated result. However, oyster culture in lower latitudinal zone may be possible with the advance of study such as selection of suitable species, finding of seasonal change of fattening and experimentation of plantation, etc. and even if the culture should not be successful, it may be possible to find a way as the supplying area of seed oyster since in temperate zone the shortage of seed oyster has been observed in recent years.

III. Recommendation

For the development of marine culture in Indonesia, we would like to recommend following matters on the basis of our findings.

1) Promotion of research field

a) It is firstly requested to increase younger researcher concerning marine culture and to raise research expenses.

In connection with this, fundamental study on fish and shellfish (classification, ecology, life-history) relating to marine culture should be thought much of and be made progress because fundamental knowledge/information indispensable for the development of marine culture is hardly available yet.

b) Further, for the fullness of technical basis of marine culture, the Authorities should give consideration to source/increase high quality researcher through dispatching younger to developed countries under positive support which aims at forming "a core researcher" who promotes the study, and on the other, should not adopt such an easy-going way of thinking as invites able experts from developed countries and depends entirely upon them.

2) Development of socio-economic background

a) The coastal areas of Java Island have been contaminated by sewage in wide range. Therefore, it is a precondition for the sound development of marine culture to consolidate sewage disposal system and to tighten control over the pollution in coastal areas.

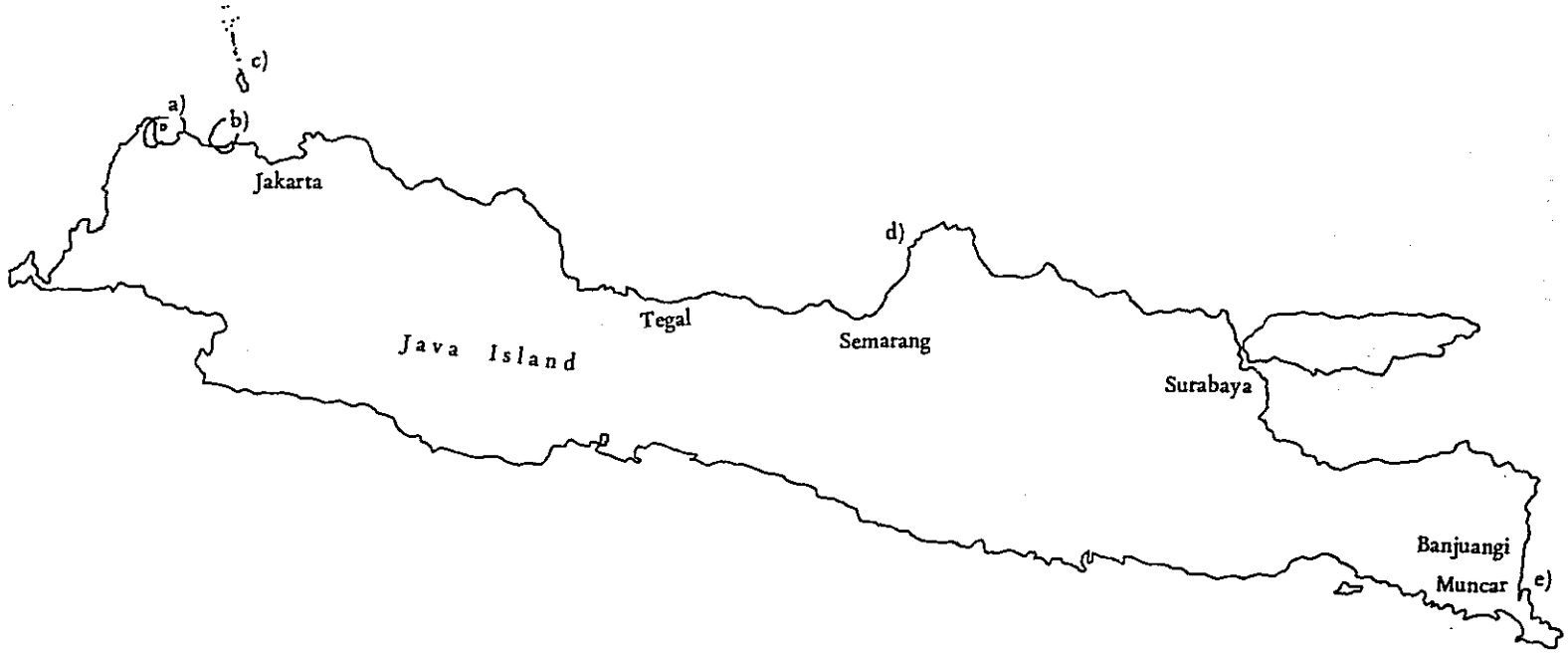
b) Moreover, for the promotion of marine culture the improvement of marketing including the consolidation of related facilities and the increase in consumption of cultural products are also requested.

IV. Acknowledgement

Taking this opportunity, we should like to express our heart-felt appreciation to the officials concerned, especially staffs of L.P.P.L. whose unlimited cooperation has been most valuable in the execution of our survey.

Survey Area

a) Banteng Bay and its vicinity
b) Kepatan (Mauk) coastal area
c) Paris Island and its vicinity
d) Djepara coastal area
e) Pangpang Bay and its vicinity



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