No.

南太平洋プロジェクトファインデング
(ミクロネシア連邦、マーシャル諸島共和国)調査報告書
別冊参考資料 II

MICRONESIAN FISHERY DEVELOPMENT PROJECT:

MANUAL FOR FISH PRESERVE AS BAIT OF SKIPJACK AND REPORT FOR BIOLOGICAL SURVEY

I. Technical Manual for Fish Preserve as Bait of Skipjack in 1980 FY (April 1, 1980–March 31, 1981); authored by Tokuichiro Kamei, team leader of Japanese experts

II. Biological Survey in 1980 FY; co-authored by Shoichi Kigawa and Itsuro Uotani, Japanese biological survey experts

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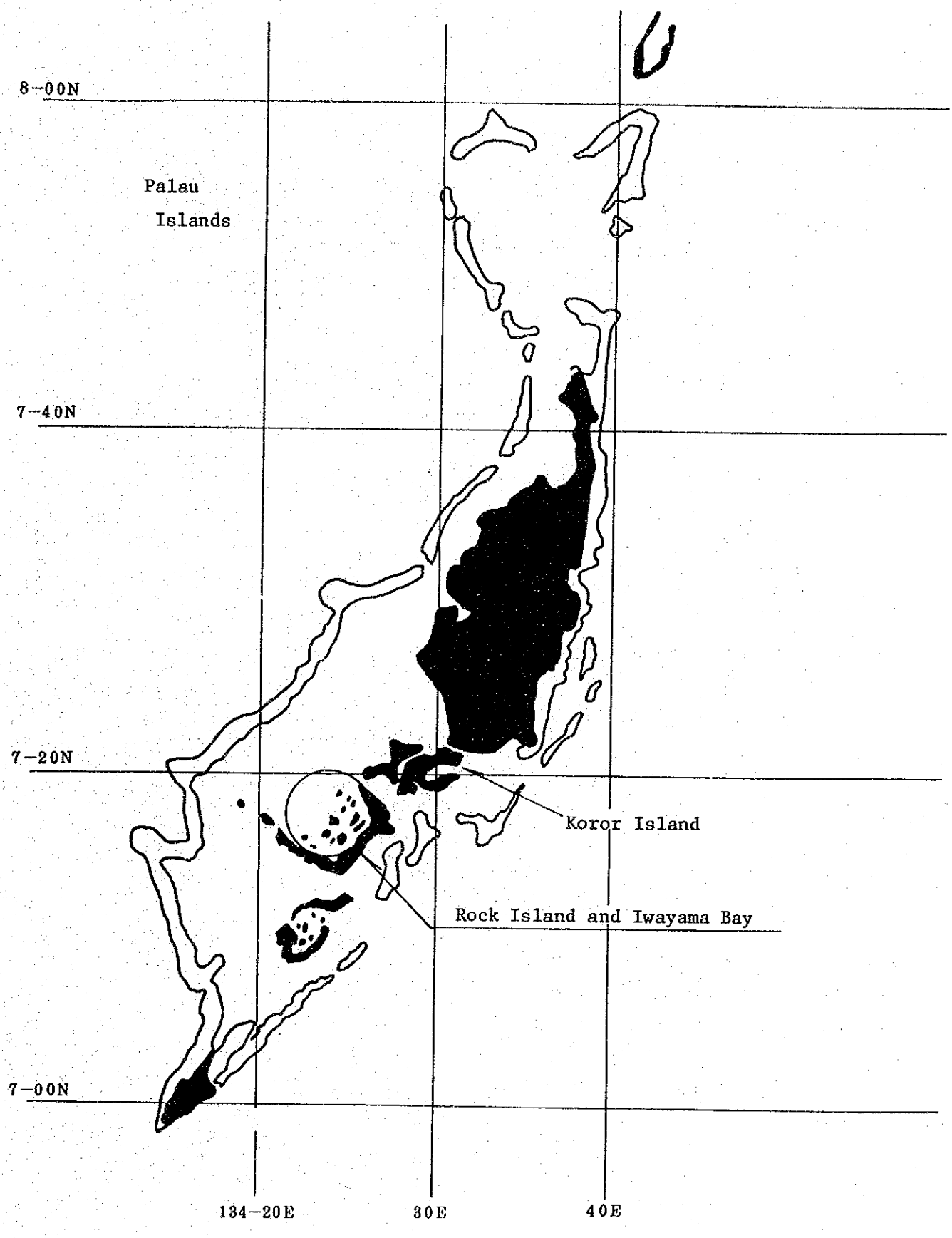
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PREFACE

This year is the third year for JICA Project in Palau. Activities of this year according to R/D are as follows:

1. To develop techniques to supply live biat fully and effectively through a year to skipjack pole and line fishing boats;

2. Followings are required to fulfil the above purpose.

   a. To find out a way to catch live bait fish effectively;

   b. To develop techniques of fish preserve to increase the survival rate of live bait fish in fish preserve and live bait tank of a fishing boat;

   c. To survey bait resources in Palau water and it's neighbouring water (within reef), including their seasonal change and migration; and

   d. To collect basic data on spawning area, volume of spawning, it's growth and survival rate. Then understanding of basic nature of bait resources in Palau water is possible.

The above-mentioned was activities of this year and it ended on March 31, 1981 successfully under valuable corporation of the specialists of the TTPI and Palau Marine Resources Division.

Live Bait for Skipjack in Palau and JICA Project

Skipjack fishing in Palau has been active since pre war age. Today VAN CAMP, American capital company, has the base to purchase skipjack from Okinawa boats and Korean boats.

In comparison with per war age, a fishing boat now is bigger. Still fishing remains unchanged in regard to self-supply system of bait and a day's fishing. Under the condition, 24 hours work is required for fishermen. It is heavy labor. Problem to be solved exists for Palau fishermen

woking under the condition. This fishing method comes from using telai as live bait. Telai is weak and to keep telai for a long time in a live bait tank of a fishing boat is difficult. Telai seems to be weak compared with Japanese live bait for skipjack fishing or anchovy off African coast. However, cause of death is complicated. To keep telai in preserve in natural condition as much as possible is necessary in order to study the cause of death and to eliminate the cause of death.

If supply of telai is possible from long-term fish preserve to a fishing boat, labor condition would be improved remarkably. In addition, effective fishing would be expected and it may bring bigger catch. Then, JICA Project on live bait in Palau started.

Aquatic Resources in Palau and Telai

Change of temperature in Palau water is small both holizontally and vertically and spring layer exists between 100-200m. Aquatic resources are poor except in some areas. It is not notable regarding aquatic resources. Both color of water and degree of clearness are excellent. Plankton is not much in contrast with high latitude area. To set up good fishing ground is not often.

The conditions are the same in demersal fishery in Palau islands. Though development of a new fishing ground may bring rich catch, the fishing ground may not bring the same level of catch if overcatching would be made once. Recovery may be difficult. However, a number of lagoons in reefs are very suitable places for spawning of fish. In Palau, a fishing ground of telai is located in the water where bottom is lime and mud. Area of fishing ground in Palau is small compared with continental shelf fishing ground in Africa, Venezuela, Panama and Peru. Accordingly, orderly catch will be required.

I. CATCH OF LIVE BAIT

To decide on the most effective way of catching live bait, the following fishing was tried.

(1) Purse Seiner

Lampara net is considered to be suitable for catching of fish that swims near surface of water. Such a fish is Spratelloidas delicatulus, Herklotsiehys punctatus and Atherinidae spp.

Telai is weak and it swims deeper than the above fish. A lampara net was not at hand at that time. Then a small two-boat netting was used on trial. To use this was also a request from Palau Marine Resources Div. This net was used once off Ghana water for anchovy catch as live bait of skipjack fishing.

How to use the net for specialists is as follows:

a. In case of two-boat netting, each boat has a winch usually. To work without a winches is difficult. To find out a way to operate with a boat is a future problem.

b. A newly purchased 14 M FRP boat has capability to carry the net. However, to carry fishing gear with this boat is limited and remodelling must be studied.

There are many unknown aspects in catch of live bait by the net in Palau. Still we tried our best in consideration with requests of Palau government.

a. To make one-boat netting with a 14 M FRP boat.

b. Two-boat netting (full length of net: 315 M, length of floating net: 219 M) was unfamiliar to the people in Palau. It was difficult to change it into one-boat netting. Then, change was made to put off first and second side nets in both sides. Then length of the net became smaller (full length: 135 M), but other parts were unchanged. If the results of test are not satisfactory, further change is planned.

c. The winch for purse line winding may not have enough capacity. To use the dram of 300 kgs lifting winch that is directly connected with a gasoline engine is possible.

A. Netting

Telai collected by a main boat with a fish lamp is transfered to a 4 M hand sailing boat with underwater lamps and a small generator (HONDA ER-1200). Then conditions of wind and water must be surveyed. Netting is made under the initiative of the light boat. The light boat is carried by wind. Then to keep location carefully near fish catch must be made.

Fig. 1

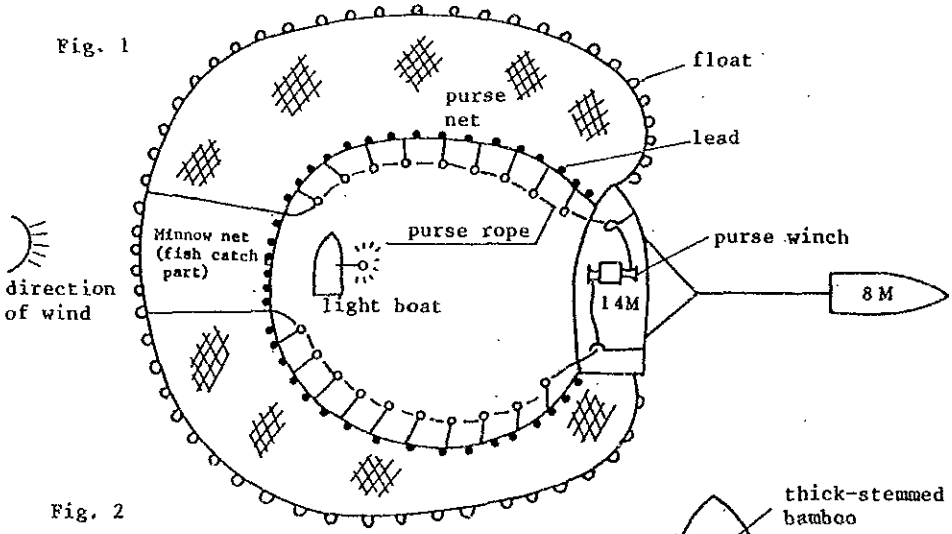
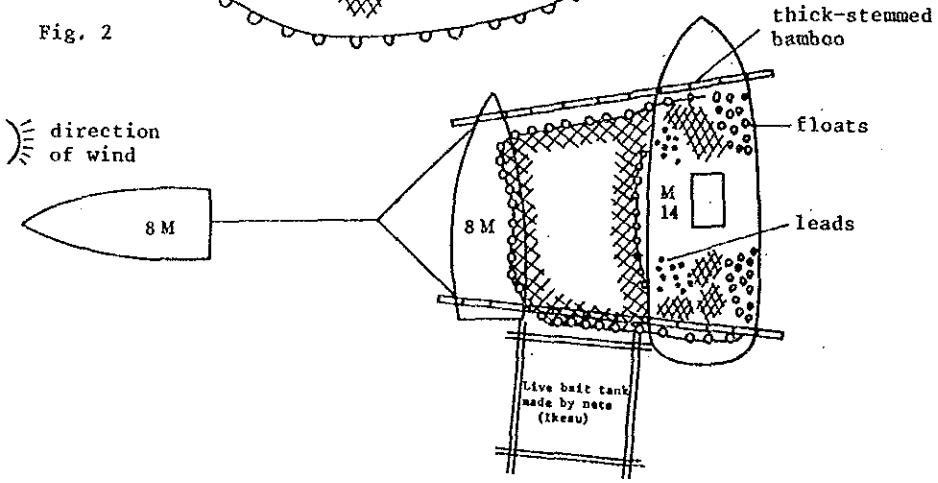


Fig. 2



As Fig. 1 shows, each of purse seine at both sides was haulded by 300 kg lift winch. Hauling of the body of the net was done separately at bow and stern of 14 M boat. This operation seemed somewhat dangeous for Palau trainees. Then the traing was made in day time off MMDC and Bay of Malakal. This was training for laying out and hauling of the net.

It was impossible to catch much telai without times of the tow. (In contrast with rich catch off Ghana water and off Venezuela water, where 200-300 buckets of catch is possible with one tow.) The tow was only possible when it was done according to Fig. 2. On and after second time of the tow, half of the net at bow side was transfered to stern side at 14 M boat and preparation was made for laying out of the net. This was difficult for Palau trainees because of limited space of the boat. Consequently, one tow at night was made. It took about an hour, at the beginning, to lay out and haul the net. Later it took shorter time, 40 minutes.

B. Results of fishing

After many times of fishing, balance of the net needed reconditioning. Therefore, first side net and second side net on both sides were undone. Minnow net was used for all fish catch parts (480 m/m x 58 box). Then the diameter of the net became about 70 M and the fish within net was fully caught.

C. Fishing gear

Detail of the net

Nylon	210d/6 x 9.9 m/m	x 400	cross x	80 M	1
"	210d/4 x 11.1 m/m	x 400	" x	30 M	36
"	210d/4 x 13.0 m/m	x 400	" x	30 M	19
Cremona minnor net					
	20s/4 x 117		x 480 m/m	.....	58

Attachments

Headline PP rope 12 m/m	600 metres
Footrope PP rope 12 m/m	600 metres
Float styrofoam G-3	600 pcs.
Bullet zinc 188 g.	1000 pcs.
Purse seine nylon rope 18 m/m	600 metres
Purse seine bridle PP rope 12 m/m	200 metres
Purse ring zinc galvanizing	70 pcs.

D. Problems of towing this time

1. The fishing was made by a 14 M boat as one boat netting although fishing gear was made as tow boat netting. Therefore this was unusual. This was application.

2. Nylon rope 18 m/m was used as purse line and sinking was not enough. To use wire rope as purse line or to put on additional zinc to corkside was impossible judging from the capacity of the purse winch: 300 kgs. max.

3. The boat hauling the net (14 M boat) had very limited space to put on the purse line at stern side, according to it's structure. And the transfer of the net from bow side to stern side was difficult. It had to be done many times at night for fishing.

4. Density of telai is poor so that the catch of telai by using the net was not big. Therefore, the use of the net again and again at night was necessary. (One of the cause of poor catch was that we avoided to fish at the same area as Van-Camp's.)

E. How to improve fishing

In case of one boat towing, there is a possibility that telai may be weakened at fish catch part of the net. Two boat towing may be better. Concerning the fish preserve of telai, the following is recommended personally. Frequent use of the light boats is hopeful.

1. Fishing boat (FRP)

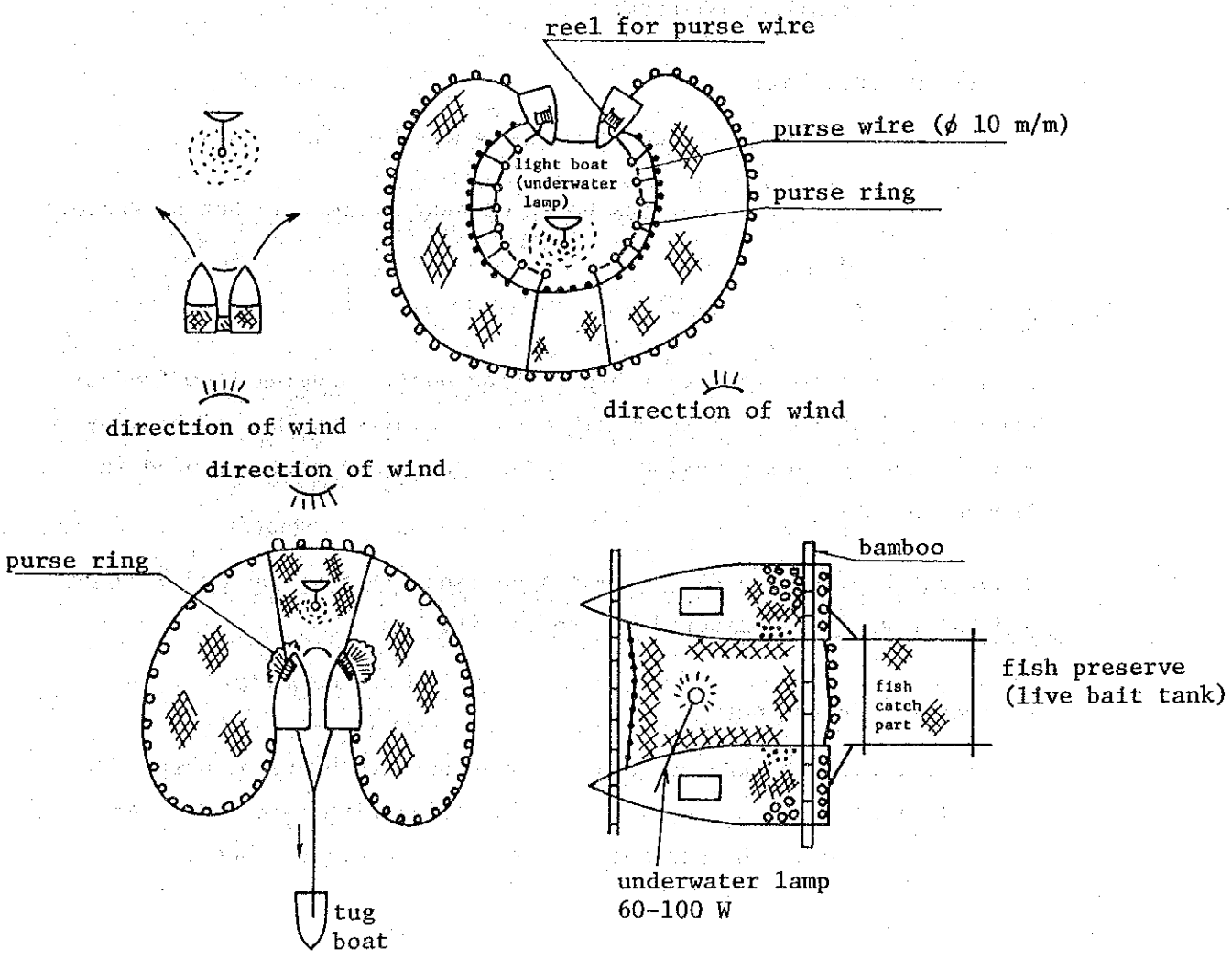
Type of boats required	LxBxDm	Main engine	Number of boats	Price (FOB,Yokohama) Japanese Yen
Net boat	6.0x2.0 x1.1	Yanmar 20 HP	2	6,540,000
Tug boat	4.0x1.56x0.8	Yanmar 6 HP	2	1,480,000
Light boat	Small flat-bottom boat	-	2 ∿ 3	300,000

(Including attachments)

2. Fishing gear

Two-boat netting (for anchovy fishing) that was used this time is suitable.

3. Net strip plan



F. Advantage/disadvantage of using two-boat netting for telai fishing.

1) Advantage

a. Fishing is possible at any time and anywhere, if the water has enough depth, in spite of considerable wind or flow or tide. Catching of fish which swims near the surface of water (Spratelloides delicatulus & Herklotsichthys punctatus) in the daytime is possible so that it can be used both at night and day.

b. Fish within the net can be caught fully.
To run away of fish at night is rare, in contrast with a stick-held dip net or bagan net.

c. Number of workers is small compared with that of stick-held dip net.

d. Excellent mobility

2) Disadvantage

a. Fishing gear and boat cost much.

b. Fishing at sharrow water or near current is not suitable.

(2) Bagan Net

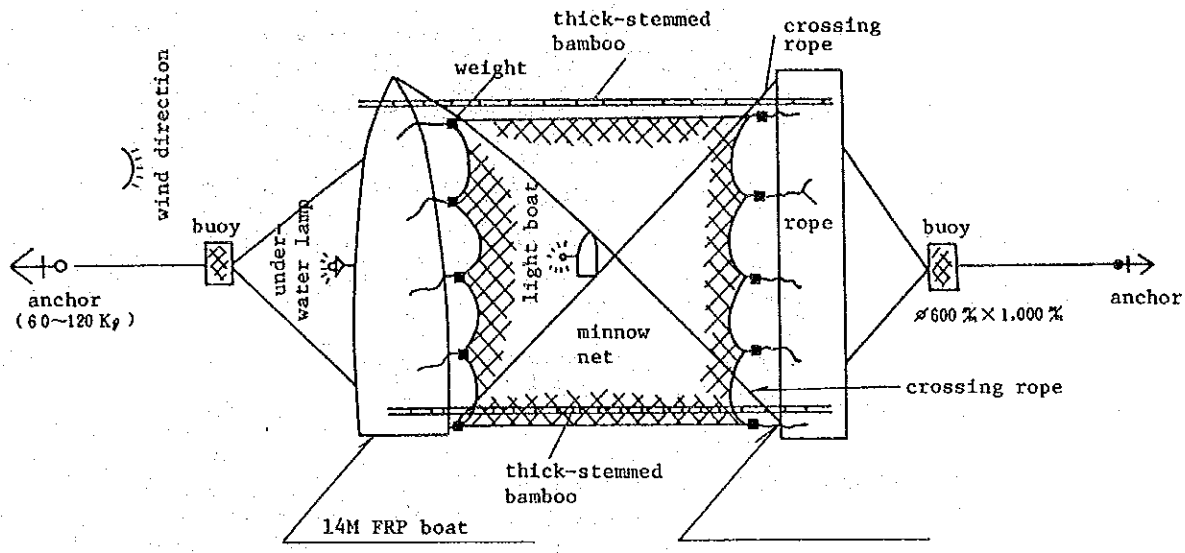
Bagan net does not require a big fishing boat. Judging from fund or number of fishermen, it is possible for a family to make fishing by a bagan net as family business. Today many bagan nets are used in Indonesia water.

Telai catch using a bagan net was done many times as part of Project and Palau trainees mastered how to use it.

A. How to use the net

In the evening, the net must be sunk between boats or barge (floating landing stage) in consideration with tide and direction of wind. The net must be set 2-5 M above the bottom.

Then a under-water lamp is put on at the main boat. On fish gathering, fish is introduced to the centre of the net by using a small boat. Towing must be started at the same time at both sides of the boats or barges.

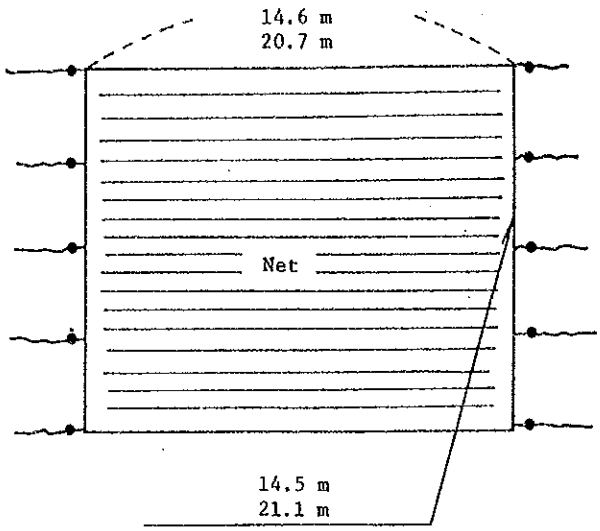


B. Results of fishing

In telai fishing ground at Rock Island, Palau, the fish ground or fish way is always located at a good place to fish, in contrast with migrating fish. Even if telai disappears from the fish ground, it will come back soon. Therefore, if the right place for telai fishing is found out, catch of 20-50 buckets in a tow is possible. This fishing method is like sinking cloth into water and haul quietly. Therefore, fishing in water with flow or tide or in a place where considerable wind blows is impossible. Even if you fish under this condition, telai will disappear or its catch is poor.

During the period of the Project, excellent results of fishing occurred in quiet Rock Island. In channel or coral reef where influence of the open sea is clear, satisfactory results cannot be expected except the time of stop of the flow.

C. Fishing gear



Minnow net ..... cremona 20S/4 x 4
11 cross x 480 m/m x 44 tan

Minnow net rope ... 12 m/m cremona rope
60 m x 1 piece

Hauling rope ..... 18 m/m cremona rope
35 m x 10 pieces

Crossing rope .... 18 m/m cremona rope
30 m x 2 pieces

Bullet ..... 3 kg x 10 pieces

Bamboo ..... (dia./more than 10 cm)
10 m x 4 pieces

Styrofam buoy ..... ϕ 600 m/m x 1,000 m/m

D. Problems on bagan net this time

1. To use a bagan net is very easy. The flow of tide and wind often prevent fishing. Particularly, the conditions of tide is decisive in fishing. Therefore, the working ratio is low.

2. Once the net is striped, to move it is not easy. Attention must be paid when a boat sails with a stick-held dip net through inside of narrow Rock Island water or when boats share the same fishing ground among others.

E. Plan to improve bagan net

1. There is nothing in particular to improve fishing.

2. In consideration with the competition with a bigger boat and safety fishing, to set up the exclusive water for bagan net fishing and to avoid unnecessary competition may be considered.

3. Live bait supply business requires keeping stable level of supply. Then considerable number of bagan net boats is necessary.

F. Advantage/disadvantage of bagan net

1. Advantage

a. Economical.

b. Fishing is possible almost regardless the depth of water.

c. Number of fishermen is less than 10 people so that family-unit operation is possible.

2. Disadvantage

a. It is deeply influenced by tide and wind so that fishing ground is limited.

b. Poor mobility

(3) Stick-held Dip Net

In Palau, Van Camp boats have adopted this method of fishing. During this term of the Project, Van Camp had made fishing for monthes and kept telai as fish bait and supplied it to the commercial boats (total 716 buckets).

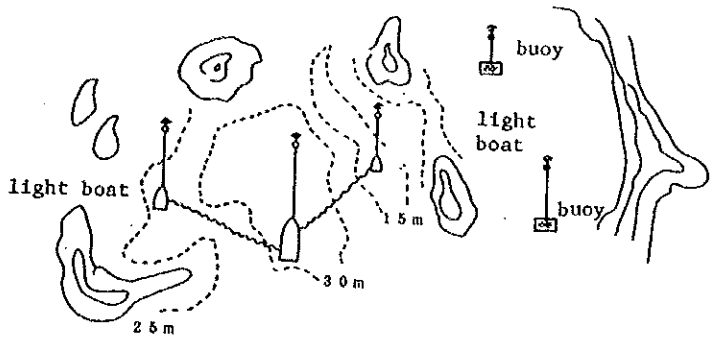
Size of the net is decided on according to the length of a boat. Many Van Camp boats are 59 ton skipjack-fishing boats. Then the length of many nets at boat landing side is 20-25 m. Fishing by using this net was made from time to time. During this follow-up term, large scale fishing was made in February when it was nearly end of the term. Now fishing by using the net by Palau trainees is possible without any assistance.

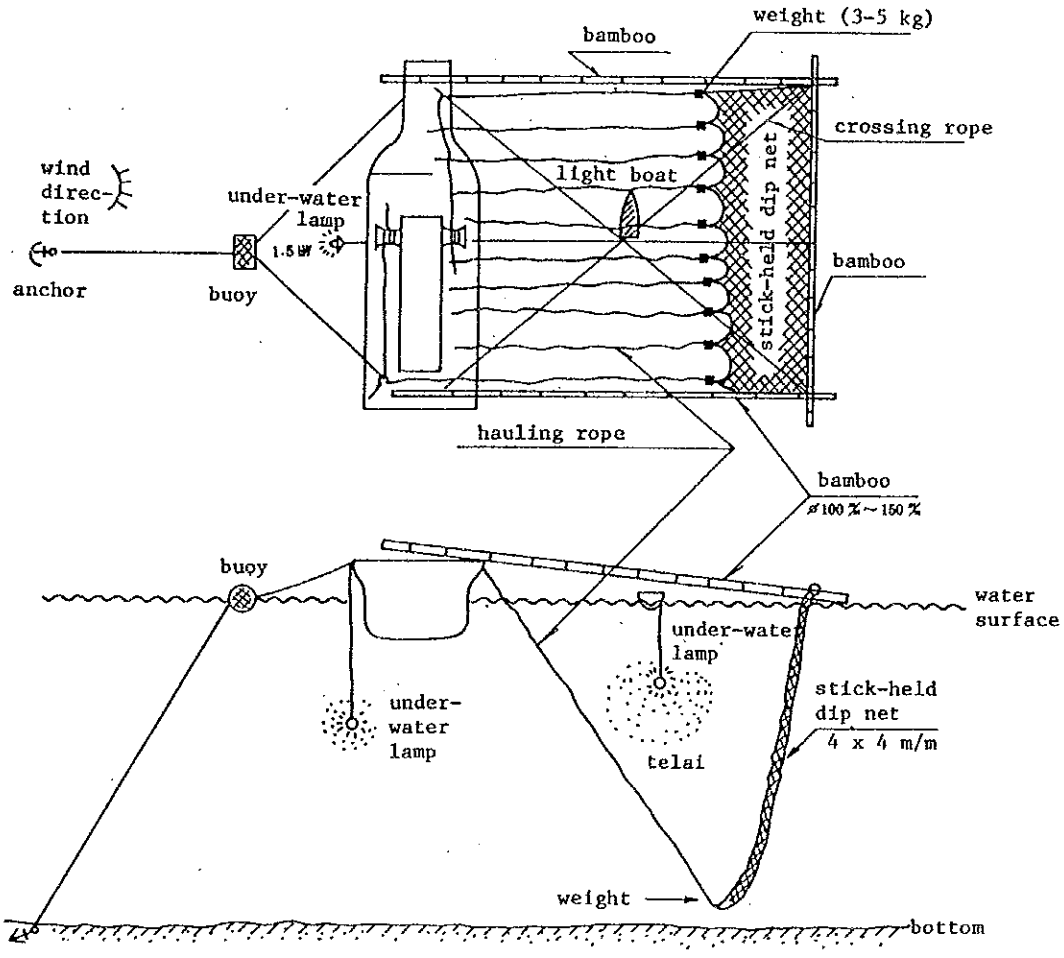
A. How to use the net

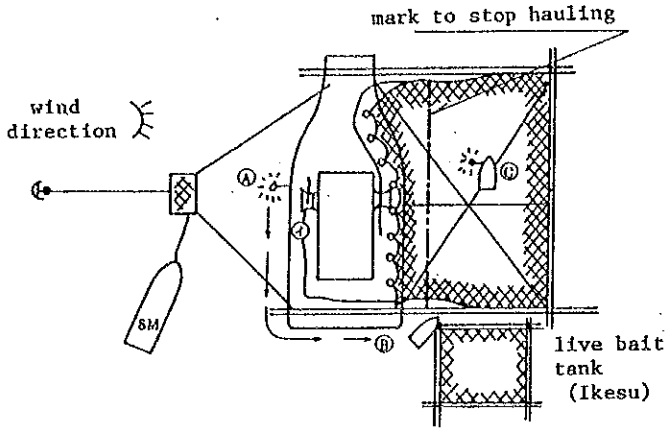
In setting up a fishing ground, it is hopeful to find out a fish-way, judging from the location of islands and the depth of water. Then fix up anchors in distance of 100-200 m from the main boat and put a buoy. 14 m boat and 8 m boat must be prepared and the under-water lamp must be put on as soon as it gets dark.
It is hopeful that there is no projection at bottom when fishing is made. The hopeful depth of water is about 30 m.

More than 4 hours of lighting is adequate. Still, excessive lighting gathers horse mackerel and sawara niponia. They deprive telai. Then continuous watching of telai condition is necessary by using a water glass. This time two light boats (14 m, 8 m) were used. Gathering was done in three places together with the main boat. If additional light boats are available, two more light boats are hopeful. It may bring bigger catch. When gathering is satisfactory according to a water glass or a sonar, to watch gathering by light boats 100-200 away from the main boat must be made.

<One example of location of boats in Rock Islands>







If catch to fill up the fish preserve (about 70-100 buckets) is expected, extend a cable net and make the main boat to meet angle to the wind by using a fork rope at wind blowing side. When the boat comes to be stable, lay out a stick-held dip net to the boat leeward. On the other hand, start hauling quietly the rope kept by the two light boats (about 12 m/m). Then put off the underwater lamp at windward buoy of the main boat. And send telai to the under-water lamp of the main boat. This method is the same even if number of light boats increases. Telai is timid to shriek and change of light. Work, therefore, must be done carefully. After the change of telai from lighting at the main boat is necessary to tame telai.

When telai is tamed around the under-water lamp (A), move the lamp quietly following the arrow to (B). Then put on the under-water lamp as dark as 100 W at a manual boat and watch the telai swimming up near the surface suing the water glass.

When telai school swims up (in this case, the depth of under-water lamp is about 2 m), extend the cord of the under-water lamp through crossing net and watch the telai through the water glass. Then induce telai by moving the boat to the centre of stick-held dip net. Watch the density of telai school for minutes at the centre of the net. Then the rope (D) at both sides starts to be haulded by the winch. The haul by fishermen starts for middle net.

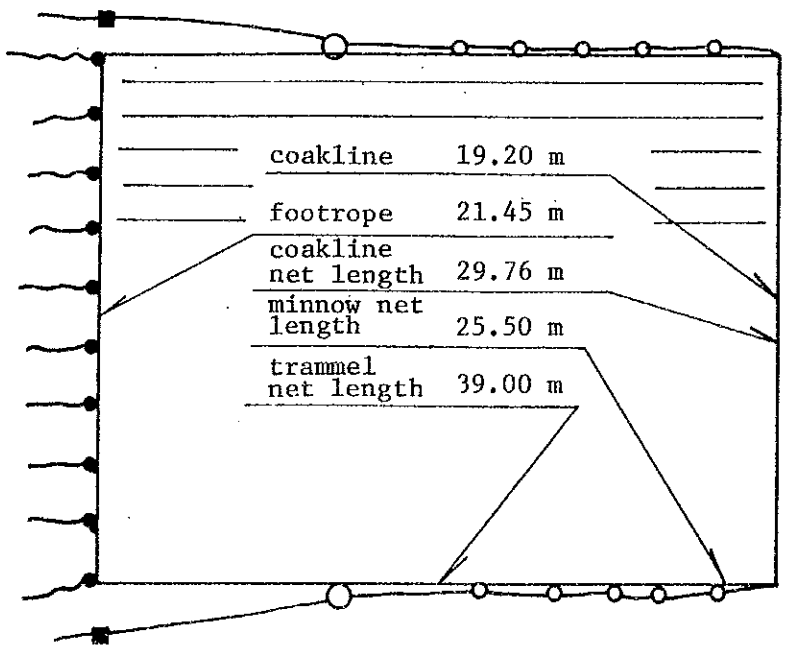
The haul must be made even simultaneously: if the haul is delayed by a member, telai run away from that part. When the net is hauled up to overside, take a pushing bamboo into a boat. The haul must be continued to reach the marked place. Then stop it. Telai gathers around the under-water lamp at (C) through the process. Then work to induce telai into a live bait tank starts.

B. Results of fishing

Stick-held dip net as well as bagan net are influenced much by flow of tide and the setting of the net is easily broken so that full catch of telai within the net is impossible. Accordingly, in Palau, fishing must be stopped until the tide become calm even if the density of telai is rich.

The location of fish preserve is limited to inside of the Rock Island water, considering that long distance of carrying a live bait tank is impossible. Judging from the size of the net, results of catch were slightly good compared with the results in case of using a bagan net. To increase the catch is possible if additional light boats are used.

C. Fishing gear



1. Netting

   Small trammel minnow net (20S/4 x 4 117 meshes)
   480 m/m x 62 pieces ..... 29.76 m

2. Ring ϕ 8 m/m x 40 m/m ..... 30 pieces

3. Weight 3 kg. ..... 9 pcs. 5 kg. ..... 2 pcs.

4. Bamboo 9 $\sim$ 12 m (100 $\sim$ 120 ϕ) ..... 16 pieces

5. P.P. Rope 18 m/m ..... 2 rolls of rope

D. Problems on fishing this time in using a stick-held dip net.

1. Size of the net is limited according the size of a boat. Bigger boats can carry a bigger net. Smaller boats carry only a smaller net.

2. Much influence is given by flow of tide and wind. This net has the same nature as a bagan net.

3. Labor saving is necessary to increase times of towing.

E. Plan to improve the net

1. There is no special way to improve towing. Still, labor saving is possible by using a hauling winch.

2. To increase the catch is possible by using as much light boats as possible.

F. Advantage/disadvantage of a stick-held dip net

1. Advantage

   a. Use of a skipjack fishing boat is possible.

   b. When skipjack boats are used, bigger catch is expected with bigger number of fishermen. In this concern, there is no problem in use of a stick-held dip net.

   c. Fishing by using many big boats is possible.

2. Disadvantage

a. Fishing by using 20 m x 20 m stick-held dip net is not possible without a skipjack fishing boat. It needs considerable amount of fund.

b. At least 18 people are necessary to haul the net.

(4) Method of Catching Telai in Palau Islands

Each method of catching telai has both advantage and disadvantage. Payability is important for fish preserve of telai if it runs on commercial basis.

The catch is gained effectively by using a net without much influence of tide and wind. Fishing is possible at night and the daytime. Fishing ground is limited by the depth of water. Enough depth is necessary. The big school of live bait is not seen in Palau, in contrast with Japanese water and that off Africa, where big school is seen. In this concern, fishing of telai in Palau might not bring great success. All of skipjack fishing boats based on Palau have used stick-held dip nets. These boats are 59-ton type which uses big net of 22 m x 22 m and 20 people are required for fishing. If a 14 m FRP boat is used, the size of the net becomes as small as 15 m x 15 m.

In considering the above-mentioned, a bagan net must also be discussed here. If a bagan net is used, fishing is possible without a big boat so that it is economical. Today bagan nets are popular in Indonesia water. The use of a bagan net increases employment opportunities in each area. Difficult technique is not reeded. Therefore, the use of a bagan net is suitable to catch telai in Palau.

II. FISH PRESERVE FOR LIVE BAIT

To increase survival rate of telai at fish preserve or bait tank of a boat, following method of fish preserve was discussed and carried out.

(1) Fishing Ground of Telai and Place for Fish Preserve in Palau

Later half of this report is the results of biological survey on telai in Palau.

The study up to now shows that many places are suitable for spawning within coral reef, except places where flow of tide is fast. Reproduction of resources may be possible in relatively short time. Main telai fishing ground is located around the Rock Island 10-20 miles south west of Koror Island, and in lagoons in extent of reef. The depth of water there is 25-35 m and bottom of water is lime mud. Skipjack fishing boats of Van Camp here all year round use a stick-held dip net.

Water where telai may live is inner part of the bay surrounded by coral or islands. Coral and islands prevent tide of open sea. Fresh water mingle at inner part of the bay where river mouth exists. Telai may also live in water that has sand sea bed in coral reef.

Besides Rock Island, fish preserve is possible if its facilities can be kept safely from tide and wind. Much rain brings good conditions for telai in fishing ground of the Rock Island. There, trees grow up tightly and hold much rain water.

(2) Place for Fish Preserve and Sailing of Fishing Boats

Skipjack boats of Van Camp have caught live bait in fishing ground at the Rock Island for years. The reason is as follows:-

A. Free entering to bait-supply facilities is possible without risk, regardless day and night.

B. Catch of live bait is possible regardless weather because the fishing ground is surrounded by islands and such natural conditions protect flow of tide and wind.

C. 50-100 buckets of live bait is enough for one-day fishing operation. Quick catching of live bait and survey of remote fishing ground are necessary to increase catch volume. Therefore, place where a bait catching boat takes much time to go and return back is not desirable.

D. Development of a new fishing ground has a problem because of risk in sailing and catching.

E. Joint fishing with other boat is useful to exchange information on live bait. In addition, effective use of live bait is possible with other boats and irritation is avoided. Sailing of skipjack boats of Van Camp is rotated between the base in Koror and skipjack fishing grounds regardless volume of its catch. Namely, Van Camp ∿ Rock Island ∿ Fishing ground ∿ Van Camp.

Conditions of place for fish preserve:

A. Water where stable catch of telai is possible is near at hand.

B. Quiet inner part of the bay or water that is protected from tide and wind with 20-30 m depth.

C. Non-pollution is necessary for fish preserve.

In consideration with safety sailing, the best place for fish preserve is Rock Island in Palau where meets the conditions of fish preserve. This is applicable to both skipjack boats of Van Camp and foreign boats (Japanese skipjack boats) seeking live bait.

Even if much telai lives near at hand, the place is not suitable for fish preserve without adequate management and with a view to safety operation.

(3) Supply of Live Bait by Setting up Fish Preserve in the Rock Island

As mentioned before, Rock Island is the best place for fish preserve. However, following three conditions are indespensable for supplying live bait as business. All of members for this Project have the same opinion.

A. Familier telai must be kept always to meet demands for fishing boats.

Stable supply is necessary. If bagan nets are used, considerable number of boats are necessary. This means joint management by some boat owners. To realize this, management of organized catching, bait conditioning and joint sales are required. That suggests to organize a fishermens' co-op or suggests a contract between fishermen and a considerable number of fishing company. Anyhow, representative for the negotiation must have initiative over the group of people.

B. Cost of telai production and fish preserve must be economical when it is purchased by fishing boats.

The most economical one is bagan net, followed by stick-held dip net and towing. Order of catching efficiency shows a contrast: towing is best, followed by a skip-held dip net and a bagan net. Bagan net is suitable for family-unit business like Indonesia. Fish preserve in Rock Island must is located near the water where easy and rich catching of telai is possible.

Concerning telai resources, boats of Van Camp have used the fishing ground the in Rock Island for more than 10 years. According to an American scientist, volume of catch reached 90% of max. continueous productivity by month. If this is true, stable supply by using a bagan net is suitable rather than effective catch by towing.

To set up a prohibited zone in certain water of the Rock Island may be considered in conjunction with live bait supply business. Basic policy of Marine Resources Division is unknown. The Division has administrative right and initiative to avoid overfishing of telai at

the Rock Island. However, Van Camp boats totally depend on the Rock Island water. Consequently, prohibited zone or piscary charge may be necessary.

(4) Some Points to Run Live Bait Supply Business

A. Reliability of fishing boats

Traditionally a local fishing boat operates at skipjack fishing ground in the daytime. To manage washing, purchasing goods and catching bait is done at night. Therefore, 24 hours continuous work is required and it is very hard.

B. Consequently, the expectation to live bait supply by local boats is:-

1 Improve working conditions.
3-4 days continuous fishing off coast is possible by using live bait from fish preserve. Then fishermen can have rest at night.

2 Improve operational ratio.
Time and cost saving is possible without coming back to the port every day.

3 Effective reserch of fishing ground is possible.
Loss due to seasonal change can be controlled. Fishing in distant water, which was traditionally impossible, may save loss due to seasonal change of fishing ground.

<Advantage for foreign skipjack boats fishing in Palau water>

Japasnese skipjack boats would enjoy the advantage very much. Big skipjack boats sailing from Japan to south have 600-1,000 buckets of expensive sardine. Death rate of sardine, however, is high with change of temperature. Countermeasure has been tried. Test of cooling water, for example, has been tried.

Still the problem remains unsolved. If Japanese boats can get live bait in Palau, the boats would visit Palau to purchase live bait as well as food. And they would take rest there. Then port of Palau would be activated.

C. Close contact with customers is necessary for live bait supply business

Japanese skipjack boats have long history in fishing in the South Pacific water. However, they have never heard about live bait supply in Palau. To run live bait supply as business in Palau, contact with Japanese organizations concerned is necessary. Also advertizing is important.

(5) How to catch telai and induce it into fish preserve

A. To minimize stimulation over telai

Telai seems to swim near the sand mud seabed in the daytime. At night school of telai swims under fish-gathering light (under-water lamp) usually. (Only in favorable cases, telai swims up near the surface so that catching by a landing net was possible.) We have to be careful not to fasten the net too tightly, regardless of fishing method, particularly fish-catch part of the net.

Usually telai does not like to swim near the surface, in contrast with Spratelloides delicatulus and Herkiotsichthys punctatus that swim near the surface. If telai comes across stimulation such as sound and light near the surface, telai suddenly rushes due to shock and it will die from face hurt.

B. To minimize hurt by the net

Strong light would give shock and it causes telai's rush into meshes of narrow fish-catch part. Then use of a minnow net in fish-catch part is necessary.

Hauling must be stopped to keep slow telai school swimming. Skin of telai is weak unlike Spratelloidea delicatulus and Atheridae calulus. The net must be hault with balance to prevent telai from rushing into the meshes of the net and from hurting the skin of telai.

C. Tame telai with ample time and induce telai into fish preserve naturally

To keep telai's swimming slow is important. The fastener set vertically at the fish preserve is put down. The catch-fish part of the net is hung over along the fastener and is pulled into fish preserve.

The 60 W lamp at the center of the fish-catch part is moved slowly near the surface and, then, is fixed at the center of fish preserve. Fastly swimming fish such as Spratelloides delicatulus and Herkiotsichthys punctatus and Atherinidae calulus is headed first toward the light. Then slowly swimming telai follows and is induced into the fish preserve. Telai moves so dull that it apts to go down near the bottom of the net. Therefore, care must be taken to avoid hurt of telai against the net. Screen net is necessary to prevent horse mackerel and barracuda from coming into the fish preserve. These are likely to eat telai.

(6) How to Manage Fish Preserve of Telai

A. We have to be very careful not to make the net loose at the corner of the fish preserve. Telai swims slowly and dull and telai is likely push it's head into the meshes of the loosed net. To avoid to make loose the net of the fish preserve, size of the pipe at the bottom must be fitted with the size of the net.

B. How to clean up the dead body of telai in fish preserve

To remove dead telai that is sinking at the bottom by using a landing net with a long bar, watching through a water glass is adequate.

If men dive as usual to remove the dead body, be careful not to give shock to telai. Diving must be limited once, using aqua-lung. Diving should not be repeated.

C. Fish preserve must be clean always by removing dead body of telai

Certain number of telai will die day by day after it is induced into the fish preserve even if telai is treated very carefully. Dead body of telai sinks down at the bottom of the net of the fish preserve must be removed every day. The temperature of water is 29-30 °C and it causes decomposition and gas. If dead body is not removed, it gives damage to telai alive.

D. To avoid to make a dent at the bottom of the net

If a dent exists, dead bodies are gathered there and it makes a pile of dead bodies at the dent. Then a shark, searching for dead bodies of telai from the outside, will break down the net.

E. To prepare the net to protect against damage from birds.

F. For 2-3 days after inducing telai into fish preserve, a floating lamp at the center of the fish preserve is required to prevent telai from getting into the meshes of the net.

G. To clean up the fish preserve

The flow of water in the fish preserve must be maintained without stagnation. In Palau water, white incrustation and larva of shellfish stick to the minnow net of the fish preserve in a week. Then, the flow of water through the net is obstructed. Therefore, the net of fish preserve must be withdrawn at least every 10 days and must be dried up under sunshine. Then it must be washed. Judging from the above-mentioned, the use of a big net is may not be suitable though the use of a big net is usual in Japan.

H. Relation between the capacity and number of fish

Many factors decides on relationship between the capacity of the fish preserve and number of telai: telai species, size of telai,

temperature of water, oxygen contained in water, spawnning season of telai etc. Accordingly, it cannot be decided simply. We must be careful not to put too much telai in the preserve. According to our experience, it is recognized how much fish should be preserved. Roughly speaking, 6-8 buckets per M^3 are adequate, using 10 liters bucket (net weight: 5 kg).

I. To feed telai in fish preserve

Test of feeding telai in fish preserve was made once in a while. The test was elemental trial. In this Project, the test was made with telai (4 days after catching) in presence of Mr. Ramon Rechebei of TTPI. The feed was SHINWADATSUMI, assorted feed which was manufactured by Nihon Kosan Kogyo as sardine feed. Telai showed little reaction to this. Then, the feeding test was made with Sparatelloides delicatulus and Atherinidae calulus at the wharf in front of the Marine Resources Division. Most of the stomach contents of telai was plankton. Telai has not been accustomed to eating such assorted feed. Test must be continued. Feeding telai in fish preserve is a future subject.

(7) How to Keep Telai in a Fish Tank of a Fishing Boat

Basic point is the same as the mentioned before concerning how to induce telai into a fish tank and concerning how to keep it there. Still followings must be attended also.

A. Loading of telai into a fish tank of a boat

There is no other way but to load telai together with a full of water in a bucket by hand carry to a fish tank. When the net is hauled to gather telai, care must be taken not to hurt the skin of telai.

B. Bubbles in a fish tank

Most of skipjack boats today have the equipment of forced circulation, flow from upside, to supply fresh water to a fish tank. We saw small bubbles overflowing in the fish tank of a boat in Palau. The cause of this is inadequate mechanical setting of

such a equipment. Air will damage telai in the fish tank so that quick repair is important.

C. Number of live bait in a fish tank in relation with it's capacity

When forced circulation pump system is equipped in a fish tnak, volume of circulation is not simply decided because some factors are closely related, for example, relation between the number of telai and the capacity of a fish preserve. Roughly, 5-7 buckets (10 liters) of telai are acceptable per M^3 if the circulation is 4-5 times per unit time. Number of buckets of telai to be loaded in relation with the volume of circulation must be set about at the same level as above-mentioned. The location of circulation in a tank is important, too.

D. Feeding telai in a fish tank of a boat

When a skipjack boat reaches a fishing ground, minced fish meat (bonito for example) is given to the live bait 2-3 times a day. If not feeding, telai becomes thin and its shape resembles to a tadpole with big head and it becomes weak. Then this affects the eating behavior of skipjacks. Further study must be done on feeding telai.

(8) Something to be Observed on Telai in a Fish Preserve

Data on death rate of telai in a fish preserve is attached separately. Our observation was that death rate was high just after the beginning of bait conditioning and it might decline as time passed. The cause is as follows:-

A. Death resulting from hurt of a fish body

When fish is induced from a bagan net or skip-held dip net in the form of natural flow, excitment of telai cannot be avoided. Then telai touches one another and hurt the body. Some of telai touch the net, causing congestion of blood at mouth. Telai with hurt will die as time passes according to the degree of hurt.

B. Damage by sea birds eating telai

Sea birds search after telai swimming near the surface. The cause is as follows:-

1. Flow of water in a fish preserve is prevented by dead fish the head of which is put into the mesh of the Ikesu net.

2. A dead body of telai at the bottom of the net generates gas.

3. Big fish (horse mackerel, mackerel and sawara niponia, for example) searches for telai from bottom side.

4. Normal swimming is impossible because of the hurt of its body.

C. Damage caused by fish that eats telai in the fish preserve

Weakened telai is eaten by a bigger fish mixed with telai school in the fish preserve. White dead body of telai at the bottom of the net is eaten by another species of fish swimming near the bottom of the net, turned its body into only bone and head. The bore and head drop down to the seabed through the net (4 m/m x 4 m/m).

D. Telai not having feed will get tired and die

According to a biological survey, the results of autopsy of dead telai show that in case of some of telai there is nothing in their stomach and their body is thin. The fact that they did not eat anything may be the cause of the death.

III. COMMENTS AT THE TIME FOR END OF THE PROJECT

(1) Need of Basic Technique and Education

What Palau has is wonderful scinery and aquatic resources within 200-mile exclusive water. To develop this aquatic resources for Palau, people who are engaged in the development will require enough knowledge and technique on ocean and a boat.

The project of JICA has been engaged in a feasibility study for past three years on skipjack boat fishing and live bait supply by setting up a fish preserve. The Project was conducted according to R/D. To catch live bait for skipjack or tuna does not only mean fishing with a fishing rod and a towing net and pulling rope, but it also means operating or engine, sailing a boat with a generator and maintaining a fish light. To catch bait, all of the above-mentioned must be fulfilled. With the development of fishery, as far as it uses a boat, basic knowledge and training of sailing a boat is necessary. If a boat with an engine is used, repairing work occurs sooner or later.

Without basic knowledge, we may break down the machine due to its mis-use. On the job training on a boat or at a factory to obtain techniques through experience is most important to fishery development in Palau.

(2) Training of Managers for Fishing

In order to run business including effective fishing, adequate management is indespensable. Necessary for fishing is as follows:-

A. Management of sailing a boat

B. Labour management of employees

C. Management of effective use of materials for fishing (including a fishing boat & gear)

D. Cost management and profit & loss management

Success of business is expected only when all of the above-mentioned is is satisfied. Lack of ability in any of one field gives serious influence over fishery business. Education for fostering a general manager as well as engineers is very important.

(3) Shore Facilities Related with Sailing of a Fishing Boat

A fishing boat with excellent equipment cannot be used effectively without an engineer. Also an engineer for maintenance, inspection and repair is necessary together with adequate shore facilities. Without these, working efficiency would become low even if a boat is full of expensive equipment.

In case of modern fishing and sailing of a fishing boat, shore repair facilities, materials and relevant parts must be taken into consideration when a fishing boat is built and operated.

Table 1

Live Bait Conditioning and Supply Observation Record

From Oct. 7, 1980 - Oct. 17, 1980

Number of buckets includes water (10 liters)

Place: Rock Island, Palau
Depth of Water: 26-27 metres
Seabed: Sand mud
Fish: Telai 70%, Herkiotsichthys punctatus 10%, Sparatelloides delicatulus 10%, Others 10%

Month/Date	Time	Weather	Wind		Temperature	Water temperature	Tide	Fish preserve No.1(Ikesu No.1)			Fish preserve No.2(Ikesu No.2)			Fish preserve No.3(Ikesu No.3)			Fish preserve No.4(Ikesu No.4)			Fish preserve No.5(Ikesu No.5)			
			Direction	Velocity				In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	
10/ 7	2130	B C						35.4															
8	1630	B C	S	1	27.6	29.6	—		0.6	34.8	39.6												
9	〃	〃	S E	1	27.1	29.7	N W		1.8	33.0		0.8	32.1										
10	〃	B	E	2	28.1	29.7	—		3.0	30.0		2.4		0.6	31.5	22.5							
11	0600	B C	—	—	28.4	29.4	—		2.4	27.6		2.4		2.1	29.4			2.1	20.4				
12	1200	〃	—	—	29.0	29.7	—		2.4	25.2		3.0		3.0	26.4			0.3	20.1				
13	0900	〃	W	1	29.7	29.6	S		1.5	23.7		2.1		1.8	24.6			0.3	19.8				
14	1630	〃	N E	1	28.6	29.1	〃		2.1	21.6		2.4		1.5	23.1			0.3	19.5				
15	〃	〃	—	—	28.4	29.7	N		2.4	19.2		1.5		1.2	21.9			0.9	18.6	8.4			
16	〃	〃	S E	1	29.0	30.2	〃		2.1	17.1		2.4		2.1	19.8			1.2	17.4		1.5	6.9	
17	0900	〃	—	—	29.7	29.6	—		2.1	15.0		2.1		1.8	18.0			0.9	16.5		0.9	6.0	
Total								35.4	20.4	15.0	39.6	18.6	32.1	14.1	18.0	22.5		6.0	16.5	8.4	2.4	6.0	
Mortality (Total death rate)								57.6 %			46.9 %			43.9 %			26.6 %			28.5 %			

Table 2

Live Bait Conditioning and Supply Observation Record

From Oct. 28, 1980 - Nov. 12, 1980

Number of buckets includes water (10 liters)

Place: Rock Island, Palau
Depth of Water: 26-33 metres
Seabed: Sand mud
Fish: Telai 80%, Others 20%

Month/Date	Time	Weather	Wind		Temperature	Water temperature	Tide	Fish preserve No.1(Ikesu No.1)			Fish preserve No.2(Ikesu No.2)			Fish preserve No.3(Ikesu No.3)			Fish preserve No.4(Ikesu No.4)			Fish preserve No.5(Ikesu No.5)			
			Direction	Velocity				In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	
10/28	2000	B C	WSW	3	28.5	29.4	—	39.0															
29	〃	〃	〃	〃	28.4	29.8	—		1.8	37.2	27.0												
30	〃	R	WNW	2	28.0	29.9	NNW		0.9	36.3		0.6	26.4	30.0									
31	1700	C	〃	1	27.8	30.0	〃		1.2	35.1		1.2	25.2		1.2	28.8							
11/ 1	0900	B C	〃	〃	29.6	30.0	—		2.1	33.0		1.8	23.4		1.5	27.3							
2	〃	〃	〃	2	30.0	30.0	NNW		2.4	30.6		2.1	21.3		1.5	25.8							
3	1700	〃	SSW	〃	28.0	30.0	〃		2.4	28.2		1.5	19.8		1.8	24.0	30.0						
4	0900	〃	〃	〃	29.9	30.2	〃		2.1	26.1		1.8	18.0		1.8	22.2		2.1	27.9				
5	1700	〃	N	3	29.4	29.8	SSE		2.1	24.0		1.2	16.8		1.2	21.0	0.9	2.1	26.7				
6	〃	B	SSW	2	29.4	30.5	〃		1.8	22.2		1.2	15.6		1.5	19.5	9.0	2.4	33.3				
7	〃	〃	E	〃	30.0	30.0	〃		2.1	20.1		0.9	14.7		1.8	17.7	6.0	3.0	36.3				
8	0900	〃	〃	1	30.2	30.0	〃		1.2	18.9		0.9	13.8		1.5	16.2		1.8	34.5				
9	〃	〃	〃	〃	30.1	29.9	〃		2.7	16.2		1.2	12.6		1.2	15.0		2.1	32.4				
10	1700	R	〃	〃	26.7	30.0	—		2.4	13.8		1.5	11.1		1.2	13.8		2.4	30.0	19.5			
11	1000	R.C	—	—	29.8	30.1	—		2.1	11.7		1.8	9.3		1.8	12.0		2.4	27.6		1.5	18.0	
12	〃	〃	E	1	30.0	29.7	—		1.8	9.9		1.8	7.5		1.5	10.5		2.1	25.5		1.5	16.5	
Total								39.0	29.1	9.9	27.0	19.5	7.5	30.0	19.5	10.5	45.9	20.4	25.5	19.5	3.0	16.5	
Mortality (Total death rate)								74.6 %			72.2 %			65.0 %			44.4 %			15.4 %			

Table 3

Live Bait Conditioning and Supply Observation Record

From Jan. 6, 1981 - Jan. 17, 1981

Number of buckets includes water (10 liters)
In-coming No. (estimated)/Supply No. (real)

Place: Rock Island, Palau
Depth of Water: 18-24 metres
Seabed: Sand mud
Fish: Telai 85%, Others 15%

Month/Date	Time	Weather	Wind		Temperature	Water temperature	Tide	Fish preserve No.1(Ikesu No.1)			Fish preserve No.2(Ikesu No.2)			Fish preserve No.3(Ikesu No.3)			Fish preserve No.4(Ikesu No.4)			Fish preserve No.5(Ikesu No.5)			
			Direction	Velocity				In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	
1/ 6	2000	B C	N E	2	28.5	29.0	S	5															
7	〃	R	〃	〃	28.0	29.4	〃	25	0.6	29.4													Telai 4 — 5 cm
8	〃	C	〃	3	28.0	29.5	〃		1.8	27.6	40												
9	〃	B C	〃	1	28.5	29.8	—		3.0	24.6	90	0.3	129.7										
10	1100	R	N E	2	25.5	29.0	—		1.5	23.1		1.5	128.2										
11	〃	〃	〃	〃	26.0	〃	—		1.5	21.6		1.0	113.2										
12	2000	B	N E	1	27.5	29.9	—		0.6	21.0		1.2	112.0	150.0									
13	〃	B C	ENE	2	28.1	29.7	—	151 buckets supplied to Taiyu-Maru No. 27.							0.6	149.4	90.0						
14	〃	R	NNE	2	27.2	29.8	—								2.4	147.0		0.6	89.4	80.0			
15	〃	B C	S	1	28.2	29.9	—	90.0			149 buckets supplied to Taiyu-Maru No. 27.							1.5	87.9		0.6	79.4	
16	〃	C	〃	2	28.0	29.7	—		0.3	89.7	40.0							0.9	87.0		0.9	78.5	
17	1100	R	〃	3	28.0	29.6	—		1.5	88.2		0.6	39.4				170 buckets supplied to Taiyu-Maru No. 27.						
								Ikesu was withdrawn due to stormy weather and moon light condition.															

Table 4

Live Bait Conditioning and Supply Observation Record

From Feb. 2, 1981 - Feb. 13, 1981

Number of buckets includes water (10 liters)

Place: Rock Island, Palau
Depth of Water: 15-26 metres
Seabed: Sand mud
Fish: Telai 85%, Others 15%

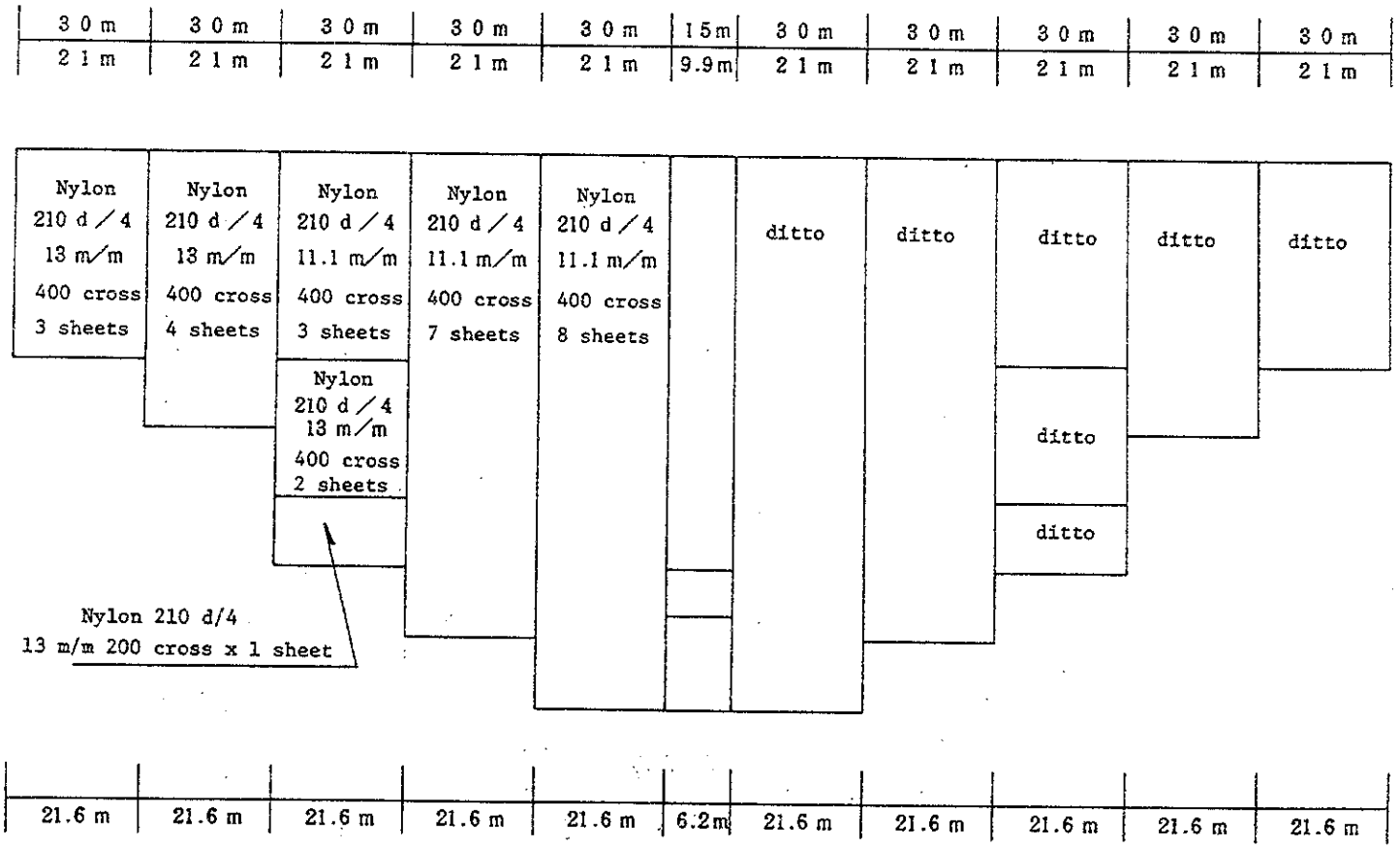
Month/Date	Time	Weather	Wind		Temperature	Water temperature	Tide	Fish preserve No.1(Ikesu No.1)			Fish preserve No.2(Ikesu No.2)			Fish preserve No.3(Ikesu No.3)			Fish preserve No.4(Ikesu No.4)			Fish preserve No.5(Ikesu No.5)			
			Direction	Velocity				In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	In-coming (No. of bucket)	Dead (No. of bucket)	Remain (No. of bucket)	
2/2	2000	B C	NWE	2	26.7	29.0	N	36															Young sardine (2cm) (Whitebait 4-5cm Telai 90%
3	〃	〃	N	2	25.5	28.4	〃	40	2.0	74.0													〃
4	〃	C	N E	1	27.2	28.8	S		1.8	72.2	70												〃
5	〃	R	NNE	2	25.0	28.2	〃		1.0	71.2		3.3	66.7	70									〃
6	〃	〃	〃	〃	27.0	28.2	N E		0.3	70.9		1.2	65.5		0.6	69.4	60						〃
7								Lejabil			136 buckets supplied												〃
8														Lejabil			130 buckets supplied						〃
9	2000	B C	N E	2	26.8	28.8	—	20															
10	〃	〃	N	3	〃	〃	—		2.5	17.5	35												
11	Observation only due to stormy weather											1.0	34.0										
12	No fishing due to stormy weather																						
13								Ikesu was withdrawn for cleaning 50 buckets remaining.																

Table 5

Two-boats purse seiner for catching eel

Total length of net 315 m

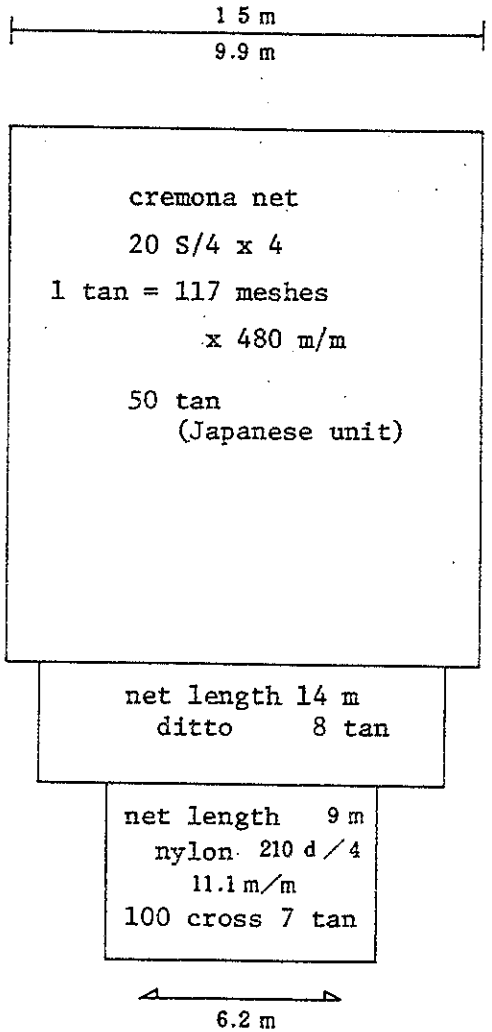
Total length of head line 219 m



Total length of footrope 222.2 m

Table 5

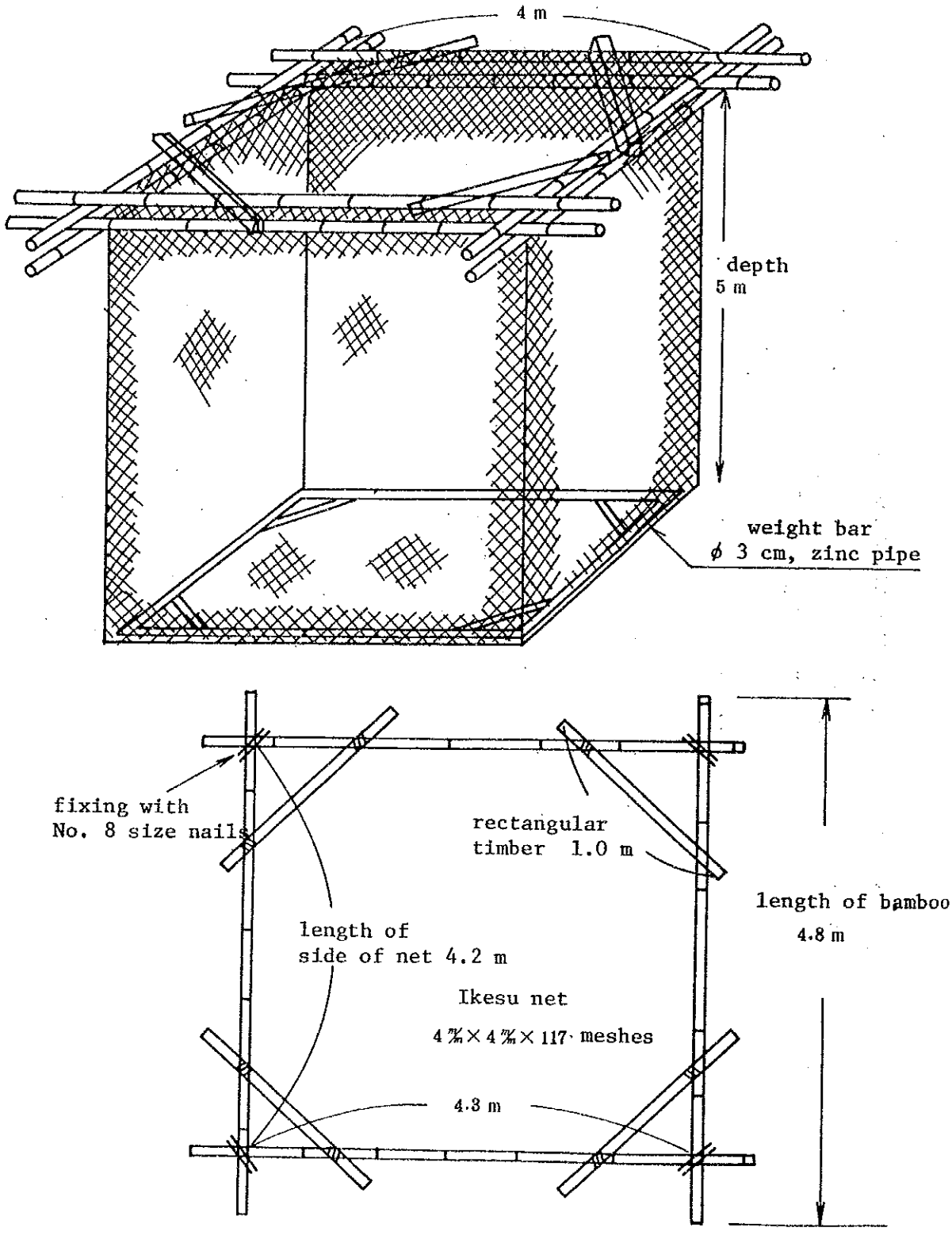
Fish-catch part of two-boat purse seiner for catching eel



1 tan = 117 meshes x 480 m/m

Table 6

Telai fish preserve (Ikesu) in Palau



II. Biological Survey in 1980 FY; co-authored by Shoichi Kigawa and Itsuro Uotani, Japanese biological survey experts

CONTENTS

I. PREFACE

Biological survey was made as part of the Japanese-Micronesian Fishery Development Project (pole-and-line skipjack fishing). The purpose of the survey is to collect biological data on telai that is necessary for skipjack fishing as live bait. How the survey was planned is not mentioned here.

The survey was originally planned to be implemented through the follow-up term of the Project. Actually, the survey was made intermittently.

This report shows the results of the biological survey and some writer's comments on telai resources in Palau. The survey made this time includes only limited seasonal data on telai inhabiting in the Palauan waters. Further survey is, therefore, desirable. Data on telai survey are attached to this report. Indication No. is put for reference.

On the occasion of publishing this report, the writer wishes to express appreciations for kind coopration of Mr. R. Rechebei of Marine Resources Div. of TTPI. and the staff members in the Palau District. Also the writer deeply thanks for cooperation of Captain Sumita and crew of Tentaka Maru, a training ship of Fishery College, which supplied samples for the biological surveys in Palauan waters and other relevant information.

II. SURVEY PERIOD AND OBJECTIVES

Biological data on live bait (fish) was produced between May, 1980 and December, 1980, particularly for each one month of May/June, August/September and November/December. In May/June period, most of the time was devoted to preparatory activities. Then, in the latter two periods, data collection was done.

The following are the items surveyed in each period.

1st survey: May 15, 1980 ----- June 11, 1980

Preparatory period: Maintenance of a survey boat & fishing gear, preparation for survey instruments, laboratory and collection of samples of live bait from fishing boats.

2nd survey: August 19, 1980 ----- September 18, 1980

(1) Survey of distribution of bait fish: Catching of fish by using a underwater lamp and a bagan net, collection of samples.

(2) Oceanographic observation arrangement: Water sampling to measure temperature and salinity at surface & middle depths (2M, 5M, 10M, 20M and 30M) around the stations where the survey of night fishing with lamps was done.

(3) Survey of plankton: Kitahara-type plankton net (50-metre vertical tow; selection, fixing and counting of gathered species.

(4) Survey of telai larvae: Larva net (1.4 M dia.) towing at night for 5 minutes. Fixing, counting and measuring of total length of stolephorus.

(5) Collection of biological data: Total length, measurement and investigation of sex, maturity, gonad weight and stomach contents.

3rd survey: November 27, 1980 ------ December 24, 1980

(1) Survey of distribution of bait fish: Survey of bait fish and catch by using a underwater lamp and a stick-held dip net, collection of samples.

(2) Oceanographic observation: Measuring of temperature and sampling of water for salinity at surface & middle depths (2M, 5M, 10M, 20M and 30M) around the stations where night fishing with lamps was done.
Measuring of surface temperature, collecting of water for salinity at the stations where eggs larvae were observed.

(3) Egg and larval survey: Surface larval net towing at night around the stations where night fishing with lamps was done.
While sailing in day time, surface towing at 2-3 mile intervals.
Fixing, counting and measuring of total length of stolephorus larvae.

(4) Acoustic survey: Research of distribution of bait fish while sailing in day time by means of a Furuno-type small fishing sonar.

(5) Collection of biological data: Body weight, sex, maturity and gonod weight.

III. HOW THE SURVEY WAS DONE

2nd and 3rd surveys were made as follows (except 1st survey):-

2nd survey: Trips were made from August 25 to September 7.

In this season, the prevailing westerlies blew day by day. At the biginning of September, a typhoon approached and skipjack pole-and-line fishing in the island was impossible. Lengthy suspentions of island fishery continued. The strong prevailing westerlies forced us to cancel a plan to sail to the open lagoon off the west-south coast of the main island. Instead, trips were made to the Malakal Harbor area and the eastern lagoon, where the influence of wind was less.

Survey (First Time) August 25 --- September 1 (except August 31)

Survey by a fish-gathering light at night, 1 station at Iwayama-bay, 4 stations at Malakal harbor water, 2 stations at Iwayama bay area (total 7 stations). Two boats were used (14-metre boat and 8-metre boat.).

Survey (Second Time) September 3 --- September 7

Same survey as the above, 2 stations at narrow barrier reef of the east coast of the main island. 1 station off the east coast of Urukutaberu Island. 1 station at Eelmook Island. (Total 4 stations.). 26-ton type boat ANGARAP and 14-metre boat were used.

3rd survey: Onboard survey from December 2 --- December 16

ANGARAP and 14-metre boat were used. In order to get information on telai widely in the islands, larval survey was done at 2-3 mile intervals in the day time and fish finder observation was done while sailing.

First sail was done from December 2 to December 5, visiting three places off the west coast of the main island to survey larvae by using a fish-gathering light and a stick-held dip net. In the day time, at stations both outside and inside of barrier reef a larva net was towed.

Second sail was done from December 8 to December 11. Bait fish survey was done at night at three stations in lagoon connecting with the Iwayama Bay area. In the day time, larval survey was made and the results of a sonar was recorded. On December 11, larval survey was made again in the Iwayama Bay connecting with Malakal harbor.

Third sail was done on December 15 and 16. Larva net towing was made at stations both inside and outside the eastern bareer reef. No bait fish survey at night was done this time.

IV. RESULTS OF SURVEY

<Fish Gathering Tests and Environment Survey>

1) To Set Up Station

The bait grounds are concentrated in the so-called Rock Islands area. For a fishing boat, it is ideal to get baits here. General and systematic study on telai was made in this area (Muller 1976, ms). However, distribution of telai of this island is not limited to this area. Volume of telai supplied at the Rock Islands seems to have relation with telai resources existing at different places of the island. In this concern, location of station was stressed to setting up widely and outside of the Rock Islands. Fish gathering tests were made at 17 stations.

2) Survey Method

After arriving at the station, measurement of water temperature and water sampling was made in advance of fish-gathering light test. 1.5 kW incandescent lamp was used as a light. The lamp was put on at 6:30 PM in August/September (2nd survey) and in December (3rd survey) at 6:00 PM as the sunset came earier. The depth of a under-water lamp was usually 6M ∿ 9M. The duration of gathering fish was between 2 and half and 3.

A bagan net (2nd survey) and a stick-held dip net (3rd survey) were also used. A bagan net was small and its catch of fish was also small. When the catch was big with the stick-held dip net, only necessary sample was kept and other fish was returned into the sea after eye's observation. Samples were fixed immediately with formalin and precise observation was done later on land.

3) Telai

Before mentioning the results of fish gathering test, what is telai is mentioned here simply.

Followings are known as Gen. Stolephorus of the family Engraulidae living in Palauan islands: Stolephorus heterolobus, Stolephorus buccaneeri, Stolephorus indicus and Stolephorus Tri (Abe 1939). Telai or Tarekuchi, important live bait fish of this island, is mainly S. heterolobus. However, Stolephorus devisi was reported later as a telai sample of Palau. (Smith and Kearney, 1974). Therefore, there is a possibility that telai involves these two. These two have similar morphology and wide distribution in the South East Asia. In Papua New Guinea, these are very important as live baits.

Some say that two types of telai exist in Palau: relatively strong one and weak one (Akitsu report, 1976). It is not certain whether or not these two in Palau are the same as the above-mentioned two.

Test of fish gathering and measurement of many samples of telai was made. Judging from the measurement of shape, there might be no ground of distinguishing telai into two species at this stage: S. heterolobus and S. devisi.

Therefore, in this report, the writer wishes to decide tentatively that telai indicates S. heterolobus, following the conclusion of Mr. T. Ozawa of Kagoshima University in Japan who surveyed the sample once again.

In Palau there are waxen telai and telai with yellow color in the body. Quantity of samples of the latter was few this time. Further study on telai is advisable from a viewpoint of a specialist. Table 1 shows gill-rakr counts and head length in standard length for 60 fish.

4) Occurence of Telai

The location of 17 stations for bait fish study in the island and the results of fish gathering are shown in Fig. 1. Slanting stroke shows part of mixing catch. Details of caught fish species at each station are shown in Table 2.

A small bagan net was used at station 1 - station 11. Later, a stick held dip net was used and to catch thereby was much bigger compared with the bagan net. The result of gathering by the bagan net was poor. One reason may be that, during the term, the moon rose at night. Rather than difference of net, moon light darkness, place and time would much affect the catch.

At station 22, the northermost, only a test of gathering was done. Towing was impossible due to tide. Gathering result was poor at the station and telai was not seen.

Results of gathering test shows (Fig. 1) mixing catch of telai, almost 100% in the western open lagoon adjoinning to the Rock Island area (after station 30). While the rate of mixing catch was low in the narrow barrier reef (station 1 - station 11) including the Malakal Harbor.

The former test was done at the beginning of December and the latter at the end of August/beginning of September. In case that a seasonal change of distribution is not notable, the results show that main distribution of telai in the island is located in water inside the barrier reef, which is west side of the island and widest area.

The gathering was very good at the stations in this area (stations 30, 36, 39, 53 and 56) and telai was widely seen with high density together with telai gathered by light.

Water in the Malakal Harbor and within the barrier reef in east, many species appeared besides telai. Representative ones were Spratelloides delicatulus and Herklotsichthys punctatus. Oiognathidae sp. dominated in station 4.

Besides telai, two Gen. Stolophorus species occured at the east coast of the main island (station 8, station 9): Stolophorus batauiensis and Stolophorus baelama. The volume of these was not much. About half of the catch at station 3 in Malakal Harbor water was one of anchovy family: Thrissina baelama.

Table 1 Gill-raker counts and head length in standard length for 60 fish of Stolephorus randomly sampled from the night light catches.

SL/HL	Gill-rakers (upper + lower)									
	43	44	45	46	47	48	49	50	51	Total
3.61-3.65				1						1
3.66-3.70										
3.71-3.75										
3.76-3.80						1				1
3.81-3.85			1	1	1					3
3.86-3.90		2				1				3
3.91-3.95					2	1		1		4
3.96-4.00				3	4	1				8
4.01-4.05				1	2			2		5
4.06-4.10				1	4	1	1	2	1	10
4.11-4.15					2	1			1	4
4.16-4.20					2	2	1			5
4.21-4.25		1			1	3				5
4.26-4.30					3				1	4
4.31-4.35					2	1				3
4.36-4.40										
4.41-4.45					2			1		3
4.46-4.50							1			1
Total		3	1	7	25	12	3	6	3	60

Counts and measurements by Dr. T. Ozawa of Kagoshima University.

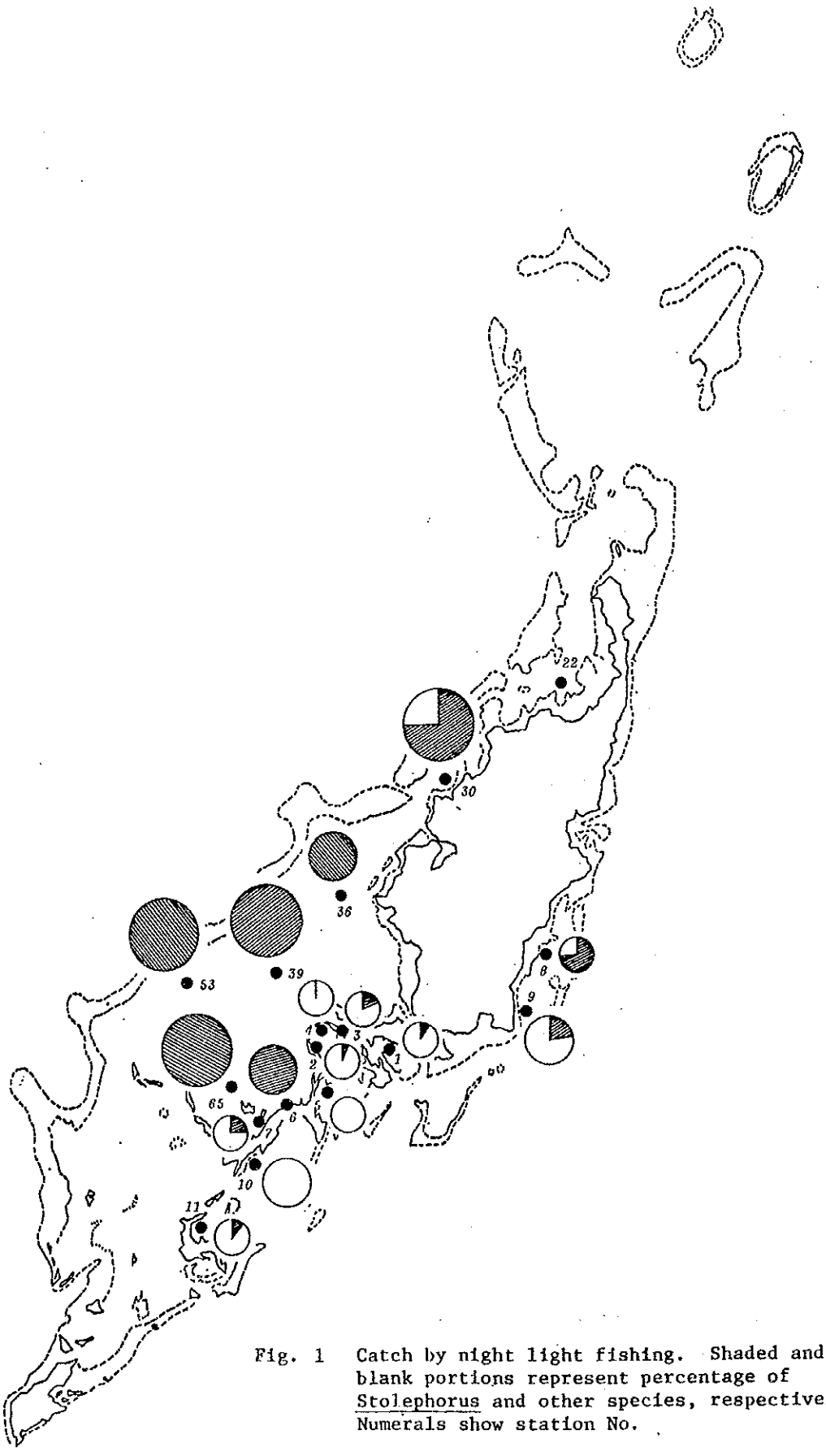


Fig. 1 Catch by night light fishing. Shaded and blank portions represent percentage of Stolephorus and other species, respectively Numerals show station No.

Table 2 Catch in bucket and species composition by night light fishing.

St. No.	Date	Catch (Bucket)	Fish species	Percentage in number
1	Aug.25	1	*Herklotsichthys punctatus*	68
			Stolephorus heterolobus	12
			Others	20
2	Aug.26	1	*Spratelloides delicatulus*	90
			Stolephorus heterolobus	7
			Planesus pinguis	3
3	Aug.27	3	*Thrissina baelama*	51
			Stolephorus heterolobus	21
			Archamia sp.	14
			Herklotsichthys punctatus	2
			Planesus pinguis	2
			Others	10
4	Aug.28	10	Leiognathidae sp.	95
			Herklotsichthys punctatus	2
			Stolephorus heterolobus	2
			Spratelloides delicatulus	
			Dussumieria sp.	1
			Archamia sp.	
			Pranesus pinguis	
5	Aug.29	3	*Spratelloides delicatulus*	50
			Herklotsichthys punctatus	28
			Atherinidae spp.	20
			Archamia sp.	2
			Others	
6	Aug.30	60	*Stolephorus heterolobus*	99
			Others	1
7	Sep. 1		*Spratelloides delicatulus*	72
			Stolephorus heterolobus	24
			Atherinidae spp.	4
8	Sep. 3	5	*Stolephorus heterolobus*	73
			Spratelloides delicatulus	7
			Herklotsichthys punctatus	6
			Stolephorus bataviensis	4
			Stolephorus indicus	1
			Atherinidae spp.	8
			Archamia spp.	1
			Others	
9	Sep. 4	23	*Spratelloides delicatulus*	58
			Stolephorus heterolobus	25
			Atherinidae spp.	15
			Stolephorus bataviensis	
			Rhabdamia sp.	2
			Others	

St. No.	Date	Catch (Bucket)	Fish species	Percentage in number
10	Sep. 5	20	*Spratelloides delicatulus*	66
			Atherinidae spp.	28
			Rhabdamia sp.	2
			Bregmaceros sp.	
			Herklotsichthys punctatus	4
			Leiognathidae sp.	
			Others	
11	Sep. 6	10	Atherinidae spp.	47
			Spratelloides delicatulus	22
			Stolephorus heterolobus	12
			Archamia spp.	12
			Herklotsichthys punctatus	7
			Others	
22	Dec. 2	0		
30	Dec. 3	100 (Estimated)	*Stolephorus heterolobus*	75
			Spratelloides delicatulus	10
			Sardinella sp.	5
			Atherinidae spp.	5
			Others	5
36	Dec. 4	50 (Estimated)	*Stolephorus heterolobus*	99
			Spratelloides delicatulus	
			Pranesus pinguis	1
			Others	
39	Dec. 8	100 (Estimated)	*Stolephorus heterolobus*	99
			Dessumieria sp.	1
			Leiognathidae sp.	
53	Dec. 9	100 (Estimated)	*Stolephorus heterolobus*	98
			Archamia spp.	2
			Leiognathidae sp.	
65	Dec.10	120 (Estimated)	*Stolephorus heterolobus*	99
			Spratelloides delicatulus	1
			Leiognathidae sp.	

The habitat of anchovy family (except telai) is limited. These cannot be seen in the wide inner water of the barrier reef in west. Time to survey in the inner water of barrier reef of Kossoi channel up to the north of the main island was not available. Judging from experience, distribution of telai is not expected or expected a little in this water where the influence of rain fall is small. However, another survey in this water in the future may be important.

Water in the southern-most barrier reef in west has shallow sea bed and many reefs exist here and there, which prevent safety sailing of a boat. The test of gathering was not done this time. Still distribution of telai is expected in this water.

5) Results of Survey at Live Bait Station

The outline of the results of observation which started at the time of anchoring and continued until the time of putting on a underwater lamp are as follows.

Depth of water: Depth of anchorage is between 15 M (station 5) and 40 M (station 9). Many of it are between 25 M and 35 M. Water inside barrier reef rarely exceeds 40 M deep.

Quality of sea bed: Involvment of sand mud, coral fine sand and reef is confirmed.

Sand mud ..... stations 8, 22 and 26.
Clay & coral fine sand ..... stations 10, 11 and 53.
Reef ..... station 39.

Temperature of water: Not much change of temperature was seen betweem surface and bottom at any station. Fig. 2 shows vertical distribution of water.

The temperature of the Iwayama-Bay (station 1) reached about 30 °C at surface, 1 °C higher compared with that of other stations (station 1 - station 11) throughout the upper and lower layers. There was an inversion layer at 5 M depth.

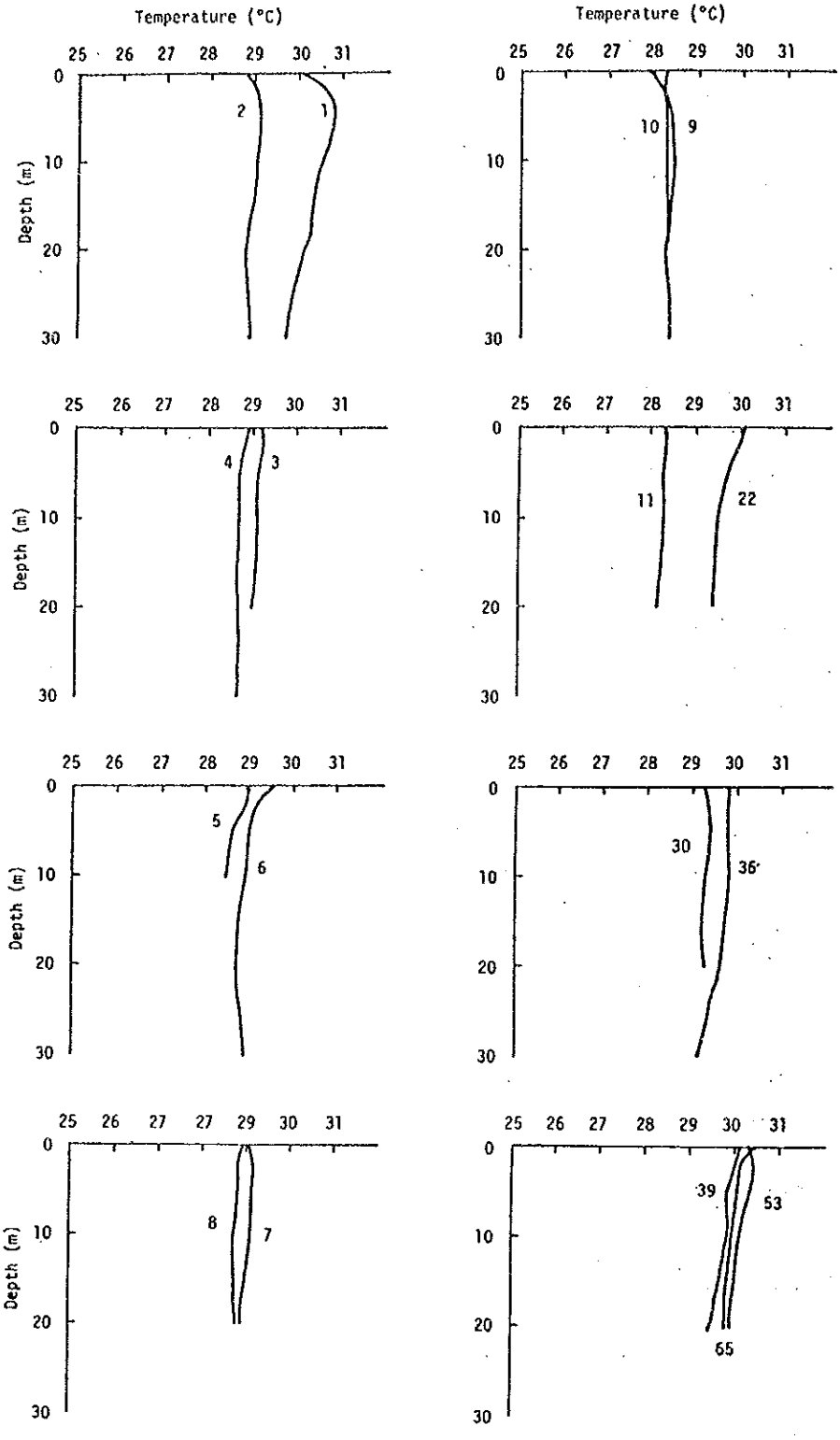


Fig. 2 Vertical distribution of water temperatures at baiting stations.

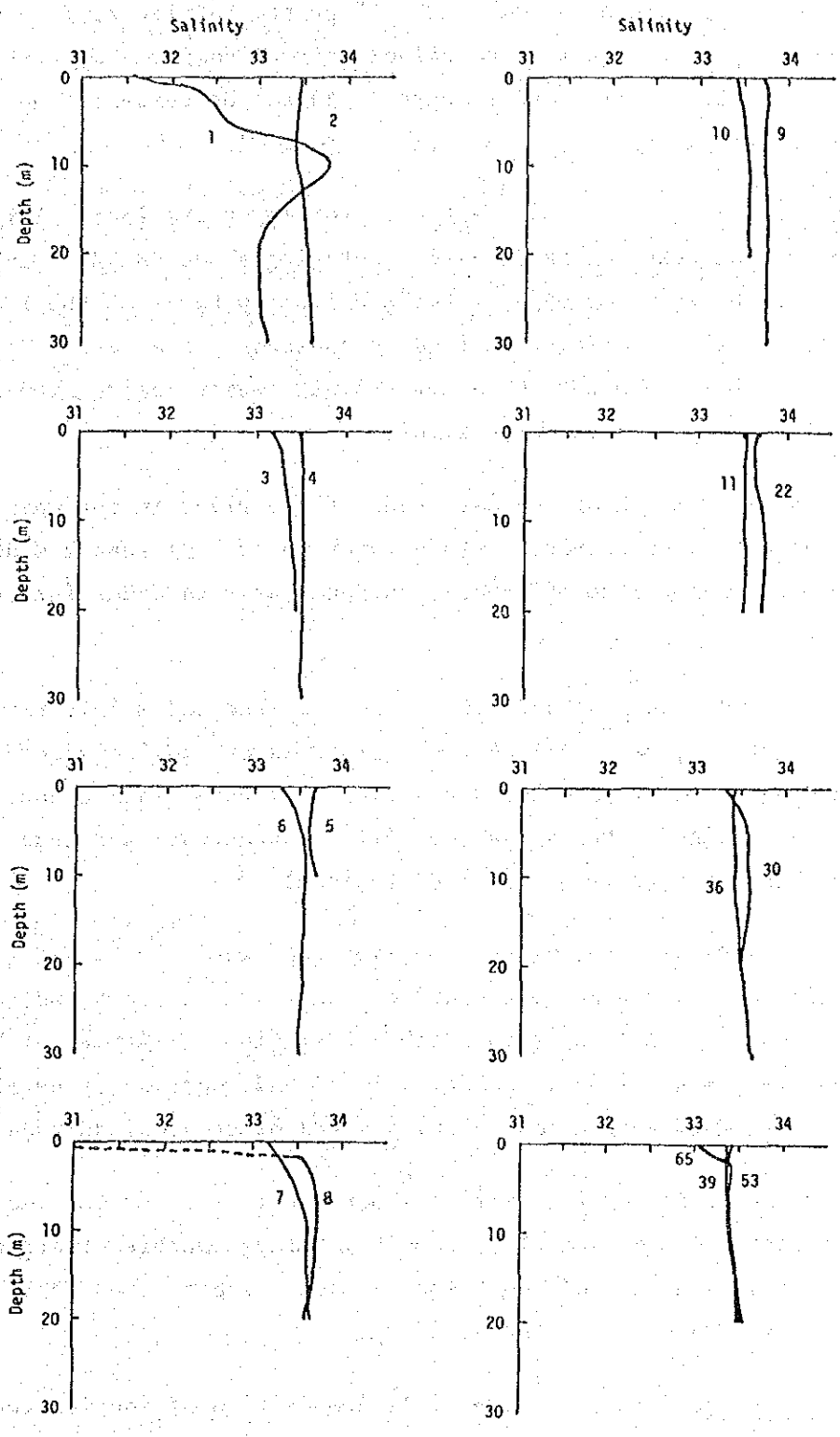


Fig. 3 Vertical distribution of Salinity at baiting stations.

The temperature at station 22 - 65 at the barrier reef in west at the beginning of December is relatively higher compared with the temperature at the barrier reef in east in August/September: The difference is about 1 °C.

Salinity: Fig. 3 shows vertical profile at stations. Salinity at most of the stations is 33-34 %: averaging about 33.5%. Much change is not seen between the upper water and lower water. At the Iwayama Bay (station 1), a salinity maximum is apparently seen at 10 M depth. Surface water is covered with a low salinity water coming from the land. Salinity at surface is 31.56%.

At a river mouth of the east side of the river in the main island, a low salinity water covers surface layer up to less than 2 M depth. At a station about 1 km off shore, surface water is under influence of land water.

In islands located south of the main island and mainly formed by many lime-stones, rain fall becomes ground water and flows into the surrounding sea. Average surface salinity of water inside barrier reef is according to the survey, 33.41% (54 stations) and that of water outside barrier reef is 33.57% (30 stations).

In more detail, salinity of barrier reef water is 33.41% (20 stations), outside 33.66% (12 stations) in west. In east, salinity of inner barrier reef water is 33.40% (6 stations), outside of barrier reef 33.51% (18 stations). Salinity is 33-34% outside of barrier reef with a feature of a low salinity water of tropical surface water.

Difference is small in salinity between inside and outside of barrier reef because tide flows smoothly through barrier reefs at offshore east and west of the Palau Islands. Table 3 and Table 4 show temperature of water and salinity.

Zooplankton: Table 3 shows it's composition of zooplankton that occured at station 1 - station 4. Zooplankton composition at Iwayama Bay is relatively simple in terms of copepoda. Centropages, Pseudodiatomus and Acartia have nature of plankton living in inland sea.

This is probably because Iwayama Bay has exclusive surroundings and this does not deny the results of marine reserch.

Pontella, Undinula, Calanus and Labidocera occured at other three stations in the Malakal Harbor. These have nature of plankton living in the open sea. At these stations, species of copepoda exists more than that in the Iwayama Bay. This fact suggests the influence of the open sea over these stations.

Table 3 No. of zooplankton groups that occurred at four stations (No./m^3).

Groups	St.1	St.2	St.3	St.4
COPEPODA				
Calanus			3	
Canthocalanus				70
Undinula		91		5
Eucalanus	101	10	8	35
Acrocalanus			+	
Centropages	48	50	13	45
Pseudodiaptomus	10			
Temora		5	+	196
Candacia				5
Calanopia				5
Labidocera			+	
Pontella		25		
Acartia	10	262	64	25
Tortanus		+	1	30
Oithona				5
Corycaeus		+	+	
Copepoda nauplius			10	
Others				
Coelenterata	10	35	14	126
Polychaeta larvae		5		3
Sagittidae	82	70	25	73
Evadne	13	3	+	
Ostracoda		5		
Cirripeida nauplius	3			
Amphipoda		8		3
Lucifer		3		
Macrura larvae (Mysis stage)	4	60	4	25
Brachura larvae (Zoea stage)	4	23	1	43
Squilla larvae (Arima stage)		3		
Cavolinidae		23		8
Gastropoda larvae		10	+	3
Echinodermata larvae	1	3	6	28
Doliolum		3		
Appendicularia	1	63	15	13
Anchovy larvae	3	20	+	
Other fish larvae		8		
Total	290	788	164	746