

OUTLINE OF POLE-LINE SKIPJACK FISHING WITH SELF-SUPPLIED LIVE BAITS

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PREFACE

It has been the worldwide trend in recent years to exploit and make effective use of skipjack resources of the South Seas.

Skipjack fishing may be represented by Japan's traditional pole and line fishing and the U.S. purse seining.

The present text is intended to outline the pole-line skipjack fishing developed in Japan, out of her representative fisheries.

The objective of skipjack fishing is, in short, to convert live baits into skipjacks as efficiently as possible.

In other words, it is to catch as many skipjacks as possible in exchange for as few live baits as possible.

In order to realize sound development of the pole-line skipjack fishing, it is necessary, while working for effective utilization of skipjack resources, to ascertain the condition of resources, solve various problems resulting from the use of live baits in large quantities forming the special nature of this type of fishing, develop reasonable and efficient fishing methods and gear, and make efforts for upgrading the utilization and processing of catches in a comprehensive manner.

The present text has been prepared from the above points of view to outline the pole and line skipjack fishing based on the text of the Asian Association, and the writer's experience in the Gulf of Guinea, WEST AFRICA.

(Translated by JICA)

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SECTION I. ECOLOGY AND DISTRIBUTION

1. Species

The primary species for this type of fishing is skipjack and the secondary ones include frigate mackerel, tuna and miscellaneous. The emphasis in the present text will be placed on skipjack.

1-1. On Bonito (*Katsuwonus pelamis*)

Bonito normally means skipjack and its ecology may be outlined as below.

The body is rather short and stout with the body girth nearly elliptical. The beak is pointed.

The dorsal appears dark violet green; the ventral side is silvery white with four to ten dark blue linear strips which decreases in number as the fish grows. An approximate maximal size of the fish is 80 cm in body length and 18 to 19 kg in weight. It is found by marking test of some skipjacks that they generally grow at the rate of 1 kg per year upto the age of about 5 or 6, for example, 3-year old one is weighing about 3 kg.

The age group to be found most often among the catches is 2 to 5. It may be added that the characteristic stripes on the paunch become clear after death.

1-2. On Frigate Mackerel Family

One of the family has several black dots under the pectoral fin instead of the linear stripes, and prefers to live over reefs or banks around a promontory or a remote island swept by a fast current. As this species seldom follows pelagic migration or comes up to the surface when moving about, it does not suit for pole-line fishing.

Another this family has a number of narrow linear stripes on the dorsal. The teeth are sharp and long. Usually it swims on a mid-water layer close to the shore.

The other families have ripple-like spots on the dorsal part. The beak is short with the eyes located more anteriorly than those of their allied species. They are round in the body girth, and live close to shore, come into a bay or an inlet in a mass along a rapid current beneath a cliff, and also stay out often in the offing without forming a school.

However, they prefer to live in a warm current.

Therefore, their migratory status such as the time and the size serves as a key to the strength of the current which fluctuates from time to time.

1-3. On Tuna

Those tuna fish to be covered by this type of fishing are normally small ones of under 10 kg with the largest ones weighing 30 kgs.

Generally ones over 30 kgs have been caught by long-liners and purse-seiners. These relatively small tuna fish are often found at the same fishing ground as skipjack, forming a mixed school.

1-3-1. Yellow-fin tuna

This species is widely distributed in the warm waters, growing to a length of 3 m and weighing 200 to 300 kgs. Its fins have yellow coloration, especially bright yellow on the caudal fins.

Japanese and some other people prefer to take the meat of these tuna fish family as raw fish (SASHIMI). However canned yellow-fin tuna is consumed in the West as light meat.

1-3-2. Big-eye tuna

This species is distributed in the tropical and sub-tropical zone of the Pacific, the Indian and also the Atlantic Ocean, growing to a length of 2 m. It has a spindle shape with especially large eyes. The color of the meat is more pale red compared with blue-fin tuna and, when processed, turns darkish red due to oxidation, reducing its commercial value. However, its taste is not changed compared with before processing.

1-3-3. Albacore tuna

This species is also widely distributed in the warm and temperate waters, growing to length of 1 m, and weighing about 50 kgs, and has long pectoral fins.

In Japan, the albacore is caught with long-line fishing in the winter months from October to ensuring April, and then with pole-and-line fishing in summer from the end of April to mid July.

The fishing grounds in the summer months are considerably overlapped with those for skipjack.

Therefore, fishing boats which operate for skipjack in these

months are also prepared to catch albacore as it brings a high profit from export market.

In winter when skipjack boats are not busy, some of them can be also used exclusively for catching albacore with long-line fishing.

2. Distribution and Migration

Here is described regarding skipjack's distribution in the western Pacific Ocean because of the insufficient or unbalanced data, their spawning areas and migration pattern in the other waters have not yet been ascertained.

In the general vicinity of the Philippine Islands, various species of the skipjack are commonly distributed close to the shore.

Fishing is undertaken throughout the year with the months from October to ensuing January as the busiest season.

The region around the South Sea islands is regarded to provide a source of the skipjack migrating up to the Philippines and Japanese waters. Therefore, they are found occurring here and there in the region all the year round. Dense schools of the fish are also to be seen in a vast area covering Borneo, Halmahera, and Amboina. In the sea adjacent to Australia, they are distributed from the South of Queensland to St. Helens to northeast of Tasmania with the offing of Victoria as their center.

They migrate as far as Lord Howe Island and New Zealand. The size of the fish caught in this region ranges from 1.4 to 7.3 kgs in weight, four years old group, each weighing 2.7 to 4.5 kgs., usually constitutes 80 percent of the catch in a normal year.

3. Food

Since a bait has to be used in the pole-line fishery, it is imperative for the fishermen to study types of food the fish usually eat and to use them as bait.

Stomach contents of skipjack specimens which were fished in warm waters included various species of fish. Some of them are sardine, anchovy, mackerel, horse mackerel, lantern fish, flying fish, squid, shrimp, larval form of crab, Schizopoda, Amphipoda, and several kinds of rock fish.

Sometimes globefish, frigate mackerel, and larvae of the skipjack

are also eaten by the skipjack. The facts suggest that those which prey on littoral fish such as mackerel, horse mackerel, shrimp, larval crab, and Amphipoda are ones living around islands, reefs, and banks, while those preying on pelagic fish like flying fish, squid and schizopod are the members living in the high sea.

In views of such factors as stomach content composition, distribution of their food in different regions of the sea, their relations with environments, and predation on their own young, it is conceivable that the skipjacks eat whatever type of food that are abundant in their particular environment and easy for them to prey upon, without showing a very strong preference over any types of food.

4. Spawning and Growth

It is inferred that the skipjacks have their spawning and nursery grounds in the neighbourhood of islands and reefs in warm water regions where food for the young fish is abundant. In the Pacific Ocean, for instance, the tropical and subtropical regions are supposed to provide such a niche for them.

Examinations of the gonad of the skipjack have indicated that they seem to spawn in one region or another throughout the year when a tremendous expansion of the potential spawning area is considered as a whole, though the spawning season for a particular region occurs during certain months of the year. The number of eggs per female, depending on the size of an individual fish, is estimated to be about 110,000 or 610,000 or 860,000 for the fish of 48, 56, or 61 cm in body length, respectively.

The young fish from one to three years old, weighing less than 1.9 kg. has a slender body and seems to like jumping up above the surface of the sea. They feed on larvae of schizopods, amphipods, decapods and various other fish. When they are still inhabiting around reefs, they are quite cautious to strangers in their environments. They are not easily attracted to baits thrown to them, and sink all at once when a boat approaches them.

However, as they grow old enough for migration, they become more and more readily attracted to bait.

Particularly, at the beginning of the migratory stage, the skipjacks are hungry enough to be easily caught on baits thrown to them, because they have not got so used to take food on the surface of the sea by pushing up water as do the old fish. The medium sized fish, weighing 1.9

to 3.8 kgs and three to four years old, are the dominant migrating on the warm waters. With their body shaped like a spindle, they would linger around reefs and banks but only for a while, and form a large school to migrate from region to region of the ocean. At this stage, they vigorously swim along the upper layer of the sea, and marvellously push up the water in a wide skirmish line which makes the sea foams and ripples almost spectacularly. The fish in this stage are usually caught on baits sprayed on them with ease.

The large-size fish weighing more than 3.8 kgs and older than four years, become fat with the depth of the body being large for the length. They tend to remain around reefs of small islands, without forming a large school.

The fish larger than 7.5 kgs in weight, seem to like staying over reefs in a low latitude throughout the year. But occasionally, they follow the yellow-fin, big-eye, and albacore in swimming across the sea to a cold water region of about 18°C. Usually they live close to the depth except when they swim up to the surface in pursuit of food at dawn or dusk or along the ebb tide.

Therefore, they are apt to be attracted to a troll line and baits sprayed upon them.

5. Schooling Habits

The skipjacks often swim in a school together with other marine animals or following drifting objects on the sea. It may be convenient to distinguish these schools according to what they swim along with. There are, for instance, a school accompanied by a shark or a gray whale, another followed by a flock of birds flying over, and another chasing a group of small fish. A group of the fish which has nothing to follow or to be followed is called a lone school. In case some numbers of the lone school are seen jumping up every now and then, they are called a jumping.

The skipjacks seem to be in symbiosis with the shark or the whale. Because they are protected by these animals from their enemy such as marlins and sword fish, although a shark or a whale often snatches away food of skipjacks like sardine which they could drive up all the way. A fairly good catch is expected from a school followed by a shark, as the skipjacks in that state swim slowly and are readily attracted to bait. A timber or a wooden board drifting lengthwise along

the current would induce a larger number of the skipjacks to accompany than a wood drifting crosswise.

The more a wood is stuck with timber bores or amphipods, the more the fish would follow it. A shoal following a wood is usually large and thick, often swims together with other fishes such as dorphine, big-eye tuna, etc.

A large number of catch can be obtained repeatedly from the same shoal in this state.

The lone school may be classified according to their ecological features into a few sub-categories: a shoal swimming round under the surface may be called a circling school; one which makes the color of water reddish may be a red school; a school called the "breeze" (leeward) moves slowly leeway, with birds flying over. In most cases, they are caught plentifully and easily with baits.

Whereas it is rather difficult to lure a jumping school to baits, as they live in a mid-water. Even if a large school of this state can be induced to the surface, it takes a long time before a successful number of fish are caught. A flock of birds excitedly skimming back and forth over the sea always tells where the shipjacks swim about on the surface.

Birds soaring in a jaunty circle are often associated with the fish swimming in a mid-layer, while a flock staying still on the surface suggests the fish remaining in a fairly deep layer of the sea.

6. Other Ecological Features

6-1. Eye Sight:

Visual investigation of the skipjack's eyes have proved, contrarily to a conventional belief, that the fish are strongly hyperopic. Although their visual field is relatively narrow, they seem to have the eyesight for a distance of about 20 m. or more depending on the transparency of water. It is for this function that they can swim pretty fast in a large school without colliding on anything else or also encircle a mass of sardines or the like.

Water spray which is often used in pole-line fishing for the skipjacks is intended for, among other reasons, disturbing this farsightedness. Furthermore, when baits are thrown over-board or jigs are used, their eyesight has to be taken into consideration by anglers.

6-2. Vertical Migration:

Diurnal changes in the amount of catch reveal that a substantial portion (about 70%) of a daily catch is hauled up from about 5 to 9 o'clock in the morning. This is probably because they are most active in having breakfast at dawn. A slack fishing in succeeding hours may be attributable to a low appetite as well as disturbance of the school by fishing and some other causes. About the noon to 13 hours you may have an afternoon catch to some extent, and lastly a pretty good harvest at dusk from 16 to 18 hours.

No catches are expected during the night till 4 to 6 hours. In other words, the skipjacks seldom come to the surface in the daytime when the sunlight is strong. Even if a few do, they look like playing about and few take bait.

These facts indicate that activities of the fish and their food are largely influenced by underwater brightness. In case of the skipjacks staying above reefs, they seem to emerge out of a depth along with plankton and upwelling due to the ebb and flow. But they sink down again at the dead tide.

6-3. Preference of water temperature:

When the sea off Japan is taken as a whole, temperatures of water in which the skipjacks like to live have a wide range from 17°C to 30°C difference between the both extremities being 13°C. But in particular fishing grounds the difference between the lower and the upper limit of temperature is 5°C to 10°C. The most suitable temperature for skipjack fishing is 28 to 29°C in the tropical and sub-tropical waters.

In the temperate waters it is 19 to 23°C.

6-4. Other Characteristic Habits:

In regard to ecological peculiarities so far reported with the skipjack there are reasons to believe that the fish are induced to come into an area which has had an epicenter in a local earthquake. Because sometimes the geographical position of a fishing ground which has produced the skipjack in quantities has more or less coincided with the position of the epicenter.

When the fish are about to migrate, a low pressure passing over their living water lowers the water temperature of the area and thus

promotes their migration all at once. When a low atmospheric pressure develops above the Japan Sea, and a high pressure over the Pacific, rich catches of the fish take place in the vicinity of Izu Peninsula on the Pacific while poor fishing is associated with the adverse distribution of the atmospheric pressures.

Some other findings suggest a possibility of fishing for the skip-jack at night with the help of underwater lamps to attract the fish.

SECTION II. FISHING VESSELS

1. Hull Structure and Nautical Instruments

The size of wooden boats for skipjack fishing ranges from 30 to 150 gross tons classes.

Most of the boats, however, are smaller than 100 gross tons, with 90 tons class forming the majority. Steel boats are from 150 to 500 gross tons, with 400- to 500-ton class as the major strength. Although wooden boats have been replaced one after another with steel boats or with FRP boats and the former size is getting larger and larger, because they have to be made fit for skipjack fishing with high operational efficiency, there is a certain limit in further enlargement of the hull size which is dependent upon characteristics of skipjack fishing as well as harbour facilities.

Under the present circumstance after the second oil-shock world-wide, a steel boats of 400-ton class and a FRP boats of 70-ton class seem economically to be the most suitable for this type of fishing. The former is a pelagic boat aimed at frozen fishes, the latter is a coastal boat aimed at fresh fishes for Sashimi.

Japan has a biggest pole-line fishing boat in the world of about 1,200 gross tons class.

In regard to nautical instruments, it is described as below:

1-1. Radar	: One or two sets.
1-2. NNSS/Loran	: One set.
1-3. Fish finder	: One or two sets.
1-4. Sonar	: One set.
1-5. Direction finder	: One set.
1-6. Wireless communications	: Two or three sets.
1-7. Gyro compass	: One set.
1-8. Magnet compass	: One set.
1-9. Chronometer	: One pc.
1-10. Sextant	: Two or three pcs.
1-11. Binoculars	: Ten pcs or more.

2. Cruising Range and Speed

Since the majority of skipjack boats have to operate busily over a vast expansion of the fishing grounds nearly all the year round, and concurrently to win a competition with fellows, it is desirous for these boats to have the cruising range as large and the speed as fast as possible.

As for driving power, diesel engines are adopted in all of cases, as they consume fuel per horse power less than hot-bulb engine and are more reliable and more durable. The capacity of an engine for skipjack boats has gradually become great, and it is 2.5 H.P. per ton in lower level, usually 3.5 H.P. per ton, and over 6 H.P. per ton in higher level.

The cruising speed of a boat is dependent on adequacy her hull structure, engines, and horse power. A normal level of speed required for a skipjack boat is about 10 knots because she should be capable of 1) cruising to and from a fishing ground in a minimum time, 2) taking as many trips as possible in one season, and 3) surpassing with higher efficiency over fellow boats in the same fishing ground.

The recent speed of higher skipjack boats reaches 12 to 13 knots.

3. Bait Tank

One of the most remarkable features of skipjack boats is the bait tank, the capacity of which determines the number of operation in fishing grounds and the amount of catch there of. On an earlier occasion the tank was built in center of the fore position of the boat where live baits such as anchovy could be kept as healthily as desirable under a minimum heaving and where they were conveniently handled at the time of operation. Recently the tanks of large sized boats are built in the both side of mid-ship, and have two purposes of bait tanks and fish holds concurrently.

Ample and continuous supply of fresh sea water is needed for keeping bait healthy, adequacy of water renewal being dependent on the density of bait kept in the tank. Renewing of water in the bait tank could have been done by either one of two means or both; a hole furnished through the bottom of a boat formerly, and a powered pump in the engine room recently.

Some of the boats is equipped with cooling water system for reducing activities of bait, and some of the boats over 400 gross tons is done

with aerating water system for protecting bait from oxygen starvation. The boats adopted both of these systems is successful in decreasing a mortality of bait.

4. Fish Hold.

In order to supply fish as many and as fresh as possible to market, the fish hold of a boat has to a perfect structure and capacity.

So, the structure and capacity is shown by figures separately. [I give to see the figures]

5. Accommodation of Crew.

In pole-line skipjack fishing, it is necessary to take on board as many expert fishermen as possible for securing success of operation which is determined in a spell of time. Some of important factors that limit the number of fishermen acceptable to a boat are accommodation of living quarters, recreational facilities, and fish-storing structures such as the fish hold and bait tanks.

Formerly the average number of crew was 29 for boats of 20 ~ 50 ton class, 45 for 50 ~ 100 ton class, and 54 for a boat larger than 100 gross tons, recently the number of crew ranges 25 to 35 in all sized over 70 ton class pole-line skipjack boats.

6. Water Spray System

This is a unique facility to take advantage of a habit of skipjack into fishing. Proficiency in spraying water has a direct effect upon the catch. A galvanized iron pipe, 75 mm in diameter, perforated at proper intervals, is equipped all around the foretop and the platforms. The foretop, built of steel in a guarder style, has the frontal end relatively wide, the rear connected with the platforms, and a chute for sliding catches down to the deck. The platforms are built on the outside of the bulwarks from the bow to the stern, have water proofed plate flooring, and should be strong enough against waves.

Water is fed from a pump in the engine room. In a modernized large boat, one can control water spray from the bridge by the use of a motor while watching behaviours of a school operated. Adoption of the electric motor has made it possible to use a small yet more powerful pump than before.

7. Communication System, etc.

Wireless system is indispensable for securing fishing conditions and safety of a boat at sea, as well as economical navigation. A modernized boat is installed with a loran, NNSS, radar, echo sounder and fish finder, gyro remote controller stand, engine remote controller stand, transmitters and receivers, and wireless telephone systems.

SECTION III. LIVE BAITS

1. Species, Sizes and Ecology of Live Baits

Desirable conditions for live baits for skipjack are: 1) they can be caught in large numbers throughout the year; 2) it is possible to preserve them in live bait wells on board; 3) they respond well to chumming; and 4) the body length of between 5 and 10 cm.; 5) more suitable weight ranges 4 to 8 gr. in anchovy.

This is a reason that it is needed to catch as many skipjacks as possible in exchange for as few numbers of live baits as possible.

If possible, it expects to exchange one piece of live bait into one piece of skipjack.

1-1. Anchovy Family

This family can be spotted widely in the temperate zone, reaching to 18 cm. in body length. Round-shaped scales are apt to come off so easily that the mortality of the bait fish is very high. The bait fish is a compressed cylinder in shape with the shorter lower jaw.

This family can be fished in great quantities and kept alive for longer periods in fish cages. Therefore, this family is most widely used as bait in angling skipjack and tuna, and essential to skipjack and tuna fishing.

The mortality of this family in fish cages changes in accordance with its size: the closer to middle size, it means the body length of between 5 and 10 cm., the stronger the bait fish.

Especially thus large-sized anchovies of over 10 cm. in length with spawn are very weak.

Some of anchovy family used as bait fish in the tropical waters has a high mortality.

This family is found particularly weak when spawning both in spring and in autumn.

They grow to adults fish with body length of 7 to 8 cm. in half a year.

1-2. Sardine Family

This species inhabits both the temperate zone and the frigid zone where it grows to a body length of 20 cm. Scales of sardine are so

easily separable as those of anchovy.

Sardine usually has 6 to 9 dark marks on both sides of the body. But some of sardine family have no mark at all. Sardine family can be caught in a great number and can be kept in fish pens for longer periods like anchovy.

If compared with anchovy family, this family is not so suitable as bait fish because the latter tends to dive when sprayed over the schools of skipjack, and is weaker than anchovy in a high temperature waters such as over 29°C. But if compared with the other bait except anchovy, Sardine family is more suitable than the other bait fish.

Small-sized sardine has a positive photo-taxis, likely to be worked to lighting, but large one such as over 15 cm. in length is hard to attract by lighting. This species is noted for its sensitiveness to shock. A shock wave may disturb the baits in fish ponds so that they may be induced into desperate rushing, colliding violently against the walls in the fish cages on board or against the nets in the fish cages in the sea water, causing death to a large number of them.

1-3. Herring Family

These species can be stored in cages safely for longer periods, and useful as bait fish.

The family, however, is not available in a great number throughout the year and hard to catch by fishing lamps at night.

2. Conditions of a Baiting Site.

2-1. Prerequisites for a baiting site are as follows:

2-1-1. The site must be close to rivers containing nutrition or nutritious acids. Recently, some rivers bring the industrial waste fluid such as from the mining and manufacturing industries, the farming, and the atomic powered plants.

That influences into the sites harmfully.

2-1-2. Generally the site must be in shallow waters with muddy or sandy seabed of little undulation and must be under the influence of a moderate current comprising upper and lower stream layers to provide necessary nutrition to bait fish.

2-2. Most frequented baiting sites are generally 10 to 30 meters deep with surface temperatures of 21 to 27°C. Moderate transparency of water at the bait fishing grounds is preferable.

2-3. A bay or an inlet having an open mouth with a long coastal line is ideal as bait fishing grounds.

2-4. In tropical waters, great care must be taken because baiting areas are, in most cases, located in a narrow area with covered by coral reefs which can hardly accommodate a clipper safely.

3. Breeding

In angling fish, live bait is ideal lure.

However, utmost care is needed for breeding, transporting and any other handling of bait fish lest they should die. When the season for skipjack fishing approaches, a fish cage made of net is set up inside a sheltered bay in the vicinity of waters where bait fish occur. The net is webbed with net in fine meshes so that they do not enmesh small bait of 3 to 6 cm. in length, yet do allow water to flow in and out sufficiently.

The net, normally measuring 6.5 m × 6.5 m × 6.5 m, is supported with a iron pipe frame and hanged down like a bag, and yet is fixed with anchors, sinkers, and made to float on the water of the bay. The system as mentioned above is rare adopted except in Japan.

Generally speaking, in the countries except Japan, wild bait is used for the pole-line fishing operation.

3-1. Catching for Bait:

The baits are caught with a purse seine, or a set net, or a stick-held dip net specifically designed for the purpose. However, one may use any other type of gear available at a locality and suitable for catching bait.

The fish entrapped in a net are carefully transfered without a scoop net into a frame boat or a pound net described above which may be towed to the bay where they are bred as mentioned before.

3-2. Breeding in Bait Pound:

It is necessary to make the bait get used to a crowded room. For this purpose, the capacity of the bait pond which has received fish is recovered little by little so that mortality can be kept at a minimum. The bait immediately after catch may be called wild bait, whereas those acclimated in a pound, tame bait, to distinguish one from the other. A sheltered bay with adequate flow of water but protected from dashing waves is ideal to be chosen for bait fish rearing. A place where temperature and other properties of water change from time to time should be avoided. By giving a good shelter over the pond, the fish have to be protected from attack of predatory birds and fishes.

When they are reared for a long period, they have to be fed healthily from after 3 days them caught, and no dead fish should be left in the pound.

3-3. Supply to Fishing Boats:

The fish which have been acclimated for more than a week are supplied to skipjack fishing boats. They are scooped with a bucket and heedfully brought into a bait tank on board of the boat. One of crew fishermen from each skipjack boat has to go to a bait rearing place to secure a needful amount of bait. He is called bait buyer, and occasionally is compelled to buy wild baits when tame baits have been sold out.

3-4. The amount of bait acceptable in the bait tank is dependent, as stated before, on an extent of water reviewing, breeding water temperature, presence or absence of oxygen aeration, and adaptability, size, and fatness of the fish.

An optimal amount would be somewhere around 5 to 10 kg. of baits per 1 cubic meter of the tank. (See page 30)

When oxygen concentration in water becomes lower than 1 c.c. per liter, bait fish becomes weak and dies. In that case large sized fish shows higher mortality than small ones, and so does sardine than anchovy.

Bodily damage due to wrong handling or excessive excitement in the bait tank also can be a cause of mortality. Small sized and/or thin fish like anchovy are more vulnerable than large and fat fish like sardine.

Temperature in the bait tank is another important factor controlling mortality of the fish.

A higher temperature such as over 29°C may accelerate the death more than does a lower temperature.

When these factors as mentioned before are taken into account, fat anchovies and sardines measuring 6 to 8 cm. in length, 5 to 7 gr. in weight are supposed to be most suitable as bait for skipjack fishing, as they can better attract the aimed fish and be kept alive more easily.

SECTION IV. FISHING GEAR

1. Angling Gear

The gear for this type of fishing operation means angling gears, and is simple and inexpensive as outlined below and other fishing equipments are not required.

1-1. Types of Hooks

On several types and many sizes of hooks used for skipjack and tuna angling fishing, a common feature is that they have a barb or barbless. all. One of main types is the hook for fishing with bait, and the other is for jigging.

1-1-1. Bait hooks

The shape is nearly round with a barb or barbless at the top. The inner contour forms a well developed pocket. Materials is steel or tempered iron, galvanized but seldom blackened. The bait hook is used to improve fish-feeding with live baits, available in several sizes to suit different sizes of skipjack.

The bait hook in barb type is made in such a way that the catch, once it is caught, cannot easily free itself and that the bait will not drop off.

The size ranges from 2.4 to 7.2 cm. in length, depending on the size of fish caught or bait to be used; hook of 3.3 to 4.3 cm. is for middle sized skipjack; 4.5 to 6.4 cm. for large sized fish; 6 to 7.2 cm. for albacor and tuna; over 7.2 cm. for middle or big sized tuna; smaller than 4.3 cm. for bait of 3 to 4.5 cm. in length; less than 6 cm. for bait of 4.5 to 9 cm; around 6 cm. for bait bigger than 9 cm.

1-1-2. Feather Jigs

The body of a feathered jig is made of chrome steel, zinc, brass, or tin of about 5 to 20 mm. in diameter, shaped like a bullet, a knife, or a cigarette pipe. Material used for jigs includes horns, bones, tusks, fangs, teeth, and feathers of various kinds of animals or birds, and fish skins. Animals of which horns are used for the body of jigs are oxen, buffalos, deer, goats, whales, and elephants. Whole bones and beak of

sword fish are also used. A round barbless hook is fastened into the body of jig: then the hook is wrapped up with several kinds of bird feathers and covered again with the ventral skin of globefish or cat skin. Thus, a horn jig is shaped like a squid or octopus, with the length of about 10 cm. A horn for the body is prepared in a length of about 3 cm. and a diameter of about 15 to 20 mm. inlaid with shiny pieces of shell for effect. Red horns are said to be good for attracting fish in a clear water, and black ones for both a clear and dark water.

This type of jig is used when skipjack or tuna is readily attracted to bait by swinging and waving it on the surface of the sea: and when feeding is favorable to beat the surface to lure the fish.

It is consumed at a high rate as it accounts for 80 to 90 percents of the total catch.

As in the case of the bait hook, this artificial hook is available in several sizes.

However, since the artificial jig is to hook the fish, no barb is provided to make unhooking easy. As it requires little time to hook and to unhook the fish, its fishing efficiency is high.

The feather jig may be combined in various ways to suit the angler's intention.

In a troll line fishing for schools hiding deep, another type of jig is employed. A troll jig shaped like a squid, octopus, and sardine wrapped up with feathers and globefish or synthetic skin.

Most of hooks for the troll jig have beard.

The jig is hanged at the end of a troll line extending for 50 to 100 m. from a pole fixed at the stern. Some of the jigs are used for checking the fish to be attracted on the feather jigs of the troll line. As it is unnecessary to catch the fish in that time, barb hook is not used for the feather jigs.

1-2. Angling Line

As in the case of the other fishing lines, material for skipjack fishing line is chosen with such views that it should be strong enough against a powerful jerk given by the fish, that it should not affect the fish by its color or luster under water, and it should not be entangled itself on the fishing operation.

Consisting of two parts, main line and leader, the total length of the line is shorter by about 50 cm. than the pole's length. That is

protecting the angler-self from the dangerous hook attacking after the fish was unhooked.

The main line and leader are made of synthetic nylon of a high quality, it is satisfied with several factors as a fishing line as mentioned before. The line has the total length of depending on the free-board of the fishing platform.

Nylon gut of Nos. 60 to 100 is used for the main line and that of Nos. 20 to 60 for the leader of the skipjack fishing line according to the size of the fish.

Knotting of nylon gut should be made correctly to prevent unknotting.

1-3. Fishing Rods

1-3-1. Bamboo Rods

A great number of bamboo was used as an angling pole until about 10 years ago; however it is a little used nowadays. Its merits are: inexpensive, flexible, springy enough against a strong fish's jerk particularly at the tapered end, and little effect on the angler's body after a long period of a fishing operation.

Its demerits are: 1) the time and the skill required to make a bamboo with its natural characteristics into a fishing pole as a pole is usually selected and prepared to a specification by a fisherman himself, 2) possibility of cracking in the sun, 3) necessity of many spare poles because of its short service life.

1-3-2. Glass Fiber Rods

Glass fiber rods have thus replaced bamboo rods and are now extensively used on most skipjack fishing boats. As for its merits, anyone can produce a fishing rod without acquiring special techniques. Moreover, though it is not up to the level of bamboo, it has good flexibility and a long service life without cracking.

Its demerits are that the angler feels exhausted after using it for a long period of time and that it is more expensive than the bamboo pole.

1-4. Outline of Automatic Fishing Rod

This automatic fishing rod was developed about 10 years ago to make up for the shortage of labor force. With improved performance due to continuous improvement, it has spread rapidly and come to be installed

on most of the ocean-going pole-line skipjack fishing boats of over 200 tons.

Its level of performance has on the whole been improved to about 70 to 80 percents of that shown by very experienced fisherman with delicate fishing techniques. Moreover, fishing operation can be carried out for a long period of time and the weather conditions are of no importance.

It is particularly effective in fishing those weighing more than 5 kg.

1-5. Cautions in Producing Fishing Rods

1-5-1. On Bamboo Rod

Both the top and the butt end of a wild bamboo should temporarily be cut off leaving about 1 m. according to the weight of the fish.

The joints are to be trimmed evenly and the natural curve of the bamboo should deftly be corrected at a stroke with direct heat and cold water. If this correction fails, the bamboo will lose its elasticity and can, therefore, not be used as a fishing rod.

This correcting work requires a skill and experience.

On producing fishing pole, the lower part of the pole is dressed with cotton yean or the like in such a manner as a few round of the thread are fastened a little apart from another until they cover one or two lower knots of the bamboo. This is to give the pole a fast grasp; when the pole is not in use, the hook is fastened at this position so that the line may not be entangled.

A thread is used to wind the top of the pole a few rounds and to form an eyelet to which the fishing line is fastened. In preparing the eyelet the point is to prevent it from falling off and secure easy handling of the pole.

1-5-2. On Glass Fiber Rod

In the case of glass fiber, it is simpler than bamboo and requires no special attention.

It may be mentioned, however, that when fixing the eye to the tip of a rod, the area may be filed to prevent the eye from dropping off or a material with a rough surface may be selected for the eye. Since centering can be made at any point unlike in the case of bamboo, no experience is necessary for producing the rod of required particulars.

2. Accessory Tools

- (1) Hydrosopes
- (2) Goggles
- (3) Fishing Rubber Aprons
- (4) Knives
- (5) Gaff Hooks
- (6) Harpoons
- (7) Wooden Hammer
- (8) The Others

SECTION V. FISHING METHOD

1. Outline of Pole-line Skipjack Fishing Trip of the Bait Self-supply Type

The fishing cycle of a skipjack clipper starts with the preparations for next fishing operation to be made at the base port in parallel with the unloading of catches.

This is followed by proceeding to a baiting site. After catching and loading bait fish, the clipper streams to a fishing ground for fishing operation.

If there is some room left in fish wells on board after using up live baits, the clipper returns to the bait fishing ground to obtain more bait fish to return to the skipjack fishing ground.

These operations, i.e., replenishment of live baits and skipjack fishing, are to be repeated as required until the fish holds are completely or nearly filled with catches before returning to the base port for unloading.

Unloading, loading of supplies for the next fishing trip, medical treatment of the sick and the injured and the other necessary operation are to be carried out at the base port to complete one cycle of fishing activities.

2. Live Bait Fishing by Two-boat Purse Seining

In Japan, there is an enterprise specialized in commercial bait catching, storing them in fish cages and supplying them to skipjack clippers bound for fishing grounds.

Skipjack fishing fleets based at foreign ports, however, can not take advantage of such enterprises. Therefore, those clippers operating in foreign waters must catch and use the wild bait fish by themselves.

The wild baits are remade the tame baits bred in fish cages on the sea around one week after catching them. The wild bait's mortality is much higher than the tame bait's one.

The wild bait can live in bait fish hold on board around a few hours to one week, and also the tame bait, around one week to one month, furthermore, they can live more than two times in bait fish hold if using a current cold breeding bait system. The mortality of live baits is dependent on the kind and size of bait, the degree of bait's wound by net or handling, fishing gear and method, and sea water temperature and so on.

2-1. Selection of the Bait Fishing Ground

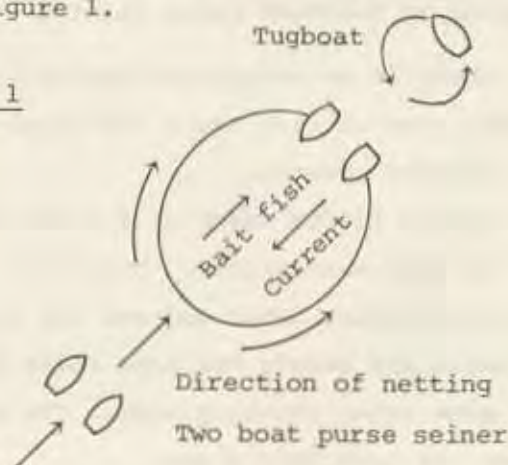
Selection of bait grounds can be made from among already known sites in view of the kind and the size of the bait fish available, weather and sea condition, the distance between the baiting sites and skipjack fishing.

2-2. Day Bait Fishing

Live baits can best be handled within two to three hours after the sunrise. Bait fish spotting should be made early in the morning. All the crew of a clipper must try to catch sight of birds over schools of bait fish or any sign of other vessels fishing on schools of bait fish by means of usual observation, optical observation, detectors (binoculars) and radio communications.

The location of bait fish can be determined from the discoloration of the sea water in reddish brown, jumping and rippling water, and marks of fish finder. Though bait catching is operated by set net, stick-held dip net, and small purse seiners-two tonner; FRP of two-boat-type in combination of a towing/lighting skiff, here is mentioned about this small purse seiners. In day-time, as the school of bait fish tends to move in various directions, a mobile net boat is needed, two-net-boats must steam ahead of the school to observe and encircle them at full speed as shown in Figure 1.

Fig. 1



The towing skiff must maintain the position at the mouth of a seine net to keep bait fish from going out of the net. In case moving bait schools suddenly disappear, however, a good record must be kept with a fish finder and floats should be thrown overboard to mark the school. As for another operational method after disappearing the bait school, since the skiff can hold the mark of the school by means of a portable fish finder the netlers can encircle the skiff-self with holding the mark of the school.

A clipper comes alongside the stern of the bait net boats as soon as the encircling of the school is over and drying up of the bunt (cod net) is ready for scooping of wild baits from the bunt.

The clipper must be very careful not to disturb the trapped baits while approaching to the netters.

When scooping the bait fish must be protected from the influence of strong winds and waves with the clipper maintaining the windward position.

2-3. Night Bait Fishing

Night bait catching is supplementary to daytime bait fishing if an amount of needful live baits for a clipper is not enough in the first baiting operation at daytime. Baiting sites are usually located in the waters 20 to 30 meter deep and a little further and deeper from the baiting sites during daytime.

It is better for attraction of bait that lighting gets started at the sunset.

Arriving at a baiting site, either from a base port or directly from skipjack fishing grounds, a school of bait fish must be searched for by fish finders in layers of 20 to 30 meter deep. When signs of school are made sure by visual observation and fish finder, the clipper comes to anchor. Lighting can kept on as long as the baits appear to be of a satisfactory school, but it is wise to shift to another baiting site after a baiting operation if a school of baits of about 20 bucketfuls does not come to attraction lamps even after one hour of lighting. Twenty bucketfuls mean and include live bait and sea water in half and half, the live bait's weight is about 100 kg. (20 bte $\times$ 5 kg/bt).

When attracting the baits less than 20 bucketfuls, it is not so valuable as a bait so that many other kind of fishes except bait fishes are also attracted.

Experience has shown that the first two hours after the sunset and before the sunrise can be timely for the most productive bait catching.

To this time zone can also be added an interval between the time of the moon at the meridian and the high tide.

- 2-3-1. Reflectors or shades should be attached to fishlamps in order to make lighting more effective when fishlamps are on with all other lights on the clipper switched off.

By the time bait fish have gathered around the attraction lights, a small skiff with a underwater lamp of 500 ~ 1000 watts comes to stay with the clipper. By turning off fishlamps of the clipper one by one, the school of bait fish is eventually transfered to the underwater lamp of the skiff when the last fishlamp on the clipper is gradually darkened and put out by the reducer.

- 2-3-2. Transfer of the bait fish to the underwater lamp of the lighter can be checked visually by bubbles, of bait to breathe in underwater, coming up from around the underwater lamp, and also by a change of image shown on the fish finder.

With the transfer of bait fish, the clipper weighs anchor to keep away from the lighter. Contrary to daytime baiting, the purse seiners lay out the net only to hold the tide because the bait fish remain stationary with the underwater lighting.

- 2-3-3. The lighter stays close to the place where the net has been cast (laid out), keeping away from the opening between the wings of the net by rowing, if necessary, it allows to use the engine. Since the catch depends on the lighter's position in the net, the skiff should move and adjust to hold the good mark by means of rowing and fish finder, and the skiff should maintain its position with its light on till the drying up of the bunt is finished in the night baiting.

But in the daytime, the skiff must maintain its position with the float thrown in the net circle until pursing is finished.

Care must be taken not to get any accident during the operation in the non-light except the light-boat, and pursing should be worked out as promptly as possible to avoid escape of bait fish through the net opening.

- 2-3-4. When the bunt of the purse seine comes to the point of scooping bait fish, the lighter moves out of the place, after putting out the light, and starts towing the purse seiners.

- 2-3-5. By this time, having weighed anchor and keeping away the net boats, the clipper makes an approach to the net leaving a distance of about 100 meters until further notice or signal by the seiners, for the finish of pursing operation.

2-3-6. The clipper must come quietly along-side the seiners after making sure, visually by binoculars, of the signals by the seiners or the lighter. Access to the netter can be made through frequent going ahead and stopping of the engine lest bait fish should be spoiled by a strong screw current caused by the clipper.

When the bunt is larger, getting a plenty of wild baits, they are more vulnerable with the said current. In contrast, if the clipper comes to a sudden stop repeatedly with engine astern for some time, the clipper comes to be exposed to the wind on the portside, then at stern and eventually on starboardside, making it impossible for the vessel to scoop up bait fish from the bunt due to disorder in the configuration of each boat, as the screw is the right-hand-clockwise.

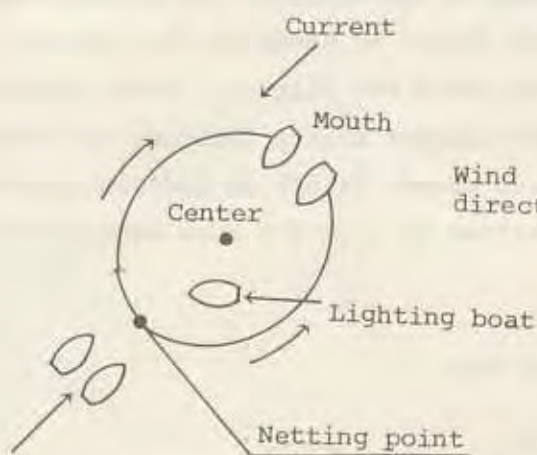


Fig. 2

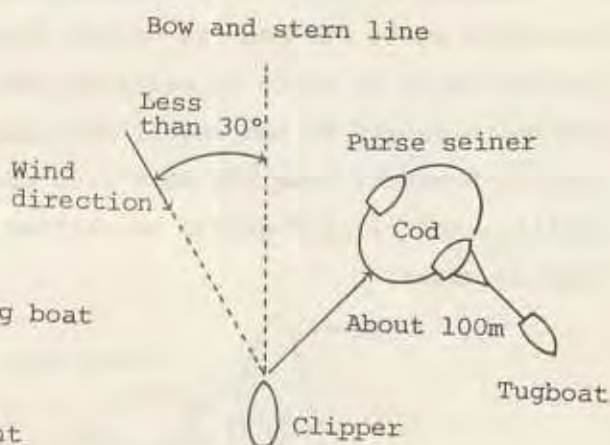


Fig. 3

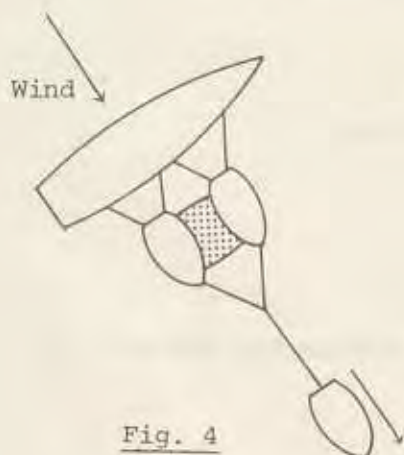


Fig. 4

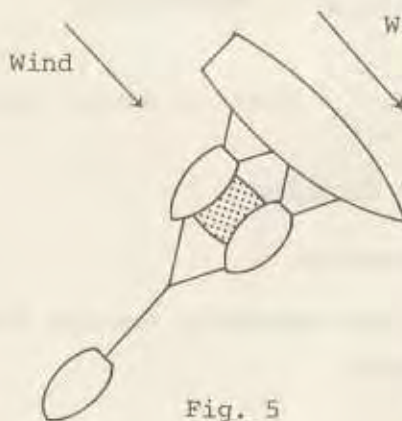


Fig. 5

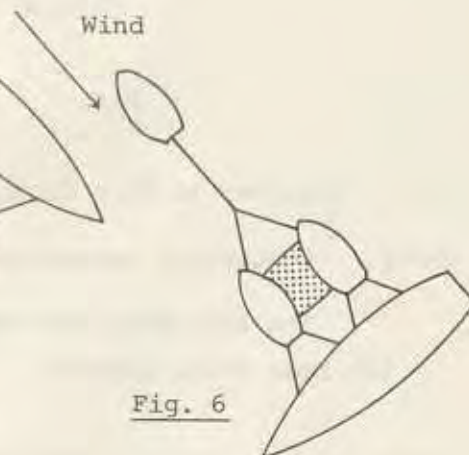


Fig. 6

2-3-7. To protect the bait fish against the wind and waves and also to scoop the bait fish conveniently, the clipper, the netting boats and the lighting/towing boat must keep the configuration shown in Figure 7. Under a strong wind, the small skiff keeps towing the netter on the lee with engine full or half speed. Under a moderate wind, slow or dead slow speed.

If the influence of the wind and waves appears to be strong, the clipper and skiff have to hold the said configuration by means of the engine and steering. For example, after the wind became calm, sometimes the wind will start to blow from the opposite direction during scooping wild baits from the bunt.

2-3-8. Keeping an ideal configuration of the clipper, the seiners and the light/tow boat, the bunt is heaved slowly by hands of the crew to scoop up wild baits to store in wells on board the clipper. After shifting the baits caught to the wells, the clipper starts lighting all over again. However, when the bait fish caught is not so good in quantity or quality, the clipper should be shifted to look for more satisfactory baiting sites.

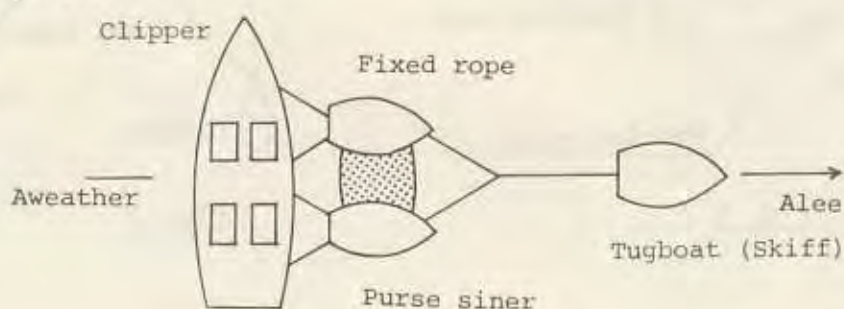


Fig. 7 Shape of mutual relations

2-4. Cautions in Bait Catching

2-4-1. Concerning Operation

The followings are governing factors for successful operation by two boat purse seiners.

2-4-1-1. Location of baiting sites: Change of lighting position on the same baiting ground or move to another sites. (See page 25)

It is a fact that some fortunate clippers are able to get appearance of baits, when a few clippers have tried to attract wild baits by means

of lighting at the same baiting site for some time, however, unfortunately the other clippers have non-chance of appearing of baits.

2-4-1-2. In daytime baiting, decision on the direction to set the seine net and on encircling speed depends on the moving direction of the school, current and weather conditions.

2-4-1-3. Pursing speed is decided according to (1) the depth of the purse seine and also the depth of the baiting sites and (2) the trend of the school, whether rising up to the surface or diving down to the bottom. Generally, pursing must get started after the seine net has taken a proper shape in the water if the depth of the baiting site is sufficiently deeper than that of the seine net and if current is not struggling itself and if the speed of current is moderate. Otherwise, pursing should take place as soon as possible, especially in the shallow waters. The reason why the above things should have been kept is the net should not have been entangled with a rock, a sunken vessel and so on in the seabed.

2-4-1-4. In order to keep the configuration of the seine net symmetrically, each of the two boats should carry out pursing at the same speed. Otherwise there may be a partial, imbalanced and harmful concentration of the bait fish in the net. As for the above matters, even one boat purse seiner is also same.

2-4-2. Cautions in loading bait fish into wells

2-4-2-1. Along with the drying up of the bunt, scooping up of bait fish is carried out carefully, harmlessly and speedily through the use of a large scoop net of 40 cm. in diameter into buckets, of 20 liters each, in which are carried live baits upto bait wells on board the clipper.

As scooping of the bait fish is more vulnerable through the use of a scoop net, if possible, it is more reasonable and desirable, to scoop the bait fish with a bucket directly.

However it is more difficult than scooping with a scoop net.

2-4-2-2. When taking in wild bait fish, the bait wells on board the clipper must have sea water, filling 80 to 90% of the full capacity of the tank. Otherwise the baits run away through the overflow and dive

not easily down to the bottom of the wells.

After that, water supply must be made to a point of overflowing which, however, does not necessarily mean to drive out the bait fish because of too strong a flow nor to choke the bait fish because of too weak a flow. Appropriate supplying of seawater into the tanks must be considered in view of the volume of baits, water temperature and mortality of the baits.

Generally its rate of changing seawater in the wells 3 to 4 times per hour at a standard.

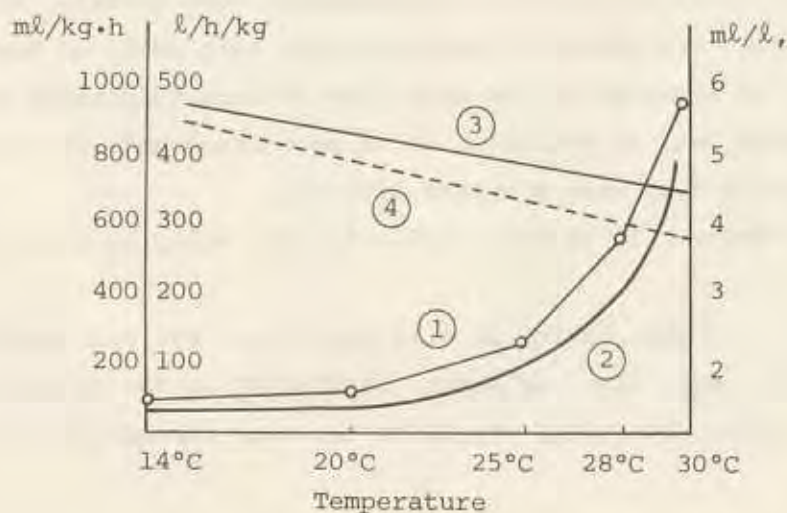
2-4-2-3. Quantity of wild bait fish allowable to bait wells depends on the extent of vigor of the bait fish: Usually in the warm water areas with surface temperatures of over 29°C, about one ton of well-circulated water, can accommodate less than 5 kgs of wild baits, while in the temperate waters around between 25°C and 29°C, around between 10 kgs and 5 kgs, about below 25°C, around 10 kgs.

On an occasion of a clipper adopted a cooling/breeding system for live baits, the quantity of live baits can accommodate around between 15 kgs and 20 kgs about one ton of well-circulated and cooled water.

The warmer water can not keep so many live baits as the cooler water. In the warmer waters, the baits are apt to react excessively, consuming more oxygen, the content of which in the warmer waters is smaller than in the cooler waters.

Moreover, the mortality of the baits in the warmer waters grows up than in the cooler waters. Because after getting injured in the warmer waters, the bait gets ill easily and dies soon.

Relations of between dissolved oxygen and breeding of live baits in wells.



- ① : Consumable volume of dissolved oxygen (ml/kg.h)
- ② : The water volume required per 1 kg of live baits (l/h/kg)
- ③ : Saturation volume of dissolved oxygen (ml/l)
- ④ : Dissolved oxygen volume (approximate) (ml/l)

2-4-2-4. The durability or the vigor rate of the bait fish can be determined by natural mortality, phase of growing, and damage sustained at the time of hauling.

2-4-3. Breeding of live bait fish

The object of bait breeding in bait wells on board the clipper is to keep alive as many bait fish as possible till the clipper reaches fishing grounds, and finishes to use the baits completely for the fishing operation.

Artificial death rate or mortality in the well must be kept to a minimum.

Breeding conditions in the bait wells on board the clipper should artificially reproduce the natural environment under which the bait fish were caught, or breeding must be performed by keeping the water temperature of the wells at about 15°C.

While breeding water is kept in low temperature, as both of the actions and oxygen intake of the baits in the wells are reduced, the baits is not easily to get ill and alive longer even they are injured a little, because the disease germs not easily grow up in low temperature.

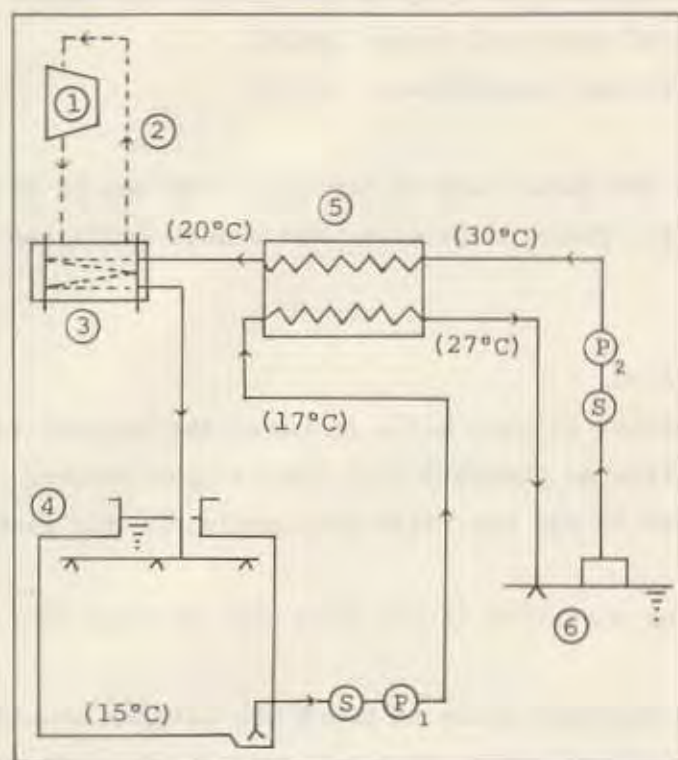
This was developed recently in Japan for the oceangoing shipjack clippers. The cost is 70 millions yen, about U.S.\$ 300,000 for 500 T type.

The industry appreciate the progress in this field as epoch-making. The following are traditional breeding methods giving an environment under which the bait fish can move about in a circle at the speed of 12 cm/sec or slower.

The artificial circumstances can hold the mortality of the bait fish on a constant level.

The following epoch-making plant will do a major service to the skipjack fisheries industries in the near future.

Outline of the live bait breeding plant with cooling system.



- 1 : Freezer
- 2 : Cooled ammonia gas
- 3 : Seawater cooler
- 4 : Bait well
- 5 : Thermo-shifter
- 6 : Overboard seawater
- () : Seawater temperature
- P₁ : Pump for pumping out spoiled seawater overboard.
- P₂ : Pump for pumping up natural seawater inboard.
- S : Strainer

2-4-3-1. General environmental conditions to be provided for bait fish in wells on board.

- a. Pumping in regularly fresh and constant quantity of seawater from outside the clipper while overflowing is done accordingly.
- b. Mechanical discharge is employed in pumping out used and deposited water twice a day as necessary, morning and evening each.
- c. Adoption of lighting in the wells at night.

An underwater lamp of 40 ~ 60 Watts hung half-way down in a bait well helps the bait fish move about in a circle around the lamp at night. Otherwise, the baits in the wells are going to die immediately after they have collided with the well's walls and with each other in the dark wells or they have come out toward the light overflow and hatch-coaming.

- d. Cleaning of bait tanks and wells must be worked out to dispose of harmful deposit for the bait fish.

2-4-3-2. Factors affecting mortality

- a. Foreign substance in breeding water such as polluted matters due to excrement by the bait fish, dead fish, oil, etc., and extremely fine air bubbles causing the suffocation of bait fish.
- b. Poor oxygen content due to a sudden increase in breeding water temperature and to a careless supply of uncontrolled quantity of breeding water-regardless of temperature, amount of the bait fish contained, etc.
- c. Noise shock given to the hull of the clipper might threaten the bait fish so that they may try to run away impulsively and desperately.

Thus the mortality increases owing to wounds suffered from collision against walls of the wells and against each other in mouth, heads, eyes scales and internal organs.

Moreover, big noise and shock are also causing to frighten detectors in looking for schools. Therefore, it is important to keep quiet onboard as longer as possible, because the detectors are concentrating their spirits of individuals for finding out schools.

3. Pole and Line Skipjack Fishing

3-1. Scouting

3-1-1. Preparation of Trip

The number of days for a trip is determined mainly on the basis of the distance to and from a fishing ground. An extra number of days should be included in the time schedule.

Careful preparation has to be made according to the itinerary in regard to fuel, food, fresh water, ice block, and live bait, of course, fishing gear, conditions of the clipper and engine have to be checked satisfactorily.

Dependent on these preparations are all the results of operation which has to be efficiently carried out in a very short time by many fishermen in a narrow space of the clipper.

Most of consumable items are loaded at a base port except live baits which are taken onboard at a rearing pound in a coastal area just

before leaving the home water, or onboard with self-supplied at a baiting site.

The amount of bait need for a clipper is usually indicated by the number of bucketful with an 18 liter capacity. One bucketful may hold 800 to 1,000 baits of 5 to 6 cm. in length.

The amount of ice block to be loaded on a clipper is determined by the expected number of catch, the length of a trip, and conditions of the fish hold.

3-1-2. Selection of fishing ground

A general region for operation is chosen according to a season of the year. More exact locality of a fishing ground within the chosen region has to be decided by taking such factors into consideration as movements and abundance of fish shoals at the time of leaving the base port and the number of days needed for reaching the fishing ground.

In overall evaluation of a fishing ground to be chosen, knowledge of habitual movement of the fish at a specific time and locality should be made the best use of in association with information which may be obtained from local or regional research institutes, fellow fishing boats and experienced fishermen in regard to fishing conditions at that time and place.

When a clipper has left her base for a fishing ground, fishing gear has to be brought in a state ready for use at any moment.

With the help of wireless communication to and from fellow clippers and the base, attention is always given even to a slightest change of fishing conditions in the water ahead so that the operation may be adjusted accordingly. Works to be done in the vicinity of the fishing ground are: to find out an optimal temperature zone and a water boundary exsisting along the thermal zone by measuring temperatures and water color; to detect a symptomatic sight of a fish school with a binocular; to make trial with a troll line which may tell presence or absence of fish school in the area.

All the efforts are concentrated on a point to find a school sooner.

The surface temperature outside the optimal range makes a school of fish stay too deep from the eyes of fishermen. Even in such an area, however, one may often find the fish very susceptible to bait when there is a distinct water boundary in the area.

Meteorological phenomena that can be often associated with occurrence of a fish school and a good catch are a cloudy day, calm sea, any symptom of changes of the weather and certain effects to be found after the passage of a low atmospheric pressure. A clear and fast current also also presents fish easy to hook.

Although there is no established criterion for evaluating susceptibility to bait or the rate of catch, except a rough decision based on year's experience of fishermen, the following equation has been proposed by a Japanese biologist (Y. Suehiro):

$$Q = (b/t) \cdot f \times 100$$

where Q : the number of fish caught in 100 minutes by a single fisherman,

b : the number of fish caught by him in an operation,

t : length of the operational time in minutes,

f : the number of hooks used,

When $Q \geq 17$, the rate of catch is supposed to be at a normal level or higher.

Generally speaking, schools of fish occurring in the high sea are more readily attracted to bait than those staying around an island and reefs. Both in the high sea and around a reef, however, there may exist a deeper water than its neighbourhood.

It is such a deep water that oftener presents a prosperous catch. Comparing with a fine weather, catch is better on a cloudy day, and not always so bad on a rainy or a foggy day. Within a day, the morning has the best catch to be followed by catches in the evening and the daytime.

The factors which determine the results of the pole and line skip-jack fishing operation may be outlined as below.

- (1) Response of the school to chumming with live baits thrown by the clipper,
- (2) Number of anglers,
- (3) Skill and the physical strength of anglers.

When these conditions are met, the fishing operation will result in a good catch.

When even one of them is not met, it will lead to a poor catch.

However, there are some schools which respond well to chumming but

not to feather jigs. This type of fishing operation is based on the use of a single fishing rod with a feather jig and the period of good chumming is very short. Accordingly, the best possible combination is required of the three parties concerned, feeder, angler and the master-fisherman.

In this type of fishing, the catch is determined by how many skip-jacks the angler can catch in a unit hour and his skill and physical strength are particularly important.

He is required to have rational and effective fishing techniques of reducing the time required for conducting a series of operations such as luring the fish to the feather jig without interfering with other anglers, fishing it and unhooking the fish.

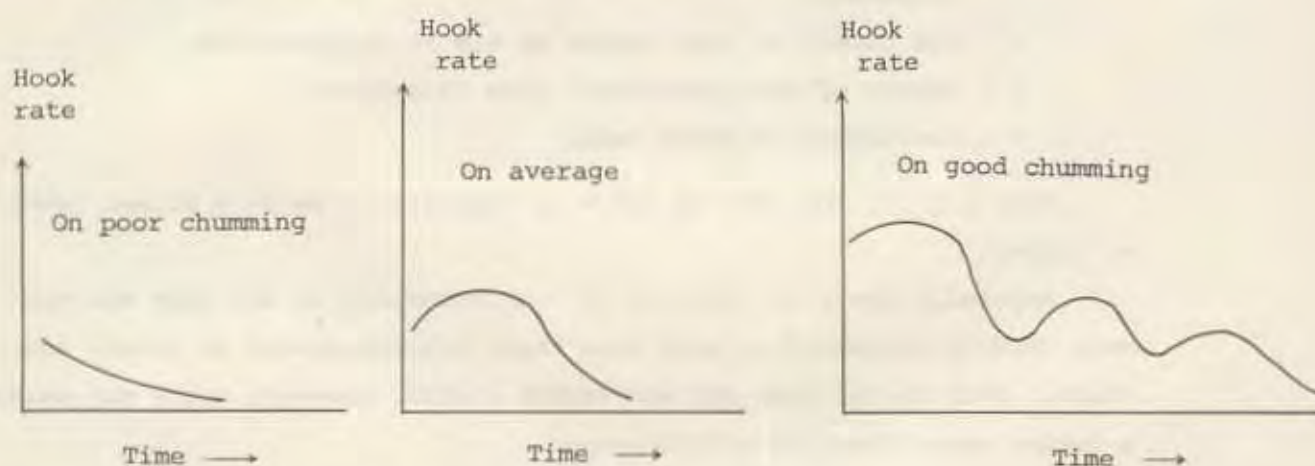


Fig. 8 The above figures are hook rate curves

3-1-3. Forms and sizes of schools in relation to chumming.

3-1-3-1. Schools of positive to chumming.

If schools of over 50 tons are classified as large schools for convenience' sake, they usually form rippling schools and show good chumming.

Forms of schools with good chumming are accompanied by:

- a. Shoal with drifting objects.
- b. Shoal with whale sharks, milk sharks, etc.
- c. Shoal with whales (though schools accompany baleen whales, they show a negative response to the toothed whale family, for example, killer whales, blackfin whales, sperrn whales.)

- d. Shoal with bird, schools which do not move to the current, with lots of birds.
- e. Shoal with boat, those which are negative in small schools but accompany the boat in large schools.

3-1-3-2. Schools negative to chumming

Schools not covered by the above positive schools are considered to be negative schools to chumming. Of course, even small schools are worked to a feeding frenzy, but catches are only handful. Schools of 10 tons or less of skipjack are categorized as small schools which usually are hard to react positively to chumming.

Schools of skipjack are sometimes in possession of live baits (accompanying baits) for themselves. Extent of abundance of the bait fish to the skipjack is a decisive element to make the school whether positive or negative. Skipjack with stomachs full of contents are likely to respond actively to chumming. Those skipjack whose stomachs are nearly empty show the opposite response.

This matter is very stranger things owing to the feeling on the part of the human beings. But this is a fact.

In view of the limited live baits on board the clipper, it is not economical to spray the baits over negative schools described in (3-1-3-2) above and

- a. Schools accompanying few flocks of birds,
- b. Schools in possession of "accompanying baits" whose quantities are improperly abundant,
- c. Schools in speedy movements but nearly coming to the point of rippling.
- d. Solitary schools.

3-1-4. Means of finding schools

- (1) Electric equipments based on the reflection of radio waves, such as sonar, echo sounder, radar, etc.
- (2) Trolling lines with hooked lures or nonhooked ones.
- (3) Visual observation
 - a. with naked eyes,
 - b. with binoculars, (a) portable type of (10 ~ 14)-power

binoculars, and (b) fixed type of (15 ~ 25) power ones.

3-1-5. Cautions for optical observation and chasing of schools

Beginners for optical observation by binoculars, if already immuned to seasickness, may suffer from yawning, vomiting and headaches similar to seasickness due to tired eyes. In such cases, the beginners must have refreshment to ease eyes of strains of observation. The sickness may be overcome after using binoculars in about a week.

Keys of finding out and spotting shoals:

- (1) Discovery of flocks of birds accompanying schools of fish.
- (2) Birds flying in a fixed direction are usually independent of schools below and birds flying high as well as low in various directions are mostly accompanying schools.
- (3) In order to look out for birds at a long distance, binoculars set in positions are looked through by focusing at the horizon within the visual range for a few minutes. This looking through can be repeated till a sight of birds comes into view. This can be followed by judgement if the birds are with skipjack school.

The skipper must be notified of the judgement.

- (4) Continuous observation should be supplemented by lookout for signs of other clippers and/or clouds in the vicinity of the schools sighted.

Direction, distance and estimated arrival time at the spot, etc. should be notified to the skipper.

- (5) Expert for the chasing of a certain school or catching sight of other schools nearby, the skipper tries to set course according to the notified observation. Once the course is set, the school comes under chasing at full speed.
- (6) In parallel with the chasing of the school sighted and kept in view in the direction of the bow, lookout for any other school is also made.

It is for the skipper to decide on the school to be worked out for fishing.

- (7) A huge flock of birds at a distance of 30 miles or so can be detected if visibility is good. When birds tend to soar, flashes can be seen due to reflection of the sun beam by the birds.

For the beginners, it will take some time before they get used to the flashing birds.

3-2. Fishing Operation

3-2-1. Preparations for operation

3-2-1-1. Preparations for bait throwing

According to directions of the skipper for stand by fishing, the crew in charge of bait fish transfer buckets of live baits from the wells on deck to bait-throwing-tanks on bow and stern.

Scooping up of bait fish is always done in the upper layers of the wells and tanks which are frequented by weak bait fish.

Thus all the bait fish are made use of baits getting weaker in the order of strength.

The purpose of sprayed bait fish from bow is just to tempt the school toward the clipper, one or two bucketfuls of baits are sufficient for the bow tank. While the tank at stern may keep five to eight bucketfuls of baits for each cubic meter of the tank.

The number of buckets can be adjusted according to chumming conditions or the size of the school aimed.

3-2-1-2. Spraying of water

Sprinklers fitted in front of fishing platforms are to give out sprays of seawater all at once. This sprinkling combined with live bait fish sprayed overboard may lure skipjack to the clipper.

3-2-1-3. Preparations for receiving catches

Before and after fishing, the working deck must be cleared of unnecessary matters.

The catches are washed well and carried into fish holds filled with cooling brined water.

3-2-1-4. Operational station of the crew

- a. Steering room: The skipper or his assistant

- b. Engine room : Chief engineer or his assistant
- c. Bait spraying tanks: Baitmen (bow and stern)
- d. Fishing platforms: Fishermen including bait carriers

The feeder at the bow tank must refrain from spraying baits when he is certain that the school is close to the clipper and is worked to a feeding frenzy, returning to the fishing platforms to join other fishing hands as a angler.

3-2-2. Maneuver of clipper

The school of skipjack tends to dive reacting to the approaching clipper. Flocks of birds accompanying the school tend to soar leaving the school behind. The school is lured by trolling or lookout is instructed by the skipper for a concentrated portion of the school, to which is sprayed live baits for chumming the whole school.

At this stage the clipper cruises with engine slow ahead. The skipper directs the feeders to throw 2 ~ 3 pieces of live baits to see if the school responds positively and actively to chumming. The quantity of bait fish to be sprayed varies according to the following behaviors.

- (1) Baits of 2 ~ 3 pcs are sprayed to entice the initial response of the school.
- (2) To throw incessantly as many bait fish as possible like falling rain over fishing platforms into the dense part of the submerged school to be worked to a feeding frenzy.

The chumming and feeding skill can be obtained from experience.

- (3) To spray bait fish in a similar way to (2) above but rather slowly. This spraying is necessary when the reaction by the school become slackened.

In other words, the clipper is made to proceed in the swimming direction of a fish school at the operation. When fish are noticed attacking at the troll line or chum bait, the skipper stop the boat and turn the portside lee-wards to begin fishing on the portside.

The advantages of working in the lee wind is that the fishing line and the baits thrown can be blown ahead as far to expand the operational reach, and that the line is always, kept stretched free from an adjacent

pole or line, so as to secure efficient operation.

When a school of fish is large and dense, showing a strong appetite to bait, it may not be easily dispersed no matter what happens around them. In such a case the operation can be extended to either one of the sides which is otherwise left idle. On another occasion when a school accompanied by sharks is chased after by repeatedly putting the boat in slow and stop, the operation is carried out on the both sides at the fore deck. In short, it is recommendable to prepare things in such a way that the operation can be readily started on any side as soon as the situation calls for it.

3-2-3. Handling of gear

When the boat is put in a fishing position, groups of the crew members are assigned to either angling, chumming, taking care of bait, or steering the boat, as the mentioned before.

In skipjack fishing, each angler has his own fishing pole and hook, the point which is different from albacore fishing to be described later. Upon approaching a school of fish, an amount of chum is sprayed overboard to test the appetite of the fish. If they are found chumming enough, the clipper is put standstill, and seawater is sprayed from the side so as to promote the effect of bait upon the fish.

At the same time some of the anglers use a jig by waving it back and forth like a fish swimming on the sea surface.

Unless heaving of the sea is risky, the pole is usually maneuvered from a standing position rather than from a sitting position, which is safer but too awkward for the operation. The angler firmly supports the lower end of the rod at his waist and grasps, in his right hand, a handy part of the rod.

At a jerk on the rod, up he hauls the fish, giving a bend to the top of the rod but no slack to the line, hugs the fish under the left arm to unhook. This manner of unhooking is done both in fishing with bait and in jigging. Another way of unhooking practised in jigging is this: With a full swing of the pole the catch is lifted up overhead the angler.

Just at that reaction the fish in the air comes off hook by itself and falls on the deck.

When the school shows a good appetite, use jigs rather than bait-hooks so as to save the bait and the time for hooking bait and unhooking

the catch. In jigging, repeat chumming once for a while in order to keep the school close to the clipper. When jigs start to fail in catching fish, use the baithooks again.

The bait has to be hooked in a quick and easy manner to give a least harm to it.

A usual hooking position is the clavicle, though either the dorsal, snout, eyes, or the like may be hooked depending on species and sizes of bait. Let the bait swim as freely as possible by gently swinging the pole in every direction the bait fish goes.

Repeat chumming from time to time until no more fish comes to bait. Then stop operation and start scouting another school again.

One operation may sometimes end in a mere ten minutes, sometimes last for one hour or two, yet occasionally all day long.

In the albacore angling, two men cooperate each other to haul up one big fish by the use of a pair of poles. Each pole of the pair has a main line; the both main lines are joined together at the end and are connected with the leader for a single hook. The catch is swung up between the two fishermen and falls overhead on the deck just as in skipjack jigging. An expectable size of albacore determines the size and strength of gear as well as the size of bait.

One of the pair fishermen may be able to lift the fish weighing up to about 10 kgs to 30 kgs, it depends on the height of freeboard at the platforms. When the catch is heavier than 10 kg., if necessary, a third man may have to help them pull up the fish by the aid of a gaff.

3-2-4. Operation

3-2-4-1. Fishing effort

As the described before, the skipper must have the clipper steered so that its fishing platforms may be on the lee when the clipper comes to a complete stop to chum the school of skipjack. The baitman at stern, whether directed or not by the skipper, sprays live bait fish over the school in a way described in (2) on page 40, while the other baitman at bow joins the anglers on the platforms whether suggested or not by the skipper.

The best feeding of skipjack can be obtained, generally, in the first chumming opportunity. It is important to avoid every possible cause to reduce the frenzy of the school.

It is prohibited to put loose any fish once hooked as it tends to dive deep into the water, causing the school to follow suit.

Reaction to sprayed baits by the school of skipjack can not be kept long. It is the skipper's judgement whether a certain school is to be kept being chummed. Repeated chumming on the same school will gradually end up with a certain school, setting course to go to another aimed school.

Fishing on the same school within the same day may turn out to be fruitless.

Except for such an occasion when there appears to be not so many schools around or when the majority of live baits kept on board appear to be getting weaker, the skipper will not stick to the same school.

The schools, once chummed and became reluctant to sprayed baits, must be left alone for at least a day or two before they become normal or positive feeding.

3-2-4-2. Preparations for the next operation

According to the skipper's direction, immediate processing of the catches, transportation of bait fish back to the bait wells on deck when the next aimed school is too far, or when the rest of the live baits in the bait throwing tank is still good enough, and deck washing must be carried out in preparation for another school to be tried.

Detectors (Men in charge of lookout) and the skipper should try to find out a new school.

There is often another separate school within 2 ~ 3 miles from larger schools of good biting.

3-2-4-3. Cautions in the pole-line fishing

a. Concerning safety in operation

Safety must be assured through precautions taken by all the crew working on board the vessel, which must be steered in a well balanced condition in terms trimming, even heel, rolling cycle, reasonable G.M., cargo and buoyancy of the vessel in rough sea.

Overload or top heavy causes, among others, an extreme heeling of the vessel, which must be corrected by adjustment of fuel oil, catches, water and brines, a light skiff, fishing nets and gear.

Physical safety of fisherman against hazards should be ensured. The fisherman at wheel must steer the vessel putting fish platforms on the lee, enabling the feeder (the bait sprayer) to work efficiently.

b. Prevention of steps with adverse effects on good feeding

- (a) As described under "Fishing effort" it is prohibited to put loose any dying individual fish back to sea.
- (b) During angling operation on a certain school, as feeding becomes poor, fish blood must not be shed overboard.
- (c) Amount of baits to be thrown over the school has something to control with efficiency.

c. Requirements for the crew, particularly for the fishing master and other senior members of the crew.

- (a) If there is conversion of seawater as current rips and numerous sightings of schools in the clipper's vicinity here might be an opportunity for the school to accompany the clipper during her drifting at night (Funazuki).

Therefore, before the daily lookout trip fish finders must be checked to see if there is any possibility of accompanying schools.

- (b) The first as well as the last fishing, chances may be productive, in the early morning as well as in the late evening.
- (c) The unchummed schools must be found out as possible, because the school chummed once is not good enough biting and also poor productive.

SECTION VI. TREATMENT ON BOARD

The market price of catches, if other situations are the same, is determined by freshness of landings, which again depends upon the treatment and storage of fish to be done on board during or after the operation. In the trip taking about ten days as in skipjack fishing and the clipper for the Sashimi market, recently cooling of the combined fresh water with seawater is the most popular preservations in Japan, and for the processing materials over ten days, brine freezing is the most effective.

As for the former, during the operation, the live skipjack fished and unhooked is automatically come down by being on a shoot or conveyor into the fish hold filled with the combined water of about minus 2°C.

After processing as the above, it is cooled again down upto plus 2°C, and is stored by the temperature around plus 2°C, as the temperature of the combined water comes up owing to radiating heat of skipjack.

As for the later, after the operation, the dead skipjack on deck is brought by being on a shoot or conveyor into fish hold filled with the brine water of about minus 20°C.

After that, it is freezed again upto minus 15°C and is stored by the temperature continuously upto unloading.

In the both progress of processing, fish must be kept wet and cool, or cool enough without giving it wound and bruise.

1. Treatment after Operation

Prior to operation, the deck has to be well washed and cleansed. The moment one shoal of fish has been finished, store all the catches piled up on the deck. Even when an operation lasts many hours for one school or another near by, catches have to be brought in the fish hold as frequently as possible.

If this care cannot be taken, cover the catches from direct exposure to the sunshine, and spray seawater every now and then.

The men in charge of bait may be able to help the others, when they are free, with such works as washing it with seawater.

2. Carrying Catches to the Hold

Two or three persons may be required for taking care of processing catches, the rest attend to carrying ones to the shoot or conveyor, the work which is performed with such a care that large fish like albacore and bigeye tuna, one by one, while skipjack, two by two, are handed from one of the attendants to his nearest next all the way upto the shoot or conveyor or fish hold.

Collections of biological data and samples are desirous during the deck work.

Items of data to be collected for future study are: measurements of length and weight, the number of catches, which may be counted at the entrance to the fish hold; fishing log such as data, time, position, meteorological and oceanographical records; species, density of school, appetite of fish; fishing duration, and the number of hooks used. Stomach samples should be preserved in formalin for later analysis of stomach contents. These data and information are indispensable for undertaking scientific researches of skipjack fishing.

Results from researches based on the data will, in turn, provide valuable advices for rational management of skipjack fishery.

3. Works in the Hold

Among a number of bait wells on board, those in the fore deck should be used first.

When baits in their respective store are used out, wash the wells well, beginning with the upper wall, then the lower part, to convert them into the fish hold; water in the bait well is pumped out after the above works.

Every individual fish which has been thoroughly bled and cleansed is received as round and piled up one layer above another, and showered with the cooled brine water at the same time.

A normal amount of salt for brine water consumed is about 5 ~ 10 weight percent of the fish kept in the hold per year.

After putting the catches in the hold, and closing the double hatches as soon as the work is over, the engineer in charge of pumping fills the hold with the cooled brine water to prevent from damage of the fish due to jostling.

After that, keep them closed unless otherwise required.

4. After-care of Catch

From the time of first catch until unloading, the fish in the hold has to be looked after, and the concentration of the brine water has to be checked before closing the double hatches, after the work is over, if necessary, add salt, or drain bloody brine water and add salt into the hold.

The temperature in the hold has to be examined at a regular interval of time. Let freezer run thermostatically.

SECTION VII. FISHING PORTS

Existence of the following conditions, facilities and easy accessibility are indispensable or, at least, desirable for fishing ports frequented by skipjack and tuna boats.

1. Favorable fishing grounds for skipjack in the vicinity of the port. A short distance between the port and the fishing ground will enable to save time for a trip, prolong time for operation, increase both the number of trip and the amount of catch per season.
2. Facilities for landing, preservation, marketing, and transportation.
3. Live bait catching/supplying places in case of skipjack fishery.
4. Supply of consumable items such as fuel, fresh water, foods, ice, and engine parts.
5. Facilities to repair or prepare boats, gear and fishing accessories.
6. A wireless station to render services for fishing boats at sea.
7. Manning, boarding house, medical establishments, amusement centers, financial organization, rescue forces and so on.

Among a number of ports for skipjack and tuna boats in Japan, the most famous port is Yaizu in Shizuoka Prefecture.

In the south east Asia, Penang is well known for tuna boats.

SECTION VIII. INFORMATION FOR THE CREW AND MASTERFISHERMAN

1. Information for Pelagic Fishery Crew

- 1-1. General conditions required of seaman with the ability maintaining the boat and its equipment and machines.
- 1-2. Sound body and mind to stand life on board for a long period of time.
- 1-3. Adaptability (Flexibility) to the environment combining special occupational and living conditions and to group life such as severe limitation on free time, recreation and family time.

Any change in an effective fishing plan will sometimes cause loss of workability of the boat. During the periods of good catch, loss in workable time due to carelessness by the crew will not be recovered for good. There lies the importance of discipline on the boat.

2. Crew for Angling

Each crew member shall be responsible for the respective position aboard the boat according to the command of the skipper such as bait fishing, breeding, lookout for schools, chasing, fishing, freezing of catches, discharge, collection and analysis of information obtainable on baiting sites, fishing grounds, fishing ports.

All hands are requested of their cooperation in looking out for the schools.

Cleaning of the bait wells of spoiled water and filth twice a day can also be expected of the hands.

Some boats offer prizes according to the catch when it is over a certain standard.

3. Information for the Skipper

Qualifications as skipper must contain vigorous and tough challenging spirit to deal with all possible situations combined with fortune, patience and suitable judgement. Catches from poling and handling are proportional to the skills and physical strength of fishermen.

Therefore, there is a big demand for well experienced fishermen.

A clipper is an independent enterprise aiming at profits under the command of the skipper. The owner of the boat is desirous of as big a profit as possible by recruiting excellent fishermen.

3-1. Basic Factors and Means

3-1-1. Good fishing boat, gear and the crew to be secured.

Systematic cooperation under the command of the skipper by the crew must be of a high quality, assigning the right men to the right positions. The system of cooperation works successfully at the baiting sites, fishing grounds, fishing ports and eventually for the economy of the fishing.

The successful clippers are in most cases manned by well experienced and patient fish-detectors gifted with good sight.

3-1-2. Discipline on board the clipper and the training of officers is necessary for the management of an enterprise.

3-1-3. Planning and performance of the plan.

In accordance with the fishing plan, effective operation should be carried out.

3-2. Business Efforts

Fishing efforts must be applied aiming at an increase in catches and eventually in income of the enterprise.

Efforts by the crew at the respective stage must be fulfilled: culture of bait fish, selection of fishing grounds, locating of school, catches sorting, processing, discharge of fish, and fishing market.

3-2-1. Decision on baiting sites and fishing grounds

Decision on fishing sites and the amount of bait fish to breed can be carried out by the skipper. After obtaining of live baits, the clipper sails out to the fishing grounds.

During breeding of the wild baits, periodical checking must be made.

At the potential fishing ground, decision is made for an immediate locating of school in consideration of discoloration of seawater,

surface seawater temperature, current rips, objects afloat: (oil waste, jelly fish, etc.), drifting objects: (log, wood, tree, bamboo, dead whale, etc.), sharks, whales, dolphins, birds and other clippers operated.

3-2-2. Fish finding and fishing operation.

One of the responsibilities of the fishing master is to live upto the expectations placed on him by the shipowner and the crew for good catches.

If fishing operation producing favorable catches can be continued for several days, getting hold of schools with good chumming, it may be called a excellence of catch.

However, it is extremely difficult to produce a good or nearly good catch on every fishing trip.

In fact, an error in selecting the fishing ground may produce no catch even after a day's desperate efforts to locate a school.

As for the methods of chasing and fishing, one method is to deal with as many schools as possible and the other to deal with them in the order of distance and of chumming response. Usually the method combined with the above two ways can be carried out.

After one or two operations at a fishing ground, it is possible to ascertain the chumming trend of other unoperated schools around the vicinity of the clipper.

Therefore, decision has to be made in good timing on whether to remain in the area and further operations have to be carried out accordingly.

Basically any fishing boat is assigned to a norm of catch. Therefore, the crew should make every efforts to achieve the daily target while striving for as many good catches as possible to live upto the expectations placed on them.

3-2-3. Steering of vessel

Good catches expected of the school of skipjack have something to do with the steering of vessels. Since a given vessel is different from another one, it is necessary to become familiar with particulars of the given vessel to make full use of it.

At the same time, the baitman should be directed to keep best

spraying of live baits while the vessel is steered so that it remains on the lee, making it easier for the feeder (baitman) to spray the baits over speedily school for catching.

According to the wind and waves by which the clipper is influenced, the clipper must change its relative position toward the aiming school.

Since school has its own direction to move about, the clipper should be forced to chase the school closely.

In this connection, maneuvering of the clipper can surely be a decisive and effective factor.

On maneuvering of the clipper, it is preferable for the skipper to the equipped with variable pitched propellers, side thruster, etc.