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Fishing techniques for a constant amount of catch

Coastal Commercial Type Angling

A NGLING IS a fishing method that catches the fish by means of a hook and line. This fishing method has been used worldwide since prehistoric days. In modern times angling still exists as one of the most important fishing methods, and fishermen are always developing technical improvements.

1982 fishery statistics show that 9.41 million tons of fish excluding shellfish and seaweed species were landed in Japan (inclusive of Cephalopoda like squid and octopus), and 1.06 mil. tons of this total were caught by angling. In particular, coastal angling operated in a number of different ways accounted for 510,000 tons, thus making up about 50% of the total catch by angling. (see table 3 on the next page)

Angling plays a vital role in the development of coastal fisheries in every country where it is operated. In this connection, it now poses the following two problems:

1. How to improve the productivity of presently operated traditional angling.
2. How to increase the commodity value of diverse fish species each of which is caught in relatively small quantities.

In this issue we wish to discuss item one of the above two, with specific emphasis being given to the informative illustration of various technical problems involved in the improvement of productivity.

To this end, in introducing several different types of angling fisheries presently in operation in Japan, we will limit our explanations as follows:

1. Only seawater commercial type angling will be discussed here. This means that sport fishing, recreational fishing and inland water angling are excluded from this issue.
2. In this issue we have defined "angling" as a fishing method that uses a hook and line to catch the fish. Therefore, dart and eel combs that use a hook alone or octopus and crab pots that use a long-line without a hook, are also excluded from the discussion.
3. A fish can be caught by angling only when it reacts, spontaneously or by instinct, to a fisherman's positive angling motion. Therefore, in this issue various types of angling fisheries are illustrated from the standpoint that angling technique should be understood as a well-timed interaction between fisherman and fish.



TECHNICAL DISTINCTIONS AND CLASSIFICATION OF ANGLING FISHERIES

The technology of commercial type angling fishery is technology aimed at catching the largest possible number of salable fish by means that are both effective and economical. In this way it is basically different from sport fishing and recreational fishing.

Although there are a number of factors involved in angling technology, there is a basic system by which a particular technology is evolved, shown in Table 1, that involves both the knowledge gathered by researchers and the acquired skills of the fishermen combined with knowledge gained from experience.

Now, as illustrated in Table 2, we will divide commercial type angling fisheries into three major categories and eight sub-categories. The major categories are divided according to the basic fishing gear types, while the sub-categories are divided according to the life habits of the fish to be caught. Although the eight sub-categories can be further divided according to the configuration and use of the fishing gear, such distinctions rely mainly on the individual fisherman's technical preferences.

In comparing the three categories of angling, long-line and automatic angling the individual skill of the fisherman is the big-

Table 1 System for Angling Technology

Object	Condition	Connotation
CHOICE OF FISH TO BE CAUGHT	resources	•life habits (life cycle & feed resources) •biological environment (water temp., water quality & sea bottom quality)
	sea conditions	•current flow •wave conditions •climate
	capabilities of fishing boats available	•running capability (wave tolerance, accommodations, speed) •fish finding capabilities (LORAN, fish finder, wireless radio) •operating capabilities (mechanization of fishing operation & fish hold)
TYPE OF FISHING GROUND	habitat of schools	•tendency to inhabit one location •migrating tendencies (spawning migration, feeding migration)
	density and movements of fish schools	•schooling movements •daily movements (for feeding) •traveling characteristics (taxis)
CHOICE OF FISHING GEAR & FISHING METHOD	fish attracting activities	•spreading bait in water •fish lights •showering water •underwater sound •use of artificial reefs •FAD
	fishing gear configuration and setting	•depth of setting •single hook or multiple hooks (vertical or horizontal line setting)
	movement of fishing gear	•still or set in one position •drifting •towing
FISHING OPERATION	signal stimulus	•jiggling & drifting with current •bait, lure
	instinctive or reflective	•nibbling at the bait •attacking
CATCHING		

gest single factor in the success angling, being directly related to the fishing results but in the case of long-line and automatic angling, this is not necessarily true, as individual skill plays only an indirect role in the final fishing results.

Table 2 Classification of Angling Fisheries

Major categories	Sub-categories
Angling	hand-and-line pole-and-line vertical line trolling
Long-line	drift long-line bottom long-line
Automatic angling	automatic squid jigging automatic skipjack angling

Comments: to be introduced in next issue

Table 3 Catch of Japanese Angling Fisheries (1982)

Fishing method	Fishery type	Coastal	Offshore	Pelagic	Fishing boat license & tonnage
Angling	Skipjack pole and line	23	103	153	Coastal: under 20 tons Offshore: 20 to 120 tons Pelagic: over 120 tons
	Mackerel 'hane' angling	3	2	nil	Coastal: under 20 tons Offshore: 50 to 200 tons
	Other mackerel angling	3	nil	nil	Coastal: under 20 tons
	Automatic squid jigging	113	106	51	Coastal: under 30 tons Offshore: 30 to 100 tons Pelagic: over 100 tons
	Other angling fisheries	78	10	nil	Coastal: under 10 tons Offshore: over 10 tons
Long-line	Tuna long-line	19	78	218	Coastal: under 20 tons Offshore: 20 to 120 tons Pelagic: over 120 tons
	Northern sea salmon & trout long-line	nil	nil	38	200 to 500 tons
	Coastal and off-shore salmon & trout long-line	2	nil	nil	10 to 200 tons
	Other long-line fisheries	41	61	nil	Coastal: under 10 tons Offshore: over 10 tons

Note: Numbers in these columns represent catch in 1,000 ton units.
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Angling Variations

Methods

Angling can be classified into four sub-categories, hand-and-line, pole-and-line, vertical-line, and trolling, the different characteristics of which are shown in Figures 1 - 4. Each of these methods has particular qualities that make it best suited to a certain type of fishery, based on the life habits of the fish to be caught (migrational habits, feeding habits), and the fishing ground conditions (seasonal, tidal, current and time of day).

1 Hand-and-line

This is a fishing method in which the fishing line is worked by hand to bring up the catch. This method is used primarily for catching fish which inhabit the sea floor or fish which migrate in the bottom sea waters, and can be used to catch nearly any kind of fish. There are also some hand-and-line fisheries aimed at middle-depth fish species.

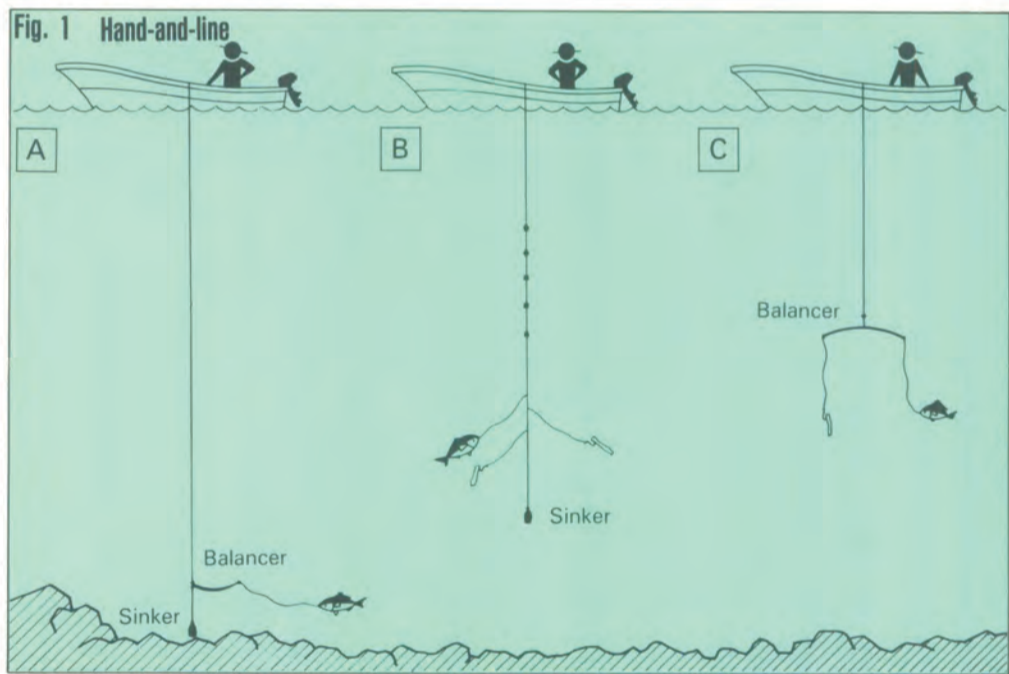
One of the most important points in successful angling fishery is to accurately determine the depth at which the fish to be caught is migrating. For this reason, fishermen use a number of techniques such as hanging down a vertical line fixed with numerous hooks at regular intervals to see at which depth the most fish are caught, or, sending down a line with a sinker to the sea floor and then raising it carefully to an appropriate depth in order to measure the proper length for the fishing lines. Also, since most bottom-inhabiting fish prefer a certain type of sea environment, such as around the edges of reefs or sand and mud bottom areas, it is important to research and memorize, or record, the sea bottom topography of a given fishing ground.

In angling there are two basic fishing techniques, one in which the line is mov-

ed gently through the water to attract the fish to the baited hook, and another in which the line is hung perpendicularly in the water and remains still in one position. Both of these techniques may be used alternately for catching the same type of fish, depending on the season. For example, in the case of sea bream, the former technique is used in spring and autumn, when the fish are migrating constantly between the deep and shallow waters, while the latter is used in summer and winter, the seasons during which sea bream remain in the bottom waters.

A variety of baits, including live bait, fish pieces, paste bait and lures, are used depending on the type of fish and the size of fish being caught, seasonal and sea conditions, and, based on these, the fishermen will constantly make further variations and improvements in the bait material, shape, color, and smell, as they feel necessary. Also, in addition to the bait attached to the hook, fishermen will at times use methods such as spreading bait in the water or, at night, using fishattracting lights to increase fishing effectiveness.

Recently, with the increased recognition of the effectiveness of man-made reefs as a means of gathering fish, such artificial fishing reefs are being used in increasing numbers throughout Japan's coastal waters.



Shape and Function of the Fishing Hook

The fundamental requirements of the fishing hook are that it, first, hooks the fish as it tries to take the bait and, second, that it holds the fish firmly once it has been hooked. It goes without saying, therefore, that the design of the hook is of singular importance. Unlike land animals, when a fish feeds, whether it is on planctons or on other fish, rather than trying to bite into the food, it usually tries to swallow the food whole. The fish's gills function as a sort of pump that pumps water out as the fish sucks water in through its mouth. Using this function, the fish tries to "inhale" its food as it moves through the water. However, this feeding process differs slightly with each species of fish, making a slightly different shape of hook necessary to function best with each different type of fish.

Although the materials, the size and the shapes of fishing hooks vary greatly from country to country and region to region, we can, nevertheless, divide fishing hooks into four basic types.

(A) Angling type for bottom fishes:

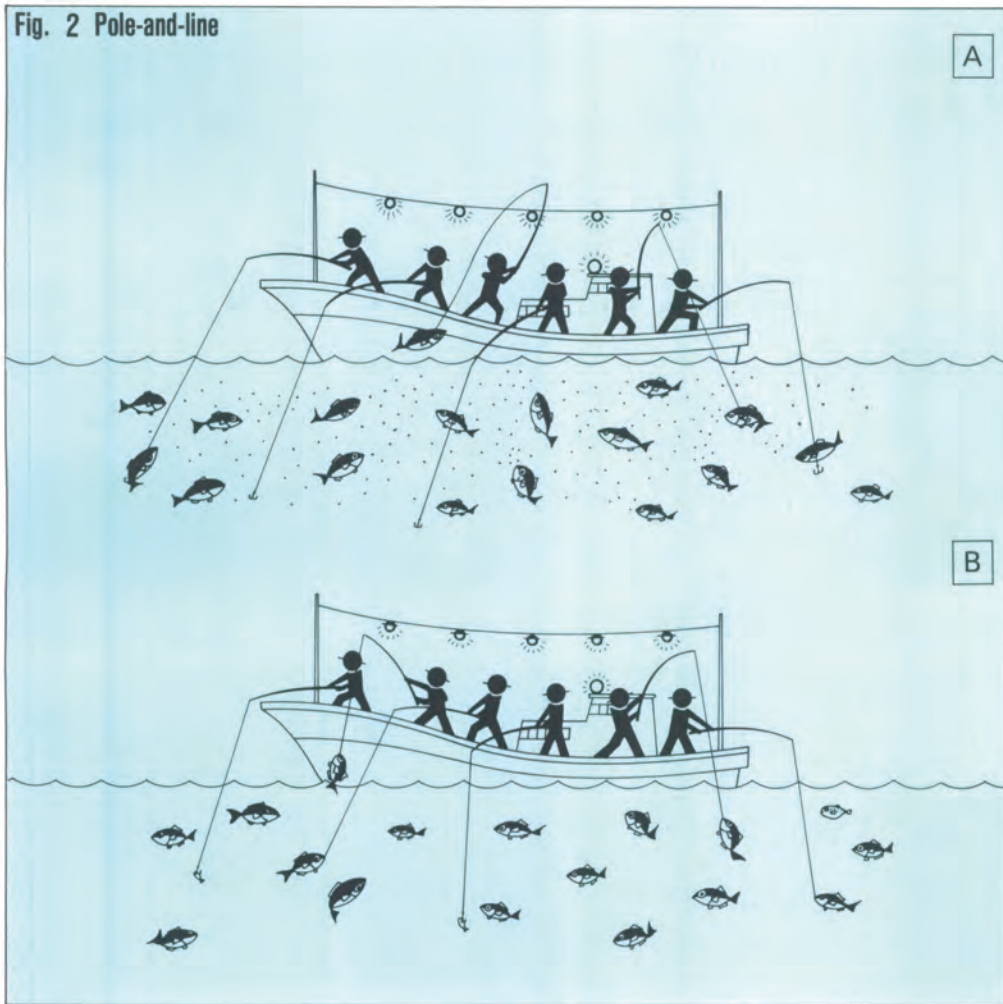
As the feeding process here involves slowly approaching the food and sucking it into the mouth, and then, if an undesirable object is present, spitting it out again and trying to escape, the requirements for a fishing hook for bottom fishing include; (1) a deep, gentle curve to the bend of the hook which allows it to be taken into the mouth easily, (2) a sharp point which will easily puncture the inner surface of the mouth, (3) a hook that is difficult to dislodge, and (4) a hook that does not easily snag on bottom rocks.

(B) Pole-and-line type:

Here, skipjack or yellowtail are competing actively for the bait. They approach the bait rapidly and bite into it. Once they have been hooked, the force of the fisherman's pull on the line keeps the hook firmly in place so it does not dislodge easily. Therefore, the important factor in this case is, rather, that the hook be one that can be quickly and easily dislodged once the fish has been hauled aboard. So, in this case the hook is designed with a point that runs parallel to the shank, for easy dislodging. In some areas the shank is made very long and shaped in a way that prevents the fish from swallowing the hook too far down into the gullet.

Based on Fish Movements

Fig. 2 Pole-and-line



2 Pole-and-line

This fishing method, using a pole to which is attached a line and fishing hook, is a method in which the pole is hand held and the hooked fish is brought up manually. Two representative fisheries which use this method are skipjack pole-and-line fishery and mackerel "hane" fishery. For purposes of explanation we will use here the skipjack pole-and-line method as an example. First of all, signs are sought which indicate the likely presence of a school of skipjack. These signs may include a flock of seabirds over the water of the type that feed on small fishes, or changes in the color of the water surface or ripples caused by schools of small fish such as sardine near the water surface. At times, artificial floats of logs are used to attract the skipjack. When a school of skipjack is discovered, the fishing boat approaches the school at full speed and quickly spreads live anchovy on the water as bait, or sprays water on the surface from a pump on board the fishing boat to stimulate the appetite of the skipjack. Then the fishing operation begins, hooking skipjack that come to the surface in search of food.

(C) Trolling type:

Basically, the shape here is the same as in pole-and-line. However, fish like skipjack, tuna, and marlin tend to have rather weak mouth structures in comparison to their body size. This means there is a concern that the pulling force of the towing line and the resisting force of the fish as it tries to free itself may be enough to tear the mouth tissues and thus dislodge the hook. Therefore, in addition to one-barb hooks, two-barb and three-barb hooks are used in trolling.

(D) Long-line type:

The hooks used here are basically the same as those used in hand-and-line or pole-and-line fishing. However, because of the fact that in long-line there is a period between the time that the fish is hooked and the time it is hauled in, during which the fish will try to free itself, the hook is designed with a narrower gap and a shank which curves inward at the end to make it more difficult to dislodge. Also, because larger fish remain alive and fighting for a long time after being hooked, the eye of the hook is fitted with a swivel which prevents the line from becoming overly twisted and thereby weakened.

3 Vertical line

This fishing method utilizes numerous fishing hooks on one line suspended vertically in the water, in order to increase the effectiveness of the fishing process. It can be considered, in essence, to be a vertical long-line fishing method. Vertical line angling can be divided into three main types.

- 1) A multiple-hook long-line is suspended vertically in the water and moved in an up and down motion. (as in squid jiggling)
- 2) A similar long-line is attached to a float (made of wood, plastic or styrofoam) and allowed to drift with the current.
- 3) As with (2), a long-line is attached to a float, but a sinker is attached to the end of the line and sunk to the sea bottom to hold the line in one place.

One thing that all of these vertical line methods have in common is that the length of the line is set after determining the depth at which the fish are migrating by means of a fish-finder. For bait, either fish pieces, small shrimp or lures may be used.

Fig. 5 Shapes of fishing hooks

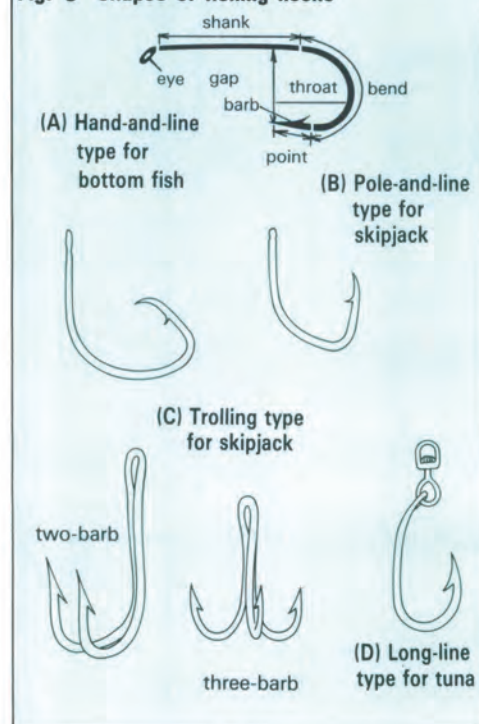
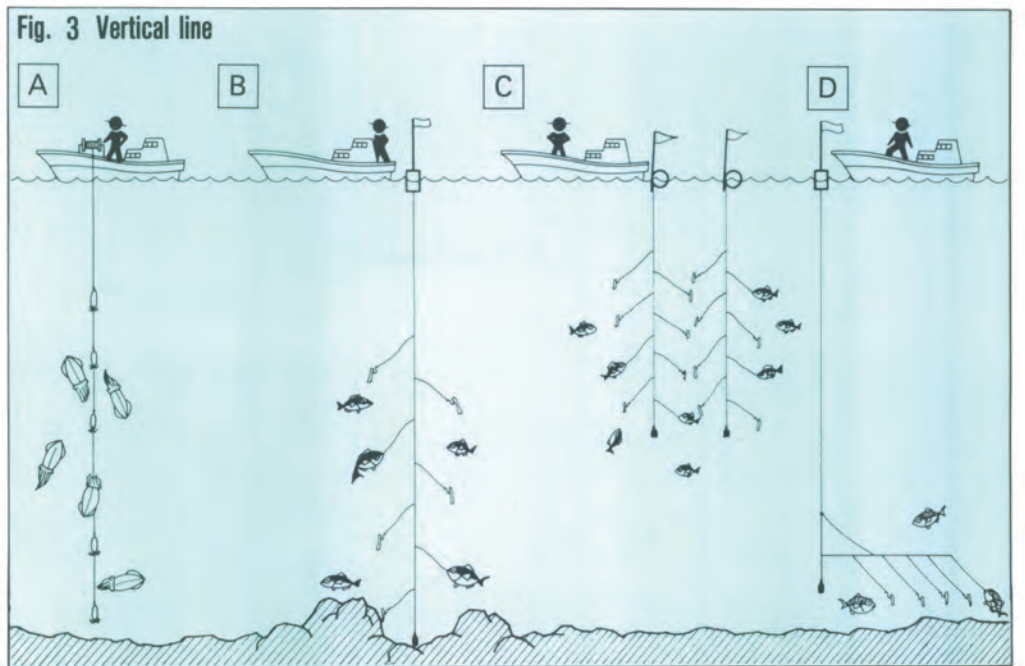


Fig. 3 Vertical line



4 Trolling

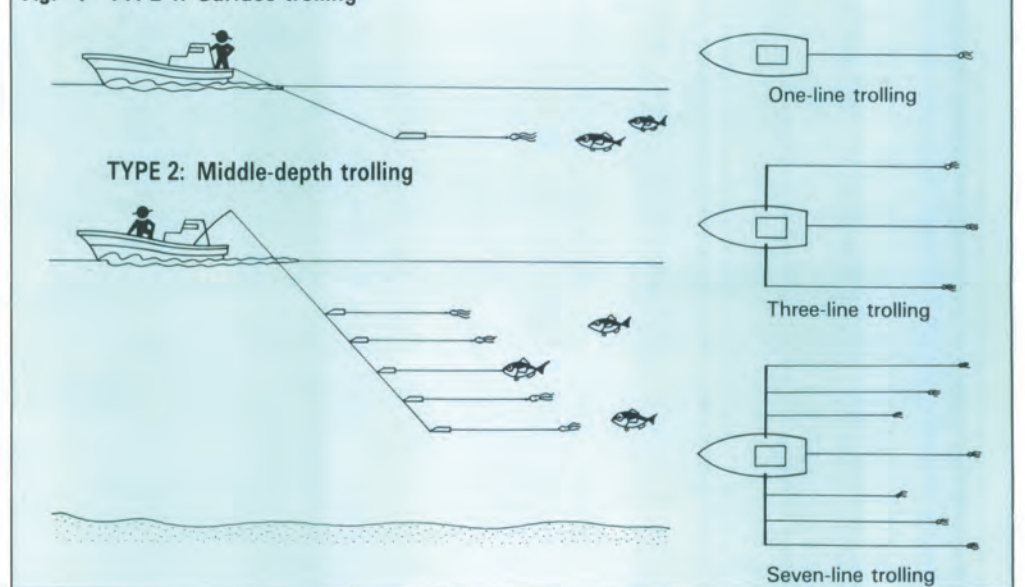
Trolling fisheries may be divided into two major types.

Type 1) This method is one in which the lines and hooks are towed horizontally near the surface of the water. The fish caught by this method are fish-eating species with a large migrating range, such as middle to large sized tuna, marlin, skipjack, Spanish mackerel, yellowtail and dorado. In the case of a small fishing boat, one to three lines may be towed, but a middle to large sized boat may extend poles from either side of the boat to allow six to eight lines to be towed. For this type of fishery extremely effective lures have been

developed which attract the fish by the quick "swimming" motion they simulate as they move through the water. In commercial fishery operations the usual fishing boat size is three to five tons. This method is also popular, however, among sport fishermen.

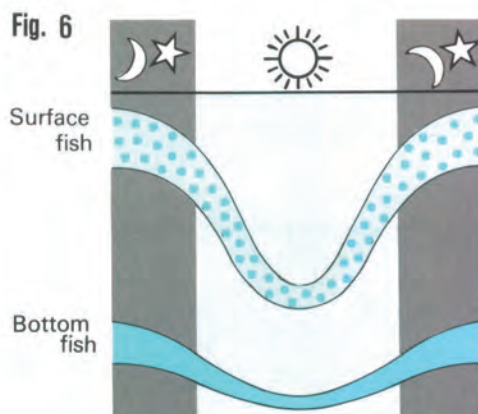
Type 2) This is a fishing method aimed at catching middle to bottom depth migrators such as sea bream, yellowtail, trout, and flatfish. The lines are equipped with devices such as sinkers, underwater plates and floats that cause the line to troll in the middle to bottom depth waters. This is a method in which a line fitted with multiple lures is towed through the water. The design of the fishing gear is similar to that described in the vertical line method, and, as with vertical line, this method can be considered a type of long-line fishery.

Fig. 4 TYPE 1: Surface trolling



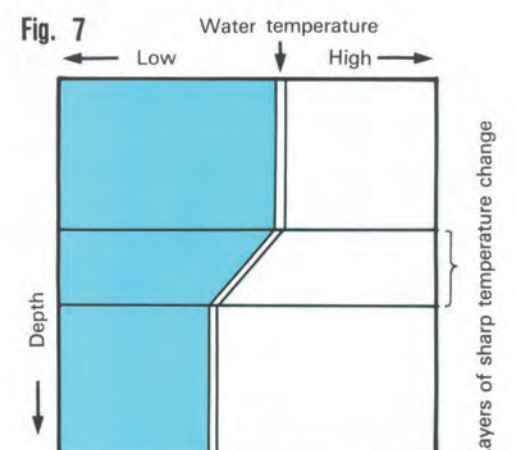
Daily Movements of Fish

There are many species whose daily life patterns involve spending the daylight hours in the bottom depths and then migrating to the middle depths or even the surface waters during the night. It is believed that this is due to changes in the depth of the plankton, in response to the amount of sunlight penetrating the water, or schools of small fishes on which these species feed.



Water Layers of Sharp Temperature Change

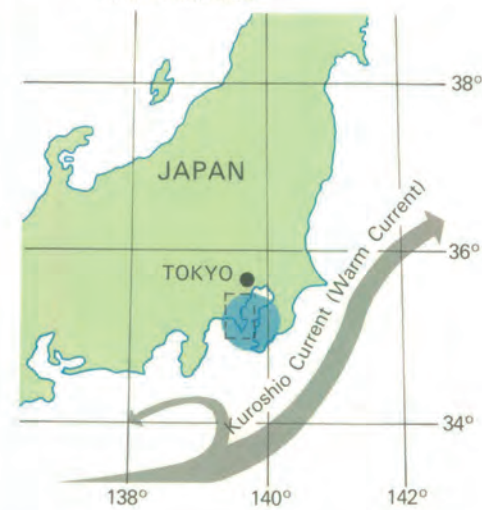
Each fish species has its own optimum water temperature. Where migrating fishes are concerned, the strength and the depth of these layers of sharp temperature change will greatly effect the conditions and the distribution of fishing grounds.



Angling Fisheries OF THE MIURA PENINSULA



Fig. 8 Main fishing villages of Miura Peninsula



There are approximately twenty fishing villages found on the Miura Peninsula of Kanagawa Prefecture. Although all kinds of fishery activities can be found here, the majority of the fishing villages are involved either in (1) fishing business based primarily on angling or (2) fishing business based primarily on set net fishery. Although there are some villages involved primarily in gillnet fishery, dive fishing, or a half-agriculture half-fishery type economy, their number is small and, geographically speaking they are exceptional cases. Because the Miura Peninsula lies approx-

imately 100 kilometers from the major urban centers of Tokyo and Yokohama, the peninsula is famous as a marine recreation area, and there is a large business in tourist-oriented lodging houses and lodging houses offering guide services for sea-fishing. A large number of the peninsula's fishermen are involved in this type of tourist-fishing business as a side job to supplement their fishery incomes. The families which are engaged in fishery business based primarily on angling fishery, in addition to angling for the various species of fish which migrate into their fishing grounds seasonally, will also

engage in some other type of supplementary fishery, such as undaria (a variety of seaweed) culture, gill net, dive-fishing and long-line, depending on the seasonal and geographical characteristics of their region. Furthermore, the angling fisheries engaged in by the families of this region can be divided into two categories, those conducted in the coastal waters near shore and those in the offshore waters or waters around the nearby island groups. And, these two categories can be further divided into two groups, those fishing for migrating fishes and those for bottom

fishes. At present, these fisheries are catching over thirty different varieties of salable fishes. (See Table 4) In the following sections of this issue we will take a close look at three fishing villages, Mitsuwa, Misaki and Sajima as examples and investigate the details concerning their different fishing gear and fishing methods.

RESEARCH COOPERATION: Kanagawa Prefectural Fisheries Experimental Station

Comparison of the three fishing villages

Table 5 Number of fishing units by fishery (1982)

Type of fishing ground	Main fishery	Sajima	Mitsuwa	Misaki
Coastal waters	two-boat surrounding net	3	-	-
	gillnet	37	4	-
	angling	10	83	29
	squid angling	4	1	-
	long-line	12	2	-
	shellfish gathering	19	9	-
	undaria culture	43	9	-
	other fisheries	17	18	5
Offshore and pelagic waters	skipjack pole-and-line	2	-	-
	tuna long-line	1	-	24
	squid angling	-	-	12
Total		148	126	70

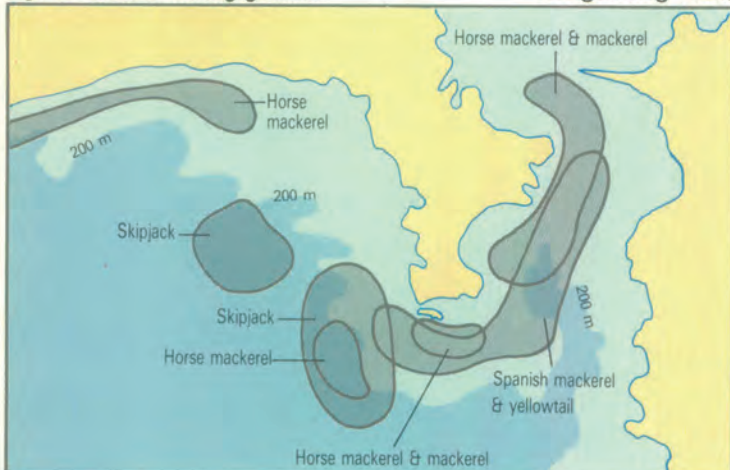
Table 6 Amount of catch by species (1982)

Type of fishing ground	Species	Sajima	Mitsuwa	Misaki
Coastal waters	shark family	7	-	930
	sardine family	1,968	-	-
	horse mackerel	-	3	16
	mackerel	32	122	-
	Pacific saury	-	-	128
	yellowtail	4	38	4
	dorado	21	-	-
	sea bass	3	9	-
	filefish	2	86	-
	Centrophid fish	-	3	41
	Alfoncino	1	86	86
	big eye	-	14	36
	grunt	1	50	-
	other fish species	47	57	1,972
	squid family	4	11	819
other marine animals	9	8	-	
shellfish	27	18	-	
seaweed	91	85	-	
Offshore and pelagic waters	tuna family	98	-	22,981
	marlin family	24	-	2,827
	skipjack family	87	-	2,946
	squid family	-	-	5,732
Combined fishery catch		2,426	590	38,518

Table 4 Type of angling fisheries in Miura Peninsula

Fishing ground	Fish caught	Main types of fishery	Fishing boat	Number of crew	Length of fishing trip
Coastal	migrating fishes	skipjack pole-and-line, squid angling, horse mackerel angling, mackerel angling, trolling for young tuna, & dorado long-line	up to 3 tons	1 or 2 men	one day
	bottom or middle-depth fishes	grunt angling, sea bream angling, flatfish angling, sea bream long-line, & sea bass long-line	up to 3 tons	1 or 2 men	one day
Offshore or island waters	migrating fishes	skipjack pole-and-line & trolling for tuna	3-5 tons or 5-10 tons	4 or 5 men	2 or 3 days
	bottom or middle-depth fishes	vertical line for Alfoncino, Big eye Centrophid fish	3-5 tons or 5-10 tons	4 or 5 men	2 or 3 days

Fig. 9 Inshore fishing grounds (migrating fish)



(bottom fish)

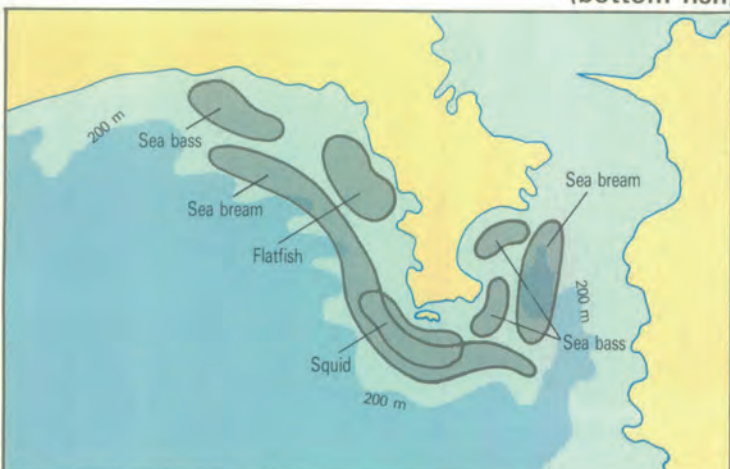
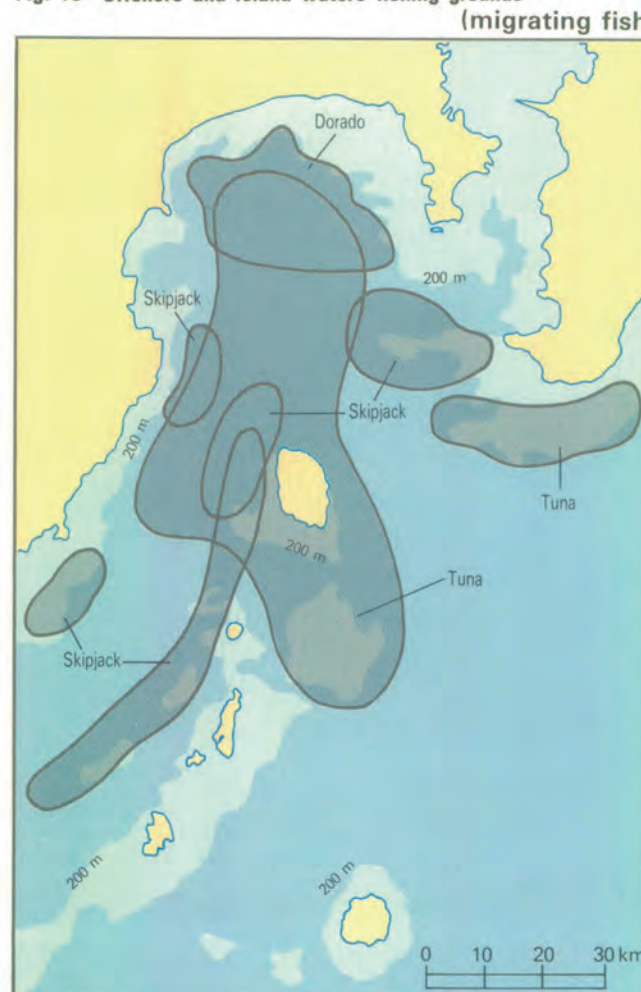
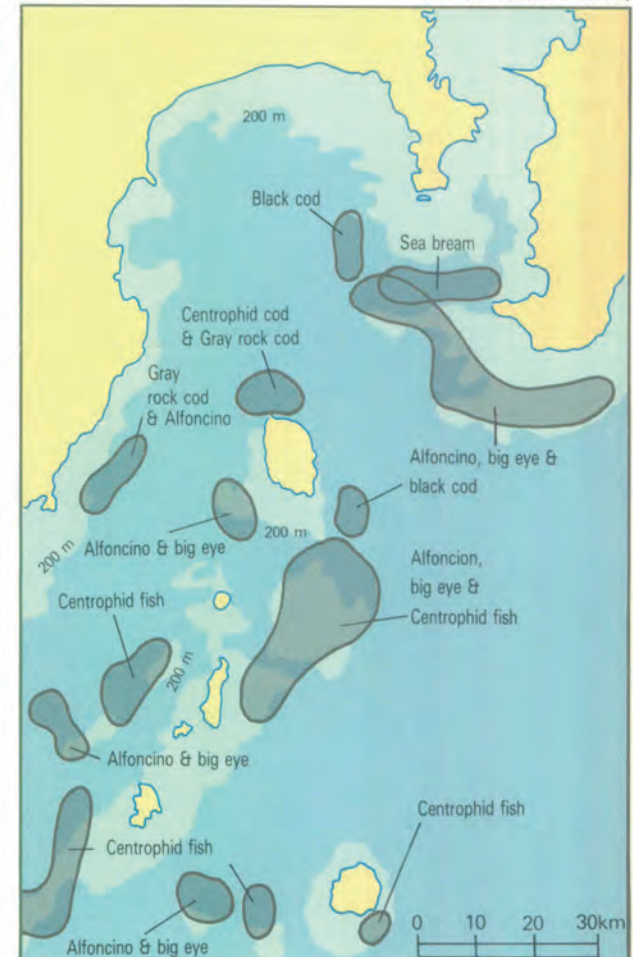


Fig. 10 Offshore and island waters fishing grounds (migrating fish)



(bottom fish)

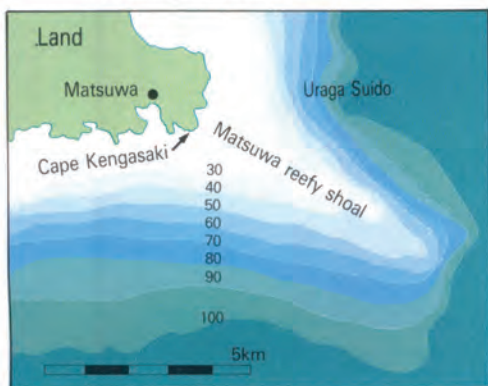


TYPE 1 HAND-AND-LINE

Example: Grunt angling by spreading bait
Location: Matsuwa, Kanagawa Prefecture

Fishery Environment

Fig. 11 Sea-bottom topography in Matsuwa waters



Extending southeast from the Kengasaki Cape on the eastern edge of the Miura Peninsula is an underwater reef about six kilometers in length over which flow the tidal currents coming and going between Tokyo Bay and the open sea. This rocky reef, called Matsuwa-se (reefy shoal), is an excellent fishing ground endowed with numerous species of fish which inhabit or make temporary visits to its waters. The fishermen of Matsuwa utilize a number of fishing methods in order to make full use of the marine resources of these waters. First of all, in the shallow waters of less than 10 meters they conduct seaweed gathering (undaria & agar-agar), spear-fishing, dive-fishing for shellfish (turbo & abalone), and bottom gill-net fishery (sea bream, flatfish & lobster). Next, throughout the Matsuwa-se reef waters, all varieties of angling, bottom gill-netting for lobster, and in the surrounding waters, trolling for yellowtail and tuna are also conducted. Also, in recent years, due to the increase in the number of filefish, there has been a growing number of scoopnet operations for them.

Beginning in recent years there has also been an increase in fishing operations going out to the offshore island waters in 3 to 5 ton boats to fish for bottom fish species by the vertical line method. However, for the fishermen of Matsuwa, the Matsuwa-se reef waters remain the main fishing ground, with the catch there accounting for about 60% of their total annual fishery sales.

Fishing Boats

Table 7 Fishing boats affiliated with the Matsuwa Fisheries Cooperative

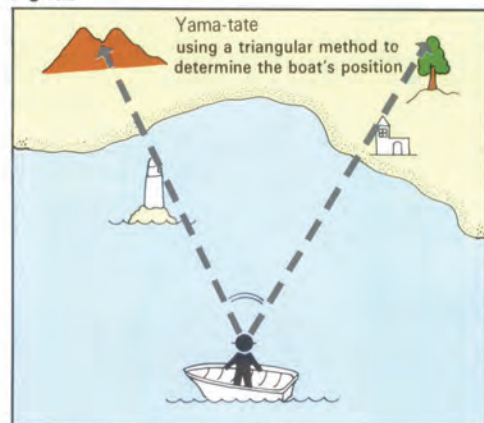
up to 3 tons	170 boats
3-5 tons	65 boats
over 5 tons	5 boats
Total	240 boats

There are approximately 240 fishing boats in operation in Matsuwa. Since most of the fishing is done in the inshore waters, the

vast majority of these boats are either less than 3 tons or of the 3 to 5 ton class.

Since long ago, fishermen have sighted mountains along the coast in a triangular method to verify the position of their boats and the position of fishing grounds. This technique is called "Yama-tate" in Japan. (Fig. 12) Today, however, most small fishing boats are equipped with LORAN and direction finders which enable accurate position finding. Also, fish-finders today allow fishermen to "see" underwater to locate fish schools and know the sea-bottom topography. LORAN proves to be especially effective for determining position on the sea during foggy weather.

Fig. 12



Fishing Gear

In this issue we will introduce angling fishery for grunt. The grunt (*Parapristipoma*



Fig. 13 Fishing gear for bait-spreading type grunt fishing

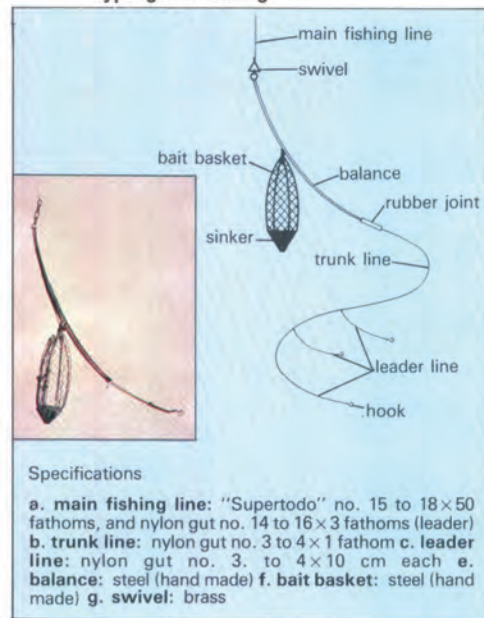


Table 8 Fishing calendar for Matsuwa fishing grounds

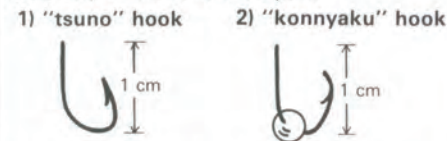
Main fishing ground	Fishing method	Type of fish	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Inshore waters (about 10 meters deep)	sea weed gathering	undaria, agar-agar			■		■							
	dive fishing	abalone, wreath-shell					■	■	■	■				
	gill-net	flatfish, seabream												■
		lobster												■
Coastal (Matsuwa-se and surrounding waters)	hand-and-line	grunt						■	■	■	■	■	■	■
		mackerel												■
		Japanese parrot fish												■
	trolling	Spanish mackerel & yellowtail												■
		tuna												■
		sea bass												■
scoop-net	filefish											■		
Offshore (Island waters and underwater ridges)	vertical line	Alfoncino, big eye, Centrophis fish & gray rock cod											■	
	hand-and-line	squid											■	

NOTE: Thin lines indicate a standard fishing period, while thick lines indicate periods of peak catches.

ma trilinealum), which inhabit the coastal waters of Japan from its central regions south to the China Sea, has a maximum adult body size of 40 centimeters. These fish are caught by one of two basic methods; spreading bait on the water or fishing without spreading bait. Here we will introduce the former method.

Baiting the hook

Here, two types of hooks are used, a (1) "tsuno" hook and a (2) "konnyaku" hook. For (1), a piece of squid meat or a thin piece of fish skin is stuck on the hook. Hook (2) features a silver colored glass bead positioned on the bend of the hook which functions as a lure. No live bait is necessary with this hook. A unique quality of this hook is the deep inward curve of the point-



"Komase" (spreading bait)

A steel cage is filled with small shrimp having a body size of 1 to 2 centimeters. The cage is lowered to the bottom and then raised, spilling bait as it goes. The freed shrimp then begin to float around spreading their smell which attracts the fish. The bottom of the cage is made to serve as a sinker.

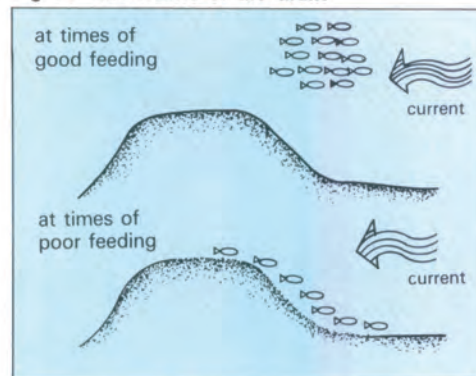
"Tenbin" (balance)

The "tenbin", utilizing the spring action of steel, gives a pulsing motion to the line, as well as functioning to relieve the shock to the line when the fish takes the bait. It also helps to prevent the trunk line and the leaders from becoming entangled with the main line while the line is being lowered in the water.

Fishing Operation

As mentioned earlier, the most important point of the angling operation is to locate the habitat and the migrating depth of the fish to be caught, and then to place the hooks accurately in this range. Especially in the case of bottom fishes with their strong tendency to stay in one place with regard to current and bottom topography, the success of the fishing operation depends largely on the fisherman's ability to locate the fishing ground, based on his knowledge of the preferred habitat and the movements of each species of fish. Grunt inhabit open sea waters with a depth of 5 to 50 meters, tending to gather mainly in areas with considerable up-and-down variation in the rocks of the sea bottom. In the Matsuwa-se reef area, grunt tend to inhabit the rather shallow reef areas with a depth of 8 to 12 fathoms during the summer season. At times of good biting conditions the grunt tend to gather along the edges and slightly above the rocky protrusions rising from the sea bottom. When biting is poor the grunt are said to distribute

Fig. 14 Life Habits of the Grunt



themselves along the lower edges of the reefs.

The second most important decision involved in the fishing operation is what time of day to fish. Fish do not feed all day long, instead, they have certain times of the day at which their feeding instincts are stimulated by such factors as tidal current or the amount of light penetrating the water. The fishermen should know at which times the fish of a given species are most easily caught, such as around the time of sunset and sunrise, or moon rise and moon set, at the beginning of the tidal change etc., and should schedule their fishing accordingly, going out in the pre-dawn or the late afternoon hours.

The third important factor is the choice of fishing hook and bait. A process of trial and error should be used to find the proper hook and bait to fit a given fish's size and feeding habits.

The final factor in angling is the actual line handling skill of the fisherman. Fishermen call this the "skill of responding to the first signal from the fish". In other words, each type of fish has a different way of taking the bait, and the fisherman should be sensitive enough to these differences to be able to respond properly.

In the case of grunt angling, after the sinker has hit the bottom the fisherman immediately begins to pull the line up. When the hooks reach the middle depths the line is again lowered to the bottom and the raising process is repeated. Since the grunt is a fish which hooks easily, if the line suddenly becomes heavy as it is being raised, that means that a fish has been hooked and the line should be hauled in immediately.

As an example of a fish with a completely different hooking technique from the grunt, let us look at the case of Centrophid fish. Since the Centrophid fish's teeth are found not in the mouth but in the gullet, it feeds by starting at the end of the bait and tries to gradually swallow it. Therefore, the fishing technique for Centrophid fish is not to respond to the first gentle touch that you feel on the line, but to wait, without moving the line, until you feel a harder second tug that means that the bait has been swallowed and the fish is starting away. Only then should the line be pulled in rapidly.

Management of Family Fishery Business

The fishermen of Matsuwa gain a number of advantages from the fact that they have such a well endowed fishing ground so close to their home.

1) Large investments have been avoided

Because of the sea conditions and bottom topography of the area, it is not suited for the development of bottom seine fishery or surrounding net fishery. This fact has led to the development of successful angling fishery operations. Angling fisheries require a considerably smaller investment in fishing gear than net fisheries. While the general trend here during the scrap-and-rebuild era between 1970 and '80 was a step by step increase in boat size from 2 to 3 and then to 3.9 ton boats, because of the fact that the fishing grounds are so close, the fishing boat size has remained in the small class and the fishermen have thus been able to avoid the excessive investments involved in the gradual progression to excessive class boats that has been seen in other areas.

2) The number of fishing days per year is large

Because of the closeness of the fishing grounds and the large variety of different fisheries that are possible here, the total number of days in which fishery can be conducted per year is extremely large. These same factors also make it easy for the fishermen here to make adjustments for changes in conditions in the fishery resources. The average number of fishing days for boats of up to three tons fishing in the shore waters is said to be about 250 days per year, while boats of 3 to 5 tons fishing in the offshore waters are able to operate from 180 to 200 days per year.

3) The average age of fishermen has remained young

There is a peak in the age of fishermen here (Continued on next page)

(Continued from previous page) between 35 and 40 years of age, which is about 5 years younger than the national average. The reason for this is that the income that can be achieved by fishermen in Matsuwa is high enough to prevent a large number of young men from leaving the fishing village in search of higher paying jobs. The yearly fishery sales for one fisherman in the Matsuwa Fisheries Cooperative ranges from 6 to 27 million

yen, with the total fishery expenses (including the repayment of loans and investments) averaging between 40 and 45%. This means that even the lowest income group can expect to take home a profit of over 3 million yen per year.

RESEARCH COOPERATION: Mr. Shigeru Suzuki et. al. (Matsuwa Angling Research Group)

TYPE 2 POLE-AND-LINE

Example: Skipjack pole-and-line
Location: Sajima, Kanagawa Prefecture

Fishery Environment

The fisheries conducted here range from shellfish gathering in shallow water areas to skipjack pole-and-line fishery in offshore waters. These fisheries can be divided conceptually as shown in Table 9, based on two main factors, the fishing ground conditions and the appropriate fishing method. The fishing families in this area have, traditionally, engaged in a combination of small-scale angling, spear-fishing and dive-fishing year round in the nearby shallow water areas with rocky reef bottom topography. However, with the improvements in fishing boat performance, the fishermen have proceeded to modernize their fishery businesses by shifting their emphasis more to angling, expanding their fishing techniques to include long-line and, by acquiring larger boats, have extended the range of their activities to include offshore pole-and-line and long-line fishing operations. As this modernization proceeded, long-line fishery became the main fishing method by 1960, and by 1970 a number of the boats of the coastal fishing fleet began to change over to pole-and-line fishery for skipjack. What made the initiation of these pole-and-line operations possible was the presence, locally, of three 19-ton class fishing units engaged in small-scale surrounding net fishery, which could supply the pole-and-line operations with the fresh live anchovy necessary for this type of fishing process.

Fishing Boats

The fishing boats here can be divided into two groups, small-scale boats (3-5 tons) and large-scale boats (5-12 tons), both of which conduct bottom long-line fishery for sea bream and pole-and-line fishery for skipjack as their main fishery activities. **Bottom long-line for sea bream:** This fishery is conducted along the edges of the continental shelf in Sagami Bay (depth 200 m). **Pole-and-line for skipjack:** The fishing grounds include areas along the 200 meter isobath in Sagami Bay and the edges of reef areas in the open sea, with the small boats fishing in the bay waters and the large boats in the open sea. Requirements for boats fishing in the open sea fishing grounds are 1) good wave-resistance capacity and 2) sleeping accommodations. Small-scale boats of less than 5 tons are not used for the fishing grounds farther south than Ohshima Island.

Fishing Gear

The fishing gear here is simple, consisting only of a line and hook attached to a pole. Floats and sinkers are not used, neither are swivel needed because of the shortness of the line. In the past, bamboo was used for these poles, but today fiberglass is replacing bamboo. The poles have a standard length of 4 to 4.5 meters and a diameter of about 3 cm at the handle, and are tapered toward the end. The pole must

Fig. 15 Fishing gear for skipjack pole-and-line

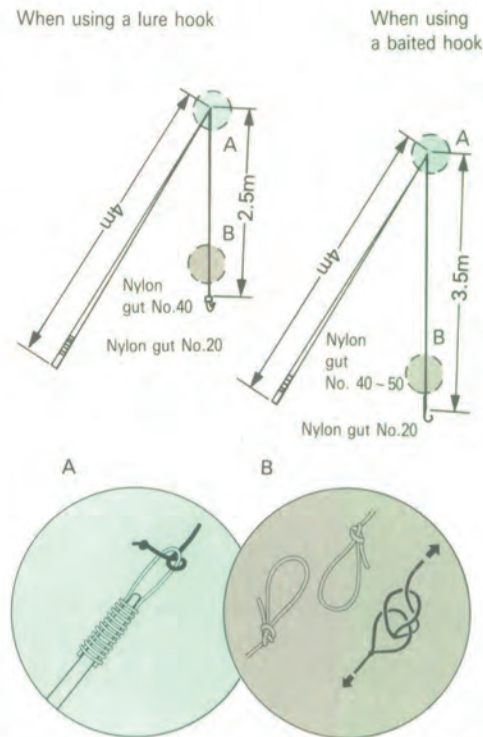
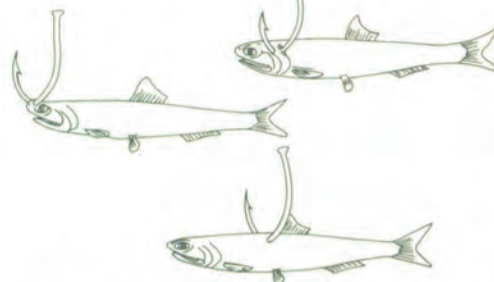


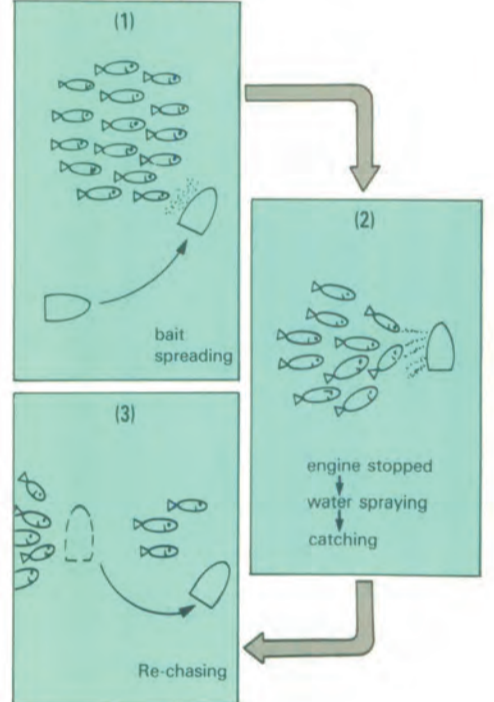
Photo A Lure hook

Fig. 16 Baiting method for live bait



3) As the number of fish passing around the boat and getting away begins to increase, the fishing operation is stopped, the engine started, and once again the school is approached carefully from behind, as in step 1), and the fishing process repeated. A hungry school of fish is generally easy to bring up to the boat, while a school which is well fed will tend to scatter and get away.

Fig. 17 Fishing process



Management of Family Fishery Business

Small-scale boats here engage in long-line fishery for sea bream as their main source of income, and during the off-season for sea bream will engage in pole-and-line fishery for skipjack, or else some other kind of long-line fishery, depending on the conditions of the fish resources at the time. On the other hand, large-scale fishing boats engage in pole-and-line fishery for skipjack in the offshore waters near the Izu Islands as their main fishery, and change over to long-line for sea bream only in the off-season for skipjack. Sometimes, schools of dorado will migrate into the fishing grounds during the skipjack season, in which case the fishermen will often change over to trolling operations for dorado.

Table 10 Operating expenses for a single fishing trip of a boat engaged in skipjack pole-and line (thousand Yen)

	Small boat	Large boat
Length of fishing trip	1 day	2 days
Number of crew	2 men	4-5 men
Cost of bait	50	100
Cost of fuel	20 (300 liters)	50 (700 liters)
Cost of ice	10	20
Total	80	170

(Continued on next page)



Skipjack poles



Panels for keeping live sardine

Table 9 Fishery structure

Water depth	Fishing grounds	Misc. fisheries	Angling fisheries	Net fisheries
10 m	Coastal fishing grounds	Spear fishing • turban shell • abalone	Hand-and-line • sea bream • squid	Gillnet • turban shell • lobster
		Dive fishing • turban shell • abalone		Small-scale set net • anchovy • squid
200 m	Offshore fishing grounds	Basket • cockle	Bottom long-line • sea bream • sea bass	Small-scale surrounding net • anchovy
		Tubular trap • conger	Pole-and-line • skipjack	
			Surface longline • dorado	

Table 11 Annual fishery schedule

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Sea bream long-line												
Hairtail long-line												
Dorado long-line												
Spanish mackerel long-line												
Sea bass long-line												
Skipjack pole-and-line												
Dorado trolling												

(Continued from previous page)
Both small-scale and large-scale boats average between 200 and 220 fishing days a year, aiming at total yearly sales of 10 million Yen for small boats and 25 to 30 million for large boats. The operating expenses for a single fishing trip by one boat engaged in skipjack pole-and-line fishery can be seen in detail in Table 10 (Page 6).

TYPE 3 VERTICAL LINE

Example: Vertical line for bottom fish species
Location: Misaki, Kanagawa Prefecture

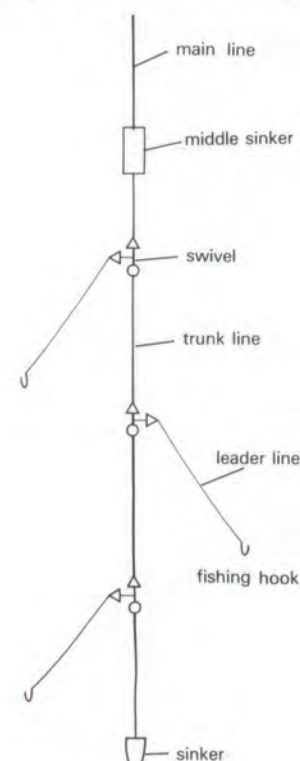
Fishery Environment

Although Misaki is a port for long-range oceangoing fishing boats engaged in long-line fishery for tuna and squid jigging, there are also about 150 fishermen in the Misaki area engaged in some kind of coastal fishery. In terms of initial investment and labor supply, there is no relation between the long-range ocean operations and the coastal operations. While the majority of the fishermen involved in coastal fishery in Misaki are engaged in year-round angling for bottom fishes, squid, mackerel, horse mackerel etc., there is one group among these involved in vertical line fishery for big eye (*Scombrops boops*), Centrophid fish (*Ocyrius japonica*) and Alfoncino in the rocky reef areas. It is this later group which we will look at here.

Fishing Boats

The fishing boats here involved in vertical line fishery for bottom fishes can be divided into two groups, small-scale boats of around 3 tons and large-scale boats of 5 to 10 tons. The small-scale boats fish in the waters of the "Oki-no-yama" reef, off shore from Misaki, to the "Mera-se" reef off shore from Boso Peninsula, while the larger boats fish much farther south in the waters around the Izu Island group and nearby underwater ridges. In particular, the large-scale fishing boats, which until 1978 had ventured no farther south than Kozujima in the Izu Islands, have, since 1979, begun to develop fishing grounds as far south as the 33rd parallel N., a distance of 200 km from Misaki. This expansion has been made possible by such factors as the adoption of LORAN, which enables fre-

Fig. 18 Fishing gear configuration



RESEARCH COOPERATION: Mr. Tomojiro Mihashi (Yokosuka City, Ohkusu Fishery Cooperative Long Line Fishery Research Group)






quent and accurate position verification, improvements in the cruising capacity of the fishing boats, and the resulting decrease in travel time to and from the fishing grounds, and improved techniques for locating fishing grounds on the sea floor.

Fishing Gear

The composition of the fishing gear is the same for both small and large-scale boats. As shown in Table 12, the specifications of the fishing gear vary slightly with each species of fish. Special note should be taken of the differences in the amount of bait and the method of attaching the bait, and the fact that the number of branch

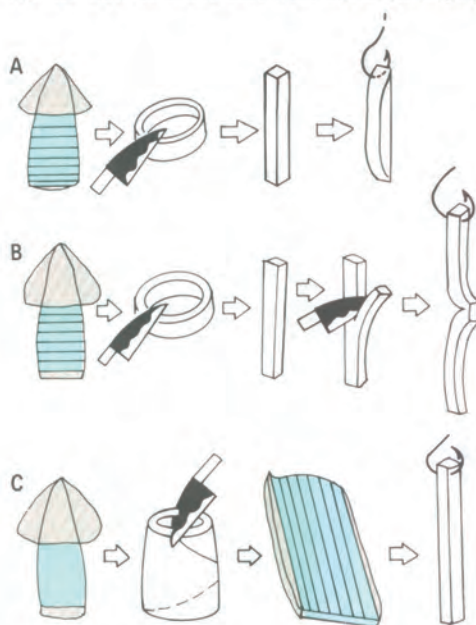


Table 12 Fishing gear specifications for vertical line

Bottom-inhabiting fish	Fish	Fishing season	Fishing ground depth		Bottom type	Main line		Trunk line		Leader line			Bait
			nighttime	daytime		thickness	length	thickness	length	thickness	length	number	
	Alfoncino	All year	150~250 m	350~450 m	Rocky reef	Super-tetron # # 30~35	450 m	Nylon monofilament # # 20~30	1.5 m	Nylon monofilament # # 20~30	1 m	nighttime 20~30 daytime 70	•common squid [Fig. 19A] •anchovy •mackerel fillet
	Big eye	All year	100~150 m	about 350 m	Same as above	Same as above	400 m	Same as above	2 m	Same as above	1 m	nighttime 10~15 daytime 20	•anchovy •mackerel fillet
	Centrophid fish	All year (but not continuously)	50~150 m	×	Same as above	Super-tetron # 40	150 m	Nylon monofilament # # 24~30	5~13 m	Same as above	2~3 m	5~10	•common squid [Fig. 19B]
	Gray rock cod	Winter (Dec.~Mar.)	×	500~700 m	Same as above	Super-tetron # # 35~40	700 m	Nylon monofilament # # 20~30	1.5 m	Same as above	1 m	20~30	•common squid [Fig. 19C] •golden bait
	Black cod	All year	×	550~800 m	Same as above	Same as above	1000 m	Nylon monofilament # # 50~60	3~5 m	Nylon monofilament # # 40~50	1.5~2 m	3~5	•common squid with a body length of about 30 cm is put on the hook whole.

lines changes with the change in the migrating depth of the fish between day and night.

Fig. 19 How to make bait from squid (example)



Fishing Operation

Following are three examples of different deep sea fish having different life habits and differing preferences in habitat.

- 1) "Ishinagi" (*Stereolepis ishinagi*):** This fish usually inhabits deep sea reef areas at a depth of over 200 meters, but during their spawning season in summer (May to June) they migrate to coastal reef areas with a depth of about 100 meters to lay their eggs. (see Fig. 20)
- 2) Gray rock cod (*Sebastes matsubari*):** Gray rock cod live in schools in the crevices of rocky bottom areas having sharp up-and-down topography at a depth of 200 to 300 meters. (see Fig. 21)
- 3) Centrophid fish (*Ocyrius japonica*):** Centrophid fish live in the waters around plateau-shaped reefs at a depth of 70 to 90 meters, forming dense schools slightly upcurrent from the top edges of the plateaus.

They are very sensitive to changes in the tidal currents, shifting their positions with the changes of the tide. The changing of the tides is also the time at which they are stimulated to feed actively. (see Fig. 22)

Fig. 20 Habitats of different fish species

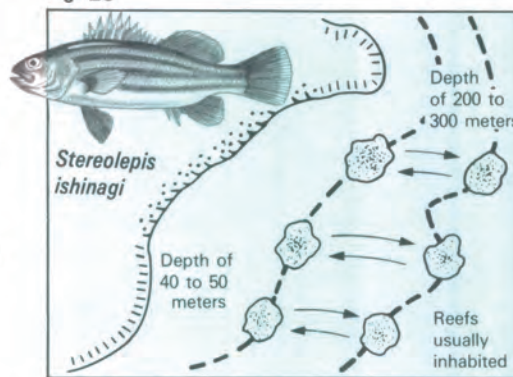


Fig. 21

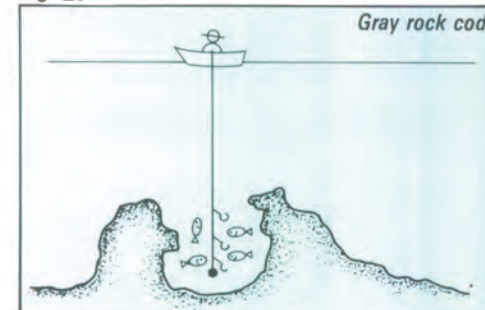
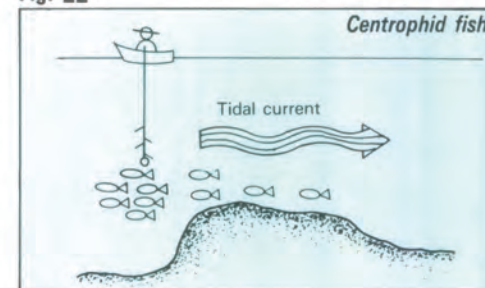


Fig. 22



Management of Family Fishery Business

In order to improve their fishery income and insure themselves a stable livelihood, fishermen must constantly cooperate with each other. These cooperative activities may be in the form of spontaneous groups formed among fishermen or cooperative groups formed under the guidance of government agencies. In either case, the objectives of such cooperative organizations will always be 1) to improve technology, 2) to exchange information, and 3) to regulate fishing operations within a certain area. At present, there are eight "Small-scale Angling Fishery Research Groups" formed by fishermen specializing in angling fisheries in Kanagawa Prefecture. Among these, the 150 member "Misaki Angling Fishery Research Group", formed in 1957, is one of the oldest and most active groups, constantly engaged in activities which benefit the fishermen year after year. The following are some examples of the activities they engage in.

Improvement of Technology: Working constantly toward the research and development of improved fishing gear and fishing methods and adoption of the most modern

(Continued on next page)

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 machinery, two of the major achievements of the group in recent years include the adoption and improvement of small-scale, powered line-haulers (1970-1973), and the adoption of LORAN receivers (1973-1979)
Exchange of Information: To encourage the exchange of information concerning fishery technology, fishing grounds and the conditions of fishery resources, the group conducts 1) meetings for the exchange of opinions between members of the group, 2) discussion meetings with other groups in the prefecture, and 3) observation tours to angling fishery operations in other prefectures. In particular, since the adoption of LORAN there has been an increase in data available concerning new fishing ground locations for vertical line fisheries for bottom fish. The group has made a valuable contribution, here, by serving as the gathering point for the data which comes back from each fishing trip, organizing the data and helping the fishermen to make profitable use of it, and encouraging the constant exchange of information between members.

Regulation of Area Fishery: The increase in the size of fishing boats and the adoption of navigational equipment has enabled the

fishermen to expand the range of their fishing activities to the point where they are now venturing into waters also fished by boats from other areas, namely in the Izu Island waters. This fact has brought with it an increasing need for some form of regulation with regard to fishing ground use. For this reason, beginning in 1982, the group has undertaken formal visits to fishery groups on the islands involved, for the purpose of discussing potential problems over fishing ground use and establishing rules concerning the use of these grounds and limits on fishing methods, in order that fishery can be conducted, here, in an orderly manner and in a spirit of mutual cooperation.

It should also be noted here that the members of the group receive constant advice and assistance in their research and execution of projects from the instructors employed by the Kanagawa Prefectural Fisheries Experimental Station.

RESEARCH COOPERATION: Mr. Kiyoshi Niikura (Misaki Small-scale Angling Fisheries Research Group)

TYPE 4 TROLLING

Example: Spanish mackerel, yellowtail and tuna
Location: Matsuwa, Kanagawa Prefecture

Trolling is the most active type of angling operation, and the vital points involved in the fishing process include; 1) the location and pursuit of a school of fish, 2) setting the proper trolling depth for the fishing line and 3) the performance of the fishing hooks and bait.

Finding and pursuing a school of fish

In order to be successful at the job of locating schools of fish, the fisherman must acquire experience to the point where he is intimately familiar with the distribution and migrating patterns of the fish in the different seasons and in different sea conditions.

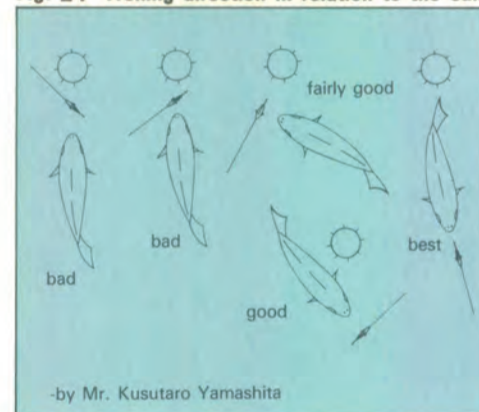
The fisherman must first choose the fishing ground where fish are likely to be found, based on the weather and sea conditions, his own recent fishing success, and information gathered from other fishermen. Upon reaching his chosen fishing ground he must then search for schools by means of signs such as current rips (the feeding grounds of yellowtail) or water temperature (which determines the migrating lanes for

fish like tuna).

After a school is located, the boat approached the school in a way that will not disturb their movement, and begins the trolling process, sweeping in front of the school at a speed of 3 or 4 knots. During this process three factors must be considered; the direction of the sun, the movement of the boat and the movement of the school of fish.

Rocky reef areas around islands tend to be feeding grounds for migrating fishes which make excellent fishing grounds. When trolling in such a fishing ground, it is best to search for the schools of fish by starting near the shore and following the isobath lines one after another out into the deeper waters.

Fig. 24 Trolling direction in relation to the sun



Trolling depth

Because of the fact that fish change their migrating depth depending on factors such as the time of day, water temperature and their degree of appetite, in order to achieve good fishing results it is necessary to be able to troll at a number of different depths from the surface to the middle depths. To make the line (and hooks) troll at the desired depth, devices such as a submarine board or a surface-planing device are used.

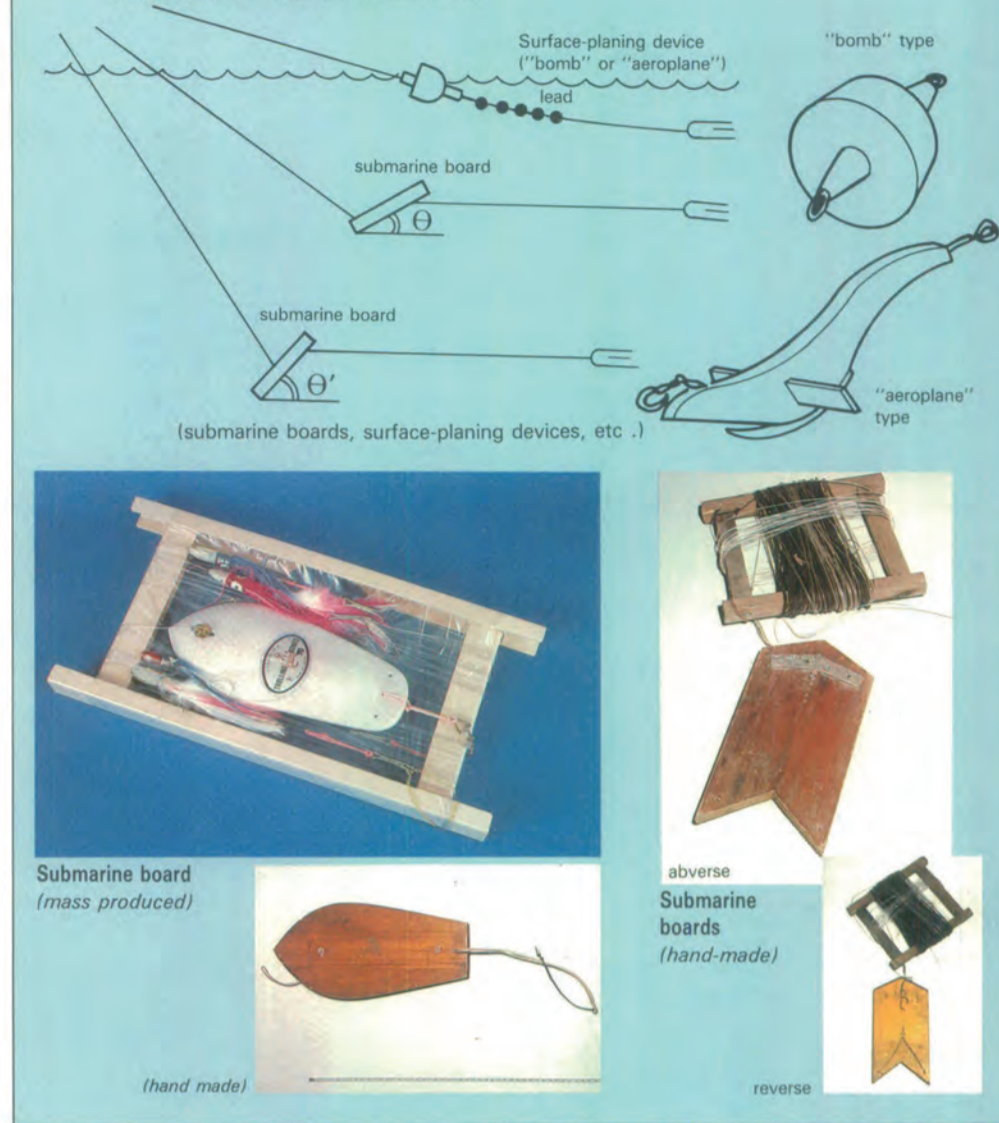
Submarine board

Using a thick board, this is a device you can make yourself. By opening 5 or 6 holes for the main line to pass through you can adjust the angle at which the board will set in relation to the surface and, thereby, control the depth at which the line and hooks will be towed.

Surface-planing device

Many devices have been developed for this purpose, including some commercially

Fig. 25 Supplementary trolling devices
 (submarine boards, surface-planing devices, etc.)



manufactured ones, but you can easily make your own using any number of materials including wood, metal and foam plastics. The device is designed so that its smooth surface receives the waves and rides up over them easily. In addition to its function of riding on the surface of the water, this device should also function as a vibrator to give a jerking motion to the baited hooks behind it of the sort that will stimulate the feeding instincts of the fish

Fishing hook and bait performance

Although both live bait, such as squid pieces, and lures, such as feather flies, are used in this kind of trolling fishery, in recent years, due to the verification of the effectiveness of artificial lures and the increasing cost of live bait, the use of such lures has reached an extremely high level, accounting for about 90% of the total.

In the case of both live bait and lures, however, it is considered extremely important that the bait be one that appeals strongly to the fish and stimulates its feeding instincts by 1) moving through the water with a quick "swimming" motion similar to that of a real fish, 2) that it provides a strong visual stimulus by means of bright colors and intermittent flashings of reflected light, and 3) that it has a slight sound as it "swims" like that of a real group of migrating fish.

The lures used in trolling fishery include commercially made and the fishermen's own handmade lures, both of which can be found in a infinite variety of shapes and materials. Here we will present a few sample lures we collected from the fisheries of the Miura Peninsula.

RESEARCH COOPERATION: Yamashita Fishing Tackels Co. Ltd.

Fig. 23 Trolling methods

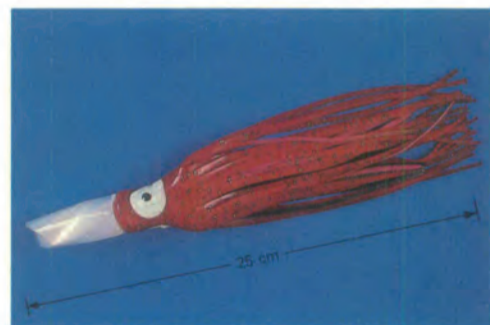
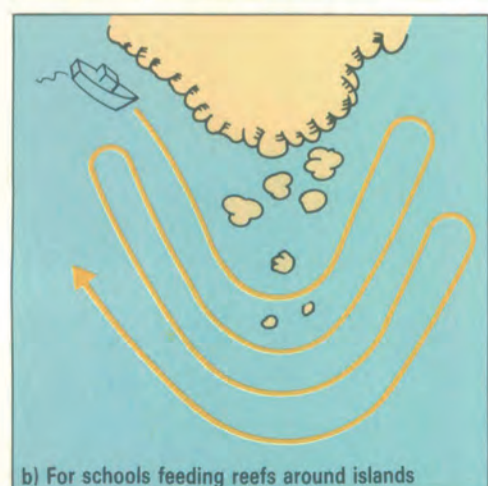
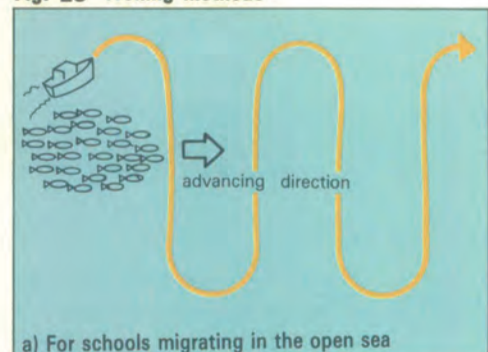


Table 13 Specifications of fishing gear used in Matsuwa trolling fishery

	Line number	Yellowtail & Spanish mackerel		Tuna	
		thickness	length	thickness	length
Main line	① & ⑤	Nylon gut #50-60	55 m	Super #70-80	15 m
	② & ④	Nylon gut #50-60	30 m	Super #70-80	15 m
	③	Nylon gut #50-60	15 m	Super #70-80	10 m
Leader line (Line between submarine board or "bomb" and fishing hook)		Nylon gut #30 15 m (Submarine board is used for ① thr. ⑤)		(Submarine board is used for ② thr. ④) Nylon gut #30, 1.5-2 meters long ("bomb" is used for ① & ⑤), Nylon gut #30, 15 meters long	
Hook (Lures are used)		"Yumizuno"		•vinyl octopus •piece of vinyl •"Yumizuno"	
Extension poles		Bamboo or fiberglass, 10-13 meters each			