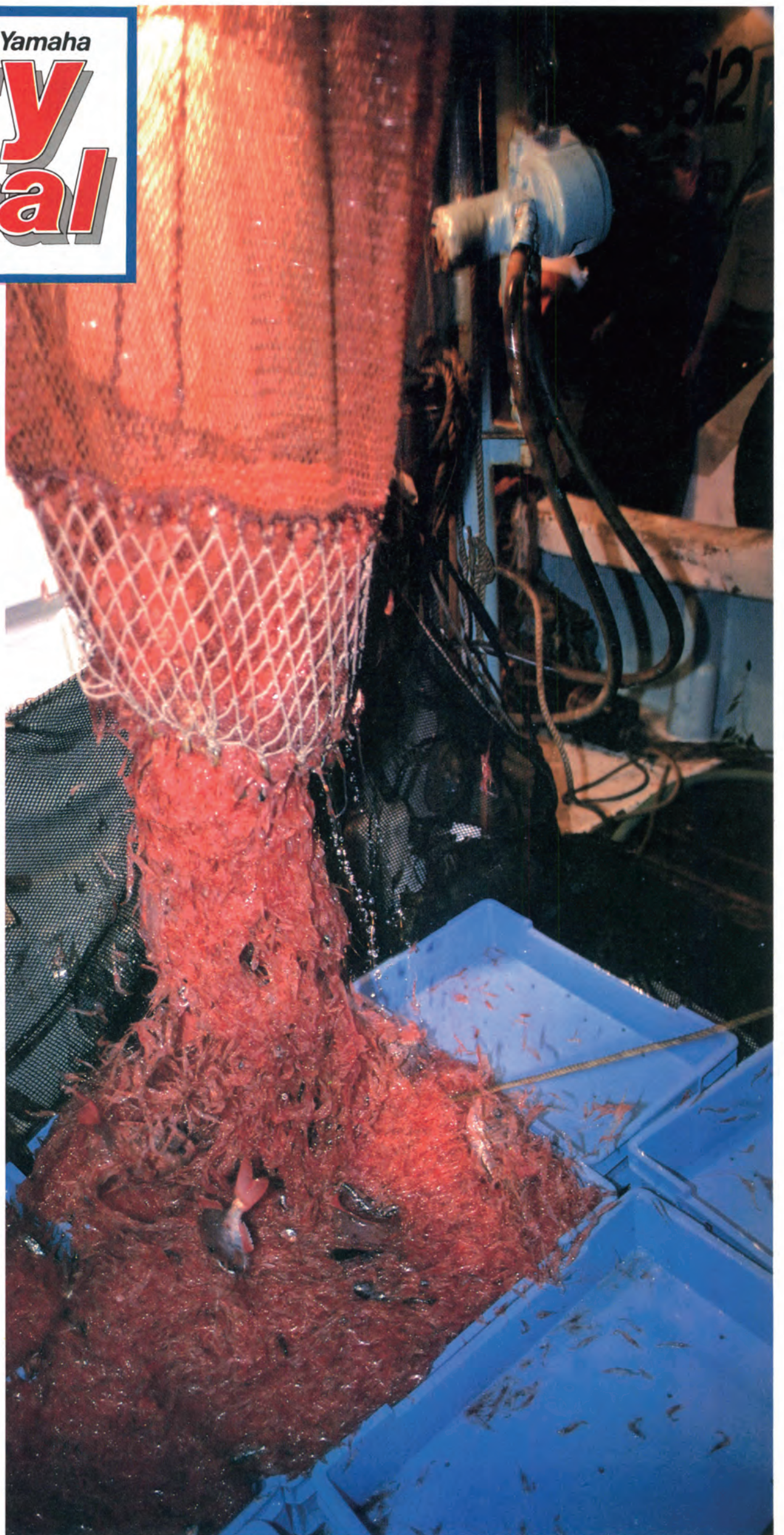


Adaption of Fishing Methods *Boat Seining*



Boat seining for spotted shrimp (Shizuoka Prefecture)

Technology aims at harmonizing use of resources with social and economic conditions

Compared to trawling, a fishing method in which a net is used to comb the sea bottom and waters of the lower depths, boat seining is a method in which fish are caught by filtering a certain volume of water with a net. In the era before boats became motorized, tidal currents or wind were used for power. However, since motoriza-

tion, boat seine fishing has become independent of the tides and winds, and some forms of operation are now very similar to those of trawling. Nevertheless, since boat seining is designed to catch certain specific types of fish, the fishing gear and nets have remained different from those used in trawling operations.

Moreover, under the Japanese fisheries system, there is a strict differentiation between boat seine fishery and trawl fishery, with each having a distinct set of operating regulations aimed at conserving the resources and maintaining order in the fishing grounds.

In this edition we will focus on outlining the basic characteristics of the boat seine fishing method. In addition, we will take a look at the differences in techniques that are seen in

the coastal fisheries of differing regions. In other words, we will be looking at the kinds of resources and social and economic conditions that are necessary to successfully establish a certain fishing method in a given region. Although the two fishing methods that we will be discussing in this issue are rather unique in the present coastal fisheries of Japan, we have chosen them because we think they are representative cases of "fishery promotion" in coastal waters.

Variations in the boat seine fishing method

Boat seining involves; 1) a wing net or grand rope, 2) a main net, 3) a bag net, and 4) a tow rope. These parts have the following functions:

1. Wing net (grand rope):

This net is used to intimidate the fish so that they gather into a school

2. Main net:

This net prevents the fish from escaping while guiding them to the bag net

3. Bag net:

This net holds the fish

4. Tow rope:

This rope is used to handle, and tow in the net.

The shape of the nets and gear used in boat seining vary a great deal; however, all of them share the same structural characteristics listed above. Needless to say, differences in the size and shape of the nets used are a result of the habits and characteristics of the particular fish that is being caught. Figures 1 to 5 illustrate variations in the boat seine fishing method. Fig. 1 is considered to be the "original" form of boat seine,

while figures 2 to 5 can be considered as variations. When there is a change in the type of fish to be caught, either certain parts of the net may be changed to suit the habits and ecological characteristics of that fish, or else the whole scale of the fishing gear may be changed along with an accompanying change in the boat's motor capacity.

A given fishing method involves the unification of three basic elements, the target fish, the fishing gear, and the fishing boat. Figures 1 to 5 show that the shape and size of the nets used in boat seining varies a great deal depending on the particular conditions of the fishing grounds, while at the same time sharing the same structural and functional characteristics.

In this issue we will introduce the two fishing methods shown in figures 1 "Hikiyose-ami" and 4 Motorized boat seine. Other fishing methods including "Gochi-ami" shown in Fig. 3 and "Pachi-ami" in Fig. 5 will be introduced in later issues.

Fig. 1 Hikiyose-ami (Anchor seine)

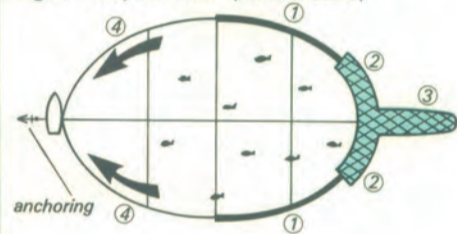


Fig. 3 Gochi-ami (Anchor seine)

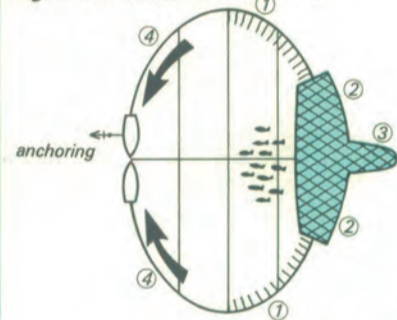


Fig. 2 Hikimawashi-ami (Flydragging)

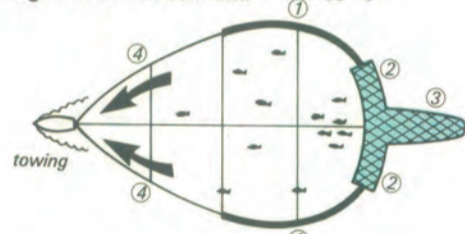


Fig. 4 Motorized boat seine

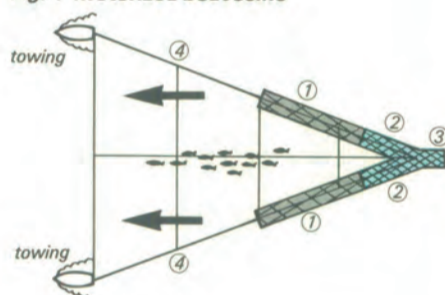
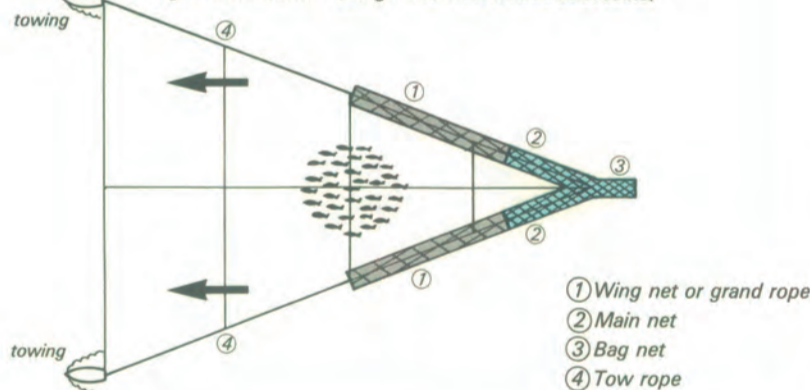


Fig. 5 Pachi-ami (Larger-scale motorized boat seine)



- ① Wing net or grand rope
- ② Main net
- ③ Bag net
- ④ Tow rope

Fishing for spotted shrimp (*Sergestes lucens*) with boat seine is a very rare type of fishery, even in Japan. Although approximately 55 species of *Sergie* (the genus of spotted shrimp) have been identified in the oceans of the world, in Japan spotted shrimp fishery is being conducted only in the coastal areas of Suruga Bay. In addition to Suruga Bay, spotted shrimp are sometimes found at the mouth of Tokyo Bay and Sagami Bay but the stock is so small that it can not be considered a fishery.

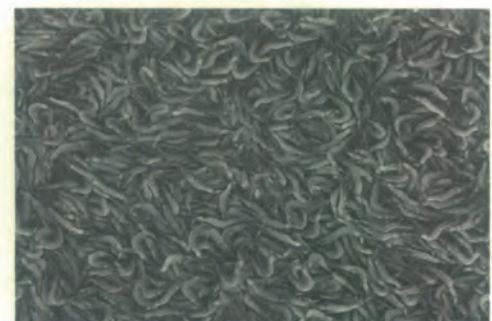
Spotted shrimp is a species of the *Sergestidae* family, and considering its size and movement, it would fall more into the category of a micronekton rather than an animal plankton. Because this species has red pigments and light-emitting tissues scattered throughout its almost transparent body, when you look at a school of these shrimp from a distance it appears pinkish in color, and is thus called "Sakura-ebi" in Japanese meaning cherry blossom-colored shrimp.

Aside from their appeal as zoological specimens, these shrimp are considered a delicacy by the Japanese for their flavor

and pleasing appearance. As a result, 1000 to 5000 tons (3 to 15 billion shrimp) are caught a year as a special produce of Suruga Bay. The profit from this fishery amounts to as much as 2 billion yen or more a year.

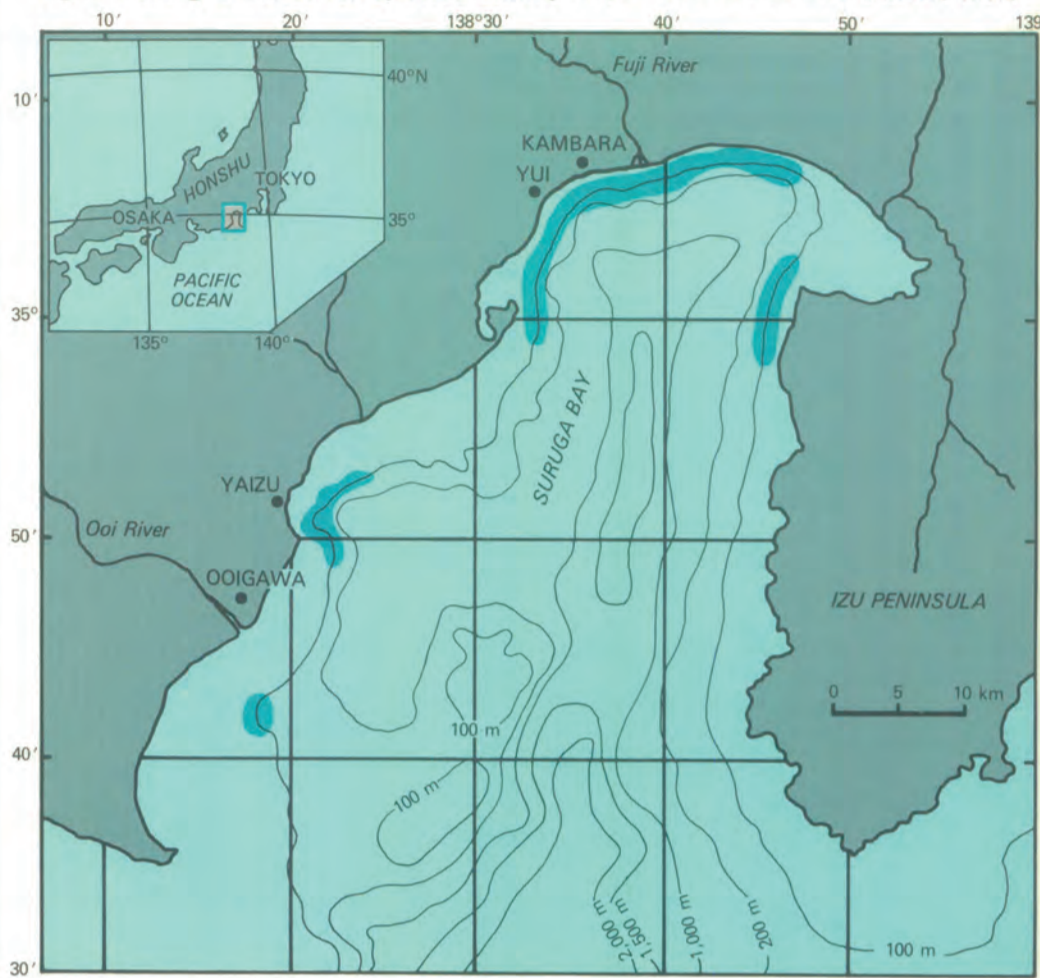


Sergestes lucens, adult female.



Accumulation

Fig. 6 Fishing Grounds for Spotted Shrimp (by Mr. M. Omori and Others, 1973)



The fishing grounds are limited to the coastal waters, and the fishing boats used are of the 4 or 6 ton class. Sixty pairs of boats (120 boats) belonging to the three fishery cooperatives at Yui, Kambara and Ooigawa are involved in this fishing operation. These three cooperatives hold a monopoly on the fishing rights for shrimp in Suruga Bay, so there is no competition from offshore fishery.

Resources

It has been confirmed that spotted shrimp are purely an embaymental resource. Spawning takes place from May to November, with the peak coming in July and August. According to surveys done from net samplings, although eggs and larvae have been found in areas throughout the bay, an overwhelming majority of the spawning schools are found in a relatively small area in the vicinity of the mouth of the Fuji River. Therefore, this area is considered the source of the spotted shrimp resources in the bay.

After the larvae have hatched they are gradually spread out into the bay along with the movement of the surface water which flows into the bay from the open sea. Although a part of the larvae population is carried out of the bay, the majority grow up within the bay area, and as they approach maturity and their swimming ability improves, they begin to congregate around the shores of the inner part of the bay.

The life span of these shrimp is 15 to 16 months. Within about a month of hatching and going through the nauplius, elaphocaris, and acanthosoma stages, they reach the post larvae IV stage with a body length of approximately 7.5 mm. Then, while repeating ecdysis at a rate of once every 3 or 4 days, within 3 to 4 months they reach a size of 20 mm, and by 10 to 12 months have reached a size of 40 mm, at which time they begin spawning.

Life Cycle and Formation of Fishing Grounds

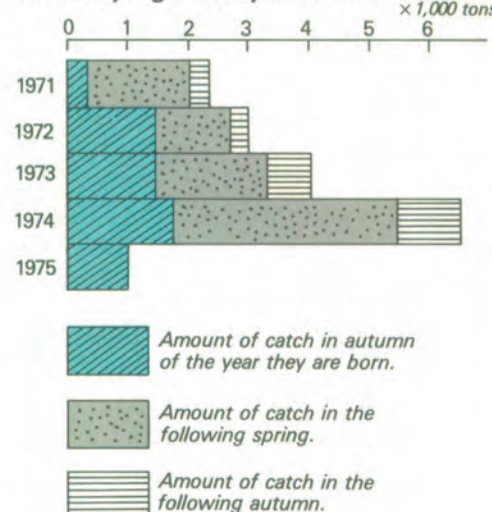
During their life cycle, spotted shrimp mature while migrating horizontally from the coast to offshore and then to the coast again. At the same time there is a daily perpendicular migration. Spotted shrimp cannot become the target for boat seining until they reach a body size of 20

mm, because not only is it when they reach this stage that they begin to gather in the coastal areas in high concentration, but also they become more adaptable to environmental changes such as water temperature and salinity, thus allowing them to increase their range of perpendicular movement.

In the daytime these shrimp form schools of several meters in diameter and descend to a depth of approximately 150 meters, and then at night they will ascend while diffusing the density of their schools slightly. The spotted shrimp which in this way ascend to the upper water layer at night are the ones which will be caught by tow net. The fishing grounds for these shrimp form mainly in the vicinity of a river mouth in an area that has an isobath at a depth of about 200 meters.

The fishery cooperatives catching these shrimp in Suruga Bay have set summer, the period when spawning activity is the greatest, and winter as the off-seasons, while the other two seasons, spring (March-June) and autumn (October-December) are set as the fishing seasons. The catching ratio by age group for each fishing season shows us the following pattern: in the autumn season of the year the shrimp are born, the catching ratio is about 30%; in the following spring season, about 50%; and at the next autumn season, about 20%. In other

Fig. 7 Yearly Transformation of Catch by Age Group and Year



of technical innovations

Spotted Shrimp (Sakura-ebi) Fishery in Suruga Bay



and 3) available nutrition in the sea water (the amount of organic substances in the water depending on the amount of rainfall) during the spawning and larva stages. In short, because the size of the stock and its survival rate during the larva stage are the most important factors determining the amount of resources for the coming year, it is considered best to forecast the amount of resources for the coming year by observing the water movement and changes in the water temperature. Presently, the Shizuoka Prefecture Fisheries Experimental Station issues a forecast of the fishing conditions one or two months prior to the start of the autumn fishing season, and spotted shrimp fishermen have been able to use this forecast effectively.

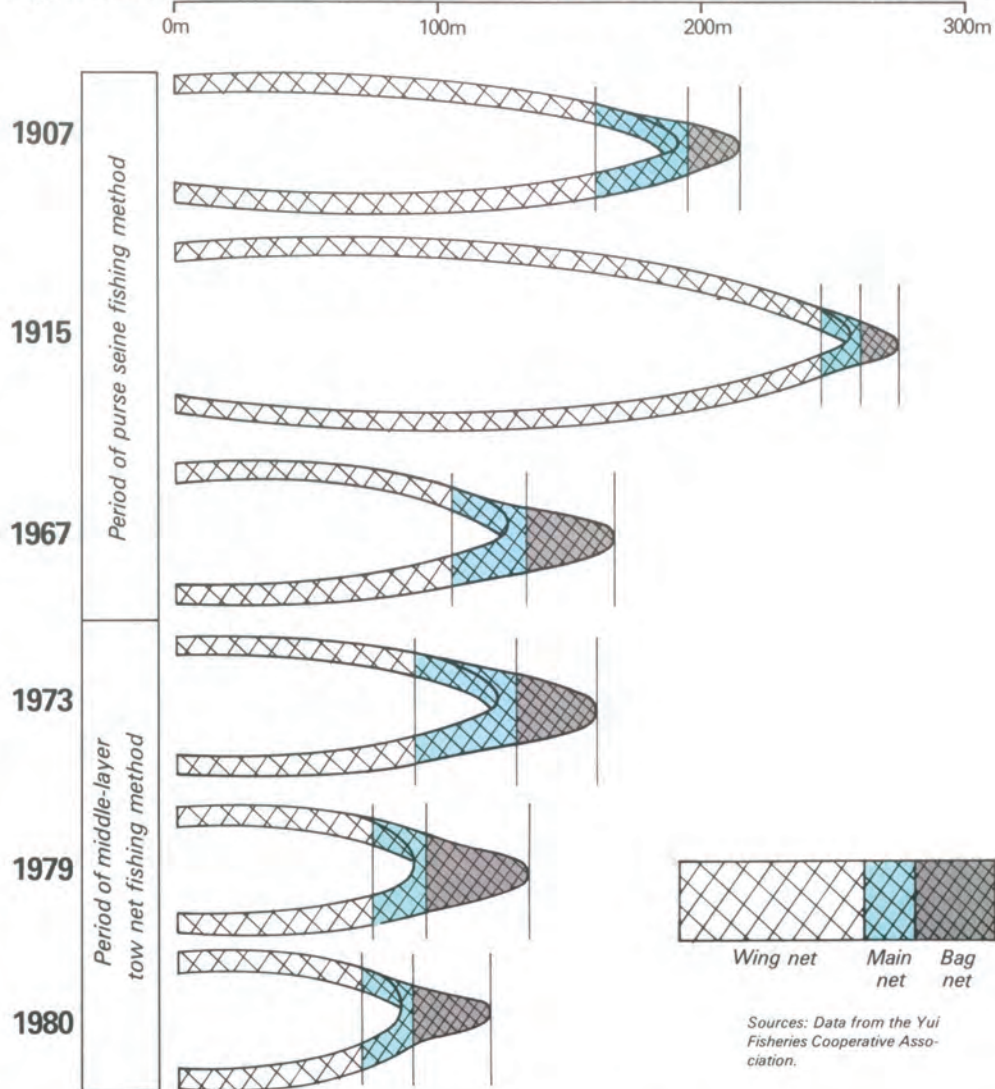
Regarding fishing techniques, various technical innovations have been made over the past 88 years. Figure (8) shows the important changes and the years they took place. The most important changes fall into three categories:

- 1) Motorization of fishing boats (combustion engine → diesel engine)
- 2) Improvement of fishing nets (straw-rope net → cotton net → synthetic net)
- 3) Mechanization of the fishing work (net-roller, fish finder, radio, net zonde, etc.)

Technical innovations do not occur separately, but rather come about as a result of changes in other elements in the social and economic conditions in the fishing community. In particular, we can see a large accumulation of technical innovations occurring in the period of Japan's high economic growth between 1950 and 1970, and this can thus be considered the era of modernization.

The technical innovations over the years have caused changes in the fishing methods for spotted shrimp. Fig. 9 shows the various shapes of net gear in use in the different periods. We can see that in the later periods the overall length of the net has been curtailed. The ratio of the wing net length to the overall length has

Fig. 9 Transformation of Fishing Gear Structure Used in Spotted Shrimp Fishery



gradually become smaller, while the proportional size of the bag net, on the other hand, has become larger. This means that the fishing method itself has changed from that of a purse seine with a bag net to that of middle-layer boat seining. This change in the fishing method took place between 1970 and 1973, after completion of the modernization period from 1950 to 1970.

The altered fishing method meant more catch efficiency which caused an increase in the annual volume of catch, which in turn has led to a change in the style of operation. This transformation is shown in Fig. 10.

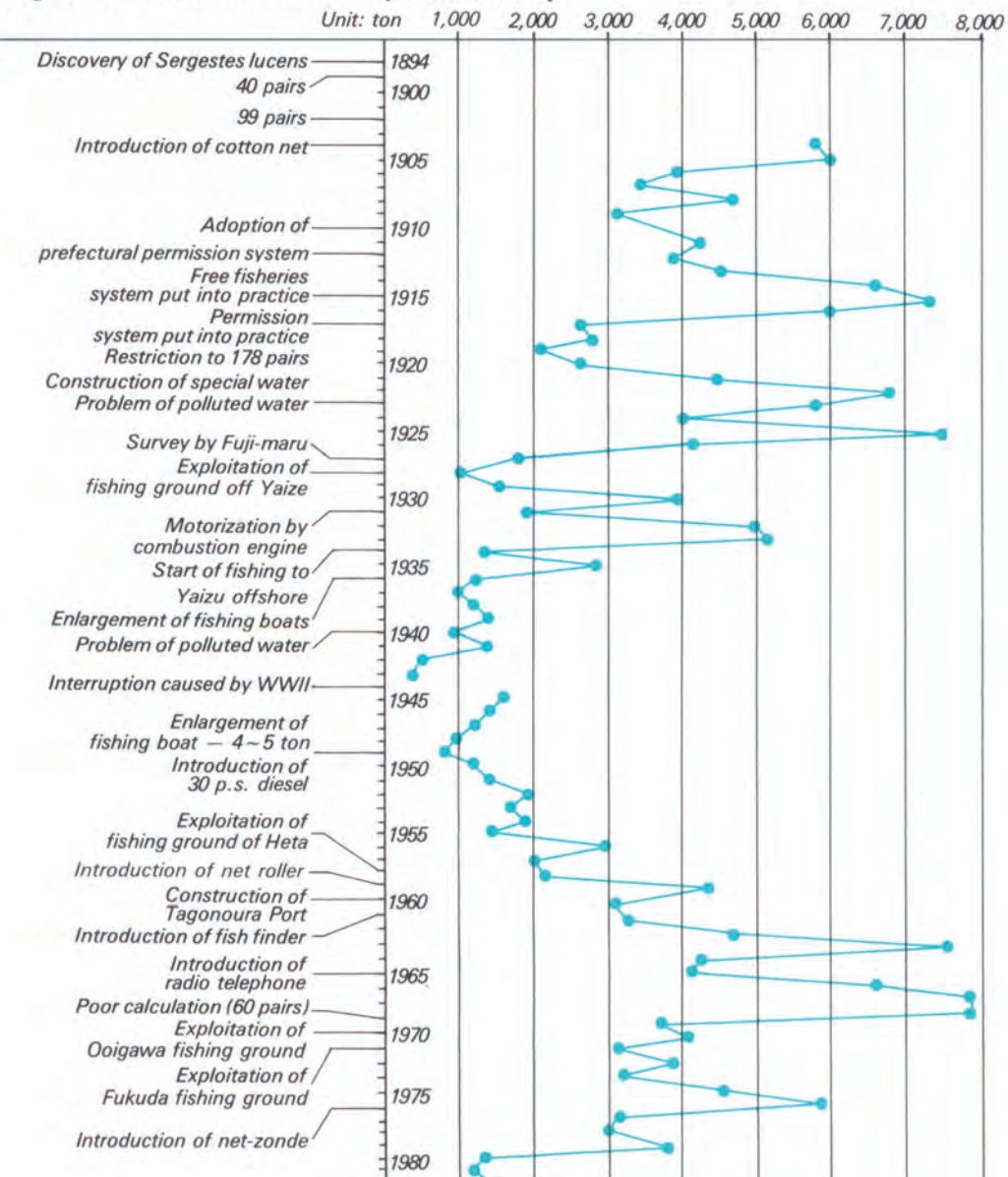
Sources: "Journal of the Oceanographical Society of Japan" Vol. 26, No. 4 (by Mr. Makoto Omori)

words, within a year and a half of the time they are born, almost all of the shrimp population has been caught.

Technical Innovations and Changes in Fishing Methods

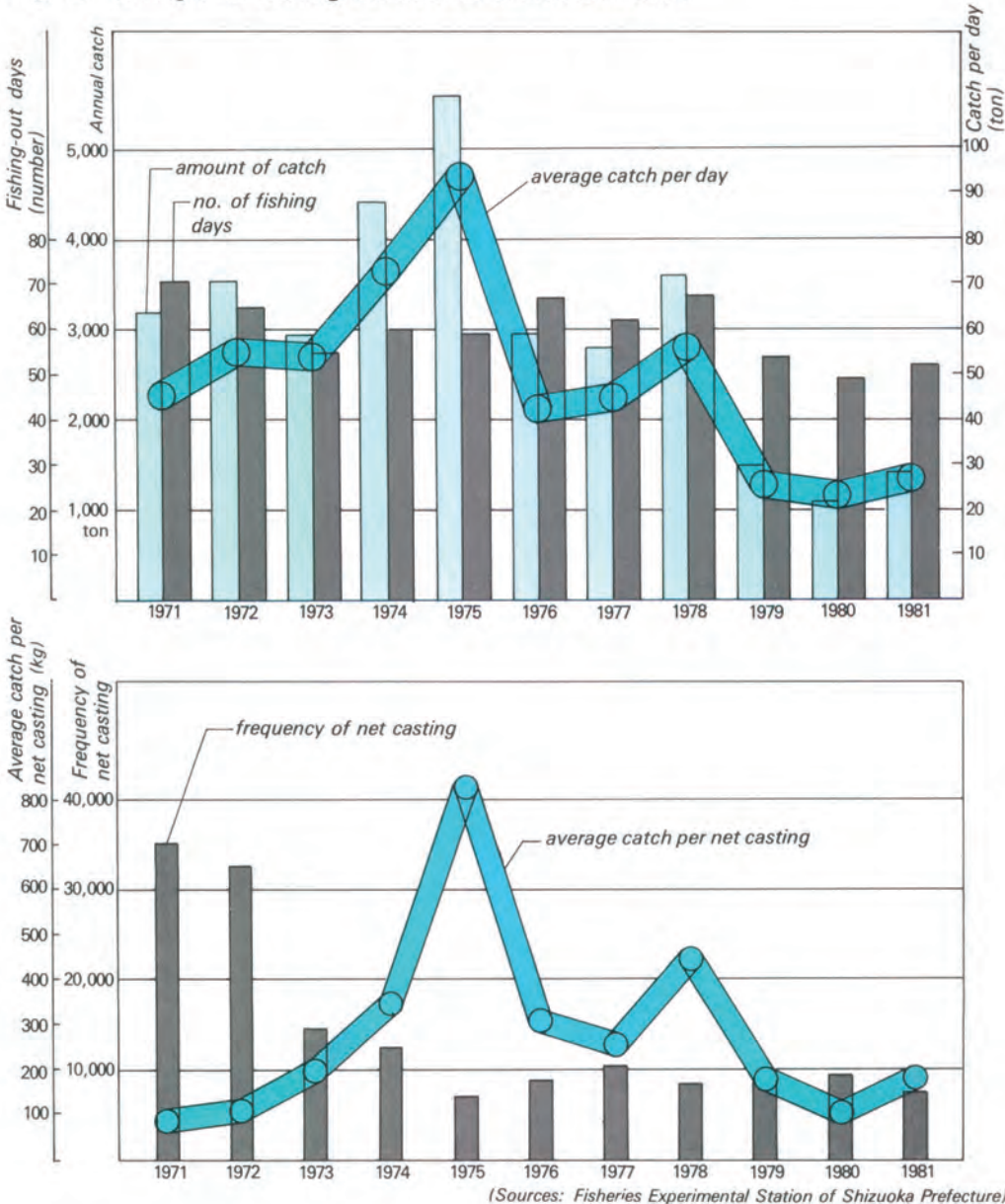
Spotted shrimp fishery was first begun in Suruga Bay in the year 1894. Statistics of the catches from that time up to the present are shown in Fig. 8. At least two primary factors influence the curve of this graph. These are the natural changes in the amount of resources and changes in the fishing effort brought about by advances in the fishing techniques. Because spotted shrimp have basically a one year life cycle, there is a great deal of fluctuation in the resources from year to year. The major factors influencing these fluctuations are: 1) the marine conditions (rate of escape to the open sea due to tidal currents); 2) the growth environment (changes in the water temperature caused by interference from the open sea waters);

Fig. 8 Statistics of Catch of Spotted Shrimp



Source: Fisheries Experimental Station and Yui Fisheries Cooperative. Drawn by Kiyoe Shida

Fig. 10 Changes in Fishing Conditions in Recent Years



(Sources: Fisheries Experimental Station of Shizuoka Prefecture)

Operation of Pair Boat Seining

(Yui District, Shizuoka Prefecture)

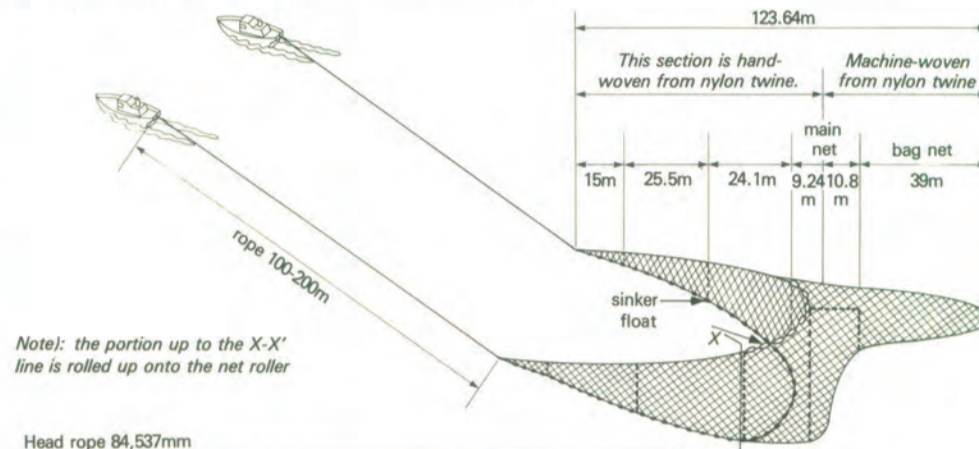
Two fishing boats of the same type leave port with their bows linked. After arriving at the fishing ground, a fish finder is used to locate a high density school of shrimp upon which the net is cast.

First of all, the rope linking the bows is untied, then the bag net and main net are cast as the two boats move away from each other at full speed. At this point the net zonde transmitter is attached to the grand rope and dropped into the water. Then the wing net and tow rope are cast.

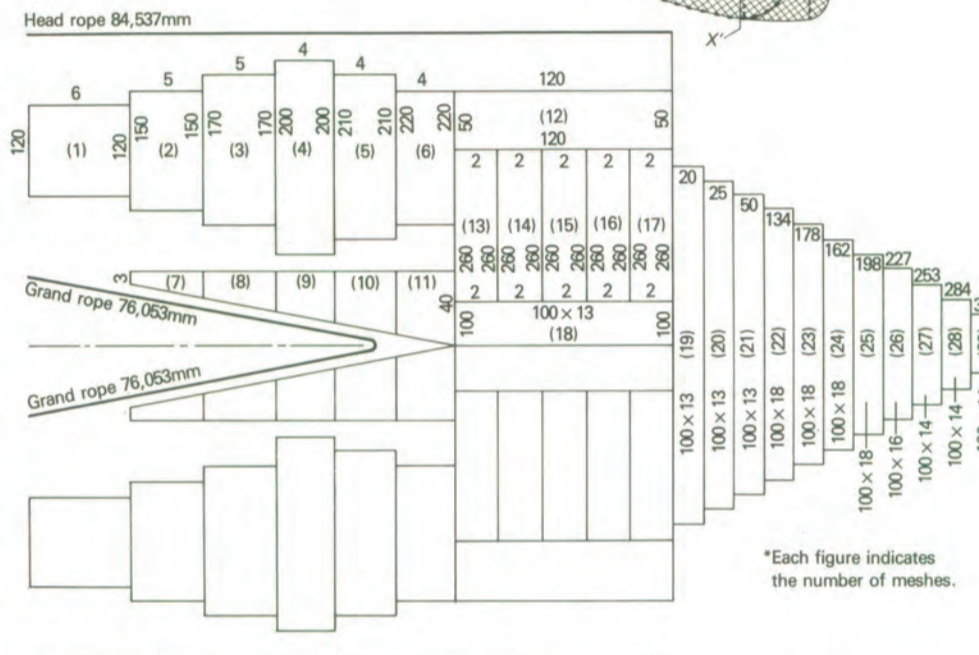
During towing the tow rope should be attached to the wire of the tow rope fulcrum controller (photo) so that the direction can be changed when necessary. The length of the tow rope is generally 1.5 times the depth of the tow net. The distance between the boats should be kept some 100 meters. The towing is done from up to down according to the tidal current, and the towing speed is about one knot (water resistance speed).

The depth of the towing net and the altitude of the net mouth are the critical factors. While observing changes in the depth of the shrimp concentration with a fish finder, the combination of the towing speed, the tow rope length and the distance between the boats is adjusted as necessary. The depth of the grand rope and of the net can be constantly monitored by means of the net zonde.

The duration of a single net towing is approximately one hour. With radio contact the two boats approach each other, and after their bows are linked, the net hauling is begun. (During net hauling the boats continue to move forward slowly.) The tow rope and the wing net are rolled up onto the net roller. During this operation, although the bows of the two boats are linked, there is a distance of several meters separating the two sterns, so the bag net is drawn up into the water surface between the two boats. While sinking away from the water surface, the bag net is drawn in gradually by hand, as if removing a long stocking; and when the catch appears at the surface, it is scooped up with a large spoon net, which is hauled up with a winch and landed on the deck. This operation requires 8 persons on each boat (16 people for the two boats). The net is usually towed 5 or 6 times during one night.



Note: the portion up to the X-X' line is rolled up onto the net roller



*Each figure indicates the number of meshes.

	Material	Mesh size
(1)	POLYAMID 210D/24	3,333mm
(2)	POLYAMID 210D/20	3,030mm
(3)	POLYAMID 210D/20	2,727mm
(4)	POLYAMID 210D/18	2,424mm
(5)	POLYAMID 210D/18	2,121mm
(6)	POLYAMID 210D/18	1,818mm
(7)	POLYAMID 210D/20	1,515mm
(8)	POLYAMID 210D/20	1,363mm
(9)	POLYAMID 210D/18	1,212mm
(10)	POLYAMID 210D/18	1,060mm
(11)	POLYAMID 210D/18	909mm
(12)	POLYETHYLENE 400D/24	90mm
(13)	POLYAMID 210D/12	1,515mm
(14)	POLYAMID 210D/12	1,302mm
(15)	POLYAMID 210D/12	1,060mm
(16)	POLYAMID 210D/12	878mm
(17)	POLYAMID 210D/12	697mm
(18)	POLYAMID 210D/20	181mm
(19)	POLYAMID 210D/24	151mm
(20)	POLYAMID 210D/24	121mm
(21)	POLYAMID 210D/24	90mm
(22)	POLYAMID 210D/9	43mm
(23)	POLYAMID 210D/6	34mm
(24)	POLYAMID 210D/6	28mm
(25)	POLYAMID 210D/6	23mm
(26)	POLYAMID 210D/6	20mm
(27)	POLYAMID 210D/9	18mm
(28)	POLYAMID 210D/9	16mm
(29)	POLYAMID 210D/9	14mm

1



Start of net casting

5



Drawing the bag net closer to



The right and left portions of the net are loaded separately one on each boat.



The bridge

Since spotted shrimp are easily damaged and their freshness drops rapidly after landing, they should be processed as soon as possible. Today there are four main processing methods:

- 1) Raw drying ("Suboshi") Fresh raw shrimps are dried naturally in the sun.
- 2) Boiling ("Kama-age") The shrimp are boiled in water with 4 to 6% salt solution, and colored with a red food coloring.
- 3) Boil-drying ("Niboshi") After being processed as in (2), the shrimp are dried further in the sun or with an artificial dryer.
- 4) Freezing Raw shrimp are washed then packed and frozen.

Shrimp processed by methods 1 - 3 are consumed widely throughout Japan

COOKING



A package of frozen food (for retail)



Boiled rice with shrimps and vegetables



Fried "Tempura" of mixed ingredients



Frizzled udon (Japanese noodle)

Operation method

2



Rolling in the tow rope

3



Rolling in the wing net

4



Linking the bows of the boats

6



the boat's stern



Pulling up the bag net

7



Landing the catch with a spoon net



Fish finders: left ▶ 50kc; right ▶ 200kc



Net zonde transmitter: The component on the right is hung from the center of the grand rope, and the left one is hung into the water from the side of the boat.

Net zonde receiver:

The depth of the net will be displayed in numbers (digital system) on the panel (dark part) of the device in front.

Tow rope fulcrum adjuster



Propeller cover: This covers the propeller when the boat reaches the fishing ground in order to prevent the tow rope or other nets from getting tangled up in the propeller.

PROCESSING

either as they are, in which case they will be used as an ingredient in sauteed or steamed dishes or soups or they are consumed after being further processed into a "Tsukudani" (a preserved food boiled in soy sauce, "Ebi senbei" (a shrimp flavored

rice cracker), or other delicacies.

Spotted shrimp are also bought fresh at the fishmarkets of the producing area, in which case they will be served in the home as fried "Tempura" or boiled and seasoned with soy sauce or vinegared soy sauce.

The package frozen process is one that was recently developed to allow the shrimp to be used after thawing in the same ways as fresh ones by people in areas other than the immediate producing area. However, for a number of reasons,

including differences in eating habits, it seems unlikely that the use of these products will spread to areas outside of central Japan.

"Niboshi" (Boil-drying)



Boiling



Cooling and packing



Boiled shrimp

Freezing



Packing before freeze-processing

"Suboshi" (Raw drying)



Natural drying in the sun: Shrimp are spread out over a wide area of river bank and dried. A black nylon net which absorbs heat is spread on the pebbled area beside the river, and shrimp are spread in a thin layer over this net.

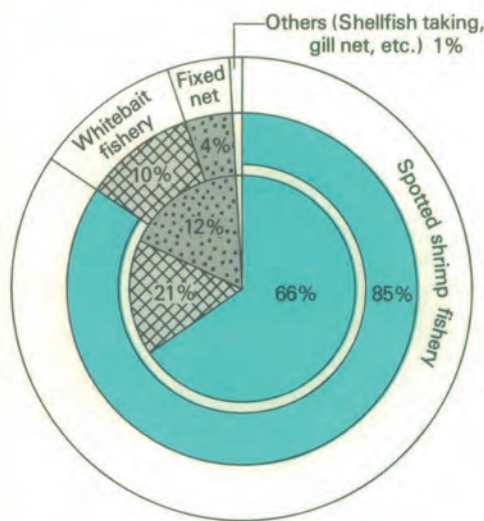
The Present State of Spotted Shrimp Fishery and Its Problems

Spotted shrimp fishery has led to the development of a fishing industry as well as a fish processing industry for the Suruga Bay area. At present the spotted shrimp fishery technology is one as high a level as any other form of coastal fishery. However, as a result of technical advancements and "industrialization" of this fishery, the fishermen have tended to rely solely on spotted shrimp fishing for their income, which has led to other problems. Let's take a look at the overall picture of the spotted shrimp industry in Suruga Bay.

Employment Structure

Let's start by talking about the Yui Port Fisheries Cooperative Association (Yui Town & Kambara Town) to which about half of the Suruga Bay spotted shrimp fishermen belong. Fishery statistics for the fiscal year 1981 show a gross catch of 1,621 tons and gross earnings of 2.154 billion yen. The breakdown of the entire catch in terms of fishing type is as shown in Fig. 1.

Fig. 1 Fishery Results for the Yui Port Fisheries Cooperative (1981)

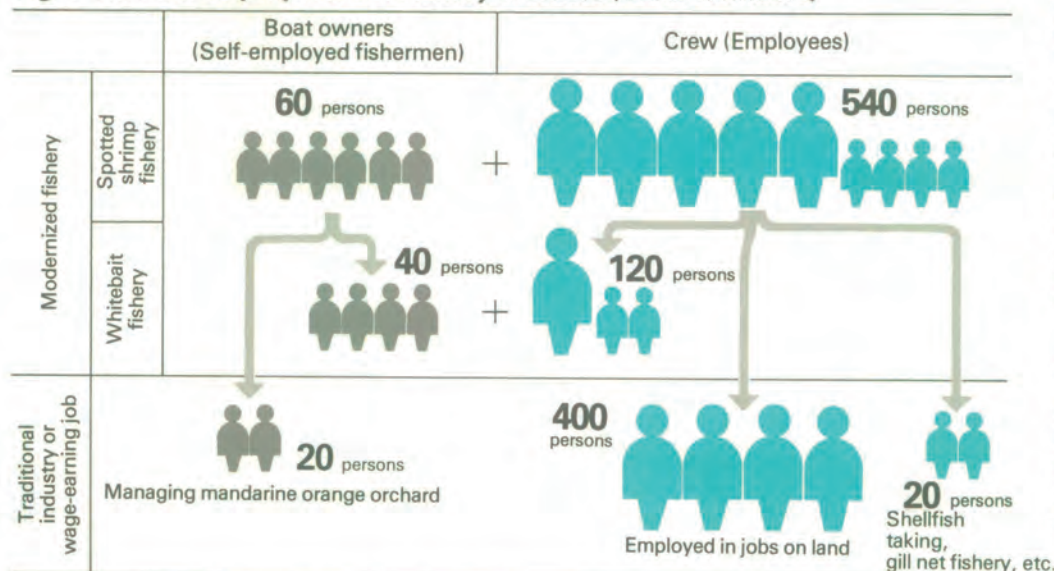


Inner circle: Percentage of total catch by volume
Outer circle: Percentage of total "earnings"

The major part of the fishery income comes from spotted shrimp fishing (60 ~ 70 fishing days a year), with single boat tow net fishing for whitebait (fry of anchovy) (170 ~ 180 fishing days a year) carried out to supplement the income from shrimp. (In addition, 40 fishermen who are not engaged in either spotted shrimp or whitebait fishing, have got together and formed a voluntary producers association and are engaged in fixed net fishery.) In addition to these fisheries, there are also some divers gathering abalone and top shell and gill net fishery for coarse fishes. However, the earnings from these catches do not account for more than 1% of the total.

If fixed net fishermen are excluded, there are approximately 600 workers involved in fishery in this area. This population is broken down into 60 boat owners (self-employed fishermen) and 540 crewmen (employees). The way they are employed during the year is as shown in Fig. 2. Because this is an area suited for mandarin orange cultivation, those who have an orange orchard have continued a traditional part-farming part-fishing type of existence. During the fishing off-season the major part of the fisheries work force find jobs on land, although a small minority will engage themselves in traditional small scale fishery such as diving for shellfish or gill net fishing from their own outboard powered boats. Those who work on land during the off-

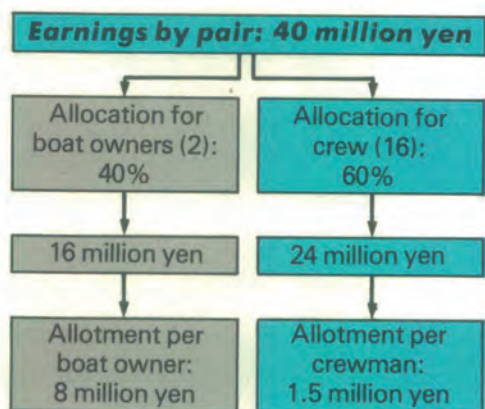
Fig. 2 Form of Employment of Fishery Workers (Yui & Kambara)



season are mainly engaged in public road work, construction work or painting work. The spotted shrimp are whitebait fisheries, which can thus be said to be an "enterprise type" fishery involving entrepreneurs and laborers.

Fishery Income and Profitability

The total earnings for the 60 pairs of boats (120 boats) involved in spotted shrimp fishery in 1981 was 2.4 billion yen. The earnings for each pair (2 boats) was thus 40 million yen. The earnings are distributed equally because of a pooling system that will be explained later. These earnings are distributed as follows:



From their allotment the boat owners must bear the expenses of depreciation on the boat, engine, fishing equipment and gear, as well as the operating expenses such as fuel costs. Present depreciation and operating expenses total about 4 million yen, which leaves the remaining 4 million yen to the owner for his household living expenses and social expenditures (expenditures necessary to maintain one's status as a boat owner). The crew members earn an average of 1.5 million yen a year.

People engaged in whitebait fishery earn about 5 ~ 6 million yen annually per pair (1 boat). From this, the boat owner's income is 2 ~ 3 million yen and the crew member earns 1 million yen.

What is becoming a problem here is the increasingly larger capital investments that must be made by the managing body. At present, it costs about 60 million yen for a completely equipped, technically up to date pair of fishing boats and their necessary gear. Each of the two boat owners must bear an annual depreciation cost of 3 million yen for a period of 9 to 10 years. Further pressure is put on these managers by the rising costs of fuel and fishing gear. In addition, we are beginning to see in recent years that the high degree of specialization of these boats can actually be a disadvantage.

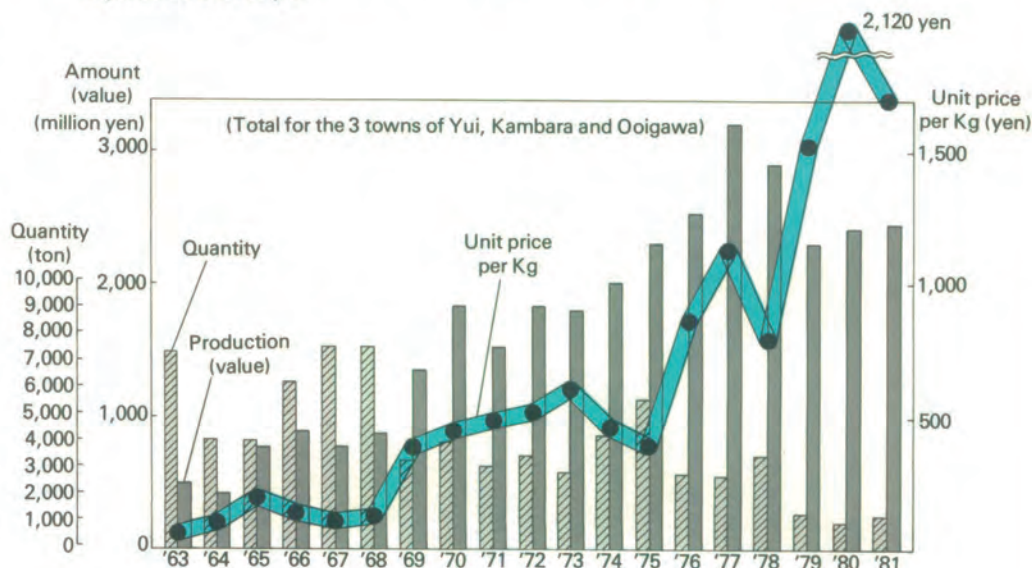
Generally, the aim of technical innovation in fishing gear and fishing methods is 1) to improve the catch efficiency per unit of labor, and 2) to improve the selectivity of the catching method. However, this has led to a tendency toward over-specialization in the fishing boat's performance. For example, the boat usually used in spotted shrimp fishing is of the 6.88 ton class, which on the other hand is too large to be used in whitebait fishing, because of the difference in fishing method. For this reason it becomes necessary for a boat owner who is going to engage in both spotted shrimp and whitebait fishery to make a double investment and build another boat of the 4.9 ton class just for whitebait fishing. (It should be mentioned that it is very rare in Japanese coastal fishery for a family to own two diesel fishing boats.)

Production Control

In the past, the improvement of fishing technology has often led to a situation where their grounds are over-fished. In such a case the fishing community handles the problem by (1) introducing a permission system that limits the number of fishermen, (2) limiting production by establishing an off-season for fishing and limiting the types of fishing gear that can be used, and (3) opening new fishing grounds for exploitation. In Suruga Bay, however, all of the possible fishing grounds are now being exploited, so the only alternative left for preventing over-fishing in the future is to limit production by agreement among the fishermen.

In 1966 the concerned fishery cooperatives of Yui, Kambara and Oigawa introduced a voluntary "producer's cartel", a system under which the operation of all the boats was unified and the gross earnings were equally allocated by means of

Fig. 3 Catch, Production (value), and Unit Price per Kg for Suruga Bay Spotted Shrimps



an agreed system, after being pooled in the fishery cooperative association's account. This system is still in use today almost without exception.

Fish Prices and Sales

There are approximately 100 processors at work at the producer's site, and the entire catch of spotted shrimp is processed (raw drying and boil-drying) locally, and then shipped to markets within and outside the prefecture. When we look at Fig. 3, we can see that despite the decrease in the amount of catch since 1975, due to the rise in fish prices the fisherman's production (value) has remained about the same.

Note: The retail prices of raw dried spotted shrimp in 1982 were 600 ~ 650 yen (June ~ July) per 100g, and 750 yen to 800 yen in August and September. It should be noted that this is twice as high as high-class *Penaeus japonicus* (Kuruma-ebi) and more than 4 times that of "Niboshi" (boil-dried sardines.)

The rising price in recent years shows that the spotted shrimp industry benefits from being a monopolistic enterprise of a specific locality. However, another factor that should not be overlooked is that the price was also effected by the fact that some large food companies came out with a new product that was a special kind of tempura, and began to buy up large quantities of spotted shrimp as a raw material. This drove the price way up and as a result the food companies were forced to switch to imported "Aki-ami" (*Acetes sp.*), a kind of spotted shrimp from Southeast Asia. This caused the price to drop again.

Mr. Yukio Matsubara, Chairman of the Yui Fisheries Cooperative, states very strongly that, "It is not a good situation when a fishing household must depend solely on the high price of fish in its business." Given the present cost of building and equipping a boat, a family engaged in spotted shrimp fishery would have to have annual earnings of 50 million yen per pair of boats (2 boats). Since the price per Kg of spotted shrimp from now on is expected to stay around 1,000 yen, considering the competition from imported shrimp, the desired total catch for the 60 pairs of boats must be over 3,000 tons.

Looking at past data, it seems possible to get an annual catch of 3,000 tons. From now on the cooperative feels it must institute a "Controlled Resources Type Fishery" operation. This will involve instituting the following: 1) surveys of oceanographic conditions, 2) forecasting the amount of spotted shrimp resources, and 3) planned fishing operation. Care will also have to be taken in maintaining a sound economy in the fishing household. With the wave of technical innovations in the last ten years, fishermen became very anxious to invest in new equipment, which led to a "Debt Type Management" situation in many cases. However, since in the fishing industry good catches and bad catches are inevitable, the fishing household must build up a certain amount of savings to see them through the times of bad catch.

Adapting to Energy Saving Era

Boat Seining (Hikiyose-ami) Utilizes Tidal Force

The fishing grounds we will talk about here are located at the western mouth of Osaka Bay, adjacent to the narrow Akashi Straits, which are 4 kilometers wide and pass between the mainland and Awaji Island. At its maximum the current here reaches a rate of 5 knots per hour, and is thus an excellent place to spread nets. The surrounding waters are also blessed with good fishing grounds, as evidenced by the Akashi Sea Bream catch, which has been famous since olden times. With a large consumer market close by, this area has been well suited for the development of private, small scale fisheries.

This region is a producing site for laver culture. Fishermen involved in laver culture fishery do their culture work starting in October and continuing to the following April. During the remainder of the year they work at other jobs. The types of fisheries that are carried out on a part-time basis during the off-season for laver culture are, "Hikiyose-ami" (anchor seine) using the tidal current force, as well as purse seine, octopus pot fishing, and squid basket fishing. However, lately more and more fishermen are being attracted to the advantages of "Hikiyose-ami" (anchor seining) which is performed with small nets. The reason for this lies in the fact that laver culture requires a large capital investment in facilities, so the fishermen prefer not to invest a lot in their part-time fishing activities. Anchor seining is also suited to these fishermen as a part-time fishery because, like laver culture, the work can all be done by one family. Moreover, anchor seining requires much less fuel than trawling, for example, and although the catch may not be so large per haul, if enough time is spent it can be profitable. In this age of soaring fuel costs these are very important considerations.

Fisheries Income

The annual income of a household engaged in laver culture fishery is about 10 million yen, 3 million of which comes from anchor seining in the off-season. In contrast to this, the annual income of a

household engaged full time in fishing boat fishery is only 5 ~ 6 million yen.

Fishing Ground

The fishing ground is a flat sea bottom with a strong tidal current (2 ~ 3 knots).

The most suitable bottom composition is one of small gravel. Sandy or muddy bottoms are unsuitable because the net can get stuck in the bottom, thus hampering the towing. The appropriate water depth is 10 ~ 40 meters.

Catch

The catch consists of octopus, shrimp/prawns, mantis shrimp, and demersal fishes such as flatfish, wrasse rock-trout and small sea bream.

Fishing Boat

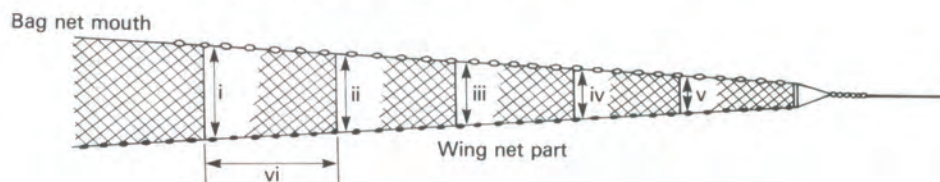
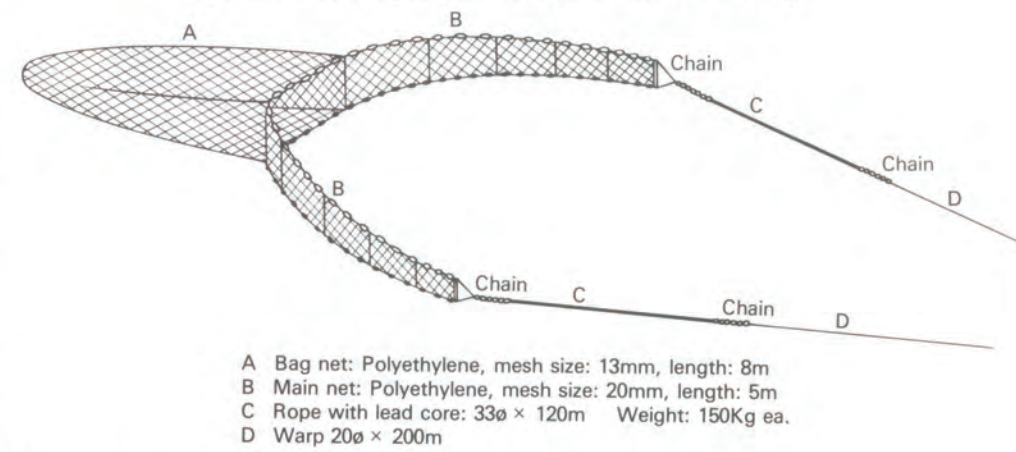
The fishing boat has an overall length of about 30 feet. Its engine is a diesel type with a maximum horse power of 15 P.S.

Fishing Equipment

The net hauling is performed by a standing-type roller made of wood (pine), that is turned by power from the boat's engine. The roller is made with 2 layers so that two ropes can be hauled simultaneously but separately. During hauling the boat's engine is put in neutral and the roller (speed reduction 1/30) is turned at the lowest speed (400 ~ 450rpm). After hauling up the net until the wing nets can be seen, the roller is stopped and the net is pulled up into the boat by hand. This operation is performed by two people.

Around 1978, a local ironworks developed a new type of roller which the fishermen have begun to use. This roller made it possible for one person to operate a "Hikimawashi-ami" (flydragging net) type of fishing, instead of the previous "Hikiyose-ami" (anchor seine) method.

Fig. 1 Net Gear: As can be seen from the photograph and diagram, the net is of a very small type. The net gear consists of a bag net, main net, rope with lead core and warp.



- i has a length of 100 ~ 130 meshes in a net with a mesh size of 20mm.
- ii has a length 10 meshes less than i. The following iii, iv, and v are progressively 10 meshes less in length.
- vi has a length of about 106cm. That is, the wing net section is 5 times the length of the smaller net (about 530cm). These wing nets are attached to both sides of the bag net.
- Floats (wood): 4 ~ 5 pieces are attached to each wing net. [They generally are attached at an interval of 8 ~ 9 "sun" (24 ~ 27cm)]
- Sinkers: 6 ~ 8 pieces per each wing net [they are generally attached at an interval of 5 "sun" (15cm)].

Anchor, Fishing Gear

Wooden anchor: used to fix the boat at a certain place during net towing. It is made of oak and weighs approximately 30 Kg.

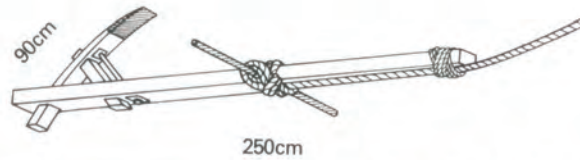
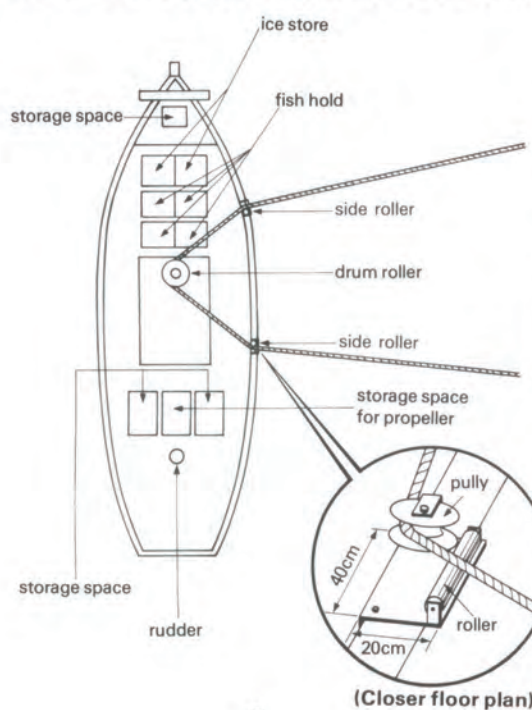


Fig. 2 Boat equipped with the conventional standing type roller



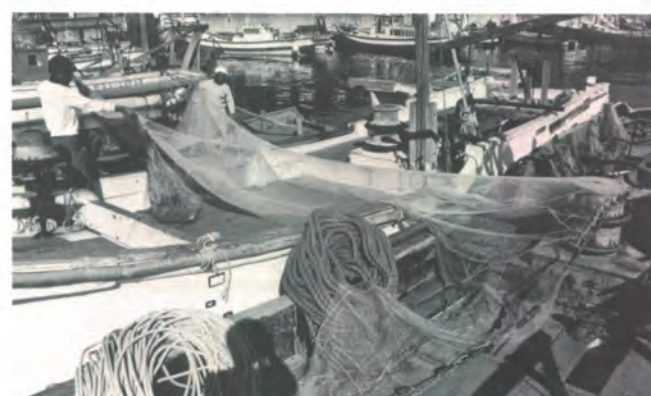
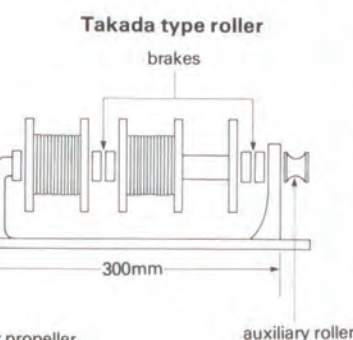
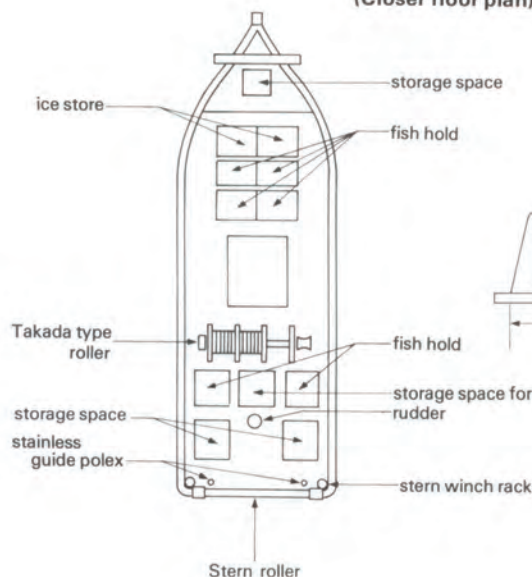
Standing-type drum (2 layers in 1 unit structure)



The Bag net section



Chafing gear (to prevent net damage) is attached to the lower part of bag net.



A picture of the entire net gear [In front, the main net and warp (left), and the rope with lead core (right) out by hand is the bag net.]



Ends of the main net

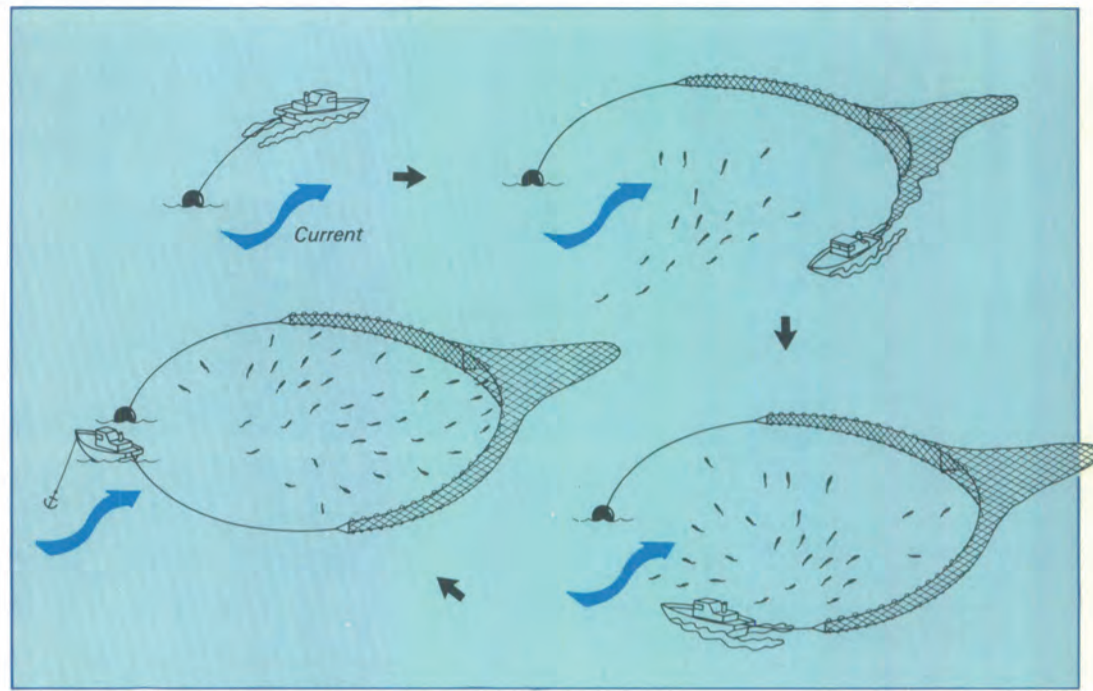
A Case Study of Anchor Seining

Japanese name: Hikiyose-ami

Higashi Futami District, Akashi City, Hyogo Prefecture

First the warp with a float attached to the end is cast into the water, then the warp, grand rope, and the net are strung out in succession with the boat moving in a circular motion at full speed. After running a circle of about 200 meters diameter, the boat returns to the starting point and picks up the

float. The boat continues to tow for 20 or 30 seconds to adjust the stretch of the net. When tension comes to bear on the warp the boat is stopped and the anchor is cast. Next the net hauling begins. A single net operation takes from 25 to 30 minutes.



Operation Method

1



A float is cast

2



Rope casting

3



Net casting

4



Picking up a float

5



Oak (wood) is used because an iron anchor can be bent by the force of tidal current; steel arrowheads are attached at the tips.

Anchor casting

6



Net hauling

7



8



9



10



Taking in the bag net

11



12



The catch is sorted and stored in the fish hold