SMALL AND MEDIUM TRAWLS IN COASTAL WATERS

- A REVIEW OF THEIR CHARACTERISTICS AND GEAR CONSTRUCTION IN JAPAN -

by

C. Miyazaki
Chief of Fishing Method Section
Tokai Regional Fisheries Research Laboratory
Tokyo, Japan

ABSTRACT

Describes studies on small and medium Japanese trawls. In beam trawling a chain is drawn ahead of ground rope to startle up the bottom dwellers. Some of the otter trawlers employ a small otter board which is light for the weight of warps. The angle of attack observed with this board was between 20° to 26° though the angle 35.5° seems to expand the board most effectively. The L-shaped board had the angle at about 40° to 50°. A sharp reduction in the number of mesh from the bag mouth toward the cod end makes the bag mouth open higher than the reduction starting from middle of the bag. Beams measuring 4.5 to 5.3 m in length were ideal for minimizing reduction in the height of the mouth square part underway.

INTRODUCTION

Depending on social and economic developments in particular regions of the world, there are enough reasons to do justice to the role of fisheries of small and medium scales in the campaign against hunger in those regions. Take Japan for instance. There are more than 28,000 fishing boats which are equipped with one of various modifications of drag nets. Although they are furnished with engines of one kind or another, most of them are in the range from 5 to 50 gross tons. According to fishery administrations of the Japanese Government, one group of them is classified as the powered medium trawlers. Ranging between 15 and 100 gross tons,

Proc. Indo-Pacific Fish. Coun., 11(II): 172-183.

they number about 1,200 out of 11,300 boats that fall under these tonnage classes. With the major strength consisting of 30 to 50-ton classes, these medium trawlers annually produce about 580,000 metric tons of fish, which represents 15% of Japan's total landings from the sea. The second group of fishing fleets is smaller in individual size than the first and is called the powered small trawlers. The number of these trawlers is about 27,000 or 1.8% of powered boats of less than 15 gross ton class. Their annual harvest is about 210,000 metric tons or 3% of the annual fish landings. In addition, of local significance is the mid-water drag-netters which are operated for anchovy, *Engraulis japonica*. They are composed of about 300 boats mostly in the range from 10 to 20 gross tons and produce about 70,000 metric tons of anchovy, its larval forms, and other miscellaneous kinds of fish.

As it is a duty of the fishing gear technologist to introduce his knowledge of prospective gear and methods from one region to another in the hope of contributing to mutual development of the world fishing industry, it may be worth having, on this occasion, a brief account of the small and medium drag-net fisheries referred to above, with regard to their characteristics, and constructions of gear and accessories. Though the term drag net fisheries may include beach seine, which is operated on a still more primitive scale, as well as highly mechanized trawlers, which are large enough for expeditions off the East China Sea, the Atlantic Ocean, and some where else, no reference will be made here to either of them because the aim of the present paper is to describe only small and medium trawls.

FISHING GROUNDS AND SPECIES OF FISH

Fishery administrations in Japan specify the powered medium trawlers as those which are larger than 15 gross tons and are operated in waters adjacent to Japan in the east of Long. 130°E. They are often referred to as the eastern drag netters and are distinguished from more or less similar types of trawlers operated in the west of Long. 130°E. Due to the merits of their gear construction which are to be described later, the eastern trawlers need not make towing for so long a distance as required by modern trawlers. The manner of operation is not so much to drag the net about along the bottom as to encircle fish with the warps and wings, as if, to scoop them up with the net. For this reason they are capable of being operated under various conditions such as: (a) depths ranging from 200 to 1000 m, (b) over the continental slope around the Japanese Islands, and (c) in narrow passages of the sea bottom scattered around with rocks and reefs.

In other words they can be regarded as a counterpart of the Danish seine in Europe. Table I indicates names of major species of fish available in these waters for the drag-netters under review.

Small-sized trawlers defined as such under Japanese fishery regulations are each less than 15 gross tons. They are furnished or not furnished with anyone of the following devices: beam, otter boards, or square frame with a dredge. Though they have engines of up to 40 h.p., some of them drag the net with help of either an engine or sail, depending upon the weather and sea conditions. The usual fishing grounds are located in sheltered bays and inland waters including Mutsu Bay, Tokyo Bay, Ise Bay, Seto Inland Sea, and Ariake Sea.

Small-mid-water trawl for the anchovy is undertaken in Ise Bay and the Seto Inland Sea on the basis of a two-boat system. This means that about 300 boats engaged in this fishery are assisted by the same number of boats of similar types. Depth of the sea suitable for the operation is from 20 to 25 m with a smooth bottom. Since they were introduced from the Inland Sea to Ise Bay around 1937, purse seines that had existed there till then were virtually driven out of the area because of the higher efficiency of the mid-water trawlers.

MAIN CHARACTERISTICS OF COASTAL TRAWLERS

Danish Seine: This type of trawl sets out the warp and net in a rhombic form without using otter boards. As the net is towed, the area encircled is getting narrower, and the fish are driven toward the center of the circle and then into the bag. The warp is usually more than nine times as large as the depth of a fishing ground. Small Danish seines are employed oftener along the coast of the open sea like off the Japan Sea than they are in sheltered waters. Construction diagram of a representative type of Danish seine is indicated Fig. 1.

Coastal Beam Trawl: As this type of trawl has no trawl head, the beam is not fastened along the float line. Instead, it is connected with the bridle or a point where the float line is tied with the wing spreader, a wooden piece proping up the wing. The length of the warp is about four to six times the depth of waters and is adjusted according to the speed of the current. A long square part is needed for catching shrimps that would otherwise crawl up the wing. In a fishing ground covered with cobblestones, sinkers made of oak wood are adopted along with usual procelain ones by fastening them one after another along the ground rope in order to avoid the stones from getting into the bag.

A $\frac{1}{3}$-in. chain, a little shorter than the ground rope, is used for scaring such bottom dwellers as shrimp and flounder. In that the chain is spanned across two corresponding points of the ground rope of the wing in such a manner that the central portion of the chain can be drawn about 15 to 25 cm ahead of the ground rope of the bag. Generally the net is towed under the sea water at one knot. Fishing for shrimp is carried out at night. Fig. 2 shows construction diagram of the beam trawl.

Coastal Otter Trawl: In Japan this type of gear is now operated only

in Osaka Bay and the sea off Chiba, Ibaraki, and Fukushima Prefectures. Of two types of the otter board used, one is the ordinary single piece of wood, while the other is made of two pieces of wood, in which a narrow board is fastened beneath a broader one in an L-shape. The narrow base board is made touch the bottom when towing. Fig. 3 gives diagrams of these otter boards.

Since the Danish seine is not capable of catching a satisfactory number of bottom fish in shallow waters, fishermen have found it workable to modify the seine with use of the otter board. Therefore, this particualar gear can be operated in the same way in the Danish seiner as well as in the otter trawlers. The length of warp required is about eight to ten times the depth of fishing ground. The one-piece otter board is furnished along the warp at the forward end of hand rope, the point which lies at one third the warp length measuring from the fore end of the wing. The L-shaped board is connected right at the end of the wing. The net is towed for about one hour at 1 to 2 knots. Fig. 4 shows construction diagram of the coastal otter trawl.

Dredge Trawl: The frame for the net mouth is made of either iron or wood. In both cases an iron comb is stretched across the lower side of the frame (Photo 1). A sailing boat or a powered one tows the dredge at a half knot to catch flatfish, shrimp, scallop, clam, cockle, and so forth. It is difficult to drag the dredge faster than a half knot. To overcome this defect, sliding runners made of iron have been invented. They look something like a ski and are fitted alongside the dredge. They were prevalent especially in the Inland Sea and Ise Bay for a short while after World War II. As they proved to be too efficient for catching bottom fish, fishermen are no longer permitted to use them.

FABRICATION OF COMPONENT NETS

The bag consists of the bating, belly, and two side panels, to which the wing, square part, and cod end are added. Generally the belly is 75 to 90 cm longer than the bating in order to lift the cod end above a muddy bottom. When towing the net along a sandy bottom, the belly and bating are designed in the same length. Sometimes the width of the belly is made a little larger than the bating to secure stability of the net under way.

The shape of the bag mouth, which is an important factor for success in fishing, is determined by seaming the bag and the wing together in anyone of the following manners:

1) To seam the rear end of the wing, a and a', to the frontal end of the side panel as in Fig. 4. This net is designed for the purpose of catching the bottom swimmers as well as the bottom dwellers on a muddy sea bed like in the Seto Inland Sea. There the net is adopted for both beam trawling and otter trawling.

2) To reduce the number of mesh on the rear corners of the wing until the height of the wing

counts 140 meshes at the rear end, a and a'. Then seam the rear end of the wing to the side panel (Fig. 2). This design is mainly applied to the beam trawl in Ise Bay.

3) In addition to seaming both the nets without reducing meshes, insert a triangular piece of webbing as a gusset between the square part and the wing. The procedure will make the bag mouth expandable and relieve tension from critical points of the bag, i.e., its upper frontal corners. This design is used for relatively large-sized nets for Danish seine and otter trawl (Fig. 1).

4) Increase the height of both the wings and the side panel toward the seam between them. Instead of using a gusset, reduce the number of meshes along the upper side of the net and give a proper contraction all over the net. This is also to make the bag mouth easy to expand (Fig. 5). The design is applied to Danish seine in the Japan Sea.

ANGLE OF ATTACK OF THE OTTER BOARD

Underwater observations and model net experiments have been conducted to measure the angle of attack of the otter board in various arrangements. The angle of the conventional otter board against the towing direction was between 20° to 26°, while the L-shaped board had the angle between 40° to 50° (Miyamoto, 1936). Tauti (1956), in his theoretical exposition of fishing gear physics, maintains that the most effective expansion of the otter boards is realized when the angle of attack on the board is 35.5° and when the value of S/L is larger than 0.105, where L represents the length of the board, and S, distance between the center of the board and a theoretical point set on the board by drawing a perpendicular from the joint of the bridle and the warp (Fig. 6).

Since the otter board under report is adopted for the trawl which seeks after fast swimming fish, the board is not designed so much to extend the distance between the wings as the conventional otter board is. Instead, it is intended to minimize contraction of the area encircled with the warps and the net under way. For this reason the board is made relatively small and light for the weight of the warps.

Function of the L-shaped board is the same as the conventional otter board.

Table II indicates specifications of different types of otter boards.

HEIGHT OF THE NET MOUTH

While in a type of trawl aiming at the bottom dwellers little attention, if any, has to be paid to the height of the bag mouth, contrary is true with a trawl operated for bottom and midwater swimmers. An exception is a shrimp trawl in the Japan Sea, as it has a relatively large height at the bag mouth.

The height of the net mouth is maintained by giving either an extra bouyancy to the floats

or a specific design to the component webbing pieces, or both. In this regard the form of the side panel is a determinant for changing the shape of the bag mouth. Fig. 7 shows forms of the side panel in general use.

For example, compare two varieties of the trawl, one in Ise Bay and the other in Osaka Bay. The bag of the trawl in Osaka Bay has 680 meshes all around the moutn. The bag is tapered by reducing the number of mesh toward the position of 200th mesh which is counted from the bag mouth and which has 380 meshes in circumference. The trawl of Ise Bay has 650 meshes all around the bag from the mouth to the 200th mesh. Reduction of mesh begins with the position of 200th mesh having 650 meshes all around, toward the cod end, distance between two positions being 50 meshes. The rear end of the bag has 380 meshes (Fig. 8). For these reasons, in the bag of the former trawl, the number of mesh is decreased backward more sharply than in the bag of the latter. In consequence, tension between the bating and the side panel of the former trawl is greater than that of the latter. This arrangement enables Osaka fishermen to obtain a larger height for the net mouth than the Ise fishermen could with their gear.

The length of the beam is also a determinant in changing the height of the square part. In this regard comparative experiments (Miyazaki, 1957) were undertaken by the use of four beams, each different in length, 3.8, 4.5, 5.3 and 6.1 m. The study revealed that decrease in the height of the square part mouth that takes place with increase of towing speed is a minimum when the beam length is 4.5 to 5.3 m and the length of the float line on each wing is same (Fig. 9).

MIDWATER TRAWL IN THE COASTAL WATERS

An important type of midwater trawl for the coastal waters is operated on a two-boat system in the Seto Inland Sea and Ise Bay. Both boats are 10 to 20 gross tons with the engine output ranging from 75 to 90 h.p. The catch per pair of boats per day is about 4 metric tons at best.

Following a scout boat that carries an echo sounder, the two boats start operating as a set while they are mooring each other. The main boat casts the bag. After both the boats set the wings together, they proceed in an opposite direction from each other. After a while they sail parallel, keeping the distance at about 200 m between them for an hour. When two 50 h.p. boats towed the net at 0.8 knot keeping the distance them at 200 m, the height and the width of the net mouth observed were about 9 m and 11 m (Nonoda, 1958), respectively. When the net was towed at 1 knot by the boats kept 200 m apart, the ground rope of the net was seen rising 2 m above the bottom. Fig. 10 shows construction diagram of midwater trawl used by 50 h.p. boats. Fig. 11 indicates a school of the anchovy reflected on an echo sounder when it was caught into the net mouth.

REFERENCES

Miyamoto, H. (1936). Model Experiments on Trawl Nets. Bull. Jap. Soc. Sci. Fish., 5(1): 19-24.

Miyazaki, C. (1957). Study on the small trawl net. Jour. Fac. Fish. Pref. Univ. Mie, 2(3): 97-220.

Nonoda, T. (1958). Model experiments on Batti-Ami. Bull. Jap. Soc. Sci. Fish., 24(4): 256-262.

Tauti, M. (1956). Physics of fishing gear. (Printed).

TABLE I

Names of major species of fish available for coastal trawlers in Japan by type of gear

Type of gear	English	Scientific	Japanese
Medium Trawlers	Flounder	---	Karei
	Cod	*Gadus macrocephalus*	Tara
	Alaska pollack	*Theragra chalcogramma*	Sukeso
	Skate	*Raja kenojei*	Gangi-ei
	Ray	*Dasybatus akajei*	Aka-ei
	Dog fish	*Squalus suckleyi*	Abura-zame
	Rock fish	*Sebastodes spp.*	Menuke
	Rock cod	*Sebastolobus macrochir*	Kichiji
	Sand fish	*Arctoscopus japonicus*	Hatahata
	Gurnard	*Chelidonichthys kumu*	Hobo
	Sea robin	*Lepidotrigla spp.*	Kanagashira
	Croaker	*Nibea argentata*	Ishimochi
	----	*Argentina semifasciata*	Nigisu
	Shrimp	---	Ebi
	Prawn	---	Ebi
Small Trawlers	Shrimp	---	Ebi
	Squid	---	Ika
	Octopus	---	Tako
	Lizard	*Synodus variegatus*	Aka-eso
	Conger eel	*Astroconger myriaster*	Anago
	Sharp toothed eel	*Synaphobranchus takedae*	Hamo
	Butter fish	*Peenopsis anomala*	Ibo-dai
	Croaker	*Nibea argentata*	Ishimochi
	Red sea bream	*Pagrosomus major*	Madai
	Flounder	---	Karei
	Flat head	*Platycephalus indicus*	Kochi
Mid-water Trawlers	Anchovy	*Engraulis japonica*	Katakuchi iwashi
	Sand lance	*Ammodytes personatus*	Ikanago
	Jack mackerel	*Trachurus japonicus*	Aji
	Larval forms of anchovy, etc.	---	Shirasu
	Squid	---	Ika

TABLE II

Dimensions of Otter Board

H.P. of Boat	Tonnage	Dimension of Otter Board
10	5	94 cm x 39 cm x 1.8 cm
12	5	1.20 m x 42 cm x 1.5 cm
13	5	1.21 m x 45 cm x 1.0 cm
45	5	1.42 m x 51 cm
		1.45 m x 53 cm x 3.6 cm
160	36	Narrow Plate 1.45 m x 29 cm x 9 cm

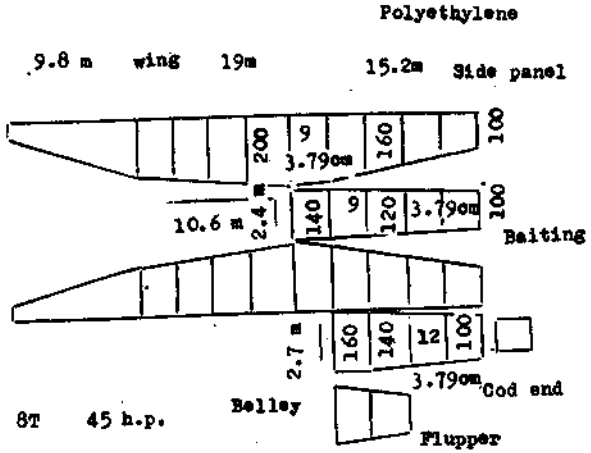


Fig. 5. Diagram of danish seine

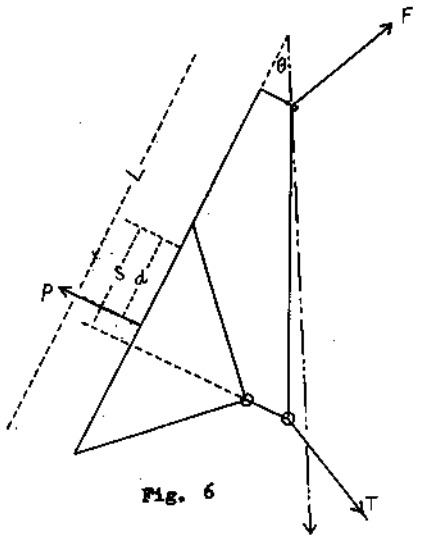


Fig. 6

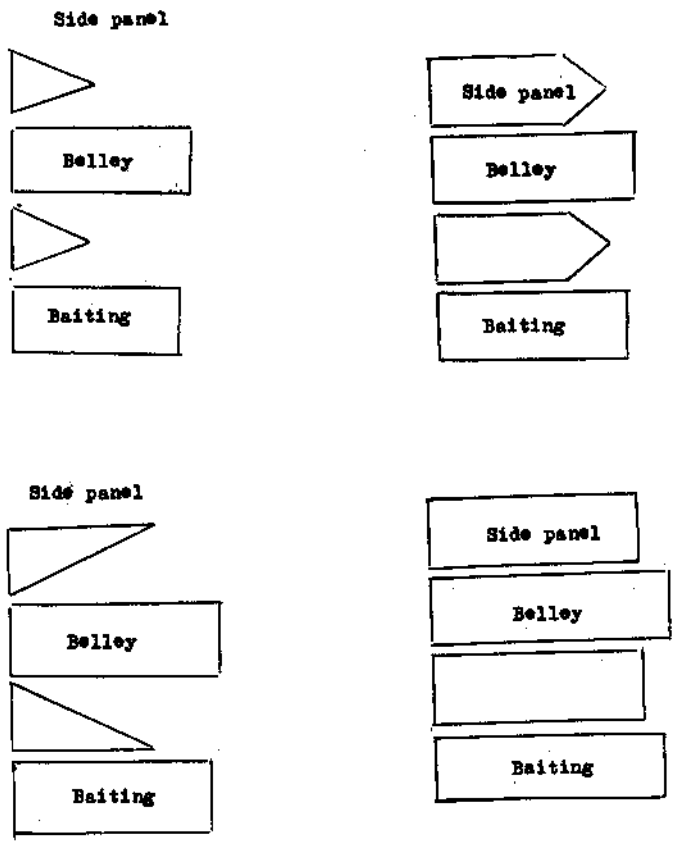


Fig. 7. Form of the side panel

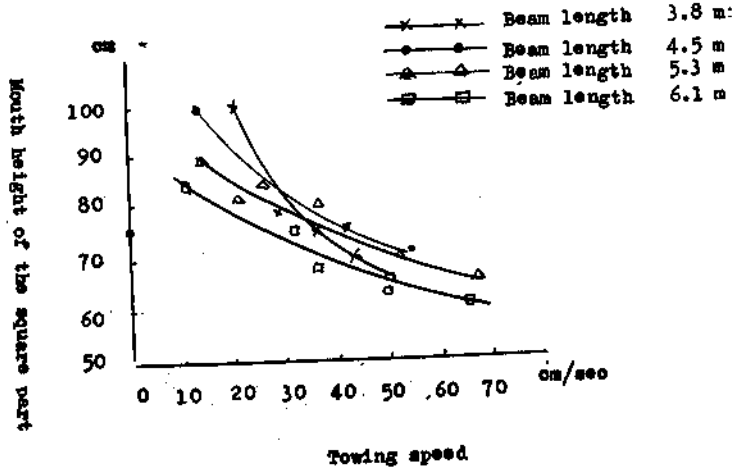


Fig. 9.
The relation between the mouth height of the square part and the towing speed

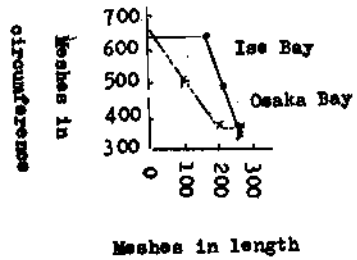


Fig. 8.

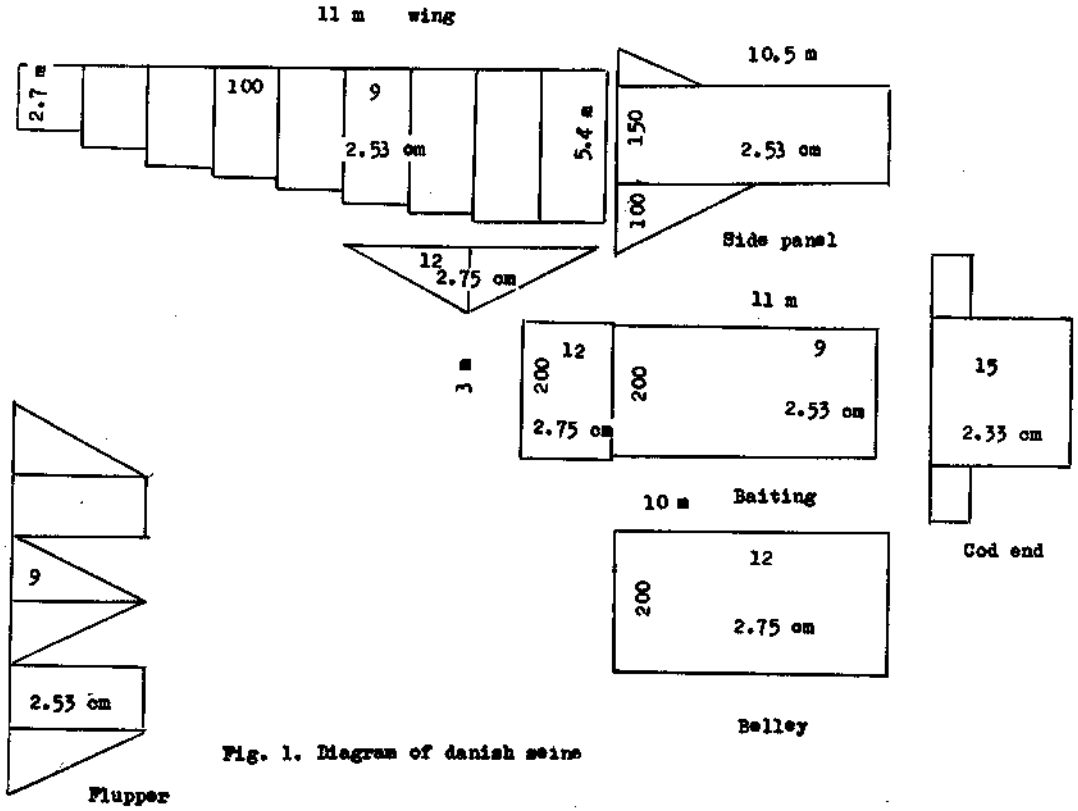


Fig. 1. Diagram of danish seine

40T 160 h.p.

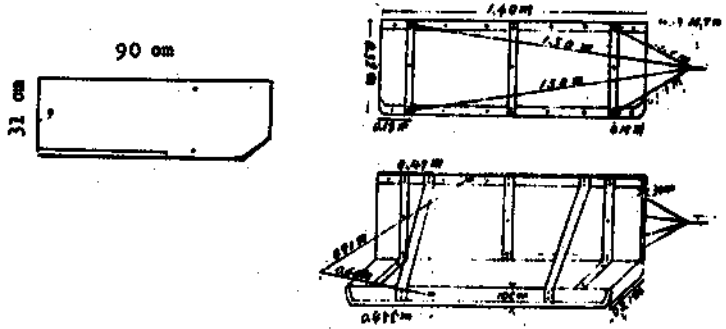
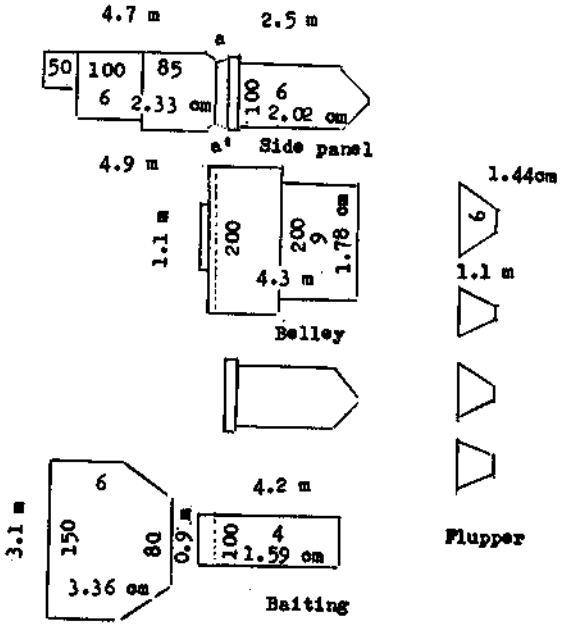


Fig. 3. Diagram of otter board



4T 8 h.p.

Fig. 2. Diagram of beam trawl

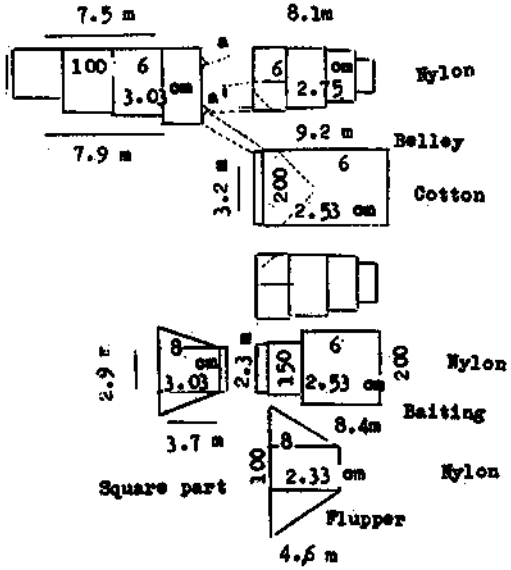


Fig. 4. Diagram of otter trawl 6T 15 h.p.

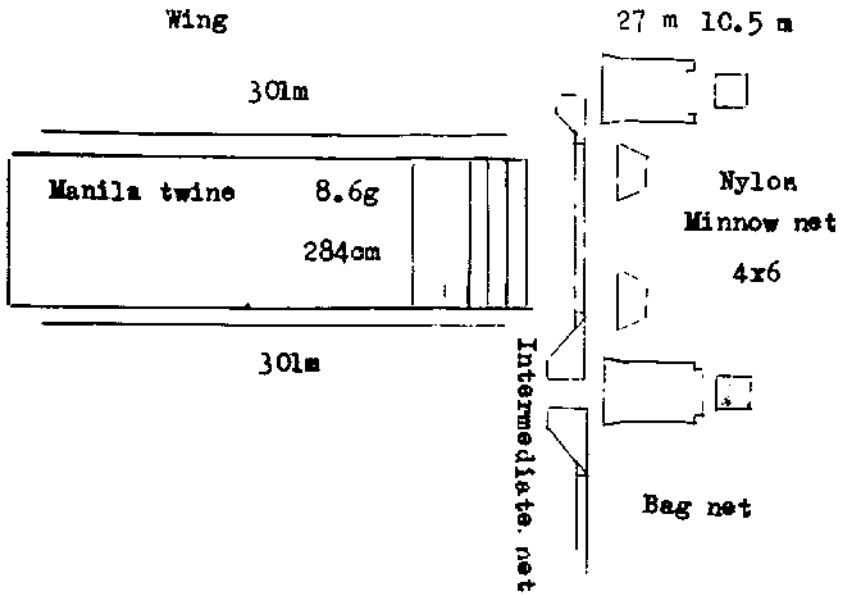


Fig. 10. Diagram of midwater trawl

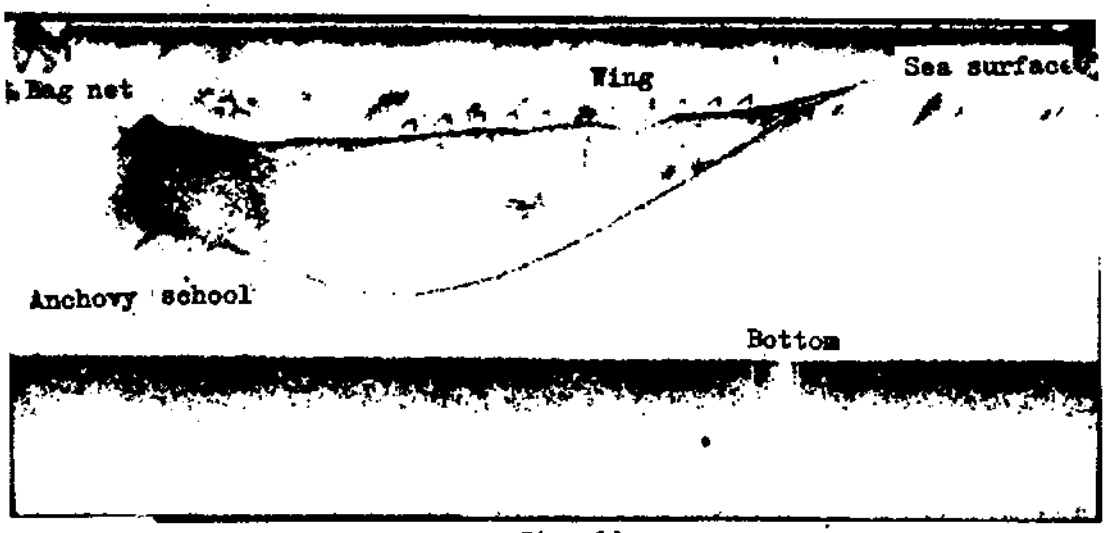
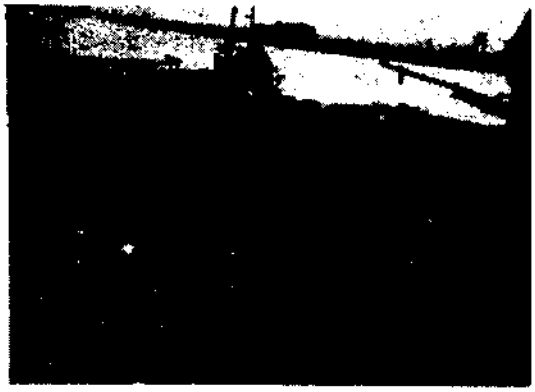


Fig. 11



Dredge

Photo. 1.