

## Studies on Saving Gear for Trawl Fishery- II \*

### Trial Operations Using a Saving Trawl with a "Bottom Curtain"

by

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As a part of the annual training and research program of Shimonoseki University of Fisheries, trial trawlings were conducted using a trawl net with a "bottom curtain" in order to develop an improved saving trawl. This gear is hopeful as a means of reducing the catch of small and immature fish. In this paper, the advantage of the gear with a bottom curtain and its effectiveness are presented, based on the data obtained from a limited number of experimental trawlings.

### 1. Introduction

During the past decade, trawling technology has advanced rapidly based on the results obtained from a large number of experimental and theoretical studies. In addition to these studies, efforts have been made to develop a new type of saving trawl designed for the purpose of reducing the catch of small and immature fish or specific species selected for preservation. Although there are a few examples in the same category with the saving trawls,<sup>1, 2)</sup> this sort of gear is still in the developmental stage. In order to put this gear into commercial use, it is essential to improve the design of the gear and the rigging plan. Such improvements will become important in order to maintain a desired level of exploitation of demersal stocks in the near future. With this in mind, the senior author developed a saving trawl during an earlier pilot program,<sup>3)</sup> in which laboratory tests were made with various model nets. These models

were generally fashioned after the pattern of the "Hover Trawl or Hovering Trawl". The Hover Trawl, designed by Larsson in 1970,<sup>4)</sup> has striking construction characteristics, such as an additional belt-shaped webbing which is attached along the groundline of the conventional trawl net from wing tip to wing tip. Larsson called the webbing a "Bottom Curtain". The authors think that the trawl net with a bottom curtain will receive wide acceptance as a promising saving trawl.

Since an improved construction plan for the bottom curtain was obtained in a series of model tests, field experiments were carried out using a full scale net in the preliminary phase of the program in 1976.<sup>3)</sup> In order to examine whether or not a trawl net with a bottom curtain would prove effective as a saving trawl, the field experiments were conducted using two trawl nets: a 47.7 m headrope standard trawl net and a standard trawl net with an attached bottom curtain. The major objective of this

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paper is to present basic data concerning the effectiveness of the bottom curtain through analyses of species and length compositions of the commercially important species taken by each type of gear.

Before going any further, the authors suggest that the trawl net with a bottom curtain possesses the following advantages:

1) Attachment of the bottom curtain makes, in effect, the vertical height of net higher than that of the same size of conventional trawl net. It is, therefore, possible to catch a school of fish swimming at a slightly higher layer above the headrope which would otherwise have been missed by conventional trawls.

2) When trawling in rough bottom areas, the bottom curtain sustains minor damage only in lower section or bottom curtain. Accordingly, this gear is suitable for research purposes in developing new fishing grounds or for exploratory trawling.

3) This net is potentially one of the most effective saving trawls because the bottom curtain can be designed to release uneconomical small fish before they enter into the codend.

4) To enlarge the gear size as a method of making high-opening trawl nets results in an increase in the amount of webbing and other materials. This gear is in effect an economical type of high-opening trawl net.

## 2. Materials and Methods

The study area was the northeast edge of the continental shelf of the East China Sea, about 200 miles southwest of Kyushu shown in Fig. 1. The bottom in this area is primarily sandy mud to a depth of 70-110 meters. For many years, the Japanese medium-scale pair-trawlers have engaged in fishing in the inner area of the 200 m-isobath. The total number of pair-trawlers authorized by the Government of Japan was  $183 \times 2$  in 1982 and the resulting annual catch was 166 thousand tons. At present, no commercial trawlers fish in the deep

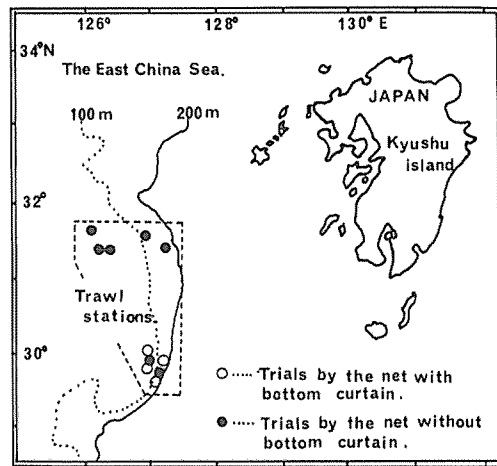


Fig. 1. Study area for a saving trawl in the East China Sea.

sea area along the edge of the continental shelf where exploratory deep-sea trawlings were conducted earlier. However, these exploratory trawlings produced poor results<sup>5)</sup>. Catch statistics for Japan indicated that since 1961, both annual catch and number of licensed pair-trawlers are declining yearly. To date, almost all the Japanese trawlers have suspended their fishing operations in the summer, i.e., July and August, a notoriously bad season for trawling. Although there are over 300 trawlable species in the study area, there are approximately 30 major species that are readily saleable and can be produced in considerably large quantities.

With the intention to examining whether or not a trawl net with a bottom curtain would be a better saving trawl in commercial usage, experiments were conducted by means of alternate hauls with a standard trawl net and a standard trawl net with an attached bottom curtain. The former is typical of the gear commonly used by distant trawlers in Japan, the size depending largely upon the size of vessel employed. The reason why the above-mentioned two gears were used is to evaluate the effectiveness of bottom curtain. This was done by comparing

the species and length compositions taken in both nets. Fig.2 shows the general arrangement of the trawl net with a bottom curtain. This gear has a specially desinged cover-net which is temporarily attached just behind the bottom curtain for the purpose of investigating the effectiveness of the bottom curtain in greater detail. The design and dimensions of the standard trawl net, bottom curtain and cover-net are shown in Figs. 3 and 4. The cover-net

makes it easy to estimate the mesh selectivity of the bottom curtain and an evaluation of the particular fish behaviour in front of the bottom curtain. As the above plan illustrates, there are nine reinforcing wires running vertically across the webbing of the bottom curtain, all of which were inserted not only to keep the meshes of the bottom curtain fairly open but also to reduce local stress damage. Each of the mesh sizes given in Figs. 3 and 4 indicates the nomin-

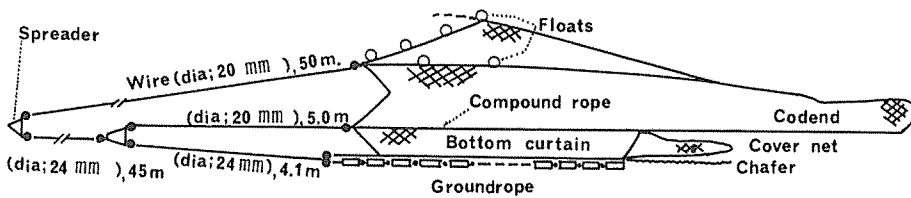


Fig. 2. General arrangement of the trawl net with "Bottom curtain". The cover net is temporarily attached for research purposes.

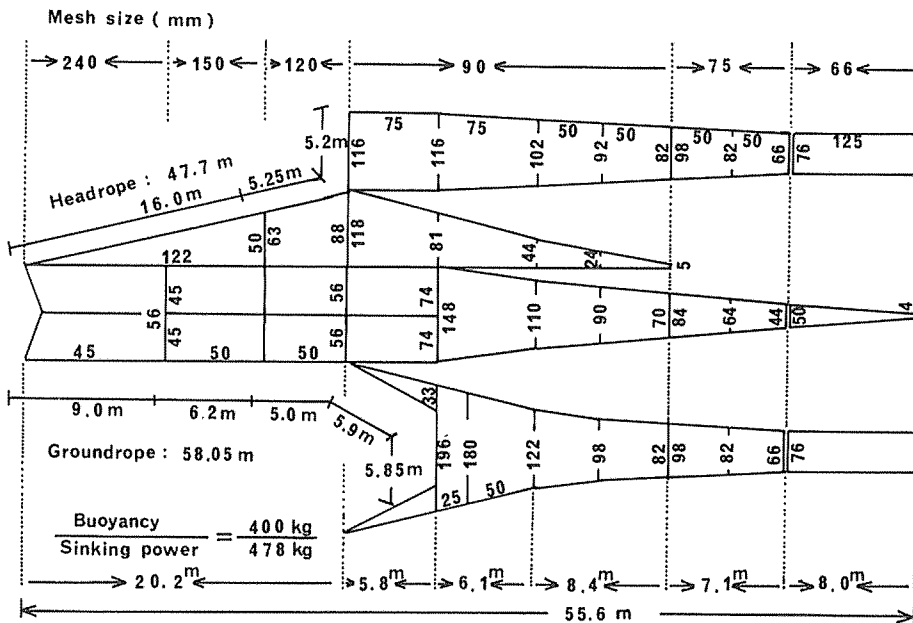


Fig. 3. Dimensions and construction characteristics of the main components of the trawl net used in the experiment.

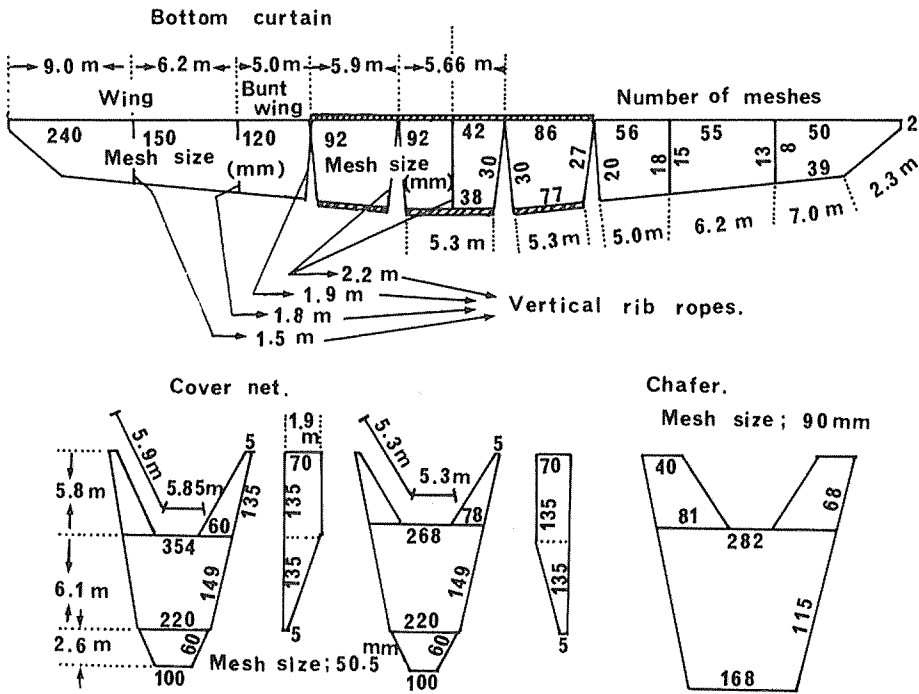


Fig. 4. Details of "Bottom curtain" and cover net.

al stretched length. The two experimental trawl nets are essentially similar in their main net components, except for the attachment of the bottom curtain. Both bottom curtain and groundrope are exchangeable with each net. Therefore, the bottom curtain can be detached from the lower part of the main net and extra groundrope is attached to this lower part alternatively, as required. The netting materials of important net sections are made entirely from twisted polyethylene twine. These are constructed of:

- Lower wing .....42 tex/90,
- Belly.....42 tex/90,
- Codend .....42 tex/160,
- Bottom curtain.....42 tex/90,
- Extention piece .....42 tex/80,
- Upper wing.....42 tex/60,

- Square .....42 tex/48,
- Cover-net .....42 tex/24.

Suberkrub otter boards with aerofoil section, each 3m × 2m (aspect ratio: 1.5) and weighing 1357 kg, were fitted to the above described gears. From each otter board, a pair of spreading wires, 60 m in length, were fitted with the respective triangular spreader which interconnected with the 50 m length of headline-and-footrope legs.<sup>5)</sup>

The experiments were conducted aboard the training vessel, Koyo-maru, of Shimonoseki University of Fisheries. The vessel is a stern-ramp trawler, 81 m in overall length, 1990 gross tons, and capable of developing 3800 BHP at 230 RPM.<sup>5)</sup> The Koyo-maru has the latest auto-trawl control system, gear and fish monitoring equipment, electronic fish finders and sonar, and

sattelite navigational equipment. During the course of experiments, eleven bottom trawlings in total were made in daytime from 7th to 10th during February, 1979. Depending on the type of gear used, these trawlings were divided into the following two steps. The first four hauls were made using the net with bottom curtain. Unfortunately, this step had to be abandoned due to excessive damage in the cover-net and posterior section of the bottom curtain during the fifth trawling. The damages were probably caused by the weakness of the cover-netting (42 tex/24). The remaining seven hauls were carried out using the standard trawl net. It should be noted that the new gear used in these experiments is smaller than those commonly used by the distant trawlers of tonnage equal to Koyomaru since the gear is designed for training and research purposes. However, the size of the standard trawl net itself is similar to the gear being used by a number of pair-trawlers.

The length compositions of fish from the codend, the posterior part of bottom curtain and the cover-net, were determined separately by measuring the body length to the nearest millimeter with a measuring board. As a rule, the lengths of 100 samples per species selected at random were measured immediately after each haul. In cases of small catches less than 100 samples, the length-measurements were made all specimens taken. The weight of the total catch did not exceed 800 kg during all experimental hauls. The length data for the three different net components was recorded for ten species. This data provided meaningful information for estimating the effectiveness of the bottom curtain, especially from the standpoint of fish behavior. Effectiveness evaluations were based on species-to-species differences in the distribution pattern in the above-mentioned net components. The data obtained was not adequate for determining the mesh selectivity of the bottom curtain, but the mesh selection curves of two species for the given codend could be roughly estimated from the samples

taken by the codend and cover-net. The mesh selection curves were constructed for only two species due to the lack of adequate numbers and were derived by the usual analytical methods used by ICNAF.<sup>6)</sup>

### 3. Results and Discussion

The main species caught and the number of fish measured per sample are listed in Table 1. The number of individuals taken in each net component was, on the whole, too small for detailed analyses, although the following general conclusions could be drawn.

Fig. 5 shows the length frequencies for five of the species and their patterns of distribution in the net component for the bottom curtain gear trials. This figure enables us to predict interesting interaction between the bottom curtain and fish behaviors. For butter fish, *Psenopsis anomala*, and cutlass fish, *Trichiurus lepturus*, it may be safe to say that the bottom curtain, whose aftermost configuration makes a steep slope against the sea bed when in action,<sup>3)</sup> acts as a guiding funnel toward the codend. Similarly, the data in Table 1 indicates that these two species did not pass through the mesh of the bottom curtain even when the larger mesh size (92 mm) was used. This suggests that these two species tend to swim gradually upward from the sea bed in front of the bottom curtain and into the codend.

All of the samples and sizes of the two species of lizard fishes, *Saurida undosquamis* and *Saurida elongata*, passed through the meshes of the bottom curtain. This may be due mainly to the round shape of fish permitted them to pass through the 92 mm mesh. If the bottom curtain with a smaller sized mesh was used, these species would have also be shepherded down into the codend. This type of species, therefore, could be caught by any type of the nets employed.

To further consider the samples presented

Table 1. The number of individuals sampled by species and by type of gear used

| Species name                       | Without bottom curtain |                   | With bottom curtain |                    |
|------------------------------------|------------------------|-------------------|---------------------|--------------------|
|                                    | Codend<br>(66 mm)      | Codend<br>(66 mm) | Cover<br>(50.5 mm)  | Curtain<br>(92 mm) |
| Butter fish.                       |                        |                   |                     |                    |
| (1) <i>Psenopsis anomala</i> .     | 55                     | 99                | 0                   | 0                  |
| (2) <i>Pampus argenteus</i> .      | 195                    | 195               | +                   | 0                  |
| Cutlass fish.                      |                        |                   |                     |                    |
| <i>Trichiurus lepturus</i> .       | 49                     | 48                | 0                   | 0                  |
| Lizard fish.                       |                        |                   |                     |                    |
| (1) <i>Saurida undosquamis</i> .   |                        | +                 | 100                 | 0                  |
| (2) <i>Saurida elongata</i> .      |                        |                   |                     |                    |
| Rock fish.                         |                        |                   |                     |                    |
| <i>Scorpaena izensis</i> .         |                        | +                 | 0                   | +                  |
| File fish.                         |                        |                   |                     |                    |
| <i>Navodan modestus</i> .          |                        | +                 | ++                  | 30                 |
| Sea bream.                         |                        |                   |                     |                    |
| <i>Dentex tumifrons</i> .          | 101                    | 56                | +                   | 0                  |
| Sea robins.                        |                        |                   |                     |                    |
| <i>Lepidtrigla g ntheri</i> .      | 200                    | +                 | 200                 | 0                  |
| Red fish.                          |                        |                   |                     |                    |
| <i>Priacanthus marcracanthus</i> . | 278                    | 200               | 200                 | +                  |

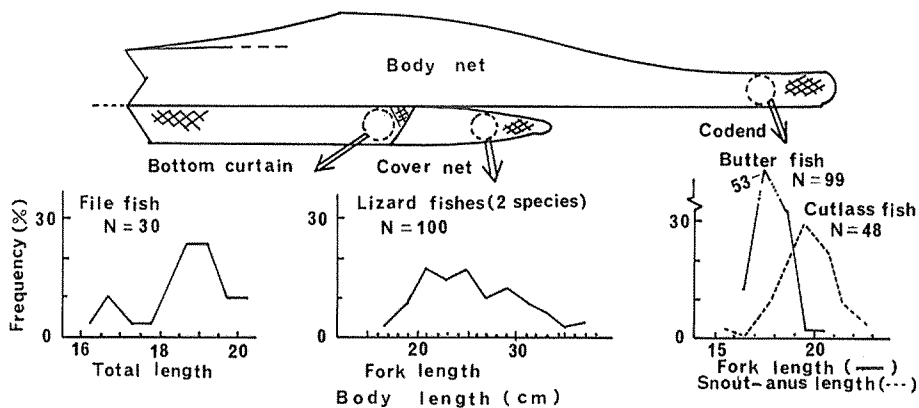


Fig. 5. Length frequencies by species of fish caught in different net components.

in Table 1, the same swimming behavior mentioned above may also be true for file fish, *Navodan modestus*, and sea robins, *Lepidtrigla güntheri*, which were caught in the lower parts of the net, either in the bottom curtain or in the cover net but were absent in the codend. The file fish was most typical of the species caught in the meshes of the bottom curtain. Its probable cause may be due in part to a specific morphological characteristics such as the upright and hard fin ray at the anterior edge of the dorsal fin.

Fig. 6 shows the differences in the length frequencies for sea bream, *Dentex tumifrons*, and another species of butter fish, *Pumpus argenteus*, which were taken in both codends. By comparing the differences in their length frequencies within and between the two types of net, we may conclude that the net with the bottom curtain, as compared with the net without the bottom curtain, is less efficient in catching smaller fish. This in turn means that the bottom curtain serves as a functional webbing to release small fish.

Insufficient data was available for estimating the mesh selectivity of the bottom curtain since only a few individuals were taken in the posterior part of the bottom curtain. By using the samples caught by both cover-net and codend, the mesh selection curves of sea robins and red fish, *Priacanthus macracanthus*, were roughly estimated by calculating the percentage of those fish retained at each cm-length grouping. The results, together with their cumulative length frequency curves, are shown in Fig. 7. The mesh selection curves obtained were determined by applying a slight modification of the alternate haul method reported previously,<sup>6,7)</sup> although some doubts have been raised concerning the application of this method. That is, all the number of individuals in the cover-net must be underestimated since they were filtered through the webbing of the bottom curtain. Furthermore, they had a little chance to swim upward in front of the bottom curtain before

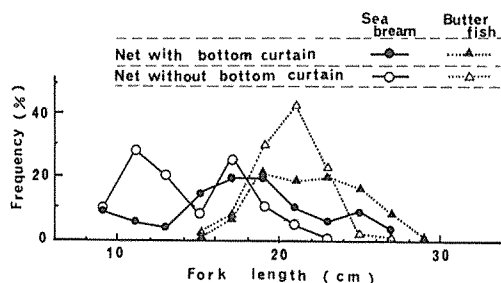


Fig. 6. Comparisons of length compositions of catches by the gear with "Bottom curtain" and one without "Bottom curtain".

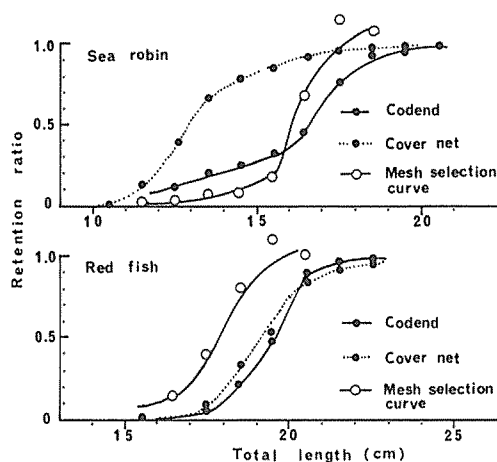


Fig. 7. Cumulative length frequency curves and mesh selection curves roughly estimated.

being caught in the codend. There is, therefore, a small differences between the mesh selectivity parameters obtainable from Fig. 7 and those obtainable from the ordinary alternate haul method. Due to existing fish size, it is recommended that a bottom curtain with a slightly smaller mesh size be used in future experiments in order to accurately estimate the mesh

selectivity of the bottom curtain. However, these results described above supply some clues to evaluate whether or not the bottom curtain was functional in sorting and releasing smaller fish from the larger ones.

No gear handling or controlling problems developed for the gear with a bottom curtain during the continuous sequence of shooting, towing and hauling back on deck. Accordingly, this gear is suitable for many types of trawlers if an adequate size of bottom curtain is attached.

Irrespective of the behaviour of specific species, it is basically important in the design of a better saving trawl so that many small fishes have adequate opportunity to escape before they enter into codend. To do this, it is necessary to maintain the bottom curtain at a steep slope against sea bed and to keep its meshes wide open so as to allow as many small fish as possible to be released. However, it is difficult to increase the height of the bottom curtain itself even if a larger size of bottom curtain is used. Further research on these problems is recommended.

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### Appendix

For reference purposes, the authors present some supplemental data about the physical properties of the gear with bottom curtain. The data was obtained through a laboratory test using a model net on a 1: 15 scale. When the bottom curtain was attached to a standard trawl net, the towing resistance was increased by about 13 percent at towing speeds ranging from 3 to 4 knots. The towing resistance of the gear with bottom curtain was estimated to be 8.2 tons in the scaled-up value of the model data at the normal towing speed of 3.5 knots. The vertical height of the gear with the bottom curtain varied from 7 to 8 meters at the same speed ranges, whereas the vertical height of the bottom curtain itself was estimated to be about 1.0 meter at the towing speed of 3.5 knots.



## 底曳網漁業の保護漁具の研究—II

### “Bottom Curtain” 付きトロール網の試験操業について

藤 石 昭 生・片 岡 昭 吉

底魚資源の有効利用には、未成熟魚を漁獲することなく有用魚だけを選択的に漁獲できる機能をもつ漁具の開発が重要になる。現在までの模型実験によって、本漁具の設計学的基礎知識が得られたので、練習船耕洋丸が使用中のトロール網の一部を設計変更し海上実験を行った。実験中に得た漁獲成績は必ずしも良好とはいえないが、“Bottom curtain” 付きトロール網が資源の有効利用に役立つことが明らかになった。本漁具の実用化に当っては、特に“Bottom curtain” に使用する網地の強度と目合の選定に留意すべきである。