Studies on Saving Gear for Trawl Fishery—I*1
Model Experiments of a Trawl Net with “Bottom Curtain”

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Study on saving gear for the trawl fishery will play an important role in saving immature fish. Model experiments were conducted with the intent to improve and develop a new trawl net with a bottom curtain. The paper published by Larsson gave important clues for designing the bottom curtain and the experiments were conducted in a circulating experimental tank. This paper deals with the behavior of a ground trawl net having a bottom curtain as a preliminary step to gear designing. Results of the experiments were obtained by means of visual observation and numerous photographs taken through the glass wall of the tank. It was found that the net height increased by means of attaching the bottom curtain, but slack in the lower part of the bottom curtain was also observed.

The saving gear for the trawl fishery have been being studied on and off, mainly with the idea of improving the escapement characteristics of the cod-ends, and then new improvements in these gear have been presented by some research workers1,2). It seems, however, that there were some problems that had to be resolved before the saving gear would receive sufficient recognition, as being a better way of use in commercial practice. The main reasons of the difficulties faced in the development of new saving gear are as follows;

(1) It is very difficult to prevent the meshes of cod-end from closing because of the U-shaped configuration of cod-end during towing.

(2) Generally, reducing the number of mesh and twine leads to make weak a net. It is desirable to use single webbing in cod-end in accordance with the size of gear instead of double webbing. At present time, the cod-end is considered to be the most important part for the escapement of fish and this part is mostly made of double webbing so as to have adequate strength and durability. Therefore, fewer fish escape from the meshes of cod-end than from those of forward parts, which have larger size of meshes, even if the fish that enters the cod-end has an ability to escape.

According to earlier observations of fish behaviour while the trawl net is towed3), the fish pass through the mesh of forward webbing such as the square, baiting and wings which are nearly always of larger mesh size than that of the cod-end. On further studies of the above, in connection with designing effective saving gear having excellent selectivity,

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*1 An outline of this article was presented in the annual meeting of the Japanese Society of Scientific Fisheries in Kyoto. Nov. 1974. The term "saving gear" means the gear designed to let undersized fish escape through meshes of the net.

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it will probably be necessary to design a net with well open meshes so that smaller fish
might be sorted out and released out of nets as much as possible, in alive condition before
those fish are shepherded down into the mouth of the net.

The "Hovering trawl or Hover trawl with a front curtain or bottom curtain" designed by
LARSSON gives helpful and constructive suggestions to open new aspects on the develop-
ment of saving gear. By using the trawl net with the bottom curtain which is kept at
steep slope against the sea bed under towing and which is made with wide open meshes to
allow as much small fish as possible to release out, it could be considered that considerable
amount of small fish may escape through the meshes on comparing the trawl net without
the curtain. Accordingly, having selected the "Hovering trawl" as a prototype and turning
it to one of the best saving gear, it is necessary first to make clear the hydrodynamic charac-
teristics of this type of gear. The present paper is concerned with the results obtained
by model experiments. The experiments were conducted with the intent to examine the
underwater performance of the bottom curtain and changes in the vertical height of the net,
using a model on 1:15 scale.

Materials and Methods

Experiments were carried out using a model of polypropylene in order to estimate
the increase in the vertical height of main net due to attachment of a bottom curtain and
the height of curtain in a circulating experimental tank of Shimonoseki University of
Fisheries. The model used was made by means of TAUTI's method with a scale of one-
fifteenth. The full scale net is a standard type of ground trawl, consisting of four panels
made of polyethylene webbing, which has a headrope of 34.5 m and a groundrope of 45.7 m
in length. Hydrodynamical properties of the full scale net have been described in detail
in the research paper together with the net plan by one of the authors, TANIGUCHI, on the
basis of field experiments in the East China Sea. But no bottom curtain was attached
to the full scale net in the field experiments.

In the present experiments, the authors investigated the underwater performance
and the vertical height of the model which had a bottom curtain along the groundrope,
and a series of floats along the upper side of the cod-end to keep it off the tank floor, as
shown in Fig. 1. Also, the authors made and tested two types of bottom curtains to seek
the defects in their design. There was a great difference between the design of these cur-
tains, hereafter, referred to as "Type I" model net with "Type I" curtain and "Type II"
model net with "Type II" curtain. In the model experiments, each type of curtain was
attached or detached from the same model alternatively. Fig. 2 shows the dimension and
construction characteristics of the bottom curtains. The authors took the net height
measurements at three positions, as shown in Fig. 1, when the groundrope of the bottom
The curtain was kept in contact with the tank floor. Current speed in the tank ranged from about 0.5 to 5.0 knots, computed in terms of the actual towing speed, while an iron bar kept the transverse distance between the foremost end of two headline legs in a width of 1.6 m (the scaled up width is 24 m). The height measurements on models were taken by direct readings on the upright measuring scales which were fixed closely in front of the headrope and the wing tip. And to measure the heights of net accurately, the height measurements were amplified and read by a number of photographs which was taken through the glass wall of the tank together with the above-said scales. On the further analysis, the scaled up values of model data are used.

![Diagram](https://via.placeholder.com/150)

Fig. 1. Dimension and construction characteristics of the model net with the bottom curtain and the positions of the height measurements.

Notes: Hatched area signifies the part that the upper edge of the bottom curtain should be sewn to the lower edge of the main net.

In the case of attaching the bottom curtain to the main net, the sinker is detached from the lower edge of the main net and is attached to the lower edge of the bottom curtain.
Results and Discussion

Height of main net  The height of headrope decreases with increase in towing speed. This correlation is also applicable to all the data obtained by the present experiments. The measured height were plotted against the towing speed of the net, of the model net with two different types of bottom curtains and of a model net without the curtains. Fig. 3 gives curves for the height of net on ground level at three positions, (i) wing tip, (ii) center of headrope, (iii) center part above the rear end of groundrope (the height of
These curves are concave upward and slope down to the right. The empirical formulae corresponding to the respective curves, and the rectangular hyperbolae, are in the same figure. As it is obvious from Fig. 3, attaching bottom curtain for the ground trawl make a considerable increase in its vertical height. The height-differences between the net with a curtain and one without the curtain can be obtained by the comparison with the curves. These difference hardly change, even if the towing speed changes in the range of 2.5 to 5.0 knots. On the other hand, in spite of the marked difference in the design of the two types of curtains, there is little difference in the height-speed curves shown by the type.

**Height of bottom curtain** Larsson suggested to us that the belt shaped bottom curtain is one of the most functional webbing to let small fish escape back to the sea bed. The fish does not escape through the meshes if the angle of the curtain and the shape of mesh are distorted very much under normal towing speed. Basic applied clues for the study of saving gear could be obtained by testing whether or not the curtain functions within its design specifications, especially in the vertical height of the curtain in action.

In the plan of the bottom curtain, the vertical height of the two types of curtains are 3.15 for the “Type I” curtain and 2.4 m for the “Type II” curtain, respectively. These height values became lower and lower with the increase of towing speed. Fig. 4 shows the relationship between the height of the curtains and the speeds. These height-speed curves also look like the rectangular hyperbolae, but gradually slope down to the right as compared to the curves in Fig. 3. When comparing the measured height in Fig. 4 with the above-said values (3.15 and 2.4 m), the measured height in Fig. 4 decreased rapidly contrary to the authors' expectation and became low to about 30% of the vertical height.

![Fig. 4. Relation between height of bottom curtain and towing speed.](image-url)
of the plan in the speed ranges of 2.5 to 4.0 knots. This percentage is in effect equivalent to the increase of the net height due to the attachment of the bottom curtain at different towing speeds as shown in Fig. 3. By comparing and contrasting with the data in Figs. 3 and 4, it will be seen that the “Type II” curtain is better than the “Type I” curtain, as the “Type I” curtain requires more webbing, considering its actual low height. However, it might not necessarily follow that the “Type II” curtain is the best. Therefore, further investigation should be made on a bottom curtain itself and the rigging of the trawl with the curtain so as to raise its maximum extent at all towing speeds.

**Shape of bottom curtain in action** Numerous photographs taken and visual observation made through the tank window revealed that both types of curtains shaped like a belt at their maximum height when the towing speed was under 1 knot. When the speed increased from 1 to 2 knots, the height of the curtain became gradually low and the belt-like curtain consequently formed a concave surface. As the speed was increased to more than 2.5 knots, there was shown much slack in the bottom curtain due to the increase of the net drag, which resulted in the webbing of two-thirds (lower part) of the curtain coming in contact with the tank floor; and slack in the webbing overlapped from wing tip to wing tip. However, the upper part of the bottom curtain was effective in making a steep angle.

**Summary and Conclusion**

It is universally admitted that the rapid increase of marine production in the last ten years owes much to the improvements of a variety of ground trawls for the ground species, in addition to the development of the mid-water trawls for the pelagic species. However, trawls can be deadly for immature fish because of its efficiency. All trawl fleets have been getting undersized and unmarketable fish due to unavoidable characteristics of the trawl net. For instance, as the towing speed becomes greater, the extra strain on the net tends to keep the mesh close, resulting in higher catches of immature fish. From the viewpoint of protecting these small immature and unmarketable fish, in many fishing ground the trawl net have come to use a admitable minimum size of mesh, on the basis of the results obtained by the mesh selectivity experiments using various size of meshes in cod-end. The use of cod-end with larger meshes so as to permit the escape of many fish of the desired minimum sizes will result in lower catches of larger fish. In other words, a great number of larger fish that should be harvested can also escape from the larger mesh. Therefore, there is needs of further investigation on the subject of saving gear having a frontal webbing such as a bottom curtain for the purpose of saving small fish.

Whether or not the bottom curtain is effective as a functional webbing to let immature fish escape, depends upon the degree of the vertical extention of the curtain. On exam-
ining the performance of a model with the curtain, there is a room for improvement of the
design of the net and its rigging, as well as of the design of the curtain itself. It is hoped
that further analysis by using a improved model will reveal more effective data for in-
creasing the height of the curtain in a future date. The results of the experiments proved
to be favorable in getting some clues for further improvement of the saving gear.

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References