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DEVICES OF SIMPLE PLANKTON APPARATUS IV

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During the work at sea we have experienced that some apparatus produced under already published designs (Motoda 1953, 1954, 1959, 1962, 1963, 1967, Kawamura 1968) could be handled practically, but need improvement in certain points. This paper describes those improved designs and the results of performance tests of two kinds of plankton nets at sea.

1. MTD Vertical Closing Double Net

(元田式垂直閉鎖二重ネット)

(Pl. I, Figs. 1, 2, Pl. II, Figs. 1-3)

It takes a rather long time to lower a net into great depth, and, to prevent the slacking of the wire cable, a serious problem in vertical haul can result. That slacking of the wire cable easily occurs especially when the ship is violently rolling, which causes the entanglement of the cable. Eventually, the kinked cable can break when it is retrieved. The MTD vertical closing net is designed according to the idea of Petersen's vertical closing net (Steuer 1910) in which each half of the mouth ring can be bent at the center rod. This allows both half circles of the mouth ring to remain upward when the net is lowered speedily into the depth, reducing the resistance of water. The shape of the designed net is an inverted cylinder-cone, 56 cm mouth diameter (0.25 m^2), 176 cm long, or 80 cm mouth diameter (0.5 m^2), 240 cm long.

A trial haul with a preliminary model of this type of net (70 cm in diameter of the mouth ring, 0.10 mm mesh openings) was reported by Kawamura (1968) with the results that the sinking velocity was 1.04–0.61 m/sec in comparison with the Juday type vertical closing net of which sinking velocity was 0.23–0.16 m/sec (40–50 kg sinker). The performance of the second model of the MTD vertical closing double net was tested on Cruise 29 of the "Oshoro Maru" in the Okhotsk Sea and the Japan Sea in September 1968.

At one station, a 56-cm MTD vertical closing double net suspending a 40 kg sinker was lowered slowly enough so as not to slacken the wire cable (4 mm dia.). The time required for paying out the wire cable as long as 539 meters was 510 seconds (1.06 m/sec) when the angle of wire cable measured on deck was 22° . To

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compare the sinking velocity of the MTD net with an ordinary net, a traversing rod was fixed at the mouth ring of the MTD net so as not to cause the mouth ring to bend. Such a net could be lowered at a speed of 0.24 m/sec when the angle of the wire cable was 20°. It indicated that the sinking velocity of the MTD net was much more improved than that of a net with a fixed mouth.

The double net of the MTD vertical closing net is to obtain medium sized zooplankton (retained on 0.35 mm mesh) separately from phytoplankton together with some small sized zooplankton (retained on 0.10 mm mesh). A double tail tube (Plate II, Fig. 2) is a device to facilitate the removal of the samples from each net. Data on plankton biomass (wet weight) taken by vertical haul with a double net are as follows:

- Sta. 1, Sept. 4, 1968, 45°20'N, 144°00'E in Okhotsk Sea
Wire angle 20°, Wire paid out to 539 m, Net closed at 43 m
Sample wet wt. 35.7 gr/haul in 0.35 mm mesh inner net
Sample wet wt. 1.1 gr/haul in 0.10 mm mesh outer net
- Sta. 2, Sept. 9, 1968, 42°10'N, 139°10'E in Japan Sea
Wire angle 50°, Wire paid out to 780 m, Net closed at 100 m
Sample wet wt. 9.7 gr/haul in 0.35 mm mesh inner net
Sample wet wt. 0.6 gr/haul in 0.10 mm mesh outer net

This shows an approximate ratio of standing biomass between two size groups of plankton below the euphotic zone.

2. MTD Horizontal Closing Net

(元田式水平閉鎖ネット)

(Pl. I, Figs. 3, 4, Pl. II, Figs. 4, 5)

It has been our long desire to have a simple gear for obtaining comparable plankton samples from different depths so as to enable us to describe detailed patterns of vertical distribution of zooplankton. A series of opening-closing nets can be reliably employed, but the handling of such nets is really troublesome and it is practically difficult to use several numbers of opening-closing nets for simultaneous horizontal tow by attaching them to a single wire cable at certain intervals. The Clarke-Bumpus sampler (Clarke and Bumpus 1950, Paquette and Frolander 1957, Paquette *et al.* 1961) can be suitably used for such purpose, but the size of the net is limited and its construction is rather complicated.

The design presented here has been developed from previously reported "Horizontal square net fixed on triangular frame" (Motoda 1963) and remodelled "Horizontal closing net with triangular frame" (Motoda 1967). The principle consists in fixing the mouth of the net to a triangular frame at 45°. The net can be lowered in an open position without catching undesired samples because the

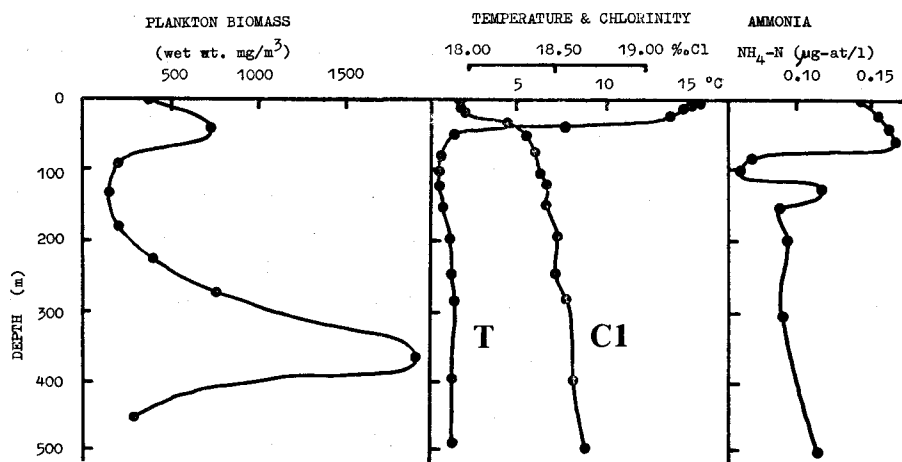


Fig. 1. Vertical distribution of plankton biomass (wet wt.) observed by simultaneous horizontal tow with ten MTD horizontal closing nets (0.35 mm mesh openings), with vertical distribution of temperature, chlorinity (Nishizawa *et al.*) and ammonia (Ishii) at Sta. 2901 (Oshoro Maru), 45°20'N, 144°00'E, in the Okhotsk Sea at night of September 4, 1968.

current flow does not direct the mouth of the net during the lowering (Pl. II, Fig. 5). A test indicated that samples obtained from undesired depths were almost negligible (Morioka, Ms). The nets had been closed before the raising, no longer sampling materials, so that no contamination occurs during the raising.

The deficiency of the first model (Motoda 1963) was the unreliability in the closing of the net, and that of the second model (Motoda 1967) was a clumsy long supporting rod. The operation of the new model was proven to be easier than old models, and that the closing of the net is satisfactorily reliable. The undesirability of the new model might be the fact that there are a trigger and other parts located in front of the mouth ring of the net that make an obstacle for entering plankton. The size of the net cannot be enlarged any further. Objects of sampling thus have to be confined to medium sized net plankton properly collected with a 0.10–0.35 mm mesh net. The main points of this model are: least number of lines and ropes which may cause entanglement; reliable closing of the net; easy handling of attachment and detachment from the wire cable (a few minutes operation); and proper size to be handled by one man.

An example of sampling with a 56-cm MTD horizontal net made at a station in Okhotsk Sea indicates very fine feature of detailed vertical distribution of zooplankton associated with temperature and salinity distribution (Fig. 1). The amount of ammonia was expected to show certain relationship with the abundance of zooplankton if the latter excreted much ammonia during active feeding. In Fig. 1, however, there is no increase in ammonia around 350-meter depth where a large mass of zooplankton exists. Any further discussion, however, is out of

matter in this paper.

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Explanation of Plates

PLATE I

- Fig. 1. MTD vertical closing double net. Before lowering.**
- Fig. 2. MTD vertical closing double net. Hauled on the sea surface after closed.**
- Fig. 3. Assembly of MTD horizontal closing net.**
- Fig. 4. MTD horizontal closing net. Position of the net during horizontal tow.**
- Fig. 5. MTD horizontal closing net. Position of the net after closed.**



Fig. 1



Fig. 2



Fig. 3

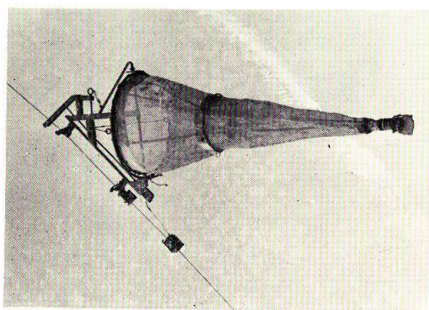


Fig. 4

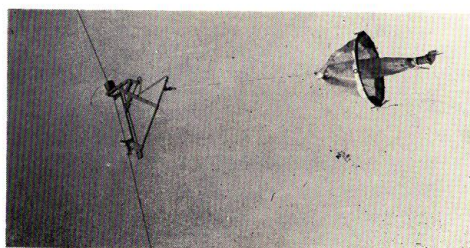
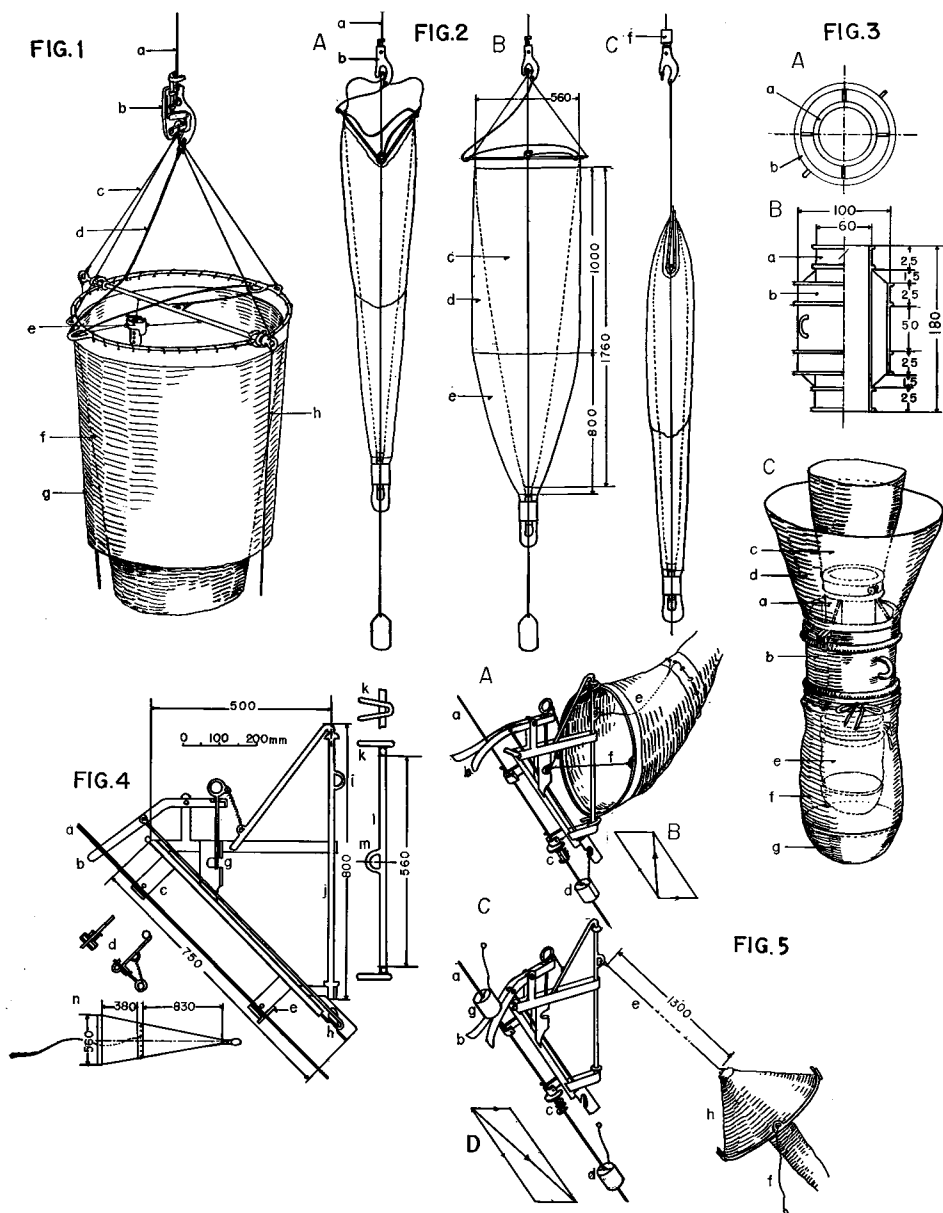


Fig. 5

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PLATE II

Fig. 1. Sketch of 56 cm-MTD vertical closing double net.

a. Wire cable b. Single release c. Bridle d. Closed ring suspender e. Flow-meter
f. Inner net, 0.35 mm mesh openings g. Outer net, 0.10 mm mesh openings h. Sinker
suspender

Fig. 2. Diagram showing the positions of 56 cm-MTD vertical closing double net in sinking, hauling during sampling, and hauling after closed.

a. Wire cable b. Single release c. Inner net d. Cylindrical portion of outer net
e. Conical portion of outer net f. Messenger weight

Fig. 3. MTD double tail tube attached to 56 cm-MTD vertical closing double net.

A. Plan B. Profile C. Sketch

a. Inner tube b. Outer tube c. Inner net, 0.35 mm mesh openings d. Outer net,
0.10 mm mesh openings e. Inner collecting bag, 0.35 mm mesh openings f. Outer
collecting bag, 0.10 mm mesh openings g. Metal bowl preventing the damage of the
sample

Fig. 4. Profile of 56 cm-MTD horizontal closing net.

a. Wire cable b. Trigger arm c. Wire hunger d. Wire hunger stopping mechanism
e. Base brim of wire hunger g. Bridle release h. Messenger release i. Eye for closed
net suspender j. Central rod k. Hook on the mouth ring l. Mouth ring m. Bridle
eye n. Dimension of the net

Fig. 5. Sketch of 56 cm-MTD horizontal closing net.

A. Sinking position of open net

B. Current vectors during sinking of the net at 2 m/sec when the ship proceeds at 1 m/sec

C. Hauling position of closed net

D. Current vectors during hauling of the net at 2 m/sec when the ship proceeds at 1 m/sec

a. Wire cable b. Trigger arm c. Wire clip d. Messenger to close underlying net
e. Closed net suspender f. Bridle g. Messenger striking the trigger arm