DEVICES OF SIMPLE PLANKTON APPARATUS V

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Before retiring from Hokkaido University in March 1971, the writer wishes to report on his final design of a horizontal closing net, named Motoda Horizontal Net (nicknamed MTD Horizontal Net) (Patent pending 45–120770, Dec. 29, 1970). After repeated performance tests at sea it was remodelled several times (Motoda, 1963, p. 155, III; 1967, p. 3, 1; 1969, p. 181, 2).

Although there have been many devices of samplers for collecting microplankton from several depths at the same time, they cannot be adopted for collecting macroplankton which can be effectively collected by towing a net. The principles of the net presented here are as previously mentioned, as simple as possible in its construction, easy to handle, and a reliable sampling. The net can separately collect sufficient number of specimens of macroplankton at short depth intervals, *e.g.*, every 10 meter stratum, at the same time by horizontal tow. The purpose of sampling is to obtain a microlayering picture in distribution of macroplankton averaging an uneven distribution at a stratum, *i.e.*, eliminating possible error due to patchiness by towing the net for a certain distance.

The main points of remodelling are: to assure the throttling of the net by the shock of a messenger weight; easy attachment and detachment of wire clamp and triangular frame supporting the net from the wire cable; and easy and reliable handling for suspending a messenger weight under the net and at the same time, it is reliable to release it after the net is throttled.

It will not be necessary to explain the structure of the gear in detail, since its simple construction could be easily understood by referring to Figs. 1 and 2. The size of the net suitable to be handled by one man is 56 cm in diameter (0.25 m^2) at the mouth, but according to the circumstances the size can be enlarged to some extent.

Operations: Several numbers of nets (ten nets are usually employed) are successively attached to the wire cable while the latter (4–9 mm in diameter) is run out. The weight attached at the end of the wire cable may be 20–50 kg. During this operation the ship's speed may be slowed down so as to keep the suspended wire cable at an angle of about 10–15 degrees. This not only makes

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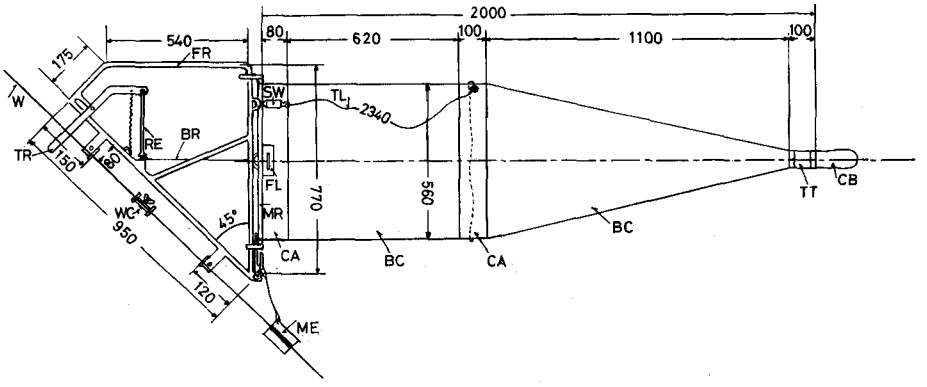

Fig. 1. Dimension of triangular frame and net of Motoda Horizontal Net
W: Wire cable, WC: Wire clamp, FR: Triangular frame (iron rod, 13.2 mm in diameter), SW: Swivel, TL: Throttling line (3.2 mm stainless steel wire), FL: Flowmeter supporter, RE: Release, TR: Trigger, CA: Canvas, BC: Bolting cloth, 0.35 mm mesh openings, BR: Bridle, MR: Mouth ring of net, 560 mm in inner diameter, TT: Tail tube, 60 mm in outer diameter, CB: Canvas bag, ME: Messenger, 2.5 kg in weight

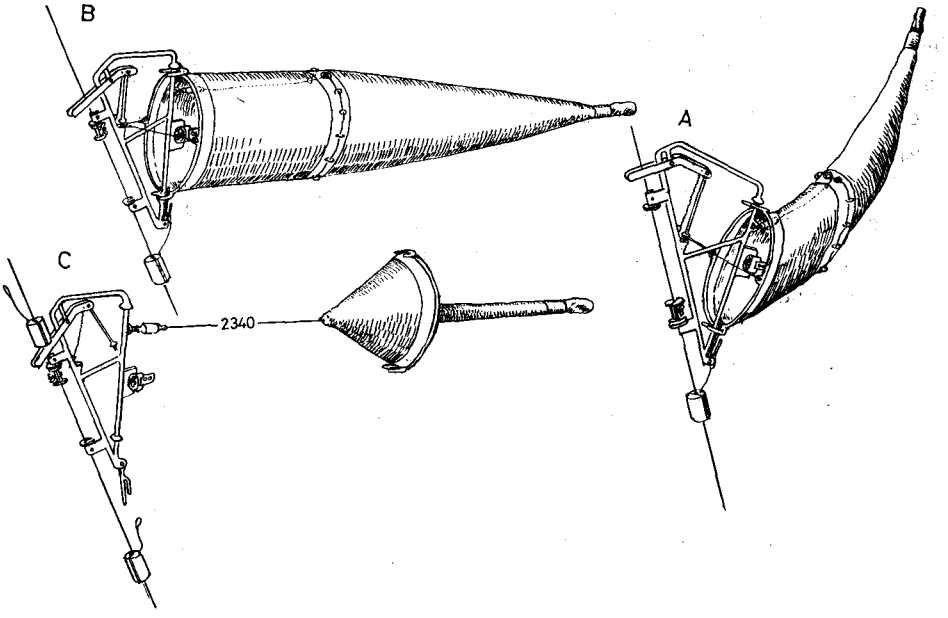

Fig. 2. Sketch of Motoda Horizontal Net
A: Net in lowering position B: Net in horizontally towing position C: Net in throttled position

the attachment of the net to the wire cable easy, but it also prevents the occurrence of contamination of samples from undesired depths during the lowering of the nets. Under this position the mouth of the net faces to the upper

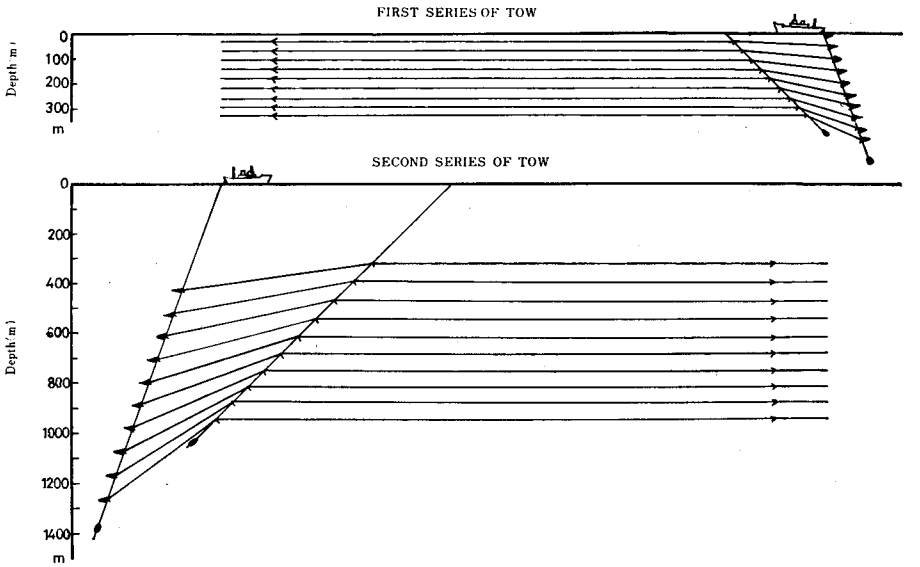

Fig. 3. Supposed loci of the nets in the first series and the second series of samplings at two stations in Aleutian waters on June 22 and 24, 1970 respectively, Oshoro Maru Cruise 37

direction and never collects plankton during the lowering. The time required for attachment of a wire clamp, a triangular frame, a net and a messenger weight is less than one minute when the man becomes skillful in this operation. After all the nets are set at proper positions, the ship's speed is raised to 1–1.5 knots to keep the angle of wire cable at approximately 45 degrees. Keeping this condition the nets are towed horizontally for a certain duration, usually 30 or 60 minutes. When the sampling is completed a messenger weight is slid down from the deck to throttle the surface net, which in turn successively throttles the nets at the subsurface strata. All the nets are hauled on deck in throttled position. The loci of the nets towed at two stations as mentioned below can be assumed as shown in Fig. 3.

A flow-meter can be mounted on the frame of the net. The flow-meter mounted on the frame will still revolute after the net is throttled, so that only the calibrated reading of the flow-meter at the surface net will indicate the approximate volume of water filtered by the net. The volume of water filtered by the subsurface nets is unknown, but it can be assumed to be almost the same as in the surface net on the assumption that clogging of the cloth meshes do not occur so differently in each net.

If one desires to collect the plankton from the depths more than ten different strata, it is recommended to divide the sampling into 2 or 3 series. In this case

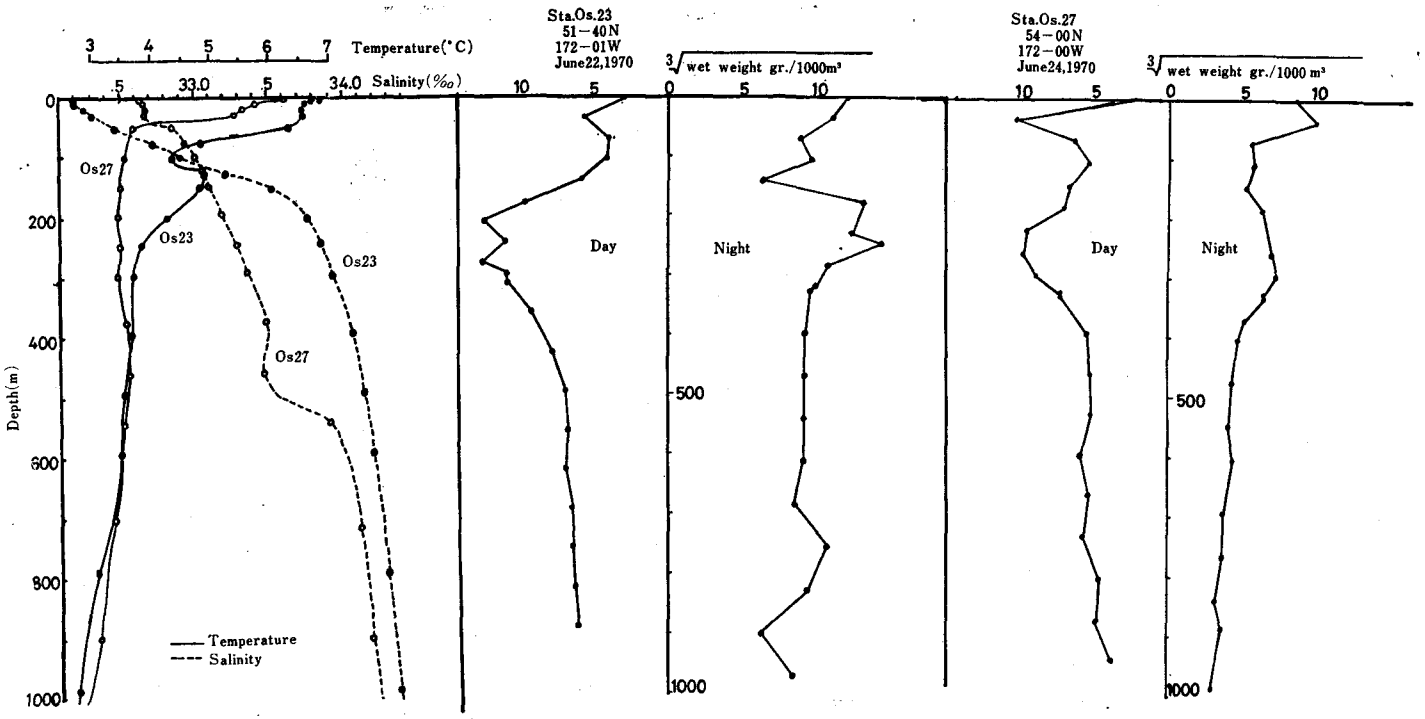

Fig. 4. Vertical distribution of zooplankton biomass in wet weight at two stations located at both sides of the Aleutian Ridge respectively, Oshoro Maru Cruise 37

two flow-meters should be used; one is at the shallowest net and the other is at the deepest net. If the first series of samplings is made at 10 strata in the upper 200 meters, the second series can be made at 10 strata from a depth of 200 m to 400 m. In the third series of samplings tows may be made at more longer intervals, say at 10 strata from 400 m to 800 m. In every case the volume of water filtered by the net should be standardized to the surface net, using the ratio of a flow-meter reading between the deepest net in the first series and the shallowest net in the second series; and the ratio between the deepest net in the second series and the shallowest net in the third series. The ship may run in reverse in the second series, and by doing so the third series will trace again the course of the first series.

Examples: On the occasion of Cruise 37 of the Oshoro Maru to the Aleutian waters, two stations were occupied on both sides of the Aleutian Ridge along approximately 172°W. Samplings were made through 19 strata in the upper approximately 1000 m in daytime and at night at both stations (Fig. 3). In the first series of samplings at both stations the intervals of depth of tow were taken at about 35 m (50 m in wire length) from the surface to 315 m (450 m in wire length), and in the second series of samplings the intervals of depth of tow were taken at about 70 m (100 m in wire length) from 315 m (450 m in wire length) to 945 m (1350 m in wire length). However, the angle of wire cable varied from 40 to 50; sometimes the nets were not towed at exactly desired depths. The time required to set 10 nets at desired depths while the wire cable was run out in the first series was about 20 minutes, and the duration of tow until the net was throttled was 30 minutes, and the time required for setting 10 nets at desired depths in the second series was about 45 minutes, and the duration of tow was 30 minutes.

In Fig. 4 vertical distribution of zooplankton biomass in wet weight at 20 strata from the surface to about 1000 m at two stations located on both sides of the Aleutian Ridge is illustrated with temperature and salinity gradient. Since the ship was drifted, the day station was not always located at exactly the same position as the night station. At Os 23 the temperature steeply dropped about 50 m below, and there was a dichothermal layer at about 100 m, while at Os 27 the temperature decline appeared at very near the surface. Nevertheless, there was seen a general trend that total zooplankton biomass in the upper 50 m increased at night compared with daytime. A large biomass centering at 200–300 m was seen in each case. Interpretation of these phenomena can be made after a close examination of the samples detailing the distribution of each species and each stage of a species.

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