A Large Trap-Type Filtering Sampler for Quantitative Microzooplankton Studies[1),2)]

HIROSHI UEDA[3)]

Department of Marine Sciences, University of the Ryukyus, Nishihara-cho, Okinawa 903-01, Japan

Abstract

A 50-liter trap-type microzooplankton sampler was constructed for quantitative microzooplankton studies. It consists of two 25-liter chambers, which have an upper lid with a self-activating air-intake hole and a detachable lower lid with a filtering net. These lids are closed simultaneously by messenger work. Because the water in the chamber is filtered out automatically at the water surface, the sampler can be lifted without a machine and so can be used on a small boat. The results of comparative samplings revealed that some zooplankton was collected more effectively by this sampler than by filtering water taken by a bottle sampler.

When we collect microzooplankton in the field using a small boat, we face difficulties in quantitative sampling. Plankton nets are most widely used for field plankton studies but are inadequate for collecting microzooplankton, because mesh size of towing nets (usually 0.1mm or more) is too large to collect it (VANNUCCI, 1968). If fine mesh, less than 50 μm, is used as net, filtering efficiency would greatly decrease due to clogging and friction of the cloth itself. Bottle samplers are also inadequate except in waters of high plankton density, since the sample size is usually too small for quantitative studies. If a large bottle is used, we are dependent on a lifting machine because of the weight of the sample. Due to this, we need a larger boat for sampling. Using a pump, we can collect larger samples but this method is not suitable from a small boat because of the size of the equipment consisting of the pump itself, a long tube and filtering devices.

I constructed a 50-liter trap-type sampler for quantitative studies of copepods including their nauplii in subtropical reef areas, where only a small boat was available for transportation because of the shallow waters. This sampler was designed to filter and discharge the trapped water when lifted to the air to decrease the weight. The special device to achieve this is a self-activating air-intake hole of the upper lid. I describe the construction of the sampler, which is called the LTFS (large trap-type filtering sampler) in this paper, and the results of a preliminary sampling compared with a Van Dorn water bottle.

[1)]Accepted 10 September 1991

[2)]小型動物プランクトン定量研究用の大型トラップ式濾過採集器

[3)]上田拓史，琉球大学理学部海洋学科

Construction and Operation

Construction

The main construction of the LTFS consists of 2 transparent box-shaped chambers made of 5mm thick polyvinyl chloride (PVC) plates, each with a capacity of 25 liters, and a 70cm long PVC tube of 32mm in inside diameter between the chambers (Fig. 1). The walls of the chambers are cut off remaining about 5 cm wide margins and replaced by an 1 mm thick PVC plate to decrease the weight. The edges of the chambers are reinforced with aluminum angle bars.

The upper lid is attached to the chamber wall by a hinge of a 1 mm thick rubber tape, and has an air-intake hole of 12 mm in diameter and a latch to connect the lid to the central tube. The hole has a shutter connected with a float between the chambers by a 10 cm long rod (Fig. 2). The float is made of a 35 cm long PVC tube, 20 mm in diameter and 1 mm in wall thickness, and both ends are sealed with rubber stoppers. Underwater, the shutter is closed by the buoyancy of the float and opened by the weight of the float when the top of chamber

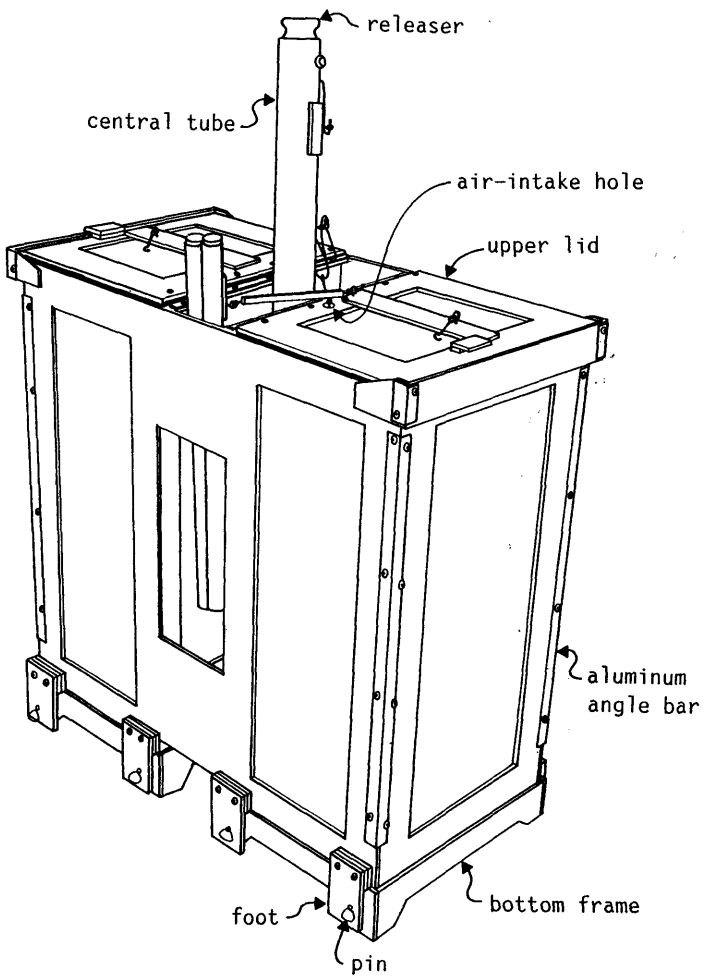

Fig. 1. Large trap-type filtering sampler (LTFS).

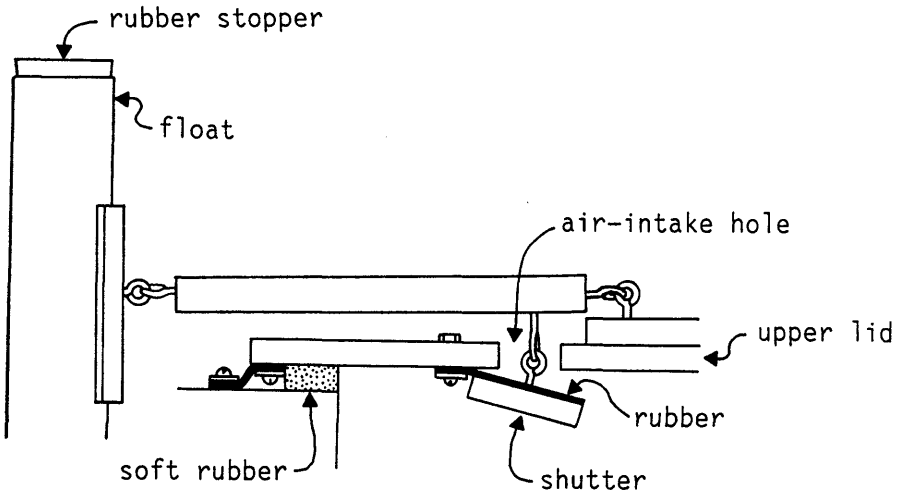

Fig. 2. Diagram of self-activating air-intake hole of the upper lid.

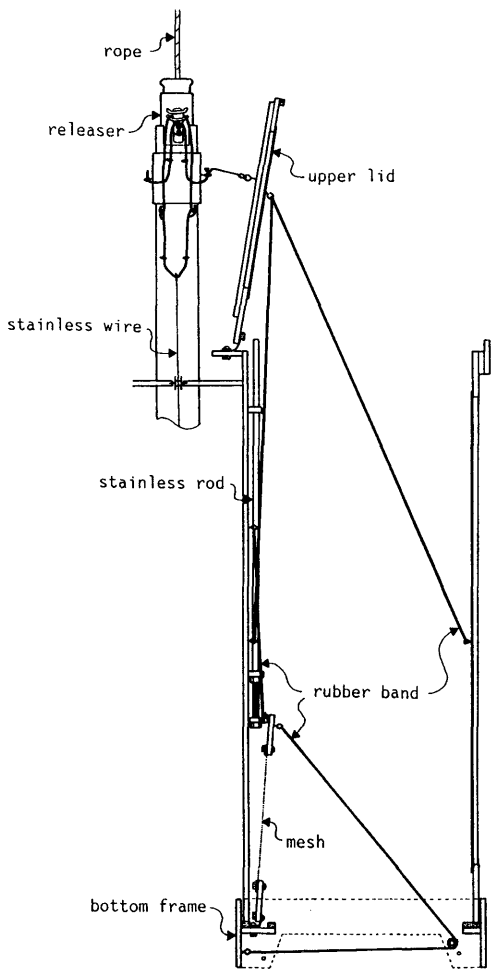

Fig. 3. Sectional diagram of LTFS, of which lids are opened.

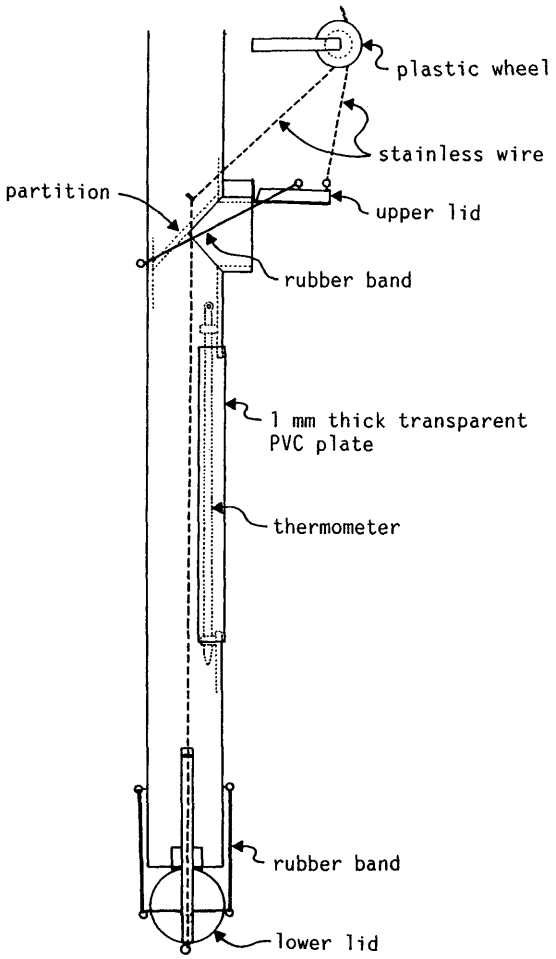

Fig. 4. Diagram of tube water sampler, of which lids are opened.

reaches the water surface.

The bottom frame carrying a lid is detachable (Fig. 3). The lid has a window closed by mesh and is attached to the frame with a hinge of rubber tape. The mesh is margined with 1 mm thick and 1 cm wide PVC plates fastened on to the lid by stainless steel bolts to be exchangeable according to objective plankton sizes. The frame is fixed to the chamber by pushing 4 pins through holes in the feet of the chamber and the side of the frame. Within each chamber, there is a sliding rod of 5 mm diameter, of which the lower end has a hook to hang the lower lid open. Soft rubber tapes of 5 mm thick and 10 mm wide are glued the downside of the upper lid and inside the bottom frame to prevent leakage; to stop leakage completely, the surface of the rubber is coated with Vaseline.

The central tube has a releasing mechanism using a plankton net releaser made by Rigosha Co. Ltd. (Fig. 3). The lower half of the tube is a water sampler with a capacity of about 250 ml, to uptake the water at the same depth of the plankton sample for salinity measurement (Fig. 4). The front side of this water sampler is partly cut off and replaced with a transparent, 1 mm thick PVC plate

and equipped with a mercury thermometer inside. The upper and lower lids of the water sampler are hinged by rubber plates and opened by stainless steel wires, which are hanged to the releaser. All lids and doors of the chambers and the water sampler tube are tightly closed by the tension of stretched rubber bands when the latches and the wires are released.

Sampling Operation

The sampler is set on board by the following operations. 1) Attaching the bottom frames to the chambers, 2) opening the lids of the water sampler by hanging the wires to the releaser, 3) hanging the latches of the upper lids of the chambers to the releaser and 4) hooking the lids of the bottom frames to the inside rods. After lowering the sampler to the required depth, a messenger is dropped, by which the releaser is pushed down and the latches of the upper lids are released. By closing the upper lids, the inside rods are pushed downward and the hook hanging the lower doors are opened simultaneously. The lids of the water sampler are also closed simultaneously by releasing the wires. Back at the water surface the shutters of the air-intake holes open automatically when the floats lose their buoyancy. As the sampler is lifted to the air, the trapped water is filtered through the mesh of the lower lids.

Soon after the sampler is lifted on board, water temperature is measured by reading the thermometer in the central tube and the water in the tube is drained into a small container by opening the lower lid of the tube. Then the bottom frames are removed by pulling the pins and the plankton is collected into a sample bottle by washing the frame with filtered sea-water using a washing bottle.

Preliminary Samplings

Comparative samplings using the LTFS equipped with 37 and 75 mesh nets and

TABLE 1. COMPARISON OF COLLECTED ZOOPLANKTON NUMBERS USING THE LTFS AND A VAN DORN WATER BOTTLE. VALUES ARE BASED ON THE NUMBER PER 1-LITER OF SEA WATER. MEAN NUMBERS WITH "*" FOR 37 μM MESH ARE SIGNIFICANTLY LARGER THAN THOSE FOR 75 μM MESH ($P < 0.01$). MEAN NUMBERS WITH "+" OR "++" FOR THE LTFS ARE SIGNIFICANTLY LARGER THAN THOSE FOR THE VAN DORN BOTTLE (+, $P < 0.05$; ++, $P < 0.01$).

	37 μm mesh				75 μm mesh			
Sample No.	1	2	3	Mean	1	2	3	Mean
LTFS								
Copepodids	1.7	1.4	1.8	1.6	1.9	2.7	1.3	2.0
Copepod nauplii	62.4	70.8	62.4	65.2*	13.9	13.1	11.3	12.8
Oikopleura dioica	44.6	43.4	54.1	47.4*+	10.3	9.4	11.7	10.5++
Van Dorn bottle								
Copepodids	1.1	2.6	1.3	1.7	1.8	2.6	1.9	1.8
Copepod nauplii	58.5	61.8	59.0	59.8*	15.8	9.9	10.9	12.2
Oikopleura dioica	33.5	36.7	39.6	36.6*	3.3	4.3	4.8	4.1

a 6-liter Van Dorn water bottle were conducted in 1 m depth at the pier of Naha Harbor, Okinawa, on June 9, 1988. The water sampled by the Van Dorn bottle was filtered by pouring into cylindrical (11 cm in diameter and 20 cm long), 37 μm and 75 μm mesh bolting nets using a 2-liter measure cup. Three replicate samples were taken for each sampler and mesh size; the two different samplers were used by turns to minimize the effects of non-random distribution of plankton. The dominant zooplankters, which were copepodids consisting mainly of *Bestiola similis* (Sewell) and *Oithona* spp., copepod nauplii and a larvacean *Oikopleura dioica* (Fol) were counted under a microscope. Most of *O. dioica* were of juvenile stage smaller than 100 μm in trunk length.

The results are presented in Table 1. There were no significant differences in the numbers of copepodids between the LTFS and the bottle sampler and between 37 and 75 μm meshes. This indicates that the LTFS can trap copepodids as successfully as the bottle sampler and there was no loss through the mesh. In both samplers, however, the numbers of copepod nauplii and *O. dioica* filtered with 37 μm mesh were several times higher than those with 75 μm mesh. This indicates that most of them passed through 75 μm mesh. A significant difference between the samplers was seen in the number of *O. dioica*, which was higher in the LTFS than in the bottle sampler especially when a 75 μm mesh was used.

Discussion

Trap-type plankton samplers which filter the sample when lifted out of the water have so far been described. MOTODA (1949) devised a 20-liter sampler consisting a cylindrical chamber (53 cm long and 22 cm in diameter) and a conical filtering net with a mouth ring of the same diameter. The chamber was stretched with a müller gauze or canvas and had two automatically closing, semicircular tin-plate lids at the upper end. Sampling was conducted as follows. The conical net was first lowered to the required depth and then the chamber was dropped. When the chamber reached to the net, the lids were closed by its own weight. At the water surface after towing, the lids were opened by a hand to filter the water smoothly. SCHINDLER' S (1969) transparent sampler made of Plexiglas sheeting, and having a capacity of 28.7 liters, was also a self-closing trap and filtered the water at the water surface. Because the upper and lower lids were hinged to the chamber and could swing freely, these opened automatically as the sampler was lowered and shut when the sampler was stopped. At the water surface, the water in the sampler was filtered through a removable conical net on a side plane.

The LTFS resembles Schindler's type in many features. The differences are in the closing mechanism of the lids and in the air-intake hole of the upper lids. I used stretched rubber bands to close the lids. Although unlike in Schindler's samplers some setting operations before sampling are necessary, closing by stretched rubber bands perfectly prevented accidental opening of the lids after tripping. Without such a forced closing mechanism, the doors would easily open if the sampler is stopped during raising or is lowered during filtering at the water surface; if there are waves, it is difficult to lift the sampler slowly and continuously during filtering. The air-intake hole is necessary to filter the water automatically. The upper lid of Schindler's sampler has a hole too, which is

screened with a 28 μm mesh. I do not think, however, that such a screened hole can let air into the chamber because a fine, wet mesh forms a film of water and air can hardly pass through. Indeed, in my preliminary design of the LTFS, the central part of the upper lid was cut off and screened with a 75 μm mesh but the air was not able to pass the wet mesh until more than a half of the chamber was lifted to the air.

Avoidance from samplers and loss through the mesh are known as a cause of bias in plankton data (CLUTTER & ANRAKU, 1968; VANNUCCI, 1968). The results of the preliminary samplings revealed that sampling efficiencies for small copepods and their nauplii were not different between the LTFS and the Van Dorn bottle. *Oikopleura dioica,* however, was more efficiently collected by the LTFS. This is possibly due to the difference in the filtering manner between the samples. The significant difference of the *O. dioica* numbers between 37 and 75 μm meshes in each sampler indicates that, although the body length including its tail was much greater than the mesh size, most of animals could pass the mesh because of their slender, compressive bodies. It is considered that, for such a slender animal, to pass or not to pass depends on the angle of the body on the mesh. The samples taken by the bottle sampler were filtered by pouring the water into the cylindrical net. In this manner, *O. dioica* once caught by the mesh would be re-suspended because of vigorous water movement in the net and get another chance for escaping through the mesh. On the other hand, the water in the LTFS would be filtered continuously without being stirred and therefore *O. dioica* once caught by the mesh would not be re-suspended unless the sampler is lowered during filtering. Thus, the continuous filtering of the LTFS is considered to increase the sampling efficiency for slender plankton by decreasing the loss through the net.

The LTFS is useful not only for microzooplankton studies but also for netplankton studies if its density is high. For example, it may be recommended for studies on vertical distribution in shallow, nearshore waters, where netplankton density is usually high, because vertical towing of a closing plankton net is not practical in such shallow depth. If a finer mesh is used, the sampler is also useful for phytoplankton studies in water with low phytoplankton density because of its large sample volume.

Acknowledgments

I express my gratitude to Dr. W. M. Hamner, University of California, Los Angeles, who informed me of Schindler's transparent sampler, and to Mr. S. Fuse, University of the Ryukyus, for useful discussion of the device of the air-intake hole with him. I am also indebted to Mr. T. Takahashi and Miss M. Yoshimura, University of the Ryukyus, for their help in constructing the sampler and sampling with it.

Literature Cited

CLUTTER, R.L. & M. ANRAKU, 1968. Avoidance of samplers, pp.57-76. In *Zooplankton Sampling* (ed. Tranter, D.J. for Part I). The Unesco Press, Paris.

SCHINDLER, D.W., 1969. Two useful devices for vertical plankton and water sampling. *J. Fish. Res. Bd. Can.*, **26**: 1948-1955.

MOTODA, S., 1949. Tesei no kansoku kigu ni, san. (Several handmade apparatuses for survey) *Sake Masu Iho,* Nos. 48/49: 16-22. (In Japanese)

VANNUCCI, M., 1968. Loss of organisms through the meshes, pp. 77-86. In *Zooplankton Sampling* (ed. TRANTER, D.J. for Part I). The Unesco Press Paris.