Short Communication

SIMPLE MICROBIOLOGICAL SAMPLERS FOR THE SURFACE AND DEEP WATER COLLECTIONS¹

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For the aseptic collection of water samples in a field survey, the author designed two simple microbiological samplers for surface and deep water collections. In designing these samplers emphases were laid on the following points: (a) Simplicity in mechanics, (b) use of the bottle of refreshing beverages as the sampling bottle, and hence (c) easiness in handling and low cost of the apparatus. These samplers were named UTY-S and UTY-D for the surface and deep water samplers, respectively.

Construction of sampling bottle. Since the bottle of refreshing beverages, such as Coca-Cola, Pepsi-Cola, Mirinda, *etc.*, was proved to be strong enough against hydrostatic pressure at the depth of 200 m, it was used as the sampling bottle. As shown in Fig. 1, the bottle (3) of 200 ml capacity is equipped with a silicone rubber stopper (7) with a two-way glass tube (9), to which are connected long (8) and short (10) pressure rubber tubings. At the end of the long tubing (length, 30 cm; inner diameter, 4 mm), a short pressure tubing (length, 5 cm; inner diameter, 2 mm) is connected, into the end of which a closed-end glass capillary (11; length, 9.5 cm; outer diameter, 3.5 mm; inner diameter, 2 mm) is inserted. The short tubing (10) is plugged with a glass plug (13) at the end.

Before using the sampling bottle, its mouth is covered with an aluminum foil and it is sterilized by dry heating. On the other hand, a stopper set (7, 8, 9, 10, and 11) without a glass plug is autoclaved (120°, 15 min) with the silicone rubber stopper and the short rubber tubing covered separately with aluminum foils. Before field survey, the stopper set is fixed into the bottle mouth and the bottle is evacuated with an evacuation pump through the end of a short rubber tubing. After evacuation, the short tubing is pinched with chain-nose pliers and plugged instantly with a sterilized glass plug. These procedures are carried out in the laboratory just before each field survey.

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Fig. 1. Plan of surface water sampler.

1, hook hole; 2, bottle-bottom supporting plate; 3, sampling bottle; 4, rubber tube band; 5, back metal plate; 6, bottle-neck supporting plate; 7, silicon rubber stopper; 8, long rubber tubing; 9, two-way glass tube; 10, short rubber tubing; 11, glass capillary tube; 12, capillary tube hole; 13, glass plug; 14, sinker line hole; 15, sinker; 16, hook; 17, fulcrum; 18, capillary breaker plate; 19, flapping board; 20, nylon string.

Inserted figure shows the process of a working capillary tube breaking system around the capillary breaker plate. (a) Before hitting the water surface with a flapping board. (b) Just after hitting the surface. (c) Hanging process of the capillary breaker plate.

The sampling bottle can be used safely within the depth of 100 m. When the glass capillary is broken by a capillary breaker in the water, it takes about 1 min for the water sample to fill up the bottle. At the depth of 200 m, the bottle is strong enough but the attachment in the bottle mouth is pressed into the bottle by the hydrostatic pressure.

Surface water sampler (UTY-S). The principle of this sampler (Fig. 2) is as follows: When it is hung down by a nylon rope near the surface of water and dropped from 0.5–1 m above the surface into the water, a flapping board hits the

Fig. 2. Whole view of a surface water sampler hung by a nylon rope. The arrow indicates the fulcrum of the capillary breaker plate.

water surface and, at the same time, the glass capillary of the sampling bottle is broken by the capillary breaker plate at the foot of the flapping board. Thus, an evacuated bottle sucks the ambient water.

As seen in Fig. 1, the sampling bottle (3) is fixed in a bottle holder (1, 2, 4, 5, and 6) made of 2-mm thick aluminum plate. To the rear side of the bottle holder is fixed a flapping board (19) with a capillary breaker plate (18) with two hooks (16) through two hook holes on the bottle holder. Just before sampling, the capillary tube of the sampling bottle is inserted into two capillary tube holes (12).

As shown in the inserts in Fig. 1, when the flapping board hits the water surface, the edge of the capillary breaker plate (17) becomes a fulcrum and the glass capillary is broken. Then, the capillary breaker plate with a flapping board is released from the bottle holder, because the hooks come out from the holes. The released flapping board is hung with two nylon strings (20). This releasing mechanism is important to reduce the drag force of flowing water, such as in the case of sampling river water from a bridge. When the capillary tube is broken, end of the long rubber tubing springs out from the capillary tube holes by its elasticity. In a shallow water area in the river, the end of the rubber tubing sometimes springs up into the air and sucks the air instantly. To prevent such an event, it is recommended to attach a lead sinker at the end of the long rubber tubing during sampling in a shallow or rough water area.

Deep water sampler (UTY-D). The principle of this sampler (Fig. 4) attached to a 6-liter Van Dorn sampler (Rigosha, Tokyo) is as follows: When the releaser rod of a Van Dorn sampler is hit by a messenger, one end of the trigger lever is pressed down by the spring stopper on the rod and, at the same time, the hook at the other end of the lever is released from the capillary puncher. Thus, the capillary tube is broken and ambient water is sucked into the evacuated sampling bottle.

Fig. 3. Plan of deep water sampler attached on the side of a Van Dorn sampler.

Side view of a Van Dorn sampler is a developed figure. Side view of a capillary breaking system is inserted in the developed figure. Four metal bands around the surface of a Van Dorn sampler are numbered from the top toward the bottom, Bds. I, II, III, and IV.

1, spring stopper; 2, hook under spring stopper; 3, spring; 4, releaser rod; 5, fulcrum; 6, trigger lever; 7, hook at capillary puncher; 8, capillary puncher; 9, glass capillary tube; 10, L-shaped plate on which capillary breaking system is fixed; 11, capillary supporter; 12, rubber tubing clasper; 13, long rubber tubing; 14, band connector; 15, bottle holder; 16, sampling bottle; 17, two-way glass tube.

Fig. 4. Whole view of a deep water sampler attached on the surface of a Van Dorn sampler.

Vertical arrow indicates an L-shaped hook at the end of a trigger lever keeping a capillary puncher opened. Horizontal arrow indicates a spring stopper on a releaser rod of a Van Dorn sampler.

As shown in Fig. 3, each part of this apparatus is fixed on either one of four metal bands around the Van Dorn cylinder. The bottle holder is fixed on Bds. III and IV at the band connectors (14). The sampling bottle is fixed in the bottle holder, which is principally the same as that of UTY-S.

The glass capillary breaking system is composed of a trigger lever (6), capillary puncher (8), capillary supporter (11), and rubber tubing clasper (12). The trigger lever is fixed on Bd. I at the fulcrum (5) and the latter three parts are fixed on the L-shaped aluminum plate (2 mm in thickness), both ends of which are fixed on Bds. I and III. At one end of the trigger lever is a curved hook (2), which is located just underneath the spring stopper (1) on the releaser rod (4) of a Van Dorn sampler. At the other end of the lever is the L-shaped hook (7), which keeps the capillary puncher opened. Just before sampling, the end of the long rubber tubing (13) of the sampling bottle (16) is fixed in the rubber tubing clasper by inserting a glass capillary at its end into the holes of a capillary supporter. When a messenger hits the releaser rod of a Van Dorn sampler, the spring stopper on the rod presses down the trigger lever, then the capillary puncher will be closed with its strong spring as it is released from the hook at the end of the lever. Thus, the glass capillary is broken and ambient water is sucked into the sampling bottle.

The present apparatus was made by hand, using two paper claspers in a capillary breaking system. Of these claspers, the one used for a capillary puncher should be strong enough to repeated punchings. Therefore, an iron plate of

2.5 mm thickness is attached on the top of the puncher to strengthen the weakest part around its fulcrum (see shadowed part on 8).

Comment. ZOBELL (1) classified conventional microbiological water samplers into three types; (a) weighted glass bottle from which the stopper is removed, (b) cylinder to which water is admitted by opening valves or by withdrawing a piston, and (c) partially evacuated glass receptacle to which water is admitted by breaking a capillary glass tube (e. g., J-Z sampler, 1). In addition to these devices NISKIN (2) developed a bellows-type sampler with a polyethylene container which can be opened by a torsion spring.

UTY-S and UTY-D samplers belong to the third category in principle and water is collected in a bottle of refreshing beverages, which was recommended earlier by ZOBELL (1). These two samplers are easily made in a laboratory workshop. In UTY-S, the action for breaking the capillary tube is simply achieved by dropping the sampler into water without using a messenger or other special device. In UTY-D, the use of a Van-Dorn sampler as a carrier may be characteristic, since the latter sampler is routinely used for field survey.

In our extensive survey of the river and sea-water areas (3), we have employed these samplers quite frequently. When sampling river water, we used UTY-S successfully from a high bridge, even more than 30 m above the water surface. On a windy day on such a high bridge, however, the sampler should be lowered slowly and carefully, otherwise the flapping board will be flung up by the wind.

As for the mishap in the use of these samplers, though it seldom occurs, two points should be noted. The one is sucking of air into the bottle in UTY-S by the springing up of the end of the long rubber tubing out of water in a shallow or rough water area. This will be prevented, as already pointed out, by attaching a lead sinker at the end of the tubing. The other is a spontaneous refilling of air in the sampling bottle by leakage. Most probable leaking portion is (a) at the end of the long rubber tubing, where a glass capillary is inserted or (b) a crack in the sampling bottle. The former will be prevented by an occasional change of the short rubber tubing connected to the end of a long tubing and the latter by the careful checking of bottles before field survey. It is advisable to evacuate the bottles just before the start of field survey.

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