Two Useful Devices for Vertical Plankton and Water Sampling

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Two devices for taking plankton and water samples are described. One, an inexpensive syringe sampler, will obtain small uncontaminated samples from thin strata in lakes. The other, a self-activating transparent zooplankton trap, combines many of the advantages of both net and trap-type samplers. It is capable of removing the smallest zooplankton and its light weight allows large samples to be taken easily from a small boat. Comparisons with other samplers prove the self-activating trap to be more efficient than other devices which are commonly used.

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IN THE COURSE OF investigating the plankton and water chemistry of several small lakes in the Canadian Shield it was necessary, both from a standpoint of cost and of function, to develop two new sampling devices rather than use those commonly employed in limnological investigations. Both devices are described here, in hope that they may prove useful to other investigators facing similar sampling problems.

Device 1. The first device is one designed for obtaining samples from thin undisturbed strata within a water column. The sampler was designed as a means for sampling near the thermocline, chemocline, or bottom of a lake without the disturbance associated with most commonly used sampling devices. The sampler may be constructed in most laboratory workshops for a cost of $15–20.

Sampler construction — The body of the sampler is an inexpensive disposable plastic syringe of 50 ml capacity. Such syringes are made completely of inert material, and come in sizes ranging from 1 to 1000 ml, so that with appropriate modifications several sizes of sampler might be constructed. A single syringe will normally last several seasons, and may be replaced in a matter of minutes with pliers and screwdriver. A bayonet-style mount allowing syringes to be changed more rapidly could easily be constructed.

All other parts of the sampler are constructed of brass, with the exception of the three slide-rods which are of stainless steel. Construction detail is shown in Fig. 1.

Sampler operation — The sampler is lowered in the closed position, as shown in Fig. 2A. Dropping a messenger-weight releases catch B (see Fig. 1) allowing the weighted barrel of the syringe to move downward until it comes

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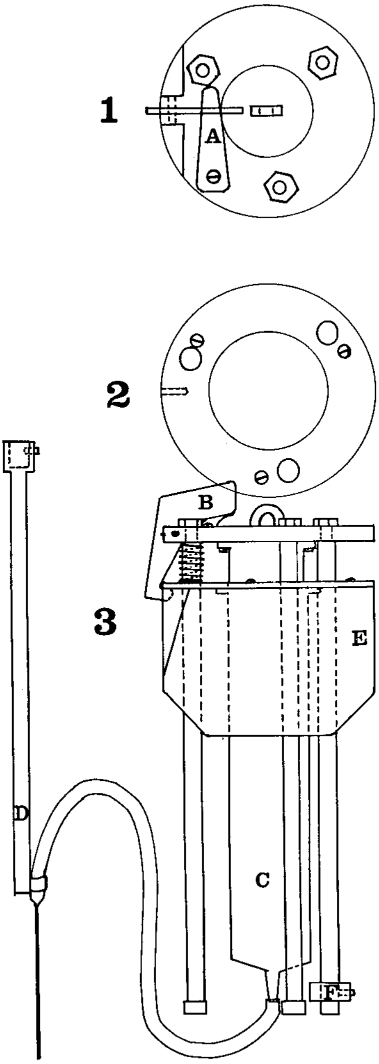

Fig. 1. Construction details for the syringe sampler. (1) Top view; (2) top view of weight; (3) side view. See text for explanation.

against stop F, drawing water into the barrel of the syringe. Stop F is movable, so that the volume drawn by the sampler may be adjusted. The sampler in filled position is shown in Fig. 2B.

In its simplest form the sampler may be used without the syringe needle attachment. The aperture of the 50-ml syringe moves a maximum of 12 cm vertically while filling. To draw samples from very thin layers where turbulence must be completely avoided, the syringe-needle attachment shown in Fig. 1 and 2 should be used. This consists of an extension rod to which a large bore syringe needle may be attached by a clip. The needle is connected to the aperture of the syringe barrel by a length of flexible tygon tubing.

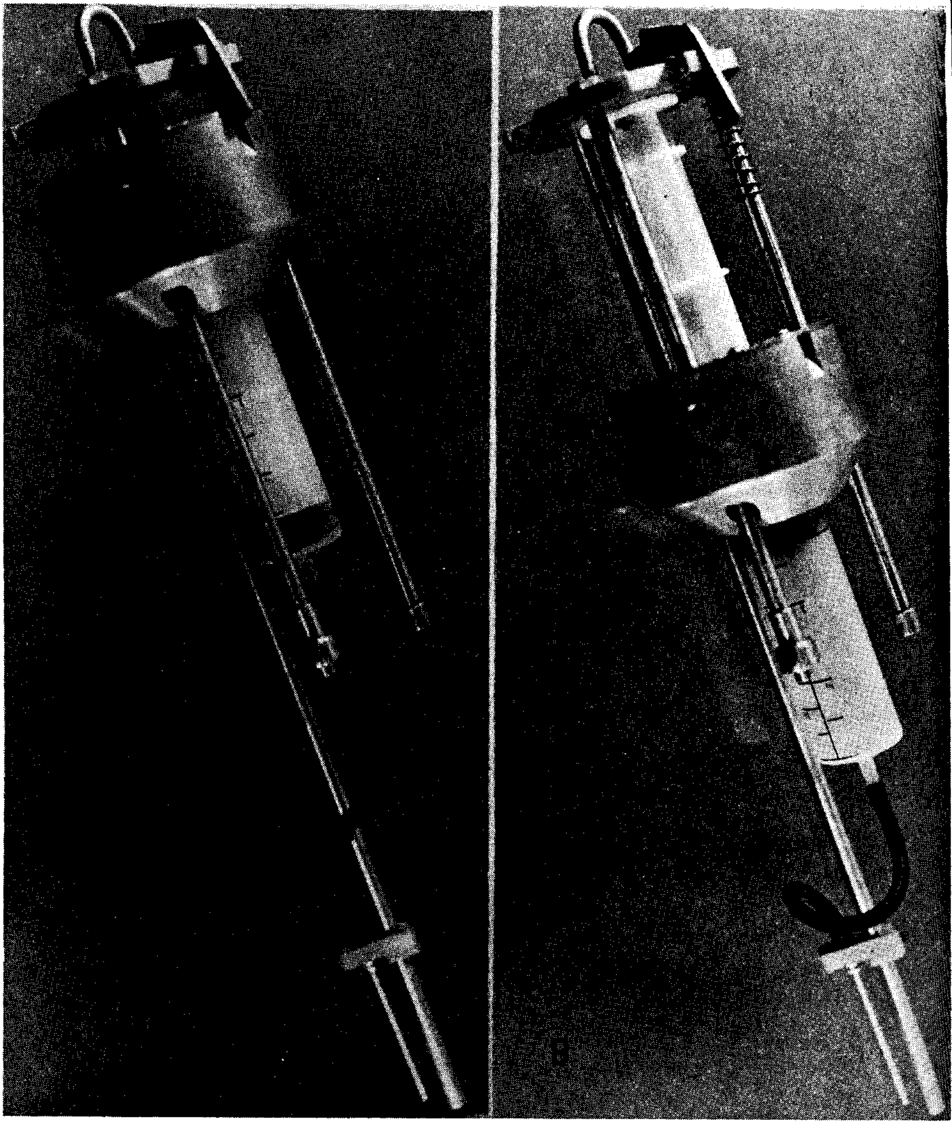

FIG. 2. (A) Syringe sampler in empty position; (B) syringe sampler in full position.

If lowered slowly into position, disturbance of strata by the sampler should be very slight.

Microbiological sampling — If sterile samples are desired, a separate length of tubing, complete with a syringe needle and a small plug of cotton in the upper end of the tubing, should be prepared for each sample to be taken. Each needle and tube should be sealed in a separate container for autoclaving. As the needle is held by a simple clip, tubes can be speedily changed between samples. The volume held by the sterile tube is sufficient to inoculate several cultures.

Device 2. The second device is a modification of Patalas' self-activating plankton trap. All popular zooplankton samplers have several undesirable characteristics. Most of the metered netting devices, including the frequently used Clarke–Bumpus sampler, are priced beyond the budget of a private investigator or a small laboratory. In addition, a power boat is usually required for towing except when vertical tows are satisfactory. The metering devices commonly employed will not operate properly when fine mesh townets are used; therefore, quantitative samples of small organisms cannot be obtained. Complicated opening and closing devices are necessary if metered nets are to be used for obtaining vertical distribution data, and the depth of the sampler must be calculated from the length and angle of the tow wire. There is recent evidence to suggest that tow bridles of any sort have a detrimental effect on the efficiency of nets (Mahnken, 1967). Avoidance reactions, particularly by larger zooplankton are also of importance, as discussed later.

Trap-type samplers, including the designs of Juday (1916), Rawson (1956), and Patalas (1954), as well as the large van Dorn or Kemmerer samplers, suffer from one or more of the following objections:

1. Many samplers have complicated tripping mechanisms which do not function dependably in cold weather, are difficult to reset, and require a messenger for closing. Taking several samples is a tedious process.

2. The sample size is too small, or, if a larger sampler is used, it is heavy and difficult to lift into a boat when full of water. Most must be held over a net for emptying.

3. Most have been constructed of opaque materials which may cause avoidance reactions from some planktonic organisms (see Szlauer, 1964).

The sampler described here is in many respects similar to that of Patalas (1954). It is, however, almost entirely constructed of transparent material, and its light weight and method of emptying make it possible to use samplers of up to 100 liters from even a small car-top boat.

A picture of the sampler in operation is given in Fig. 3, and construction details for a model of 28.7 liters capacity are given in Fig. 4. The body of the sampler is entirely constructed of plexiglass sheeting.[1] This material has proven extremely durable during one season's field work. Small repairs may be quickly made in the field using chloroform as a solvent. A small nannoplankton net is attached to the side ring for filtering the contents of the sampler. Two mesh sizes, 28 and 10 μ, are available from G. M. Manufacturing Corporation, New York. Either meshs ize will retain the smallest of rotifers and nauplii. The 10-μ size will also trap many phytoplankton species, though it filters more slowly than the larger mesh.

Sampler operation — The upper and lower doors of the sampler swing upward to the vertical position as the sampler is lowered, with the lower

[1]When not in use, the trap was usually carried in a fitted box lined with $\frac{1}{8}$-inch foam rubber, which helped to prevent scratching of the plexiglass. After a year's field work the transparency was still good.

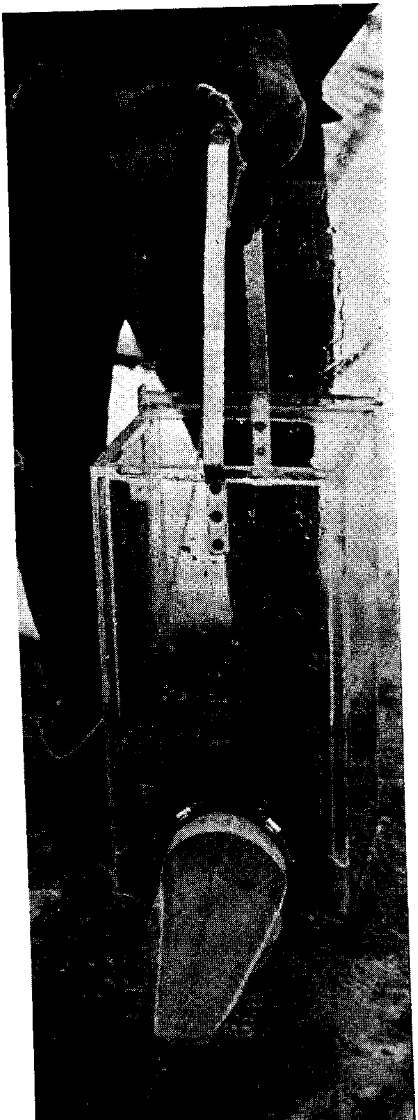

FIG. 3. The transparent trap in use during winter.

door blocking the mouth of the net (see Fig. 4). When the sampler is stopped, both doors swing gently shut, and seal tightly as the sampler is raised. Leakage is negligible; if the screened hole shown in the upper lid is not added, the seal is so tight as to keep water from running out through the net. As the sampler is pulled from the water its contents are filtered through the net, so that only the empty sampler is raised from the water. The contents of the net are easily rinsed into a sample bottle with the use of a wash bottle. No messenger is required and there are no tripping devices to set before lowering the sampler, so that several samples may be taken very quickly.

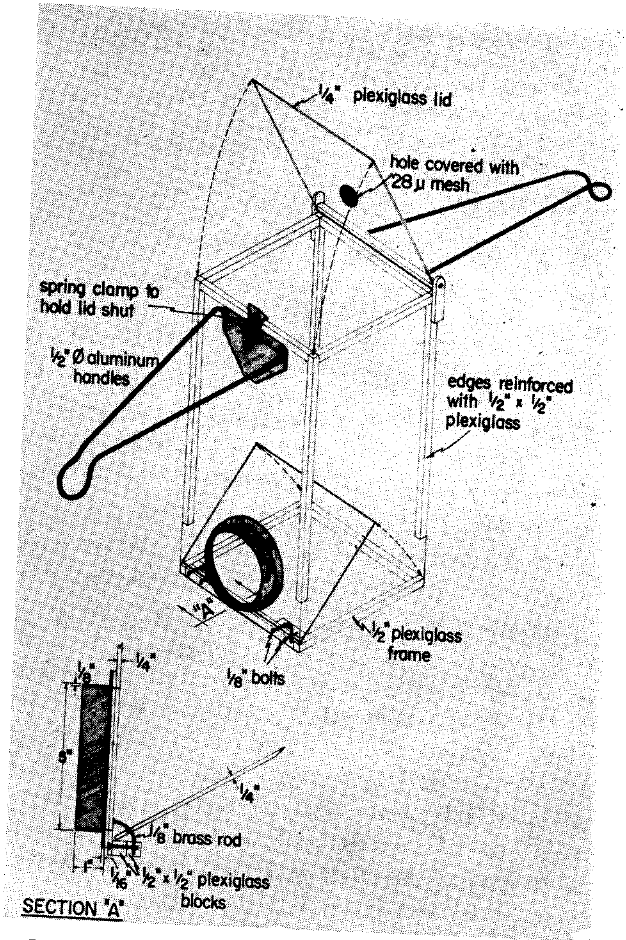

FIG. 4. Construction details for the transparent trap.

Sampler efficiency—The transparent sampler was tested against three other sampling devices which are currently very popular. The test was performed in FRB Experimental Lake No. 122 near Kenora, Ontario. The test procedure was similar to that designed by Patalas (1954).

At each of 10 stations two vertical series of 10 samples were taken at 1-m intervals using a 9-liter opaque van Dorn for one series, and the transparent trap for the other. All 10 samples taken with each device were pooled and considered to be one replicate. Two 10-m vertical hauls were also made at each station using a Clarke–Bumpus adapted for vertical tows for one haul and a 12″-diam metered townet for the other. The same procedure was repeated at all 10 stations. Replicate samples were concentrated in graduate cylinders and subsampled for counting. At least 100 animals of each species were counted from each replicate, except when there were fewer than 100 specimens of the species in the sample. Results are set out in Table 1. All

TABLE 1. Relative effectiveness of several zooplankton samplers. All figures are based upon an index of 100 for the transparent trap. Figures to the right of the ± sign represent approximately 95% confidence limits for 10 replicates.

Species	Sampling device: 28-liter transparent trap	Opaque 9-liter van Dorn	5-inch Clark–Bumpus #15 net	12-inch metered townet #20 mesh
Holopedium gibberum	100±18	65±15	71±18	65±24
Daphnia sp.	100±14	62±18	74±13	60±30
Leptodora kindtii	100±26	54±41	35±24	59±33
Diaptomus leptopus	100±21	60±22	54±23	49±21
Diaptomus minutus	100±18	105±25	68±12	86±31
$\bar{x}$	100±19	69±24	60±18	64±28

results are relative to an arbitrary index of 100 for the transparent trap. None of the other samplers were as efficient as the transparent trap except for the high capture efficiency for the small *Diaptomus minutus* by the opaque van Dorn trap, a result which is inexplicable in light of data for other species. The differences in trapping efficiencies among samplers are greatest for *Leptodora kindtii* and *Diaptomus leptopus*, the species which have the strongest avoidance reactions. Patalas (1954) found that *Leptodora* and *Eudiaptomus gracilis* were underrepresented in samples taken with a plankton pump, an unmetered townet, and a Ruttner sampler when results were compared with his self-closing trap. The differences in efficiency were decreased when sampling was done at night, leading Patalas to hypothesize that either visibility of opaque samplers or increased sensitivity by Crustacea to water current in the light was the responsible factor. The presence of towing rope and bridles may be partly responsible for the reduced efficiency of the nets tested in this study, as both devices were towed directly from the front. Sampler capacity and relative aperture size of net or trap may also be important characteristics. It is likely that the transparent trap catches different species with different efficiencies, though this was not tested.

The sampler as shown has been tested only on small lakes. Much heavier materials should be used in construction of samplers to be used on large lakes. During rough weather on large lakes, the pitching motion of a ship may allow the sampler to drop back occasionally during ascent. It is conceivable that such action might allow the lower door of the sampler to open by forcing water out through the net. This possibility can be avoided by constructing a lid to close the net aperture during sampling, which can be removed at the water surface so that the sample may be filtered (see Fig. 4). Such a lid will also protect the net during transport.

Material for constructing the transparent trap costs approximately $60, including the nannoplankton net.

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