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Two new integrating samplers for zooplankton, phytoplankton, and water chemistry

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With 2 figures and 1 table in the text

Abstract

Two new samplers are described which combine the concepts of the VAN DORN sampler and the integrating tube. Either sampler can integrate a 5 m layer at any depth.

Introduction

Samplers used in the plankton environment generally are designed either to take samples at a series of points in the water column or to integrate the water column. For phytoplankton and water chemistry, the VAN DORN bottle is probably the most common point sampler, at least for fresh water, and for zooplankton the SCHINDLER-PATALAS (SCHINDLER, 1969) and JUDAY traps fill a comparable role. Computations based on point samples generally assume the samples to typify layers, which they do not except under ideal circumstances. One of the most dramatic examples of the inadequacy of the assumption is reported by FEE (1976), who discovered that interpretations of plankton dynamics in the Canadian Experimental Lakes Area were grossly distorted if based on point samples.

Integrating samplers for zooplankton and water chemistry offer definite advantages over point samplers in some cases but typically some disadvantages must be considered as well. The tube sampler (LUND & TALLING, 1957) is a means of getting an integrated sample between the surface and any point below. It is not useful for zooplankton except in very shallow water where a large flexible tube can be used (PENNAK, 1962). Tube samplers of this type can only integrate a layer bounded by the air-water interface. The integrating sampler of SCHRÖDER (1969) has similar limitations. For zooplankton, the metered townet is the most common integrating sampler, but it presents several problems, including (1) sacrifice of information on vertical variations, and (2) clogging and resultant uncertainty in efficiency. The latter difficulty is partly corrected by meter readings, but this is not a perfect solution, as the clogging is not uniform over the sampling path. The objections to townets are especially acute for eutrophic lakes in which clogging of nets occurs rapidly.

Attempts to combine the virtues of point samplers with those of integrating samplers have resulted in the use of pumps and closing metered nets. Pumps introduce an unwelcome amount of complexity in the sampling gear itself, invite avoidance errors in zooplankton sampling, and are difficult to use in integrating

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thick layers because of the effect of pressure head on pumping rate. For horizontal integration at a fixed depth, pumps may prove to be best for everything except zooplankton, but for sampling a fixed station at multiple depths they are far from ideal. The closing metered nets (e.g. Clarke-Bumpus) are complicated to use and share some of the overall disadvantages of townets.

An obvious need exists for samplers that are (1) capable of integrating over thick layers so that a combination of successive samples will truly represent the whole water column, (2) 100 % efficient (or nearly so) in all kinds of water, and (3) simple and inexpensive. We think that a very close approach to these conditions can be achieved by combining the VAN DORN and tube sampler concepts.

Sampler for Phytoplankton, Bacteria and Chemistry

Fig. 1 shows a sampler capable of integrating water layers as thick as 5 m at any depth. The sampler consists of a piece of PVC water pipe 5 m long with a VAN DORN closing mechanism attached. The pipe comes in sections, which can either be permanently glued by means of coupling cement and couplings, or constructed to disassemble at the couplings for more convenient carrying. The inside diameter of the sampler is 2″ (5.0 cm). A thick-walled PVC (280 PSI) is used so that the assembled tube is very stout. The sampler holds 9.8 l and weighs 4 kg empty. The sampler is surprisingly easy to handle, even in a small boat. For use by one person, it is most convenient to have a stable prop mounted at the far end of the boat so that the uppermost end of the sampler can be positioned easily when it comes out of the water.

When the sampler is emptied rapidly into a mixing vessel or bucket, an integrated aliquot of the desired size can be withdrawn and the rest discarded. The integrating sampler is especially useful for metabolism studies involving oxygen, but in this case requires a special integration chamber. Measuring oxygen change through time, even at intervals as long as one week, often proves frustrating because the point samplers that are used for such work do not sample the same layers on two successive samplings. Water movements often result in anomalous or uninterpretable results. Integration over adjacent 5 m intervals would obviously minimize such problems but the sample cannot be mixed freely in an open bucket without altering the oxygen content. The mixing chamber shown in Fig. 1 B circumvents this problem by eliminating air-water contact prior to the time subsamples are taken. The sampler is emptied into the chamber through the port in the bottom and the plastic baffle rises as the tank fills. Sufficient mixing occurs as the sample flows into the chamber. An aliquot is then withdrawn from the chamber spout through a rubber hose into a BOD bottle as usual. The tank and baffle are available from chemical supply houses (Nalgene 54100—005), but a tubulated spout and a smooth plastic underside for the baffle must be added. In a laboratory test using

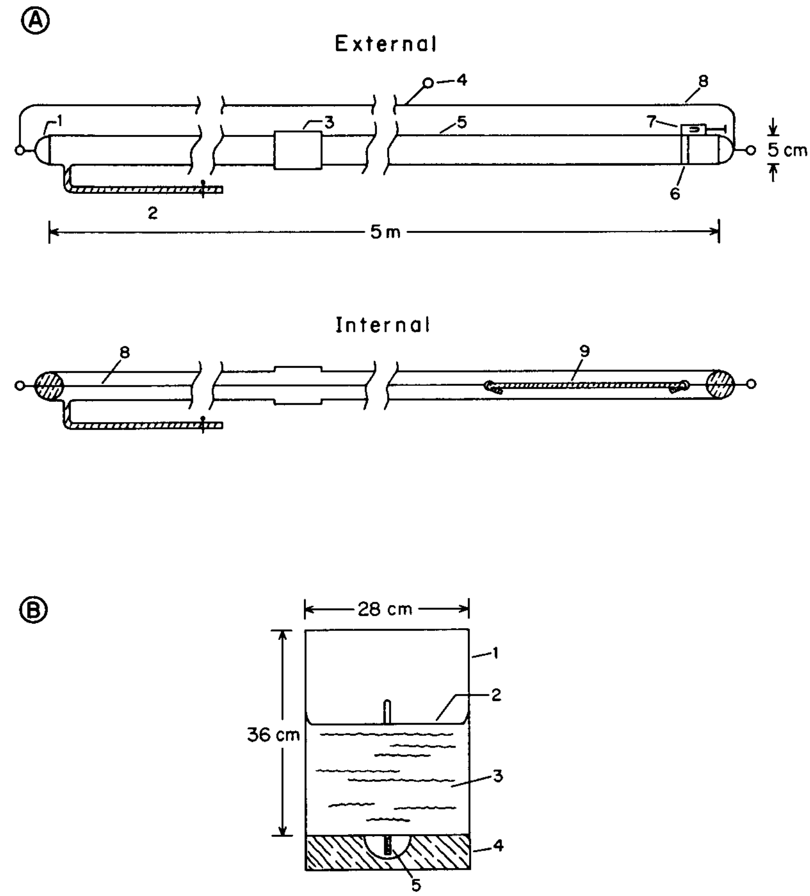

Fig. 1. A. Integrating sampler for water chemistry, phytoplankton, and bacteria. 1, solid rubber ball; 2, rubber hose; 3, PVC coupling (at intervals of 1 m); 4, metal ring attached to sash cord; 5, PVC pipe (280 PSI wall); 6, worm clamp; 7, trigger mechanism; 8, sash cord; 9, surgical rubber tubing, $^1/_2''$ diameter. — B. Mixing chamber with baffle to prevent oxygenation of sample. 1, plastic container; 2, baffle; 3, water; 4, wooden bottom shim; 5, tubulated spout.

water with a very low oxygen content (0.13 mg l^{-1}), we found that the gain in oxygen caused by transfer of water through the tank averaged only 0.08 mg l^{-1}. This is sufficiently low for most studies, especially since it will tend to be constant for a given oxygen concentration, and it could probably be reduced by special precautions.

Sampler for Zooplankton

The zooplankton sampler is simply a much larger tube (4″ diameter, 10.1 cm). It is not convenient to lift a tube of this diameter from the water, however. We have therefore made the entire middle portion of the tube flexible so that both ends can be held at the surface simultaneously, and one end can be raised gradually as the other empties through a net (Fig. 2). This also allows the sampler length to be adjusted very easily and allows the sampler to collapse to a length of 1.5 m for carrying.

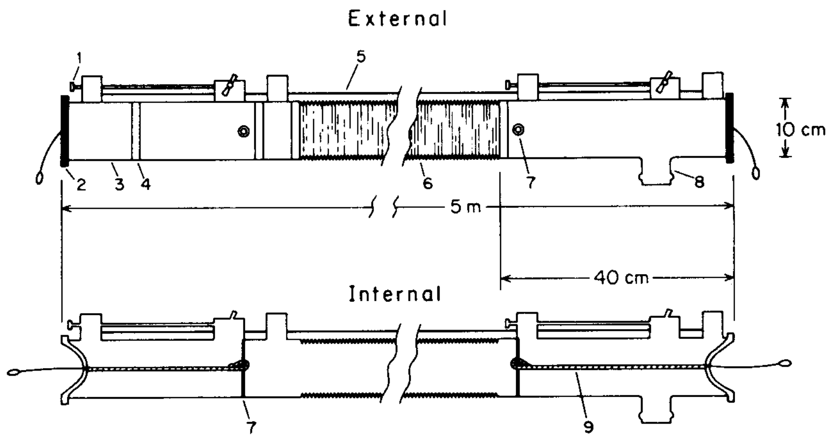

Fig. 2. Integrating sampler for zooplankton. 1, trigger; 2, toilet plunger head; 3, PVC pipe, 4″ diameter, 2 mm wall; 4, worm clamp; 5, sash cord; 6, duct pipe; 7, bolt; 8, PVC nipple to take plankton net and bucket; 9, surgical rubber tubing. Sampler collapses to a length of 1.5 m.

The key design feature of the integrating zooplankton sampler is a piece of collapsible plastic duct pipe of the type used to vent clothes dryers. These duct pipes are quite sturdy but also flexible and collapsible. At either end is a van Dorn closing mechanism attached to a piece of thin walled PVC pipe. Two messengers are used, one of which activates the upper trigger and the other the lower trigger.

The integrating zooplankton sampler holds 40.5 l. This is a large enough volume to yield reliable data on even fairly rare species. The sampler in Fig. 2 weighs 5 kg empty. The large diameter makes escape of zooplankton very difficult, as the tube falls freely with virtually no pressure cone in front of it. Water filters through the bucket when the sampler is brought into the boat, or for situations in which plankton abundances are high, the water can be emptied into a large net attached to the side of the boat.

Table 1 compares the integrating tube sampler of Fig. 2 with a Clarke-Bumpus (metered net). The Clarke-Bumpus samples were corrected for filtration efficiency (average, 53 %) using the meter readings, and the tube samples were assumed to be 100 % efficient. The samples were taken from the 0—5 m stratum of Allen's Lake, Colorado, on May

Table 1. Summary statistics for 5 replicate samples with the Clarke-Bumpus and the integrating sampler. Samples were taken from Allen's Lake, Colorado. Means are given in individuals l^{-1}. Asterisk indicates significant difference in means at 0.05 level.

	Daphnia rosea	*Daphnia parvula*	*Cyclops* CI—VI	*thomasi* N 1—6	*Polyarthra*	Unknown Rotifer	Total
Clarke-Bumpus							
Mean	8.7	18.9	25.4	25.4	31.05	12.5	120.9
Coeff. Variation	11.6	10.0	8.1	12.4	32.5	23.0	11.7
Integrating Sampler							
Mean	12.5*	21.3	24.4	21.1	37.7	13.7	130.8
Coeff. Variation	24.2	14.2	6.7	17.2	37.7	23.4	15.4

1976. Five replicates were taken with each sampler and total counts were made of the samples so that sample splitting would not contribute to variance (total number counted, 44,975). The mean for the Clarke-Bumpus sampler was compared to the mean for the integrating sampler by means of the Wilcoxon two-sample test (Sokal & Rohlf, 1969). All of the taxa in Table 1 were compared individually in this way, and then the sums of all zooplankton were compared. Significant difference between samplers occured only for *Daphnia rosea*. *D. rosea* may have a detectable avoidance response to the pressure cone that precedes the Clarke-Bumpus. The results support the validity of the assumption that the new integrating sampler is very nearly 100 % efficient. We feel that the sampler will be particularly useful in studies of zooplankton dynamics, where the distribution and absolute number of individuals are both of interest.

Acknowledgements

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Summary

Two samplers are described which combine the features of the Van Dorn point sampler and the integrating tube sampler. The first, which is used for phytoplankton, bacteria, and water chemistry, is constructed of rigid PVC pipe and integrates a 5 m layer at any depth. A special integration chamber is described for use in conjunction with the sampler so that reliable integrated oxygen samples can be taken with the sampler. The second sampler is for zooplankton, and is based on a collapsible plastic tube with rigid ends. The tube takes a core of the water column measuring 10 cm diameter by 5 m length at any depth. The sampler collapses in the boat for easy handling. A comparison with metered nets indicates that the sampler is 100 % efficient for copepods, cladocera, and rotifers.

Zusammenfassung

Zwei Wasserschöpfer, die die Eigenschaften des VAN-DORN-Schöpfers und des integrierenden Zylinderschöpfers vereinigen, werden beschrieben. Der erste der für Phytoplankton, Bakterien und Wasserchemie verwendet wird, wird aus hartem PVC-Rohr gebaut und integriert eine 5-m-Schicht bei beliebiger Tiefe. Eine integrierende Sonderkammer wird beschrieben. Diese wird zusammen mit dem Schöpfer verwendet, damit zuverläßliche integrierte Sauerstoffproben mit dem Schöpfer genommen werden können. Der zweite Schöpfer, geeignet für zooplankton-Entnahme, wird aus einem zusammenlegbaren Plastik-Rohr mit steifen Enden hergestellt. Das Rohr entnimmt eine Wassersäule von 10 cm × 5 m aus beliebiger Tiefe. Ein Vergleich mit dem CLARKE-BUMPUS-Schöpfer ergab, daß das Entnahmegerät für Copepoden, Cladoceren und Rotatorien voll geeignet ist.

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