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A simple and inexpensive trap-tube sampler for zooplankton collection in shallow waters

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Abstract

The paper describes a new type of zooplankton sampler, which combines the concepts of the Pennak core sampler and the Schindler-Patalas plankton trap. The new sampler, called Trap Tube Sampler, consists of a PVC water pipe (1.5–2.0 m, long; 10 cm diameter) provided, at the bottom end, of a filtering unit and closing mechanism which alternatively closes the mouth of the tube and the mouth of the filtering unit. The new device is particularly suitable for collecting samples from the entire water column in shallow vegetated water bodies, fish ponds and mesocosm tanks.

Introduction

Many devices for quantitative sampling of the zooplankton have been developed, but as yet none meets all the criteria for the ideal or its suitable use in all environments (Tonolli, 1971). Most traditional sampling techniques, such as towed nets and plankton traps, were developed to be used in open waters of a large and deep lake. (Schwoerbel, 1970; Tonolli, 1971; Lind, 1979; De Bernardi, 1984).

However, it is often necessary to take samples in special environments, shallow or densely vegetated, where the use of the conventional sampling devices present many technical difficulties. One of the main problems to be afforded in this type of environment is to take a sample producing little disturbance. In these cases, when an integrated sample between the surface and any point, in shallow waters, is desired, the use of a tube or 'water core' is recommended (Tonolli, 1971; Boltovskoy, 1995).

Various specialised equipment using flexible or not flexible tubes have been developed of obtaining phytoplankton or zooplankton samples (Lund & Talling, 1957; Pennak, 1962; George & Owen, 1978; Nicholls, 1979; Solomon et al, 1982; Boltovskoy, 1990; Sutherland et al., 1992).

Pennak (1962) described a simple 6.4-cm diameter tubular sampler, made of a flexible tube, for collecting zooplankton in the littoral areas of lakes. George & Owen (1978) designed a similar but improved 'water core' which incorporate a pneumatically operated closing system and a stainless-steel filtering cone. In both samplers, after reaching the bottom or the selected depth, the lower end of the tube have to be raised to the surface and then the top end, provided of the filtering gauze, fall free in the water describing a 'U'-shaped trajectory. The operation of these devices in mesocosm tanks and in shallow waters covered with floating mats produces a great disturbance by resuspension of materials deposited on the bottom or on the roots of the plants.

The trap tube sampler (TTS) described in this paper offers the combined possibilities of a conventional tubular sampler, which collect a composite sample from surface down to the bottom or a selected depth, with those of a 'plankton trap' filtering the catch *in situ*.

Lowering and lifting operations of TTS describe a vertical straight-line trajectory producing little disturbance. So, it collects a volume of water during lowering and, during lifting after the closing mechanism is activated, filter the water, which flow through a filter unit located close to the mouth of the tube.

The key design feature of the integrating zooplankton sampler, due to one of us (R.O.M.), who also constructed the sampler and drew the figures, is the closing mechanism. This mechanism consists of a door made of a brass disk attached to a lever hinged outside to the body of the tube. The same door alternatively closes the mouth of the tube and the mouth of the filtering cone. The new device shares some features with one of the samplers described by Solomon et al. (1982), but they differ most markedly in the body structure and the lower end, principally in the design of the closing mechanism.

The TTS has been routinely used to take more than 400 samples during 6 months in mesocosm tanks and has proved reliable and easy to operate. Moreover, its operative efficiency has been tested successfully, when it was used to take integrated samples from a fishpond, and to take samples from the water beneath mats of floating plants (*Eichhornia*, *Pistia*, *Salvina*, *Azolla*) in a shallow lake of the Paraná River floodplain. One person can easily operate it from a small boat.

Materials and construction

The body of the sampler is a piece of a thick-walled PVC (polyvinylchloride) water pipe commercially made for house drainage system, 3 mm thick, 100 mm inner diameter and 1.5–2 m long (Fig. 1).

The lower end consist of (slip × slip × male threaded) tee fitted to the tube and fastened with PVC cement (Fig. 2). The female threaded cap corresponding to the male threaded branch of the tee was converted into a threaded ring by cutting a 93-mm circle from the top surface (Fig. 3). This threaded ring was used to fasten the net collar of the filtering unit (Fig. 4).

On the inner surface of the tube mouth (the free slip branch of the tee) was fitted and fastened with cement a PVC ring, 7 mm thick (Fig. 5), and on this ring another rubber ring (Fig. 6) which is the stop of the door.

The filtering unit consists of a small cone net, 150 mm long, made of monofilament nylon fabric, with a 50-μm aperture (Fig. 7), with a bucket at its lower end. The plankton bucket was made of a 25-mm diameter acrylic tube with aluminium screw off end and a latex drain tube closed with a Mohr clamp (Fig. 8).

The closing mechanism consists of a circular door, 99 mm diameter, made of brass, 2 mm thick (Fig. 9), screwed to a brass lever, 2 × 15 mm cross-section (Fig. 10), which is connected to the tube body by mean a hinge (Fig. 11). The connection hinge-lever is provided with a stainless steel spring (Fig. 12) to force the door against the PCV stop ring on the inner side of the tube mouth.

On the door there are: a lead weight (Fig. 13), to assure the effective closing of the door, a 'U'- shaped brass latch (Fig. 14) which fit a cylindrical brass piece attached to the inner side of the mouth (Fig. 15). The latch is adjusted to hold the door against the top ring during retrieval.

The trigger mechanism consists of a brass pin with two screwed stops and a stainless steel spring (Fig. 16). The upper end of the pin is connected with a pulling cord whose opposite end is attached to the upper end of the tube (Fig. 17).

Around the tube mouth there are four legs made of PVC reinforced with a piece of brass (Fig. 18). The purpose of these legs is to avoid a direct contact of the tube mouth with the bottom.

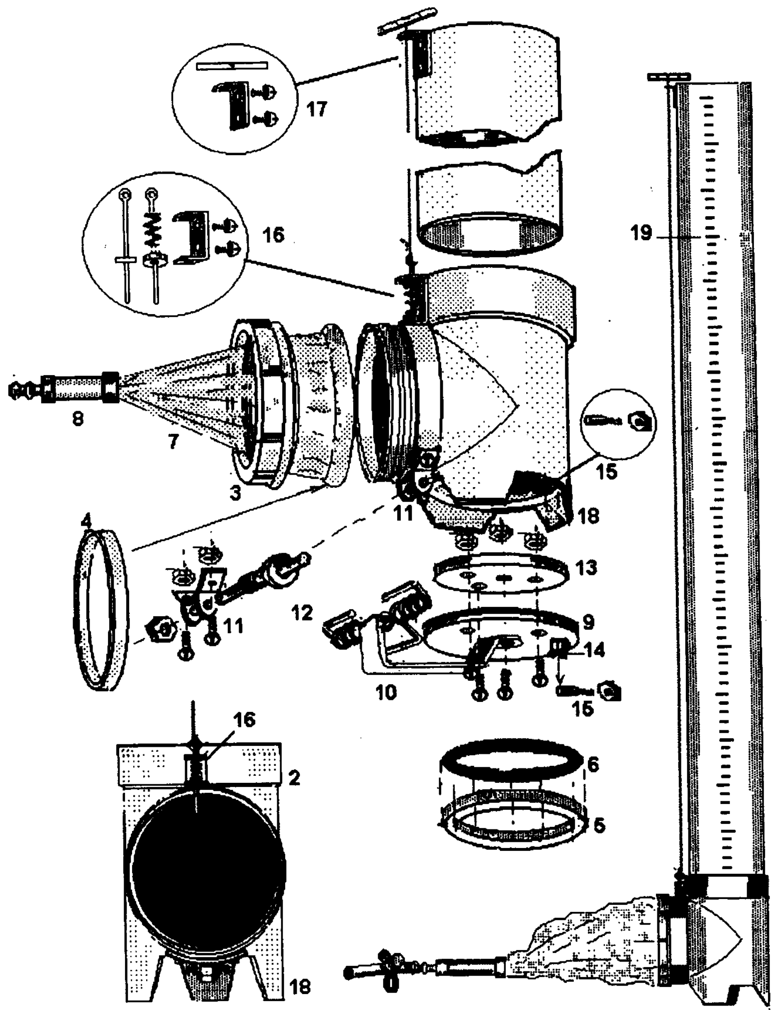
Along the outer side of the tube there is a metered scale, starting at level of the inner top ring, which allow to know the length of the collected water column and to determine its volume (Fig. 19).

Operation

(1) Open the mouth of TTS and lock the door vertical, closing the mouth of the filter unit (Fig. 20).
(2) Lower TTS up to the bottom or the selected depth (Fig. 21).
(3) Activate the closing mechanism by pulling the cord, so the pin is withdrawn, releasing the lock. Then the door closes the tube mouth and opens the mouth of the filtering unit (Fig. 22). Read the depth from the metered scale on the body of the tube.
(4) Lift TTS. When the sampler is retrieved to the surface, the water flow unimpeded through the net and concentrates the zooplankton in the bucket (Fig. 23).

Comparison test

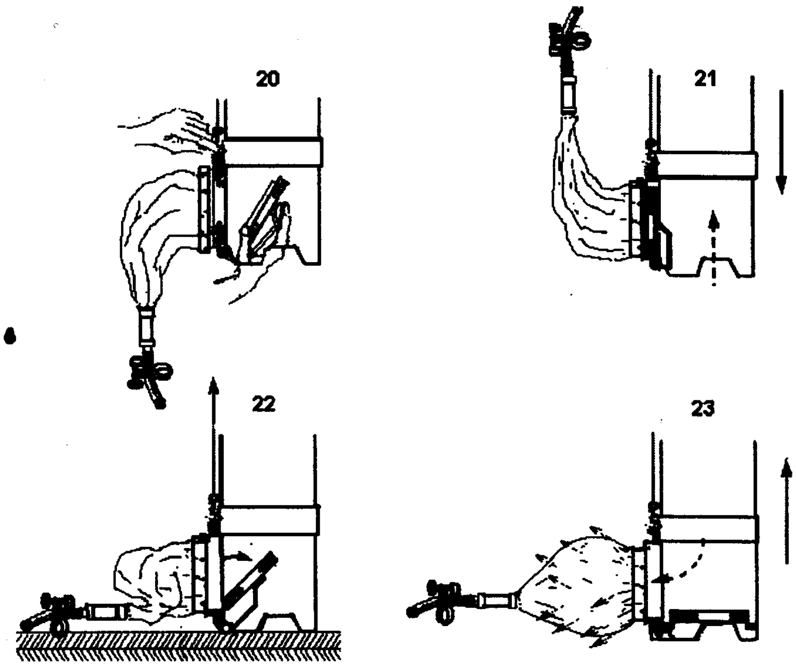
In order to test the efficiency of the new sampler, we compared the densities of organisms collected with



Figures 1–19. Components of the trap-tube-sampler (TTS). (1) Sampler, lateral view; (2) closing mechanism and filtering unit (parts are shown disengaged for clarity); (3) threaded ring to fasten the net collar; (4) net collar; (5) plastic stop ring; (6) rubber ring; (7) net; (8) net collector; (9) door; (10) lever; (11) hinge; (12) spring; (13) lead weight; (14) latch; (15) cylindrical brass piece; (16) trigger; (17) pulling cord; (18) legs; (19) metered scale.

Table 1. Comparison of zooplankton numbers in five replicates samples collected by the Schindler–Patalas plankton trap (SPPT), the Ruttner bottle (RB) and the trap tube sampler (TTS). Means and 95% confidence limits are given in individuals per litre.

	SPPT		RB		TTS	
	Mean	95% Conf. limits	Mean	95% Conf. limits	Mean	95% Conf. limits
Diaphanosoma birgei	31.3	8.2 – 54.4	22.3	12.4 – 32.2	52.3	23.2 – 81.4
Metacyclops mendocinus (adults + copepodites)	17.5	13.4 – 21.6	19.2	15.4 – 22.9	25.1	17.7 – 32.4
Nauplii	738.4	639.4 – 837.3	876.2	533.1 – 1219.2	1058.7	216.1 – 901.4
Filinia longiseta	557.6	306.3 – 754.9	580.9	524.7 – 637.2	634.9	279.5 – 990.4



Figures 20–23. Operation or the trap-tube sampler (TTS). (20) Opening the door and locking it vertical; (21) lowering the sampler; (22) closing the sampler and opening the filter unit; (23) lifting the sampler and filtering of the collected water. Dashed arrows show the direction of the water flow, solid ones, the direction of the sampler or any mechanism motion.

TTS with a Ruttner bottle (RB) and a Schindler–Patalas plankton trap (SPPT) (Table 1). The samples were taken from a 1-m deep fish-pond at the Instituto Nacional de Limnología, Argentina. Five replicate samples were taken with each sampler. Samples of several depths, collected with SPPT and RB, were pooled in each case to be comparable with the integrate column collected by TTS.

The means of the samples, obtained with the three above-mentioned devices, were compared with a one-way ANOVA, on no transformed data (Sokal & Rohlf, 1969). Significant differences were found only for *Metacyclops mendocinus* which seems to be better captured by TTS than to SPPT (Tukey–Kramer multiple comparisons test, $q = 3.931$, $P<0.05$). The results support the assumption that TTS is as efficient as, or more efficient than, SPPP and RB.

Routinely samples obtained in mesocosm tanks with clear waters suggest that TTS produce little obvious disturbance and practically not re-suspension of bottom sediments as it is lowered through water. An additional advantage of TTS, as all the tube samplers, is its speed of operation because repeated casting of the sampler are not required to take a top-to-bottom sample.

The TTS allows getting composite samples by repeated samplings, without removing previously collected organisms, due to the features of its closure mechanism. The door, which closes the filter unit during lowering, precludes losses and possible contamination of the net during sampling.

The length of the body of the sampler can be extended by adding new pieces of tube which can be attached to the top end of any section by a bayonet fitting, and connecting each to other the pulling lines.

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