academicJournals

Vol. 15(39), pp. 2172-2175, 28 September, 2016
DOI: 10.5897/AJB2016.15505
Article Number: 7C53ECD60681
ISSN 1684-5315

http://www.academicjournals.org/AJB

African Journal of Biotechnology

Short Communication

A novel sampler for limnological investigation in developing world

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Received 1 June, 2016; Accepted 7 September, 2016

A simple pump sampler for shallow water bodies, constructed with materials that are affordable and readily available in the local market is presented. It is simple to operate and no electric motor is required. The challenge of cost of acquisition of conventional samplers for sampling the lentic habitat, especially small water bodies such as small natural lakes, rivers, streams and reservoirs for fisheries and water treatment facilities is minimised. The device can collect samples with ease, from various depths, up to five metres. The sampler consists of a manual suction pump produced from a hand bicycle pump-connected to a series of sample bottles by plastic delivery tubes. Samples were taken into the sample bottles by suction via a calibrated transparent plastic hose lowered to the required sampling depth.

Key words: Sampler, lentic, limnology, shallow water.

INTRODUCTION

There are various customized water samplers that have been designed for sampling of various water bodies for various aspects of limnological studies viz: plankton, zoological, phycological, bacteriological and physicochemical studies; some of which are towing nets for plankton (Pal and Choudhury, 2014; Alhassan, 2015); Irwin, Van Dorn and Kemmerer (Henny and Nomosatros, 2016; Anonymous, 2016), Meyer, Niskin and Friedinger (APHA, 1995; Pal and Choudhury 2014) water samplers to mention a few. These samplers though efficient are not readily available to many investigators or aquatic scientists in developing countries because of high costs of procurement and sometimes some may be unsuitable for sampling shallow water bodies, especially those less than one meter depth because they may induce turbulence.

The genesis of the development of this sampler was the loss of a Kemmerer sampler owned by the Hydrobiology Unit of the Department of Zoology and Environmental Biology at the University of Nigeria, Nsukka during an investigation on Agulu Lake, Anambra State, Nigeria in 1985. There was then an immediate need to develop a sampler for below water surface samples.

Irwin sampler (Welch, 1952) was originally designed to sample shallow water bodies such as puddles, etc. This new sampler adapted the principles behind the mode of operation of Irwin's sampler to design a sampler for water

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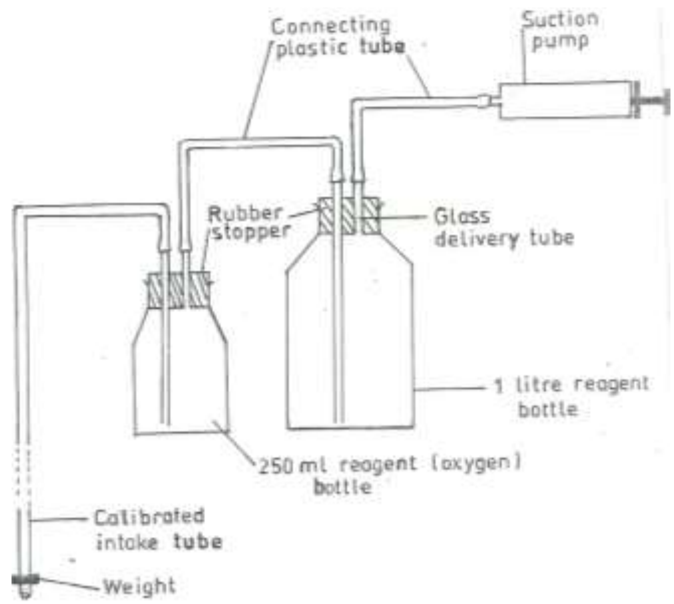

Figure 1. Sampler for shallow water bodies (Nweze, 1992).

bodies of about 5 m depth. It solves the problem of cost of acquisition of conventional samplers for sampling small water bodies such as small natural lakes, rivers, streams; and reservoirs for fisheries and water treatment facilities, that need to be studied in order to document the biodiversity and study of various local aquatic ecosystems.

Design

The sampler under presentation utilises suction pressure induced by a suction pump to collect water from various depths from a shallow water body. The sampler consists of a manual suction pump produced from a hand bicycle pump connected to a series of sample bottles by plastic delivery tubes. A calibrated plastic hose from the last bottle in the series away from the pump is dropped into the depth of sampling from a boat, dingy or raft. Samples from appropriate depths are sucked into the sample bottles by operating the bicycle pump (Nweze, 1992) (Figure 1).

Merits of the sampler

Materials for its construction are affordable and readily available in any local market. Samples from various depths can be collected with ease. It is simple to operate and no electric motor is required.

MATERIALS AND METHODS

1. Bicycle pump with air outlet at the tip: The base of the bicycle pump was unscrewed and the plunger was pulled out. The valve was removed, turned inside out (inverted) and greased with petroleum jelly. The valve of the pump was inverted to create a suction pump.
2. Reagent bottles of various volumes with plastic/ground glass caps: Their mouths (in-let openings) were wide enough to fit a rubber stopper with two openings. The number of bottles used depends on the replicates needed and the variables under investigation.
a. Two 250/300 ml oxygen bottles, preferably with ground glass caps. More bottles may be needed for biochemical oxygen demand (BOD) and chemical oxygen demand (COD).
b. Two 500 ml bottle for sample's phycological, bacteriological and physico-chemical analyses: temperature, colour, pH, alkalinity, phosphates, etc.
c. One 1000 ml bottle for chlorophyll, etc.
d. One 2500 ml bottle to receive the initial water that passed through the system. This could be used for investigations of integrated samples from the water column.
3. Glass delivery tubes
Dimension: diameter of 4 or 4.5 mm; minimum length required = 100 cm; Number = 12 (a pair for each bottle). Using a glass cutter, six tubes 8 cm long for attachment of the inlet hose were cut neatly, followed by another set of six tubes measuring 7 cm long, for attachment of the outlet hose. The glass delivery tubes could fit perfectly into the openings in the stopper and the plastic hose without air leaks. Lager diameter tubes require more suction pressure and the bicycle pump may not be adequate.
4. Plastic rubber stoppers to fit each bottle (six in number): The stoppers have 2 holes bored, each with 4 or 4.5 mm diameter depending on the size of available glass delivery tube.
5. Transparent plastic delivery tube/hose. The quantity required depends on the number of bottles used and the maximum depth to be sampled. A minimum of 7 m should be purchased for a water body of about 5 m depth.
a. For each bottle, there will be a long inlet tube (about the dimension of the depth of the bottle) cut as follows: 8 cm length: for the oxygen bottles = 16 cm for two bottles; 12 cm length: for 500 ml reagent bottles = 24 cm for two bottles; 14 cm length: for 1000 ml reagent bottles = 14 cm; m length for 2.500 ml bottle =18 cm.

Plate 1. Photograph of assembled pump sampler for shallow water bodies.

b. Connecting tubes for the bottles and pump cut as follows: 30 cm length: six pieces for 5 bottles and the suction pump = 180 cm; used plastic tube (total length) = 252 cm.
Note: The long inlet tube in the sample bottle will let in water to the bottom of the sample bottle and displace the air out of the bottle into the next bottle. Inlet glass delivery tubes could be long enough to reach the bottom of the sample bottles but they are not as durable as the plastic tubes.
c. Inlet tube: The remaining plastic tube is calibrated in centimetres and meters starting from one end, the 'zero' (0 cm) end, that will be dropped into the water under investigation.
6. Petroleum jelly: This acts as grease for lubricating the valve of the suction pump and sealing of junction between glass delivery tube and rubber stopper.
7. Bunsen burner/gas lighter (optional): For flaming plastic tubes to fit into the glass delivery tubes.
8. Wooden frame to accommodate bottles (optional).

Assembling steps

A schematic representation of the basic composition of the sampler is presented in Figure 1.

Step 1: One piece of 60 cm length plastic tube was flamed at one end and attached to the valve end of the suction pump.
Step 2: Two glass delivery tubes were passed through the openings on each of the rubber stoppers. The intake glass tube (8 cm) was extended a few centimetres into the specimen bottle, while the outlet glass delivery tube stopped at the opening of the rubber stopper.
Step 3: The remaining five (5) 30 cm lengths of plastic tubes are used to connect the rubber stoppers in series starting from the first oxygen bottle (A) to the next (B), to the 500 ml bottles (C and D), 1000 ml bottle (E) and lastly to the 2500 ml bottle (F) (outlet of bottle A to inlet of bottle B; outlet of bottle B to inlet of bottle C and so on to the last bottle- 2500 ml).
Step 4: The 2 500 ml bottle is connected to the 60 cm plastic tube from the suction pump.
Step 5: A weight is attached at the 'zero' end of the calibrated intake hose that will be dropped into the water during sampling (a needle and nylon thread may be used). The weight will make the tubing to be erect in water. The other end to the intake tube is attached to the intake glass delivery tube of the first oxygen bottle.
Step 6: The bottles are placed in the wooden rack (optional) and covered with their appropriate rubber stoppers with connecting tubes.
The sampler is ready for use (Plate 1).
Note: If the setup is not air tight, the junctions between glass tubes and stoppers are greased with petroleum jelly or water proof sheet/tape applied to make the system air tight.

Procedure for using the sampler

1. The weighted end of the calibrated intake tube (zero end) was dropped into the water to the depth to be sampled. Water is pumped up into the bottles until the 2500 ml bottle is filled. On initial filling, the contents of the bottle were discarded if a composite sample of the water column is not required. It contains water displaced from the depth of sampling to the surface that flushed out the air in the oxygen bottles. It gives a composite sample for the entire column, from the depth of collection to the surface and cannot be taken as a component of the depth sampled.
Note: The volume of the submerged tube in the water should be less than the volume of the last bottle in the series to ensure complete displacement of air in the sampling bottles and water from unwanted depths. The plastic tubes of 4 and 4.5 mm diameter have the capacity of 12.57 and 15.91 ml, respectively for one metre length.
2. The rubber stoppers of the oxygen bottles are removed and the bottles capped with the ground glass stoppers. The hose is removed from the water; the stoppers with tubes on the other bottles are removed and the bottles covered with their caps.
3. The samples were fixed or analysed as directed for the methods of determination of the various parameters under investigation. For instance, the dissolved oxygen was recorded immediately if using a field meter or fixed with reagents for the appropriate titrimetric method. Alkalinity and colour determinations should not be delayed. Also, other parameters that can be recorded immediately with *in situ* probes should be attended to.

DISCUSSION

The limitations faced by limnologists in developing countries in having access to standard samplers are enormous. Those that have the opportunity of working with standard samplers in laboratories overseas may not afford to purchase them and bring them home due to high cost of procurement, hence the need to develop an affordable alternative.

The use of this sampler eliminates the challenge of the investigator being restricted to subsurface and net samples only because of unavailability of standard underwater samplers. Studies have shown that even in shallow water bodies, there could be vertical variations in population and water quality parameters; hence, reports based on sub-surface samples only may not give a true picture of the characteristics of the water body. This shortcoming can be eliminated by sampling below the surface at various depths.

The sampler has the advantage of ensuring that there would not be the need for turning out water samples for oxygen and BOD determinations into other vessels/bottles, and samples for biological (plankton and bacteriological) and physicochemical studies are also collected simultaneously.

Apart from the low cost of assembling the components which are readily available locally, the sampler will not induce turbulence in the water; it is highly adaptable and its light weight makes it easy to transport.

Conflict of interest

The author has not declared any conflict of interest.

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