Proc. Indian Acad. Sci. (Anim. Sci.), Vol. 95, No. 6, December 1986, pp. 751–756.

Discharge-time method. A new technique for sampling plankton in fluvial systems, with a note on the modified plankton sampling device

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MS received 10 January 1986; revised 21 July 1986

Abstract. A technique to sample plankton efficiently in the fluvial systems is being propounded along with a note on the need and design of the plankton sampling device suited to torrential reaches. The technique, christened as discharge-time method, has certain advantages. The requirements are minimum (detachable bucket of the conical plankton net with bolting silk cloth of required mesh size) and the efforts are nominal. In order to sample plankton the device has to be dipped into the river with its open end facing the current, for a pre-calculated period of time. The formula, 't' seconds $= x/4v$ was computed to calculate the time for which the device should remain submerged. It is thus, an efficient and time saving technique for large volumes can be filtered within seconds. The validity of this method has been assessed by employing 't' test.

Keywords. Fluvial system; plankton; sampling; torrential reaches; discharge-time method.

1. Introduction

Water sampling in the fluvial systems, especially in the torrents is not without limitations. In the alluvial plains where long stretches are navigable, sampling is facilitated by country made vessels. Contrary to it difficulties of many kind appear while sampling in the torrential stretches. The latter are characterised by high gradient, deep gorges which account for alternating rapids and pools as well as high velocity and turbulence of water.

The present paper deals exclusively with plankton sampling in the fluvial systems, especially the torrential waters. Various types of plankton nets ranging from simple conical Hansen, Juday, Wisconsin, Birge Cone and Clarke Bumpus nets have been described alongwith their merits and demerits by Welch (1948), APHA, AWWA, WPCF (1975) and Trivedy and Goel (1984). In India while limnologists may use them, depending on the nature of water body to be explored and efficiency desired, the riverine ecologists, according to the literature available, are still short of an adequate technique. Chakrabarty *et al* (1959), while conducting studies on the hydrobiology of the river Yamuna at Allahabad, have sampled plankton by collecting and filtering the river water. Lakshminarayana (1965) used a country boat and a conical plankton net with 50 ml clean and rimmed pyrex tube attached to its caudal end. The vessel, according to him, moves against the current and the net is lowered into the river for 5 min. Similarly, John (1976) while sampling plankton from the river Kallayi (Kerala) made use of a canoe, the speed of which was kept constant and a plankton net having 77 threads/cm was towed for 10 min.

Evidently, no uniform technique exists as far as plankton sampling in the fluvial system is concerned. If the task of plankton enumeration has to be achieved by the formula:

$$n\,(\text{units/litre}) = \frac{(a \times 1000)\,c}{1}\ \text{(Welch 1948)},$$

a known quantity of water '*l*' has to be filtered from which a concentrate '*c*' has to be prepared before the average number of plankton '*a*' and finally the number of plankters/litre '*n*' can be obtained. The quantity of water filtered is thus of prime importance, irrespective of the means sought to achieve this goal. In usual practice containers of known volume are used to collect water, which in itself is a tedious and time consuming process. Further, strong current and turbulence in the torrential stretches, prevents navigation and mid-stream sampling, thus rendering the sample inadequate. However, curvilinear path and thorough mixing of water may act as an approximate compensation for samples collected along the river banks.

The above account discusses the major obstacles encountered while sampling plankton in the torrential waters. They can be overcome if an efficient method of filtering the desired volume of river water and a way to obtain an adequate sample at a distance of at least 1·5 meters from the river bank, can be devised. Idea of propounding a new and efficient technique, was thus conceived. The same has been christened as Discharge–Time Method. It is based on the experiments conducted at Srinagar–Garhwal, through which flows the turbulent Alaknanda (altitude 500 msl; latitude 30°11'), a major tributary of the Ganga.

2. Result and discussion

2.1 *Discharge–time method*

The technique involves the recording of velocity with which the water flows at the sampling site, calculating the discharge through the plankton net's detachable bucket (referred to hereafter as bucket only in the text) and converting the value into time for which the device should remain submerged so as to allow the desired volume of the water to be filtered. The requirements are nominal; the bucket of a simple conical plankton net (with bolting silk of desired mesh size, figure 1) provided with 1·5 meter long handle (a modification, discussed later in the text), a current meter or a suitable float and a stop watch. The method can be successfully implemented in two steps, prior to which a formula has to be computed, equipped with which the technique can be taken to the field.

2.2 *Computation of formula*

For all practical purposes the discharge of the river water through the bucket has to be calculated first.

2.2a *Calculation of discharge through the bucket*: Discharge (*D*) is expressed as; $A \times c \times V$ (1)*, where *A*, *c* and *V* are, area of the bucket, a constant** and velocity of

*Equation (1) has been adopted from Welch (1948) and presented here in a simplified form.

**The value of 'c' is 0·8 if the river bottom is rough, loose, rocks, stones and coarse gravel and 0·9 if sandy or muddy. The former is true for the fluvial systems of Garhwal Himalaya.

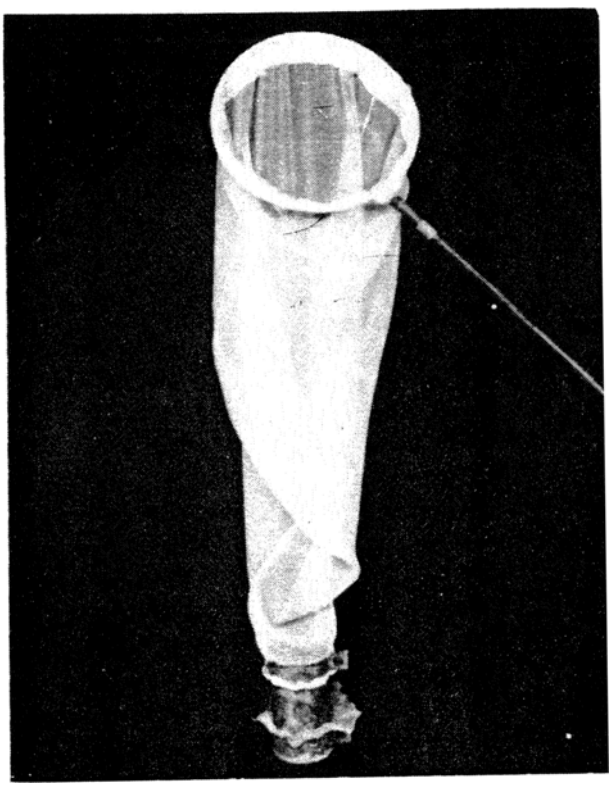

Figure 1. Conicol plankton net.

the river water, respectively. Since calculation of the area 'A' of the bucket is based on the formula πr^2, the radius of the bucket was measured (0·04 m in present case) and the equation (1) rewritten as;

$$\begin{aligned} D \text{ (cumecs)} &= \pi r^2 \times c \times V \\ &= 3{\cdot}14(0{\cdot}04)^2 \times 0{\cdot}8 \times V \\ &= 0{\cdot}0040192\ V. \end{aligned} \tag{2}$$

2.2b *Estimation of time period*: This is the first major step which facilitates conversion of discharge 'D' into time period 't', the factor of prime significance in this method. This was achieved in the following manner;

$$D \text{ (cumecs)}^* = 0{\cdot}0040192\ V \tag{3}$$

or

$$\text{(litres/sec)} = 4V \tag{4}$$

$$t \text{ (sec)} = x/4V \tag{5}$$

where 'x' is the desired volume of water to be filtered through the bucket (lit).

*1 cubic meter = 1000 litres.

2.2c *Plankton sampling*: The process of plankton sampling shall be completed in 3 phases.

(i) *Measurement of velocity*: In torrential reaches, the mechanical current meters are not of much practical value. Shooting current and high turbulence have been observed to prevent regular rotation of the bucket wheel. Hence a float method (Welch 1948) was used to measure the velocity of the section of the river to be sampled.
(ii) *Calculation of 't'*: The velocity 'V' once recorded simplifies the procedure. Its value when fitted into the formula $t = x/4V$ easily computes the time 't' in seconds (the value of 'x' being known)*.
(iii) *Sample collection*: The bucket possessing a desired mesh bolting silk cloth at its caudal end is then extended into the river and dipped for 't' seconds so that the 'x' volume may get filtered. The sample thus collected may be processed further for qualitative and quantitative analysis.

2.3 *Validity of the method*

In order to establish the validity of discharge-time method 4 sampling stations at a distance of 25 m each were selected along the left bank of Alaknanda. At all the 4 sites 50 litres of river water was filtered firstly by collecting with a bucket of known volume and secondly by discharge-time method. The plankton counts were made by the help of Sedgewick-Rafter Cell and enumerated by the formula:

$$n \text{ (units/litre)} = \frac{(a \times 1000)c}{l} \text{ (Welch 1948).}$$

The difference in the counts was tested by 't' test and found to be insignificant (table 1), which may be attributed to errors while making plankton counts.

2.4 *Qualitative and quantitative analysis*

In the present study the diatoms constituted 83·05% of the total plankton. They were represented mainly by *Navicula*, *Nitzschia*, *Cymbella*, *Diatoma* and *Synedra*. The green algae which accounted for 13·61% exhibited a very narrow spectrum of species (*Cladophora*, *Spirogyra* and *Ulothrix*). The desmids accounted for 3·33% of the total population.

2.5 *Plankton sampling device for torrents*

The need for modifying the device has already been emphasised. In shooting current the conical plankton net with large surface area provides resistance and thus cannot be held stationary for a long time. In order to offer minimum resistance, as already suggested under discharge–time method, only the detachable bucket of the plankton net should be used.

As plankton samples are usually collected from the river bank (for reasons already

*The desired volume of water 'x' to be filtered shall depend on plankton density in the water body.

Table 1. Characteristic features of the sampling spot and statistics of plankton sampling.

	Sampling sites			
	1	2	3	4
River bed	Rough	Rough	Rough	Rough
Composition	Stones	Gravel, Pebbles, Stones	Gravel, Pebbles, Stones	Stones, Gravel
Turbulence	High	Slight	Nil	Normal
Velocity (V–m/sec)	0·55	0·40	0·45	0·52
Volume of sample to be filtered (x–litres)	50	50	50	50
Time (t (sec) = $x/4V$)	22·73	31·25	27·78	24·04
Plankton (units/litre)				
Manually	1140	2500	1820	1365
Discharge–Time Method	1020	2540	1780	1405
't' test Observed	0·22*			
't' test Table 5%	2·36			

*Insignificant

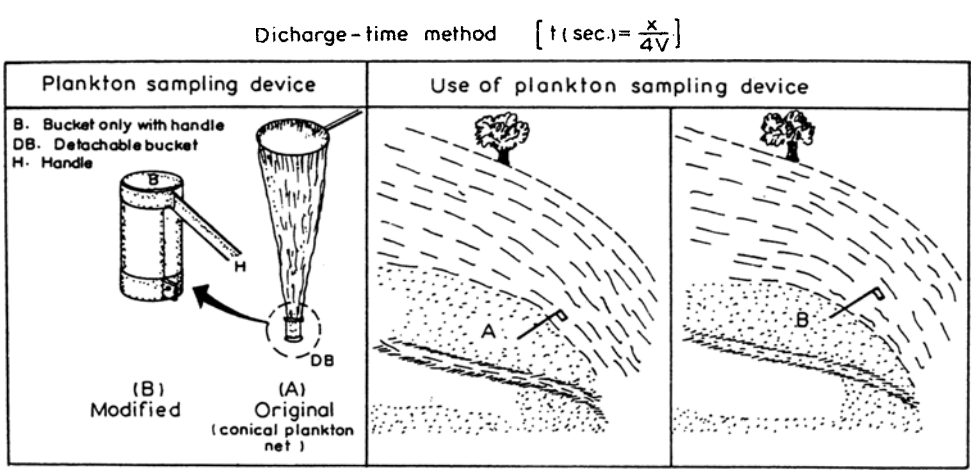

Figure 2. Discharge–Time Method.

mentioned in the text), in order to have a better sample, the bucket must be provided with a 1–1·5 meter long handle (wooden/metallic), which can fit into the bolt provided in the collar of bucket (figure 2).

In order to know the discharging velocity through the bolting silk, a meter or an electronic gadget shall have to be fitted at its caudal end, which shall record the discharge and enhance its efficiency.

The above account is, thus, a preliminary attempt to simplify the sampling process and enhance its efficiency in the torrential reaches.

Acknowledgement

The authors are thankful to the Department of Environment, New Delhi for financial assistance under the National Ganga Project.

References

APHA, AWWA, WPCF 1975 *Standard Methods for the Examination of Water and Wastewater* (Washington: American Public Health Association) p 1193

Chakrabarty R D, Ray P and Singh S B 1959 A qualitative study of plankton and the physico-chemical conditions of the river Yamuna at Allahabad in 1954–55; *Indian J. Fish.* **6** 186–208

John V 1976 Hydrobiological studies on the river Kallayi in Kerala; *Indian J. Fish.* **23** 72–85

Lakshminarayana J S S 1965 The seasonal growth and succession of the plankton algae in the river Ganges; *Hydrobiologia* **25** 138–164

Trivedy R K and Goel P K 1984 *Chemical and Biological Methods for Water Pollution Studies* (Karad: Environmental Publications)

Welch P S 1948 *Limnological Methods* (Philadelphia: Blakiston Co) p 381