From this set of data an empirical correction of 4°C was derived. The statistical treatment of the difference between ship measurements and the blackbody temperature showed a standard deviation of 1·2°C. The collection of remotely-sensed data over a 14-day period allows more than 10 samples over an area of about one degree square were to be received. This results in an inaccuracy of less than 1°C. Although the ground resolution was only 50 km at the nadir, the thermal structure is better resolved than in conventional maps. An analysis using the multispectral approach and the empirical correction for the absorption of radiation by gases is shown in Figure 1.

Reference

Shenk, W. & V. V. Salomonson (1972). A multispectral technique to determine sea surface temperature using Nimbus 2 data J. Phys. Oceanogr., 2: 157–67.

J. Cons. int. Explor. Mer, 35(3): 364–367. Juin 1974.

A new device for subsampling plankton samples [1, 2]

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Introduction

The subsampling of plankton collections has been a standard practice since the inception of quantitative studies (Wiborg, 1962). Windsor and Walford (1936) have shown that it is not necessary to count large numbers of each species when other sources of variation in sampling are taken into account. Several splitting devices are widely used at present (Wiborg, 1962). These include the whirling vessel (Wiborg, 1951; Kott, 1953), the Folsom splitter (McEwen, Johnson, and Folsom, 1954) and the Motoda (1959) splitting chambers. Results obtained during the operation of any of these devices are dependant upon the skill and dedication of the operator. While this is also true of the device presently described, an even distribution of plankters may be obtained prior to splitting, and plankton that adhere to the apparatus may be washed unbiased into the two aliquots. Another feature of the device allows concentration of the sample during splitting.

Description

The Splitter (Figs 1 and 2)

The apparatus is constructed of corrosion-resistant materials (acrylic plastic, brass, stainless steel and nylon). It consists of a cylindrical acrylic chamber (A) affixed to a square block (B) which is machined to form a conical bottom to the chamber. The chamber has a centered vertical tube (C) enclosing a piston (D). In down position the piston closes two holes (E) located opposite each other in C were they open to the bottom of the chamber. Raising the piston opens these two holes. Just below B, the vertical tube (C) is divided by a knife edge at a point where two opposing tubes (F) enter the vertical tube (C) at 45° angles. Tubes (F) connect to extension tubes (G) by compression couplings (H). Nylon or stainless steel netting may be placed over the distal ends of extension tubes (G) using collars (I) to hold them in place. Four brass rods (J) suspend this mechanism above a

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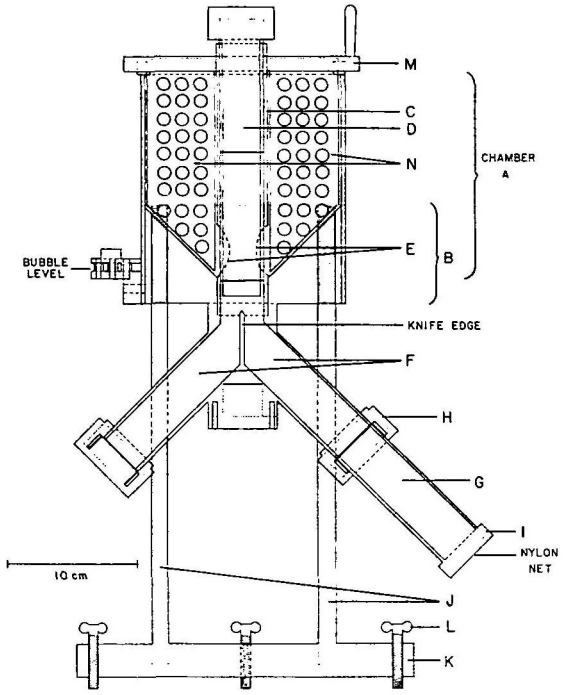

Figure 1. A drawing of the splitter.

base plate (K). Three brass screws threaded through the plate (K) serve to level the splitter. A mechanic's level is affixed to the block (B) and leveled with the block before the legs (J) are attached. Two stainless steel screws which attach the level to the block should be sealed with dichlorethylene. Three stainless steel screws, which are seated on rubber grommets and which attach the level to its base, should be sealed with a locking type epoxy, to prevent tampering with the screws. Alternatively, an acrylic plastic cover could be placed over the mechanic's level and its base. An arm (M) bearing two perforated paddles (N) turns on the vertical tube (C) and rides on the rim of the chamber. The paddles projecting into the chamber (A) ride against the vertical tube (C) and the bottom of the chamber (A) but have a clearance of 1·5 mm from the sides of the chamber (A). A plankton sample is split by passing it from chamber (A) through holes (E) over the knife edge and out tubes (F).

Operational procedure

Prior to splitting a sample the apparatus is leveled using the screws threaded through the base. Then, with the piston in down position, a volume of water half the capacity of A is poured into A. Two identica-beakers are placed beneath tubes (G) and the piston is raised allowing the water to flow into the beakers. If the water level in each beaker appears the same when the two beakers are placed side by side, the splitter is ready to receive the sample to be fractionated. Should there be a difference in the water levels, and a recheck shows the apparatus level, then the knife edge plug is not centered. This is corrected by loosening the retaining screws and reseating the plug. The splitter should be used only on a sturdy table or other work area not subject to bumps and vibrations.

Large plankters (e.g. salps, coelenterate medusae, and ctenophores) should be removed from a sample before splitting and the volume adjusted to one half or three fourths that of chamber (A). With the piston in down position, the sample is evenly distributed throughout the chamber by moving arm (M) back and forth a half rotation several times. With the paddles positioned equidistant from holes in the central tube, the piston is raised with one hand while the apparatus is steadied by the other hand pressing down on arm (M). After the fluid has drained from the chamber, the piston should again be placed in down position and all plankton clinging to the device washed down into the bottom of the chamber for

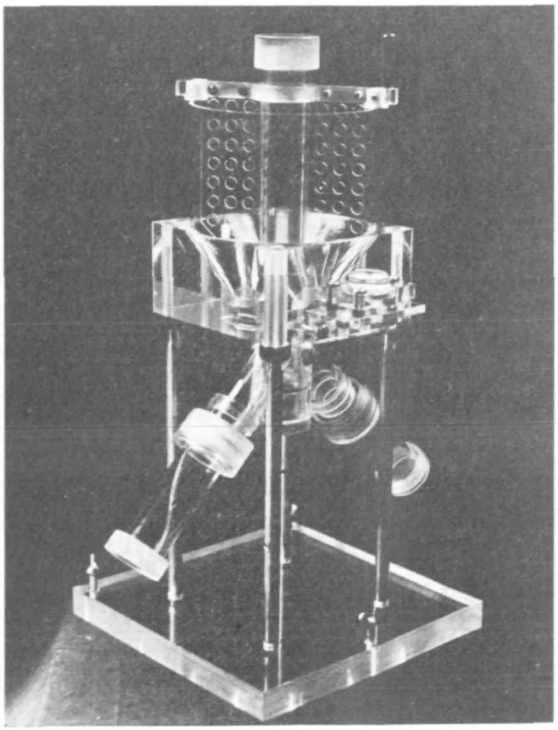

Figure 2. A photograph of the splitter.

restirring and splitting. Splitting may be repeated by returning the aliquot from one tube to the chamber until the desired fraction is achieved. Operators may place netting at the ends of tubes (G) to collect and concentrate the plankton at this point and avoid the problem of excess liquid from the washdown process.

Test of the splitter

The splitter was evaluated using two procedures. First, four plankton samples were made up, each containing one type of organism: 2140 *Acartia tonsa*, 2000 chaetognaths, 1000 *Morone saxatilis* eggs and 214 *Alosa* sp. larvae. These were split and each subsample counted and recombined 10 times so that counts could be compared. Paired t tests as described by Li (1968) were made on the four kinds of organisms.

Table 1. Results of 10 splits of the same four plankton samples listing the values of $\bar{y}$, the mean difference; s^2, the variance; and t

Species	N	$\bar{y}$	s^2	t d.f.9
Acartia tonsa	10	5·3	1164·9	0·49
Chaetognatha	10	2·6	933·38	0·27
Morone saxatilis eggs	10	1·8	410·84	0·28
Alosa sp. larvae	10	1·2	39·73	0·60

Table 2. *Acartia tonsa* counts in the final aliquots when the first subsample was further fractionated. The number of splits includes the first and subsequent splits of the aliquot of the respective side

Total Splits	Left	Right	Difference
2	206	201	−5
2	316	334	18
4	222	293	71
5	460	424	−36
6	632	624	−8
6	528	544	16
6	614	594	−20
7	209	193	−16
7	837	860	23
8	177	181	4
8	206	212	6
8	211	216	5
	4 618	4 676	58

$N = 12$
$\Sigma y = 58$
$\bar{y} = 4{\cdot}84$
$s^2 = 445{\cdot}82$
$t = 0{\cdot}8$ with 11 degrees of freedom

The second evaluation was made by subsampling twelve plankton samples containing large numbers of *Acartia tonsa*. Each sample was split into a right and left aliquot, i.e., the first subsamples. Of these, the right subsample was split a second time. The right side of the second subsample was retained or split again and the left side was discarded. Similarly, the first left subsample was split a second time, the left side of the second subsample retained or split again, and the right side discarded. The number of splits of both sides of a sample were equal. The numbers of *Acartia tonsa* in the final aliquots were compared using the paired t test.

Conclusions from test of the splitter

Comparison of single splits of four prepared unispecific zooplankton samples gave t values in each instance of less than 1 ($P > 0{\cdot}50$), indicating that errors introduced by the splitter were insignificant (Table 1). Comparison of counts of *Acartia tonsa*, when each side of the initial split was further fractioned, gave a t value of 0·8 ($P > 0{\cdot}40$; Table 2). The second test indicated that differences in counts were random and tended to cancel each other. Therefore, the use of this apparatus to subsample zooplankton collections is not likely to introduce significant errors in estimates of abundance.

References

Kott, P. 1953. Modified whirling apparatus for the subsampling of plankton. Aust. J. Mar. Freshw. Res., 4:, 387–93.

Li, J. C. R. 1968. Statistical Inference 1. Edwards Bros., Ann Arbor, Mich. 658 pp.

Motoda, S. 1959. Devices of simple plankton apparatus. Mem. Fac. Fish. Hokkaido Univ., 7: 73–94.

McEwen, G. F., Johnson, M. W. & Folsom, T. R. 1954. A statistical analysis of the performance of the Folsom plankton sample splitter, based upon test observations. Arch. Met. Geophys u. Klimatol., Ser. A, 7: 502–27.

Wiborg, K. F. 1951. The whirling vessel, an apparatus for the fractioning of plankton samples. Fisk Dir. Skr. serie Havundersøkelser, 9 (13): 16 pp.

Wiborg, K. F. 1962. Estimations of number in the laboratory. Rapp. P.-v. Réun. Cons. perm. int. Explor. Mer., 153: 74–77.

Windsor, C. P. & Walford, L. A. 1936. Sampling variations in the use of plankton nets. J. Cons. perm. int. Explor. Mer., 11: 190–204.