A SPHERICAL SAMPLING DEVICE FOR BLACK FLY LARVAE

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ABSTRACT. A sampling device for black fly larvae constructed of a ball firmly attached to a support anchored in the stream is described. The advantage of this device over those previously used is the increased numbers per unit area and the consistency between samples collected in turbulent streams. This is because the orientation of the device in relation to current direction is not a factor as it is a sphere.

INTRODUCTION

Over the last 25 years several objects have been used for sampling larval black fly populations in streams. The two main forms were cones made of plastic, rubber or some other material and strips made of plastic or natural material, particularly leaves of tropical plants. (Fredeen and Spurr 1978). Of these, cones probably give the best quantitative data as current flows over the whole surface when they are properly oriented thus giving a measured surface from which to calculate larval densities. A major disadvantage of cones is that they must be mounted facing into the current, and this is not always easily accomplished in a fast flowing stream. Also cones with a long taper are not readily available especially in a form easily attached to a support in a river. Plastic tapes, which are easily obtained, have been attached to a support and allowed to trail in the stream giving good consistent results under certain conditions (Williams and Obeng 1962, Pegal and Rühm 1976, Fredeen and Spurr 1978). However, in fast turbulent water they do not collect larvae in large numbers (Lewis and Bennett 1974, Colbo unpublished). Lewis and Bennett (1974) used ceramic tiles which were all of the same size and texture. This device, while having known dimensions has a disadvantage in that the tiles often are not oriented in a manner to give a suitable current for simuliid larvae over the whole surface, particularly in uneven stream beds. Therefore the suitable area on the tile for attachment is not consistent among tiles and is still unknown. They are also often shifted by minor spates (Colbo unpublished).

Siting a sampling device is very difficult in turbulent fast flowing streams with a coarse substratum. Microcurrents over the stream bed flow in several directions and at several velocities, with the result that only certain areas on the substratum are suitable for simuliids (Décamps et al. 1975, Colbo 1979). Thus an ideal sampler must have a uniform surface area exposed to the current irrespective of the direction of flow over the device. A sphere appeared to be the best shape for this purpose. Our prime aim was to test a spherical sampler for smaller streams which can be sampled by wading, although this sampler should be adaptable to larger streams.

MATERIALS AND METHODS

The sampling device was a ball affixed to a holder which was secured in the stream. In the present study three sizes of polystyrene foam balls (3.8, 5.7 and 7.0 cm in diameter), each with a hole bored through its center, were secured to iron rods. The rods were threaded and a nut and washer were secured at a level on the rod which would leave sufficient rod exposed on top of the ball to permit a 2nd nut and washer to be attached so as to clamp the ball between the 2 washers. The ball was held rigid and could not rotate. Three balls, 1 of each size, were placed 15 cm apart and 10 cm above a piece of wood (2.3 × 2.5 × 60 cm). Three of these pieces of wood holding the balls were placed across the stream flow and secured by large rocks at 5 sites in Broad Cove River, near St. John's over a 500 m stretch below Healey's Pond. The stream bed consisted of rubble and coarse gravel. The samplers were placed in the river in late February and left in place for a maximum of 3 weeks.

From previous studies (Colbo 1979; Colbo unpublished), it was known that the simuliid population at all sites except one below Healey's Pond outlet consisted almost exclusively of *Prosimulium mixtum* with less than 1% *Stegopterna mutata*. *Cnephia ornithophilia* and *Simulium vittatum* made up the majority of the larval simuliids at Healey's Pond outlet but downstream they were quickly replaced by *P. mixtum* which became dominant within 50 m of the outlet. Thus in this trial only site 1 had a significant number of simuliids other than *P. mixtum*. In addition, 1 trial with 3 styrofoam balls and 3 smooth plastic balls was performed using 7 cm balls to test the effect of surface texture on larval collections. For comparison with previous methods we placed 9 ceramic tiles (10 × 10 < 0.8 cm) described by Lewis and Bennett (1974) and nine plastic strips (1.3 × 20 cm) at sites 1, 3 and 4.

The sampling programme called for the removal of 1 set of balls, 3 tapes, and 3 tiles (from each site) at the end of weeks 1, 2 and 3. The larvae were washed off with alcohol and counted. As these were winter species which had hatched from October to December (Colbo 1979) they were from 3rd to 6th instar larvae, predominantly the 5th and 6th instars.

RESULTS

The number of larvae recovered from the ball samplers is shown in Table 1. The samples were remarkably consistent and an analysis of variance showed that there was no significant difference between simuliids per cm² on the 3 sizes of ball (Table 2). Further, it was noted during the sampling that the simuliid larvae concentrated in a ring around the equator of the ball. This was a strip approximately 2 cm wide. If it was assumed that the equatorial zone was a cylinder 2 cm wide, the densities per ball recalculated and an analysis of variance performed, there was

Table 1. Simuliid larvae collected at 5 sites along Broad Cove River on 3 sizes of polystyrene foam balls over a 3 week period.

Ball size			Total larvae			larvae/cm²			Average for all sites/cm²		
Diameter (cm)	Surface area (cm²)	Site	Weeks I	Weeks II	Weeks III	Weeks I	Weeks II	Weeks III	Weeks I	Weeks II	Weeks III
		1	188	143	58	4.1	3.2	1.3			
		2	230	180	365	5.1	4.0	8.0			
3.8	45.4	3	107	142	348	2.4	5.3	7.7	2.6	2.8	4.4
		4	61	55	200	1.3	1.2	4.4			
		5	5	13	21	0.1	0.3	0.5			
		1	130	319	85	1.3	3.1	0.8			
		2	655	468	519	6.4	4.6	5.1			
5.7	102.1	3	302	546	687	3.0	5.4	6.7	2.3	3.0	3.6
		4	50	127	457	0.5	1.2	4.5			
		5	3	56	23	0.1	0.6	0.8			
		1	46	337	306	0.3	2.2	2.0			
		2	348	506	1018	2.3	3.3	6.6			
7.0	153.9	3	530	590	944	3.5	3.8	6.1	1.4	2.2	3.6
		4	117	243	469	0.8	1.6	3.1			
		5	13	79	43	0.1	0.5	0.3			

Table 2. Analysis of variance (2 way) with no replication for samples shown in Table 1.

	DF	SS	MS	F
Total	—	6.45	—	
Row (size)	2	1.13	0.57	5.70 NS
Column (weeks)	2	4.92	2.46	24.6**
Error	4	0.40	0.10	

NS = not significant, F value < F(0.05) = 6.49.
** = highly significant, F value > F(0.01) = 18.00.

no significant difference in density per cm- between the size of balls but there was a significant increase over the 3 week period in numbers of larvae accumulating per ball. (Table 3).

Table 3. The mean number of larvae per cm² of a 2 cm band around the equator of each ball by size and week with the analysis of variance.

Ball size	Weeks I	II	III	
Small	4.9	5.3	8.3	
Medium	6.4	8.5	9.9	
Large	4.8	8.0	12.6	
	DF	SS	MS	F
Total		54.06		
Row (size)	2	9.76	4.88	2.65 NS
Columns (weeks)	2	36.96	18.48	10.04*
Error	4	7.34	1.84	

NS = not significant, F value < F(0.05) = 6.49.
* = significant, F value > F(0.05) = 6.49.

The difference between rough styrofoam and smooth plastic was marked. The 3 polystyrene foam spheres collecting 688, 648 and 535 larvae while the plastic balls caught 278, 179 and 166 larvae for a mean of 627.0 and 207.7 respectively. Thus the polystyrene foam spheres collected 3 times as many larvae over the 3 week period.

The results of collections from the tapes and tiles are shown in Table 4. It is evident that both tapes and tiles collected far fewer simuliid larvae than the balls and that the variation between individual tapes and tiles was very high.

DISCUSSION

It is important that a sampling device be stable in the water column if it is to collect simuliids reliably. For this reason short tapes floating in the current will not collect simuliids in a turbulent stream. During the present study a length of clear plastic tape about 5 m long was found in the river near Site 2. The tape had caught on rocks and weeds with part of it held taut and part floating in the water. The taut section had several thousand larvae attached to it while the free portion had very few, supporting the above thesis. The tiles were again very unreliable because they were not all equally exposed to the current. Tiles placed in the stream at our benthobservatory were observed over a period of time and it was clear that only the portion of the tile directly in the current was suitable for simuliid larvae.

It is therefore clear that the balls will work only if held firmly in place and not permitted to turn in the current. Once this is accomplished then the exact placing of the samplers in the stream with regard to bottom topography is less critical than with tiles or other devices. The balls need only be placed in the correct main current velocities for the species which one wishes to sample, or dispersed over the stream bed if that is the aim of the study. The downstream surface of the ball should also be a suitable surface for pupation in species moving into turbulent water for this purpose (Maitland and Penny 1967, Colbo and Moorhouse 1979).

Although the rough polystyrene foam balls collected more larvae it was difficult to remove the larvae from the pitted surface. Therefore, it is better to use a smooth surface to decrease sampling time. The styrofoam balls produced for hobby and craft shops should provide the proper inexpensive spheres for this sampler.

Table 4. Number of simuliid larvae per cm² on plastic tapes and ceramic tiles.

			Larvae/cm²			Average no. larvae/cm² week		
	Site	Tape	Wk I	Wk II	Wk III	Wk I	Wk II	Wk III
		1	0.08	0.00	0.00			
Tape	1	2	0.00	0.60	0.12			
		3	0.24	0.00	0.80			
		1	0.24	0.00	1.40	0.30	0.04	0.53
	3	2	0.13	0.00	0.28			
		3	0.24	0.36	1.88			
		1	0.00	0.00	0.00			
	4	2	0.00	0.00	0.12			
		3	0.00	0.00	0.16			
		1	0.81	1.63	3.19			
Tiles	1	2	1.26	0.66	1.07			
		3	0.63	0.80	3.17			
		1	0.07	2.35	0.24			
	3	2	1.22	2.23	1.74	0.50	1.04	1.55
		3	0.55	1.06	1.83			
		1	0.00	0.09	0.43			
	4	2	0.00	0.22	0.17			
		3	0.00	0.34	2.13			

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