Comparison of Samples of Stream Bottom Fauna Collected During the Day and at Night[1]

ABSTRACT

Bottom samples were taken throughout the year at 1600 and 2300 hours from a riffle region of a brown-water stream of Alberta, Canada. For the abundant taxa, the variance of numbers was much greater than the mean for both day and night samples. For the entire study period, there were no significant differences between day and night samples for total numbers, total number of taxa, and total volume-biomass.

It is difficult to obtain accurate estimates of the total number or total weight of stream benthos per unit area from a few bottom samples, because the great diversity of microhabitats in the streambed usually results in a pronounced contagious distribution of most stream invertebrates. Needham and Usinger (1956) studied a single riffle of a California stream and found that 73 samples of 0.1 m^2 each would be necessary to give significant figures (95% level) of total numbers. They sampled the top few centimeters of substrate during daylight hours with a Surber-type sampler that in all likelihood (considering the small number of animals collected per unit area) had a fairly coarse mesh netting. Coleman and Hynes (1970) reported substantial numbers of stream invertebrates, especially small ones, deep in the substrate of a stony stream, suggesting that samples collected down to 30 cm might not accurately represent the fauna. It is also now known that several groups of stream invertebrates drift downstream in large numbers, with the greatest drift rate of most species at night, so that for a period each night some species might be more randomly distributed in and on the substrate than during the day. Some of the animals normally found deep in the substrate may, for a short period each night, move to the surface of the substrate. Sampling an area of the streambed at night, especially near midnight, may thus result in values for total numbers, biomass, and number of taxa different from the values obtained with daylight samples.

MATERIALS AND METHODS

During a drift study (Clifford, in prep.) of a brown-water stream, the Bigoray River (53° 24′ N, 115° 07′ W) of central Alberta, the benthos of a shallow riffle was sampled during the day (1600 hours) and at night (2300 hours). The bottom sampler, somewhat like those used by Neil (1938) and Waters and Knapp (1961), was a square box 58 cm high, open at the top and bottom and with Plexiglas sides. The lower part of the upstream side had a 30 × 30 cm opening covered with copper mesh of 497-μ pore size. This was large enough to allow the water to flow through the sampler, but small enough to keep out most of the drifting macrofauna. The lower part of the downstream side also had a 30 × 30 cm opening to which was attached a net having a 320-μ pore size. A 320-μ mesh, although quite fine, does not retain small chironomid and simuliid larvae (Mundie 1971). The net was attached to the frame with wingnuts and could be detached before removing the animals. The sampler enclosed an area of 844 cm^2. Its lower border was so constructed that it could be pressed only into the first 7 cm of the substrate, since the main interest was in differences between day and night samples that might be due to invertebrates settling on the substrate from the drift or coming to the surface of the bed from deeper down. To determine the relationship between the variance and the mean for day and night samples of individual taxa, I took 4 samples at 1600 hours and again at 2300 on 3 July 1970; thereafter only one sample was taken at each of these hours. In the laboratory, the samples were sorted under ×10 magnification. Organisms were identified and counted and volume-biomass

[1] This study was supported by a grant from the National Research Council of Canada.

TABLE 1. *Numbers of animals of the abundant taxa, total number of taxa, and total volume-biomass (cc) per 0.08 m² for each of the day (D) and night (N) samples, 3 July 1970–14 May 1971. Day and night totals of 3 July are each averages of four samples. All aquatic insects are immatures*

	3 Jul		28 Jul		18 Aug		2 Oct		13 Mar		14 May		Averages	
	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Baetis	182	146	66	118	38	37	7	2	56	63	1	0	58	61
Caenis	0	0	0	0	45	42	22	16	168	90	9	11	61	39
Leptophlebia	0	0	5	6	8	36	16	3	52	9	0	0	20	14
Arcynopteryx	2	5	3	8	4	4	0	0	3	11	1	0	3	6
Nemoura	39	21	25	149	18	61	25	4	26	37	0	0	27	54
Hydropsyche	39	25	102	345	45	52	22	13	108	166	1	2	53	101
Dicranota	37	24	37	42	1	1	2	2	18	17	0	0	19	17
Chironomidae	436	175	254	236	5	26	160	133	153	99	8	5	169	112
Elmidae	60	48	34	24	38	38	17	12	77	81	7	13	39	36
Ostracoda	30	16	17	21	39	25	40	51	20	54	18	21	27	31
Oligochaeta	15	17	13	24	19	21	0	0	4	1	34	29	17	18
Others	248	217	38	124	14	22	161	180	183	223	20	18	111	131
Total No.	1088	694	594	1097	274	365	472	416	868	851	99	99	566	587
Total Taxa	17	21	20	24	19	23	21	20	22	20	15	15	19	21
Vol. Biomass	0.68	0.55	0.32	1.16	0.30	0.58	0.84	0.60	3.40	3.30	0.11	0.12	0.94	1.05

determined by water displacement using a microburette.

RESULTS AND DISCUSSION

For each of the abundant taxa, the variance of numbers was much greater than the mean for both the day and the night of 3 July. Therefore the populations exhibited contagious distributions; following Elliott (1971) for small sample size, I made the general logarithmic $(x+1)$ transformation of the counts. This eliminated the dependence of the variance on the mean. Sampling at night reduced the variance-to-mean ratio for certain taxa, e.g. larvae of Chironomidae, *Hydropsyche*, Elmidae, and Simuliidae; but for other groups, e.g. *Nemoura*, *Dicranota*, and *Baetis*, the variance-to-mean ratio was greater at night than during the day. None of the taxa was found in significantly greater numbers (t test, $P < 0.05$, after log transformation of the values) in either the day or night samples of 3 July. For the fauna as a whole on this date, there were no significant differences between daytime and nighttime total numbers, total number of taxa, and total volume-biomass.

For the entire study period, daytime and nighttime numbers of most taxa were quite similar, surprisingly so considering that only two 0.08-m² samples were being compared (Table 1). Large disparities in numbers between day and night samples for individual dates were mainly in groups having large motile nymphs, i.e. the plecopterans *Arcynopteryx* sp. and *Nemoura cinctipes*, and the ephemeropteran *Leptophlebia cupida*. These three species exhibit night-active drift patterns in the Bigoray River, but so do *Baetis tricaudatus*, *Caenis simulans*, and Chironomidae larvae. Only *Arcynopteryx* and *Hydropsyche* were found in larger numbers at night throughout most of the study period. But neither any single taxon nor the fauna as a whole was found in significantly larger numbers ($P < 0.05$) in either day or night samples when the entire study period was considered, i.e. pairing the day and night values (after log transformation) of each taxon for each sampling date throughout the year (paired variate t test). For *Arcynopteryx* $P = 0.30$ and for *Hydropsyche* $P = 0.40$; for all other taxa, P was ≥ 0.50. For the fauna as a whole (total numbers) $P = 0.80$.

There were no significant differences (paired variate t test) between day and night samples for total number of taxa and total volume-biomass (Table 1); in fact, the average day and night volume-biomass values are surprisingly close together considering the possible heterogeneity of mi-

crohabitats. The large volume-biomass of 13 March was due mainly to large numbers of hydropsychids that had congregated in the riffle region, which at that time was reduced because of water freezing into extensive areas of the substrate.

In brief, there is no indication from my study that a more accurate picture of the stream's fauna would be obtained by sampling the bed at midnight instead of during the day.

HUGH F. CLIFFORD

Department of Zoology,
University of Alberta,
Edmonton.

REFERENCES

COLEMAN, M. J., AND H. B. N. HYNES. 1970. The vertical distribution of the invertebrate fauna in the bed of a stream. Limnol. Oceanogr. **15**: 31–40.

ELLIOTT, J. M. 1971. Some methods for the statistical analysis of samples of benthic invertebrates. Freshwater Biol. Ass. Sci. Publ. 25. 144 p.

MUNDIE, J. H. 1971. Sampling benthos and substrate materials, down to 50 microns in size, in shallow streams. J. Fish. Res. Bd. Can. **28**: 849–860.

NEEDHAM, P. R., AND R. L. USINGER. 1956. Variability of the macrofauna of a single riffle in Prosser Creek, California, as indicated by the Surber sampler. Hilgardia **24**: 383–409.

NEIL, R. M. 1938. The food and feeding of the brown trout (*Salmo trutta* L.) in relation to the organic environment. Trans. Roy. Soc. Edinburgh **59**: 481–520.

WATERS, T. F., AND R. J. KNAPP. 1961. An improved bottom fauna sampler. Trans. Amer. Fish. Soc. **90**: 225–226.

SEPARATING CONSTITUENTS OF NATURAL PHYTOPLANKTON POPULATIONS BY CONTINUOUS PARTICLE ELECTROPHORESIS[1]

ABSTRACT

The Beckman continuous particle electrophoresis (CPE) system was used to isolate components of mixed phytoplankton suspensions. Twenty-one freshwater phytoplankton genera were tested. All algal cells examined migrated toward the anode and different mobilities frequently resulted in fractionation of mixtures of different genera. Organic debris, clay particles, and bacteria often exhibited distinct mobilities that led to their separation from other constituents. Tris (hydroxymethyl) amino methane, *p*H 9.2, provided greater particle mobility and better resolution than sodium diethylbarbiturate, *p*H 8.6. Increase in buffer *p*H tended to make algal particles more negative and increased mobility. A direct relationship existed between applied field gradient and particle mobility. Resolution generally improved at higher field gradients. The effectiveness of the separation was limited by such algal properties as motility, size, formation of aggregates, and buoyancy.

Present methods of isolating component species of natural phytoplankton communities are not adequate to provide large, reasonably pure samples. Differential centrifugation (Welch 1948) and serial filtration (Soli 1964) are the more successful techniques, though both yield small isolates and are very time consuming.

The Beckman continuous particle electrophoresis (CPE) system for fractionation of microparticles in free media is different in a number of respects from other more traditional systems of electrophoresis. The primary difference is that the sample particle suspension is injected into a thin, rapidly flowing curtain of buffer to which a lateral dc field is applied. Continuous collection of fractions resulting from migration of particles is possible and their electrophoretic patterns can be observed and recorded. This system has been used successfully in the separation and isolation of diverse inorganic microparticles and in fractionation of components of such biological mixtures as mitochondria and cellular elements, virus and cellular debris, bacteria and cellular debris, and bacteria and blood cells of various sorts (e.g. *see* Strickler et al. 1966; Beckman Instr., Inc. 1969*d*).

[1] Based on a portion of a dissertation presented to the Graduate Faculty of Auburn University by D.R.B. in partial fulfillment of the requirements for the Ph.D. degree.