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MACROINVERTEBRATES OF A COLORADO HIGH MOUNTAIN STREAM

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ABSTRACT. The macroinvertebrate community and associated environmental parameters of a high mountain stream were studied biweekly during the open season of two consecutive years. Physicochemical parameters were similar both years indicating a cold, clear stream with soft waters, near neutral pH, and sparse algal growth. Aquatic insects comprised approximately 95% of the total macroinvertebrate numbers each year. Similar numbers of taxa were collected in 1975 (48) and 1976 (40). Although there were differences in abundance between years, the predominant organisms were generally the same. Ephemeropterans were by far the most abundant organisms both years. A high degree of sympatry was exhibited by the trichopteran *Rhyacophila*; six species were collected from a single riffle. A lower mean macroinvertebrate density in 1976 (774 org/m^2) than in 1975 (1467 org/m^2) can be attributed to heavy rainfall resulting in a 400% increase in discharge over a short time period. The differential effect of a short-term flood on the fauna also explains composition differences between years. Coarse particulate organic matter exhibited qualitative differences, lower standing crop values, and earlier seasonal maxima than a similar montane stream in the same drainage basin. Collectors and scrapers were more abundant and shredders much less abundant (and composed of different dominants) than in small eastern woodland streams.

While the invertebrate fauna of Rocky Mountain streams has been the subject of several studies, few have dealt with the higher reaches of streams, those sections above 3000 m elevation. Dodds and Hisaw's (1925) pioneering study employed only qualitative sampling and did not include physicochemical measurements (except temperature). Elgmork and Saether (1970) studied a small Colorado stream above timberline, but their field collections were limited to 4 days in July and did not include physical or chemical data other than temperature. Other Colorado studies which included high elevation stations were of limited taxonomic scope (Knight and Gaufin

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1966, Mecom 1972, Allan 1975). In a recent study of 20 Rocky Mountain streams (Pennak 1977), only one sampling site out of a total of 47 was located above 3000 m, and no detailed information was given on the fauna. In order to obtain more information on the benthic fauna of high mountain streams, such a stream was intensively studied from June through October for two consecutive years.

STUDY AREA. Joe Wright Creek is a small, third-order tributary of the Cache la Poudre River located on the east slope of Cameron Pass in north-central Colorado. The study site was located in a riffle area flowing through a meadow at 3045 m elevation. Riparian vegetation was dominated by willows (*Salix* spp.) and sedges (*Carex* spp.). Stream width varied from 2 to 13 m. Substrate consisted of gravel, pebbles, and cobbles (Cummins 1962). Benthic algal growth was generally sparse.

METHODS. Biological and physicochemical data were collected biweekly from late June through mid-October during 1975 and 1976. A Surber sampler which encloses 929 cm^2 and which was equipped with 700 μm mesh was used to collect six replicate samples on each date. The substrate was disturbed to a depth of about 10 cm, which may not adequately sample the hyporheal community. Samples were preserved with 5% formalin. In the laboratory the macroinvertebrates were separated from the detritus and placed into 80% EtOH for identification and enumeration. Detrital material was washed free of sediment, dried to constant weight at 60°C, and weighed. Ash-free dry weight was determined after combusting at 550°C for 24 hours.

Current velocity and discharge were determined with a Gurley water current meter. Bound CO_2 was measured titrimetrically using methyl orange and hydrochloric acid (Pennak 1977). Hydrogen-ion concentration was determined in the field with Hellige color disks. Dissolved oxygen was measured by the azide modification of the Winkler method. Suspended solids were determined by filtering a one-litre sample of stream water through a 0.45 μm millipore filter and weighing the residue after drying to constant weight at 60°C.

RESULTS AND DISCUSSION. Table 1 summarizes the physico-

TABLE 1. *Physicochemical data*[a] *for Joe Wright Creek, Colorado.*

Parameter	1975	1976
Discharge (m^3/sec)	0.31	0.32
Temperature (°C)	1.2	2.5
pH (median)	7.2	7.1
Dissolved oxygen (mg/l)	9.6	9.2
Bound CO_2 (mg/l)	13.0	11.4
Suspended solids (mg/l)	1.3	2.5

[a]Mean values, except pH.

chemical data for the 2 years. The values for all parameters were similar both years and indicate a cold, clear stream with soft water and near neutral pH.

Aquatic insects comprised approximately 95% of the fauna collected each year and were represented by five orders (Fig. 1). Ephemeropterans were by far the most abundant organisms, accounting for 42.0% of faunal numbers in 1975 and 58.5% in 1976. Relative contributions of plecopterans, trichopterans, and coleopterans were very similar both years, whereas dipterans were less abundant in 1976 (6.3%) than 1975 (17.5%). Other studies on Rocky Mountain streams give similar results (e.g., Gaufin 1959,

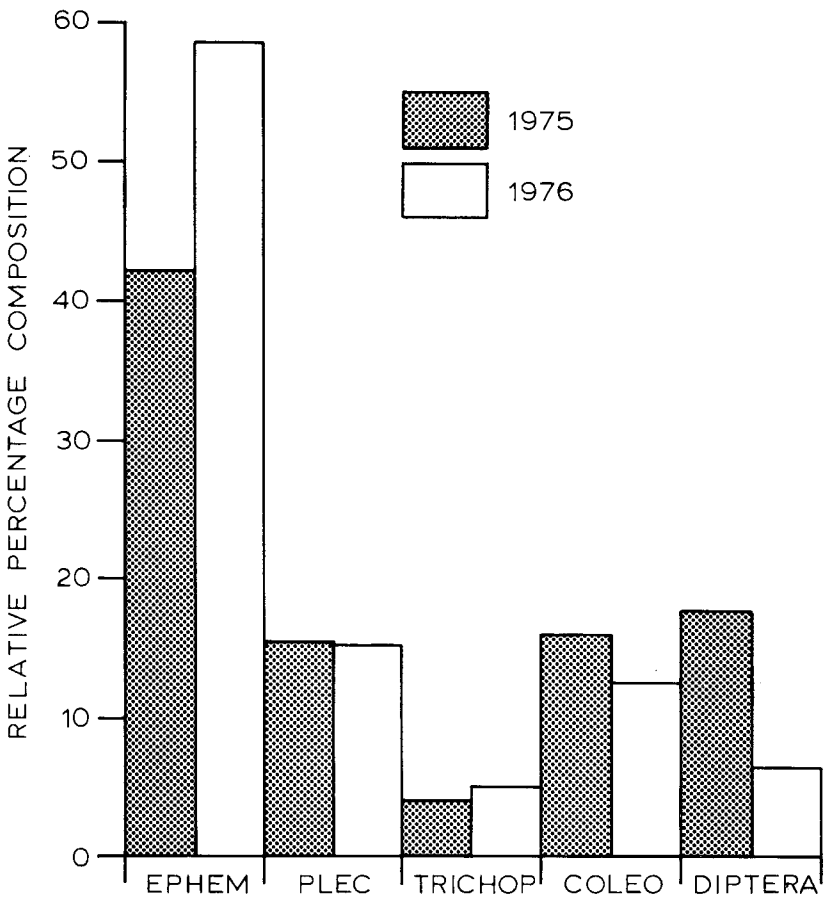

Fig. 1. Percentage composition by numbers of major taxa, Joe Wright Creek, Colorado.

Ward 1975). Ephemeropterans are generally the most abundant, with other orders often demonstrating shifts in abundance. At higher elevations plecopterans are often more abundant than trichopterans, while the reverse may be true at lower elevations. For example, Gaufin (1959) reported that Plecoptera (27%) were more abundant than Trichoptera (8%) at an elevation of 2895 m, whereas Ward (1975) found that Trichoptera (22%) were more abundant than Plecoptera (5%) on rubble substrate in a stream at 1677 m. In the present study, Plecoptera (15%) were far more abundant than Trichoptera (5%), which likely results from the low water temperatures (Kamler 1965).

Similar numbers of taxa were collected in 1975 (48) and 1976 (40). Although there were differences in abundance between the 2 years, the dominant organisms were generally the same (Table 2).

TABLE 2. *Mean density of macroinvertebrates (org/m²) from Joe Wright Creek, Colorado.*[a]

Taxon	1975	1976
Ephemeroptera		
Ameletus sparsatus McDunnough	28	10
Baetis sp.	56	59
Rhithrogena robusta Dodds	183	148
Cinygmula sp.	200	125
Epeorus deceptivus (McDunnough)	48	92
Ephemerella coloradensis Dodds	39	24
Ephemerella doddsi Needham	61	3
Paraleptophlebia sp.	6	0
Plecoptera		
Zapada haysi (Ricker)	117	14
Zapada cinctipes (Banks)	12	14
Nemoura sp.	+	+
Malenka sp.	0	+
Capnia spp.	12	14
Alloperla spp.	58	67
Isogenus sp.	18	9
Megarcys sp.	18	0
Trichoptera		
Rhyacophila acropedes Banks	+	3
Rhyacophila angelita Banks	27	11
Rhyacophila coloradensis Banks	1	0
Rhyacophila hyalinata Banks	+	+
Rhyacophila tucula Ross	1	1
Rhyacophila verrula Milne	2	0
Rhyacophila pupae	3	0

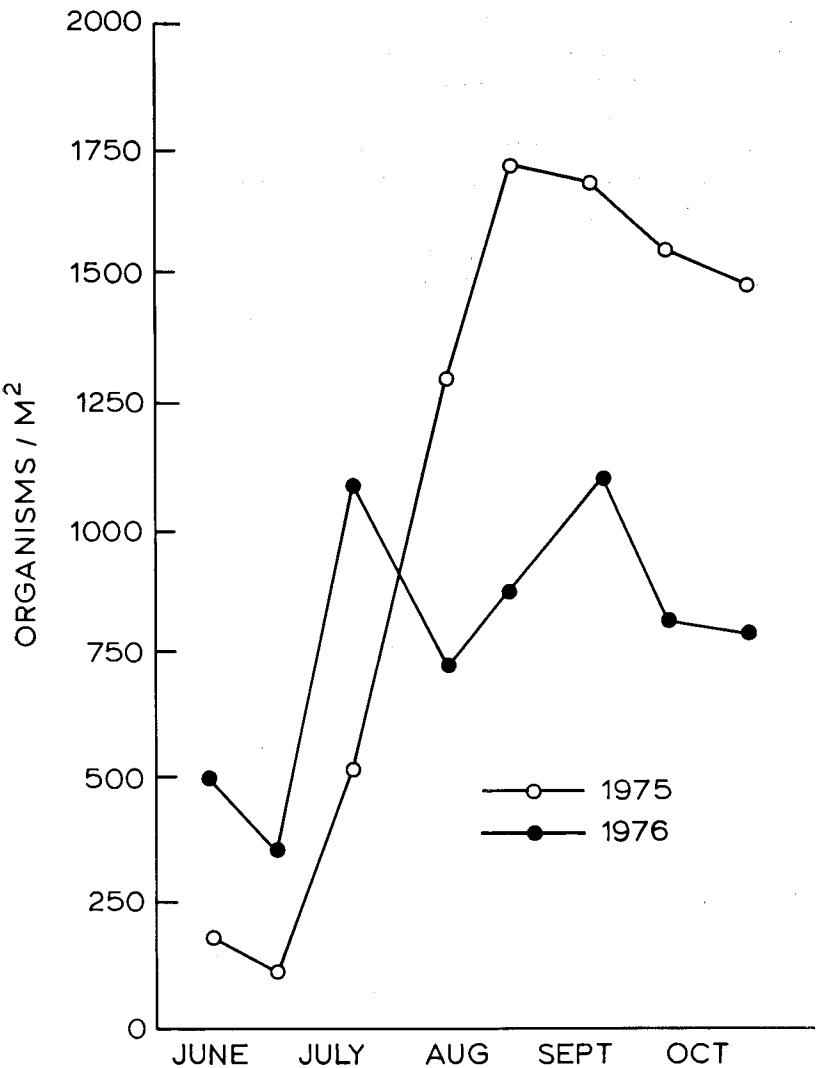

Fig. 2. Total macroinvertebrate density during the open season for two consecutive years, Joe Wright Creek, Colorado.

(leaf packs) will be severely reduced by increased flow (Ward and Short, 1978). This may explain the reduction of *Zapada haysi* in 1976.

The importance of detritus in the stream ecosystem is well established and may be the primary energy source for stream insects

(Cummins 1974). The change in standing crop of coarse particulate organic matter (CPOM) with time is shown in Fig. 3 for Joe Wright Creek and Little Beaver Creek, a stream of similar size located at 2410 m elevation in the montane zone (Short, unpublished). Low values during spring runoff were followed by peak values which corresponded to the time of leaf abscission in both streams. The maximum for Joe Wright Creek occurred in late August, approximately 30 days earlier than for the lower elevation stream, which may have considerable importance to the stream fauna since temperature affects the processing rate of leaf litter.

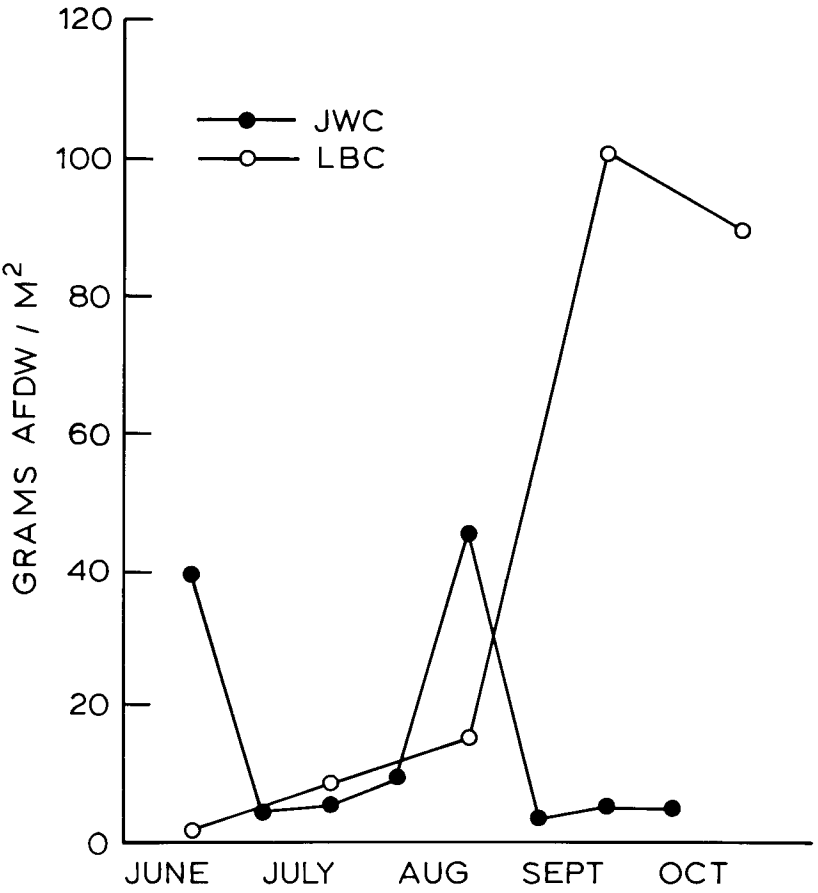

Fig. 3. Standing crop of coarse particulate organic matter in Joe Wright Creek (JWC) and a Colorado montane stream (LBC) in the same drainage basin during the open season.

It was only during the period of autumnal abscission that leaf litter dominated the CPOM in Joe Wright Creek. At all other times the majority of the CPOM was composed of twigs, branches and conifer cones. This could explain the high densities of *Heterlimnius corpulentus* observed in Joe Wright Creek since other elmid beetles may utilize wood material as a food source (Merritt and Cummins 1978). Except during the August peak in Joe Wright Creek, CPOM standing crop was much greater in the montane stream.

To gain futher insight into the role of macroinvertebrates in the high mountain stream ecosystem, the fauna was divided into functional groups based upon Cummins (1974), utilizing information on food habits contained in Merritt and Cummins (1978). The fauna of Joe Wright Creek is predominantly comprised of collectors and scrapers (Fig. 4); shredders composed only about 10% of the fauna and were largely made up of nemourid stoneflies. This clearly distinguishes the high mountain stream from small eastern woodland streams where shredders often comprise the majority of the fauna with Tipulidae and Limnephilidae as the dominant shredders (Cummins 1974). The predominance of ephemeropterans accounts for the large scraper and collector categories in the high mountain stream.

More data on the food habits of individual taxa and on the energetics of the high mountain stream ecosystem are clearly needed to more fully elucidate the role of macroinvertebrates in the system.

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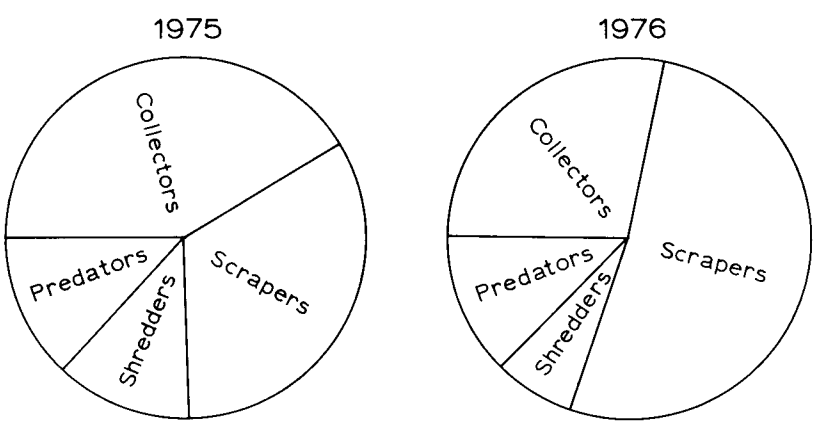

Fig. 4. Functional group classification of macroinvertebrates of Joe Wright Creek, Colorado, 1975 and 1976.

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