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Submerged undercut banks as macroinvertebrate habitat in a subalpine meadow stream

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Abstract

We compared macroinvertebrate samples from submerged undercut banks with samples from rifles and pools in a low-gradient-meadow reach of a small stream on the Snowy Range, southeastern Wyoming, from July to September 1985. Macroinvertebrates collected from submerged undercut banks were similar to those collected from riffles and pools, but densities varied among the three habitat types. In July Ephemeroptera, Plecoptera, Trichoptera, Coleoptera, and Diptera, as well as Hydracarina, were all substantially more numerous in samples from undercut banks than from riffles or pools. By contrast in September little difference was observed in the abundance of macroinvertebrates in samples from submerged undercut banks, riffles and pools. While forming only 8.5% of the area of aquatic habitat within the study reach submerged undercut banks were estimated to contain 44% of the aquatic insects in July and 30% in August. Further, submerged undercut banks are macroinvertebrate habitat in this subalpine meadow stream, contributing to overall macroinvertebrate abundance and probably an additional food source for trout.

Introduction

The amount of undercut bank occurring in small stream has been shown to exert a positive influence on trout abundance (Bowlby & Roff, 1986; Wesche *et al.*, 1987). It is generally believed that the mechanism by which undercut banks influence trout abundance is by providing overhead cover, but submerged undercut banks may also enhance macroinvertebrate abundance and subsequently increase the food supply for trout.

Submerged undercut banks are a unique feature in small, low-gradient streams. The undercut is formed by meander processes that erode the outer bank of streams bends leaving an over hanging bench of soil held together by plant roots. Where dense growths of riparian vegetation occur, like willows (*Salix*) and sedges (*Carex*), undercut banks can become abundant. Exposed root filaments hanging into the water from the underside of undercut banks can provide substrate for macroinvertebrates.

We know of no previous studies describing submerged undercut banks as habitat for aquatic macroinvertebrates. Our purpose here is to describe the macroinvertebrates present in samples of root filaments from submerged undercut banks, to compare the composition and abundance of macroinvertebrates in samples from these undercut banks with samples from adjacent riffles and pools, and to estimate the relative contribution of submerged undercut banks to the total abundance of macroinvertebrates in a subalpine meadow stream.

Methods

Our study was conducted from July to September 1985 on the Snowy Range, Medicine Bow National Forest, southeastern Wyoming. The study site was a 100 m reach of Telephone Creek at an elevation of 3205 m. The creek drains a 3.9 km^2 basin by way of several glacial lakes from its headwaters 1.6 km upstream. Discharge for the 5 years preceding this study ranged from 0.01 to 0.78 $m^3 s^{-1}$. Gravel and cobble were the dominant substrate in both riffles and pools.

At the study reach, Telephone Creek is a second-order stream (Strahler, 1957) that flows through a meadow formed by past activity of beaver (*Castor canadensis*). Mean width of the stream channel over the study reach was 2.1 m, mean water depth was 16 cm, and the gradient was 0.4%. Water depth under the submerged undercut banks generally exceeded 20 cm. Dominant vegetation along the riparian zone included willows (*Salix*), sedges (*Carex*), and grasses. Submerged undercut banks lined 57% of the total length of stream bank within the study area.

We sampled submerged undercut banks by gathering handfuls of roots from within a wire circle, 20 cm in diameter, held up against the underside of the bank. A net (363 μm mesh) was held immediately downstream from the collection point to catch macroinvertebrates that may have been dislodged from the roots. The roots were placed in the net as they were collected. We used a modified Hess sampler (363 μm mesh) to collect macroinvertebrates from riffles and pools (Canton & Chadwick, 1984). Three samples were taken from each habitat type in each of three months – July, August, and September.

In the laboratory, we elutriated samples using methods described by Stewart (1975), then removed the macroinvertebrates from a U.S. Standard Number 30 sieve (589 μm openings). Additional washing and picking of macroinvertebrates from the roots in each undercut bank sample was conducted to ensure that all organisms were collected. The macroinvertebrates were identified using several keys including Edmunds *et al.* (1976) for Ephemeroptera, Baumann *et al.* (1977) for Plecoptera, and Wiggins (1977) for Trichoptera, as well as Edmondson (1966), Usinger (1968), Merritt & Cummins (1978), and Pennak (1978).

The surface area of undercut banks, riffles and pools was estimated using transect methods. Habitat was identified at 15 cm intervals across each transect. All macroinvertebrate densities were standardized to number of organisms per 0.1 m^2 to enable comparisons.

Results

The composition of aquatic macroinvertebrates in samples from undercut banks did not differ substantially from riffle or pool samples. Of 35 taxa identified, eight did not occur in common among undercut banks and riffles or pools, but all eight taxa were relatively rare in our samples. Three taxa, *Isotomurus*, *Podura aquatica* and Leptophlebiidae, were found exclusively in samples from undercut banks. A few taxa were absent from undercut bank samples, but occurred in riffles or pools; they were *Serratella*, *Rhithrogena hageni*, *Malenka*, *Glossosoma*, and Stratiomyidae.

Several taxa of aquatic insects were substantially more abundant in samples from undercut banks than in samples from riffles or pools. The taxa that were most abundant in undercut bank samples included the Ephemeroptera genera, *Baetis* and *Ephemerella*, as well as unidentified Leptophlebiidae. Similarly, the Plecoptera genera, *Zapada* and *Megarcys*, as well as unidentified Nemouridae, were most abundant in samples from undercut banks. Among the Trichoptera, *Neothremma* and *Rhyacophila* were most abundant in undercut bank samples, along with unidentified Leptoceridae and Limnephilidae.

The elmid beetle, *Heterlimnius corpulentus*, was also most abundant in undercut bank samples as were several dipteran taxa: *Bezzia*, *Hemerodromia*, *Prosimulium*, *Tipula* and Chironomidae.

In August, fewer differences in aquatic insect abundance were noted between undercut bank samples and riffles and pools. Among the Ephemeroptera, *Baetis*, as well as unidentified Heptageniidae and Leptophlebiidae, were most numerous in undercut banks samples. As for Plecoptera, only *Alloperla* remained more abundant, while the Trichoptera genera, *Rhyacophila*, and unidentified Leptoceridae were most numerous in samples from undercut banks. No taxon of Coleoptera or Diptera appeared to be more abundant in undercut bank samples in August.

By September even fewer taxa were dominant in undercut bank samples. The Ephemeroptera genera, *Baetis* and *Ephemerella*, as well as unidentified Heptageniidae and Leptophlebiidae, were most abundant in samples from undercut banks. The Plecoptera genus, *Malenka*, was the only other taxon to be considered as most abundant in undercut bank samples in September.

In order to assess trends in abundance of aquatic insects among undercut banks, riffles and pools over the three-month study period, we computed the mean densities (number/0.1 m^2) for the five most abundant insect orders found in Telephone Creek (Table 1). All five orders were three to 30 times more numerous in undercut bank samples than in either riffle or pool samples in July. All orders were more abundant in undercut banks than in riffles in August, but only Ephemeroptera and Trichoptera were more numerous in submerged undercut bank samples than in pool samples. In September none of the orders was more predominant in samples from undercut banks.

Table 2. Estimated total numbers (in thousands) of aquatic insects in submerged undercut bank, riffle and pool habitats[1] of Telephone Creek in July, August, and September 1985. Percent composition in parenthesis.

Habitat type	July	August	September
Undercut bank	136 (44)	50 (30)	41 (3)
Riffle	29 (9)	23 (14)	99 (7)
Pool	143 (46)	92 (56)	1319 (90)
	308	165	1459

[1] 14 m^2 undercut bank, 38 m^2 riffle, and 112 m^2 pool over the 100 m study reach.

The contribution of submerged undercut banks to the total number of aquatic insects in the study reach was estimated for each sampling month (Table 2). While the surface area of undercut banks (14 m^2) made up a small proportion of the available habitat (8.5%) compared with riffles (38 m^2, 23.2%) and pools (112 m^2, 68.3%), the contribution of undercut banks to the total number of aquatic insects was very high. Our estimates of aquatic insect abundance (Table 1), when coupled with the estimates of habitat availability, indicated that 44% of the total aquatic

Table 1. Mean densities (organisms 0.1 m^{-2}) of aquatic insect orders from submerged undercut banks (U), riffles (R), and pools (P) of Telephone Creek in July, August, and September 1985.

Order	Month								
	July			August			September		
	U	R	P	U	R	P	U	R	P
Ephemeroptera	68	28	7	14	10	4	54	22	23
Plecoptera	54	5	11	37	15	40	24	24	43
Trichoptera	32	1	1	14	2	3	0	2	4
Coleptera	118	26	34	33	16	135	57	27	103
Diptera	700	16	75	262	17	638	160	185	1005
	972	76	128	360	60	820	295	260	1175

insect fauna in July, and 30% in August, occurred in undercut banks.

Six major taxa of aquatic macroinvertebrates other than insects were found in samples from Telephone Creek: Turbellaria, Nematoda, Annelida (Oligochaeta), Hydracarina, Gastropoda (*Physa*), and Pelecypoda (*Pisidium*). Hydracarina were extremely abundant in undercut bank samples, but rare in samples from riffles and pools. The sporadic occurrence of the other aquatic macroinvertebrates in our samples did not enable comparisons in abundance among habitats over the three-month sampling period.

Discussion

Densities of aquatic insects in riffle and pool samples from Telephone Creek were similar to those observed for streams of comparable size and altitude in the central Rocky Mountains (Pennak & Van Gerpen, 1947; Elgmork & Saether, 1970; Allan, 1975; Ward, 1975). Previous studies have not considered the occurrence of aquatic insects associated with root filaments hanging from undercut banks, but our data indicate that substantial densities of aquatic insects and mites occur in undercut banks and appear to contribute to the overall macroinvertebrate productivity of the stream.

Previous studies have related substrate composition (Ward, 1975; Williams, 1980; Peckarsky & Dodson, 1980), detrital material (Rabeni & Minshall, 1976; Short *et al.*, 1980) and the composition of aquatic plants (Rooke, 1986) to the abundance and diversity of macroinvertebrates in stream systems. We expect that the root filaments extending below undercut banks function similar to aquatic plants with fine leaves and stems by providing substrate for macroinvertebrates (Rooke, 1986). It is possible that the root filaments also serve as detrital sieves and accumulate food for certain macroinvertebrates that utilize the roots as substrate. We also hypothesize that the root filaments may serve as sieves and capture macroinvertebrate drift, thus accumulating high densities of aquatic organisms during periods of substantial drift (Waters, 1972).

Submerged undercut banks in small mountain streams such as Telephone Creek appear to make a substantial contribution to the habitat supporting macroinvertebrates, especially in July and August. This contribution probably yields more food for brook trout (*Salvelinus fontinalis*) and enhances the standing stock (Hubert & Rhodes, 1989). Subalpine meadow streams in the Medicine Bow National Forest often have very high standing stocks of brook trout (> 300 kg ha^{-1}) compared to other streams, and they also tend to have more undercut bank than other streams (Kozel, 1987). It is possible that both the cover and greater food supply provided by undercut banks is enabling the very high standing stocks to occur among subalpine meadow streams.

This study provides evidence of the value of submerged undercut banks, not only as cover but also as a source of food for fish in small streams, and enhances the justification for protection of this habitat feature. Further study of macroinvertebrates associated with submerged undercut banks is needed to better define their function within stream ecosystems.

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