EFFECTS OF TREE FALL ON MACRO-INVERTEBRATE ABUNDANCE AND DIVERSITY IN A TROPICAL STREAM

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Abstract: Allochtonous inputs can affect invertebrate community structure in streams. We compared the aquatic invertebrate community structure around a recent and an older tree fall in the Quebrada Machina in Costa Rica. We hypothesize that invertebrate communities would change with tree fall age. We found that the branches and leaves of fallen trees supported a more abundant and diverse aquatic invertebrate community than did the rocks around tree falls. We also found a difference in invertebrate functional feeding group composition between the old tree fall and new tree fall, with a greater proportion of filter feeders in the branches of the new tree fall and more gatherers in the old tree fall. We propose that these results reflect a difference in available organic matter between the two sites.

Key Words: functional feeding group, gatherers, shredders, stream invertebrates

INTRODUCTION

In a shallow forest stream, allochthonous inputs of terrestrial organic matter may serve a dominant role in establishing community structure (Fisher and Likens 1972, Minshall et al. 1983). Invertebrate communities are often divided into functional feeding groups including filterers, scrapers, shredders, gatherers, and predators. These feeding groups comprise a variety of trophic levels and have been recognized as essential parts of stream communities (Lehmkuhl 1979).

We studied the aquatic invertebrate community around a recently fallen tree and an older, more decomposed tree fall. We hypothesized that the aquatic invertebrate community structure would be affected by tree falls and would change with the amount of time that the fallen trees had been in the stream. Specifically, we predicted higher invertebrate abundances and diversity in the old tree fall where invertebrates would have more time to colonize. We also expected the proportions of the functional feeding groups to differ between the two tree falls, as their different ages would cause different levels or distributions of nutrient availability between the two sites. We predicted that the older tree fall, with more decomposed leaves, would have more shredders and scrapers than the newer tree fall while the new tree would have more filterers.

METHODS

We surveyed the macro-invertebrate communities around two tree falls of different ages in the Quebrada Machina near the Estacion Biologica Monteverde, Costa Rica. We used a kick-net to sample the benthic fauna at four locations under and around a recent tree fall (new). We collected nine samples of invertebrates: three

from 25 m upstream of the tree fall, three from 25 m downstream, and three from underneath the trunk and crown of the fallen tree. Each sample consisted of all invertebrates collected from under two rocks of similar size. Four other samples were collected from the leaves and branches of each fallen tree by holding the kick-net in front of the branches and shaking them. We repeated these collection methods at the nearest older fallen tree (old) approximately 0.5 km upstream from the new tree fall. The new and old tree falls had similar diameters and were both orientated lengthwise within the stream. The old tree fall had lost all of its leaves, while the leaves were still present on the branches of the new tree fall.

We sorted invertebrate samples and recorded invertebrate abundance, taxa (to family), and functional feeding groups (Lehmkuhl 1979) for each tree fall, and for specific locations within each tree fall. Two-way analyses of variance were used to compare number of individuals in each invertebrate functional feeding group, number of families, and total invertebrate abundances between the two tree falls and between specific locations within each tree fall.

RESULTS

We found a total of 575 individuals from 19 invertebrate families from the two sites (Appendix A). Filterers and gatherers comprised the majority of individuals in all samples, and most of these were black flies (Diptera: Simuliidae) (Appendix A).

We found a significant effect of location on number of individuals per sample More individuals were found on branches than in other locations in the stream at both the new and old tree fall ($F = 2.57$, $df = 3,18$, $P < 0.01$; Fig. 1). There was no effect of tree age on number of individuals per sample ($F = 2.57$, $df = 1, 18$, $P = 0.13$) and no significant interaction between tree age and location for the number of individuals per sample ($F = 0.95$, $df = 3, 18$, $P = 0.44$).

We also detected a significant effect of location ($F = 7.88$, $df = 3, 18$, $P < 0.01$) and tree age ($F = 14.62$, $df = 1, 18$, $P < 0.01$) on the number of taxa (families) per sample. Samples from the new tree branches contained more taxa than the other locations

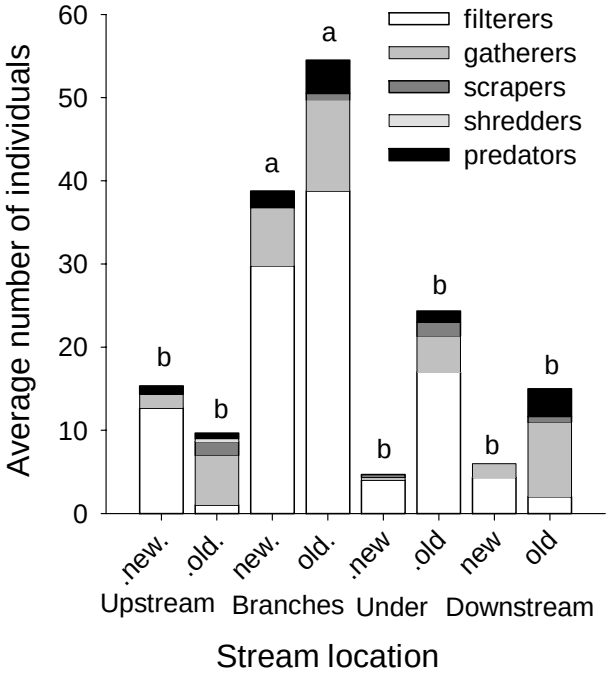

Figure 1. Average number of individuals in each functional feeding group found in each stream location. More individuals were found on the branches of both old and new tree falls. In the new tree, filterers had the same proportion in all locations. In the old tree, filterers had a higher proportion in and under the branches. Different letters (a, b) indicate groups that are significantly different (Tukey multiple comparison test).

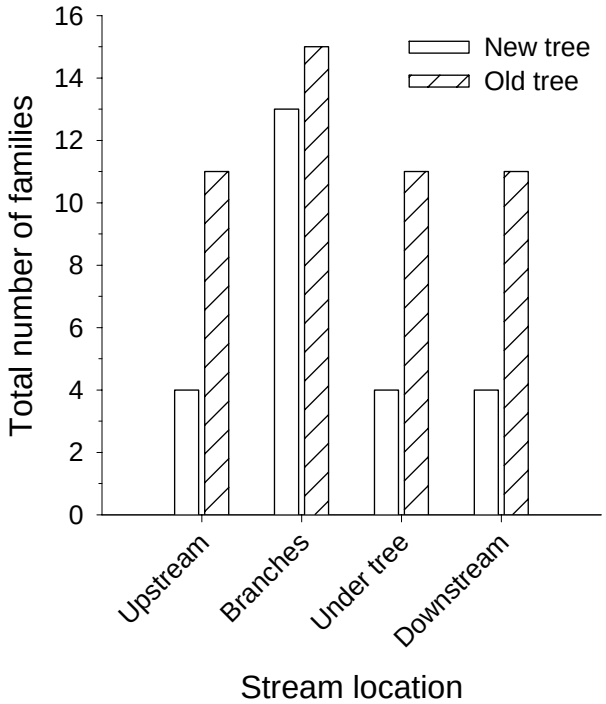

Figure 2. Number of taxa (families) found in each stream location for both a new and an old tree fall. At the old tree site, there were significantly more taxa in the branches than in other locations.

around the new tree (Fig. 2). There was no significant interaction between tree age and location for the taxa per sample ($F = 0.58$, $df = 3, 18$, $P = 0.63$).

There was also a significant effect of location (2-way ANOVA, $F = 3.96$, $df = 3, 18$, $P < 0.01$) and tree age ($F = 15.40$, $df = 1, 18$, $P = 0.03$) on number of (filterers / (filterers + gatherers)) per sample. In the new tree fall, filterers and gatherers were found in approximately the same proportions at all locations (Fig. 3). There was no significant interaction between tree age and location for the taxa per sample ($F = 2.13$, $df = 3, 18$, $P = 0.13$). In the old tree fall, filterers had a marginally significant higher proportion in the branches and the rocks underneath the branches then at other locations within that tree fall (Fig. 3).

DISCUSSION

Tree falls add both structural complexity and nutrients to a stream. This may have contributed to the high aquatic invertebrate abundances found in submerged leaves and branches. In our study, black fly larvae, a filterer, comprised most of these invertebrates, and is a highly mobile and abundant invertebrate in Costa Rican streams (Vargas and Fallas 1983). Its mobility may allow it to colonize quickly after a tree falls into a stream. Since black flies filter fine particulate matter from surrounding waters, they were probably using tree fall branches and leaves as substrate and not as a nutrient

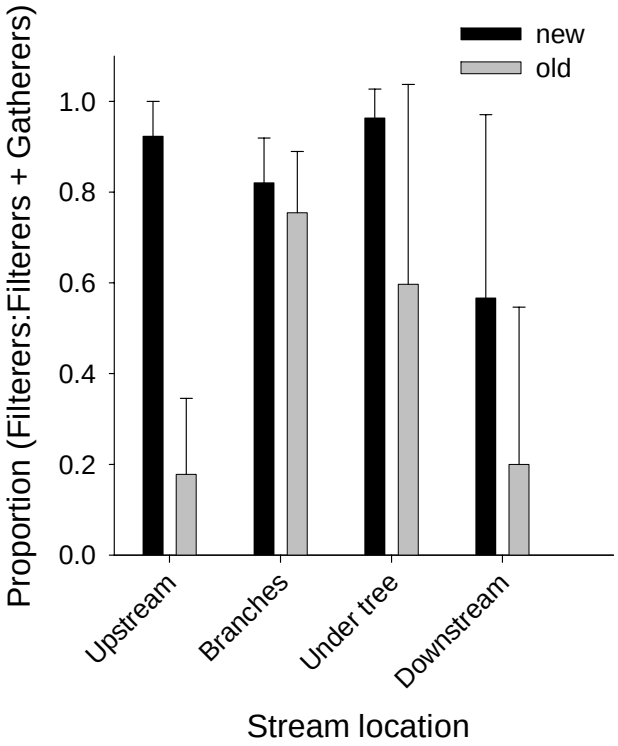

Figure 3. Mean (± 1 SE) proportions of filterers to filterers + gathers in different locations of the old and new tree fall sites (n = 3 samples for upstream, under tree, and downstream, n = 4 for branches). In the new tree fall, filterers have the same proportion in all locations. In the old tree, there were proportionally more filterers in and under the branches.

resource. The high structural complexity of tree fall branches and leaves probably also provided substrate supporting the greater number of invertebrate families found associated with branches and leaves.

Invertebrate gatherers, represented in our study primarily by Elmidae, Chironimidae, Amphipoda, and Baetidae, require undissolved fine particulate organic matter. Higher total abundance of gatherers at the old tree fall (Fig. 1) and higher gatherer abundances relative to filterers at the old tree fall (Fig. 3) suggest a difference in available organic matter between the two sites. Leaves at the new tree fall were still green and unfragmented, a form unavailable for consumption by invertebrate gatherers (Hauer and Lamberti 1996). At the old tree fall the branches served as 'debris dams' in which allochtonous leaf inputs could collect. These leaves were fragmented and partially decomposed, and therefore more available for consumption by gatherers. Thus, as tree falls age, they may act not only as substrate for filterers but also as nutritional resource retainers that support invertebrate gatherers.

The results of our study indicate that structural and nutritional resources provided by tree falls may change with time and that a tree fall in a stream provides complexity that supports high abundance and variety of stream invertebrates.

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Appendix A.

FFG	Family	Tree	Upstream	Branches	Under tree	Downstream
Filterer	Simuliidae	New	38	110	10	11
		Old	2	142	46	6
	Hydropsychidae	New	0	9	2	2
		Old	0	12	5	0
	Polycentropodidae	New	0	0	0	0
		Old	1	1	0	1
Gatherer	Elmidae (small)	New	4	6	1	0
		Old	7	12	0	4
	Elmidae (medium)	New	0	2	0	0
		Old	0	6	1	2
	Elmidae (large)	New	0	4	0	5
		Old	1	2	2	1
	Amphipoda	New	0	2	0	0
		Old	0	15	0	1
	Chironomidae	New	0	6	0	0
		Old	3	1	8	16
	Tricorythidae	New	1	8	0	0
		Old	0	0	0	0
	Baetidae	New	0	0	0	0
		Old	3	7	1	3
	Limnephelidae	New	0	0	0	0
		Old	0	1	0	0
	Platyhelminthes	New	0	0	0	0
		Old	2	0	0	0
Scraper	Psephenidae	New	0	0	1	0
		Old	1	1	0	0
	Leptophilibidae	New	0	0	0	0
		Old	4	1	5	1
Shredder	Odontocera	New	0	0	0	0
		Old	1	0	0	0
Predator	Coenagrionidae	New	2	4	0	0
		Old	0	3	0	0
	Tipulidae	New	0	2	0	0
		Old	0	0	0	0
	Perlidae	New	0	0	0	0
		Old	1	8	1	0
	Libellulidae	New	0	0	0	0
		Old	1	0	1	1
Total		New	45	153	14	18
		Old	23	212	70	36