Landscape variation in phosphorus concentration and effects on detritus-based tropical streams

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Limnol. Oceanogr., 47(1), 2002, 278-289 | DOI: 10.4319/lo.2002.47.1.0278

ABSTRACT: Landscape-scale variation in streamwater phosphorus (P) concentration can affect aquatic food webs. Such variation occurs naturally in streams at La Selva Biological Station in Costa Rica due to spatially variable inputs of geothermally modified groundwater. We examined effects of this gradient on detrital food web components at 16 stream sites. The Michaelis-Menten model provided a good fit of the relationship between soluble reactive phosphorus (SRP) and leaf decay rate, fungal biomass, and invertebrate biomass, indicating that these variables were controlled by P concentration and that half-saturation constants were relatively low (7-13 μg L^{-1} SRP). In a subsequent short-term (3 week) whole-stream P enrichment study, we found no effect of P addition on leaf decay rate or on biomass or density of invertebrates. However, laboratory tests of P, N, and Ca concentrations on mass loss of leaves showed detectable stimulation by both N and P after 3 weeks. A fourth study assessed the relative contribution of invertebrate consumption versus P concentration in determining decay rates among streams. The majority of variation was due to P concentration (71%), compared to effects of invertebrates (3%) or invertebrate X P interactions (14%). Overall, we found that a landscape-scale natural gradient in P concentration influenced decay rates of organic matter and biomass of consumers, providing evidence that benthic detrital food webs can be limited from the bottom up by nutrients. Microbial processes appeared to be most important in driving differences in organic matter decay among sites, but invertebrates also contributed to elevated decay rates at high-P sites.