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title: "Litter decomposition in afrotropical streams: effects of land use, home-field advantages, and terrestrial herbivory"

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### **Abstract**

Land use can strongly affect litter decomposition, a key ecosystem function in low-order streams. Recent evidence suggests that additional drivers of decomposition rates could include 'home-field advantages', when litter decomposes faster at nearby than distant sites, and terrestrial herbivory, whereby leaf inducible defenses triggered by herbivore damage can slow down subsequent decomposition in streams. To assess the relative importance of these three drivers, we conducted a decomposition experiment in an afrotropical stream system, manipulating land use (farm vs. forest sites), home-field advantage (home vs. away from site of leaf collection), and terrestrial herbivory (using leaves varying in their extent of herbivore damage). We measured decomposition in both fine-mesh and coarse-mesh litter bags to compare drivers of microbial vs. invertebrate-mediated decomposition. We found a weak home field advantage, but only for microbial decomposition in fine-mesh bags. For coarse-mesh bags, land use was the only significant (and a strong) driver of decomposition rate, most likely because invertebrate shredders are absent from farm sites. We conclude that relative to major anthropogenic disturbances such as land use, home-field advantages and terrestrial herbivory are unlikely to have large effects on litter decomposition rates in afrotropical streams.

### **Intro**

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everything that land use can do to decomp in streams. water chem, benthic fauna, etc.

### **Methods**

Fieldwork was conducted in and around Kibale National Park, a 795 km<sup>2</sup> mid-altitude (1100-1600 m) rainforest located in southwestern Uganda (0°13' – 0°41' N, 30°19' – 30°32' E). We

focused on two forest and two agricultural (farm) streams. The two forest streams have a fully forested (and protected) watershed. The two farm sites have a watershed dominated by intensive agriculture of food and cash crops, pastures for goats and cows, and sparse exotic trees planted for timber. The four study sites are small first-order streams (<1.5 m mean wetted width; < 10 cm mean depth) with a similar geomorphology and hydrology, but they vary greatly in water chemistry and community composition based on land use; these differences have been described extensively elsewhere (**FW BIOL**). Briefly, the two farm sites have a much lower canopy cover than the two forest sites, as well as higher water temperature, higher turbidity, lower specific conductance, lower nitrogen and phosphorus concentrations, and a much lower richness and biomass of benthic invertebrates. Invertebrate shredders dominate the composition of forested sites but are almost completely absent from farm sites (**ecosphere**).

Our decomposition experiment focused on the tree species *Neoboutonia macrocalyx* Pax (Euphorbiaceae), the only species of tree occurring within < 10 m of all four streams. This tree, abundant within the park (**ref**), is kept for shade outside of the park in pastures that are otherwise entirely cleared. Other than *N. macrocalyx*, vegetation in the riparian zone of agricultural streams was composed exclusively of grasses and emergent macrophytes, while the riparian zone of forested streams included a high diversity of tall (> 25 m) and understory trees (**Table S1**).

The experiment occurred when, during the summer dry season of 2015.

To measure litter decomposition rates, we conducted a litterbag experiment (Graça, Bärlocher, & Gessner, 2005) using leaves from

We also chose this tree species because shredders were often associated with *N. macrocalyx* leaves in benthic samples, and because feeding observations in laboratory aquaria confirmed that two common shredder taxa (Calamoceratidae and Lepidostomatidae) readily consumed *N. macrocalyx* leaves (V. Fugère, unpublished data). Leaves were collected near trees located close to each study reach by gently shaking branches and gathering fallen leaves, which were then brought to the laboratory and air-dried in a food dehydrator. A subset of air-dried leaves was weighed, then oven-dried to constant mass at 60 °C for 48 hrs and then weighed again to obtain an air-dried to oven-dried (i.e., DM) conversion equation ( $DM = -0.0118 + 0.86 \times \text{air-dried mass}$ ;  $R^2 = 0.9988$ ). A subsample of these dried leaves was combusted at 550 °C to estimate mean ash content (10.2 %) and to convert DM to AFDM. Another subset of air-dried leaves was immersed in water for 72 hrs, and then oven-dried and weighed to estimate a correction factor for leaching (leaching-corrected AFDM =  $-0.008 + 0.8 \times \text{AFDM}$ ;  $R^2 = 0.9769$ ). The remainder of air-dried leaves was weighed, rehydrated, and placed in either fine- or coarse-mesh litterbags (mesh sizes = 0.5 and 10 mm). Fine-mesh and coarse-mesh bags, respectively, prevent and allow macroinvertebrate shredders from accessing the leaves that they contain, and can thus be used to compare rates of microbial decomposition (fine-mesh bags) vs. microbial + shredder-mediated decomposition (coarse-mesh bags).

A total of 320 bags were constructed (160 fine-mesh bags and 160 coarse-mesh bags), allowing 40 bags of each type to be deployed in each of the four focal streams. Sites of leaf collection were standardized, such that an equal number of leaves from all four collection sites were used for each stream. Before deployment, the leaching-corrected AFDM of each litterbag was calculated (AFDM<sub>t0</sub>). Bags were then anchored to the stream bottom across each study reach using stones and twist ties. Ten bags of each type were subsequently retrieved from all streams at weekly intervals over four weeks. The litter content remaining in each bag was dried to constant mass, weighed, and combusted to calculate AFDM of litter retrieved from the stream (AFDM<sub>t1</sub>). Proportion of leaf litter remaining in each bag after stream exposure was then calculated as AFDM<sub>t1</sub> / AFDM<sub>t0</sub>. We estimated decomposition rate for each site and mesh type combination by fitting a linear regression between ln-transformed proportion AFDM remaining and days of stream exposure; the slope of this regression gives the exponential leaf decay rate ( $-k$  / day). Land use effects on decomposition rates in fine and coarse mesh bags were tested by using separate LMMs and LRTs for each mesh type, using as replicates arcsine-transformed values of proportion AFDM remaining in litter bags collected on week 4, the last time point of the experiment.

## Results

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## Discussion

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## Figure legends

*Figure 1.* Site and design of experiment.