SEASONAL VARIATIONS IN STEMFLOW CHEMISTRY IN A RIPARIAN FRAGMENT IN SOUTHWESTERN AMAZON

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INTRODUCTION

Nutrient transfers on forest ecosystems occur through flowpaths which connect atmosphere, vegetation, soil, and surface waters (Bormann & Likens, 1967). The amount of water infiltrating an ecosystem depends on the hydrologic regime, whereas its chemistry is controlled by pathways surrounding this system. All these processes evidence the interactions between nutrient and water cycling.

In this context, forest canopy may play an important role, since several atmospheric materials (derived from both biogenic and anthropogenic sources) which are settled in this cover are leached by rainfall, promoting an enrichment of water passing through canopy (Chiwa *et al.*, 004; Tobon *et al.*, 004). These inputs may be very significant for tropical regions, with old and highly weathered soils which constitute a small nutrient reservoir (Irion, 1978).

Stemflow is an important component of the wet deposition (which also includes throughfall) corresponding to the water that flows along tree trunks (Levia & Frost, 2003), and its chemical composition is highly variable, as function of different tree species, morphological characteristics of the trunks and presence of gaps in the forest.

There are very few studies regarding stemflow chemistry in forests of the Amazon basin and much less in the southwestern region.

OBJECTIVES

This study aimed to monitor fluxes of water and solutes (major cations and anions) in stemflow in order to complement other hydrochemical studies on a riparian forest in the Amazonian state of Rondônia.

MATERIAL AND METHODS

The study was performed on a riparian forest fragment of the Urupa river, eastern Rondonia State, Western Amazonia (11.00107ºS, 62.11766ºW). The experimental plot covers a 2 ha area which is located between the river and an adjacent pasture area at the Fazenda Apurú, with three main trails opened to facilitate the access (Figure 1). The mean annual precipitation is approximately 2,735 mm, measured from December 2005 to December 2006, most of which falls as rain between November and April; this value is close to that reported in other studies in Rondônia (Cassiolato, 2002; Germer, *et al.*, 007). The vegetation in the stand is tropical rainforest, locally denominated "Floresta Ombrofila Aberta", mostly dominated by leguminous and lianas. The soils are classified as ultisols (argissolos), exhibiting moderate texture, sandy granulometry (60-80%), with silt and clay content increasing in depth (Kelly Balster, personal communication).

Stemflow water was collected in the studied plot by using collars around the tree trunks (as suggested by Likens & Eaton, 1970) which drained into 50 L plastic storage gallons. Before installing samplers, a phytossociological survey was performed, including the measurement of diameters at breast height (DBH), in order to select the most representative plot among nine ones. Sixteen trees comprising all individuals DBH $\geq$ 7cm were selected within 10 m X 10 m plot and monitored fortnightly over 5 months, from January 2007 to May 2007.

All volumes were measured in situ; an aliquot was selected to measure electrical conductivity (using an Amber Science meter, model 2052), pH and temperature (using an Orion meter, model 250A). Sub - samples were taken for analysis, filtered through a 0.45 um membrane (GF/F), preserved with thymol and kept cold before analysis. In the lab, major (Na^+, Ca^{2+}, Mg^{2+}, K^+, Cl^-, SO_4^{2-}) and minor ions (NO_3^-, NO_2^-, NH_4^+ and PO_4^{3-}) were analyzed by ion chromatography using a Dionex DX - 500. The quality of analysis of each sample was checked for ion balance calculations (Dunnivant, 2004) as:

Ion Percent Difference = [(Cations-Anions) / (Cations + Anions)] x 100.

RESULTS AND DISCUSSION

Statistical analysis showed that there was a significant positive linear correlation (rs = 0.90, $p < 0.05$; Spearman Rank Correlation) between rainfall and stemflow, and stemflow accounted for 5% (=59 mm) of the incident rainfall (=1,173 mm). This percentage was slightly higher than has been reported for other studies in the Amazonia (de Oliveira, 2008; Lloyd & Marques Filho, 1998; Ubarana, 1996; Leopoldo *et al.*, 987; Franken *et al.*, 1982), possibly due to the large number of palmaceas at the study site, as previously observed in a nearby forest in Rondônia (Germer *et al.*, 006).

The median stemflow pH at Fazenda Apurú was 6.2 (± 0.2) being less acidic than found in throughfall (5.8) and incident precipitation (5.7). Except for areas exposed to heavy loads of atmospheric pollutants (Skrivan *et al.*, 995; Radzi Abas *et al.*, 992), pH of stemflow is likely the result of acid neutralization due to the high concentrations of base cations, especially K+, Ca2+ and Mg2+.

In fact, several authors have reported higher pH and ion concentration in stemflow than those found in precipitation (Fan *et al.*, 999; Holscher *et al.*, 998; Zhang *et al.*, 996), although its effect on soil characteristics are more pronounced near the trees, since stemflow is usually deposited within a small area surrounding the tree trunks.

Concentrations of chemical constituents in stemflow showed high spatial variability, especially for anions. The general order of dominance of cations in the studied area is K+ > > Ca2+ > Mg2+ > NH4+ = Na+ and for anions HCO3 - > > Cl - > NO3 - = PO43 - > SO42 - .

Although element concentration in rainfall usually increases after passing through stemflow and throughfall, some events exhibited decreasing solute levels, reflecting lesser leachate or even net uptake by the canopy, as observed with SO42 - (which is derived from dry deposition rather than from leached metabolites). The high concentration of HCO3 - (median = 4,62 mg.L - 1) in stemflow may be caused by the high pH in the studied site, reflecting a great proton exchange for K+, Ca2+ and Mg2+. This could be partly explained by the evaporation of intercepted rainfall, which causes an increase in ion concentration at the canopy, concentrating the solution in accordance with the amount of water intercepted.

Stemflow is greatly enriched in K+ concentrations (median = 9.71 mg.L - 1), which is predominantly of internal origin from vegetation during the wet season. This can be attributed to a greater canopy leaching associated with higher physiological activity in the growing season (Lovett and Lindberg, 1984).

Ammonium was negligible and close to detection limits (median = 0.23 mg.L - 1). In addition, low nitrate concentration (median = 0.65 mg.L - 1) may indicate a vegetational demand for inorganic nitrogen during the studied period.

CONCLUSION

Stemflow contribution to the rainfall partitioning was higher than observed in other studies suggesting that palmaceas and other species found in open tropical rainforests may play an important role in reallocating rainfall. There are no clear seasonal patterns for most ions in stemflow chemistry. The higher bicarbonate concentrations may be associated to the high pH values in the studied site. Potassium concentration increased considerably after passage through the forest canopy, pointing out the high mobility of this element. Conversely, nitrogen concentrations (for both nitrate and ammonium) were relatively low, indicating absence of N leaching in the studied forest.

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