IMPACTS OF THE EXPANSION OF THE SUGARCANE AGROINDUSTRY ON FRESHWATER COMMUNITIES

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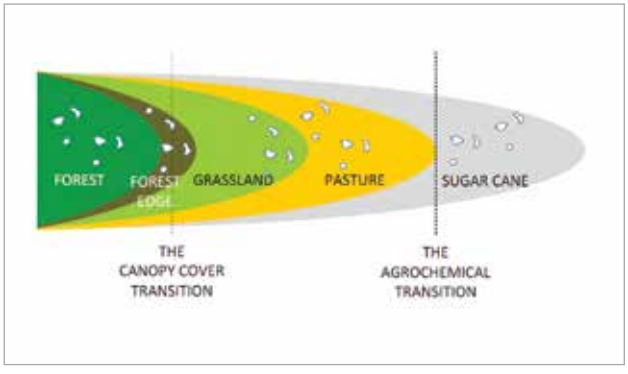

Figure 1. The gradient of environmental degradation in landscapes of sugarcane expansion ranges from native habitats (various cerrado physiognomies) to pastures and sugarcane plantations and is here conceptualized as presenting two steep transitions in physico-chemical properties, with important consequences for the organization of freshwater communities: the canopy cover transition, where most of the changes in the community are expected to be mediated by the presence or absence of a canopy and its influence on pond hydroperiod, temperature and primary production, and the agrochemical transition, where most of the changes in the community are expected to be mediated by the employment of fertilizers and pesticides and their influence on water quality

The dawn of a new paradigm in energy supply – biofuels – points to the continued expansion of agriculture in Brazil in the near future. The country is in a favorable position to assume the global leadership in biofuel production for possessing both ideal geographic and environmental conditions and the already most efficient ethanol industry worldwide. Not surprisingly however, agriculture involves both benefits and costs to society. Industrial agriculture is one of the most environmentally harmful human activities, being directly involved in habitat destruction and in the contamination of water resources. It is unacceptable that Brazil, entering the XXI century with the largest share of the world´s biodiversity and native tropical habitats, and with adequate technical and scientific human resources, misses the historical opportunity to assume, in addition, a model role in reconciling economic growth with environmental preservation.

This project proposes to test the hypothesis that the expansion of sugarcane and soybean – the most important feedstocks of ethanol and biodiesel in Brazil – has substantial impacts on freshwater communities, a significant part of which can be directly or indirectly attributed to agrochemicals such as fertilizers and pesticides. More than documenting impacts, it proposes to understand the mechanisms through which these impacts are generated. This project proposes in addition to validate, for tropical systems, methodologies employed in ecological and ecotoxicological studies in temperate systems, as well as to establish the foundations for the development of a bioindication concept for the contamination of water bodies. These objectives will be achieved in a broad research programme involving sampling and experimentation in laboratory, mesocosms and field. Sampling surveys of temporary pond communities – including algae, tadpoles and predatory insects – across a gradient of environmental degradation (*Figure 1*) will reveal patterns of association among land use, environmental physico-chemical properties, and community composition and structure. In turn, experiments will test the importance of agrochemicals in generating the observed patterns. Through studies conducted in multiple experimental scenarios, we aim at generating a line of extrapolation from lab to field, and to establish clear cause-and-effect relationships between hypothesized processes and observed impacts. Knowledge derived from this project will be important in the development of better agroindustrial practices, towards sustainability in biofuel production and a larger acceptance of Brazilian biofuels in international markets.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

Land use and land management had strong effects on water quality and community composition. In general, ponds embedded in agricultural fields had higher temperature, pH, turbidity, and nutrient concentrations than reference ponds. We also detected residues of pesticides and elevated concentrations of some metals. Overall, there was an impoverishment of amphibian (*Figure 2*) and predator faunas as one moved from forests to pastures to plantations. However, patterns are complex, particularly in Mato Grosso where land management actually increases habitat available to fast developing amphibian species, at the same time that insecticide application wipes out much of the predator fauna.

Regarding the experimental component, short term bioassays and laboratory experiments indicate that inorganic N can have lethal and sublethal effects to anuran larvae, and that the magnitude of these effects is modulated by species identity, developmental stage, and duration of exposure. Field concentrations of N do not appear to reach toxic levels to anuran larvae with the possible exception of early developmental stages and at higher pH. Mesocosm experiments manipulating simple food webs and N, P, and N:P scaled to field-measured concentrations indicate significant effects on primary production and consumer performance.

As a first step towards the risk assessment of pesticides in biofuel crop production, we reviewed the toxicity of all pesticides registered for use in sugarcane and soybean in Brazil, and their potential to cause effects of concern for humans or the environment. We are now crossing this information with quantitative on-site application data.

Increased nutrient levels and phytoplankton standing crop, predatory insect depletion, and tadpole die-offs in ponds embedded in agricultural fields are consistent with a role for agrochemicals in influencing community composition and structure across gradients of environmental degradation in agroindustrial landscapes.

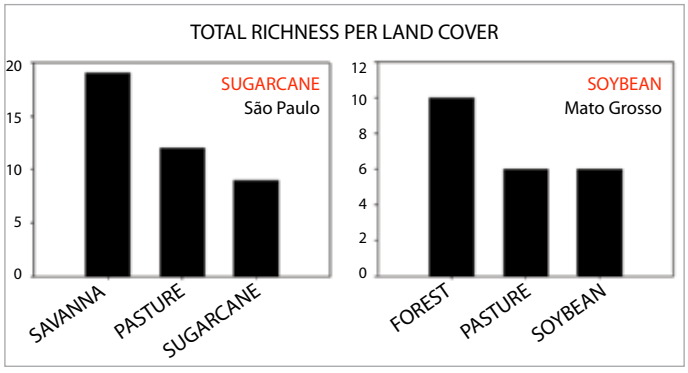

Figure 2. Total species richness per land cover for amphibian larvae. In both sugarcane- and soybean-dominated landscapes, land use for production is associated with an overall impoverishment of the fauna

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