IMPACTS OF THE EXPANSION OF THE SUGARCANE AGROINDUSTRY ON FRESHWATER COMMUNITIES

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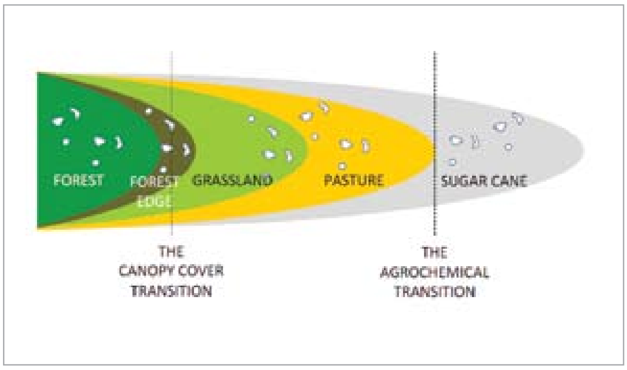

Figure 1. The gradient of environmental degradation in landscapes of sugarcane expansion ranges from native habitats (various cerrado physiognomies) to pastures and sugarcane plantations and is here conceptualized as presenting two steep transitions in physico-chemical properties, with important consequences 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 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

As a first step towards understanding the potential hazards of agrochemicals, we reviewed the toxicity of all 225 pesticide formulations registered for use in sugarcane in Brazil and their potential to cause effects of concern for humans or the environment. Among the 62 active ingredients employed, we found one compound listed as banned or severely restricted in the Rotterdam Convention; two (possibly three) compounds included among the ´Dirty Dozen´, a selection of chemicals of priority concern that are generally persistent organic pollutants (Stockholm Convention); and 26 compounds considered ´Bad Actors´ by the Pesticide Action Network, substances that are highly toxic in acute exposure, neurotoxic, probable or known carcinogens, known groundwater contaminants, and/or of known reproductive or developmental toxicity. Regarding hazards specific to the aquatic environment, 16 compounds are of high or very high acute toxicity to the aquatic biota (*Figure 2*).

We recently completed two pilot sampling surveys in over 30 water bodies. These pilot surveys will provide the basis for associating land use, environmental physico-chemical properties, and freshwater community composition and structure in the definitive sampling surveys of 2010/2011. The experimental component was started with an evaluation of the toxicity of fertilizers to anuran larvae in both acute and chronic exposure in the laboratory. Focusing on the inorganic nitrogen species – nitrate, nitrite and ammonium – we investigated lethal and sublethal endpoints including effects on behavior, growth, and development. Nitrate, the most chemically stable and pervasive nitrogen species, is of lower toxicity when compared to nitrite and ammonium. As expected, lethality increased with prolonged exposure; in other words, concentrations considered harmless in the more traditional, standardized, short-term ecotoxicological bioassays could be lethal in a more ecologically realistic long-term exposure. The experience acquired is useful in the development of a tropical model experimental system. Some species but not others have been shown to be amenable to maintenance and experimentation in the laboratory from egg to metamorphosis, and as such have excellent tractability for ecological and ecotoxicological studies.

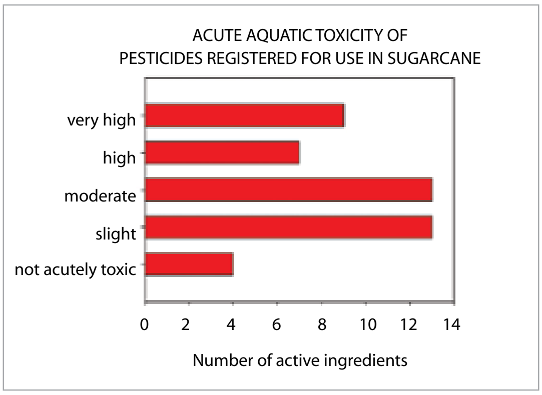

Figure 2. Distribution of the toxicity of the active ingredients included in pesticide formulations registered for use in sugarcane in Brazil to aquatic organisms in acute exposure. Among the 62 registered active ingredients there are also 38 known to be toxic to aquatic organisms in chronic exposure, as well as 8 known and 17 potential groundwater contaminants. Data from Schiesari and Grillitsch in press

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