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SÉMINAIRE

From ecotoxicology to stress ecology: Exposure to and impacts of pollutants in interaction with other environmental parameters in wildlife

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Résumé:
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More than 195 millions of both organic and inorganic substances have been registered worldwide, the toxicity of most of them, especially in combination, being little or even not documented. Consequently, there has been a strong social demand for concepts and methodologies allowing assessing the toxic effects of substances. Ecotoxicology, i.e. the science studying the fate and the effects of pollutants in the environment, developed first a laboratory-based paradigm where dose-response relationships from standardized lab tests on various organisms are used to underpin decisions on authorization of chemicals and on derivation of environmental quality criteria. A second paradigm relies on the study of toxic chemicals and ecological responses in the field, usually along pollution gradient from point sources emitting a single chemical or a simple mixture of chemicals. Despite the relative efficiency of those two approaches to give sound scientific data upon which environmental protection against pollutants could have been built, these paradigms suffer from limitations. Apart from the speed of substance production that often overtakes risk assessment regulatory procedures, the two approaches generally oversimplify the system studied and do not consider pollution as only one of the numerous stressors that may affect natural populations. A new paradigm, sometimes named stress ecology, has emerged, which proposes to consider pollutants and pollution impacts in the real complexity of ecosystems. Our researches take place in the second and third paradigms and aim at understanding the mechanisms underlying the exposure to and the impacts of pollutants in wildlife, taking into account other environmental parameters that may modulate exposure and/or impacts. Mostly based on our long-term (from 2006) monitoring of small mammals, birds, plants and invertebrates in a former metal smelter, I will present how organisms are exposed to total or extractable (supposedly bioavailable to organisms) concentrations of metals in soils, and how this exposure is modulated by other environmental parameters that are less commonly taken into account in classical studies. In particular, we showed that soil occupancy modulated both metal concentrations in soils around the smelter, but also metal concentrations in rodent tissues. Considering these results and the consensual assumption that exposure to pollutants mainly occurs through diet in wildlife, we focussed on the impact of pollution on potential shifts in diet using a next generation sequencing approach for diet assessment, and inventories of plant and invertebrate (as food resources) biodiversity. By analogy to the dilution effect hypothesis that proposes a net reduction of infectious disease risk in highly diverse animal (host) communities, we tested the hypothesis that diversity of resources would exert a dilution effect on exposure to and accumulation of metals in organisms. Our results indeed showed that diversity of resources decreased exposure to and accumulation of some metals, and we determined the underlying mechanisms. We also studied the effects of metals at different levels of biological organization and showed variations of small mammal communities, changes in bird population structure, and (sub-)individual impacts on morphology, haematology, histopathology, and behaviour in small mammals. In parallel, we studied the prevalence of various pathogens in different animal models (small mammals, birds, bats) from the former smelter area and elsewhere, and showed positive association between exposure to pollutants and prevalence of pathogens. The mechanisms underlying this phenomenon, which may involve nutritional and immunological aspects, are currently under investigation and I will present first results and ongoing studies about this. For ethical and scientific (long-term monitoring) reasons, we developed as much as possible non-lethal procedures to assess exposure to and impact of pollutants in interaction with other environmental stressors.