

Report on the fifth meeting of INRA's national network of ecotoxicologists, ECOTOX

Christian Mougin^{a*}, Agnès Bouchez^b, Laurence Denaix^c, Isabelle Lamy^a, François Laurent^d, Fabrice Martin-Laurent^e, Michel Mench^f

^aINRA, UMR1402 ECOSYS (Joint Research Unit for the Functional Ecology and Ecotoxicology of Agro-Ecosystems), F-78026 Versailles cedex

^bINRA, UMR0042 CARTELE (Alpine Research Centre for Food Webs in Lentic Ecosystems), F-74203 Thonon-les-Bains cedex

^cINRA, UMR1391 ISPA (Joint Research Unit for Soil-Plant-Atmosphere Interactions), F-33883 Villenave d'Ornon cedex

^dINRA, UMR5245 ECOLAB (Laboratory for Functional Ecology and the Environment), F-31400 Toulouse

^eINRA, UMR1347 (Joint Research Unit for Agroecology), F-21065 Dijon

^fINRA, UMR1202 BIOGECO (Joint Research Unit for Biodiversity, Genes and Communities), F-33612 Cestas cedex

Abstract

The fifth meeting of INRA's national network of ecotoxicologists took place on 25 to 27 November 2014 in Biarritz, France. The main aim of the meeting was to bring together ecotoxicologists from INRA and associated partners, providing them ample opportunity to share and discuss their latest scientific results as well as the national policy of research in ecotoxicology, and to precise perspectives for the network.

Keywords: ecotoxicology; network; aquatic ecosystems; terrestrial ecosystems; soils; contaminants; fate; impact

Context

INRA's network of ecotoxicologists, ECOTOX (<http://www6.inra.fr/ecotox>) was set up in 2009, about ten years after initiation of the transversal action on ecotoxicology, in order to pursue the management and federation of research on this subject within INRA. It has three priority objectives: (i) to encourage scientific thinking within INRA's community of ecotoxicologists, whether they are dealing with aquatic or terrestrial ecosystems, (ii) to contribute to defining a national research strategy in this field, and (iii) to favour scientific production involving ecotoxicologists. It now benefits from more than 110 members, some thirty of whom belong to other research and higher education institutions (IRSTEA, IRSN, CNRS, universities, AgroParisTech, etc.). The network receives support from three of INRA's scientific divisions: "Forest, Grassland and Freshwater Ecology", "Plant Health and the Environment" and "Environment and Agronomy", as well as from the "Sustainable Management of Crop Health" metaprogramme (SMaCH).

Seminars for the network offer an important opportunity for exchanges within the French ecotoxicology community. After Thonon les Bains (1999), Antibes (2002), Dinard (2006) and St-Lager (2011), the most recent seminar welcomed some fifty participants in Biarritz from 25 to 27 November 2014 (Fig. 1). These three days devoted to ecotoxicology enabled a collective update on changes to the national landscape and its structure, in which the ECOTOX network plays a leading role. The time allotted to presentations during plenary sessions allowed sufficient opportunities for debate which enabled a review of current and prospective thinking in the field.

Conference sessions and highlights

The ECOTOX network now occupies a clearly defined position in the national debate that has developed in response to the French Initiative for Research in Environment and Health (IFRES) launched by the AllEnvi, Athena and Aviesan alliances in the context of the roadmap for Ecological Transition. The IFRES report in 2013 (<http://www.allenvi.fr/actualites/2013/rapport-ifres>) underlined the need for knowledge and proposed a research strategy and action plan in response to societal challenges in the field of environment and health, which includes the disciplines of toxicology and ecotoxicology. At

the invitation of the ECOTOX network, two other French actors: (i) the French-speaking Network for Microbial Ecotoxicology (<http://ecotoxicomic.irstea.fr/>) dedicated to studying the impact of toxic chemicals on micro-organisms and the ecosystem functions they fulfil, and (ii) the Rovaltain Foundation for Scientific Cooperation (<http://www.fcsrovaltain.org>) which focuses on research in environmental toxicology and ecotoxicology, were also able to present their viewpoints and future orientations.

Participants in the seminar presented their important research findings during some thirty oral presentations spread between three scientific sessions which focused on: (i) the characterisation of exposure scenarios, (ii) study of the ecodynamics of contaminants, and (iii) the evaluation of direct and indirect effects on the physiology, behaviour, resilience and dynamics of populations and communities.

The exposome, considered during the first session, was demonstrated as being a pertinent concept to define the exposure of an organism within its environment. The aim of this framework is to establish causal relationships between numerous environmental factors, including toxic chemicals, and their effects on organisms. The presentations concerned both aquatic and terrestrial environments. Experimental methods, data processing and modelling to quantify the exposure of organisms were described, based on measurements of the bioavailability of micropollutants, applied alone or in mixtures. One presentation concerned *in situ* studies revealing the advantages of passive samplers, accumulating toxins over a given period, coupled with ecotoxicological approaches to characterise the toxic potential of aquatic environments. The five other presentations concerned *ex-situ* studies and tried to deal with some specific issues: (i) the experimental evaluation of the (bio)availability of micropollutants to edaphic organisms (earthworms or snails) and how graphical modelling can reflect this bioavailability, (ii) the study of soil-plant transfer mechanisms through the identification of transporters involved in trace element absorption and translocation processes, or the physiological determinants involved in these processes relative to trace organic compounds, and (iii) evaluation of the efficacy of exogenic materials such as biochar in modifying the exposome of cultivated plants in order to ensure the remediation of polluted soils. This panorama made it possible to clarify the technical and conceptual obstacles that need to be overcome in order to better define the exposure of organisms to micropollutants, and to propose appropriate remedial solutions.

The issue of the dynamics of chemical contaminants introduced into agricultural soils was addressed relative to human activities. It was thus shown that the source and treatment of organic residues containing antibiotics influenced the fate and bioavailability of these compounds in cultivated soils. Biological toxins (cyanotoxins) present in irrigation water are also likely to accumulate in agricultural soils. The potential impacts of these compounds on the abundance, diversity and activity of microbial communities, as well as on flora and fauna, requires a clearer understanding of the ecodynamics of these emerging pollutants. The risks of transferring low concentrations of these compounds throughout different food chains, or the appearance and dissemination of resistance, are issues that could be addressed by innovative research at the interface between ecosystem and human health.

Finally, research designed to evaluate the impact of different types of the chemical stressors encountered in agro-(eco)-systems was presented. The stressors considered were organic contaminants (pesticides, PAH), trace elements (metal and non-metal: mercury, copper, zinc, nickel and cadmium), as well as cropping systems (conventional versus organic) and biological control agents (*Bacillus thuringiensis* used as a bio-insecticide). They concerned different elements in the biological component of aquatic and terrestrial ecosystems. Impact measurements were designed to study direct and indirect effects on the physiology, molecular determinants of resistance, behaviour or dynamics of populations and communities. These studies have been carried out at different scales: cell culture (genotoxicity test on trout liver cells), microbial communities (bacterial, fungal), populations and communities of single-cell organisms (algae, diatoms), communities of higher organisms (earthworms) or model organisms (e.g. snails, grasses, *Arabidopsis halleri*, macrophytes, etc.).

All these presentations clearly evidenced the specificity of ecotoxicology as being based on multi-disciplinary approaches. Our discipline draws on a cascade of generic and applied knowledge concerning chemistry, molecular biology, plant and animal physiology/biology and ecology, in order to quantify or even manage the pathways of exposure to contaminants. The aim is to describe and understand the responses and resilience of the organisms exposed, propose solutions that can prevent or limit negative effects (e.g. impacts on individuals and/or on their descendants, or the health safety of trophic chains) or to preserve/restore environments and ecosystem functions.

Several discussion sessions also provided an opportunity to debate the documentation watch strategy implemented by the network (<http://www6.inra.fr/ecotox/Veille>), and its contributions to the SMaCH metaprogramme (<http://www.smach.inra.fr/>). One presentation also concerned the "Analysis and Experimentation on Ecosystems - France" infrastructure (AnaEE-F, <http://www.anaee-s.fr>), which offers numerous dedicated observation, experimentation, analysis and modelling services which could be mobilised for continental ecotoxicological research. The visibility of the network, enhanced by the results achieved by its research scientists, and its plans for scientific production, were also discussed.

Principal conclusions

This ECOTOX network seminar demonstrated the range of skills and approaches available within INRA and its partners. The ambition of the network is to contribute to the optimum organisation of these specialised and complementary human and material resources and ensure their interface, thus enabling multidisciplinary and ranked solutions to the many cases of exposure to contaminants that can cause proven deleterious effects. Although it may be possible to further improve the contribution of our scientists to the field of ecotoxicology, it was nevertheless observed that the critical mass of the network is reaching a threshold above which its resources will no longer be sufficient. For example, skills dedicated to understanding the mechanisms of the ecotoxic response and its underlying molecular determinants, to characterising the fate of chemical compounds in the environment and the organisms that populate it, developing applied solutions for diagnosis or remediation, or searching for biological alternatives to chemical methods (ecological engineering), all deserve to be reinforced. To confirm the Institute's positioning in the ecotoxicology field, in light of the demands specified in the IFRES report and the roadmap for Agroecology, we feel it is important that our community should benefit from sustained resources at a national level in order to develop new research themes and implement ambitious studies, notably to characterise the exposome of agrosystems in the long term.

At the end of this event, the participants were able to look forward to meeting again in the autumn of 2017 for their 6th seminar. However, it is planned that discussion and scientific foresight workshops should be organised each year on specific topics. We shall keep you informed!

Acknowledgements

This meeting benefited from funding from two of INRA's Scientific Divisions: “Forest, Grassland and Freshwater Ecology” and “Environment and Agronomy”, as well as the “Sustainable Management of Crop Health” metaprogramme and the EcoBASC Network of the “Biodiversity, Agroecosystems, Society, Climate” Laboratory of Excellence. This LabEx is part of the French Investments for the Future ("*Investissements d'Avenir*") programme initiated by the French National Research Agency (ANR) (LabEx BASC, ANR-11-LABX-0034).

We would like to thank our colleagues who were particularly closely involved in organising the meeting: Anne-Marie Bouchon and Patricia Braconnier (ISPA Bordeaux), as well as Céline Duisit (PESSAC Versailles) for her work on publishing, logistics and secretariat, and Christine Sireyjol (PESSAC Versailles) for website and documentary watch development.

Compliance with Ethical Standards

The paper follows the rules of good scientific practice presented in the “Instructions for authors”. More precisely, research of the network’s members do not involve Human participants and/or higher animals. Authors whose names appear on the submission have contributed sufficiently to the scientific work and therefore share collective responsibility and accountability for the informations presented. There are no potential conflicts of interests that are directly or indirectly related to the work presented.

Legend to figure

Fig. 1. Colleagues attending the fifth meeting of INRA's national network of ecotoxicologists in Biarritz.

