ARISTO PROJECT NEWSLETTER

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ARISTO

Academia Network for RevIsing and Advancing the Assessment of the Soil Microbial TOxicity of Pesticides.

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EDITORIAL

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Agroécologie, INRAE Bourgogne Franche-Comté

Are we all wrong about pesticide impacts?

Pesticides are still used worldwide to protect plants from various pests. On one hand, pesticides are enabling the production of high-quality plant products to feed animals and humans. One the other, they are known to have side effects on non-target organisms in the agricultural fields and to contaminate the environment outside of the fields, with possible adverse effects on 'One Health'. The use of pesticides in agriculture has therefore become a divisive issue in society, particularly in Europe. The objective of reducing pesticide use by 50% by 2030 has recently been rejected by the European Commission because it was judged as too constraining for the famers, further weakening the European Commission's commitments under the GreenDeal. National politics to reduce pesticide use in agriculture, such as EcoPhyto in France, are not successful: instead of having reached the 50% reduction by 2025, it increased by 20% during the past ten years with two successive EcoPhyto plans. Aware of these difficulties, we have to admit that 'the Eldorado' of an agriculture with less or without pesticides is not yet the reality even if efforts are put towards the agroecological transition of agri-food systems. Therefore, being protective to limit as much as possible the side-effects of pesticides should be our main goal and requires a better assessment of pesticides impacts on ecosystems. But is this objective reachable as we might have been wrong until now?

Indeed, all the active ingredient entering in the composition of pesticides sold on the market are authorized by competent environmental agencies (EFSA in Europe) based on the analysis of a homologation dossier composed of a large dataset produced by the firms claiming the authorization. Most of the authorized active ingredients are judged as non-persistent and with limited side-effects on non-target organisms. This is in contrast with a series of reports on soil survey showing that residues of pesticides are found not only in almost all arable soils exposed to these agrochemicals but also in soils that were not initially exposed to pesticides such as organic fields, forests, grasslands, and brownfields (Silva et al., 2019; Froger et al., 2023). Both Silva et al., 2019 and Froger et al. 2023 showed that glyphosate, and AMPA its main transformation products, contributed to 70% of the pesticides detected in soil even though this herbicide is objectively supposed to display a relatively low persistence (median half-life of 47 days according to the Herbicide Handbook, 2002). Riedo et al. (2021) showed that even 20 years after the conversion to organic farming, herbicide residues (linuron, napropamide, chloridazon, and atrazine (including TPs)) were detected in the soils of organic fields in different farms in Switzerland suggesting a very long-term persistence of these residues in the soil environment, far longer than expected according to half-life data provided in the homologation dossier. Aside from demonstrating unexpected persistences, this study also reports that microbial biomass and specifically the abundance of arbuscular mycorrhizal fungi, a widespread group of beneficial plant symbionts, were significantly negatively correlated to the amount of pesticide residues in soil.

The true question that arises from these observations is: are we all wrong? Is the EU-Regulation 1107/2009/EC concerning the placing of plant protection products on the market protective enough? Storck et al. (2017) proposed ways for a better pesticide policy in Europe and EFSA proposed ways to improve the current regulations by formulating specific protection goals to protect soil ecosystem services, considering the 'ecological recovery' concept in ERA of pesticides, and giving a list of various endpoints to consider to better apprehend the impacts of pesticides on soil-living organisms. Unfortunately, the EU-Regulation 1107/2009/EC has not yet been and will probably not be revised in the coming years. Even if it is, will it be protective enough for One Health? An alternative way to explore would be the better *a posteriori* monitoring of pesticides impacts which until now is the poor parent as there is still no regulatory obligations to monitor pesticide residues in soils while it is already the case for the water and the air compartments (EU-Water Framework Directive 2000/60/EC and EU-Air Framework Directive 2008/50/EC, respectively). Within the Soil strategy for 2030, the EU recently launched the soil monitoring law with the objective to have healthy soils by 2050. This may change the actual paradigm of pesticide regulation which is still relying on *a priori* ERA, as the assessment of soil contamination and health will be a regulatory obligation. *A priori* ERA of pesticides will still be required but will be completed with *a posteriori* ERA of pesticides residues resulting from soil survey monitoring.

For us, microbial ecotoxicologists, this paradigm shift puts the emphasis on the understanding of the effects of complex mixtures of pesticides residues (and other contaminants found in soils) on in soil-living organisms and their associated ecological functions. This is very challenging because this topic is rarely addressed as it is quite complex to be tackled properly. Within the framework of the ARISTO project, Camilla Drocco under the supervision of Anja Coors (ECT) and Aymé Spor (INRAE Bourgogne Franche-Comté) explored this complex question by investigating the responses of both soil microbes and free-living nematodes communities to pesticide mixtures, through lab-to-field experiments. ARISTO will therefore contribute to the exploration of this challenging issue but much more has to be done to propose a framework to conduct appropriate *a posteriori* ERA of pesticides residues in arable soils. These efforts are necessary for including it as specific protection goals to be appended to the soil monitoring law. Additionally, as proposed by Morhing et al. (2020), a holistic approach has to be developed to merge all current pesticide policies, in a single policy effective to reduce potential risks from agricultural pesticide use.

References

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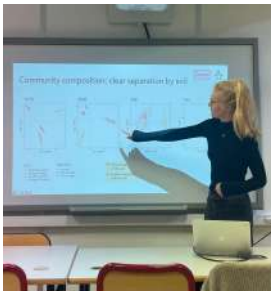
MEET THE FELLOWS

Eleftheria Bachtsevani
ESR1. *In vitro* assessment of the toxicity of pesticides on AOM
Ecole Centrale de Lyon – Dr. Graeme Nicol
NCIMB Ltd – Dr. Carol Devine
Eleftheria is in the final stage of her Ph.D. She has finished the experimental phase and is now concentrating on writing her thesis and her scientific papers. Recently, she submitted her first research article, which explores the development of a novel single-species test using soil nitrifiers as bioindicators for the toxicity of pesticides on soil microorganisms.

Marjan Roshanfekrrad
ESR2. *In vitro* assessment of the toxicity of pesticides on AMF
Universite Catholique de Louvain – Prof. Stephane Declerck
INOQ – Dr. Caroline Schneider
Marjan has returned to the University of Louvain in Belgium for the final (fourth) year of her PhD. She has commenced new *in vitro* experiments to prepare samples for the ultimate objective of the project, which involves molecular analysis.



Laura Johanna Müller
ESR3. Studying the toxicity of pesticides on AOM, and other nitrifiers, in soil
Swedish University of Agricultural Sciences – Prof. Sara Hallin
SAYENS – Dr. Abdelwahad Echairi
Laura finalised the time with her industrial partner SAYENS with a secondment at HYDREKA in Lyon (France), where she also used the opportunity to visit partners at Ecole Centrale de Lyon to discuss her work. Now she is back at SLU in Uppsala (Sweden) for the fourth and last year of her PhD.

Anna Manukyan
ESR4. Assessing the toxicity of pesticides on natural soil and plant assemblages of AMF
University of Thessaly – Dr. Kalliope Papadopoulou
INOQ – Dr. Caroline Schneider
Anna recently completed her three-month secondment at Bayer Crop Science in Monheim am Rhein, Germany. During her time at Bayer, Anna underwent intensive training in Environmental Risk Assessment and led a greenhouse study on pesticide-AMF interactions, under the expert guidance of Bayer's team. Currently she is working on data analysis and writing her thesis.

Cara I. Meyer
ESR5. Studying the toxicity of pesticides on soil microbial networks
INRAE – Dr. Laurent Philippot
SYNGENTA – Dr. Claudio Screpanti
Cara has completed three microcosm experiments and has published her first article in the Journal of Hazardous Materials entitled "Soil microbial community fragmentation reveals indirect effects of fungicide exposure mediated by biotic interactions between microorganisms".

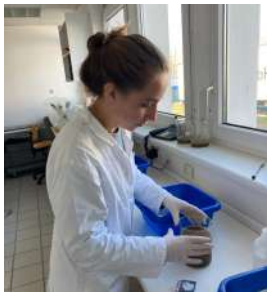
Marta E. Pérez-Villanueva

ESR6. Pesticides toxicity at the soil food-web level: Assessing effects on microbial predator-prey systems

UFZ – Leipzig – Prof. Antonis Chatzinotas

HYDREKA – Dr. Cedric Malandain

Approaching the end of her contract, Marta has shared a summary of the results of her PhD research in an oral presentation at SETAC Europe 34th Annual Meeting in Sevilla, Spain, where more than 3000 people participated from both academy and industry. She is currently finishing the writing of her paper addressing the effects of different protist diversity treatments on the structure, composition and functionality of the soil bacterial community, and is also finishing the analysis of the results for the second paper that focused on the combined effects of pesticides and protist diversity treatments.



Camilla Drocco

ESR7. Assessment of the toxicity of pesticide mixtures on soil microorganisms

INRAE – Dr. Fabrice Martin-Laurent

ECT Oecotoxicologie – Dr. Jorg Roembke

Camila has recently finished her three-year PhD and will defend her thesis in October. She was hired by ECT Oecotoxicologie, where she will start working in June.

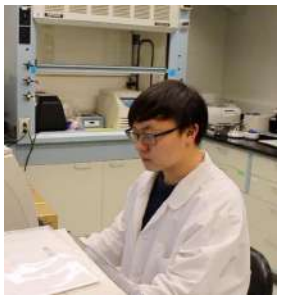
Alexandre Pedrinho

ESR8. Assessing the toxicity of bio-pesticides on soil microorganisms

University of Thessaly – Prof. Dimitrios Karpouzas

Metabolic Insights Ltd – Dr. Ofir Ramot

Alexandre has recently completed a one-month secondment at Bayer Crop Science in Monheim am Rhein, Germany. During this period, he had the opportunity to work on data analysis and participate in training of Environmental Risk Assessment. Currently, Alexandre is writing his thesis.



Kunyang Zhang

ESR9. Development of tools for in silico prioritization of pesticide TPs for soil microbial ecotoxicity testing

EAWAG – Dr. Kathrin Fenner

ENVIPATH – Tim Lorshbach

Kunyang published his first work regarding automatic rule generation on the Journal of Bioinformatics. This manuscript is entitled “enviRule: An End-to-end System for Automatic Extraction of Reaction Patterns from Environmental Contaminant Biotransformation Pathways”. He is currently working on the toxicity prediction leveraging the transfer learning and interpretability enhancement in Graph Neural Networks.

Aristo fellows and PhD students from all over Europe during the Summer School at the Cultural Centre of the University of Thessaly, Monastery Paou, Pelion, Greece

UPCOMING EVENTS

Aristo Workshop with Swiss stakeholders
Online training
28.10.2024

EcotoxicoMic 2024
4th International Conference in Microbial Ecotoxicology
Gothenburg, Sweden
12.11.2024 – 14.11.2024

Final ARISTO meeting
Gothenburg, Sweden
12.11.2024 – 14.11.2024

Academic beneficiaries

Industry beneficiaries

Third-party partners

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