Microbial adaptation to pesticide biodegradation: contribution to soil natural attenuation of pesticides

Fabrice Martin-Laurent

PESTICIDES 2010

6TH EUROPEAN CONFERENCE ON PESTICIDES AND RELATED ORGANIC MICROPOLLUTANTS IN THE ENVIRONMENT AND

12TH SYMPOSIUM ON CHEMISTRY AND FATE OF MODERN PESTICIDES

SUMMER SCHOOL GRIFA 8TH EDITION

SEPTEMBER 5TH-10TH, 2010
MATERA, ITALY
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PESTICIDES 2010
Matera, Italy, September 5th - 7th, 2010
1st Colloquium GRIFA
Summer School GRIFA 2010 - 8th edition
Programme

Sunday, September 5th

15.30 - 19.30 Registration of Participants

20.00 - 22.00 Welcome buffet dinner

Monday, September 6th

08.45 - 9.00 Opening ceremony

Chairperson: Prof. Mustafa Ibrahim Khamis

09.00 - 10.40 **Prof. Jean-Marc Chovelon**

Université Lyon 1, CNRS, UMR 5256, IRCELYON, Institut de Recherche sur la Catalyse et l'Environnement de Lyon, Villeurbanne, France

"Photocatalysis, an efficient tool for pesticides remediation in limited environment"

10.40 - 11.00 Coffee Break

11.00 - 12.40 **Prof. Shlomo Nir**

Department of Soil and Water Sciences, The Robert H. Smith Faculty of Agriculture, Food & Environment, The Hebrew University of Jerusalem, Rehovot, Israel

"Principles and application of micelle- and vesicle-clay complexes in water purification from herbicides and other pollutants"

12.50 - 13.50 Lunch

14.00 - 15.00 **Poster Session and Attendees' Oral Communications**

Chairperson: Prof. Rafik Karaman

15.00 - 17.40 **Dr. Tomás Undabeytia**

Institute of Natural Resources and Agrobiology (CSIC), Seville, Spain

"Slow release formulations of crop protection agents"

Prof. Mustafa I. Khamis
Department of Chemistry and Chemical Technology, Faculty of Science and Technology, Al-Quds University, Jerusalem, Palestine

"Towards integrated wastewater treatment technology: a Palestinian experience"

17.40 Free access to the hotel fitness centre

Tuesday, September 7th

Chairperson: Prof. Shlomo Nir

09.00 - 10.40 **Prof. Costantino Vischetti**
Dipartimento di Scienze Ambientali e delle Produzioni Vegetali, Università Politecnica delle Marche, Ancona, Italy

"Mitigation measures to reduce pesticide point contamination at farm level"

10.40 - 11.00 Coffee Break

11.00 - 12.40 **Dr. Fabrice Martin-Laurent**
INRA-CMSE, UMR 1229 Microbiologie du Sol et de l'Environnement, Dijon, France

"Microbial processes responsible for natural attenuation of pesticides in the Agrosystems"

12.50 - 13.50 Lunch

14.20 - 15.20 **Poster Session and Attendees' Oral Communications**

Chairpersons: Prof. Marco Trevisan - Prof. Ettore Capri

16.00 - 18.00 **Colloquium GRIFA**
open to School and Conference attendees and with the participation of all Lecturers and Chairpersons

"Sustainable use of pesticide directive: impact, opportunity & problems"

18.00 Free access to the hotel fitness centre

MICROBIAL ADAPTATION TO PESTICIDE BIODEGRADATION: CONTRIBUTION TO SOIL NATURAL ATTENUATION OF PESTICIDES

Fabrice Martin-Laurent

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Repeated applications of pesticides often lead to the adaptation of soil microflora to enhanced biodegradation of pesticides. Enhanced biodegradation of pesticides contribute to increase the performances of soil natural attenuation by decreasing the persistence of pesticides in the soil thereby their further dispersal in the environment. In most of the cases, this adaptation relies on the acquisition of the genetic potential coding the enzymes forming the biodegradation pathway. Until very recently, the studies of pesticide-degrading microbes were mainly based on classical microbiology notably allowing the isolation of those microbes and their further characterization by biochemical and molecular approaches. However, the recent development of molecular tools allowing the direct extraction of nucleic acids (DNA/RNA) from soil offers new insights in the analysis of pesticide degrading microbial communities. To illustrate the importance of these new advances in the field of pesticide biodegradation, I will report the results of several studies aiming to understand the molecular mechanisms involved in *s*-triazine (atrazine) biodegradation.

The repeated application of atrazine, one of the most widely used *s*-triazine herbicides during the past four decades, led to the adaptation of soil microflora which acquired the genetic potential (*atz* and *trz* genes) coding the catabolic pathway responsible for atrazine mineralization. The development quantitative PCR (Q-PCR) targeting *atz* and *trz* genes allowed the estimation of the atrazine-degrading genetic potential and of the expressed atrazine-degrading genetic potential in soil DNA and RNA extracts, respectively. Q-PCR notably allowed to show that the atrazine-degrading genetic potential and that the expression of this potential were transiently increased in soil treated with atrazine. Indeed, maximal values were observed concomitantly with maximal atrazine-mineralization rates. The use of Q-PCR also permitted to demonstrate that the bacterial host may influence the expression of plasmid borne atrazine-catabolic potential. In addition, the molecular characterization of atrazine-degrading consortia isolated from the maize rhizosphere revealed that microbial consortia genetically able to degrade atrazine were highly complex being made of different bacterial strains and harbouring hi-

ghly diverse atrazine-degrading genetic potential. Altogether, these results tend to indicate that microbial communities able to degrade atrazine are highly diverse and opportunist, and that they share atrazine-degrading genetic potential through the establishment of cooperative catabolic pathways in soil. Genetic based studies showed that atrazine-degraders were able to exchange atrazine-degrading potential by horizontal gene transfer (HGT) and to modify their degrading potential by homologous recombination mediated by IS-elements. These results highlight the great genomic plasticity and dynamics of the atrazine-degrading community and offer new perspectives in the understanding of the molecular mechanisms involved in the microbial adaptation to pesticide biodegradation.