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EDITORIAL

# Environmental biotechnology and engineering: crucial tools for improving and caring for the environment and the quality of life of modern societies

**Héctor M. Poggi-Varaldo[1] · Damien A. Devault[2,3] · Hervé Macarie[4] · Isabel Sastre-Conde[5]**

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In 2003, a group of pioneering biotechnologists in Mexico led by Professor Elvira Ríos-Leal, Dr. Fernando Esparza-García, and Dr. Héctor M. Poggi-Varaldo, accompanied by a constellation of international scientists such as Dr. Isabel Sastre-Conde from Spain, Dr. Hervé Macarie from France, Dr. Franco Cecchi and Dr. Paolo Pavan from Italy, Dr. E. Foresti from Brazil, Dr. Irene Watson-Craik from Scotland, Dr. José Luis Sanz from Spain, and others, identified a gap in the dissemination of both environmental biotechnology and environmental engineering. This was particularly true for developing countries, although the situation in developed countries was not much better

On the one hand, there were several international and regional events dealing with biotechnology but no international event was devoted to environmental biotechnology. At most, environmental biotechnology had one or two sessions in a Biotechnology Congress. On the other hand, most regional environmental engineering events showed a strong commercial component that negatively competed with the exchange of advanced knowledge and the formation of research networks. Moreover, environmental biotechnology and environmental engineering are two dynamic drives with a strong interaction, and the scientific community could obtain several advantages from their joint diffusion. In short, there was a need for an international event dedicated to both disciplines, with a strong vocation for serious dissemination of scientific and technological knowledge, as well as research networking.

The synthesis to this diagnostic was to launch a new event focused on both disciplines. In this way, the First International Meeting on Environmental Biotechnology and Engineering (IMEBE) was born and held in 2004 in Mexico City. This first event was co-organized by the Dept. of Biotechnology and Bioengineering of CINVESTAV del IPN in Mexico, the French National Research Institute for Sustainable Development (IRD), the Rural, Agricultural and Food Research & Development Institute from Madrid (IMIDRA, Spain), the Mexican Polytechnic Institute (IPN), the National University of Mexico (UNAM), and the University of Hidalgo (UAEH, Mexico), among others. The event was backed-up by a diverse International Scientific Committee that had the

Responsible editor: Philippe Garrigues

✉ Héctor M. Poggi-Varaldo
r4cepe@yahoo.com

Damien A. Devault
damien.devault@univ-antilles.fr

Hervé Macarie
herve.macarie@ird.fr

Isabel Sastre-Conde
isabelsastre2003@yahoo.es

[1] Environmental Biotechnology and Renewable Energies R&D Group, Dept. Biotechnology and Bioengineering, Cinvestav-IPN, Av. Instituto Politécnico Nacional 2508, Col. San Pedro Zacatenco, Delegación Gustavo A. Madero, C. P. 07360 Apartado Postal: 14-740, 07000 Mexico City, Mexico

[2] Ecologie Systématique Evolution, Univ. Paris-Sud, CNRS, AgroParisTech Université Paris-Saclay, Paris, France

[3] Laboratoire Matériaux et Molécules en Milieu Agressif, UA-UMR ECOFOG, DSI, Campus Universitaire de Schœlcher, Schœlcher, France

[4] Aix Marseille Univ, Univ Avignon, CNRS, IRD, IMBE, Marseille, France

[5] SEMILLA-INAGEA, calle Babieca n°2, 07198 Son Ferriol (Palma), Islas Baleares, Spain

contributions of outstanding scientists and professionals from Brazil, Italy, Spain, Scotland, France, and Mexico.

After the Second International Meeting on Environmental Biotechnology and Engineering also held in Mexico City, Mexico, in 2006, we had the satisfaction to see that the 3rd International Meeting on Environmental Engineering held in Palma de Mallorca had exponentially grown and matured. Its outreach was multiplied by a factor of 10 compared to that of the 1st IMEBE. The Organizing Committee led by Dr. Isabel Sastre-Conde, Dr. Hervé Macarie, and Dr. José Luis Sanz should be congratulated for the success and resonance of the third version of this event. This fact is a confirmation of the original diagnostic: the scientific community was avid of an international event with the characteristics of the IMEBE now ISEBE

Indeed, the name of the event has been changed from meeting to symposium, in order to reflect the increases on both quantity and quality. So, in 2014, the name of the event is the Fourth International Symposium on Environmental Biotechnology and Engineering. Since then, ISEBE is also the official biannual event of the Mexican association ABIAER (Asociación de Biotecnología, Ingeniería Ambiental y Energías Renovables, http://abiaer.com/quieacutenes-somos.html).

Environmental biotechnology and environmental engineering are two faces of a modern, valuable, and indispensable scientific and technical coin. The growing significance and awareness of environmental problems, caused especially by use of fossil resources in connection with industrial pathways of production, depletion of finite natural resources, mismanagement of renewable resources, etc., have led to the development of both disciplines. They have their own historical roots, i.e., one has blossomed from biotechnology and the other has grown from the old Civil and Sanitary Engineering. Yet, they have developed in full-fledged branches of knowledge and specialization, and at the same time, they complement each other.

Regarding environmental biotechnology, its contributions span from environmentally-friendly and cost effective "end-of-the-pipe" solutions to environmental pollution and problems (bioremediation of soils and aquifers, biological waste treatment), to the development of sustainable alternatives for their prevention and alleviation, such as the replacement of fossil fuels by bio-hydrogen and methane from wastes and futuristic "biorefineries". Biotechnology has the potential of a reduction of operational and investment costs for the design and operation of more sustainable processes based on microbes and other living organisms as agents. Yet, so far, the sustainability of technical processes is more the exception than the rule. In this regard, environmental biotechnology is a serious candidate to provide substantial advances in the near future.

On the other hand, environmental engineering has developed several significant fields of research and applications (everything matters in environmental engineering; natural sciences and social sciences are as significant to its practice as classical engineering skills); some of them partially overlap with environmental biotechnology (for instance, biological waste treatment), whereas other subjects are original and cover issues that environmental biotechnology cannot, and have proved to be of use to other branches of knowledge. With respect to this, we would like to highlight a significant contribution of environmental engineering that has transcended to other fields of engineering and technology: sound environmental engineering has designed the unpredictable framework of System Engineering Analysis applied to environmental issues, also known as Life Cycle Analysis (LCA) and other denominations. The contemporary history of industry and technology has sadly taught us that new technological solutions and new processes derived from environmental biotechnology (and from other fields of knowledge) should be examined under the light of LCA and environmental impact analysis before attempting their implementation. Very often, a precipitated and immature application of a new product or process has led to adverse impacts on health and the environment that have become technical, ethical, and economic burdens to modern societies.

The synergistic interaction of environmental biotechnology and environmental engineering has a tremendous potential for making outstanding contributions to the sustainable development and sustainable management of resources in modern societies. To a great extent, we expect that these contributions will also positively impact on societies' organization and improve people's conscience, education, and habits. Sustainable development should become the basis for the life of future generations as opposed to over-exploitation of non-renewable energy and material resources.

We want to acknowledge all authors of the works presented in the 4ISEBE. Also, we express our gratitude to the support to 4ISEBE from our *alma mater* the CINVESTAV del IPN and its Department of Biotechnology and Bioengineering, CONACYT (Council of Science and Technology of Mexico), the IRD and the Mediterranean Institute for marine & continental Biodiversity and Ecology (IMBE) from France, the American Chemical Society from the USA, the public company SEMILLA from the Balearic Islands, Spain, the Mexican Society of Biotechnology and Bioengineering (SMBB), the Mexican Association of Solar Energy (ANES), the Mexican Society for Hydrogen (SMH), and a constellation of Mexican higher education institutions as well as Mexican private companies, among others. Without their varied contributions and support, the 4ISEBE would have not happened

We are also very grateful to editor-in-chief Professor Dr. Phillipe Garrigues and his team of Associate Editors and Reviewers for their excellent work in the selection, evaluation, and management of articles from 4ISEBE submitted to the journal *Environmental Science and Pollution Research*.

The Special Issue 4ISEBE of *Environmental Science and Pollution Research* published 24 articles after a strict refereeing process. These 24 papers should be added to the 14 articles from 4ISEBE published in *Revista Internacional de Contaminación Ambiental* (2017) (International Journal of Environmental Contamination) also indexed in the Web of Science Journal Citation Report database. As a digression, the 38 published articles are part of the nearly 250 oral and poster presentations of 4ISEBE.

The research areas represented by the 24 articles in *Environmental Science and Pollution Research* are soil and aquifer remediation (29.2%), energy-bioenergies-other renewable energies and bio refineries (20.8%), water and wastewater treatment (20.8%), bio electrochemical systems (8.5%), and atmospheric emissions and air pollution control, environmental microbiology, solid and hazardous wastes with 4.2% each. Finally, two papers were allocated to miscellaneous. Below, there is a succinct list of the articles, classified by research areas and title.

Soil and aquifer remediation

1. Desorption from activated carbons and subsequent dechlorination of chlordecone by zero valent zinc reduced vitamin $B_{12}$ and intermediate formation studied by GC MS/MS
2. Remediation by chemical reduction in laboratory mesocosms of three chlordecone contaminated tropical soils
3. Acetate bio stimulation as an effective treatment for cleaning up alkaline soil highly contaminated with Cr(VI)
4. Bioremediation of estuarine sediments contaminated with diesel oil
5. Effect of sudden addition of PCE on performance of fluidized bed bioreactors operated in simultaneous electron acceptor modes
6. Naphthalene degradation by catalytic ozonation based on nickel oxide: Study of the ethanol as cosolvent
7. Metal bioleaching from anaerobic sediments from Reconquista river basin (Argentina) as a potential remediation strategy

Energy, bioenergies, other renewable energies, and biorefineries

1. Public policy performance for social development: solar energy approach to assess technological outcome in Mexico City Metropolitan Area
2. Feedback regarding OTEC power plant implementation in Martinique
3. Bioenergy and bioproducts from municipal organic waste as alternative to landfilling: a comparative life cycle assessment with prospective application to Mexico
4. Biomass and lipids production from *Nannochloropsis oculata* growth in raceway ponds operated in sequential batch mode under greenhouse conditions
5. Lipid extraction from the biomass of *Trichoderma koningiopsis* MX1 produced in a non-stirring culture for potential biodiesel production

Water and wastewater treatment

1. Degradation alternatives for a commercial fungicide in water: biological, photo-Fenton and coupled biological-photo Fenton processes
2. The removal of illicit drugs and morphine in two Waste Water Treatment Plants (WWTPs) exposed to tropical conditions
3. Biodegradation of a commercial mixture of the herbicides atrazine and s-metolachlor in a multi-channel packed biofilm reactor. Kinetics and microbial diversity
4. Simultaneous oxidation of ammonium and cresol isomers in a sequencing batch reactor: physiological and kinetic study
5. Desalinization of seawater with aquatic lily

Bioelectrochemical systems

1. Comparative study of different carbon supported $Fe_2O_3$-Pt catalysts for the oxygen reduction reaction
2. The unphosphorylated form of the PilR two-component system regulates pila gene expression in *Geobacter sulfurreducens*

Atmospheric emissions and air pollution control

1. Oxidation of methane in biotrickling filters inoculated with methanotrophic bacteria

Environmental microbiology

1. Different genotypes of *Silene vulgaris* (Moench) Garcke grown on chromium contaminated soils influence root organic acid composition and rhizosphere bacterial communities

Solid and hazardous wastes

1. Biodegradation of compostable and oxodegradable plastic films by home composting and bioaugmentation

Miscellaneous

1. Effectiveness of rabbit manure biofertilizer in barley crop yield
2. Ship breaking or scuttling? A review of environmental, economic and forensic issues for decision support

We invite the readership to consult the articles published in *Environmental Science and Pollution Research*, along with those published in *Revista Internacional de Contaminación Ambiental* and the chapters of the book entitled *Environmental Biotechnology and Engineering-2014* (in three volumes, Poggi-Varaldo et al. 2015) to keep updated in the efforts that we should still make in order to improve our environment and quality of life.

We look forward to meeting all of you and as well as a stream of new participants in the next 6th ISEBE in 2018, Ciudad Obregón, Sonora, Mexico (www.itson.mx/6isebe).

## References

Poggi-Varaldo HM, Bretón-Deval LM, Camacho-Pérez B, Escamilla-Alvarado C, Escobedo-Acuña G, Hernández-Flores G, Muñoz-Páez KM, Romero-Cedillo L, Sastre-Conde I, Macarie H, Solorza-Feria O, Ríos-Leal E, Esparza-García F (2015) "Environmental Biotechnology and Engineering – 2014" vols 1 to 3. CINVESTAV, México D.F., Mexico. (http://www.documentation.ird.fr/hor/fdi:010067250)

Revista Internacional de Contaminación Ambiental (2017) Special Issue "Environmental Biotechnology and Engineering". vol 33 (http://www.revistascca.unam.mx/rica/index.php/rica/issue/view/4087)

**Professor Dr. Héctor M. Poggi-Varaldo** is a full professor in the Dept. of Biotecnology and Bioengineering at the Centre for Higher Studies and Research (CINVESTAV del IPN) in Mexico City, Mexico. He is the founder and leader of the Environmental Biotechnology and Renewable Energies R&D Group (GBAER for its abbreviation in Spanish). He holds a Sc. D. degree in Biotechnology from CINVESTAV del IPN, a M. Sc. Environ. Eng. from the National Autonomous University of Mexico, and a B. Sc. Chem. Eng. from the National University of Uruguay. He has been awarded the Prize to Distinguished Academic Career from the Mexican Polytechnic Institute in 1999. He has also won two awards to the Best Research Projects from the Mexican Society for the Management of Solid and Hazardous Wastes in 1998. In 2017, Prof. Poggi-Varaldo received the McKee Award for Groundwater Protection, Restoration and Sustainable Use from the Water Environment Federation, USA. With his students, he has won six international awards to Best Articles in international Battelle Conferences and Symposia (USA, 2007 to 2013) related to biorefinery of wastes and bioelectricity. He has been invited as an expert in soil bioremediation by the French government for advising on the chlordecone contamination and remediation in the French West Indies in 2010. Also, the European Commission invited him in 2011 to perform as a referee for evaluation of megaprojects submitted to the 7th EU Research Framework Program. Furthermore, he is the author of a Mexican Patent on a type of anaerobic fluidized bed reactor as well as a patent application for generation of biohydrogen and methane from organic solid wastes. His research interests are focused on *(i)* bioenergies and biorefinery of organic wastes, *(ii)* bioremediation of heavy soils polluted with pesticides, *(iii)* bioelectricity from effluents, *(iv)* treatment of toxic and industrial wastewaters, and *(v)* nanobiotechnology applied to bioelectrochemical devices and bioremediation of soils and aquifers. He is the author of nearly 140 articles in refereed journals indexed in the Web of Science. He holds the category H24 according to the WOS. Also, he has published more than 40 chapters in books and has been the editor of 10 books, as well as more than 150 full articles in international symposia and congresses.

**Damien A. Devault** is a research officer at the Université Paris-Sud, ESE lab, located in French West Indies. He has been successively in position at Paris and Martinique centers of the National Research Institute of Science and Technology for Environment and Agriculture (IRSTEA), then at the University of French West Indies, AIHP-GEODE lab. He focuses on organic micropollutant fate in the aquatic environment, especially where standard conditions (oxygen saturation, neutral pH, standard redox…) are not reached: wastewater, sludge, but mainly sediment under early diagenesis influence. He previously led the first study crossing in situ early diagenesis indicators and pesticide content in sediment cores and highlighted the massive storage of pesticides in sediment depth, the more than tenfold increase of their lifespan in sediment, and the most efficient dam configuration to promote natural degradation of micropollutants in such reservoirs. In recognition of these results, the Toulouse Science Academy awarded him the Edouard Maurel price for public health (2008). Damien A. Devault pursues his monitoring studies of such non-conventional matrices and related biocenosis, and particularly focuses on the use of passive sampling and how eventual alterations of their response due to non-conventional conditions could be compensated. Organic micropollutants studied by Damien A. Devault are pesticides, pharmaceutical residues, and illicit drugs. Illicit drug studies led him to be appointed as French representative for e-COST "SCORE" for the evaluation of population health based on chemical tracers in water. He is expert of the French sanitary and environmental agency (ANSES) for pesticide issues. He is the assistant treasurer of the Groupe Français des Pesticides, the association responsible for the organization of an annual colloquium gathering French-speaking and above-scientist's community focused on pesticide issues

**Hervé Macarie** is a research officer at the French National Research Institute for Sustainable Development (IRD ex-ORSTOM). In this position, since October 1994, he has developed research on the technological and the microbiological aspects (taxonomy & ecology) of the anaerobic treatment of industrial wastewater and he has both an experience at lab and full scale (up to reactors of 20,000 $m^3$). One of his main interests has been for the anaerobic degradation of xenobiotic compounds such as terephthalic acid and pentachlorophenol and the development of synchronous anaerobic/aerobic systems to achieve the full mineralization of this last compound. Since 2008, his research has been almost entirely focused on the microbial degradation of chlordecone, an organochlorine insecticide classified as POP that was once used against the banana black weevils and that is now responsible, more than 2 decades after the ban of its utilization, of a health, environmental, economic, and social crisis in the French West Indies islands of Guadeloupe and Martinique. Along his career, he has been successively in position in Canada (postdoctoral fellow, BRI, NRC, 1992–1994), Mexico (visiting Professor, UAM-Iztapalapa, 1995–2000), continental France (Aix Marseille University, 2001–2010), and Martinique (CAEC, 2011–2014). Since 2015, he is back to Aix Marseille University and IMBE (Mediterranean Institute for marine and continental Biodiversity and Ecology) where he pursues his research on the theoretical and experimental aspects of chlordecone degradation with the objective to understand the factors limiting its natural attenuation and the possibility to manipulate them in order to propose a bioremediation process to decontaminate the polluted soils.

**Isabel Sastre Conde** holds a BSc in Biological Sciences from Complutense University of Madrid and a PhD in Agricultural Chemistry at the Autonomous University of Madrid. Short after the defense of her thesis, in the frame of the AECI–ANUIES Spanish-Mexican program of reinforcement of Mexican province Universities, she was appointed for 2 years as visiting Professor first at the UNACAR (Universidad Autonoma del Carmen), Campeche, and then at UV (Universidad Veracruzana) in Veracruz City. Thereafter, she worked in Spain for 2 years as postdoctoral researcher at IMIDRA (Instituto Madrileño de Investigación y Desarrollo rural, Agrario y Alimentario). During this period, she started a collaboration with Dr Poggi's environmental lab at Cinvestav-IPN, Mexico, where she made three short-term stays. In 2004, she obtained a 5-year researcher position at Conselleria d'Agricultura from Balearic Island (Spain) into the DOC-INIA frame. Since 2006, she got a permanent researcher position at SEMILLA (a semi-public company under the authority of the Agricultural Regional Direction of the Balearic Province Government). Currently, she is a permanent researcher of SEMILLA-INAGEA. Her main research interest has been towards the study of the risk of contamination of soils and sediments as well as towards the restoration and remediation of impacted environments. For instance, she participated in projects on the impact of the Mexican oil industry on the mangroves of the Pom & Atasca lagoon system, on the evolution of the soils irrigated for more than 100 years with raw sewage in the Mezquital Valle (Mexico) and on the microbial remediation of pesticide-polluted soils (simazine in Spain and chlordecone in Martinique). Since 2006, her research activity has been focused towards the use of composted organic material as an alternative to the inorganic nitrogen fertilizer presently used in important crops of the Balearic Islands (almonds and tomatoes) with the objective to reduce at maximum the risk of aquifer pollution by nitrate. All these research activities have given her a deep knowledge of the soil characteristics under stress situations (natural, agrarian, degraded, and polluted soils)