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Persistent Organic Pollutants (POPs):  
Analytical Techniques, Environmental  
Fate and Biological Effects

**EDDY Y. ZENG**

Comprehensive Analytical Chemistry

Volume 67

# Persistent Organic Pollutants (POPs): Analytical Techniques, Environmental Fate and Biological Effects

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*Edited by*

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Comprehensive Analytical Chemistry  
Volume 67

# **Persistent Organic Pollutants (POPs): Analytical Techniques, Environmental Fate and Biological Effects**

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# Series Editor's Preface

Our first volume on environmental analytical chemistry was Volume 32. After its publication in 1997, I remember well being appointed editor-in-chief of the Comprehensive Analytical Chemistry book series (CAC). After that, several volumes on environmental contaminants were published, focusing on specific group of pollutants, such as Volume 40 on surfactants and more recently Volumes 50 and 62 on pharmaceutical residues. In addition, other environmental applications were included in state-of-the-art books on analytical techniques, like the use of advanced gas chromatography–mass spectrometry (GC-MS) and time-of-flight, two-dimensional GC and passive sampling techniques, in CAC Volumes 61, 55, and 48, respectively.

This book, edited by Eddy Zeng, is an excellent cocktail of novel analytical techniques and applications to the trace determination of persistent organic pollutants (POP) as well as of pharmaceuticals and personal care products (PPCP). The general introduction covers a comprehensive variety of analytical techniques, including field application of passive sampling, microextraction, and bioanalytical approaches for the determination of POPs and PPCPs in the environment. Occurrence, fate, and removal of selected pollutants in a broad range of matrices are reported in different chapters, including e-waste, wastewaters, soil/sediments, the atmosphere, biota, and human health samples. Finally risk assessment chapters dealing with ecological effects in the aquatic environment, reproductive toxicity, and in-silico toxicity models, are also reported. The 19 chapters of this book make it a very comprehensive title in our series to better understand the analysis, fate, and toxicity of POPs and PPCPs in the environment.

I am convinced that this book will be today the reference book in the analytical and environmental chemistry community of POPs and PPCPs. The book is specially suited for newcomers who want to become familiar with this research field and it can also be used for advanced training courses. Finally I would like to thank not only the editor of the book but also the various authors for compiling such a world-class book on environmental organic contaminants.

**D. Barceló**

IDAEA-CSIC, Barcelona, and ICRA, Girona  
October 10, 2014.

# Volume Editor's Preface

The initial persistent organic pollutants (POPs), targeted by the Stockholm Convention in 2001, specifically include a group of pesticides, industrial chemicals, and unintended by-products, i.e., aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-*p*-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs), often referred to as the “Dirty Dozen.” In 2009, nine new POPs were added to the target list of the Stockholm Convention, including chlordecone, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, hexabromobiphenyl, hexabromodiphenyl and heptabromodiphenyl ethers, lindane, pentachlorobenzene, perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride, and tetrabromodiphenyl and pentabromodiphenyl ethers. In a broader sense, however, any organic chemicals that are persistent and widespread in the environment, able to bioaccumulate and biomagnify in living organisms including humans, and toxic to both humans and wildlife, may be regarded as POPs. Such a broad perception of POPs has been widely used in the scientific literature, and is beneficial in recognizing and consequently minimizing the negative environmental and health impacts of organic contaminants in general. With this in mind, the current book not only focuses on the POPs targeted by the Stockholm Convention, but also covers nontarget and/or emerging organic contaminants.

The subject matters of the 19 chapters constituting this comprehensive book are divided in three categories, i.e., sampling and analytical methods, environmental fate, and biological effects, as explicitly revealed in the book's title. These topics reflect the main components of past and present research activities on POPs worldwide, and are expected to continuously dictate the research trends for many years to come.

Chapters 1–5 fall into the first category. Chapter 1 summarizes the important features of sampling and chemical analytical procedures for measuring POPs in complex environmental matrices. Chapter 2 reviews the current biological approaches for assessing the chemical exposure and its toxicological implications and points to the need for establishing an integrated framework for linking the two. Chapter 3 previews the recent advances in microextraction techniques for sample preparation and analysis for a variety of POPs. Chapter 4 evaluates the applications of passive sampling techniques in field-measuring dissolved hydrophobic organic chemicals *in situ*, particularly the utility of passive samplers in determining the escaping/depositing fluxes of HOCs between

the sediment–water interface. Chapter 5 synthesizes the latest developments in application of solid-phase microextraction methods for evaluating the toxicity of sediment-associated organic contaminants to benthic organisms.

The second category includes Chapters 6–14, comprising the book's main content, which may be consistent with the dominance of the global POPs research output in the same area. Chapter 6 deals with the removal of pharmaceuticals and personal care products (PPCPs) from wastewater by constructed wetlands. Chapter 7 discusses the fate of PPCPs during wastewater treatment processes and influencing factors. Chapter 8 recaps the progress in measurements of dry and wet depositional fluxes and diffusive air–water exchange of selected POPs. Chapter 9 discusses the likelihood for electronic waste (e-waste) as a new and important source of halogenated organic contaminants and metals, based on an assimilation of current literature. Chapter 10 also deals with e-waste, but focuses on human exposure to emerging contaminants released from e-waste recycling activities and related health effects. Chapter 11 assimilates available information about the long-range atmospheric transport of POPs and methods for assessing sources of POPs in remote areas. Chapter 12 describes the state of coastal contamination by emerging contaminants, particularly halogenated polybrominated diphenyl ether (PBDE) alternatives, as characterized by their occurrences in sediment and marine mammals. Chapter 13 analyzes the current monitoring data about the long-range atmospheric transport of POPs to polar regions and suggests the need for more long-term monitoring efforts. Chapter 14 presents evidence that brominated flame retardants are similar to POPs in terms of the potential to bioaccumulate and biotransform.

The themes of Chapters 15–19 are within the third and final category. Chapter 15 reviews the current approaches for measuring bioavailability of organic contaminants in soil and sediment and how bioavailability and bioaccessibility have been used in risk assessment and bioremediation of contaminated soil. Chapter 16 examines the environmental occurrence and ecological effects of benzotriazoles, a group of organic compounds with similar characteristics to POPs and of emerging concern. Chapter 17 demonstrates the utility of models based on quantitative structure–activity relationships in predicting the thyroid hormone effects of PBDE derivatives. Chapter 18 presents an integrated report on the fate, transport, and toxicity of selected POPs, such as PCBs, PCDDs, PCDFs, perfluorinated chemicals, and organobromide compounds, in aquatic environments. Chapter 19 reports an integrated health-based risk assessment of PBDEs, using China as a case study.

Aside from providing a comprehensive coverage of past research efforts on POPs, this book also demonstrates the hard work and fruitful outcome of the international team involved. The authorship of this book includes scientists from 13 countries around the world, i.e., Australia, Belgium, Canada, China, Germany, New Zealand, Norway, Romania, Spain, Sweden, Switzerland, the United Kingdom, and the United States. It is truly a great example of a successful multicontinental collaboration, which is also mirrored in the global battle

against the potential adverse effects of POPs. I feel extremely honored to have the privilege to work with such a highly respectable group of scientists, without whom this book could not have possibly been completed. Thanks also go to Series Editor, Dr Damià Barceló, the Editorial Project Manager at Elsevier, Mr Derek Coleman, and the production team for their professionalism during the entire process. Finally, I would be very gratified if readers find this book helpful and/or useful in their pursuits of information about POPs.

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