Otto Jaag Water Protection Prize 2023 and ETH Medal for Charlotte Bopp

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Topics: Organisation & Staff

Environmental scientist Charlotte Bopp has been honoured twice for her dissertation. She received the Otto Jaag Water Protection Prize on ETH Day on 18 November. In January, she will also accept the ETH Medal. Her work makes an important contribution to understanding the biodegradation of organic pollutants in the environment.

The Otto Jaag Water Protection Prize is awarded by ETH Zurich in recognition of outstanding master and doctoral theses in the field of water protection and hydrology. Charlotte Bopp received this award on ETH Day on 18 November for her dissertation on the following topic: “The role of oxygen uncoupling by Rieske non-heme iron dioxygenases in the biodegradation of aromatic contaminants.” In January, she will also be conferred the ETH Medal, which ETH Zurich awards for outstanding master and doctoral theses.

Inefficient oxidation of pollutants

As a doctoral student in the Environmental Chemistry department of the aquatic research institute Eawag, Charlotte Bopp examined the biodegradation of persistent organic pollutants. If such aromatic compounds, which are found in pesticides, medicines and explosives, for example, get into soil and water, microorganisms can oxidise them thanks to a groups of enzymes called “Rieske oxygenases” and thus break them down. Bopp focused on the sub-group of explosive-degrading enzymes and wanted to know how efficiently they worked. Her results do not give the enzymes much support. Instead of transferring the oxygen directly to the pollutants, the enzymes first form a particularly reactive form of oxygen. Only around half of this oxygen subsequently reacts with the pollutants, the other half of the reactive oxygen oxidises all kinds of other substances. This can be detrimental to the microorganisms

and damage them.

New enzymes are more efficient

But this process can also have benefits, as Bopp was able to show. If the existing enzyme spectrum of the microorganisms is not suitable for breaking down new pollutants they come in contact with, they can adapt. The reactive oxygen leads to selective mutations in the enzymes, whereby individual amino acids within the enzyme change and new enzymes are created as a result. Some of them work even more efficiently than the original ones. Thanks to this evolutionary process, the microorganisms are able to metabolise the new pollutants after some time.

“With her research, Charlotte Bopp has uncovered connections in the biodegradation of pollutants that were previously unknown,” says Thomas Hofstetter, head of the Environmental Chemistry department at Eawag, who supervised her dissertation. Previously, the capacity to break down pollutants was based purely on the quantity of enzymes present in the environment. “Charlotte Bopp’s results show that we need to take a closer look here and take into account the varying efficiency of the organisms and their enzymes.”

Charlotte Bopp is delighted that her work has been recognised: “We decided to look where enzymes seem to fail.” It is precisely this deficiency that allows microorganisms to deal with a wide range of pollutants on a long-term basis. “We were only able to solve this mystery thanks to Eawag’s interdisciplinary organisation and a team that has earned these awards as a whole,” explains Bopp. Since completing her dissertation, she has been working in industry and is involved in the further development of ozonation processes in drinking and wastewater treatment.

Cover picture: ETH Rector Günther Dissertori presents Charlotte Bopp with the Otto Jaag Water Protection Prize 2023 (photo: ETH, Giulia Marthaler)

Original publications

Bopp, C. E.; Bernet, N. M.; Kohler, H.-P. E.; Hofstetter, T. B. (2022) Elucidating the role of O2 uncoupling in the oxidative biodegradation of organic contaminants by Rieske non-heme iron dioxygenases, *ACS Environmental Au*, 2(5), 428-440, doi:10.1021/acsenvironau.2c00023, Institutional Repository
Pati, S. G.; Bopp, C. E.; Kohler, H.-P. E.; Hofstetter, T. B. (2022) Substrate-specific coupling of O2 activation to hydroxylations of aromatic compounds by rieske non-heme iron dioxygenases, *ACS Catalysis*, 12(11), 6444-6456, doi:10.1021/acscatal.2c00383, Institutional Repository

Related Links

Otto Jaag Water Protection Prize

Project page “Enzyme Mechanisms and Kinetics of Organic Contaminant Oxygenation”

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