



Dr. Frank Loeffler

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Frank Loeffler is an environmental microbiologist whose research centers on discovering novel microbial processes that advance understanding of natural and engineered systems.

The Loeffler lab conducts fundamental research in interrelated focal areas: microbial detoxification of environmental pollutants, carbon and nitrogen cycling processes in soils and subsurface environments related to greenhouse gas emissions, the natural cycling of halogens, and microbial ecology. His research group uncovers novel microbes with properties of interest, explores microbe-microbe interactions to better predict microbial community structure, function and evolution, studies degradation pathways and enzymes of interest, and develops environmental monitoring tools for organisms and processes of interest. He interacts with professional engineers and remediation project managers to effectively transition research findings into practice (i.e., bioremediation applications).

In this work, Dr. Loeffler integrates cultivation and physiological characterization of enrichment cultures and isolates with (meta)genome and (meta)transcriptome sequencing, metaproteomics and metabolomics workflows, and various analytical techniques (e.g., geochemical measurements, NMR, qPCR). These efforts unravel how microbial community structure and dynamics determine function under different environmental conditions and in response to perturbations (e.g., climate change). These collaborative efforts train students at the interface of microbiology, chemistry, environmental engineering and computational biology (bioinformatics).

Research questions are addressed in interdisciplinary teams, often in conjunction with industry or government partners for rapid transition of laboratory findings to real world applications.

Projects:

- Microbial degradation of chlorinated ethenes
- Design and validation of a high-throughput qPCR approach for environmental monitoring of reductive dechlorination processes
- Microbially mediated abiotic degradation of carbon tetrachloride
- Microbial metabolism of chlorinated C₁ compounds
- Treatability studies to assess intrinsic degradation potential
- Fate of bisphenol A (BPA) in anoxic sediments
- Nitrogen cycling and nitrous oxide emissions from soil ecosystems
- Effect of cobamides on microbial community structure and function
- Microbial degradation of per- and polyfluoroalkyl substances (PFASs)
- International collaboration in the area of the food, energy and water (FEW) nexus. Dr. Loeffler leads a team to establish a research coordination network (FEWSTERN) between the U.S. and China. FEWSTERN identifies transdisciplinary research opportunities for researchers in the U.S. and China working on the sustainable use of natural resources for FEW systems.

Selected Papers

Chen, G., A.R. Fisch, C.M. Gibson, E.E. Mack, E.S. Seger, S.R. Campagna, and F.E. Löffler. 2020. Mineralization versus fermentation: Evidence for two distinct anaerobic bacterial degradation pathways for dichloromethane. *The ISME Journal*. 14:959-970 | doi.org/10.1038/s41396-019-0579-5

Kaya, D., B.V. Kjellerup, K. Chourey, R.L. Hettich, D.M. Taggart, F.E. Löffler. 2019. Impact of fixed nitrogen availability on *Dehalococcoides mccartyi* reductive dechlorination activity. *Environ. Sci. Technol.* 53:14548-14558 | doi: 10.1021/acs.est.9b04463

Im, J., E.E. Mack, E.S. Seger, and F.E. Löffler. 2019. Biotic and abiotic degradation of 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113): Implications for bacterial detoxification of chlorinated ethenes. *Environ. Sci. Technol.* 53:11941-11948. | doi: 10.1021/acs.est.9b04399

Kucharzyk, K.H., J.E. Meisel, F. Kara-Murdoch, R.W. Murdoch, S.S. Higgins, S. Vainberg, C.M. Bartling, L. Mullins, P.B. Hatzinger, and F.E. Löffler. 2019. Metagenome-guided proteomic quantification of reductive dehalogenases in the *Dehalococcoides mccartyi* - containing consortium SDC-9. *J. Proteome Res.* 19:1812-1823 | doi.org/10.1021/acs.jproteome.0c00072

Lawson, C.E., W.R. Harcombe, R. Hatzenpichler, S.R. Lindemann, F.E. Löffler, M.A. O'Malley, H. García-Martin, Pflieger, L. Raskin, O.S. Venturelli, D.G. Weissbrodt, D.R. Noguera, and K.D. McMahon. 2019. Unmasking common principles and practices for microbiome engineering. *Nat. Rev. Microbiol.* 17:725-741. | doi: 10.1038/s41579-019-0255-9

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Villalobos Solis, M.I., P.E. Abraham, K. Chourey, CM Swift, F.E. Löffler, and R.L. Hettich. 2019. Targeted detection of *Dehalococcoides mccartyi* microbial protein biomarkers as indicators of reductive dechlorination activity in contaminated groundwater. *Scientific Reports*, 9:10604 | doi.org/10.1038/s41598-019-46901-6

Yin, Y., Yan, G. Chen, F. Kara Murdoch, N. Pfisterer, and F.E. Löffler. 2019. Nitrous oxide is a potent inhibitor of bacterial reductive dechlorination. *Environ. Sci. Technol.* 53:692-701.

Kleindienst, S., K. Chourey, G. Chen, R. Iyer, R.L. Hettich, S.R. Campagna, E.E. Mack, E.S. Seger, and F.E. Löffler. 2019. Proteogenomics reveals novel reductive dehalogenases and methyltransferases expressed during anaerobic dichloromethane metabolism. *Appl. Environ. Microbiol.* 85:e02768-18.

Higgins, S.A., E. Padilla-Crespo, and F.E. Löffler. 2018. Draft genome sequences of the 1,2-dichloropropane-respiring *Dehalococcoides mccartyi* strains RC and KS. *Microbiol. Resour. Announc.* 7:e01081-18.

Clark, K., D.M. Taggart, B.R. Baldwin, K.M. Ritalahti, R.W. Murdoch, J.K. Hatt, and F.E. Löffler. 2018. Normalized quantitative PCR measurements as predictors for ethene formation at sites impacted with chlorinated ethenes. *Environ. Sci. Technol.* 52:13410-13420.

Higgins, S.A., C.W. Schadt, P.B. Matheny, and F.E. Löffler. 2018. Phylogenomics reveals dynamic evolution of fungal *p450nor* and its undiscovered relationship to secondary metabolism. *Genome Biol. Evol.* 10:2474-2489.

Marcet, T., N. Capiro, Y. Yang, F.E. Löffler, and K.D. Pennell. 2018. Impacts of low-temperature thermal treatment on microbial detoxification of tetrachloroethene under continuous flow conditions. *Water Research*, 145:21-29.

Marcet, T., N. Capiro, L.A. Morris, S.M. Hassan, Y. Yang, F.E. Löffler, and K.D. Pennell. 2018. Release of electron donors during thermal treatment of soils. *Environ. Sci. Technol.* 52:3642-3651.

Chen, G., O. Shouakar-Stash, E. Phillips, S.D. Justicia-Leon, T. Gilevska, B. Sherwood Lollar, E.E. Mack, E.S. Seger, and F.E. Löffler. 2018. Dual carbon-chlorine isotope analysis indicates distinct anaerobic dichloromethane degradation pathways in two members of the *Peptococcaceae*. *Environ. Sci. Technol.*, 52:8607-8616.

Hallin, S., L. Philippot, F.E. Löffler, R.A. Sanford, and C.M. Jones. 2018. Genomics and ecology of novel N₂O reducing microorganisms. *Trends Microbiol.* 26:43-55.

Yan, J., M. Bi, A.K. Bourdon, A.T. Farmer, P.-H. Wang, O. Molenda, A. Quaile, N. Jiang, Y. Yang, Y. Yin, B. Şimşir, S.R. Campagna, E.A. Edwards, and F.E. Löffler. 2018. Purinylcobamide is a native prosthetic group of reductive dehalogenases. *Nat. Chem. Biol.* 14:8-14.