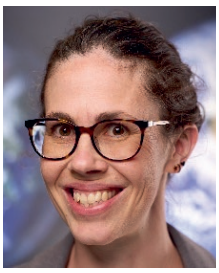
Editorial



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Meredith C. Schuman is an Associate Professor *ad personam* for the Spatial Genetics of Ecosystems at the University of Zurich. She obtained her PhD from the Friedrich Schiller University, Jena, based on research conducted at the Max Planck Institute for Chemical Ecology. Her group studies the genetic and chemical diversity of populations, and the relevance of this diversity for ecosystem functioning and management.

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Navigating the natural chemical space and its fringes could be an infinite task. The extent of the natural chemical space remains unknown but is estimated to include more than a quarter million documented natural products, plus millions more still to be discovered.[1–3] Therefore, in this special issue, we do not claim to illuminate or explore it, but rather to navigate it – and its fringes, which may be understood as a, at least equally vast, space of nature-inspired synthetic chemical structures. The contributions cover remarkable ground.

We begin with a primer from ***Simon Sieber*** on emerging technologies for the discovery of natural products, or: new tools to help us to explore the vast natural chemical space. We continue with perspectives from ***Karl Gademann*** on how to use organic synthesis as a scientific method to better understand natural products, their biosynthesis and transformations. This introduces the concept of synthetic natural products as a strategy for navigation, using synthesis not (only) to go beyond the natural chemical space, but to also better understand it. We continue with another perspective from ***Jean-Luc Wolfender*** and colleagues on how to navigate the natural chemical space – as well as its fringes of nature-inspired synthetics – by establishing, and probing, networks of chemical structures through mass spectrometry, digitization, and pattern recognition. Having thus assembled our navigation toolkit, we then move out into the interface of the natural chemical space and its fringes.

First, we investigate what happens when humans introduce new chemistry into ecosystems, thereby expanding the local chemical space, often with chemistry at the fringes of the natural chemical space. The contribution from ***Ksenia Groh*** views this situation through a mechanistic lens, presenting how the mTOR pathway, responsible for prioritizing maintenance and communication versus growth processes in cells, can be impacted by exposure to toxins. ***Johannes Raths*** and colleagues chart larger-scale patterns: how the kinetics of toxin uptake and metabolism in aquatic and terrestrial biota are impacted by temperature, so that the ecological consequences of chemical pollution may be strongly affected by climate change in ways that are not yet fully understood.

Following on from these two accounts of how introducing chemistries not previously known to nature can negatively affect ecosystem functioning, we next ask what can we learn from the natural chemical space that could help us to do more good than harm. ***Akanksha Singh*** and colleagues present a roadmap for integrating the use of botanicals – mixtures of natural products – into environmentally and socioeconomically sustainable agricultural practice. We end with another kind of map from ***Pengjuan Zu*** and colleagues: patterns of plant natural product diversity along elevational gradients, and a set of theories about why these may be observed. We thereby end the special issue on one example of how organisms make use of, and contribute to, the natural chemical space, and how they adjust their own synthesis and use of chemistry to their environments. There is still much left unknown.

We hope that you will enjoy this journey through an awe-inspiring and vast space of molecules, materials, signals, messages, and much more, and that, in navigating this space with us, you will take away some new tools and understanding for the future. The authors thank the contributors to this special issue and *CHIMIA* for the invitation, and our institutions and funders of our work as acknowledged on our group homepages.

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[1] Y. Chen, M. Garcia de Lomana, N.-O. Friedrich, J. Kirchmair, *J. Chem. Inf. Model*. **2018**, *58*, 1518, https://doi.org/10.1021/acs.jcim.8b00302.
[2] C. E. Hart, Y. Gadiya, T. Kind, C. A. Krettler, M. Gaetz, B. B. Misra, D. Healey, A. Allen, V. Colluru, D. Domingo-Fernández, *GigaScience* **2025**, *14*, giaf033, https://doi.org/10.1093/gigascience/giaf033.
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The cover image was created by Dr. Ting Tang, Departments of Geography and Chemistry, University of Zurich.