Turning Spiroketals Inside Out: A Rearrangement Triggered by an Enol Ether Epoxidation

Invited for this month's cover picture is the group of Professor Mark Peczuh at the University of Connecticut. The cover picture compares the rearrangement of a small molecule to the process of turning a stuffed animal inside out. The recycled, inside-out stuffed animals are both artistic and philosophically provocative. They capture the essence of the rearrangement reaction because the compounds themselves turn inside out over the course of the reaction, extending the diversity of products that can arise from simple starting materials. Small molecules often have functional groups with latent reactivity; under the appropriate conditions, those groups can react with other compounds (e.g., reagents) and also with other groups in the same molecule in an intramolecular reaction. The research team found that the epoxidation of some highly functionalized spiroketal compounds promoted rearrangements of their structures that turned them inside out. Some of the features of the products led them to use X-ray crystallography or a combination of computer-assisted structure elucidation, computation, and a new version of the 1,1-ADEQUATE NMR experiment to determine their structures. For more details, see the Communication on p. 577 ff.

In one word, how would you describe your research? Collaborative. There were several moving parts in this project: synthetic method development, computer-assisted structure elucidation, and new spectroscopic techniques supported by computational chemistry. Each team member brought something unique to the work. As a result, the manuscript represents the fruits of a modern collaboration. For us, modern means that, despite the fact that we worked productively together, the team has never met together in the same place.

Who contributed to the idea behind the cover? We informally referred to the rearrangement as an “inside-out” reaction even before we knew the details of the product structures. At some point in the early days of the project, an internet search yielded the photos and cartoon of the Outsiders, which are inside-out stuffed animals (http://ateliervolvox.ch/filter/Produkte/Outsiders; for other examples of inside-out stuffed animals see http://www.kentrogowski.com/projects/bears/). Atelier Volvox was generous in allowing us the use of their teddy bear transformation cartoon to give a strong visual anchor for the rearrangement. We were lucky to leave the rest of the work to a program assistant in the UConn Chemistry department, Aneesa Bey. She works on finance and accounting but also happens to have a great sense of design and composition. The cover is really her piece. Thanks Aneesa!

Did serendipity play a part in this work? The manuscript would not have been possible without a healthy dose of serendipity, especially if serendipity’s alias is the ChemConnector. A visit by Antony Williams (known online as the ChemConnector) to UConn in Fall 2014 was essential to the formation of the team. At the time, we had already obtained the structure of one class of the rearranged, inside-out compounds by X-ray crystallography. We were grappling with the other class of compounds because the NMR data we had were difficult for us to interpret. He “connected” us with the rest of the team, and the project came together very quickly after that. His visit was definitely serendipitous.