into account. Furthermore, the authors argue that a longer experiment would have resulted in better-adapted populations. The suggestion seems plausible; the multi-clone populations adapted more than the single-clone populations, indicating that even better adapted variants are possible, but have yet to occur in the single-clone experiments.

Lohbeck *et al.* also show that coccolithophores can evolve as a result of between-lineage sorting of existing variation and *de novo* mutations within a single lineage (Fig. 1). In the multi-clone populations, one clone repeatedly outcompeted the others, and growth rates rose in the single-clone populations. Thus, we can expect that future coccolithophore populations will be shaped by a combination of species succession and adaptive evolution.

There are two important limits to the study. Among-clone sorting cannot be disentangled from evolution in clonal lineages. Furthermore, we have no idea whether the extent of adaptation seen in the single-clone population is representative or exceptional — only one of six clones was used for the single-clone experiments, and this clone never became the most frequent in the multi-clone populations. However, given the logistical challenges associated with the experimental evolution of marine microbes[5], a more complete experiment would have been prohibitive.

Lohbeck and colleagues show that calcifying phytoplankton can adapt to high carbon dioxide levels. The experiment uses, rather than advances, evolutionary theory, and that is fine: the response of coccolithophores to ocean acidification is a case of overwhelming ecological importance, and the study is a significant step forward in using interdisciplinary approaches to better understand the ramifications of global change in the oceans. ❐

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SHERRY ROWLAND

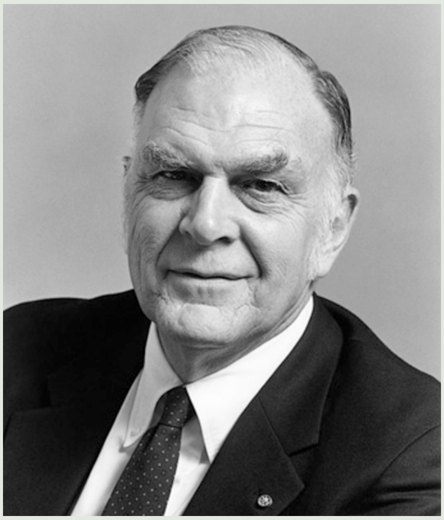
Ozone and advocacy

In 1973 I was invited to the Royal Swedish Academy to present some of my research on stratospheric ozone. The atmospheric chemistry community was critically reviewing the impact of nitric oxide emissions from supersonic aircraft on stratospheric ozone at the time.

Before my talk, Sherry Rowland sent me a preprint of an article by himself and Mario Molina, neither of whom I had heard of. The article postulated that reactive chlorine atoms, generated by the photolysis of industrially produced chlorofluorocarbons (CFCs), could destroy ozone in the stratosphere. I immediately realised that we had a potentially highly important issue on our hands: ozone loss by the action of chlorine compounds.

I discussed the paper briefly during my talk, not knowing that a journalist from a Swedish newspaper, *Svenska Dagbladet*, was in the audience. She reported the findings the following day, and the message reached Rowland, who was in Vienna on a sabbatical from his position as professor at the University of California, Irvine. He and his wife Joan decided to visit me. I was a good host, and took them on a walking tour of some of the famous places in Stockholm, such as the old town. I heard only later that they were exhausted.

During the same visit, Rowland gave a seminar about his new finding. In the subsequent discussion, it occurred to me that he might have neglected an important reaction. A spirited argument ensued, following which neither of us could sleep.



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After checking the significance of the missing reaction with our pocket calculators, we came to the conclusion that it did not matter much.

In the coming years, Sherry Rowland and Mario Molina showed that industrially produced CFCs are broken down by sunlight when they enter the stratosphere, yielding chlorine atoms that play a very important role in ozone depletion. This was their great discovery.

According to their original work, most chlorine atoms would be generated, and most ozone destroyed, at altitudes above about 30 km. So it was a big surprise when, in 1985, Joe Farman of the British Antarctic Survey and colleagues reported massive ozone loss below about 25 km over Antarctica during spring — famously termed the 'ozone hole'. Rowland played a key role in the explanation of these findings, pointing to the role of ice particles in the generation of chlorine atoms and radicals from CFCs.

Apart from the science, Rowland took the lead in the fight against the worldwide use of CFCs, often working against the interests of the chemical industry. In 1987, his efforts paid off: the nations of the world agreed to stop using CFCs and signed the Montreal Protocol. Sherry Rowland became forever one of the great environmental heroes of our time.

But CFCs were not the only atmospheric chemical that Rowland took an active interest in. In the late 1970s, his research group began to collect air samples from a variety of remote sites to study their chemical and climatic significance. The air was analysed for methane, as well as for halocarbons. This methane monitoring continues to this day, and is the world's longest-running remote methane analysis programme. Most recently, Rowland was keen to sample air in the region of the Deepwater Horizon oil spill in the Gulf of Mexico.

We will always remember Sherry Rowland with respect and admiration, and I am grateful for having known him.

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