CSIRO PUBLISHING

www.publish.csiro.au/journals/env B. Maher, *Environ. Chem.* **2005**, *2*, 139–140. doi:10.1071/EN05063

Foreword: Research Front—Arsenic Biogeochemistry

Bill Maher[A]

[A] Ecochemistry Laboratory, Institute of Applied Ecology, University of Canberra, Belconnen, 2601, Australia.
Email: bill.maher@canberra.edu.au

Manuscript received: 10 August 2005.
Final version: 10 August 2005.

Arsenic is a major problem worldwide in its inorganic form. Its presence in drinking water derived from arsenic-contaminated surface and groundwater in Bangladesh, Southern Thailand and other areas has caused many deaths and cancers.[1] However, arsenic is also a natural constituent of all life. It has been known since the 1930s that arsenic in most marine animals is non-toxic and rapidly excreted.[2] In 1977, arsenobetaine ($(CH_3)_3As^+CH_2COO^-$) was isolated as the major arsenic compound in the rock lobster *Panulirus longipes cygnus*[3] and it is now known to be the major arsenic compound in most marine animals.

These observations have led to an awareness that the chemical form (chemical speciation) of arsenic needs to be identified to understand its biogeochemical cycling and toxicity. Hence it was deemed to be important enough to publish a Research Front on the topic in *Environmental Chemistry*. A Research Front is a cluster of papers on a topical or new area of research. Research Fronts typically consist of a foreword introducing the field (i.e. what you are now reading), a review by a recognised authority, a Highlight or Opinion article and several Rapid Communications. The aim is to give readers not only an introduction to an important topic but also a snapshot of current research directions. Thus we hope the following papers will provide a good overview of current arsenic biogeochemistry research.

With the advent of modern analytical instrumentation, such as high pressure liquid chromatography coupled to an inductively coupled mass spectrometer or a mass spectrometer[4] and X-ray spectroscopy, arsenic is being analysed in more and diverse samples including marine organisms such as polychaetes[5] and scallops,[6] terrestrial organisms such as mushrooms and snails,[7,8] food crops[9] and animal and human urine.[10] These studies have led to the discovery of new arsenic compounds, e.g. arseno sulfur sugars in marine animals[6] and corn[9] and metabolites produced in urine on ingestion of seaweed, such as dimethylated arsenic species,[12] that are potentially carcinogenic.

Arsenic continues to fascinate environmental chemists because there are many questions to be answered concerning the pathways of how arsenic compounds are formed and their cycling through water, sediment and biota (including humans) and ultimate fate. Is arsenic an essential element at trace levels? Results reported in this issue[9] show the unexpected beneficial effects of arsenic: corn grows better in media containing arsenic. While some processes, such as how arsenic is either remobilised from or fixed in sediments, are well known,[13] even after 30 years we still, for example, do not understand how arsenobetaine is formed in the marine environment. Commercially, the presence of arsenic in pyrite and arsenopyrite is important in resource exploration as a pathfinder element particular for gold and base metal deposits. However, the cause of why arsenic-bearing pyrite is associated with gold is also not understood.

How can we move our understanding of the environmental chemistry of arsenic forwards? First, we should not uncritically accept published work on arsenic as gospel. Recently, for example, Cullen and Bentley[14] examined the literature pertaining to the toxicity of trimethylarsine—'Gosio Gas'—and gave a convincing exposé that trimethylarsine is not toxic, thereby dispelling an urban legend that has persisted for over

Bill Maher (M.App.Sci. 1977; Ph.D. 1981) is a professor in environmental/analytical chemistry at the University of Canberra. His research interests are the biogeochemical cycling of trace metals, metalloids, and nutrients in aquatic ecosystems, development of water quality and sampling guidelines, and developing analytical procedures for measuring trace contaminants in waters, biota, and sediments. He is director of the Ecochemistry Laboratories at the University of Canberra. He was awarded the RACI Analytical Division's medal in 2002 and the RACI Environmental Division's medal in 2003.

1448-2517/05/030139

100 years. Second, we need to define the important questions to be answered. Too many papers report data on arsenic concentrations and species in water, sediment and biota that fundamentally don't fill a gap or provide information on arsenic cycling, the metabolism of arsenic or why arsenic species act as toxins or carcinogens. The papers presented in this 'Research Front' give us an insight into current research directions in this field.

References

[1] J. C. Ng, *Environ. Chem.* **2005**, *2*, 146. doi:10.1071/EN05062

[2] A. C. Chapman, *Analyst* **1926**, *51*, 548. doi:10.1039/AN9265100548

[3] J. Edmonds, K. Francesconi, J. Cannon, C. Raston, B. Skelton, A. White, *Tetrahedron Lett.* **1977**, *18*, 1543. doi:10.1016/S0040-4039(01)93098-9

[4] J. Szpunar, R. Lobinski, *Hyphenated Techniques in Speciation Analysis RSC Chromatography Monographs* (Series Ed. R. M. Smith) **2003** (Royal Society of Chemistry: Cambridge).

[5] J. Waring, W. Maher, S. Foster, F. Krikowa, *Environ. Chem.* **2005**, *2*, 108. doi:10.1071/EN05027

[6] M. Kahn, R. Raml, E. Schmeisser, B. Vallant, K. A. Francesconi, W. Goessler, *Environ. Chem.* **2005**, *2*, 171. doi:10.1071/EN05045

[7] D. Kuehnelt, W. Goessler, K. J., Irgolic, *Appl. Organometallic Chem.* **1997**, *11*, 289. doi:10.1002/(SICI)1099-0739(199704)11:4<289::AID-AOC582>3.0.CO;2-1

[8] A. Geiszinger, W. Goessler, W. Kosmus, *Appl. Organometallic Chem.* **2002**, *16*, 473. doi:10.1002/AOC.327

[9] G. Evans, J. Evans, A. Redman, N. Johnson, R. D. Foust, Jr., *Environ. Chem.* **2005**, *2*, 167. doi:10.1071/EN05046

[10] S. J. Martin, C. Newcombe, A. Raab, J. Feldmann, *Environ. Chem.* **2005**, *2*, 190. doi:10.1071/EN05053

[11] K. A. Francesconi, *Environ. Chem.* **2005**, *2*, 141. doi:10.1071/EN05042

[12] B. M. Adair, S. B. Waters, V. Devesa, Z. Drobna, M. Styblo, D. J. Thomas, *Environ. Chem.* **2005**, *2*, 161. doi:10.1071/EN05054

[13] W. Maher, E. Butler, *Appl. Organometallic Chem.* **1988**, *2*, 191. doi:10.1002/AOC.590020302

[14] W. R. Cullen, R. Bentley, *J. Environ. Monit.* **2005**, *7*, 11. doi:10.1039/B413752N