

# How our India-Canada collaboration advanced fungal endophyte research

## INTRODUCTION

Google Scholar's slogan is "Stand on the shoulders of giants" (Kemmen, 2015). It reflects the notion that new knowledge, rooted in previous research, is created slowly and laboriously. Natural and physical sciences students learn about Karl Popper's scientific method, of which tedious replication is a fundamental pillar. The peer-review process of publishing results is an essential step for quality control in conservative, cautious science research.

Thomas Kuhn's 1962 book, *The Structure of Scientific Revolutions*, described paradigm shifts as a consensus-based process: after a long period of experiments and data accumulation, a theory or hypothesis is overthrown or accepted. Decades later, the limitations of Popper's scientific method and of Kuhn's analysis of knowledge creation are still being dissected, debated, and critiqued (Hyslop-Margison, 2010)—though not much by researchers in STEM (science, technology, engineering, and mathematics) fields.

How do creativity and innovation feed into this apparently highly constrained way of "doing" science? Natural and physical scientists have many avenues for bringing new ideas into their research. Here, I describe how an international collaboration with my colleague, Prof. Shibani Chaudhury, at Visva-Bharati University, India, led to both a local, methodological advance and a broader, paradigm-shifting perspective in my group's research.

## FUNGAL ENDOPHYTES

The study of plant–animal interactions is one major research area in my laboratory at York University (Vicari & Bazely, 1993). Plants cannot run away from their predators, so many of them have evolved mechanisms to deter herbivory. In return, herbivores have evolved ways

BY DAWN R. BAZELY

Dawn R. Bazely, DPhil, is a professor in the Department of Biology and a project investigator in the Canada-India Project for Research and Innovation (CIPRI), York University.

Frugal innovation is a radically different way of thinking about how research funds shape our approach, compared with the prevailing norms in Canada.

of getting around plant anti-herbivore defences.

Many temperate grass species contain hidden fungal endophytes that are systemic, growing throughout the host plant. These fungi synthesize toxic alkaloids and live their life cycles entirely within their host plant. The alkaloids they make have lethal and sublethal effects on both vertebrate and invertebrate herbivores grazing on the host grass.

Research progress in this field has often been limited by the available methods. In 2015, our fungal endophyte research at York University stalled. Standard bioassay tests with insect herbivores for detecting the toxic effects of these alkaloids were not sensitive enough to test the small amounts of grass plant yielded by our experiments. We needed a more sensitive method. At the 9th International Symposium on Fungal Endophytes of Grasses in Aus-

tralia, my colleague, Dr. Mark Vicari, learned about an old bioassay that had fallen out of use (Harwig & Scott, 1971). The method used brine shrimp (sea monkeys), but we were unable to obtain detailed methods from either the presenter or the existing literature.

I learned from Prof. Choudhury, a sabbatical visitor in my laboratory, that at Indian universities, unlike at Canadian universities, environmental microbiology and toxicology are still vibrant research fields, owing both to the high ambient levels of arsenic in the soils (Bhomick et al., 2018) and to ongoing, widespread industrial pollution (Khan & Tarique, 2015).


## FRUGAL INNOVATION

Because our research funds for developing this new bioassay approach were limited, we adopted the "frugal innovation" approach, which originated in India. We developed a rapid bioassay for testing fungal endophyte toxicity by using a combination of inexpensive, easily available brine shrimp and commonly available laboratory equipment. Navi Radjou and Jaideep Prabhu articulated the concept of this approach in their 2014 book, *Frugal Innovation*, which advocates maximizing outcomes with the minimum amount of resources, and embracing old and new technology. We incorporated an inexpensive, recent invention, the Easy-Macro lens ([www.easy-macro.com](http://www.easy-macro.com)). Results from our new, rapid bioassay showed that it provides an effective method for advancing our fungal endophyte research. We are expanding our tests and plan to publish this novel application.

Frugal innovation is a radically different way of thinking about how research funds shape our approach, compared with the prevailing norms in Canada. Our methodological breakthrough

Fungal endophyte research, page 12

# Fungal endophyte research continued from page 11

would not have been possible without this collective, international, interdisciplinary mindset. 

**Our methodological breakthrough would not have been possible without this collective, international, interdisciplinary mindset.**

## REFERENCES

- Bhowmick, S., et al. (2018). Arsenic in groundwater of West Bengal, India: A review of human health risks and assessment of possible intervention options. *Science of the Total Environment*, 612: 148-169. Retrieved from <http://dx.doi.org/10.1016/j.scitotenv.2017.08.216>
- Harwig, J., & Scott, P.M. (1971). Brine shrimp (*Artemia salina* L.) larvae as a screening system for fungal toxins. *Applied Microbiology*, 21(6): 1011-1016. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC377334/>
- Hyslop-Margison, E.J. (2010). Scientific paradigms and falsification: Kuhn, Popper and problems in education research. *Educational Policy*, 24(5): 815-831. Retrieved from <https://doi.org/10.1177/0895904809339166>
- Kemmen, M. (2015, November 19). Standing on the shoulders of the Google giant: Sustainable discovery and Google Scholar's comprehensive coverage. Retrieved from <http://blogs.lse.ac.uk/impactofsocialsciences/2015/11/19/standing-on-the-shoulders-of-the-google-giant/>
- Khan, M., & Tarique, Md. (2015). Industrial pollution in Indian industries: A post reform scenario. *Journal of Energy Research and Environmental Technology*, 2(2): 182-187.
- Kuhn, T. (1962). *The structure of scientific revolutions*. Chicago: University of Chicago Press.
- Radjou, N., & Prabhu, J. (2014). *Frugal innovation: How to do more with less*. London, UK: Economist Books.
- Vicari, M., & Bazely, D.R. (1993). Do grasses fight back? The case for antiherbivore defences. *Trends in Ecology and Evolution*, 8(4): 137-141. Retrieved from [https://doi.org/10.1016/0169-5347\(93\)90026-L](https://doi.org/10.1016/0169-5347(93)90026-L)

## Canada-India Project for Research & Innovation (CIPRI)

### MAPPING THE PATHWAYS FOR CANADA-INDIA RESEARCH COLLABORATION



<http://canadaindiaproject.ca/>



#### MISSION

- Promote awareness about the two largest democracies in the world, Canada and India.
- Promote understanding between two multicultural, multi-ethnic and multi-linguistic societies.
- Take-up non-political initiatives and become a premium Indo-Canadian resource hub in the Greater Toronto Area (GTA).
- Bring together students, researchers, academics, policy-makers, business entities, community members among others.
- Improve and expand relationship between the two countries through academic activities and help in advancement of the connectivity.
- Promote unconventional thinking by examining challenges and bring out new vision and innovative ideas.
- Provide vital information about both the Nations to the younger generation.