

David P. Janos

The Fourth International Conference on Mycorrhizae from four perspectives

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From 10 to 15 August 2003 inclusive, the Fourth International Conference on Mycorrhizae (ICOM4) convened in Montreal, Canada. The meeting was held jointly with the Canadian Societies of Agronomy and Soil Science in the conference center of the International Civil Aviation Organization. Daily security bag checks and having to pass through metal detectors—no truffle forks allowed—may have seemed excessive to “mycorrhizasts” (an appellation coined by Jack Harley), but heightened security is today’s reality.

The meeting comprised 4 very full days begun by plenary presentations, followed by invited speakers in 14 symposia, contributed oral presentations, posters almost too numerous to count, and a few workshops. Symposia concerned mycorrhizas in agronomic practice, interactions with pests, inoculum production, soil quality (including bioremediation and reclamation), global change (carbon dioxide, nitrogen deposition, temperature effects, and drought), comparative physiology (including genomics and proteomics), networks, evolution and systematics, and biodiversity. The 4 intellectually intensive days were interrupted halfway by a mid-week opportunity for a wide variety of thoroughly pleasant day-long excursions, or just relaxing and enjoying the cosmopolitan, hospitable city that is Montreal.

More than 790 abstracts were received from 50 countries. Certain recurrent topics emerged as engaging much attention. Research on the practical application of mycorrhizas emphasized the commercial production of glomeromycotan inoculants, evaluation of arbuscular and ectomycorrhizal inoculants under field conditions, and management to obtain mycorrhiza benefits for improved phosphorus nutrition, plant stress reduction, or phytoremediation. New questions were raised about the glomeromycotan fungus-produced glycoprotein glomalin, especially by Matthias Rillig and collaborators. In physiological research, genomic and proteomic comparisons

between non-mycotrophic species, myc⁻ mutants, and mycotrophic plants to elucidate host/fungus recognition processes and the bases of mutualistic function (especially phosphorus transporters) are areas of intensive investigation, as aptly summarized by Vivienne Gianinazzi-Pearson. The use of root organ cultures to study arbuscular mycorrhizas offers several advantages as noted by Yolande Dalpé, and is pervasive. Ras-mediated signaling, described by Gopi Podila, might have widespread importance in ectomycorrhizas. Aspects of mycorrhiza anatomy and morphology continue to attract attention, especially Gallaud’s *Arum* versus *Paris* typology resurrected by Andrew Smith and the elegant ultrastructural studies of Larry Peterson and colleagues. In biodiversity studies, molecular genetic approaches are revolutionizing our understanding of the occurrence of ectomycorrhizal fungi on roots, the fungus associates of orchids and ericads, and the specificity of mycoheterotrophic plants.

Unfortunately, no one person could summarize the meeting comprehensively because of its diverse, concurrent sessions. I had the pleasure of attending ICOM4 together with three students, so I offer impressions from our four perspectives.

My undergraduate thesis student appreciated hearing about research methods, such as the use of root-excluding screens to produce soil compartments occupied only by hyphae, and about the importance of extra-radical mycelium aptly described as “networks of power and influence” by Jonathan Leake. Especially thought provoking were Jan Sapp’s historical illumination of the evolutionary importance of symbioses, depiction of prior erroneous views of symbionts as “contaminants” and endosymbionts as “inferior”, and expression of the ubiquitous chimeric nature of cells and “organisms”. A symposium on “What are mycorrhizas?” illustrated that even experts have a hard time answering this question, and a simple but encompassing definition is elusive.

My second-year graduate student especially appreciated meeting the people who are actively publishing mycorrhiza research, and she commented on how approachable and interactive are mycorrhizasts, comprising

D. P. Janos (✉)
Department of Biology,
University of Miami,
Miami, Florida, USA

a true community. She noted an emerging emphasis on the importance of distinguishing among arbuscular mycorrhizal fungal (AMF) species because they function differently. This was complemented by Ian Sanders' engaging presentation on intraspecific genetic variation in *Glomus intraradices*, Alastair Fitter's comments on specificity, and Martin Bidartondo's work on obligate cheaters. There were, however, few oral presentations concerning mycorrhizas in the tropics (Ian Alexander's thorough review of mycorrhizas and ecosystem processes in the tropical rain forest being a notable exception) or how mycorrhizas might function differently there (or in other extreme environments). Fortunately, the possibility raised by Sidney Sturmer of convening ICOM6 in Brazil might remedy this, much as ICOM3 in Adelaide, Australia attracted many participants from tropical Asia.

My senior graduate student felt that our community could profit from increased formal opportunities for post-symposium open discussions, and highlighted, as an example, the interesting comments of the audience and empanelled speakers of the "What are mycorrhizas?" symposium. She found the job-openings bulletin board disappointing, with most of the few positions available seeking molecular genetics expertise. Although she thought no wholly new research themes appeared, the conditions under which AMF have negative effects on plants, as reported by Melanie Jones and Sally Smith, are attracting increased attention. Also, the effects of nitrogen on AMF and their role in nitrogen cycling need further exploration as indicated by David Read's symposium presentation.

From the sessions that I attended, it seemed at first as if we continue to grapple with the same questions: "what is a mycorrhiza, and can mycorrhizas be defined functionally", "is an ecologically meaningful amount of carbon transferred between plants by mycorrhizal fungi, and are mycoheterotrophic plants obligate cheaters of mycorrhizal fungi", "what is an AMF species, and do AMF species have specificity", and "how do ectomycorrhizal and arbuscular mycorrhizal associates coexist, and what are the effects of each mycorrhiza type on plant species diversity". But, as I reviewed my notes from the meeting, I found that even in the well-investigated fields of evolution, ecology, and ecophysiology there were some striking findings. To me, the most convincing, wholly new observation was Ignacio Querejeta's regarding hydraulic lift prolonging mycorrhiza function during drought. The subtle theme that I heard re-emerging (see Jim Gerdemann's 1955 paper) from Jonathan Leake's and Dan Durrell's talks and from Ivan de la Providencia's poster is the importance of hypha anastomoses for both arbuscular and ectomycorrhizal fungi.

Although our four perspectives are predominantly ecological, some general themes emerge:

1. Can we improve our understanding of all mycorrhizas by contrasting "mainstream" mycorrhizas against relatively little studied mycorrhiza types and against

somewhat ambiguously mycorrhizal fungus-root associations (e.g., those of dark-septate endophytes) instead of specializing upon one type of mycorrhiza or another? Similar benefit might come from a comparative approach to mycorrhiza function that incorporates extreme ecosystems.

2. May we achieve a rapprochement between molecular genetic "identities" and traditional, morphological "species" of mycorrhizal fungi? How important are ecotypes and "phylotypes" of mycorrhizal fungi? Without answers to these questions, we are not likely to soon resolve the issue of specificity.
3. Should mycorrhiza ecophysiologicals go beyond destructive harvests at an experiment's termination to add a dynamic, temporal component to an assessment of mycorrhiza function? That will be needed to capture the effects of breakage and anastomosis in common mycorrhizal networks among diverse host plants for extrapolating to community phenomena. Likewise, determining the temporal component of mycorrhiza benefits and costs is needed to bridge between whole organisms and proteomics.

ICOM4 closed with a business meeting at which many of us anticipated the establishment of a professional society of mycorrhizasts. A society might accrue several benefits (see my 1997 editorial). Mike Allen reported that following the 11 September 2001 tragedy, however, financial restrictions on international organizations chartered in the United States became especially onerous and precluded incorporating the International Mycorrhiza Society (<http://www.mycorrhizas.org>) in the USA. The possibility of chartering the society in Canada is promising, and we may look forward to this event in 2004. At an editorial board meeting during ICOM4, the managing editors of *Mycorrhiza*, Vivienne Gianinazzi-Pearson and Andrew Smith, and the editorial board strongly endorsed offering the journal to the future society, and Springer generously has done so on very favorable terms. *Mycorrhiza*, the only journal wholly devoted to mycorrhiza research, with an ISI impact factor of 1.46 ranks fifth among mycology journals.

Until we have a society and a society journal, the ICOM is the sole forum that unifies mycorrhizasts. As evidenced by its very large number of submitted abstracts and excellent attendance, ICOM4 succeeded well in bringing us together. Yolande Dalpé, Chair of the Organizing Committee, and her team of Canadian mycorrhizast hosts all deserve hearty thanks for a stimulating and enjoyable conference of "common mycorrhizal networking" that interconnected our community.

References

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