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Mycorrhiza in review

At the 1st International Conference on Mycorrhizae, the editorial board of *Mycorrhiza* reviewed several aspects of the journal, including the geographic distribution of first authors' addresses, research locations, and coverage of both mycorrhiza types and research topics. Here, we update that review to encompass the 30 issues published through volume 6. We examine authorship against the "International Directory of Mycorrhizologists" (Furlan 1996), and we compare *Mycorrhiza* to the mycorrhiza literature reflected by the 'MYCOLIT' database of nearly 12 000 references (Klironomos and Kendrick 1993).

For 1992 through 1996, the average acceptance rate of articles submitted to the journal was approximately 55%. Institutional addresses of the first authors of published articles represent 34 countries, with nearly half in Europe (Fig. 1). The regional distribution of authors' addresses differs significantly ($n = 1394$, $G = 39.141$, $P < 0.001$) from the distribution of mycorrhiza researchers listed in the 'Directory' (Furlan 1996). Papers published in *Mycorrhiza* over-represent European researchers and slightly under-represent Latin America and the Caribbean (Fig. 1).

Research reported in *Mycorrhiza* was conducted in 39 countries and the regional distribution of research location does not differ from that of first author addresses (Fig. 1; $n = 476$, $G = 4.528$, $P = 0.476$). Nevertheless, 6% fewer papers report research conducted in Europe than are attributable to European first authors, while one-quarter of published papers from Asia, Africa and the Middle East, and Latin America and the Caribbean have European or North American first authors. Half of the latter, however, have local collaborators as co-authors.

Most articles in *Mycorrhiza* deal with ectomycorrhizas (EM), arbuscular mycorrhizas (AM), or both, with just nine focused solely on ericoid, orchid or ectendomycorrhizas. Nine articles deal with more than one type of mycorrhiza, but five of these concern AM and EM. "Dark-septate" and arbutoid mycorrhizas are mentioned in two and one articles, respectively, which also deal with other types. The distribution of the journal's articles among mycorrhiza types (multiply counting articles that include more than one type) does not differ significantly from that of papers per year included in the 'MYCOLIT' database (Klironomos and Kendrick 1993) during the 1980s ($n = 591$, $G = 1.733$, $P = 0.420$). It is significantly more uniform than that for the early 1990s ($n = 914$, $G = 11.380$, $P = 0.003$), but Klironomos and Kendrick's information for the 1990s included data for less than 2 years.

Mycorrhiza published approximately 1.6 articles about AM for every one about EM. However, articles

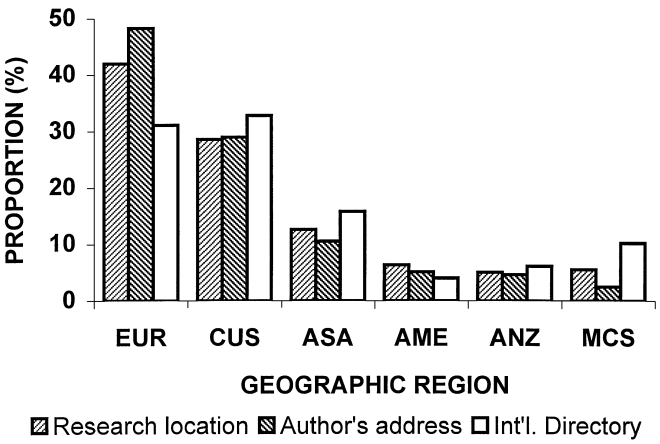

Fig. 1 Proportional geographic distribution of research locations of the 238 articles published in *Mycorrhiza* volumes 1–6 (*light upward diagonal hatched bars*), of first authors' institutional addresses (*dark downward diagonal hatched bars*), and of 1156 mycorrhiza researchers listed in the "International Directory of Mycorrhizologists, 6th edn" (Furlan 1996; *open bars*) (*AME* Africa and the Middle East, *ANZ* Australia and New Zealand, *ASA* Asia, *CUS* Canada and the United States, *EUR* Europe, *MCS* Mexico, Central and South America, and the Caribbean)

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in *Mycorrhiza* about EM are on average nearly 1 page longer than those about AM (6.9 versus 6.1 pages; ANOVA: $F_{1,\ 220} = 6.466$, $P = 0.012$). The regional geographic distribution of research locations for articles about EM differ significantly from that for AM ($n = 236$, $G = 23.921$, $P < 0.001$). Ectomycorrhizas are covered by half of articles from Europe and Asia, one-third from North America and Australia, one-sixth from Africa and the Middle East, and none from Latin America and the Caribbean.

We exclusively categorized articles published in *Mycorrhiza* by their primary research topic, multiply counting the few papers concerning both AM and EM (papers about "other" types of mycorrhizas are too few to meaningfully categorize). We examined the geographic distribution of research topics by combining all articles by authors in Europe, North America, and Australia and comparing them with those by authors in Asia, Africa, the Middle East, Latin America, and the Caribbean. Research topics differ significantly between these two groups ($n = 236$, $G = 18.042$, $P = 0.001$). The proportion of articles concerning ecology is similar between them, but the latter group contribute about half as many articles concerning physiology and almost twice as many concerning growth responses than the former.

When assorted by the categories of Fig. 2, the distribution of articles published in *Mycorrhiza* about AM differs significantly from that of articles about EM ($n = 236$, $G = 19.566$, $P = 0.001$). Research on ecology and growth responses accounts for nearly three-quarters of AM articles (Fig. 2). In contrast, physiological research predominates among articles about EM.

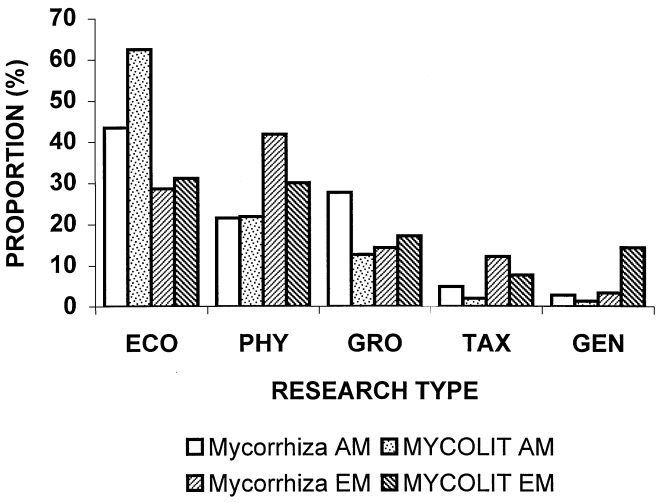

Fig. 2 Proportion of articles published in *Mycorrhiza* volumes 1–6 grouped by research topic for those concerning arbuscular mycorrhizas (AM; *open bars*) and ectomycorrhizas (EM; *light upward diagonal hatched bars*) versus the proportion of articles per year during the decade of the 1980s in the 'MYCOLIT' database (Klironomos and Kendrick 1993) for AM (*stippled bars*) and EM (*dark downward diagonal hatched bars*) (*ECO* ecology including occurrence, distribution, sporulation, interactions with other organisms, and ecophysiology, which comprises environmental effects on formation and function, *GEN* genetics, molecular genetics, and genomic libraries, *GRO* growth effects of mycorrhizas, *PHY* physiology, inoculum production, histology, immunochemistry, anatomy, and ultrastructure, *TAX* taxonomy, and phylogeny)

The topical distribution of articles published in *Mycorrhiza* differs significantly from those in the 'MYCOLIT' database for both AM ($n = 687$, $G = 26.121$, $P < 0.001$) and EM ($n = 499$, $G = 14.847$, $P = 0.005$). To make these comparisons, we combined Klironomos and Kendrick's (1993) "inoculum" and "formation/morphology/physiology" categories and equated them to our "PHY", and we omitted their non-exclusive category "methodology" (because we categorized methodological articles by their primary focus, not separately). Compared to 'MYCOLIT', articles concerning AM in *Mycorrhiza* under-represent ecological research, but over-represent investigations of growth response (Fig. 2). Taxonomic and genetic research concerning AM are proportionally very sparse in 'MYCOLIT', but are slightly better represented in *Mycorrhiza*. The topical distribution of *Mycorrhiza* articles about EM over-represents physiology and under-represents genetics in comparison to 'MYCOLIT' (Fig. 2).

Articles about EM ecology are evenly split between field and laboratory studies in both 'MYCOLIT' and *Mycorrhiza,* which do not differ ($n = 153$, $G = 0.061$, $P = 0.804$). Moreover, field studies of EM ecology are approximately evenly split between natural and disturbed ecosystems in both sources, which again do not differ ($n = 74$, $G = 0.585$, $P = 0.444$). However, AM ecology studies do differ between the two sources ($n = 404$, $G = 7.673$, $P = 0.006$). The majority (61%) of AM ecology studies in 'MYCOLIT' concern laboratory work, but the majority (58%) of those in *Mycorrhiza* report field studies. In 'MYCOLIT', AM ecological field studies disproportionately emphasize agricultural ecosystems (64% versus 15% natural and 21% disturbed ecosystems), but the distribution of articles in *Mycorrhiza*, which differs significantly ($n = 167$, $G = 20.956$, $P < 0.001$), favors natural ecosystems (50% versus 29% agricultural and 21% disturbed ecosystems).

This review indicates that *Mycorrhiza* generally well represents mycorrhizologists and mycorrhiza research as embodied in the 'Directory' and the 'MYCOLIT' database. Although especially favored by European authors, the journal has attracted numerous others who reflect the distribution of mycorrhiza researchers (Fig. 1).

Mycorrhiza fairly represents mycorrhiza literature published throughout the 1980s, but types of mycorrhizas other than AM and EM require increased attention to remedy an extreme bias in knowledge of fungus-root mutualism. Klironomos and Kendrick (1993) suggest that the abundance of hosts of AM and EM together with societal demands for increased plant production contribute to the predominance of studies of these two major mycorrhiza types. This suggestion accords with the even split between AM and EM for *Mycorrhiza* ar-

ticles from Europe and Asia, and with the paucity of EM articles from Latin America, where EM are of importance only in highlands and with exotic, plantation species. However, lack of parity in the journal between AM and EM research for North America, Australia with its extensive Eucalypt savannas and woodlands, and Africa with vast *miombo* woodlands and ectomycorrhizal legume dominants in some wet forests is at variance with the suggestion. Somewhat surprisingly, this lack of parity may indicate a need for increased EM research in the latter regions.

Mycorrhiza is more uniform in coverage of AM research than the general literature encompassed by 'MYCOLIT' (Fig. 2). Among AM research, only growth responses to mycorrhizas may be unduly emphasized by the journal. Taxonomic and genetic research generally require more emphasis (Klironomos and Kendrick 1993), although the journal performed slightly better than the general literature for AM taxonomy and genetic research. Ectomycorrhiza research as published in *Mycorrhiza*, unfortunately, is not as evenly distributed among research topics as in 'MYCOLIT'. The journal under-represents EM genetics and over-represents EM physiological research. However, we included studies of inoculum production within "physiology". The ease of culture of some ectomycorrhizal fungi and their consequent investigation as inoculant fungi (Klironomos and Kendrick 1993) may have inflated the EM physiology category.

The predominance of ecological research in both the journal and the database in part results because "ecology" is a very broad topic. For EM ecology, the journal and database do not differ, but AM ecological coverage by the journal emphasizes field studies of natural ecosystems instead of the laboratory and agricultural emphases apparent in 'MYCOLIT'. The journal thereby partially remedies the "unjust neglect" of AM field ecology in natural systems decried by Klironomos and Kendrick (1993).

In sum, this analysis substantiates the claim that *Mycorrhiza* is broadly representative of mycorrhiza research. Thus *Mycorrhiza* lives up to its name.

References

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