Living in the city: Arbuscular mycorrhizal fungi in Phoenix and the surrounding desert

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Introduction & Objectives

- Many studies compare diversity of plants and animals in urban areas with surrounding natural ecosystems, but similar studies of fungi are rare (Newbound et al. 2010). One exception are studies of mycorrhizal fungi that form mutualistic symbiosis with plant roots.
- Species richness of arbuscular mycorrhizal fungi (AMF) tends to decline with alterations associated with urbanization (Stabler et al. 2001; Cousins et al. 2003; Bills & Stutz 2009).
- We examined the impact of urbanization on AMF communities to determine which habitat factors predict AMF occurrence and abundance.

Methods

- Soil samples were collected in the Phoenix metropolitan area as part of the Central Arizona Phoenix (CAP) LTER Survey 200.
- In the field (Fig 1), soil samples were collected to establish trap cultures. Habitat characteristics (vegetation type, soil chemistry and texture, elevation, slope, and % impervious area) were measured.
- Urban sites differed in land use history (i.e., developed from desert or from agricultural land) and time since development (from 1 to 100 yrs since conversion). We categorized urban sites as having native plants (n=15) or non-native plants (n=31) based on landscape plants.
- Spores were extracted from a 100 cm^3 sample by wet sieving/sucrose density gradient centrifugation and each distinct morphotype was mounted in polyvinyl alcohol-lactic acid-glycerin (PVLG) and PVLG mixed with Melzer's reagent for identification.

Fig 1. Soil samples were collected from 3 trees nearest plot-center from 46 urban sites and 13 desert (nonurban) sites.

Results & Discussion

- **AMF species richness was lower in urban sites compared to desert sites** (Table 1). There were no relationships with AMF species richness and years since development at urban sites (Correlation coefficient = 0.0066, n=46, P>0.05).

Table 1. AMF species richness (ANOVA). Subscripts indicate multiple pairwise comparisons (Holm-Sidak method).

	AMF Richness Mean (SE)	Statistic	Significance
Desert (n=13)	8.0 (0.5)		
Urban (n=46)	6.2 (0.3)	t=-1.783	P=0.005
Desert (n=13)^{A}	8.0 (0.5)		
Urban, native plants (n=15)^{A,B}	6.4 (0.5)		
Urban, non-native plants (n=31)^{B}	6.1 (0.3)	F=4.37	P=0.017
Desert (n=13)^{A}	8.0 (0.5)		
Desert converted to urban (n=23)^{B}	6.3 (0.4)		
Ag converted to urban (n=23)^{B}	6.2 (0.4)	F=4.27	P=0.019

- There were no relationships with AMF richness and landscape plants (native, non-native) or land use history (Logistic Regression, Table1).

- **Altered edaphic conditions and habitat associated with urbanization were linked to occurrence and abundance of some AMF species** (Fig 2, Table 2). Habitat varied by soil nutrient factors - organic matter, N, and P (Principal Components Analysis, PC1 explained 34%) and by amount of impervious area and tree cover (PC2 explained 15%). Abundance of *Diversispora eburnea*, *D. spurca,* and *Glomus microaggregatum* had positive associations with urbanization (analysis not shown).

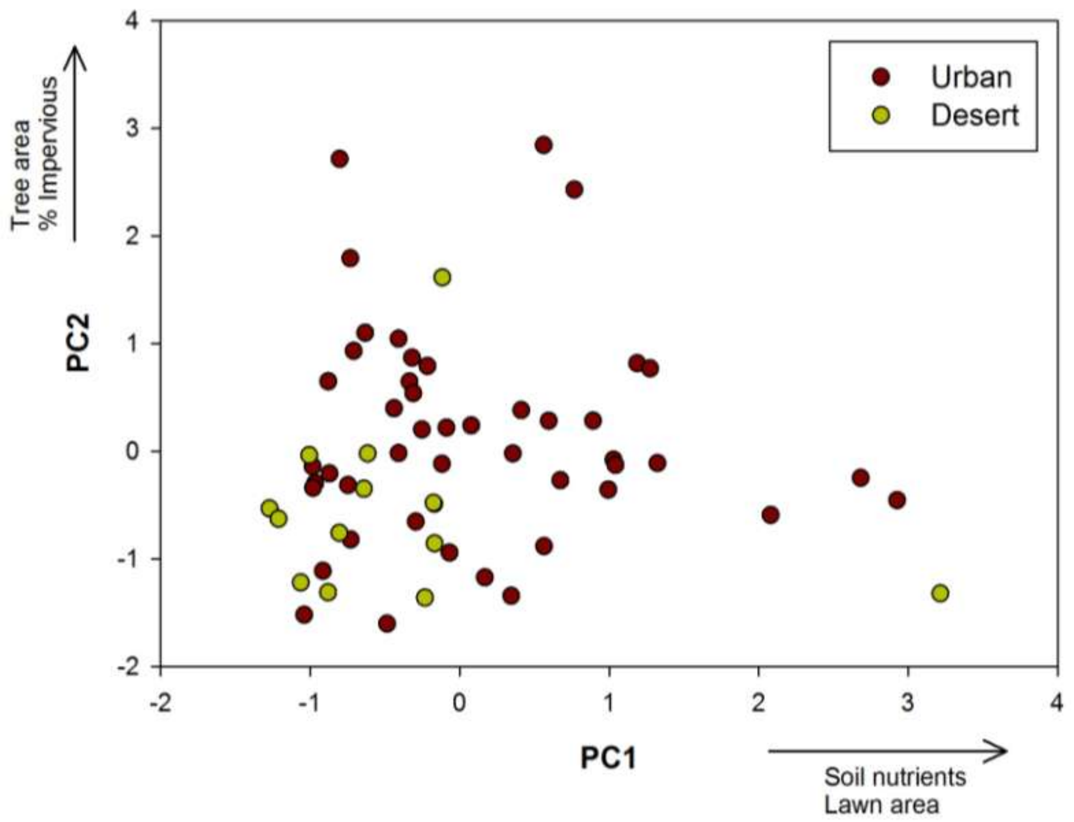

Fig 2 PCA of habitat factors at urban & desert sites.

Table 2. AMF species – habitat relationships.

Species	(Correlation), Characteristics	Significance (classification accuracy)
Entrophosporum infrequens	(-) F1 Soil nutrients (-) F2 Impervious with trees (+) F3 Sand and clay (+) F4 Topography	P=0.006 (79.3%)
Claroideoglomus claroideum	(+) F1 Soil nutrients	P=0.079 (79.3%)
Claroideoglomus luteum	(-) F1 Soil nutrients (-) F2 Impervious with trees (+) F4 Topography	P=0.027 (82.8%)
*Glomus*_AZ112	(-) F1 Soil nutrients (-) F2 Impervious with trees	P=0.013 (75.9%)
*Glomus*_AZ123	(-) F1 Soil nutrients (+) F3 Sand and clay (+) F4 Topography	P=0.024 (67.2%)
Paraglomus occultum	(+) F2 Impervious with trees	P=0.079 (63.8%)

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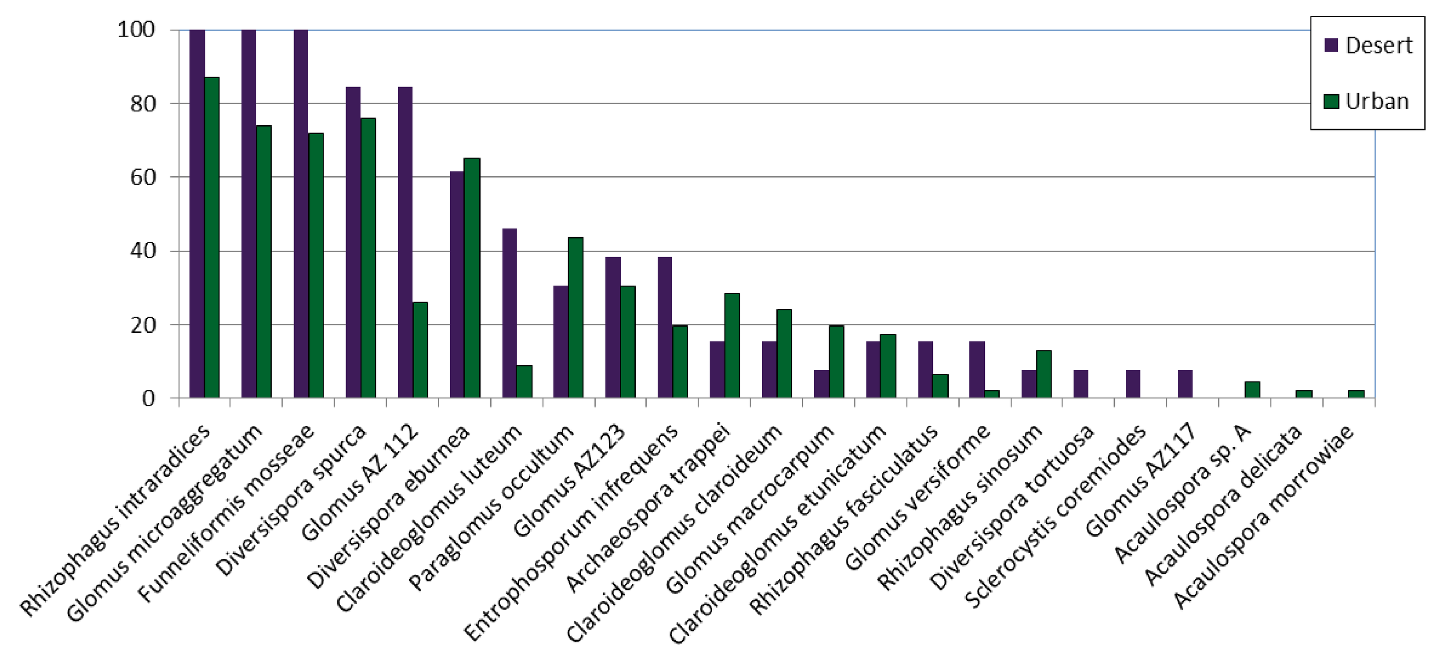
Results & Discussion

- **Although many AMF species were detected in soil from urban and desert sites, communities were dissimilar based on AMF composition and abundance** (Fig 3 & 4). We detected 23 AMF morphotypes at the 59 sites with many species differing in occurrence between urban and desert sites (Fig 3). We used non-metric multidimensional scaling (NMDS) analysis of AMF species abundance to find that most desert sites clustered together along with some urban sites having native vegetation, indicating similar species composition and relative abundances (Fig 4).

Fig 3. Percentage of sites at which each AMF species was detected.



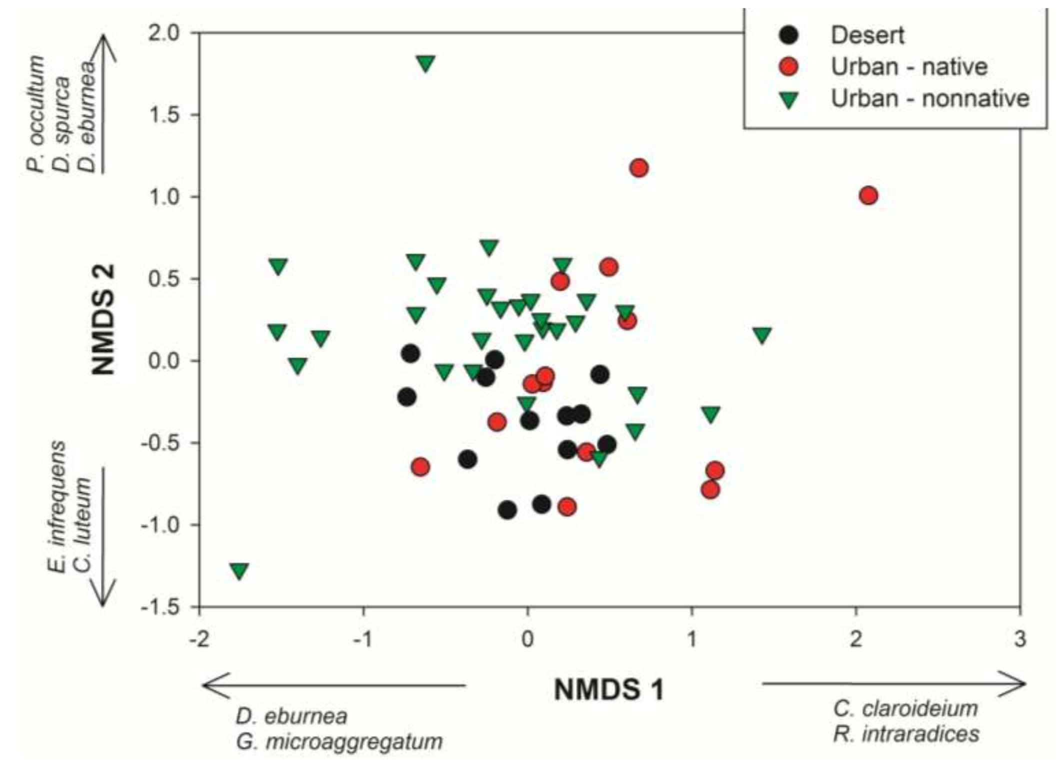


Fig 4. Multivariate ordination showing sites plotted in species space as defined by the first two axes in the analysis. A third axis solution produced a low stress value (stress = 13).

Conclusions

- Urbanization is linked to alterations in AMF community structure with decreases in species richness and alterations of community composition. These alterations could have impacts on plant productivity in urban areas.
- There were species specific responses to urbanization that were linked to increases in soil nutrients and the presence/absence of different types of landscape plants.