Small-scale spatial patterns of arbuscular mycorrhizal fungal diversity in an experimental urban landscaped site.

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Introduction

Recent work on arbuscular mycorrhizal fungal (AMF) community structure in metropolitan Phoenix, Arizona, has revealed that there is as much variability in species diversity within a single land use type as there is between different land use types (Cousins and Stutz 2001). These results may have been due to spatial heterogeneity at scales smaller than those represented in the sampling scheme.

No studies to date have been undertaken on the spatial patterning of AMF species composition at scales of less than 50 m. In this study we examined AMF species richness at the plot scale in two experimental urban landscaped sites. We hypothesized that overall species richness would exhibit a nonrandom spatial pattern, that species richness would be positively correlated with proximity to plants, and that individual species would have a clustered distribution.

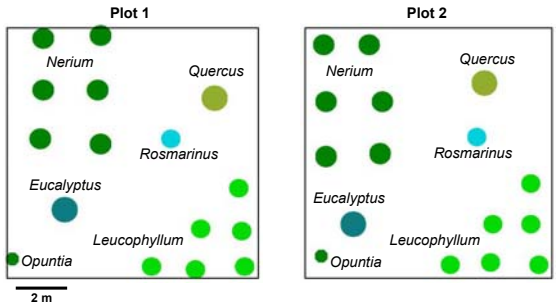

Figure 1. Locations of plants in experimental urban landscape plots.

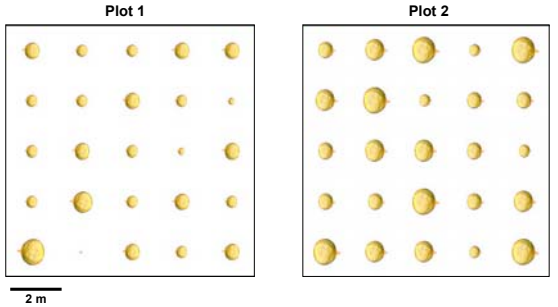

Figure 2. Maps of AMF species richness in experimental urban landscape plots. Larger spores indicate greater species richness.

Materials and Methods

Two 9.2 × 9.2 m experimental urban landscape plots were established at the Desert Botanical Garden in Phoenix, Arizona. The plots each contain six species of woody plants, which were all planted in the summer of 1999 (Figure 1). Soil samples to 10 cm depth were collected at 25 locations in each plot in a regular grid pattern. Plot 2 was sampled in October 2000; Plot 1 was sampled in February 2001.

Trap cultures from each sample were established and AM fungal spores were isolated from each trap culture using a sucrose density gradient centrifugation method. Spores were identified to species and the number of species at each location was recorded.

Regression analysis was performed to determine whether there was a correlation between AMF species richness and distance from plants. The spatial pattern of species richness in each plot was analyzed using the Moran's *I* spatial autocorrelation coefficient. Moran's *I* is a weighted product-moment correlation coefficient, where the weights reflect geographic proximity. Positive values indicate positive spatial autocorrelation and negative values indicate negative autocorrelation. Significance of the values was tested by calculating a *z* score under a randomization assumption. The join count statistic was used to determine whether individual AMF species exhibited spatial autocorrelation in the plots. This statistic is used to test whether binary variables (in this case, presence/absence of a given AMF species) are randomly distributed, clustered, or over-dispersed. Quadrats containing a given species were coded as 1 and quadrats without the species were coded as 0. The number of cases in which adjacent quadrats (joins) were both 1 or both 0 was calculated. If this value is higher than the number of joins with a 1 and a 0, this indicates spatial clustering; if it is lower, the attribute is over-dispersed. Significance was tested with a *z* score.

References

Cousins, J. R., and J. C. Stutz. 2000. Arbuscular mycorrhizal fungal species composition, richness, and abundance in the Phoenix metropolitan area. Central Arizona-Phoenix LTER Second Annual Poster Symposium. <http://caplter.asu.edu/Symposia/symp2000/index.htm>.

	Relative frequency (%)	
	Plot 1	Plot 2
Glomus eburneum	64	100
G. microaggregatum	76	64
G. intraradices	28	64
G. mosseae	44	40
G. spurcum	0	60
G. luteum	0	4
G. fasciculatum	0	4
G. sp. AZ 112	0	4
G. sp. AZ 123	4	12
Glomus sp. A	0	4
Entrophospora infrequens	20	0
Acaulospora denticulata	4	4

Table 1. Relative frequency of arbuscular mycorrhizal fungal species in experimental urban landscaped plots.

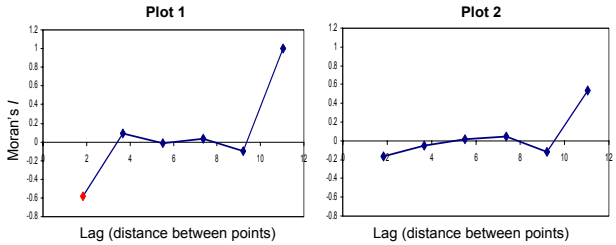

Figure 3. Spatial autocorrelation of arbuscular mycorrhizal species richness, measured with Moran's *I*, in experimental urban landscaped plots. Red diamond indicates significance at the 0.05 level.

Results

A total of 12 AMF species were found in the plots. Plot 1 contained 7 species and Plot 2 contained 11. The most frequently encountered species were *Glomus eburneum*, *G. microaggregatum*, *G. intradices*, and *G. mosseae* (Table 1). Species richness ranged from 0 to 5 species per sampling point. Plot 1 had a mean of 2.4 species per point (SE = 0.20) and Plot 2 had a mean of 3.6 species per point (SE = 0.21).

Visual examination of species richness maps does not reveal any obvious spatial patterns (Figure 2). Species richness was not correlated with distance to plants in either plot (Plot 1: r^2 = 0.01; Plot 2: r^2 = 0.02).

A lag of 1.84 m was used in calculating Moran's *I*, with 6 lags in each plot. In Plot 1, species richness values were negatively autocorrelated (Moran's *I* = –0.583, *z* = -3.03) at a scale of ≤ 1.84 m. Moran's *I* values were not significant at any other scale. Plot 2 demonstrated a similar pattern, but Moran's *I* was not significant at any scale. Both plots reveal a non-significant trend toward positive autocorrelation at the 10 m scale (Figure 3).

The *z* scores for the join count statistics were significant in two cases. *G. microaggregatum* locations in Plot 2 were positively autocorrelated and *G. eburneum* locations in Plot 1 were negatively autocorrelated (Table 2).

	Plot 1 joins			Plot 2 joins		
Species	Observed	Expected	*z* score	Observed	Expected	*z* score
G. microaggregatum						
+/+	23	22.8	0.13	19	16	1.68
+/–	15	15.2	-0.09	12	19.2	-2.54*
–/–	2	2	na	9	4.8	2.77*
G. eburneum						
+/+	12	16	-2.25*	na	na	na
+/–	26	19.2	2.40*	na	na	na
–/–	2	4.8	-1.85	na	na	na

Table 2. Results of join count statistical analysis of AMF species richness in experimental urban landscaped plots. + indicates presence and – indicates absence of given species. * indicates significant *z* scores at 0.05 level.

Discussion

- AMF species richness exhibited nonrandom spatial patterning at a small scale in one plot. The over-dispersed pattern appears to be due to "hotspots" of species richness at a very small scale, surrounded by areas of low richness.
- Two individual species were distributed in a nonrandom pattern. One was positively autocorrelated and one was negatively autocorrelated, suggesting that different AMF species exhibit different spatial patterns within the same area.
- The observed pattern of species richness was not due to existing plant locations, but may have been due to past land use. This site was previously native desert dominated by creosote bush and ephemeral annuals.
- Species richness appears to approach positive autocorrelation at the 10 m scale. Future studies should focus on the 10-50 m scale.