Probing the effects of Urbanization on Lichen Community Composition in Urban and Rural Phoenix

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Introduction:

- Lichens are composite organisms that are composed of a fungal part (mycobiont) and a photosynthetic part only activated by moisture (photobiont)
- Lichens passively exchange gasses; they are highly sensitive to air pollution and their presence can give insight on air quality.
- Studies utilizing lichens to indicate air quality are set in places with greater annual precipitation, cooler temperatures, and greater lichen diversity because of favorable conditions.
- Deserts are water limited and thus lichen growth is overall stunted because of a lack of optimal moisture to activate photobiont photosynthesis.
- However, since desert lichens are water-limited, deposition of air pollutants are typically dry rather than wet meaning that pollutants are not immediately absorbed in lichen bodies.

Research Questions and Hypotheses:

Question: In a desert setting, where water is limited and thus lichen diversity within communities is lower, are the effects of urbanization as profound in studies with greater lichen diversity and abundance baselines?

Hypothesis: Since lichens are sensitive to air pollution, it is expected that lichen community composition in rural Phoenix is more diverse and abundant relative to lichen communities within urban Phoenix.

Methods:

1. Piestewa Peak as part of the Phoenix Mountain Preserve in Central Phoenix was chosen as the urban site. The White Tank Regional Park to the West of Phoenix was chosen as the rural site.
2. Three 50-meter transects were laid at each site.
3. For each transect, a 10 square centimeter quadrat was laid every meter.
4. Once laid, ground-dwelling (terricolous) lichens present were identified to genera and percent coverage was estimated for all lichens present within the quadrat.
5. Lichens were identified to the genera level using a dichotomous key for Sonoran Desert Lichens (*Lichen Flora of the Greater Sonoran Desert Region Volume: I, II, III)* along with testing for signature secondary metabolites and analyzing microscopic structures of the lichen body
6. Percent coverage for each genera present was recorded and repeated every meter along the transect for a total of 50 quadrats.
7. For genera of lichen that could not be identified in-field, a subsample of the lichen colony was taken into the lab to identify using chemical and microscopy techniques.
8. Once identified, specimens were mounted on acid-free mounting cards and curated; a small collection was stored for future reference in lab.
9. To determine diversity and evenness, the Shannon-Weiner Diversity index was used to process percent coverage data collected in the field.
10. Statistical analysis for Shannon diversity, evenness, and abundance was performed using a general linearized model (glm) with a quasipoisson distribution and compared via Analysis of Deviance using an F-test. A NMDS was also performed for genera occurrence near sites.

Results:

When assessing diversity within lichen communities found at Piestewa peak and the White Tanks, urban lichen communities seemed to have greater diversity than rural lichen communities (P=0.011; Fig. 1). Concerning, evenness between genera found within the communities, urban Piestewa lichen communities were more evenly distributed than the rural White Tank communities (P=0.021; Fig 2). When comparing the abundance of lichen between the urban Piestewa site and the rural White tanks site, the urban site was found to support greater lichen growth than the White Tanks (P<0.001; Fig. 3). An NMDS was performed in order to visualize the typical occurrence of certain genera at either sites (Fig. 4); in the NMDS model it was found that although *Placidium*, *Peltula*, and *Endocarpon* where typically found at both sites *Diploschistes* was typically found near the White Tanks while *Psora* was common at the Piestewa site (Fig. 4)

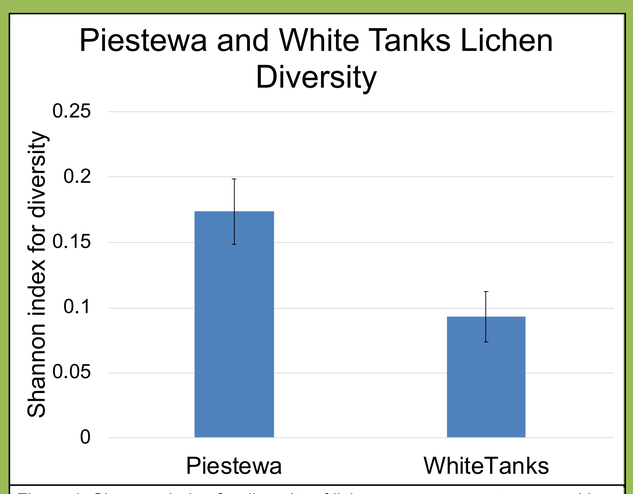


Figure 1. Shannon index for diversity of lichen genera present communities found at urban Piestewa Peak site and rural White Tanks site. Error bars are representative of standard error.

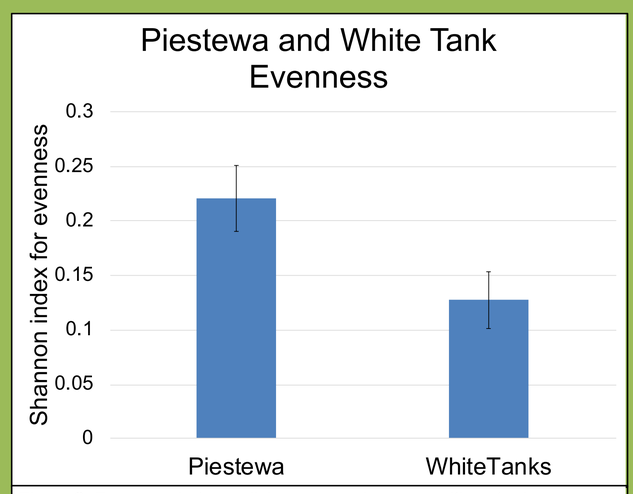


Figure 2. Evenness between lichen genera in communities at urban Piestewa Peak site and rural White Tanks site. Error bars are representative of standard error.

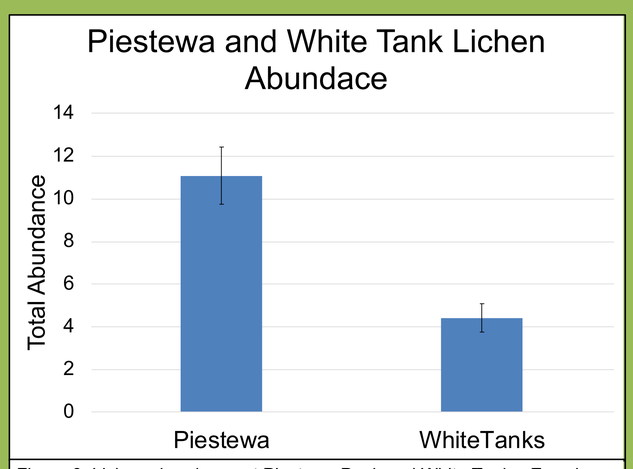


Figure 3. Lichen abundance at Piestewa Peak and White Tanks. Error bars are representative of standard error.

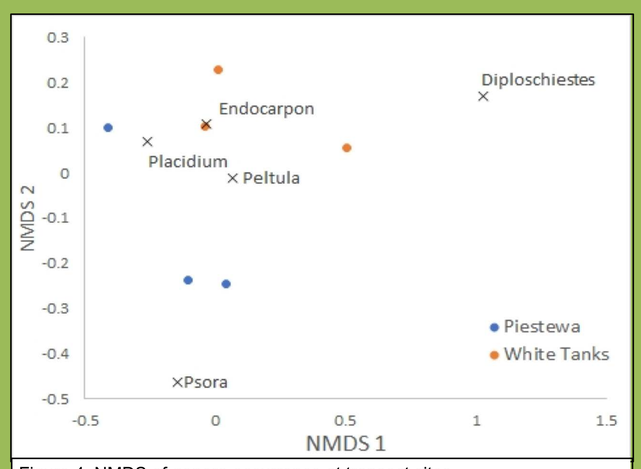


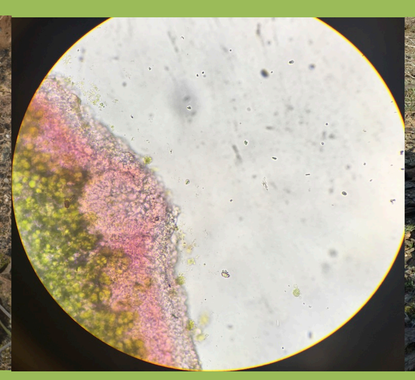
Figure 4. NMDS of genera occurrence at transect sites

Discussion + Conclusion:

- When comparing lichen community diversity between the inner-city mountain preserve, Piestewa Peak, and the rural nature preserve, the White Tanks, it is evident that Piestewa has a greater community diversity and genera-level evenness.
- It is possible that these findings could have a few explanations:

1. It is possible that since the typical air pollutants like NOx are not largely being transformed into nitric acid by combining with water (since the desert is water limited) whatever moisture lichens do encounter, it may be enough to absorb enough N to support greater lichen growth and thus abundance.
2. Thus, when NOx gasses and CO2 are released dry-deposition occurs rather than acid-rain formation which could be less detrimental to lichens.
3. It is possible that the position of the lichen communities on different mountain faces could have provided favorable conditions for lichen growth in urban sites versus rural.

- Although the differences in lichen community diversity and evenness is significant between the urban Piestewa Peak site and the rural White Tanks site, more sites would need to be visited in order to come to a sound conclusion about the effects of urbanization on desert lichen communities in metropolitan Phoenix.



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