Land-use type affects biogeochemical cycling, soil microbial communities, and the belowground food-web in an arid ecosystem.

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1. Introduction

- Arid ecosystems experience high rates of land-use change associated with urban development including the installation of managed xeriscapes and irrigated turfgrass lawns in residential and commercial areas[1].

- Regular use of water and fertilizers in mesic, turfgrass lawns modifies soil microbial community structure, distribution, and function, which can alter N cycling pathways in arid cities[1,2].

- It is unclear how land-use modifications affect belowground microflora and fauna in urban areas which, in turn, are the active drivers and regulators of urban biogeochemistry and soil function.

2. Research Questions

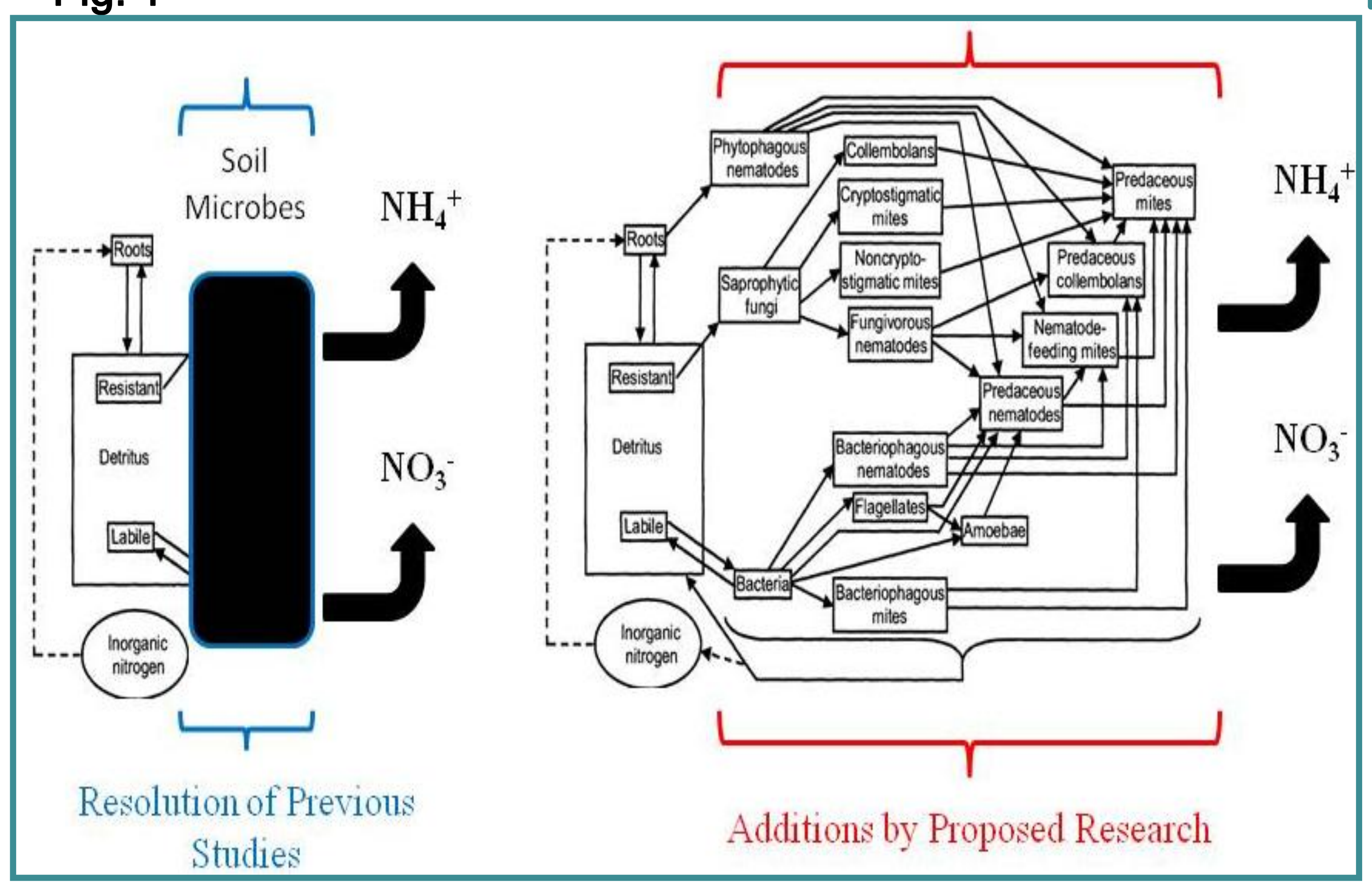
Our questions tie in with the theme of resolving the "microbial black box" that researchers use with current biogeochemistry approaches[3] **(Fig. 1)** across a land-use gradient of contrasting nutrient (NPK fertilization, N deposition) and water inputs to soil (mesic vs. xeric).

1) Who are the major groups of soil flora and fauna in an urban belowground ecosystem and how do populations change during the dry and monsoon seasons?

2) How do landscape types affect the interactions between multi-trophic communities, soil properties, and nutrient cycling?

We hypothesize that the soil conditions, determined by land-use type, will affect the trophic structure and interactions within the soil community, with consequences for N cycling rates[3].

Fig. 1



3. Methods

- In summer of 2011, we collected 80 soils at 10cm depth from 4 different land-use types **(Fig. 2)** within the Phoenix Metropolitan Area during dry and monsoon seasons.

- Soils were analyzed for soil properties and N processes. We also created a DNA "fingerprint" profile of the microbial community using clone libraries and measured biomass of the major belowground feeding groups **(Table 1)**.

- Microarthropods, soil characteristics, and N rates were compared across sites (native, native+N, xeric, mesic) using univariate ANOVAs and regression analyses in SPSS.

-This data enables us to understand **who** is involved in nutrient cycling and **how** the inputs (e.g. water, N, organic matter) of contrasting urban conditions lead to a change in belowground food web structure and soil function dynamics.

Fig. 2

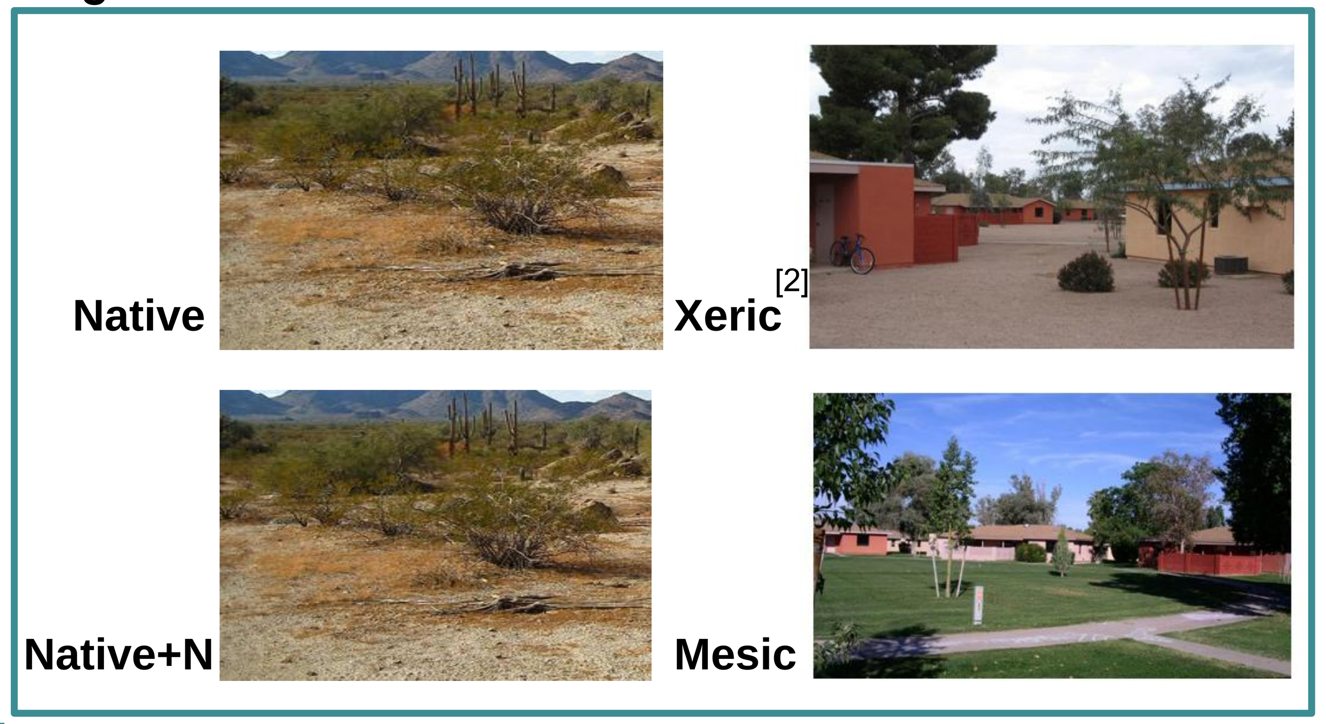


Table 1

Trophic Groups/ Variables	Sampling Type	Information Obtained
Bacteria, Fungi- biomass	Microscopic Enumeration	Biomass of bacteria & fungi
Bacteria, Fungi- DNA	DNA Extraction, Community profiling of gene markers	Microbial community diversity & relative abundance
Soil Protozoa	Microscopic Enumeration	Biomass of flagellates, ciliates, & amoeba
Nematodes	Funnel Extraction Method	Biomass of nematodes by functional group
Microarthropods	Funnel Extraction Method	Biomass of microarthropods by functional group
Epigeic Fauna	Pitfall Capture	Biomass of ground dwelling fauna
Nitrification rates	Bulk Soil, Slurry Incubation	NH_4^+/NO_3^- pool content change over time
Denitrification and Gas Flux	Soil Gas Flux	Activity of Soil Microbes & Nitrogen Gas Efflux (e.g. N_2O)
Soil/Litter C:N	CHN Elemental Analyzer	Quality of soil & litter input into system

Fig. 3 Soil biota

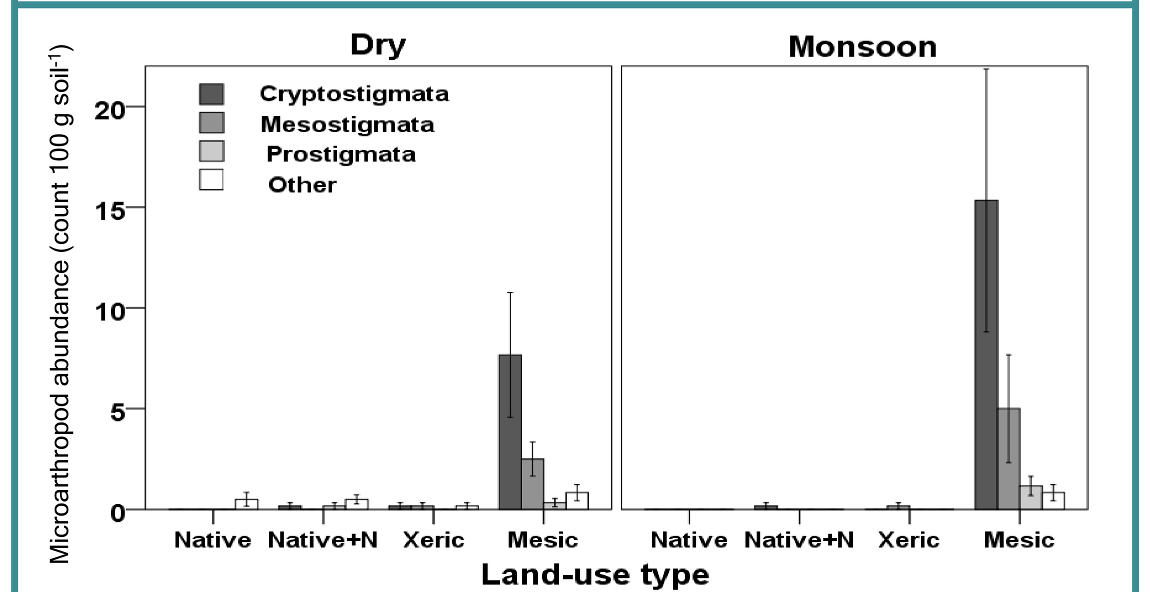


Fig. 4 Soil conditions

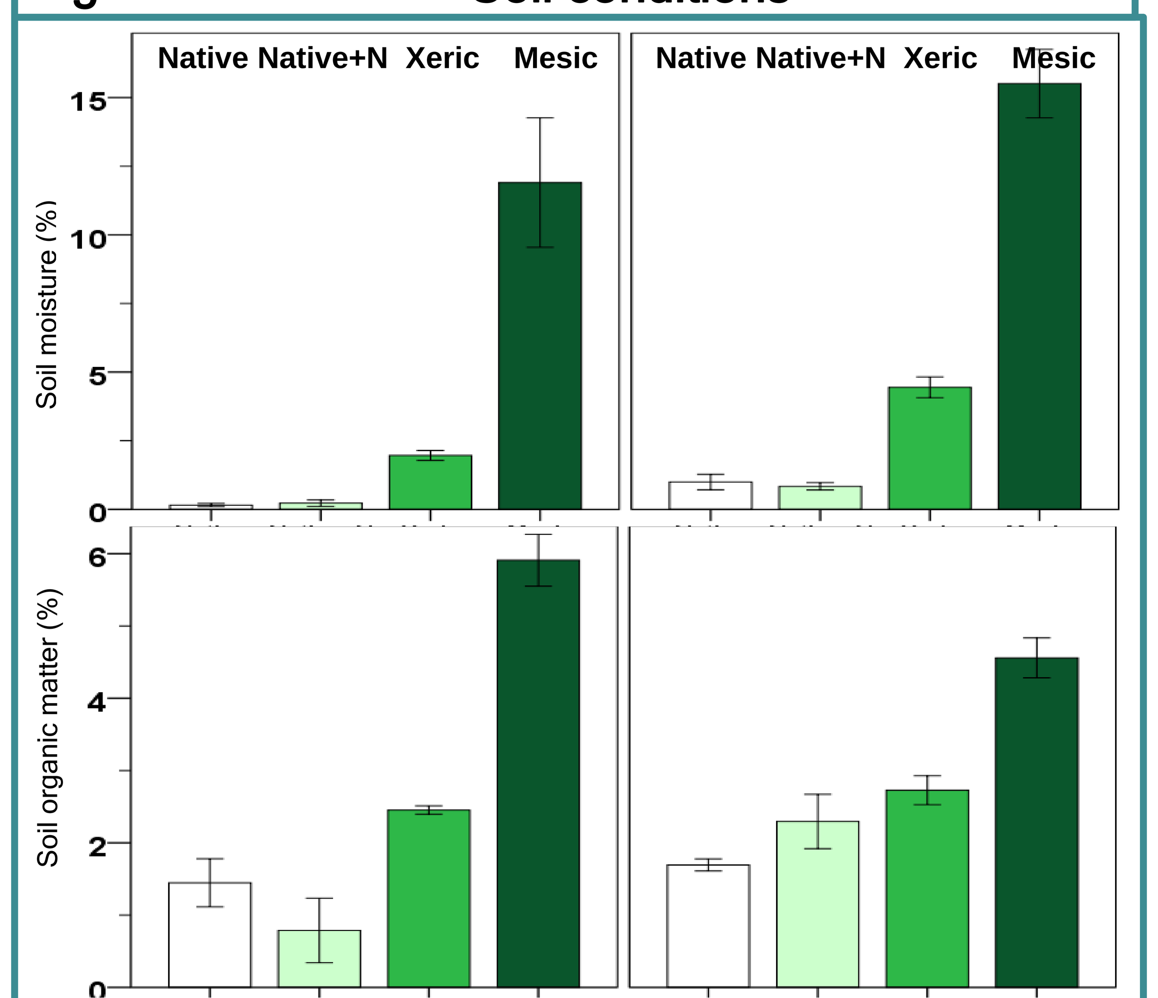
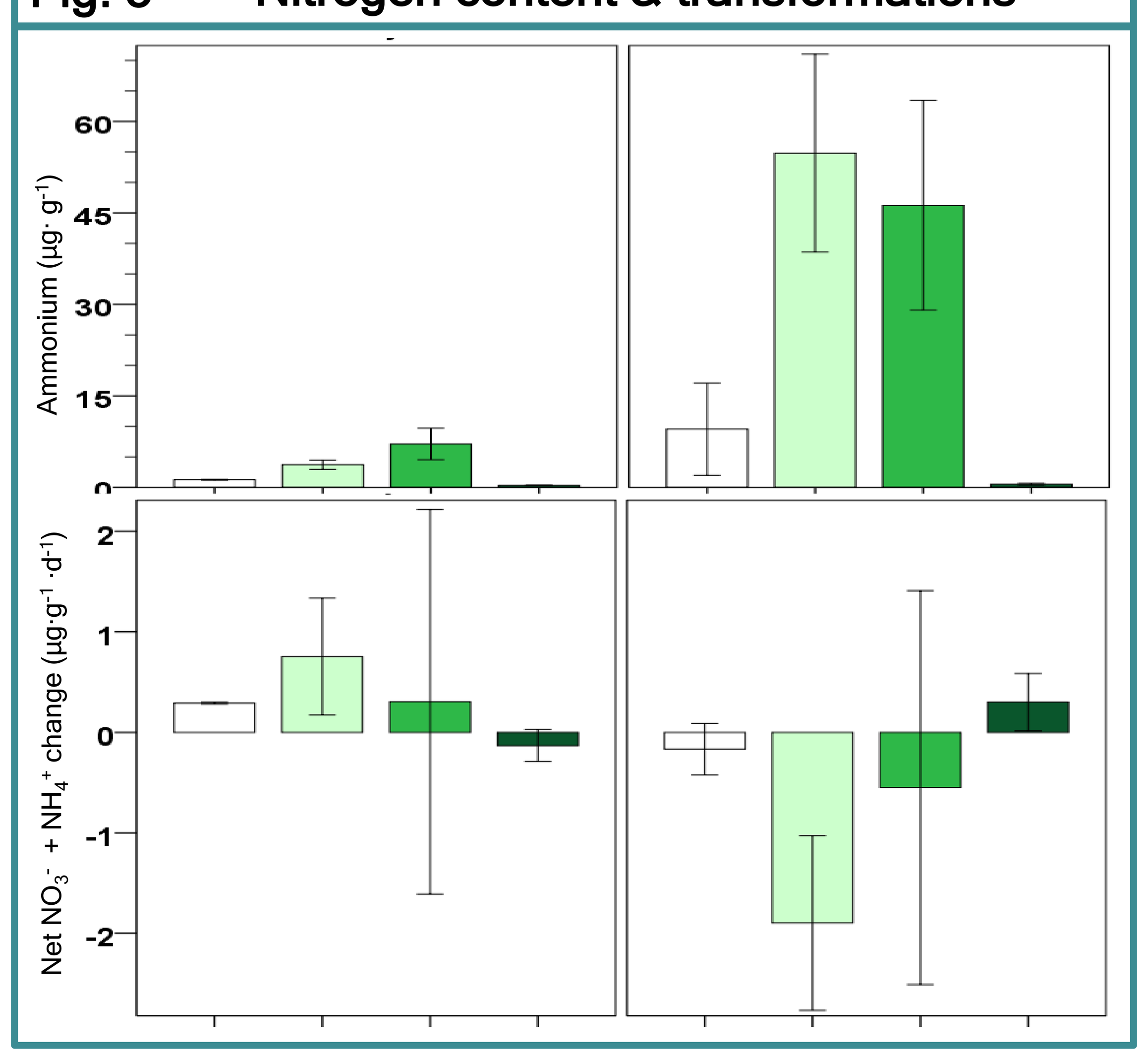


Fig. 5 Nitrogen content & transformations



4. Results

- Cryptostigmata and Mesostigmata totals differed significantly between land-use types in both dry ($p<0.01$ and <0.01, respectively) and monsoon seasons ($p<0.01$ and $=0.037$, respectively), while Prostigmata totals differed in the monsoon season ($p<0.01$; **Fig. 3**).

-Soil moisture and soil organic matter significantly differed between land-use types ($p<0.01$ and <0.01, respectively; **Fig. 4**).

- Soil microarthropods increase with soil moisture content for both dry ($r^2 = 0.19$) and monsoon ($r^2 = 0.28$) seasons.

- N dynamics were affected by land-use, N fertilization and season, but varied greatly in xeric yards. Nitrification (not shown) and mineralization (**Fig. 5**) differed in native and native+N. Monsoon elevated ammonium.

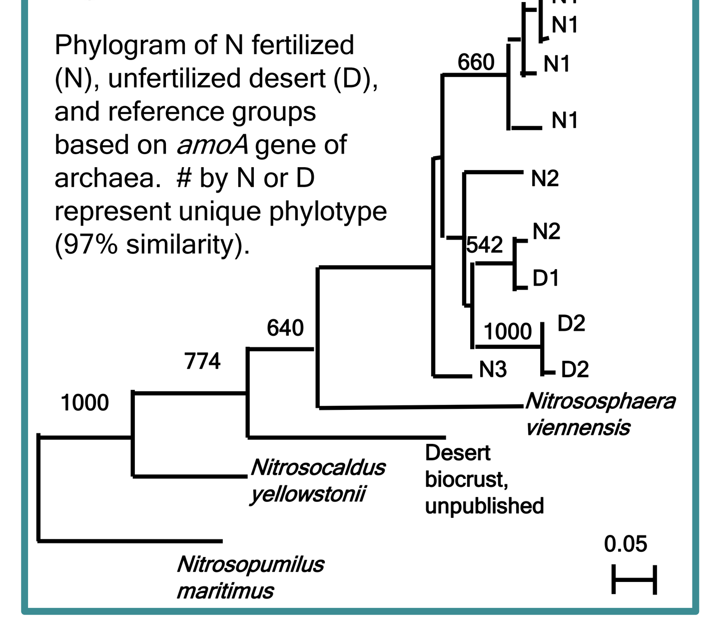
- Preliminary molecular data show that native and native+N desert sites harbor diverse archaeal ammonia oxidizers (**Fig. 6**).

5. Conclusions

- Our preliminary analyses indicate that mesic lawns support different microarthropod communities, including increased abundances of fungal feeding mites (Cryptostigmata and Mesostigmata) and a mostly predatory sub-order (Prostigmata).

- Trophic levels and N cycling rates may increase with soil moisture[4].

Fig. 6



- Xeric desert systems might be entirely dependent on microbes for physical degradation and decomposition of litter inputs due to the absence of higher trophic levels.

- Soils with altered carbon, N, and moisture inputs (due to land-use change) affect activities of heterotrophic and autotrophic microbes.

6. Next steps

- Finish measurements **(Table 1)** to continue developing our understanding of the interactions between soil properties, soil food webs, microorganisms, and N cycling **(Fig. 1)**.

- Use biocide inhibitors of specific microbial groups to explore multi-trophic food web interactions and functional contributions.

References
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