Understanding trophic dynamics in urban and desert ecosystems using arthropod communities on brittlebush (*Encelia farinosa*)

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Abstract

Do trophic dynamics differ in urban vs. 'natural' systems? Is trophic structure controlled by 'top-down' (natural enemies) or 'bottom-up' (limiting nutrients) forces in these systems? To address these questions, we established long-term arthropod monitoring experiments on brittlebush (*Encelia farinosa*) at two permanent urban CAP-LTER study sites (President's House and Desert Botanical Gardens) and one desert preserve (Usery Mountain Park). Brittlebush was selected because it is a common native desert perennial often used in urban landscaping. Experimental treatments include: bird exclosures (cages), ground predator exclosures (rings), and supplemental watering. We sample the arthropod community and plant damage once per month, apply a water treatment every two weeks, and measure plant volume and biomass accumulation four times per year. Arthropods are identified to family and feeding-guild. Family richness is similar across all sites, but abundances are much higher at the urban sites. While approximately half of the families found are herbivorous, most individuals (<90%) are herbivorous. Predator and parasite family diversity is also high (>40%), but their abundance is low (<10%). Bird exclosures appear to create enemy-free space at the urban sites, as herbivores are more abundant on plants with cages, and predators are more abundant on plants without cages. At the desert site, however, cages did not have appreciable effects, suggesting that birds are important top predators in urban but not desert areas. The ring treatment caused a decrease in the abundance of arthropods at Desert Botanical Gardens, but an increase at President's House and Usery Preserve. This suggests that ground predators have facilitative effects on arthropod communities in the urban desert remnant and detrimental effects elsewhere. At the urban sites, supplemental water decreased arthropod abundance, while at the desert site, water increased arthropod abundance. This suggests that water exerts stronger bottom-up forces in desert vs. urban areas. Although these results are preliminary, they indicate that both habitat type and trophic dynamics have strong effects on arthropod communities living on brittlebush on the Phoenix area.

3 sites

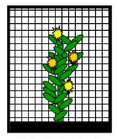
President's House (urban mesic residential)

Desert Botanical Gardens (urban desert remnant)

Usery Mountain Preserve ('natural' edge desert)

x

3 treatments
(8 combinations)



CAGE
(bird exclosure)

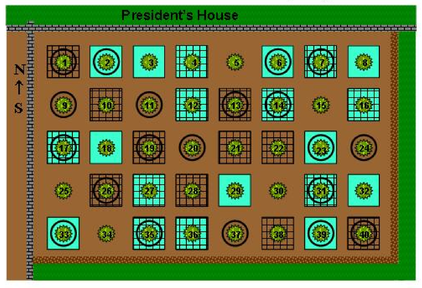
RING
(ground predator exclosure)

WATER
(5 liters--biweekly)

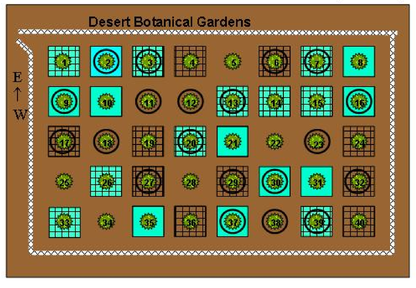
x

5 replicates

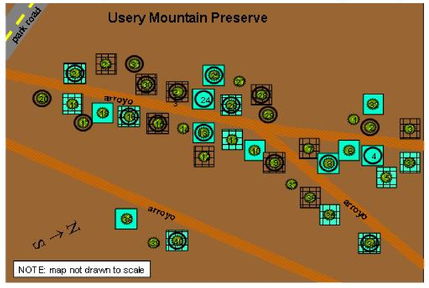
President's House (PH)



Desert Botanical Gardens (DBG)



Usery Mountain Preserve (UMP)



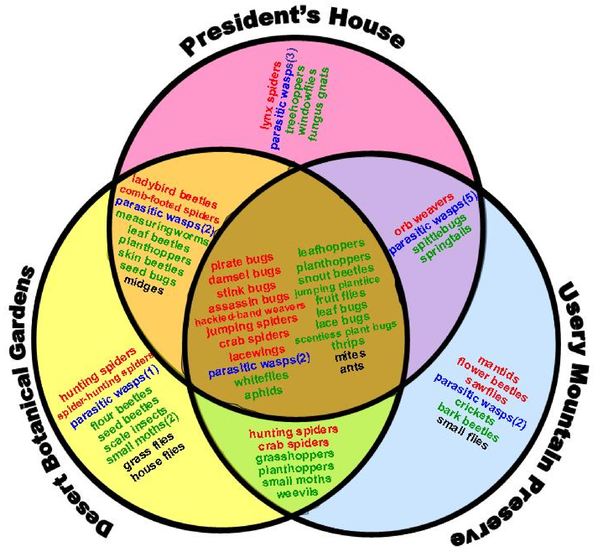


Figure 1. Arthropod families found at each site. Predators indicated in red, herbivores indicated in green, parasites indicated in blue, and omnivores indicated in black.

Results

72 arthropod families (PH = 48, DBG = 49, UMP = 45)
13,905 individuals (PH = 6268, DBG = 7052, UMP = 585)
23 families found at all three sites, 25 families found at only one site

Families: 44.4% herbivores, 20.8% predators, 26.4% parasites, 8.3% omnivores
Individuals: 91.8% herbivores, 6.6% predators, 1.0% parasites, 0.6% omnivores

Most: families in May and individuals in May
Least: families in January and individuals in August

Cages ↑: # individuals (DBG), #herbivores (DBG), # parasites (DBG, $p<0.05$)
Cages ↓: #predators (PH and DBG)

Rings ↑: # herbivores (PH), # parasites (UMP, $p<0.05$)
Rings ↓: # families (DBG, $p<0.05$), # web spiders (DBG, $p<0.01$)

Water ↑: # families (UMP, $p<0.001$), # predators (UMP), # omnivores (DBG)
Water ↓: # herbivores (PH and DBG) # individuals (DBG)

Significant effects of **site**, **month**, and **site*month** for all dependent variables.
Data analyzed using a full-factorial ANOVA ($p<0.1$ unless otherwise indicated).

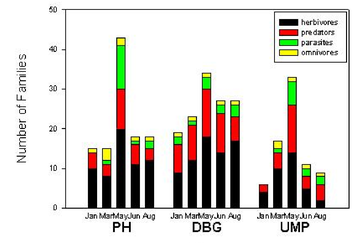


Figure 2. Number of arthropod families found at each site during five sampling periods. Families classified as predators, herbivores, parasites, and omnivores.

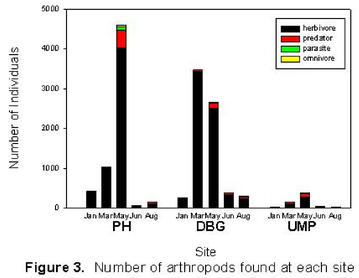


Figure 3. Number of arthropods found at each site during five sampling periods. Individuals classified as predators, herbivores, parasites, and omnivores.

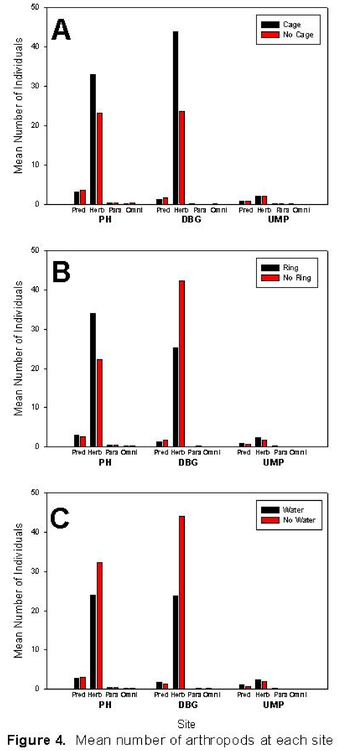


Figure 4. Mean number of arthropods at each site across all five sampling periods as a function of experimental treatment. **A.** Cage. **B.** Ring. **C.** Water. Arthropods classified as predators, herbivores, parasites, and omnivores.

Conclusions

- The richness and abundance of arthropods varies by site and month
- All sites are dominated by herbivores
- Predator and parasite diversity is high, but their abundances are low
- Birds exert top-down pressures in urban areas
- Ground predators exert top-down pressures urban mesic and 'natural' desert areas, and may have facilitative effects in urban desert remnants
- Water exerts bottom-up forces in 'natural' desert areas

Predators

jumping spider

lacewing

crab spider

ladybird beetle

Parasites

Herbivores

aphid

fruit fly

leafhopper

Omnivores

midge

ant

Encelia farinosa

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