Long-term trends in insect populations across multiple Phoenix land types

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Overview

In the Kingdom of animalia, over 1.5 million species have been described. Among these, the phylum Arthropoda alone represents over 1.2 million species, or about 80% of the total. The most successful group, the Insecta (with ~1 million species), accounts for about 66% of all animals.[1]

Insects are a key ecological community. Their presence in human environments is crucial for plants, as pollinators, as decomposers of organic matter and as the base of environmental food webs. Unfortunately, both the continued urban sprawl of the Phoenix metropolitan area and the effects of climate change have put a large stressor on the insect community population in and surrounding the city. Their decline in numbers affects not only the health of their surrounding environment but other ecological communities.

For over two decades, CAP LTER scientists have been collecting ground-based arthropods (ie; insects, spiders, mites and collembola) via pitfall trapping in a variety of habitats inside and outside the Phoenix metropolitan area. This research will focus on how insect communities specifically have fared in desert, mesic and xeric habitats around the region. These data can be used to show long-term ecological trends in insect populations as an overall community, and also to pinpoint which communities have been most affected by sprawl and climate change. The trends in the data show that insect populations have had a rapid decline both inside the Phoenix area, as well as in the surrounding, outlying desert.

Methods

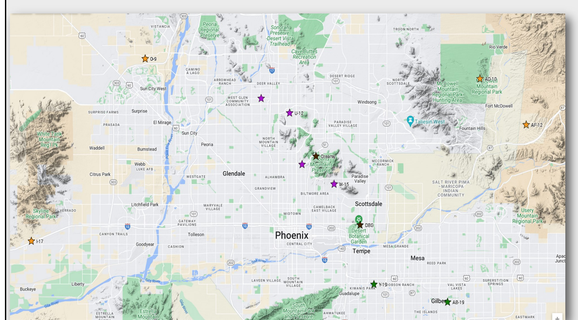

Fig. 1 - map of the CAP LTER desert sites and transect through the greater Phoenix area

Since 1998, CAP LTER has been collecting, identifying and cataloging ground-based arthropods from a wide variety of land types across the Phoenix area. Though some of these sites have changed throughout the decades — for example, loss of agricultural and desert land due to development — CAP LTER still maintains a diverse collection of sites in the outlying Phoenix desert, as well as a transect of sites running through the more populated Valley.

The method of collection for these specimens is through pitfall trap. Ten pre-dug pitfalls are located at four desert sites (arid land, sparse vegetation), two mesic sites (moderate moisture), four xeric sites (little moisture) and two desert remnant sites (desert sites within the city limits), with a recent addition of eight sites in the McDowell Mountain Preserve. These traps are opened quarterly for three days, after which time, the arthropods that have fallen into them are collected, identified and preserved in the CAP LTER insect lab in vials containing 70% ethanol.

Data

CAP LTER Arthropod Holdings

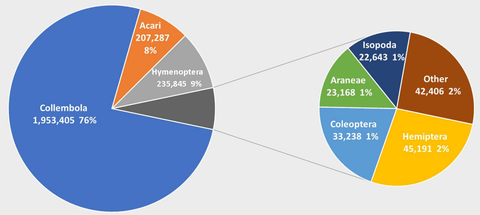

Fig. 2 - CAP LTER has amassed a total of 5,126,366 specimens through the 2019 collection season. The pie charts above illustrate the breakdown of these holdings by taxonomic grouping.

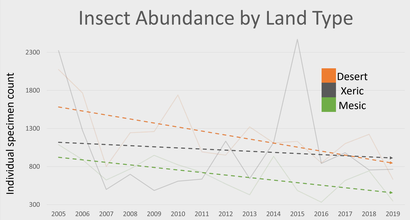

Fig. 3 - This chart depicts all insects collected since 2005, separated by land type. The trend lines illustrate a steep decrease in insect abundance in both desert and mesic sites, while xeric sites have seen a slight shift downward.

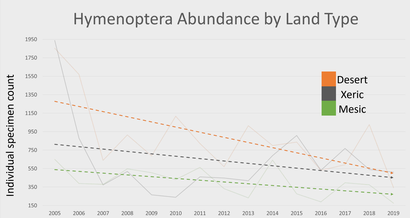

Fig. 4 - This chart depicts all Hymenoptera collected since 2005, separated by land type. The trend lines illustrate a decrease in abundance across all land types.

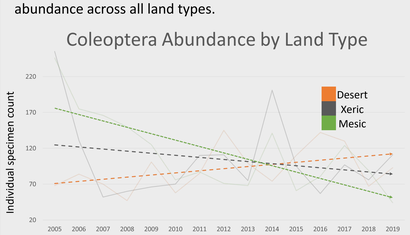

Fig. 5 - This chart depicts all Coleoptera collected since 2005, separated by land type. The trend lines illustrate a decrease in insect abundance in both xeric and mesic sites, while the desert sites have seen an increase in abundance.

Discussion

Worldwide insect population decline has been well documented in scientific literature, with studies citing an unprecedented rate of decline of up to 2% per year. This decline has been shown to be driven by several factors, including habitat loss, degradation, and fragmentation; use of polluting and harmful substances; the spread of invasive species; and global climate change. All of this puts insect populations at great risk. Furthermore, insect population decline affects more than just the insect community itself; without insects acting as pollinators, decomposers and as the base of a complex environmental food web, a host of other species and ecosystems stand to be adversely affected.[2]

Looking at the trends from the data collected by CAP LTER, it appears that the greater Phoenix area is no exception to this global trend as year after year, from 1998 through 2019, the insect population has decreased in abundance across all land types analyzed: desert, mesic and xeric.

Future Research

This data will be invaluable going forward for the purpose of studying the root cause of insect population decline by allowing for cross-comparison of other CAP projects. By utilizing multiple CAP LTER datasets, connections can be made between drought levels as well as plant abundance (as it varies between desert, mesic and xeric habitats) and the population size of associated insect communities. In addition, connections can be made between the decline in insect population and other ecosystems' abundance (ie; using CAP LTER's bird census to make connections with insectivorous bird populations).

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References:

1. Zhang (2011). Animal Biodiversity: An introduction to higher-level classification and taxonomic richness. *Zootaxa*, *3148*(1), 7. https://doi.org/10.11646/zootaxa.3148.1.3

2. Cardoso, P., Barton, P. S., Birkhofer, K., Chichorro, F., Deacon, C., Fartmann, T., Fukushima, C. S., Gaigher, R., Habel, J. C., Hallmann, C. A., Hill, M. J., Hochkirch, A., Kwak, M. L., Mammola, S., Ari Noriega, J., Orfinger, A. B., Pedraza, F., Pryke, J. S., Roque, F. O., … Samways, M. J. (2020). Scientists' warning to humanity on insect extinctions. *Biological Conservation*, *242*, 108426. https://doi.org/10.1016/j.biocon.2020.108426