VARIATION IN BLOOD PARASITES, INSECT VECTORS, AND HEMATOLOGY ASSOCIATED WITH THE RECENT COLONIZATION OF A CITY

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Rural study sites. Left to right: Riparian habitat along the Gila River (Robbin's Butte); Sonoran desert (Sierra Estrella); Hell's Canyon. All sites < 40 km of Phoenix.

Introduction

Urbanization can negatively impact wildlife, yet some species survive and prosper in urban habitats. Successful colonization of these habitats by wildlife may result from attenuated predation risk ("enemy-release hypothesis"). Although widely tested, this hypothesis has not been extended to include host-parasite interactions. We compared blood parasite prevalence and the abundance of potential parasite-transmitting vectors across an urban-rural landscape for five passerine species that vary in their tolerance to urbanization. We also examined differences in leukocyte profiles to determine the potential impact of urbanization on the ability to combat parasitic infection.

Predictions

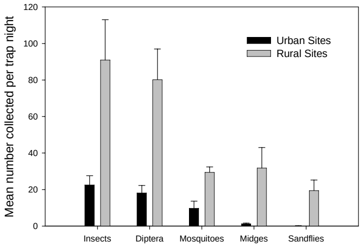
Urban-tolerant species exhibit decreased hemoparasitism due to decreased presence of insect vectors. As a result, these species have fewer phagocytic white blood cells than species with limited tolerance to urbanization.

(*Left*) Aerial view and (*right*) satellite image of Phoenix.

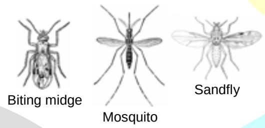
Vectors

Incandescent light traps (*left*) were places at varying heights from the ground in urban and rural settings. Trapping in rural and urban sites were time-matched to avoid temporal differences in insect abundance.

Rural trapping sites (*N* =15) collected more insects, including potential disease-transmitting vectors (order: Diptera), than urban sites (*N* =16). Fewer mosquitoes (*Culicidae*) and biting midges (*Ceratopogonidae*) were collected at urban than rural sites. Sandflies (*Psychodidae*) were collected only in rural areas.

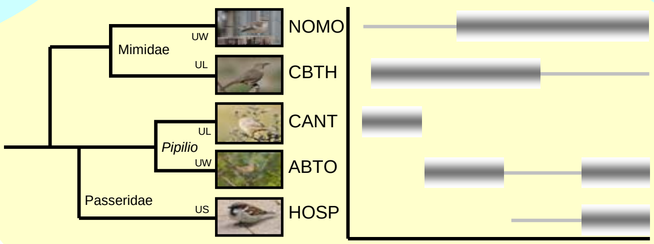


Insect abundance, including three dipteran disease vectors (*below*) across at urban and rural sites. Site comparisons: all < 0.001.



Model System

For common names of species abbreviations, see Table 1



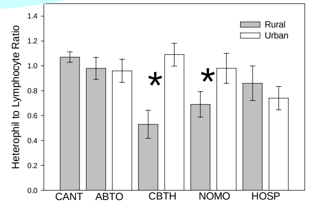
UW = "urban winner"
UL = "urban loser"
US = "urban specialist"

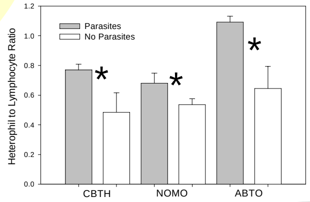
Hematology

Using blood smears we counted 100 leukocytes at 100x magnification. Leukocytes were identified as lymphocytes (*L; above left*), monocytes, eosinophils, heterophils (*H; above right*), and basophils. The ratio *H:L* was used as an indicator of the innate immune response.

Urban CBTHs had more heterophils (t=4.78, P=0.047), and fewer lymphocytes (t=4.26, P=0.038) and eosinophils (t=6.73, P=0.002) than rural conspecifics. Urban NOMOs had more eosinophils (t=4.18, P=0.004) and less lymphocytes (t=3.3, P=0.01) than rural counterparts. Rural HOSP had more eosinophils (t=2.2, P=0.039) than urban ones.

(*Right*) Differences in *H:L* ratio for 5 bird species across an urban-rural gradient and (*below*) between those with and without blood parasites. * sig. at P <0.05





Blood Parasites

Smears were prepared and Giemsa-stained using blood collected from the jugular vein of adult males. Smears were studied for parasites at 100x magnification for 10 min and then 5 min at 400x magnification, without knowledge of species, collection date, or locality.

Smears contained 3 parasite types: *Trypanosoma* (*left*), microfilariae (*middle*), and *Haemoproteus* (*right*). Parasites were not observed in urban ABTOs, but rural ABTOs had microfilariae (X^2=7.96, P=0.005). CANTs had more *Haemoproteus* (X^2=28.19, P<0.001), but not microfilariae (X^2=0.96, P=0.328), than rural ABTOs. Urban, but not rural NOMOs had *Haemoproteus* (X^2=6.24, P=0.012).

Table 1.
Blood parasite prevalence in five passerine species sampled at urban and rural sites.

Species	Habitat	*N*	Parasite Prevalence (% infected birds) *Haemoproteus*	*Microfilariae*	*Trypanosoma*	Overall
Abert's Towhee	Rural	32	0	43.8	0	43.8
(ABTO)	Urban	24	0	0	0	0
Canyon Towhee (CANT)	Rural	15	80	53.3	6.7	100
Northern Mockingbird	Rural	10	0	0	0	0
(NOMO)	Urban	23	21.7	0	0	21.7
Curve-billed Thrasher	Rural	23	30.4	8.7	4.3	39.1
(CBTH)	Urban	22	18.2	9.1	0	22.7
House Sparrow	Rural	17	0	0	0	0
(HOSP)	Urban	29	0	0	0	0

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Summary

Cities influence the distribution of insect vectors resulting in differences in parasite prevalence between urban and rural populations in some species. Thus, some species that thrive in urban areas (e.g., ABTO) may benefit from cities by escaping infection. Combating infections may be more costly for some species as they mount an immune response involving the upregulation of phagocytes. Species-specific variation in immunocompetance may partly explain differences in species' ability to adapt to cities.