Increased territorial responses in urban populations of two Sonoran Desert birds: Hormones or Ecology?

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Introduction

In many species, breeding involves the male defense of territories often to gain access spatially-limited resources. These resources may exhibit a clumped in distribution in the heterogenous landscapes generated by urbanization. If such resources can increase fitness, selection may favor individuals exhibiting increased territorial defensiveness. In a previous study, we noted increased responses to conspecific playback recordings (i.e. simulated territorial intrusions: STIs) in urban compared to desert populations of 2 Sonoran resident birds; the Curve-billed Thrasher and the Abert's Towhee. **In this study we attempt to distinguish between endocrine and ecological explanations for such urban-rural differences in territorial behavior, and explore how such factors may be interrelated.**

ENDOCRINOLOGY

In male birds, territorial behavior is often regulated by Testosterone (T), and persistent intrusion may elevate plasma T levels. Corticosterone (CORT) may also increase with defense "stress" and act to suppress plasma T. Both T and CORT may "attach" to corticosterone binding globulins (CBG), which can limit their bioavailability. Increased CORT during an STI, and it's greater affinity for CBG, may increase free T without changing total T levels, which in turn may increase aggression.

ECOLOGY

Both T and CORT may also be influenced by population density, where increased density may increase the frequency of territorial intrusions. In Phoenix, AZ, urbanization generally decreases thrasher density, and increases towhee density (Fig 1). However, densities of both species is more locally variable within Phoenix than in surrounding desert. This variation may stem from local differences in habitat, such as the amount of vegetation providing protection from predators and potential nest-sites.

Specific Questions

1) **Are urban birds are more aggressive than rural conspecifics?**
2) **Is aggressiveness related to total or free plasma T or CORT concentrations?**
3) **Does either T or CORT increase with duration of exposure to STIs?**
4) **Is aggression is related to local differences in population density?**

Methods

BIRD BEHAVIOR AND SAMPLING

We performed STIs on thrashers and towhees in urban and rural settings (described in Fig 1), using conspecific songs compiled from multiple local individuals. Upon locating a bird, the song was played at a constant volume from a speaker located beside a mist net, with the observer located about 80m away. The observer then recorded the occurrence of several stereotypical behaviors exhibited by these species in response to playback, which were reduced to principal component scores used for subsequent analysis (Table 1).

CORT, T, AND CBG ASSAYS

Blood was drawn from the right jugular vein within 3 mins (baseline) post-capture and plasma separated via centrifugation. Total CORT and T were determined from commercial competitive enzyme-linked immunoassay kits (Assay Designs Inc.). CBG was determined via a radioligand (^{3}H-CORT) binding assay using steroid-stripped plasma, where ^{3}H-CORT-bound protein was separated using rapid vacuum filtration through glass fiber filters. Sample soaked filters were counted in a liquid scintillation β-counter. Using previously estimated CBG parameters we determined the amount of free ("unbound") CORT and T using the equation of **Barsano and Baumann (1989).**

POPULATION DENSITY

To obtain density estimates, we conducted east-west 800m transect counts of all thrashers and towhees seen using the point of capture as the middle of the transect. As we only wanted to count our respective species, we used playback recordings (every 50m) to locate the birds.

Barsano CP, & Baumann G, 1989. *Endocrinology* 124: 1101-1106.

Fig 1. Study Locations and Figures Legend

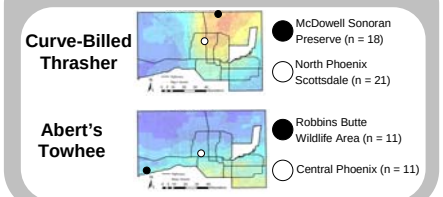

Table 1. Principal Component loadings (PC1) and % variance explained for behaviors in two Sonoran birds

Measured Behaviors	Abert's Towhee		Curve-billed Thrasher	
Air approaches	**0.775**	*	**0.857**	*
Bill wipes	-0.358		-0.329	
Calls	**0.595**	*	**0.571**	*
Feeding	0.012		-0.342	
Fly-bys and fly overs	**0.718**	*	**0.776**	*
Ground approaches	**0.662**	*	**0.807**	*
Songs	**-0.345**	*	**-0.576**	*
Squeal duets	-0.027		----	
Tail fan	-0.082		0.100	
Wing-flashes	0.172		----	
% Cumulative Variance Explained	**48.1**		**60.9**	

Curve-Billed Thrasher

Do urban Thrashers show an increased response to STIs?

YES. Urban Thrashers have a higher PC1 score (i.e. more responsive to playback than rural birds.

$F_{1,38} = 8.51, p = 0.007$

Is Responsiveness related to Testosterone or Corticosterone?

Total Hormone | Free Hormone

NO. Free and total CORT are higher in urban birds, but not associated with responsiveness.

NO. Both free and total T are not associated with responsiveness.

Does Territorial Intrusion increase Testosterone or Corticosterone?

Total Hormone | Free Hormone

NO. Neither free or total CORT increases with duration of simulated intrusion.

NO. Neither free or total T increases with duration of simulated intrusion.

Is Responsiveness related to Population Density?

NO. Aggression is not associated with local bird density.

Abert's Towhee

Do urban Towhees show an increased response to STIs?

YES. Urban Towhees have a higher PC1 score (i.e.more responsive to playback than rural birds.

$F_{1,21} = 13.18, p = 0.003$

Is Responsiveness related to Testosterone or Corticosterone?

Total Hormone | Free Hormone

NO. Both free and total CORT are not associated with responsiveness.

YES. In rural, but not urban towhees, free and total T is negatively associated with responsiveness.

Rural

Total: $F = 1.31, p = 0.22$

Free: $F = 0.65, p = 0.43$

Does Territorial Intrusion increase Testosterone or Corticosterone?

Total Hormone | Free Hormone

NO. Neither free or total CORT increases with duration of simulated intrusion.

NO. Neither free or total T increases with duration of simulated intrusion.

Is Responsiveness related to Population Density?

YES. In urban, but not rural birds, decreased density is associated with increased aggression

$F_{3,12} = 7.79, p = 0.020$

Discussion

- Urban towhees and thrashers are more responsive to STIs than rural birds, but these behaviors do not appear to be mediated by either plasma T or CORT in either species.
- Duration of the STI did not elevate either hormone, contrary to findings of similar studies (……..)
- Regulation of territorial aggression in these birds may involve other endocrine or neural mechanisms, including; arginine vasotocin, dihydroepiandrosterone, or the sympathetic nervous system.
- Increase territoriality in low density areas by urban towhees may suggest these sites are favored as foraging or nesting sites.