General and Comparative Endocrinology 186 (2013) 136–144

Contents lists available at SciVerse ScienceDirect

General and Comparative Endocrinology

journal homepage: www.elsevier.com/locate/ygcen

Habitat type influences endocrine stress response in the degu (*Octodon degus*)

Carolyn M. Bauer[a,*], Nicholas K. Skaff[a,1], Andrew B. Bernard[b], Jessica M. Trevino[c], Jacqueline M. Ho[d,2], L. Michael Romero[a], Luis A. Ebensperger[e], Loren D. Hayes[f]

[a] *Department of Biology, Tufts University, Medford, MA, USA*
[b] *Department of Biology, Bates College, Lewiston, ME, USA*
[c] *Department of Biological Sciences, University of North Texas, Denton, TX, USA*
[d] *Department of Biology, Indiana University, Bloomington, IN, USA*
[e] *Departamento de Ecología, Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile, Santiago, Chile*
[f] *Department of Biological and Environmental Sciences, University of Tennessee at Chattanooga, TN, USA*

ARTICLE INFO

Article history:
Received 5 October 2012
Revised 21 February 2013
Accepted 23 February 2013
Available online 18 March 2013

Keywords:
Baseline CORT
Cortisol
Cover
Ectoparasite
Negative feedback
Stress-induced CORT

ABSTRACT

While many studies have examined whether the stress response differs between habitats, few studies have examined this within a single population. This study tested whether habitat differences, both within-populations and between-populations, relate to differences in the endocrine stress response in wild, free-living degus (*Octodon degus*). Baseline cortisol (CORT), stress-induced CORT, and negative feedback efficacy were measured in male and female degus from two sites and three habitats within one site during the mating/early gestation period. Higher quality cover and lower ectoparasite loads were associated with lower baseline CORT concentrations. In contrast, higher stress-induced CORT but stronger negative feedback efficacy were associated with areas containing higher quality forage. Stress-induced CORT and body mass were positively correlated in female but not male degus across all habitats. Female degus had significantly higher stress-induced CORT levels compared to males. Baseline CORT was not correlated with temperature at time of capture and only weakly correlated with rainfall. Results suggest that degus in habitats with good cover quality, low ectoparasite loads, and increased food availability have decreased endocrine stress responses.

© 2013 Elsevier Inc. All rights reserved.

1. Introduction

The stress response is linked with an animal's ability to survive and cope in its environment. Activation of the endocrine stress response results in increased levels of circulating glucocorticoids, such as corticosterone and cortisol (CORT). CORT has many different physiological effects including increased glucose mobilization, increased cardiovascular tone, and inhibition of physiological processes that are not necessary for immediate survival, such as immune and reproductive functions (Sapolsky et al., 2000). While increased CORT secretion is beneficial in the short-term, exposure to high levels of CORT over long periods is thought to be detrimental (McEwen, 1998; Sapolsky et al., 2000). Field studies often measure concentrations of plasma CORT or fecal glucocorticoid metabolites to assess the relative health of animal populations (Cockrem, 2005; Creel et al., 1997; Mason, 1998; Wasser et al., 1997). While CORT levels may be good indicators of an animal's health, the stress response also reflects the interaction between an animal's physiology and environment (Romero et al., 2009). Animals may modulate their endocrine stress response to better cope with their specific environment, and more research is needed to determine how the stress response varies with environmental factors.

Many studies have examined the effects of habitat on the endocrine stress response. Researchers have studied this interaction by comparing CORT concentrations of species sampled from geographically distinct populations (Lindstrom et al., 2005; Mateo, 2006; Mueller et al., 2007; Romero et al., 2006; Silverin et al., 1997) or along altitudinal clines (Addis et al., 2011; Bears et al., 2003; Busch et al., 2011; Hik et al., 2001; Sheriff et al., 2012). There has been recent interest in the effect of human-induced habitat changes on the endocrine stress response, and investigators have focused on how habitat fragmentation (Rangel-Negrin et al., 2009), urban environments (Fokidis et al., 2011; French et al., 2008; Zhang et al., 2011), and other anthropogenic effects (Homan et al., 2003; Hopkins and DuRant, 2011) influence CORT levels in wild, free-living animals. Since most studies examining the relationship between habitat type and the endocrine stress response have used populations that are geographically distinct, differences

* Corresponding author. Fax: +1 617 627 3805.
E-mail address: Carolyn.Bauer@tufts.edu (C.M. Bauer).
[1] Present address: Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI, USA.
[2] Present address: VA Puget Sound Health Care Center and Department of Medicine, University of Washington, Seattle, WA, USA.

0016-6480/$ - see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.ygcen.2013.02.036

in CORT between habitats could be attributed to genetic differences. The hypothesis that habitat type affects the stress response within a single population, reflecting phenotypic plasticity, has been relatively less examined.

Habitat type has been reported to influence the stress response in a number of ways. Low food availability can cause increased baseline and stress-induced CORT in wild birds (Buck et al., 2007; Clinchy et al., 2004; Kitaysky et al., 1999). Food availability is linked to body mass or condition, and several studies have found body mass to be negatively correlated with baseline and stress-induced CORT (Cabezas et al., 2007; Clinchy et al., 2004; Fokidis et al., 2011; Kitaysky et al., 2007; Nunes et al., 2002; Schoech et al., 2007). Studies have shown that predator density can be positively correlated with CORT concentrations (Boonstra and Singleton, 1993; Clinchy et al., 2004; Rogovin et al., 2006; Scheuerlein et al., 2001). Within single populations, where predator density should not significantly vary, the amount and availability of suitable cover may better correlate with differences in the stress response between habitat types. Dense, overhead cover may prevent detection by aerial predators, but lateral cover that obstructs sightlines may make animals more at risk to terrestrial predators (Ebensperger and Hurtado, 2005). The lack of adequate and appropriate cover would be predicted to increase required vigilance (Vasquez et al., 2002), which could lead to decreased foraging efficiency or an increase in the number of foraging bouts. However, the cost of increased vigilance could be buffered by the fact that degus may forage socially and will respond to con-specific alarm calls (Ebensperger et al., 2006; Vasquez, 1997). Regardless, cover quality could increase the animal's allostatic load (McEwen and Wingfield, 2003) by affecting predator detection. An animal's allostatic load could also be affected by ectoparasites, which inflict metabolic and immune costs (Lehmann, 1993; Nilsson, 2003) or by poor weather conditions that could decrease food availability. An increased allostatic load could in turn result in an augmented stress response (McEwen and Wingfield, 2003; Romero et al., 2009).

Degus (*Octodon degus*) are social, semi-fossorial rodents that occupy a variety of habitats. We used degus to test whether local habitat type affects the endocrine stress response by measuring baseline CORT, stress-induced CORT, and negative feedback. We examined degus of both sexes at two sites, with one site comprising three habitats abutting each other and presumably within the dispersal distance of the population. We predicted that the stress response would vary more between sites rather than within sites, partly because of local climate but also because of genetic differences between populations (Predictions summarized in Table 1). At each habitat, we quantitatively measured cover availability and degu ectoparasite load, and qualitatively measured food availability. We predicted that degus from habitats with high cover availability and low ectoparasite loads would have lower allostatic load, resulting in decreased baseline and stress-induced CORT. We are unaware of previous studies examining the impact of cover availability or ectoparasite loads on negative feedback, but we predicted a response paralleling baseline and stress-induced CORT. We also predicted that degus from habitats with high food availability would have decreased baseline CORT, decreased stress-induced CORT, and increased negative feedback. Several studies have found significant relationships between CORT and body mass (Cabezas et al., 2007; Fokidis et al., 2011; Heath and Dufty, 1998; Schoech et al., 2007) so we also examined whether body mass correlated with baseline CORT, stress-induced CORT, and negative feedback efficacy. We predicted that body mass would be negatively correlated with baseline CORT but positively correlated with stress-induced CORT and negative feedback efficacy. We also investigated the relationship between baseline CORT with temperature and rainfall, since weather has been shown to affect baseline CORT (Astheimer et al., 1992; Romero et al., 2000). We predicted that degus sampled immediately after a precipitation event would have decreased baseline CORT since precipitation and food availability are positively correlated.

Table 1
Upper panel summarizes predictions of stress response variation between and within populations. Middle panel shows predicted, relative levels of CORT concentrations and negative feedback for each habitat variable. The lower panel displays predicted trend directions of body mass and rainfall with baseline (BL) CORT, stress-induced (SI) CORT, and negative feedback.

Comparison	Variation in stress response		
Between populations	High		
Within populations	Low		
Variable	**BL CORT**	**SI CORT**	**Neg. feedback**
High cover availability	Low	Low	Strong
Low ectoparasite load	Low	Low	Strong
High food availability	Low	Low	Strong
Body mass	Negative	Positive	Positive
Time since rainfall	Positive		

2. Methods

2.1. Study animal and habitats

We studied degus (*Octodon degus*) because they occupy a variety of habitats, they are diurnal, and their main stress hormone, cortisol, has been successfully measured in wild populations (Kenagy et al., 1999). This study examined degus in two populations, with one of those populations using three different habitats. One population was located near Santiago, Chile at Estación Experimental Rinconada de Maipú (33°23′S, 70°31′W, altitude 495 m), hereafter referred to as Rinconada, a field station managed by the Universidad de Chile. Rinconada is characterized by a sparse, relatively open matorral habitat. Similar to the chaparral of Southern California, the matorral is typified by large, grassy areas with occasional shrubs and acacia trees (*Acacia cavens*). Within Rinconada, we trapped degus at three habitats within close proximity of each other: (1) the "Field" habitat, which was a sparsely vegetated valley bottom (tree cover <10%), (2) the "Boulder" habitat, which was a gently sloping hillside littered with large rocks of varying size, and (3) the "Tree" habitat, a flat, grassy area with many acacia trees (tree cover >50%). Dispersal is not sex biased and male and female degus settle within 30–40 m on average from their burrows of origin (Quirici et al., 2011a). Maximum dispersal distances reach up to 200 m within 2 months (Quirici et al., 2011b). The second population was located at Parque Nacional Fray Jorge (30°38′S, 71°40′W, altitude 200 m), hereafter referred to as Fray Jorge, a semi-arid, cactus-dominated site approximately 350 km northwest of Rinconada. Average annual rainfall is 133 mm at Fray Jorge (Gutierrez et al., 2010) and 236 mm at Rinconada. Because reproductive state can affect the degu stress response (Kenagy et al., 1999), we trapped degus during the early stages of gestation in the austral winter from June 23rd–July 2nd (Field), July 5th–7th (Boulder), July 12th–18th (Tree), and July 22nd–30th (Fray Jorge) 2011.

2.2. Trapping, blood sampling, and individual condition measurements

Degus were live trapped with Tomahawk traps (Tomahawk Live Trap Company, Tomahawk, WI, USA) baited with plain, rolled oats. Traps were placed near burrow entrances and along runways. Traps were opened prior to emergence from burrows (approximately one hour after sunrise) and were closed at least three hours before sunset (0845–1500 h). During this time, 3–5 observers

Download English Version:

https://daneshyari.com/en/article/5901487

Download Persian Version:

https://daneshyari.com/article/5901487

Daneshyari.com