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EFFECT OF TEMPERATURE AND RELATIVE HUMIDITY ON THE BEHAVIOR OF CAPYBARAS (*Hydrochoerus hydrochaeris*) IN AN URBAN AREA

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Abstract: The capybara, *Hydrochoerus hydrochaeris* (Rodentia, Caviidae), is a species adapted to diverse environments, including urbanized areas, where its populations can reach high densities. In this study, we searched the behavioral pattern of capybaras in urban areas, and investigated the effect of temperature and relative humidity in its activity pattern. The study was conducted in an urban area of the Aquidauana municipality in the state of Mato Grosso do Sul, Brazil. Observations occurred between June 2014 and March 2015, using the scan sampling method. We found that capybaras spent most of your time in aquatic activities and rest. Temperature was positively correlated with the percentage of individuals engaged in aquatic activities. Relative humidity was negatively correlated with the percentage of individuals at rest and positively correlated with aquatic activities. Capybaras exhibit behavioral thermoregulation, which explains the large amount of time spent on aquatic activities with the increase in temperature and relative humidity.

Keywords: anthropized area; aquatic activity; thermoregulation.

The activity pattern is an important aspect of the natural history of a species and reflects physiological characteristics and ecological interactions (Tobler *et al.* 2009, Norris *et al.* 2010). These information in urban areas are needed both for increasing our basic understanding of the ecology of many tropical organisms and for understanding impacts of human activity on the behavior of them (Blake *et al.* 2012). The behavior and activity pattern of mammals can be influenced by intrinsic factors, such as: sex, age (Fernandez-Duque 2004), reproductive period (Halle & Stenseth 2000), and extrinsic factors, like as lunar phases (Sábato *et al.* 2006), photoperiod (Everts *et al.* 2004), temperature (Ferraz *et al.* 2010), precipitation and relative humidity (Carvalho *et al.* 2011). Temperature, relative humidity, precipitation and solar radiation can have effects on animal behavior, as these factors are directly related to thermoregulation, energy expenditure and animal wellbeing (Takahashi *et al.* 2009).

Thermoregulation is a key feature in the maintenance of homeostasis in mammals. Thermoregulatory capacities are strongly related to energy balance and animals are constantly

seeking to limit the energy costs of normothermia (Terrien *et al.* 2011). In addition to autonomic thermoregulatory responses, endotherms make use of behavioral responses to maintain thermal homeostasis when exposed to cold or hot environments (Cabanac 1979). In this way, knowing the animal's interaction with the environment becomes necessary, since behavior patterns can be determined by a stimulus that triggers a response or a sequence of responses.

In this study, we survey the behavioral pattern of capybaras *Hydrochoerus hydrochaeris* (Linnaeus, 1766) (Rodentia, Caviidae) in an urban area, and investigated the influence of temperature and relative humidity on their activities. The capybaras are the largest rodent of the South America. It is an herbivorous non ruminant species, with semiaquatic habit, inhabiting riparian forests, swamps and flooded fields (Borges & Tomás 2008). The capybaras are common and abundant in urbanized areas, dues its high reproduction rate and the absence of natural predators in these environments (Pereira & Eston 2007).

The data collection was performed in Lagoa Comprida Municipal Natural Park (20°27'44" S, 55°46'26" W, *datum* SAD69), which has a total area of 74.2 ha and semi-lentic wetlands measuring approximately 26.87 ha (Souza & Martins 2010). The park is located in the central portion of the municipality of Aquidauana, in the state of Mato Grosso do Sul, Brazil (Figure 1). The climate is Aw, or Tropical Savanna (Peel *et al.* 2007), with two well defined seasons, one dry and cold (winter) that runs from May to September, and another rainy and hot summer, from October to April. Observations were made in the morning and afternoon periods, from 7:00 to 18:00 h, between June 2014 and March 2015, totaling 10 h. For such, the scan sampling method was employed (Altmann 1974). In scan sampling the behavior of all the individuals in a group of animals are recorded at predetermined time intervals. Groups were observed every ten minutes with the aid of binoculars (10 x 50 mm). Temperature and relative air humidity were measured at each

Figure 1. Map of location of Lagoa Comprida Municipal Natural Park, municipality of Aquidauana, Mato Grosso do Sul state, Brazil.

observation with the aid of a digital temperature and humidity meter (Incoterm®).

Based on their size, the animals were classified with regard to maturity (juveniles and adults) and activity at the moment of observation: (1) aquatic activities – when moving in water (swimming with head above the water or diving [completely immersed]); (2) rest – when the animals were still, lying down, sitting or standing on the ground; (3) feeding – when engaged in foraging; (4) movements on ground – when on land or in the shallow portions of the aquatic environment with their feet on the bottom; and (5) social interactions – positive (playing among individuals of the same group, smelling, licking and feeding pups) or negative (chasing) (Rickli & Reis 2014).

Cluster analysis was performed (UPGMA joining method) to determine similarities in the time spent on each activity between juveniles and adults using the Bray-Curtis similarity index. Spearman's correlation analysis (r_s) with the Bonferroni correction was used to determine correlations between the abiotic factors (temperature and relative humidity) and the percentage of individuals engaged in each activity pattern.

The groups comprised two to seven individuals and were generally composed only of adults, with one or two juveniles per group. A high degree of similarity was found between juveniles and adults regarding the time spent on each activity (Bray-Curtis = 90%). Both age groups spent most of their time engaged in aquatic activities (72.9% - juveniles and 65.8% - adults) or at rest (18.9% and 24.6%, respectively), following by feeding (2.7% - juveniles and 6.5% adults) and social interactions (5.4% - juveniles and 2.5% adults) (Figure 2).

Temperature throughout the study period ranged from 27.1 to 34.8ºC (mean: 30.4 ± 1.94ºC) and relative humidity ranged from 24 to 81% (mean: 31.7 ± 12.1%). Temperature was positively correlated with the percentage of adult individuals engaged in aquatic activities ($r_s = 0.43$, $p = 0.005$). Relative humidity was negatively correlated with the percentage of adult individuals at rest ($r_s = -0.49$, $p = 0.001$) and positively correlated with aquatic activities ($r_s = 0.45$, $p = 0.003$; Table 1). The correlation between temperature and the percentage of adults at rest was marginally significant ($r_s = -0.34$, $p = 0.029$). No correlations were found between the abiotic variables and other activities (Table 1). These analyses were not performed with juveniles due to the insufficient number of individuals in this age group.

The fact that we found individuals engaged in aquatic activities a large portion of the time may

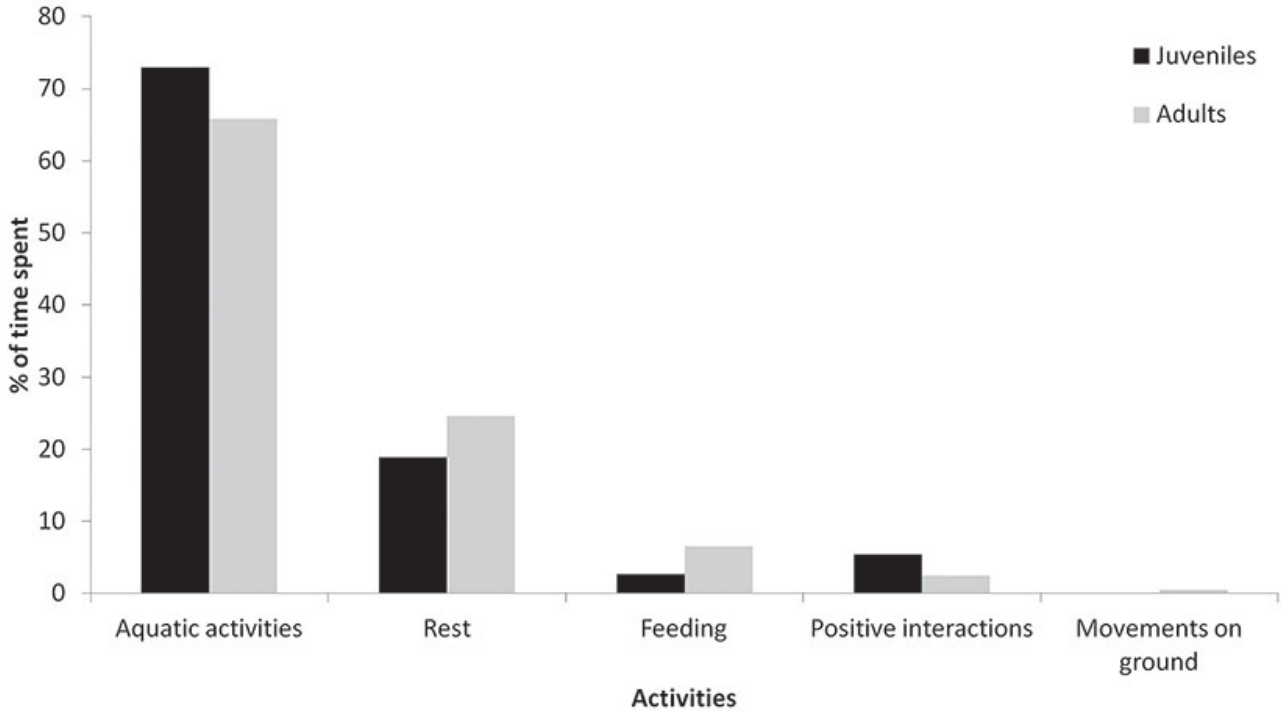

Figure 2. Percentage of time spent engaged in each activity by juvenile and adult capybaras *Hydrochoerus hydrochaeris* (Rodentia, Caviidae) in Lagoa Comprida Municipal Natural Park, municipality of Aquidauana, Mato Grosso do Sul state, Brazil.

Table 1. Spearman's correlations between abiotic variables (*i.e.*, temperature and relative humidity) and percentage of capybaras *Hydrochoerus hydrochaeris* (Rodentia, Caviidae) individuals engaged in each activity pattern in the municipality of Aquidauana, Mato Grosso do Sul state, Brazil. Values in bold indicate significant correlation ($p < 0.025$, consider Bonferroni correction).

Variables/ Activities	Aquatic activities	Rest	Feeding	Movements on ground	Positive interactions
Temperature	**0.43**	-0.34	-0.25	-0.16	0.26
Relative Humidity	**0.45**	**-0.49**	0.1	0.13	-0.189

be due to their dependence on this resource for reproductive activities, escape from predators and thermoregulation (Azcarate 1980, Moreira & MacDonald 1997). The temperature average was high in the city (~30.4ºC), and observations during the hottest part of the day also were included in the analyses. Thus, this intensive aquatic behavior could be due to the need for thermoregulation, since capybaras have sparse, insufficient sweat glands (approximately 10 to 12 per cm^2) to exercise this function (Santos *et al.* 2005), making the animals seek to stay in the water or rest near it during the hottest period of the day. This activity pattern is an ecophysiological adaptation of the capybaras (Ferraz *et al.* 2010).

There are two types of thermoregulatory mechanisms: physiological – when there are physiological organic changes stemming from thermal stress; and behavioral – when animals use behavioral patterns to adjust their temperature (Souza & Batista 2012). The present results indicate the use of behavioral thermoregulation by the groups of capybaras studied. These adjustments contribute to facilitate the management of and heat-induced responses, and mainly rely on body heat exchanges between the organism and the changing environment. Understanding how environmental change influences the behavior of organisms is central for both ecological understanding and species conservation (Norris *et al.* 2010). The results can contribute to the conservation of wildlife and assist in the planning of management measures for the species in urbanized environments.

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