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Influence of temperature on Greater Rhea *Rhea americana* activity in *restinga* habitat, southern Brazil

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RESUMO: Influência da temperatura sobre a atividade de emas *Rhea americana* numa restinga do sul do Brasil. Nós usamos armadilhas fotográficas para estudar a influência da temperatura sobre a atividade de emas ao longo de um ano. Emas apresentaram atividade predominantemente diurna. No entanto, sua atividade decresceu com o aumento da temperatura média do dia nos ambiente de restinga herbácea. Nossos resultados sugerem que em dias quentes, emas podem usar a estratégia comportamental de diminuição da atividade para regulação térmica e hídrica.

PALAVRAS-CHAVE: Atividade circadiana, ratitas, *Rhea americana,* termo-regulação, regulação hídrica.

ABSTRACT: We used camera trapping to study the influence of temperature on Greater Rheas activity for one year. Rheas were predominantly diurnal in activity throughout the day¸ however¸ its activity decreased with increased daily average temperature in herbaceous *restinga.* Our results suggest that on hot days, rheas can use behavioral strategies to diminish their activity to benefit thermal and water balance control.

KEY-WORDS: Daily activity, ratites, *Rhea americana,* thermoregulation, water balance

Thermo-independent animals, such as birds, allocate most of their metabolic energy towards body temperature maintenance. Besides physiological adaptations, birds may maintain their water and thermal balance through habitat selection, or by suppressing their activity during the hottest periods of the day (Shimidt-Nielsen 2005).

The Greater Rhea (*Rhea americana* Linnaeus, 1758) is a large flightless bird that eats mainly leaves and fruits, insects, geckos and frogs (Sick 1997). It is diurnal and inhabits exclusively open fields and savannas in South America (Bruning 1974), hence it is frequently exposed to high temperatures. Panting with the bill slightly open or entering bogs and rivers are behavioral strategies of thermal and water balance regulation used by the Greater Rhea to adapt to high temperatures (Sick 1997). Additionally, because of its foraging habits, walking constantly during the day (Sick 1997), suppression of walking on very hot days could be an additional strategy involved in temperature control and water balance. This study investigated the influence of temperature on Greater Rhea activity in open areas of *restinga* habitat in southern Brazil.

MATERIALS AND METHODS

Study area: The study was carried out in the coastal plains of the Serra do Tabuleiro State Park (27°40”S, 48°49”O), state of Santa Catarina, Brazil. The annual average precipitation is approximately 1600 mm, with February being the rainiest month (average of 211 mm) and June the driest (average of 68 mm). The annual average temperature is 19°C, with January the hottest month (average of 23°C) and July the coldest (average of 15°C) (GAPLAN 1986). The vegetation is formed by a mosaic of *restinga* over sand bars and intermingled with swampy areas, permanent and temporary lagoons (Klein 1981). Three distinct habitats were identified: 1) natural fragments of arboreal *restinga* with canopy at five m and a dense understory; 2) open matrix of herbaceous *restinga* composed of several graminaceous and cyperaceous plants, and some shrubby nuclei of Melastomaceae *(Miconia* and *Tibouchina),* Myrtaceae *(Psidium cattleianum),* Clusiaceae *(Clusia)* and some small trees; and 3) swamps with *Cyperus* dominance, with herbs that reach up to 2 m in height.

Sampling: Between June 2005-June 2006, four digital model camera traps (Tigrinus®) were used to monitor mammals in these three habitats. However, Greater Rheas were frequently recorded. Eleven sampling points were chosen: three in the swamps, four each in the arboreal and herbaceous *restinga.* A minimum distance of 200 m between sampling points was maintained. The minimum convex polygon formed by sampling points covered around 120 ha, an area large enough to record several different individuals (rheas have 1-4 ha home ranges with extensive overlap due their gregarious habits; Bellis *et al.* 2004a, Bellis *et al.* 2004b). The cameras were programmed to print the date and hour of each record, and were prepared to monitor the entire period. The sampling points used for the four camera traps were changed weekly among the eleven chosen points, representing a schedule of random selection. The total sampling effort was 1010 trap-days, with 224 in the arboreal *restinga,* 338 in the swamps and 448 in the herbaceous *restinga.* Uniform sampling effort was maintained among different seasons of the year.

Data analyses: For statistical analysis, only those records with a minimal interval of one hour between photos at each sampling point were considered independent. Each photo received an average temperature value referring to the day of record. The daily values of average temperature were supplied by an Epagri Automatic Meteorological Station located 15 km from the study area. We used linear regression analysis to test the relationship between the rhea activity and daily average temperature. We measured activity as the frequency of records in each class of daily average temperature, with the classes divided into intervals of 1°C. The frequency of records was calculated by dividing the number of photographs in each temperature class by the sampling effort (in trap-days) for each temperature class.

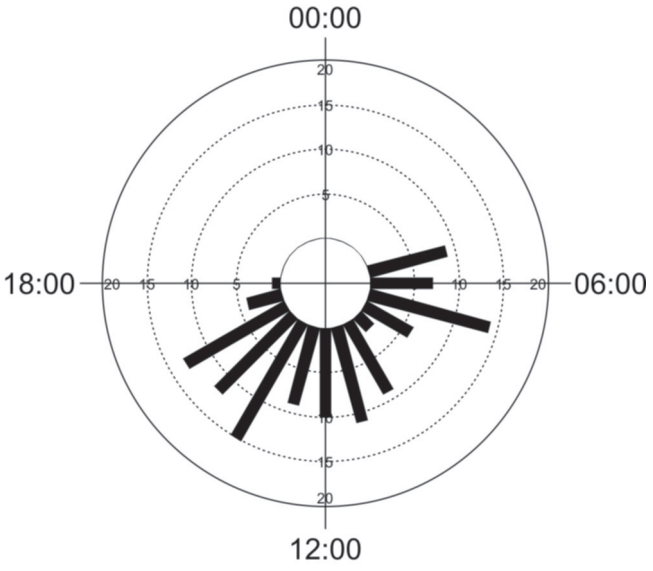

FIGURE 1: Independent record distribution of Greater Rheas during hours of the day, between June 2005-June 2006, in the *restinga* of Serra do Tabuleiro State Park.

RESULTS

We acquired 120 independent records, 118 in the herbaceous *restinga* and two in the arboreal habitat. There were no records in the swamps. Rheas were predominantly diurnal in activity throughout the day (Figure 1). For the statistical analysis we used only the records for herbaceous *restinga* (98% of all records), as the sample size was too limited for arboreal habitat. Rhea activity decreased with increased daily average temperature in herbaceous *restinga* (R^2 = 0,35; n = 13; P = 0,03) (Figure 2).

DISCUSSION

Rheas use open habitats throughout their geographic distribution, whereas forested areas can make walking difficult due to their social habits of living mainly in large groups (Sick 1997). The main anti-predator behavior developed by the species is to run at high speeds with sinuous movements, an impracticable strategy in closed habitats such as forests (Martela *et al.* 1995, Sick 1997, Bellis *et al.* 2004a). Similarly, swamps contain dense vegetation and the flooded soil can be an additional hindrance to locomotion. These factors may explain why 98% of our records occurred in the herbaceous *restinga,* a habitat of intense foraging and use (Oliveira-Santos, pers. obs.) and better visibility to detect and escape from predators (Reboreda and Fernandez 1997, Fernandez *et al.* 2003).

Selection of shadowed habitats during the hottest hours of the day was not a strategy used by rheas, probably due to the factors discussed previously. In spite of

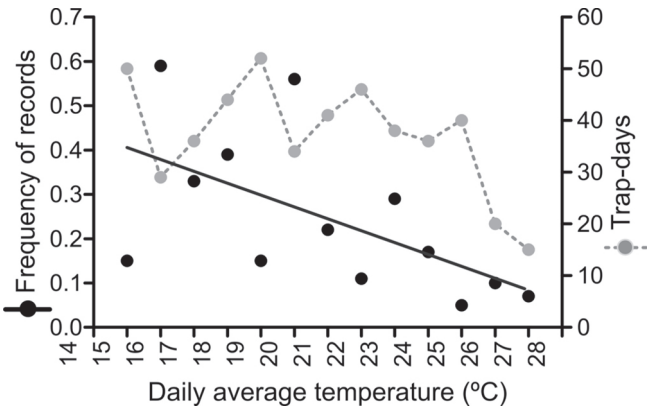

FIGURE 2: Sampling effort in trap-days in each class of daily average temperature, and the relationship between the rhea activity and daily average temperature between June 2005-June 2006, in the herbaceous *restinga* of Serra do Tabuleiro State Park (y = -0.027x + 0.808).

the constant circadian activity noted throughout the day, rheas displayed reduced activity during the warmest days. There is a direct relationship between the activity level and body temperature of the birds (e.g. Morrinson 1962, Langman 1973). Our results suggest that on hot days, rheas can use behavioral strategies to diminish their activity to benefit thermal and water balance control. They can sit upright or lay flat on the ground to protect themselves in the dense herbaceous vegetation, or within shrubs. Rheas also can simply decrease their home range to control energy expenditure for thermal regulation, also avoiding dehydration.

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