

Figure 1. Proportion of time allocated to different activities within four age and sex categories of mantled howler monkeys, *Alouatta palliata*, at Palo Verde National Park, Costa Rica.

2,  $P = 0.82$  and  $X^2 = 2.23$ ,  $df = 2$ ,  $P = 0.53$ , respectively). Juvenile monkeys spent considerably more time moving (50% vs 20-30%;  $X^2 = 7.44$ ,  $df = 3$ ,  $P = 0.059$ ) and less time alert than adults (7% vs 20-30%;  $X^2 = 7.31$ ,  $df = 2$ ,  $P = 0.06$ , respectively).

DISCUSSION

Our observations of *Alouatta palliata* showed very similar activity budgets across the three adult age classes, and a trend for greater movement and less alertness by juveniles. These results were unexpected given that other studies have shown both age- and sex-dependent behavior patterns in several species of monkey. Dominant individuals are generally more vigilant (male *Cebus capucinus*; Rose 1994) and occupy more advantageous foraging positions (female *C. nigrivittatus*; Robinson 1981). If these patterns existed in *A. palliata*, we would expect adult males to have increased alertness and decreased feeding time. Juveniles, who exhibit lower levels of alertness and increased movement, do seem to rely upon adults to

provide protection rather than assuming responsibility themselves.

The hierarchical structure of *A. palliata* may be less pronounced than in other species, but it seems more likely that the dominance hierarchy manifests itself in other areas of behavior such as reproductive competition and foraging advantage. Studies focusing on both patterns of behavior and resource use may better illuminate age and sexual class differences within groups of *Alouatta palliata*.

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DIURNAL CHANGES IN AGONISTIC BEHAVIOR OF *JACANA SPINOSA*

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*Abstract.* We examined the effect of temperature on diurnal changes in agonistic behavior patterns of *Jacana spinosa*, the northern jacana. Agonistic behavior tended to decrease in the afternoon and increase during the early evening. Heat stress during the afternoon may limit high energy agonistic behavior.

INTRODUCTION

The jacana is a tropical shorebird common in seasonally flooded areas of Guanacaste Province, Costa Rica. They are polyandrous, with males and females aggressively defending breeding territories on floating marsh vegetation. The agonistic behavior of jacana includes attacking, fleeing, wing raising, and other energetically expensive aggressive activities (Jenni 1983). Little is known about how agonistic behavior of jacanas varies throughout the day or how it is affected by environmental factors.

We hypothesized that time allocation to agonistic behaviors would change with temperature because of the changing relative costs of agonistic versus other behaviors. During the middle of the day, the jacana may face heat stress that increases the costs of high energy behaviors. If the energetic costs of agonistic behavior increases by relatively more than the energetic costs of sedentary activities like feeding and preening, then jacana may reduce heat stress during the middle of the day by engaging in fewer agonistic attacks and displays.

METHODS

We observed a jacana population of  $\approx 50$  individuals in a 0.7 hectare freshwater marsh located 0.3 km south of the Palo Verde Biological station, Guanacaste, Costa Rica. Hour-long observations were made from an observation tower at 0800, 1300, and 1700 on 9 and 10 January 1996. Sunny air temperature was recorded on 10 January with a digital thermocouple (30.4°C at 0800, 39.1°C at 1300, and 30.7°C at 17:00). We recorded each individual's behavior every five minutes over the course of the hour. Chasing, attacking, fleeing, and wing raising were classified as agonistic behaviors. Feeding, preening, and standing still were classified as sedentary behaviors. We used an ANOVA to test for the effects of time of day on percent of time devoted to agonistic behavior.

RESULTS

Agonistic behavior comprised 6-9% of the jacana time budget. Jacanas spent somewhat more time in agonistic interactions in the evening than in either the mid-day or the morning, though the effect was not significant (Figure 1; Table 1). The jacana were more clumped and more active in the early morning and early evening when temperatures were coolest.

Table 1: ANOVA testing for the effects of sample, day, and time of day on jacana agonistic behavior.

Source	df	MS	F
Day	1	66.7	1.51
Time	2	58.4	1.32
Day X Time	2	6.2	0.14
Error	66	44.3	--

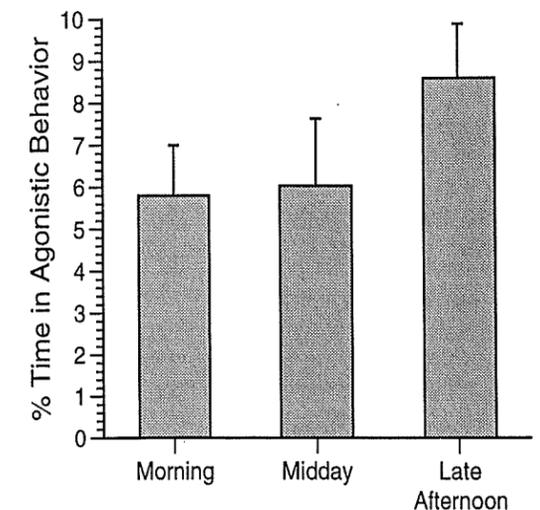


Figure 1. Percent time that northern jacana spend in agonistic behavior during different times of the day at Palo Verde (n = 24 birds per time period).

DISCUSSION

Sample sizes were too small for a powerful statistical test, but there was a tendency for increased agonistic behavior of jacanas in the late afternoon. This could be because the cooler temperatures reduce the relative costs of high energy behaviors such as attacking and wing raising. However, it may also be that jacana behavior is not temperature driven, but is instead driven by diurnal changes in food resource availability. Future studies could identify the relative costs and benefits of different activities at different times of day and examine possible patterns in the availability and use of food resources.

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