Diurnal time-activity budget of adult Greater Rheas (Rhea americana) in a farming environment

Diurnale Zeitaktivitäts-Budgets von erwachsenen Großen Rheas (Rhea americana) bei Farmhaltung

J. Sales¹, D. C. Deeming², P. J. U. van Deventer³, M. B. Martella⁴, J. L. Navarra⁴


Introduction

Increasing attention is given to ratites (typically ostrich Struthio camelus, emu Dromaius novaehollandiae, Greater Rhea Rhea americana and Lesser Rhea Pterocnemia pennata) as alternative farm animals. Although the Greater Rhea was reared in captivity as early as the mid-1800's (Bruning, 1974), this species has been poorly studied under captive conditions in comparison with the other commercially used ratites. Most information on behaviour of Greater Rheas comprises description of behaviours (Rai-Kow, 1968; 1969; Bruning, 1974) and behavioural studies of wild populations (Fernández and Reboreda, 1995; Martella et al., 1995; Codenotti et al., 1995; Codenotti and Alvarez 1997; 1998; Reboreda and Fernández, 1997).

The aim of the present study was to obtain a diurnal time-activity budget for adult rheas during the breeding season in the Northern hemisphere (April to July) in a farming environment and to test for the influence of group size and sex. It was hoped that this would establish a baseline of rhea behaviour in captivity and begin to quantify how these birds allocate their time to cope with varying energy demands.

Material and Methods

The study was conducted on a farm in Wales, UK (51°25'W, 39°55'N) in May 1997. This farm is situated 120 m above sea level, with an average rainfall of 900 mm per year. Adult Greater Rheas, hatched in the UK, more than two years of age and in breeding condition, were observed.

Birds were in two groups, a large one consisting of seven males and six females in an enclosure of 1.9 ha, and a small group of four males and three females in an enclosure of 2.1 ha. The perimeter lengths of the enclosures were 52 and 247 m respectively. All the enclosures were covered with permanent pasture, predominantly grass, but with some clover patches. Wire fencing and hedges provided boundaries and shelter around the enclosures. Birds had visual contact with other rheas in the adjacent enclosure.

In addition to forage from the pasture birds were provided with supplementary micronized flaked maize and commercial ostrich breeder pellets (180 g kg⁻¹ crude protein and 100 g kg⁻¹ crude fibre) in a 1:1.6 ratio during 0900–1000 h (300 g/bird) and 1800–1900 h (250 g/bird). Drinking water was available at all times in the enclosures.

Preliminary observations of the rheas allowed behaviours to be classified into the following categories: (1) aggression: hissing at, or fighting with, other birds, (2) chase: chasing of, or by, another bird, (3) drink: drinking water from trough in enclosure, (4) feed: eating concentrate feed directly from feed dish or that scattered immediately around the dish, (5) forage: pecking at ground and vegetation while standing, (6) other: included fence pecking, head scratching, scratching of head in grass and stretching, (7) pace: walking parallel to, and within 1.5 m of enclosure boundary, (8) preen: use of the beak to preen any part of the individual’s own or another individual’s body while in the standing position, (9) reproduction: pre-display and wing display by males, receiving pre-display by females, egg laying by females, nest trampling by males or females, nest building by males, copulation of females by males or receiving copulation by females, (10) run: self explanatory, (11) search: searching for food with head lowered, (12) sit: sitting with head raised or down, in a crouched position, while preening or pecking at ground or vegetation, (13) stand: standing with head raised, (14) walk: walking more than 1.5 m from the field boundary. All observations, except for pacing and walking, were recorded irrespective of whether they were adjacent to the boundaries or not.

Previous observations showed that human presence had no obvious influence on rhea behaviour as was recorded in ostriches (McKeegan and Deeming, 1997). Despite this, rheas were observed from various distances ranging from 5 to 50 m with the naked eye and binoculars to minimise any influence of the observer. A pause of several minutes was allowed between positioning of the observer and the start of observations. The birds in groups were identified using general features of sex and size, along with distinguishing marks such as featherless patches and tail characteristics. The legs of some birds were sprayed with patches of blue, yellow or red green paint (“MSF Stock Marker”) to aid identification from a distance.

¹ Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown, South Africa
² School of Biological Sciences, University of Manchester, Manchester, UK
³ Department of Statistics and Actuarial Science, University of Stellenbosch, Stellenbosch, South Africa
⁴ Centro de Zoología Aplicada, Universidad Nacional de Córdoba, Córdoba, Argentina
Observations were carried out on a focal animal for 10-min continuous periods. Every 10 s, as measured from a stopwatch, the code letter assigned to the behaviour observed was recorded on a check sheet. For each observation period, the 60 letter codes were subdivided to produce data for each behaviour observed. Temperature was recorded three to four times during the day and average daily temperatures varied between 7–17 °C. All observations were carried out on dry days and none when it was raining because rain significantly affects behaviour in ostriches (Deeming, 1997).

The time-activity budget of the birds was measured by spreading the observation periods over nine time periods (each of two hour duration) between 0400 h and 2200 h, which encompassed all daylight hours. Each bird was observed three times in each time period, all on separate days. To ensure greatest independence of samples birds were observed in a random order. The total observation time for all birds amounted to 54 h.

Data from the three observations for each bird in each time period were combined and treated as one sample. Data for each behaviour were converted to percentages of the observation period which were averaged over the time periods and individuals to produce an overall diurnal time-activity budget. Data showed a non-normal distribution according to the Kolmogorov-Smirnov test (Siegel, 1956), even after arcsin transformation (Bartlett, 1947). Non-parametric Mann-Whitney U-tests were thus performed to evaluate differences between group sizes and sexes, while ANOVA analysis was performed after data were transformed to ranks according to the Kruskal-Wallis method to evaluate between time periods. Least significant differences (LSD) were used to evaluate between time periods where appropriate (Steel and Torrie, 1980). Data were analyzed using the procedures of the Statistical Analysis System (SAS, 1988).

**Results and Discussion**

Only drinking and chasing in males and foraging in females differed between group sizes (Mann-Whitney U-test, P < 0.05, n = 6). Higher foraging of females in the larger group (21.7 vs 11.9%) could be, similar as the finding of McKeeegan and Deeming (1997) for male ostriches, associated with increased competition for the amount of concentrated feed, especially due to the higher number of males in this group. The small sample sizes used in the present study prevent a clear picture of the influence of group size on the behaviour of captive rheas. As a result of small sample sizes and similarity between group sizes, data for individual group sizes were combined in the evaluation of the influence of sex and time period on behaviours.

The time budget of adult rheas was significantly influenced by sex. Most activities (except sitting, running walking, drinking and preening) showed significant differences between sexes (Table 1). These results are partially consistent with those obtained by Rebookeda and Fernández (1997) in wild Greater Rheas and coincide with those reported by McKeeegan and Deeming (1997) in captive ostriches. Both rhea males and females spent a considerable amount of time pacing and standing combined (49.2% and 38.8%, respectively). Higher values for standing in males coincide with the higher rates of vigilance observed in birds of that sex by Rebookeda and Fernández (1997) in the wild. However, these authors found lower percentages of vigilance (average <17% for both sexes in all group sizes reported) compared to standing figures in this study. On the other hand, values for pacing plus standing in captive rheas are closer to those found by McKeeegan and Deeming (1997) in farmed ostriches (52% for males and 33% for females, in a group consisting of three males and eight females). Pacing could not be attributed to boredom, because it was often interrupted by other behaviours, such as standing, sexual display and foraging.

Female rheas spent significantly more time on nutrition (33.7%) than males (18.3%) (Table 1). Higher percentages for pacing and sexual displays by males lowered their time for foraging. The same pattern was reported by McKeeegan and Deeming (1997) in captive ostriches (23% for females and 13% for males, on foraging and feeding combined). Apparently, females of both ratites need to consume food at a higher rate than males. Wild rheas showed the same difference between sexes in behaviours associated with food intake (Rebookeda and Fernández, 1997), but figures were much higher in the wild (approximately 80% and 65% in females and males, respectively) than in our study. Probably, rheas in the wild need to devote more time to feeding, to satisfy their daily energetic demand. This could be a consequence of having higher daily energy consumption, less food quality and density, or a combination of these factors.

The significantly higher rate of reproductive behaviour by male rheas comprised mainly displaying to females (5.9%). Chasing and aggression were significantly higher in males than females and occurred mainly among rheas of the same sex. This coincides with data obtained in wild populations of Argentina (M. B. Martella and J. L. Navarro, unpublished).

Although differences between sexes in individual time periods appeared large, only a few were significant (Table 2). This can be attributed to the huge variability of data. No specific patterns were observed in any of the mentioned behaviours over time (Figure 1). While the highest proportion of standing was found between 0400–2200 h.

**Table 1.** Proportion of the overall time budget (± SE) as influenced by sex spent on behavioural patterns during daylight hours (0400–2200 h).

<table>
<thead>
<tr>
<th>Behavioural pattern</th>
<th>Males n = 6</th>
<th>Females n = 6</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Locomotion</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pace</td>
<td>25.8 ± 2.0</td>
<td>20.0 ± 1.7</td>
<td>0.048</td>
</tr>
<tr>
<td>Walk</td>
<td>8.5 ± 0.9</td>
<td>7.8 ± 0.8</td>
<td>0.779</td>
</tr>
<tr>
<td>Chase</td>
<td>0.3 ± 0.1</td>
<td>0.1 ± 0.0</td>
<td>0.026</td>
</tr>
<tr>
<td>Run</td>
<td>0.3 ± 0.1</td>
<td>0.2 ± 0.1</td>
<td>0.820</td>
</tr>
<tr>
<td><strong>Non-active</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stand</td>
<td>23.4 ± 1.4</td>
<td>18.8 ± 1.2</td>
<td>0.015</td>
</tr>
<tr>
<td>Sit</td>
<td>11.8 ± 2.3</td>
<td>12.6 ± 2.4</td>
<td>0.855</td>
</tr>
<tr>
<td><strong>Nutrition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forage</td>
<td>10.5 ± 1.2</td>
<td>16.8 ± 1.7</td>
<td>0.003</td>
</tr>
<tr>
<td>Search</td>
<td>4.1 ± 0.8</td>
<td>9.9 ± 0.9</td>
<td>0.000</td>
</tr>
<tr>
<td>Feed</td>
<td>2.9 ± 0.7</td>
<td>6.0 ± 0.9</td>
<td>0.000</td>
</tr>
<tr>
<td>Drink</td>
<td>0.8 ± 0.3</td>
<td>1.0 ± 0.3</td>
<td>0.118</td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproduction</td>
<td>6.6 ± 1.2</td>
<td>1.6 ± 0.7</td>
<td>0.000</td>
</tr>
<tr>
<td>Preen</td>
<td>4.5 ± 0.8</td>
<td>5.0 ± 0.9</td>
<td>0.830</td>
</tr>
<tr>
<td>Other</td>
<td>0.1 ± 0.01</td>
<td>0.4 ± 0.1</td>
<td>0.005</td>
</tr>
<tr>
<td>Aggression</td>
<td>0.6 ± 0.2</td>
<td>0.0 ± 0.0</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Significance values were assessed using Mann-Whitney U-Tests.
Table 2. P-values derived from ANOVA analysis performed after data were transformed to ranks according to the Kruskal-Wallis method to evaluate time periods

<table>
<thead>
<tr>
<th>Behavioural pattern</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locomotion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pace</td>
<td>0.002</td>
<td>0.000</td>
</tr>
<tr>
<td>Walk</td>
<td>0.083</td>
<td>0.051</td>
</tr>
<tr>
<td>Chase</td>
<td>0.023</td>
<td>0.320</td>
</tr>
<tr>
<td>Run</td>
<td>0.211</td>
<td>0.625</td>
</tr>
<tr>
<td>Non-active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stand</td>
<td>0.008</td>
<td>0.001</td>
</tr>
<tr>
<td>Sit</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Nutrition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forage</td>
<td>0.171</td>
<td>0.008</td>
</tr>
<tr>
<td>Search</td>
<td>0.231</td>
<td>0.012</td>
</tr>
<tr>
<td>Feed</td>
<td>0.162</td>
<td>0.072</td>
</tr>
<tr>
<td>Drink</td>
<td>0.000</td>
<td>0.034</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproductive</td>
<td>0.042</td>
<td>0.632</td>
</tr>
<tr>
<td>Preen</td>
<td>0.666</td>
<td>0.270</td>
</tr>
<tr>
<td>Other</td>
<td>0.690</td>
<td>0.851</td>
</tr>
<tr>
<td>Aggression</td>
<td>0.005</td>
<td>0.439</td>
</tr>
</tbody>
</table>

0600 h for males (34.7%), it was between 0600–0800 h for females (26.0%). Standing was the lowest between 2000–2200 h by both males (13.4%) and females (6.8%).

Pacing was the highest for males between 1600–1800 h (41.9%) and for females between 0800–1000 h (29.5%). In both sexes sitting was the highest between 2000–2200 h (males: 58.3%; females: 63.6%). Males did not sit between 1800–2000 h nor did females sit between 0600–1000 h. Sitting was higher in males than between females between 0400–1000 h, while the reversed situation was found between 1600–2000 h. This is in contrast with the finding of MCKEENGAN and DEEMING (1997) that ostrich females rose earlier than males but males sat for the night earlier.

Although foraging did not significantly differ between time periods for males, this behaviour was the lowest for females during the period 2000–2200 h (8.5%). Foraging during all time periods was higher for females than for males. Searching, higher for females than for males during all time periods, was the highest in females between 0800–1000 h (17.2%) and gradually lowered to the period 2000–2200 h (3.1%).

The highest frequency of drinking for both males (4.2%) and females (3.1%) was between 1000–1200 h, which was after the delivery of the morning ration. RAIKOW (1968) showed that rheas drink for prolonged periods of 5–10 min after they have been actively feeding in the wild.

Reproductive behaviour of males was the highest between 1200–1400 h (16.7%). Egg-laying was observed during the time period 1400–1600 h. This is in agreement with the statement that egg-laying almost always occurred just after midday, between 1100–1500 h, in both wild and captive populations (BRUNING, 1974). Aggression for males was the highest (3.0%) during the period 1400–1600 h and chasing or being chased at 0800–1000 h (0.8%).

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**Figure 1.** Influence of time period on the four dominant behavioural patterns for different sexes. 1 – 04.00 h–06.00 h; 2 – 06.00 h–08.00 h; 3 – 08.00 h–10.00 h; 4 – 10.00 h–12.00 h; 5 – 12.00 h–14.00 h; 6 – 14.00 h–16.00 h; 7 – 16.00 h–18.00 h; 8 – 18.00 h–20.00 h; 9 – 20.00–22.00 h (□ Males; □ Females)
MCKEEGAN and DEEMING (1997) found the sequence of activity of ostriches in a group of 11 breeding birds on a farm in Britain to be: standing (30–40%), foraging (12–27%), sitting (10–14%), walking (8–15%), pacing (3–12%) and feeding (3%). This largely coincides with the sequence derived for rheas in the present study, except that pacing for rheas was the activity carried out the most, and time spent on standing was somewhat lower. A higher amount of time was spent by rheas on feeding, maybe as consequence of providing concentrate ration twice a day.

Although the present study was conducted on a limited number of birds over a short time period, no complete time-budget analysis has previously been described for rheas in captivity or in the wild. The data presented here are a basis for rhea behaviour in captivity for comparison in further studies. This has to be expanded to evaluate differences in behaviour between different climate zones and enclosure sizes to find the optimum farming environment for the improvement of production.

Summary
A baseline of rhea behaviour in captivity was established by evaluating the diurnal time-activity budget of adult rheas during the breeding season in the Northern hemisphere (April to July) in a farming environment with group size and sex as variables. While group size has little effect on behaviour, most activities showed significant differences between sexes. Most time was spent on pacing and standing combined by both males (49.2%) and females (39.8%). Female rheas spent significantly more time on nutrition (33.7%) than males (18.3%). No specific patterns were observed in any of the behaviours evaluated over time. Foraging during all time periods was higher for females than for males. Reproductive behaviour of males was the highest between 1200–1400 h, while egg-laying occurred during the time period 1400–1600 h.

Keywords
Greater Rheas, behaviour, time-activity budget, farming environment

Zusammenfassung
Diurnale Zeitaaktivitäts-Budgets von erwachsenen Großen Rheas (Rhea americana) bei Farmhaltung

Durch die Auswertung des Zeitaaktivitäts-Budgets von erwachsenen Großen Rheas während der Reproduktionsphase in der nördlichen Hemisphäre (April bis Juli) bei Farmhaltung, mit Gruppengröße und Geschlecht als Einflussfaktoren, wurden grundlegende Erkenntnisse über das Verhalten von Rheas in Gefangenschaft gewonnen. Während die Gruppengröße keinen Einfluß auf das Verhalten hatte, wurden für die meisten Verhaltensweisen signifikante Geschlechtsereffekte beobachtet. Die meiste Zeit wurde sowohl bei den männlichen (49.2%) als auch bei den weiblichen Tieren (39.8%) für Laufen und gemeinsames Stehen verwendet. Die weiblichen Rheas befassen sich signifikant häufiger (33.7%) mit der Nahrungsaufnahme als die männlichen Rheas (18.3%). Über die Beobachtungsduer konnte für keines der Verhaltensmerkmale ein spezifischer Trend beobachtet werden. Der Zeitaufwand für die Futtersuche war in allen Beobachtungszeiträumen bei den weiblichen Tieren höher als bei den männlichen. Das Reproduktionsverhalten der männlichen Tiere erreichte zwischen 12.00 und 14.00 Uhr einen Höhepunkt, während die Eiablage überwiegend zwischen 14.00 und 16.00 erfolgte.

Stichworte
Große Rheas, Verhalten, Zeitaaktivitäts-Budgets, Farmhaltung

Literature

Correspondence: Dr. James Sales, Department of Ichthyology and Fisheries Science, Rhodes University, P.O. Box 94, Grahamstown, 6140, South Africa; E-mail: J.Sales@ru.ac.za