CHAPTER 9

ACTIVITY

Introduction

Quantitative data on the activity patterns of various antelopes have become readily available over time as a result of a large number of studies of antelope behaviour. These data all indicate that a diurnal activity regime is characteristic of all antelopes, but that variations caused by external and internal factors are superimposed on the general regime (Jarman & Jarman 1973).

Studies on the activity of animals can contribute to understanding the ecological limitations imposed on whole populations of a species, and more particularly upon individuals of certain reproductive categories within the population (Jarman & Jarman 1973). Furthermore, for reintroduced animals it is important to know how they interact with their environment so that populations can be managed effectively (Williamson, Tatwany, Rietkerk, Delima & Lindsay 1991). By quantifying the activity patterns shown during different seasons it is also possible to describe the relationship that exists between the animals and their environment. Such information on the ability of the animals to adapt to fluctuating conditions provide a scientific basis for practical decisions on various matters, including the suitability of a given habitat for the translocation of certain species of wildlife (Norton 1981).

According to Jarman and Jarman (1973), social behaviour can be divided into two components. The first one deals with behaviour in response to external factors, which in turn are attributes of the environment such as food availability and dispersion. The second deals with behaviour imposed from within the population by differences between the reaction of individual members to each other. It is generally accepted that this second category of behaviour is largely manifested in the organisation of the population (Jarman & Jarman 1973).

Each individual animal allocates its time optimally in relation to its specific metabolic and energy requirements. Comparing the time activity budgets between the different seasons and different years can help to explain any adjustments which are made by animals to variations in their environment (Giroux & Bédard 1990).

The purpose of this part of the study of the Arabian oryx therefore was to investigate and quantify the daily activities of the reintroduced animals by apportioning their daytime 12-hour activity cycles into mutually exclusive categories over a period of one year. This provides important background information for a wider behavioural and ecological study of the reintroduced Arabian oryx of the study area.

Methods

Altmann (1974) discusses seven different methods of sampling for observational studies of social behaviour in detail. Each of these techniques has different recommended uses, and each one differs in its suitability for providing unbiased data of various kinds. In activity studies the behaviour of an animal may either be regarded as events or states. The difference is that events are instantaneous while states have appreciable duration (Altmann 1974).

The most widely used method for quantifying the daytime activity of ungulates was first described for Zebu cattle *Bos taurus* (Linnaeus, 1758) in East Africa (Harker, Rollinson, Taylor, Gourlay & Nunn 1954). This technique has subsequently been used by both Richards (1966) and Smith (1968) who studied caged golden hamsters *Mesocricetus auratus* (Waterhouse, 1839) and squirrels *Tamiasciurus* spp. (Trouessart, 1880) respectively. Studies on the defassa waterbuck *Kobus ellipsiprymnus defassa* (Ogilby, 1833), warthog *Phacochoerus aethiopicus* (Pallas, 1766), Hartmann zebra *Equus zebra hartmannae* Linnaeus, 1758 and elephants *Loxodonta africana* (Blumenbach, 1797) followed (Spinage 1968; Clough & Hassam 1970; Joubert 1972; Wyatt & Eltringham 1974). Lewis (1977) also used the technique in comparing the activity patterns of eland *Taurotragus oryx* (Pallas, 1766), oryx, buffalo *Syncerus caffer* (Sparrmann, 1779) and zebu cattle. More recently the activity patterns of moose in western Alaska (Gillingham & Klein 1992) and reintroduced giraffe *Giraffa camelopardalis* (Linnaeus, 1758) in the Kgalagadi Transfrontier Park (Kruger 1994) of Southern Africa have been studied using this technique.

The technique involves classifying the behaviour of the animals into a number of specific and easily recognisable activities. According to this technique an individual's current activity is recorded at preselected time intervals (Altmann 1974). This results in a sample of states but not of events. When the behaviour of all the visible group members is sampled within a short space of time the observations approach being a simultaneous sample of all the individuals in the group. This form of instantaneous sampling is referred to as scan sampling (Altmann 1974). Such sampling has been used throughout the present study.

An important consideration in using the scan sampling technique is that an attempt should be made to scan each individual in the group for the same period of time. This type of analysis is therefore best suited to studies in which aspects of social behaviour can be lumped into a few easily distinguishable categories (Altmann 1974). The technique readily provides data appropriate to estimating the percentage of time spent on the various activities that are recognised; and on behavioural synchrony within the herd.

In the present study, an Arabian oryx group was located during the afternoon preceding the day of the study. On the day of the study, the last known position of the herd on the previous day was then used to re-locate the animals rapidly. The diurnal activity of the group was then studied. The activity of the Arabian oryx population in the 'Uruq Bani Ma'arid Protected Area was sampled over a period of 14.6 days during 1995. During this time 10 560 scans comprising 176 hours of observation were made. An attempt was also made to study the nocturnal activities of the oryxes. Even during full moon, however, it was found that a specific oryx could not be identified positively by using the tag numbers alone. It was therefore also too difficult to identify an individual oryx on any other night, when the moon was in a different and darker phase. Analysis then was therefore impossible.

Diurnal activity was recorded for mixed herds of Arabian oryxes between 06:00 and 18:00 on 14 days during 1995, with a single activity study done between 06:00 and 14:00 on another day. These activity studies were distributed across all the seasons. The standard scanning procedure requires one scan of the herd at 5-minute intervals, being repeated 12 times during each hour. Since all the Arabian oryxes in the 'Uruq Bani Ma'arid Protected Area were individually identifiable, only the identification number of each individual and the activity observed at the time of scanning were noted.

The activities recorded included feeding, ruminating, walking, standing in the sun, standing in the shade, lying down in the sun, lying down in the shade, ruminating while standing, ruminating while lying down, running away, and social interactions. Because of the inherent time restraints when scanning different animals with the selected technique, an animal's activity was recorded as walking only if the animal was actually seen moving without feeding during a scan period. Following Dieckmann (1980), ruminating was identified by the lateral jaw movement of an oryx while standing and/or lying down. When the head of an oryx was obscured behind other animals or vegetation, it was noted that rumination could not be determined. This means that all the values given on rumination here are minimum values because some of the oryxes could have been ruminating while their heads were obscured.

Social interactions are usually subdivided into courtship and dominance behaviour. Courtship behaviour as studied here included flehmen, circling, goose-stepping and mating. Dominance behaviour included dominant and submissive behaviour through means of posturing, as well as fighting, shrub-horning and squat-defecating.

Meteorological data were collected at 2-hourly intervals during the activity studies, and consisted of the following variables: ambient temperature recorded in the shade of the vehicle, wind direction as determined by compass bearing, and wind strength determined subjectively either as no wind, mild wind, strong wind or very strong wind. Cloud cover and visibility were also recorded.

Following Norton (1981) and Kruger (1994), the results are presented as percentage frequencies of each activity for every half-hour period through the daylight hours. The time allocated to the different activities was calculated by converting the percentage of observations for that half-hour period to minutes by using a factor of 0.3. When an animal, for example, spent 80% of its time during a specific half-hour in feeding, then the actual time spent on feeding would be 80 x 0.3 = 24 minutes.

Because no activity data are available for subadult male Arabian oryxes in the 'Uruq Bani Ma'arid Protected Area during the spring, the diurnal activity data were analysed for two different periods. Firstly, comparisons were made between adult males, adult females and subadult females for the spring. Secondly, the behaviour of all the age and sex classes, including the subadult males, was compared for the summer, autumn and winter.

Multi-factor analysis of variance was used to determine whether any significant differences existed in the observed activity patterns between the age and sex classes, and season. One-way analysis of variance was used to determine if any significant differences existed in the observed activity patterns between seasons, within the different age and sex classes. To determine statistically whether there was a relationship between increasing ambient temperature and the percentage of oryx that was found to be resting in the shade, a linear regression equation based on the method of least squares (Zar 1974) was applied. The confidence level was set at 95% ($\alpha = 0.05$) in all the statistical analysis procedures.

Results and discussion

The distribution of the daily behavioural activities of the Arabian oryx during the four seasons in the 'Uruq Bani Ma'arid Protected appear in Table 24 and Figures 38 to 41. These results show the following:

Feeding

Feeding was the most time consuming activity of the Arabian oryx in the 'Uruq Bani Ma'arid Protected Area during all the seasons, except the winter. Peak feeding times (51.7% of all observations) was usually in the early morning from sunrise to approximately 10:00. After 10:00 the oryx only fed occasionally (14.0% of all observations). Feeding resumed after 14:00 and continued until the end of observations at sunset. During the latter period, 34.3% of all the observations made on the oryxes were of feeding animals.

During spring it was found that there was no significant difference (P = 0.8269) in the time spent in feeding by the different age and sex classes. Multi-factor analysis of variance revealed that age and sex class on its own was not a significant (P = 0.0833) factor in determining the amount of time spent in feeding (Table 25) during the remaining three seasons. Season, however, was a significant (P = 0.0000) factor. Similarly, the relationship between the age and sex class and season was significant (P = 0.0008) during summer, autumn and winter. This indicates that the seasonal patterns of feeding behaviour differed between the different age and sex classes. For example, the adult females spent more time in feeding during the winter than did the subadult females, while the opposite was true during the summer and autumn. This seasonal change in the time spent in feeding by these two age classes is due to the different nutritional demands experienced by the adult and subadult females due to their different reproductive statuses (Lewis 1977; Norton 1981). Elsewhere it has been shown that births in the present study peak during winter (Chapter 8). It is also known that the energetic costs of lactation to female mammals are responsible for a major increase in their energetic requirements (Hanwell & Peaker 1977).

Therefore the adult females should spend more time in feeding during the winter than the subadult females. The same is probably true during the summer and autumn, but high ambient temperatures and the need for preserving water and energy are additional factors that influence behaviour during these seasons. Consequently it is more important for the

Table 24: The proportional distribution of the different daily activities shown by the reintroduced Arabian oryxes in the 'Uruq Bani Ma'arid Protected Area of the Kingdom of Saudi Arabia during the different seasons of 1995. Data were collected during one day per month and resulted in 10 560 scans comprising 176 hours of observation.

SEASON	AGE AND SEX CLASS	ACTIVITY											
		Feeding		Walking		Resting		Ruminating		Social		Other	
		Minutes	%	Minutes	%	Minutes	%	Minutes	%	Minutes	%	Minutes	%
SPRING	Adult male	238	33.1	104	14.4	206	28.6	125	17.4	25	3.5	22	3.0
	Adult female	268	37.2	97	13.5	210	29.2	114	15.8	4	0.5	27	3.8
	Sub adult female	265	36.8	72	10	257	35.7	89	12.4	10	1.4	27	3.8
SUMMER	Adult male	131	18.2	120	16.7	400	55.6	48	6.7	13	1.8	8	1.1
	Adult female	131	18.2	123	17.1	393	54.6	49	6.8	2	0.3	22	3.1
	Sub adult male	179	24.9	162	22.5	243	33.8	54	7.5	13	1.8	69	9.6
	Sub adult female	155	21.5	157	21.8	306	42.5	44	6.1	2	0.3	56	7.8
AUTUMN	Adult male	236	32.7	154	21.4	246	34.2	32	4.4	14	1.9	38	5.3
	Adult female	255	35.4	150	20.8	231	32.1	9	1.3	1	0.1	74	10.3
	Sub adult male	203	28.2	193	26.8	261	36.3	13	1.8	9	1.3	41	5.7
	Sub adult female	271	37.6	154	21.4	239	33.2	12	1.7	5	0.7	39	5.4
WINTER	Adult male	180	27.3	243	36.8	189	28.6	10	1.5	32	4.8	6	0.9
	Adult female	197	29.8	247	37.4	201	30.5	3	0.5	7	1.1	5	0.8
	Sub adult male	177	26.8	282	42.7	161	24.4	5	0.8	25	3.8	10	1.5
	Sub adult female	191	28.9	242	36.7	189	28.6	15	2.3	15	2.3	8	1.2

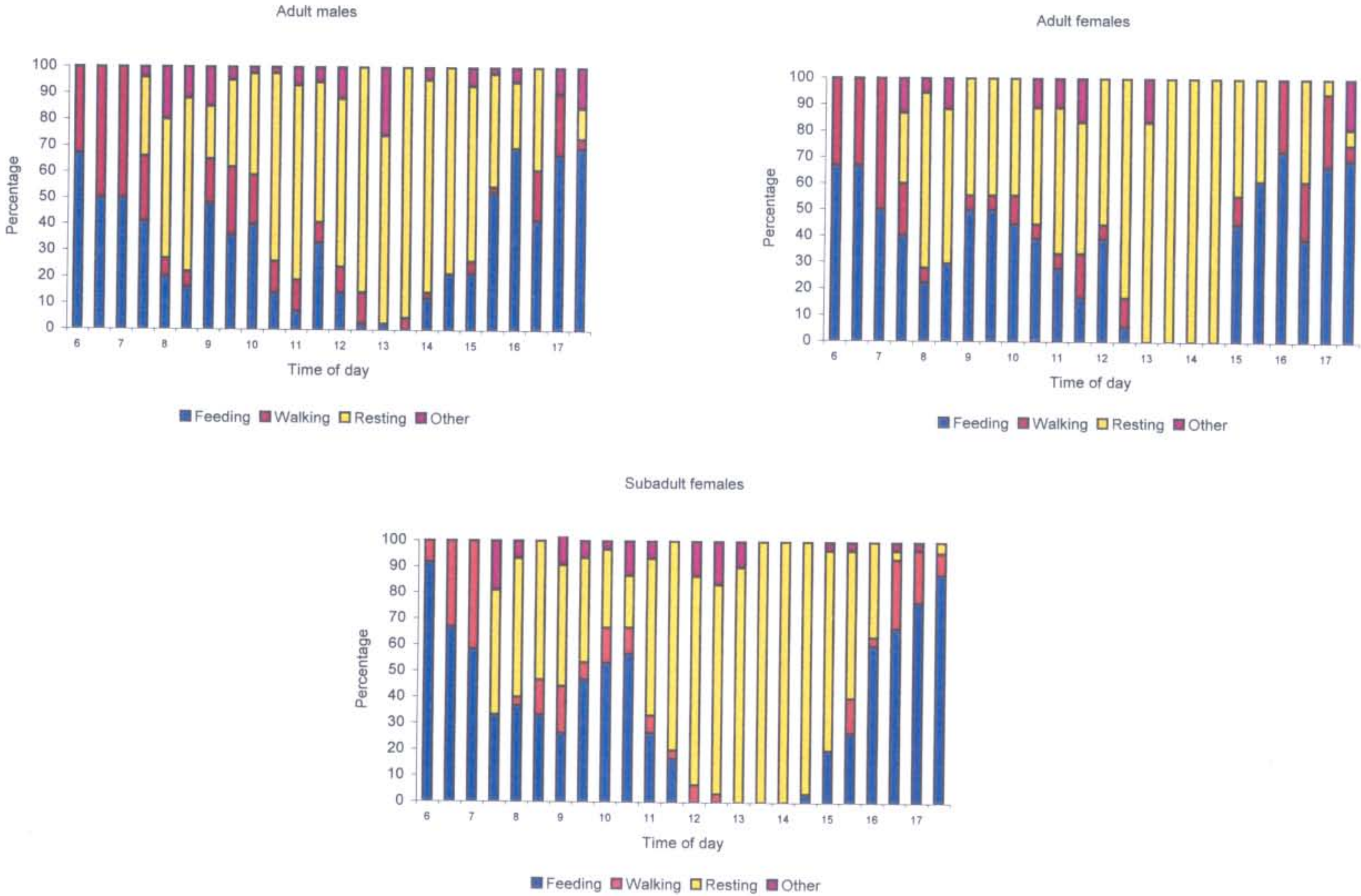


Figure 38: The frequency distribution of some of the diurnal activities of the Arabian oryxes reintroduced into the 'Uruq Bani Ma'arid Protected Area of the Kingdom of Saudi Arabia, as observed during the spring of 1995.

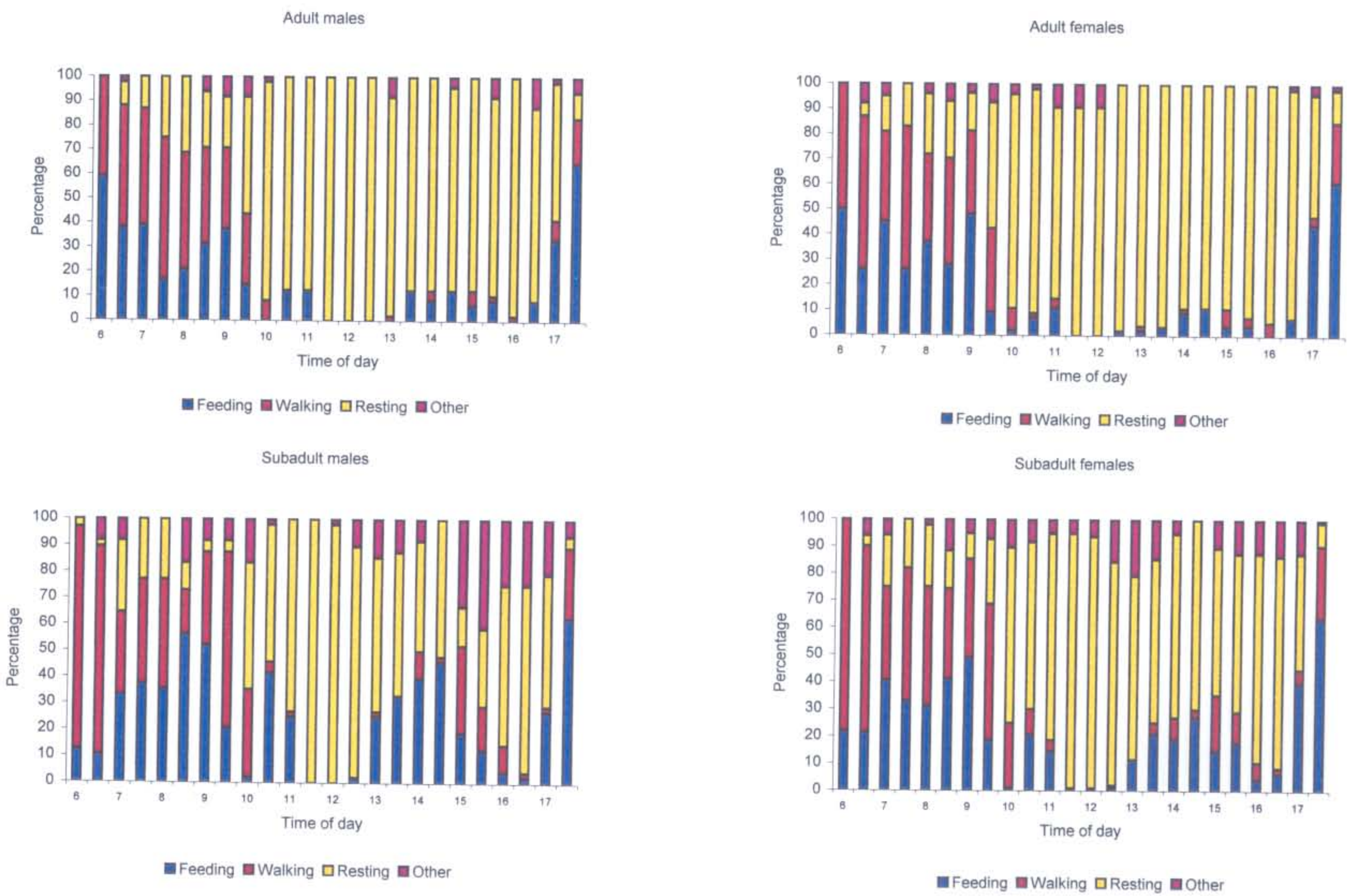


Figure 39: The frequency distribution of some of the diurnal activities of the Arabian oryxes reintroduced into the 'Uruq Bani Ma'arid Protected Area of the Kingdom of Saudi Arabia, as observed during the summer of 1995.

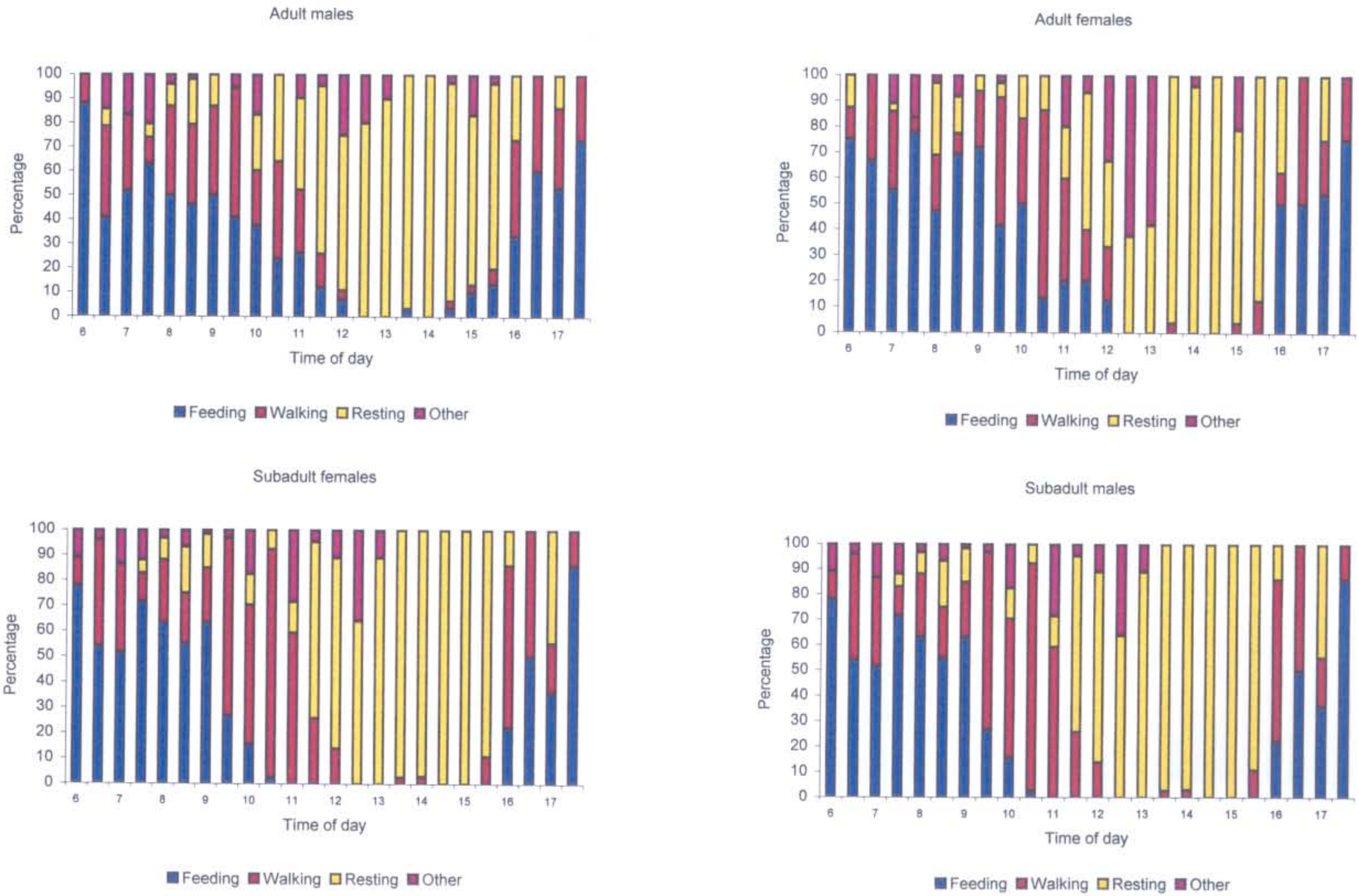


Figure 40: The frequency distribution of some of the diurnal activities of the Arabian oryxes reintroduced into the 'Uruq Bani Ma'arid Protected Area of the Kingdom of Saudi Arabia, as observed during the autumn of 1995.

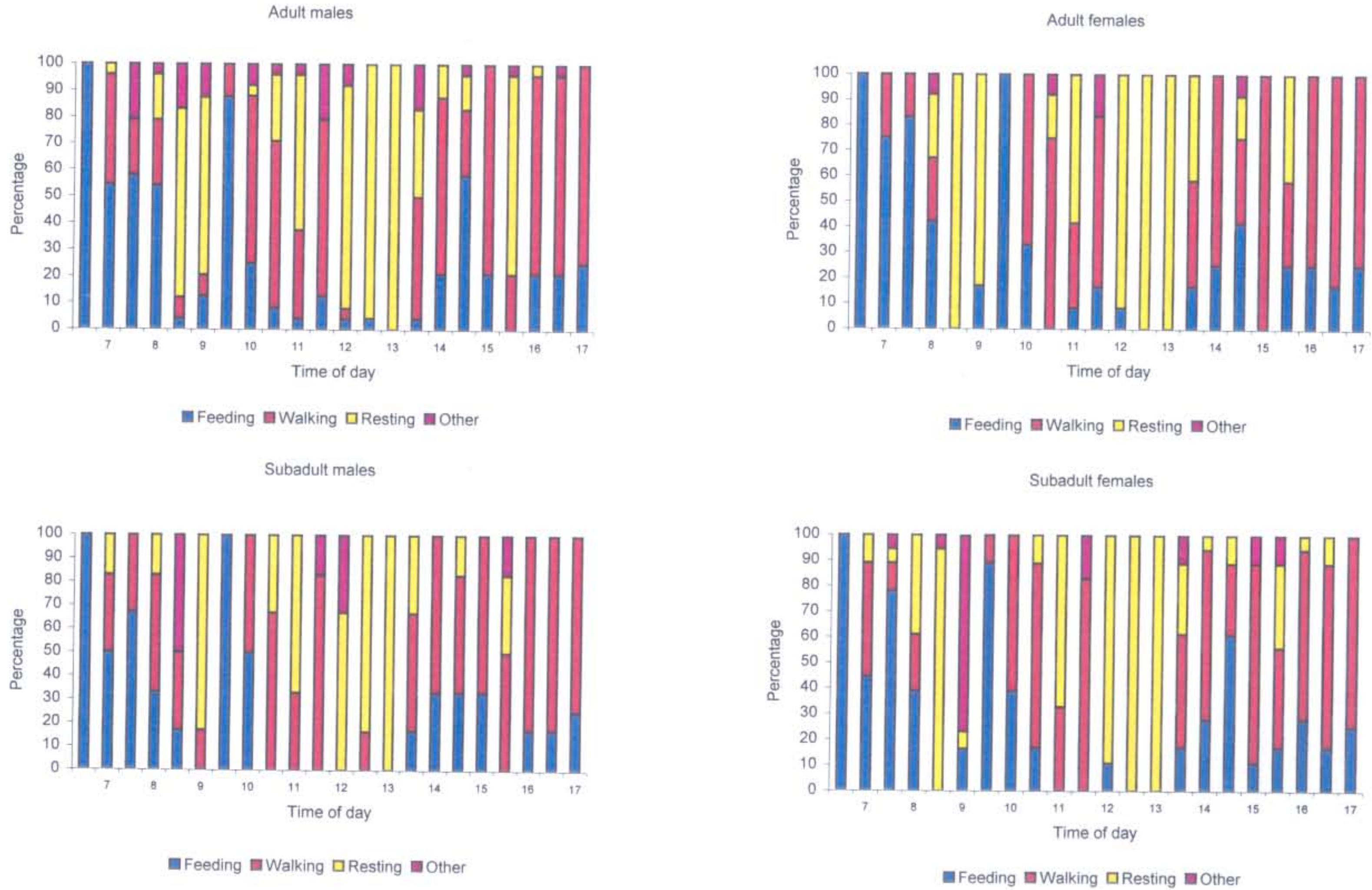


Figure 41: The frequency distribution of some of the diurnal activities of the Arabian oryxes reintroduced into the 'Uruq Bani Ma'arid Protected Area of the Kingdom of Saudi Arabia, as observed during the winter of 1995.

adult females to limit their activities during the daylight hours than it is for the subadult females or any other age and sex class to do so.

Comparatively, the Arabian oryx spends most time in feeding during the spring while the least time is spent in this activity during the summer. Significant differences exist in the actual time spent in feeding by the Arabian oryx when spring is compared with summer (P = 0.0000) and winter (P = 0.0244). Significant differences (P = 0.0003) also exist in the actual time spent feeding by the oryxes during summer and autumn. It is thought that the proportion of time spent on feeding in the early mornings before sunrise and the early evenings after sunset is higher during the summer than during spring, autumn and winter. During summer the oryxes therefore spend less actual feeding time during the daytime than in any of the other seasons, despite the difference between summer and winter not being statistically significant (P = 0.1453).

The benefits of an increase in feeding activity before and after sunset during summer, would be twofold. Firstly, it would promote the preservation of both energy and water. Secondly, it could potentially increase the amount of moisture obtained by the Arabian oryxes because the dry grass absorbs moisture from the desert air during the night, even on nights when there is no dew (Taylor 1968; 1969). This accumulation of moisture is explained by the drop in nighttime temperature, the accompanying increase in the relative humidity of the desert air and the fact that certain desert plants are known to be able to absorb moisture from the air.

Owen-Smith (in Norton 1981) suggested that most antelopes follow a feeding pattern where considerably less time is spent in feeding during the night than in the day, due to predator vulnerability during the night. However, in the harsh environment occupied by the Arabian oryx, pressure from predators is low due to the fewer predator species and lower prey densities found in these areas (Stanley-Price 1989). In addition the environment is so harsh that the need for moisture-rich food would probably outweigh the possible risk of predation when feeding during the night.

Although grazing occurs during all the hours of the day, the clear interaction found here between the time of day and season of feeding (P = 0.0000) indicates that the time of day influences the distribution of feeding activities of the oryxes between seasons. It has already been shown that there is a clear shift in the mean seasonal locations (Chapter 5) and consequently in the preferred subhabitat used by the reintroduced oryxes on a seasonal basis (Chapter 6). These changes, which are at least in part due to climatic conditions,

Table 25: A multi-factor analysis of variance test on the time spent feeding by the reintroduced Arabian oryxes in the 'Uruq Bani Ma'arid Protected Area of the Kingdom of Saudi Arabia during the summer, autumn and winter of 1995. Significant factors are shaded in yellow.

FACTOR	D.F.	F-RATIO	P - VALUE
Age and sex class	3	2.27	0.0833
Time of day	23	59.97	0.0000
Season	2	60.37	0.0000
Age and sex class X Time of day	69	1.17	0.2160
Age and sex class X Season	6	4.10	0.0008
Time of day X Season	46	27.56	0.0000

undoubtedly influence the activity cycles and therefore the feeding behaviour of the reintroduced animals. For example, during the spring or winter the animals are found to graze for long periods of the day, while in the summer it is not uncommon to find the animals shading under trees or shrubs at 07:30. The lack of interaction (P = 0.2160) between the age and sex classes and the time of feeding shows that the feeding patterns of the different age and sex classes are synchronised throughout the day over all the seasons. It is, however, known that outside the rut yearling and subadult animals in many ruminant species typically spend less time in feeding than the adults of the same species (Bunnell & Gillingham 1985). Therefore, age does have some influence on the feeding patterns of some ruminants.

Although the differences are not significant (P = 0.7404) an Arabian oryx female spends more time in feeding during the daylight hours than does a male in the 'Uruq Bani Ma'arid Protected Area. Similar observations have been made on gemsbok in the Hester Malan Nature Reserve of South Africa (Dieckmann 1980) and for klipspringer *Oreotragus oreotragus* (Zimmermann, 1783) in South Africa (Norton 1983). In the klipspringer study the foraging time of the females was 39.0% higher than that of the males. In East Africa, Lewis (1977) found that lactating oryx and eland females spent 8.0% and 5.0% more time in feeding respectively than did the males. The reasons for all these differences in feeding times between females and males are all because gestation and lactation cause the females to have higher nutritional demands than the males.

Walking

Movement towards shade is linked with feeding in the sense that an individual oryx will feed while moving to its desired place of resting. When the prevalent climatic conditions, and subsequently the distribution of the feeding plants in the study area, are taken into consideration, walking should form a large portion of the daily activities of an oryx. It was therefore not unexpected to find that the walking activities did indeed peak in the same period as the feeding ones.

No significant differences (P = 0.4775) were found between the time spent walking by the different age and sex classes during spring. The multi-factor analysis of variance showed that age and sex class is not a significant (P = 0.5060) factor in determining the time spent on walking. This indicates that all the adult oryxes but especially the males do not show any preference for or attempt to keep other oryxes away from certain feeding areas (Chapter 2). However, season proved to be an important factor, indicating significant (P = 0.0000) differences in the amount of time spent in walking by the oryxes during different seasons. There was no relationship, in terms of walking, between season and age and sex class (P = 0.9980), which indicates that the behaviour of the different age and sex classes was similar for all seasons.

Comparatively, the Arabian oryx spends the least amount of time on walking during the spring, while most time was spent on this activity during the winter. Significant differences in walking intensity occur between the spring and autumn (P = 0.0028) and the spring and winter (P = 0.0002). The differences in walking intensity between the autumn and winter (P = 0.0009) and between the summer and winter (P = 0.0001) were also significant. The fact that the Arabian oryx walks less during the spring than in any of the other three seasons is probably because vegetation of higher quality is more readily available in the spring than in any of the other seasons. In terms of vegetation quality and quantity the opposite is true for the winter, which explains why the oryxes then spend so much time walking as they search for food.

The different intensity of walking in the summer as opposed to the winter is probably the result of different combinations of environmental conditions during these two seasons. The high summer ambient temperatures will make the oryxes less active then, and the low quality of the vegetation during the winter will force them to move greater distances in search of adequate food. It is well-known that the distribution, abundance and the quality of food can influence the activity patterns of ungulates in the Northern Hemisphere (Renecker & Hudson 1989). Consequently such a result is to be expected.

The higher search rate for food in the winter also explains why feeding was not the most time consuming activity then when compared with the other seasons. Hudson (1985) states that large herbivores have high total forage requirements and that these requirements may be most difficult to meet under extreme winter conditions. Consequently, the Arabian oryx can be expected to spend more time on walking during the season of low food abundance. The animals spent less time in walking during the autumn than the winter because of the fresh growth that is available on the perennial plants during the autumn, even before the first rains (Chapter 6). The availability of food of sufficient quality therefore does not require the animal to roam widely.

Resting without ruminating

The typical relationship between the different resting activities of the Arabian oryx is illustrated in Figure 42. Although these activities occur throughout the day from as early as 07:00, resting peaks from the late morning (10:00) until approximately mid-day (14:00), a period when 56.0% of all the resting observations in this study were made.

During the spring the subadult females spend significantly ($P = 0.0142$) more time in resting in the shade than the adult females. During the remaining three seasons multi-factor analysis of variance tests showed that both age and sex class ($P = 0.0443$) and season ($P = 0.0000$) were significant factors in influencing the time spent in resting in the shade by the oryxes. In addition, the interaction between age and sex class and season was also significant ($P = 0.0289$).

The only significant ($P = 0.0309$) difference in time spent in resting by the various age and sex classes was between the adult and subadult males. A significant difference ($P = 0.0289$) was found in the frequency of resting between the age and sex class and the season involved. This also indicates that the nature of this interaction between the adult and subadult males changes over the seasons. During the summer, for example, an adult male Arabian oryx spends significantly ($P = 0.0011$) more time in resting in the shade than a subadult male. This is due to the social organisation of the reintroduced animals. It has often been observed that an adult male will stand up from where it was lying in the shade and walk across to another tree or shrub where another animal is lying. If this adult male is dominant to the animal that it is approaching, the latter will get up and move away, allowing the adult male to take over the vacated shade. Often the displaced animal will first stand in the sun or feed before looking for another place to lie down; often also in the sun. Shade use therefore is a form of competitive behaviour. No significant differences were found in the total times which adult and subadult male Arabian oryxes spend resting in the shade during the autumn ($P = 0.7329$) or the winter ($P = 0.3225$).

Comparatively speaking, the different age and sex classes of Arabian oryx spend most time in resting in the shade during the hot summer months, and least during the winter (Table 26). Significantly ($P = 0.0000$) more time was spent resting in the shade by the oryxes during the summer than the winter. In the summer the oryxes spend 44.3% of their time in resting in the shade but in the winter it occupies <1.0% of their time. There are also significant differences in the time spent resting in the shade by all the oryxes between the summer and autumn ($P = 0.0004$) as well as the autumn and winter ($P = 0.0000$). These differences are attributed to the changing environmental conditions and specifically in the decreasing ambient temperatures from the summer through autumn to the winter.

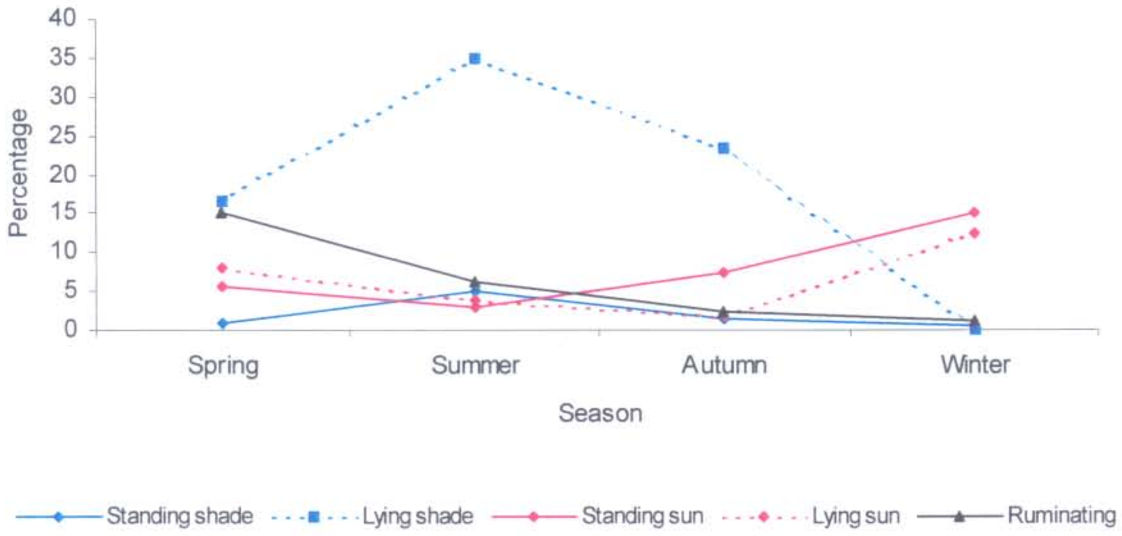


Figure 42: The percentage of time spent in various resting activities by the Arabian oryx in the 'Uruq Bani Ma'arid Protected Area of the Kingdom of Saudi Arabia during the different seasons of 1995.

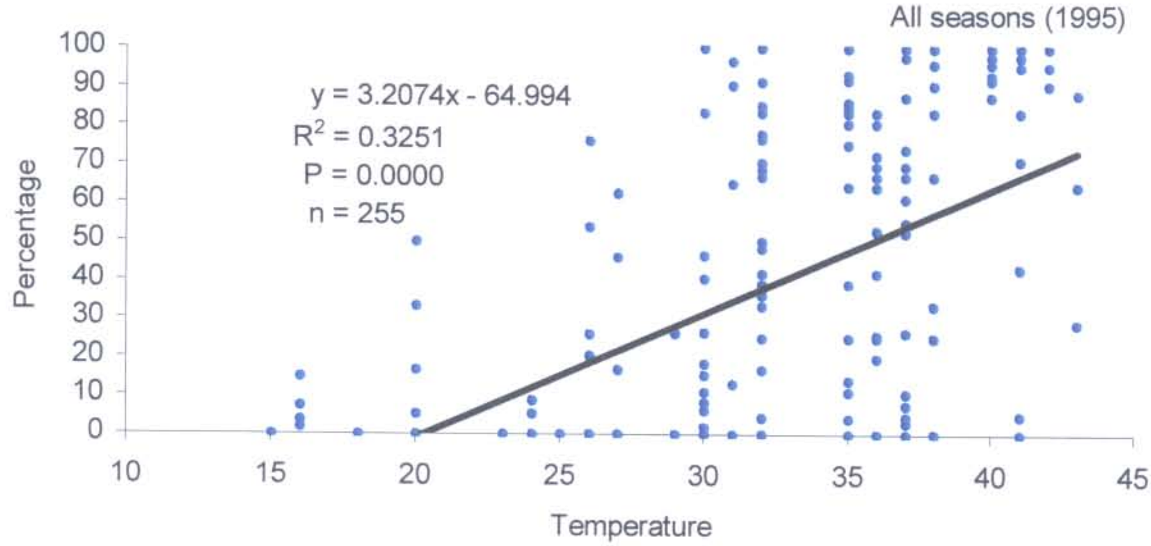
Table 26: The time spent resting by the reintroduced Arabian oryxes during the day in the 'Uruq Bani Ma'arid Protected Area of the Kingdom of Saudi Arabia, as determined through instantaneous scans of different herds during 1995.

SEASON	AGE AND SEX	RESTING IN THE SHADE						RESTING IN THE SUN					
		Standing		Lying		Ruminating		Standing		Lying		Ruminating	
		Minutes	%	Minutes	%	Minutes	%	Minutes	%	Minutes	%	Minutes	%
SPRING	Adult male	8.4	0.3	76.7	3.6	77.3	3.6	47.5	2.2	74.2	3.4	46.6	2.2
	Adult female	5.0	0.2	85.1	3.9	28.4	1.3	52.8	2.4	70.3	3.3	86.3	4.0
	Subadult male	-	-	-	-	-	-	-	-	-	-	-	-
	Subadult female	10.9	0.5	194.6	9.0	65.2	3.0	21.8	1.0	29.7	1.4	24.4	1.1
	Subtotal	24.3	1.0	356.4	16.5	170.9	7.9	122.1	5.6	174.2	8.1	157.3	7.3
SUMMER	Adult male	37.3	1.3	327.6	11.4	42.4	1.5	19.4	0.7	16.1	0.6	6.3	0.2
	Adult female	46.4	1.6	318.1	11.0	41.8	1.5	11.4	0.4	17.3	0.6	7.1	0.2
	Subadult male	25.1	0.9	143.0	5.0	23.2	0.8	32.3	1.1	43.3	1.5	30.7	1.1
	Subadult female	32.1	1.1	216.6	7.5	22.6	0.8	23.5	0.8	33.4	1.2	7.3	0.3
	Subtotal	140.9	4.9	1005.3	34.9	130.0	4.6	86.6	3.0	110.1	3.9	51.4	1.8
AUTUMN	Adult male	23.8	0.8	171.2	5.9	26.6	0.9	44.0	1.5	7.3	0.3	5.0	0.2
	Adult female	3.0	0.1	158.2	5.5	2.2	0.1	48.9	1.7	21.2	0.7	7.0	0.2
	Subadult male	4.5	0.2	179.9	6.2	10.8	0.4	63.0	2.2	13.8	0.5	2.2	0.1
	Subadult female	14.2	0.5	163.2	5.7	11.6	0.4	54.0	1.9	8.0	0.3	0.0	0.0
	Subtotal	45.5	1.6	672.5	23.3	51.2	1.8	209.9	7.3	50.3	1.8	14.2	0.5
WINTER	Adult male	15.0	0.6	0.0	0.0	0.0	0.0	92.5	3.5	81.3	3.1	10.0	0.4
	Adult female	0.0	0.0	0.0	0.0	0.0	0.0	97.7	3.7	102.6	3.9	2.3	0.1
	Subadult male	0.0	0.0	0.0	0.0	0.0	0.0	100.6	3.8	60.0	2.3	5.0	0.2
	Subadult female	0.0	0.0	0.0	0.0	0.0	0.0	108.5	4.1	80.1	3.0	15.0	0.6
	Subtotal	15.0	0.6	0.0	0.0	0.0	0.0	399.3	15.1	324.0	12.3	32.3	1.3
Total		225.7	-	2034.2	-	352.1	-	817.9	-	658.6	-	255.2	-

In the spring the actual time spent in resting in the sun by the subadult females was significantly less than that by the adult males (P = 0.0164). Season was a significant (P = 0.0000) factor in determining the amount of time spent resting in the sun by the Arabian oryxes. Neither age and sex class (P = 0.7225) nor the interaction between age and sex class and season (P = 0.8138) were found to be significant factors in determining the amount of time spent resting in the sun by the Arabian oryxes. During the winter the oryxes spend significantly more time in resting in the sun than during both the summer (P = 0.0007) and the autumn (P = 0.0000). This is the result of different prevailing climatic conditions during these seasons.

Of all the observation time spent on all of the age and sex classes of the Arabian oryxes during the summer, 52.9% was on resting activities as compared with 29.2% for the winter. The relationship between increasing ambient temperature and the proportion of animals resting in the shade was highly significant (P = 0.0000) for the entire monitoring period (Figure 43). This is so despite the fact that only 32.5% of the variance in the percentage animals resting in the shade were explained by the variance in the ambient temperature (R^2 = 0.325). During the summer of 1995 the relationship between increasing ambient temperature and the proportion of the oryxes resting was also found to be significant (P = 0.0000). During this time 44.2% of the variance in the percentage animals resting in the shade could be explained by the variance in the ambient temperature (R^2 = 0.4415). These results show that there is a direct relationship between an increase in the ambient temperature and the degree of resting in the shade by the Arabian oryx in the 'Uruq Bani Ma'arid Protected Area during all the seasons, but especially so during the summer.

The variation in the time spent by an Arabian oryx in resting in either the shade or the sun during the different seasons appears to be related to solar radiation and therefore to ambient temperature. The advantages in resting in the shade during the summer months are obvious in that the animals are sheltered from direct exposure to the sun. The difference in the ambient temperature in the sun as opposed to that in the shade is severe, as indicated earlier (Chapter 6). In the present study it has often been observed that an oryx will scrape in the sand before lying down in the shade of a tree or shrub. This is done to remove the upper, warm layer of the sand so as to get to the lower, unexposed and consequently cooler sand before lying down. This would again help in keeping the body temperature low during the summer. During the summer when the ambient temperature can reach levels in excess of 45 °C in the shade an Arabian oryx probably builds up a heat load during the day that dissipates at night, as does the Beisa oryx and the gemsbok. The Beisa oryx adapts to a waterless environment by making use of adaptive heterothermy* (Taylor 1968; 1969). This



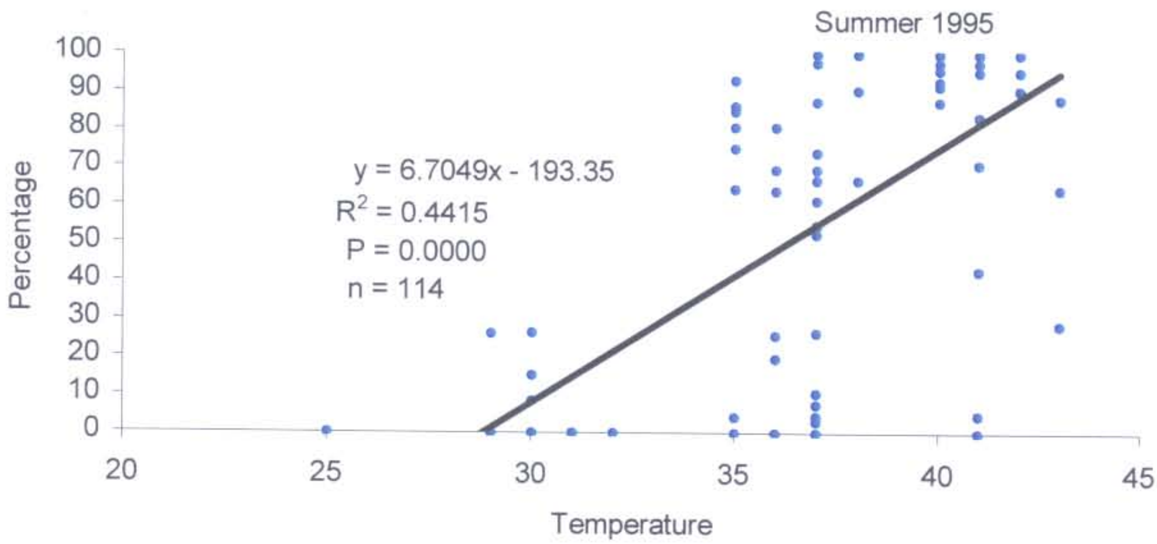


Figure 43: The relationship between increasing ambient temperature (°C) and the proportion of time spent by the reintroduced Arabian oryxes resting in the shade during each 30-minute period of the day as observed from 06:00 to 18:00 at different times in 1995 in the 'Uruq Bani Ma'arid Protected Area of the Kingdom of Saudi Arabia.

means that the oryx has an endothermic* ability to allow its body temperature to fluctuate in response to environmental stresses (Grenot 1992). This is done by accommodating extreme body temperatures, and by decreasing the amount of metabolic heat produced. It is known that the Beisa oryx can increase its body temperature to a level in excess of 45 °C for as long as 8 hours (Taylor 1968).

Such hyperthermia*, has also been observed in gazelles. It enables these animals to prevent the loss of large amounts of water even under severe heat loads. This is accomplished by reducing the amount of heat gained, creating a smaller difference in temperature between the animal and its environment. It saves water and energy through a reduced need for evaporative cooling (Wilson 1989). This ability is considered to be the critical factor in the survival of these animals in desert conditions (Taylor 1968). It is also known that the Beisa oryx does not sweat when its body temperature increases above 41 °C. Instead these animals pant like a mammal carnivore to lose an excess of heat. During the high ambient temperatures of the summer, the brain of an oryx, which is more sensitive to high temperatures than the rest of the body, is therefore kept cooler than the rest of the body by a countercurrent cooling system in the cavernous sinuses. Cool venous blood from the nasal passages drains into these sinuses, reducing the temperature of the arterial blood on its way to the brain (Taylor 1969).

Resting and ruminating

Ruminating takes place while an animal is standing up, lying down or walking around (Innis 1958; Dagg & Foster 1976). During the present study, ruminating was recorded only when an Arabian oryx was standing or lying down because it was not possible to distinguish whether an animal was chewing freshly plucked food or was ruminating while walking.

During the spring no significant differences ($P = 0.5891$) exist in the actual time spent on ruminating by the different age and sex classes. During the other three seasons, season was found to be a significant ($P = 0.0000$) factor in determining the amount of time spent by the oryxes in ruminating, while neither the age and sex class ($P = 0.7253$) nor the interaction between the age and sex class and season ($P = 0.8618$) were significant factors.

The Arabian oryx spends most time in ruminating during the summer, and the least in doing so during the winter. The difference between the actual time spent ruminating by all the oryxes in the summer and winter was significant ($P = 0.0000$). Significantly more time ($P = 0.0002$) was also spent on ruminating by all the oryxes in the summer than in the autumn.

Elsewhere it has been indicated that the Arabian oryx changes its diet during the hot summer months, as does other grazers (Chapter 7). The amount of time spent in ruminating during the summer is possibly linked to the high fibre diet consumed by the animals during such time. During the autumn, however, many of the perennial plants in the 'Uruq Bani Ma'arid Protected Area show signs of fresh growth, even before the first rains (Chapter 6). The animals are therefore able to feed on succulent, fresh, sprouting vegetation that probably requires less rumination. Dieckmann (1980) found that the gemsbok in the Hester Malan Nature Reserve, South Africa, spends the least amount of time on ruminating during the late winter (July and August). This was attributed to the diet of the gemsbok, which mostly consists of ephemerals* during this time. These plants are succulent and require little rumination. The low levels of rumination during the winter in the present study are probably partly due to the increased walking activity in search for food.

Social activity

During the spring, the adult male Arabian oryxes were socially the most active of the three age and sex classes observed. In comparison, significantly more time was spent on social activities by the adult males than the adult (P = 0.0050) and the subadult females (P = 0.0432). Of all the social activities observed during the spring, 71.0% involved the adult males and 23.8% the subadult females. Adult females were involved in 5.2% of all the social activities observed during spring. Of all the social activities recorded for all ages of female Arabian oryxes, 83.0% were in response to courtship behaviour displayed by an adult male. Spalton (1995) showed that the condition of the vegetation and the subsequent physical condition of the females are the determining factors in the reproductive cycle of the Arabian oryx. The high rate of social activity observed in the adult males during spring is thought to be due to the fact that these animals had been in the wild for a short time only. As the animals came from more than one release group there was considerable interaction between the males in an attempt to establish a dominance hierarchy. Also important during this time was the fact that many females came into oestrus during the spring because of the good environmental conditions that existed then.

Multi-factor analysis of variance showed that significant differences exist in the time being spent on social activities by the oryxes in the summer, autumn and winter (P = 0.0137). There are also significant differences (P = 0.0184) in the time being spent on social activities by the different age and sex classes. The interaction between the age and sex classes and season relevant to social activities was not significant (P = 0.9598), however. On a seasonal basis all the Arabian oryxes spend significantly more time on social activities during the winter than during either the summer (P = 0.0312) or the autumn (P = 0.0267). Significantly different times (P = 0.0002) were also spent on social activities by adult males compared with adult females. Adult male Arabian oryxes also spend significantly more time (P = 0.0103) on social activities than do the subadult females. The generally reduced activity levels during the hot months can explain the lower frequency of social interactions that was found in the summer. The differences found between the times spent on social activities by all oryxes in the winter when compared with the autumn cannot yet be explained.

The fact that there is no significant difference in the time (P = 0.5827) spent on social activities by adult and subadult male Arabian oryxes during the summer, autumn and winter, indicates that the majority of social interactions observed during these seasons were between these two age and sex classes. During these seasons, the male Arabian oryxes were involved in 83 social interactions, 65.0% of which were associated with enforcing the dominance hierarchy amongst the male Arabian oryx. The remaining 35.0% was associated with sexual behaviour.

Activity synchrony within herds

The Arabian oryx in the 'Uruq Bani Ma'arid Protected Area is synchronised in its behaviour and an entire herd will change from one activity to another within a relatively short time.

Following Berry (1980) this is illustrated here by relating the active to the inactive periods, and expressing the one as a proportion of the other (Figure 44). From these data, two clear periods of activity are shown, which are interspersed with a major period of inactivity. The rapid change from activity to inactivity demonstrates the high degree of activity synchrony within the herds. This synchrony is to a large extent thought to be due to contagious activities as has already been reported by Dieckmann (1980) for the gemsbok. Most of these activities involve feeding and lying down. A large portion of the herd usually follows the lead of an individual. Once that individual animal starts to display a particular type of activity they all follow. These contagious activities are not observed in all ungulates and are at least in part related to the climatic conditions that the animals are subjected to. For example, in western Alaska it was found that the activities of moose were not highly synchronised, and synchronised activity patterns were not observed at sunrise and sunset. These results led to the suggestion that the moose in western Alaska does not have to maintain a specific diel rhythm during the winter (Gillingham & Klein 1992). Moose are, however, heat-intolerant (Renecker & Hudson 1986) and show higher levels of activity synchrony under warm conditions.

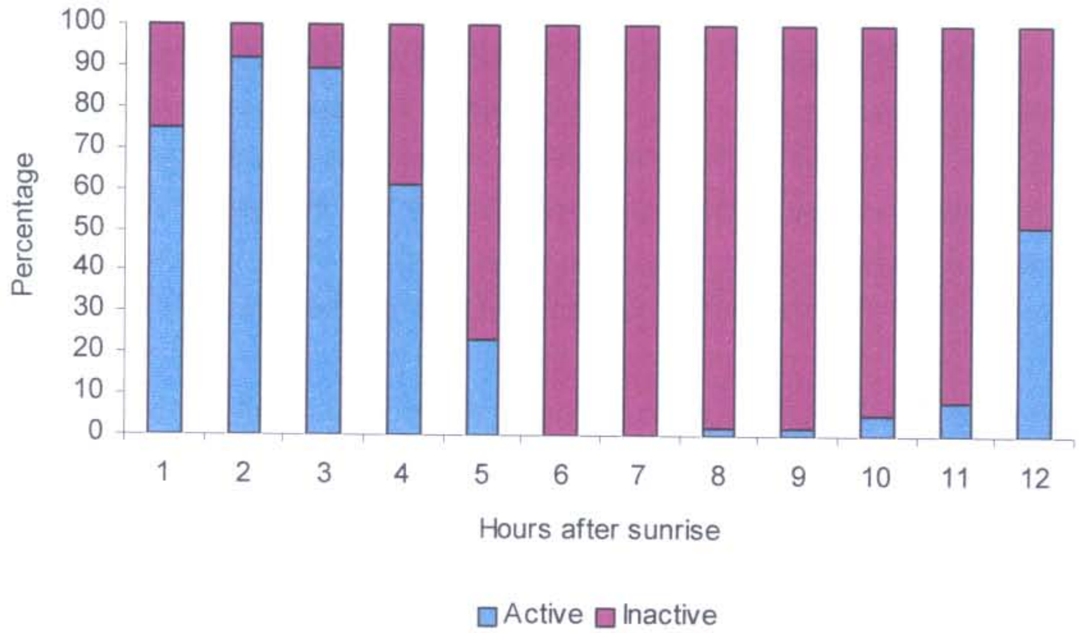


Figure 44: The proportion of time spent being active or inactive by the Arabian oryx in the 'Uruq Bani Ma'arid Protected Area of the Kingdom of Saudi Arabia as measured for 12 observations per hour for 12 hours during 1995.

Conclusions

The basic activity pattern of the Arabian oryx follows the typical pattern of diurnal ungulates, with feeding peaks in the early morning and late afternoon. This pattern is the same for all the seasons, despite the fact that more time is spent in feeding at night and in the early morning before sunrise during the summer. This activity pattern is similar to that described by Jarman & Jarman (1973) for the impala *Aepyceros melampus* (Lichtenstein 1812), Walther (1973) for the Thomson's gazelle, Petit *et al.* (1987) for captive Arabian oryx, Launay & Launay (1991) for sand gazelle and Kruger (1994) for giraffe. The daily activity of the Arabian oryx furthermore conforms to a polyphasic activity pattern as described in the Beisa oryx by Walther (1978). Activity peaks occur early in the mornings and late in the afternoons, and are associated with feeding behaviour.

The activity pattern of the Arabian oryx is driven by two main factors. They are the seasonal climatic conditions and the quality of the vegetation. Fresh growth in the perennial plants, and new growth of the annual plants are most likely after the spring rains, although some fresh growth also occurs in the autumn. Therefore spring and autumn are the seasons during which the Arabian oryx spends more time in feeding than in walking in search of food. By contrast, most time is spent on walking during the winter in an attempt to obtain enough forage of sufficient quality to sustain an individual during this lean period. The lowest level of activity in the Arabian oryx occurs in the hot summer months when the animals spend most of their day in resting. The increase in the percentage of individuals found resting as the ambient temperature increases, supports the suggestion that climatic conditions play an important role in determining the activities of the Arabian oryx. Reduced levels of activity in daytime in the summer are an important energy- and water-saving strategy that results in a decrease in the metabolic heat produced by the Arabian oryx.

In the 'Uruq Bani Ma'arid Protected Area, the grazing activity of the Arabian oryx occupies 29.2% of the total time, while 41.1% of such time is spent in resting, including rumination. The fact that the Arabian oryx spends more time resting and ruminating than in feeding suggests that the quantity and quality of the available vegetation was not a limiting factor to the number of Arabian oryx in the area during the study period.