Diurnal behaviour of mother-young pairs of Plains zebras (*Equus burchelli*) in Maasai Mara National Reserve, Kenya

Dygnsrytmen hos moder-unge-par av Burchell's zebra (Equus burchelli) i Maasai Mara Naturreservat, Kenya

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Photo: Sandra Blom

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Examensarbete, 15 hp, Etologi och Djurskyddsprogrammet

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CONTENT

ABSTRACT

The aim of the study was to investigate the diurnal behaviour of plains zebras (*Equus burchelli*). Data of 100 mother-young pairs were collected in Maasai Mara National Reserve, Kenya to record time budgets for grazing, walking, lying and standing behavior. Mares and their offspring where observed in 1-min intervals. Suckling behaviour of the foals and weather conditions was also recorded. The non-parametric Kruskal-Wallis test was used for statistical analysis and Pearson test for correlation.

My results shows that the zebras (mares and foals) were grazing significantly more in the afternoon then during the rest of the day, which could be the reason why they were walking significantly less in the afternoon. The adult zebras were standing least in the afternoon and the foals were standing most during midday. Almost no lying was observed in the adults but the foals had a peak in the morning and a absence of lying in the midday, but again at some extent in the afternoon.

The temperature rose during the day while the humidity decreased. More sun was present in the morning, while the afternoons were more cloudy.

By the results I can conclude that that the zebras is grazing all over the day but with a significant peak in the afternoon, which makes the other behaviours to be more concentrated at the earlier hours of the day. In the literature review for the study I found scientists that write about mares and foals which, to a great extent synchronized their behaviours. When I tested correlation it showed that the mares and foals synchronized the walking and grazing. I learned that there are a lot of factors that can affect the diurnal behaviours of the zebras, such as predator distribution, weather conditions, social behaviours and nutrient requirements. In my study I believe that the temperature and predation distribution had an influence on the zebras' behaviours. There is also some adaptions, namely to the habitat they live in which affects the diurnal behaviours.

SAMMANFATTNING

Syftet med studien var att undersöka dygnsrytmen hos Burchell's zebra (*Equus burchelli*). Zebrorna observerades i Maasai Mara Nationalreservat, Kenya och data från 100 stycken moder-unge par samlades in. Tidsbudgeten för beteendena beta, gå, ligga och stå registrerades för stona och deras föl med 1-minuts intervaller. Digivningsbeteendet av föl och vädret registrerades också vid varje observation. För den statistiska analysen användes det icke-parametriska testet Kruskal-Wallis test och Pearson test för korrelation.

Mina resultat visar att zebrorna (både ston och föl) betade signifikant mer på eftermiddagen jämför med resten av dagen vilket kan vara anledningen till att de gick signifikant mindre på eftermiddagarna. De vuxna zebrorna stod minst under eftermiddagen medan fölen stod mest runt lunchtid. Nästan inget liggande observerades av de vuxna djuren men fölen hade en topp på morgonen, medans de inte låg ner under lunch men sedan igen på eftermiddagen.
Temperaturen ökade under dagen medan luftfuktigheten minskade. Det var mer soligt på morgonen medans mer moln blåste in mot eftermiddagen.

Jag summerar därmed beteendena som att zebrorna betar över hela dagen men med en topp på eftermiddagen vilket gör att de övriga beteendena koncentras på förmiddagen. Jag fann att fölen och stona synkroniserade betandet och gåendet, som även det har påvisats i andra studier. Jag insåg att det finns många faktorer som kan påverka dygnsrytmen hos zebrorna, såsom närvaron av rovdjur, väderförhållanden, sociala beteenden och näringsbehov. I min studie tror jag att det var temperaturen och rovdjurens förekomst som styrde mycket av zebrornas beteenden. Det finns även en del anpassningar, framförallt till habitatet zebrorna lever i som påverkar dygnsrytmen.

INTRODUCTION

Zebras

According to Groves & Bell (2004) zebras can be classified into three groups; Plains zebras (*Equus burchelli* or *E. quagga*), Mountain zebras (*Equus zebra*) and Grévy's zebra (*Equus grevyi*).They also argument that Plains zebras have six subspecies, Mountain zebras two and Grévy's zebra none.

Plains zebras are geographically distributed from Kenya to South Africa (Grubb, 1981) and classified as Least Concern (LC) by IUCN (2008). Mountain zebras exists in South-West Africa (mainly Namibia) and South Africa (Penzhorn, 1988), classified as Vulnerable (VU). Grévy's zebras live in Ethiopia and Kenya (The IUCN Red List, 2008) and the species is the most threatened subspecies classified as Endangered (EN).

The migration of gregarious herds in Africa is well-chronicled, and the zebra is a participating species (Berger, 2004). Climatic conditions such as rainfall influence the migrations (Ogutu et al., 2008; Short, 1975).

The plains zebra (*Equus burchelli*) is considered to be one of Africa's most adaptable and successful grazers (Estes, 1991). Bennet & Hoffman (1999) and Fischhoff et al. (2007b) describe the social organization in equids as long-lasting non-territorial family groups with a stallion and one to a few mares with their foals, nonpermanent groups of bachelor or solitary males. Multiply family groups can form unstable herds, which group of bachelor males also can join (Fischhoff et al., 2007b). The Mountain zebras have breeding herds that inhabit home ranges but with extensive overlap (Penzhorn, 1988).

The Burchell's zebra is similar in its anatomy and physiology compared to other equids (Penzhorn, 1988; Bell, 1971; Klingel, 1969). Equidae are hindgut fermenters (Sponheimer et al., 2003) with a stomach, small intestines and hindgut (Bayley, 1978). The latter writer also states that the equidae normally ingest fibrous food which is predominantly digested in the hindgut, comprising the major part of its digestive system; the large intestine and caecum. Non-ruminant herbivores are able to exploit the vast amounts of cellulose in plants as an energy source (Bayley, 1978). The cellulose passes into the hindgut where it's hydrolyzed and catabolized by the micro-flora and releases volatile fatty acids (VFA).

Types of behaviours

The following part will be cited from Halle & Stenseth (1997) who write about the activity patterns in mammals. Every day consists of a 24-h daily cycle which can be called the activity pattern of a species. This pattern can be divided into two behavioural states: activity and resting. The most important activity is foraging, but there is also exploration and search for mates among others. The activity leads to an increase in mortality risk due to different dangers, such as predation. Due to locomotion activities, stress or thermoregulation the animals spend energy. To save energy the animal can rest, in a state where the energy loss is lower. During resting animals may perform "comfort behaviours" such as sleeping, resting and grooming. Resting can be seen as a luxury or a phase of recovery. In the case of zebras, one adult guards the group while the others rest (Grubb, 1981).

Diurnal rhythms

Nocturnal species are active during darkness and diurnal species are active during daylight, while crepuscular species primarily become active under the twilight conditions of dawn and dusk (Halle & Stenseth, 1997). The zebra is a diurnal species. In the same species activity patterns can vary, e.g. depending on seasons, the animal's sex, age or reproductive state (Halle & Stenseth, 1997).

There are many factors that can influence the activity pattern of an animal. Kamler et al. (2007) and Joubert (1972) list factors like temperature/climate, biological cycles, light and darkness, feeding bouts, phases of the moon, time of day/year, interactions and predation risks.

The time a zebra have to spend on feeding every day can depend on different factors such as its requirements of nutrients and energy, the availability of digestible food and at what rate the food can be ingested (Beekman & Prins, 1989). Since the zebras are hindgut fermenters they have to graze frequently throughout the day and night (Illius & Gordon, 1992; Janis, 1976). During the dry season the zebras have to drink at approximately once every day (Fischhoff et al., 2007b), which forces them to habitats not too far away from waterholes. During the wet season, Joubert (1972) noticed that the zebras could stay without water for two or more days. Grass constitutes over 95% of the zebra's diet (Gwynne & Bell, 1968).

To reduce the likelihood of being captured or encountered by predators the animals modify their behaviours as in habitat preferences and movement patterns (Bowyer et al., 1999).

Individuals in a group can encourage other individuals to do specific behaviours (Halle & Stenseth, 1997). By that a zebra can exhibit a behaviour it would not have done by its own, but do so in company with others.

Joubert (1972) noticed that temperature and rainfall were the two physical factors that affected the activity of Hartmann's zebra the most. He found that the zebras, while standing, nearly always orientated with the head facing away from the sun, even when standing in shade of a tree. When standing in this position the ratio of showing black versus white parts to the sun became 1:3; the lighter parts for radiation of heat. This is due to bigger white parts in the area around the tail (Illustr.1). In the lateral part of the body the black stripes are tighter and therefore the white parts more limited. And when colder temperatures occurred they orientated to stand laterally against the sun, apparently to raise their body temperature, and then changed the ratio to 3:1; darker parts for heat absorption (Illustr.2). The photos of illustrations are taken by Sandra Blom.

Illustration 1. White vs. black Parts ratio, 1:3.

Illustration 2. White vs. black parts, ratio 3:1.

Halle & Stenseth (1997) write that some behaviours are synchronized with the light over a 24-h cycle. Therefore animals exhibit different behaviours at different times in light or darkness. In the example of the zebra, they start grazing at first light and usually go to drink in the dark (Joubert, 1972).

Aims of the study

The aim of my study was to investigate the diurnal behaviour of Plain zebra mares and their offspring. I predict them to graze more in the middle of the day to prevent predation risks at dawn and dusk. I expect the foals to suckle for longer periods in the mornings. I believe that the foals should be more active; walking a lot.

MATERIALS AND METHODS

Caroline Gredmar recorded the data together with her fellow Swedish students Per Eriksson, Sara Gabrielsson and Maria Wagner as well as the Kenyan field assistants John Rakwa, Daniel Naurori, Jonathan Naurori, John Siololo, Joseph Temut, Caleb Ndema, Kimja, and Salomon.

Study area

The observations were carried out within the Maasai Mara conservancy area in the northern part of the Serengeti ecosystem in southwestern Kenya. The Serengeti-Mara ecosystem, an area of 25.000 km², situated on the border of Tanzania and Kenya, East Africa (34° to 36° E, 1° to 3°30' S). The main feature of this system is the support of the largest herds of migrating ungulates following a seasonal pattern, and also supporting one of the highest concentrations of predators in the world. The diversity of ungulates is extremely high; being 28 species, the major constituents being wildebeest 1.3 million, and Thomson's gazelles at 440.000 and zebras at 200.000. The Serengeti ecosystem consists of several conservation areas, the Maasai Mara National Reserve (MMNR) forming the northern portion. MMNR was formed in 1965 and make out 1.368 km² in southwestern Kenya (Broten & Said, 1995; Norton-Griffiths, 1995). Land use is restricted to wildlife tourism. The major conservation value is protection of wildlife and provision of critical dry season grazing resources for migratory populations. The MMNR is very important due to high rainfall, permanent water and high grassland productivity. The annual migrants stay for about four months (July-October) every year (Broten & Said, 1995). Temperature is relatively constant mean monthly maximum temperature of 27-28°C, minimum temperature varying from 16°C in October-March to 13°C during May-August. Rains usually follow a bimodal pattern, with the long rains during March-May and the short rains in November-December. Main dry period is from mid-June to mid-October, with a lesser dry spell in January and February. Rainfall in Mara is average 1.200 mm per year. The Serengeti is dynamic and during the last 30 years there have been both natural and human induced changes and it’s important to preserve intact assemblages of species and their habitats as functioning ecosystems.

Observations and recordings

Animals

In the present study, 100 Plains zebras (*Equus burchelli*) and their offspring, i.e. 200 animals, were observed. Since the number of foals was estimated to be around 5000 in the study area, the risk for observing the same zebra twice was very low. The foals were from newly born to close to weaning. The criteria of focal foals were that they had a brownish tinted coat with a fluffy appearance and the tail not reaching the hock when held in a vertical position. Observations were carried out between the 8th and 29th of August 2005. The methods were developed and tested in several weeks before. Data collection started at 7:30 and continued until 18:00 hours. All observations were carried out from a four-wheeled-vehicle with open safari roof. A writer recorded all the data in a field sheet. The car was kept within a distance of 30 to 150 m with the engine switched off. The GPS position of the car was taken with a handheld Garmin GPS unit at the start and end point of the observation. A rangemaster (Leica, LRF 1200 scan) were used to measure distance and direction to the focal animals, to get the actual positions of the nursing. Two persons

observed the animals; one the mare and one the foal. Only animals that seemed normal and healthy, i.e. not limping etc. were included in the study. Each observation started after finding a suitable mother–offspring pair.
When the first nursing occurred recording started and observation continued on the mare and foal until the next nursing. The duration of the suckling were timed using a stopwatch and the number of pauses were noted and the number of bouts of uninterrupted suckling. The suckling bouts and breaks were timed in seconds with one decimal. In the time between the two nursing meals, foraging and some other behaviour (grazing, standing, walking, running, lying and general social behaviour) were recorded at one-minute intervals. Other behaviours (head up when grazing, vigilance, grooming and other physical contact) and some behaviours were recorded continuously. The observation finished after the second suckling.

Behaviours

Grazing and locomotion behaviour were recorded at one-minute intervals. Definitions are given for the behaviours:
*Grazing***:** Ingesting or searching for food.
Lying: Belly on ground or side of belly on ground. If the animal performed an activity such as grazing, self-grooming etc. while lying, lying were recorded.
Standing: Belly off ground, the animal performed no other visible activity like grazing, moving, self-grooming or interacting socially with other animals. Animals watching alert are included in this category.
Walking: Moving slowly (up to 5 km/h) without performing any other visible activity.

Picture showing the behaviours standing, grazing and suckling in a group of Plains zebra. Photo, taken at 06:30 am in Maasai Mara National Reserve, by Sandra Blom

Suckling behaviour

The following details were recorded or calculated:
Meal: A distinct period of suckling including breaks shorter than one minute. If breaks were longer than one minute, the suckling was regarded as two meals.
Interval between meals: Time (minutes) between two meals.
Meal duration: Duration of suckling (seconds) including breaks of less than one minute.
Suckling duration: Duration of suckling (seconds) within a meal. Suckling included even breaks where the head remained in udder contact, for example when changing teat.

Weather

The air temperature (C°) and the relative air humidity (%) were recorded at the beginning and at the end of the observations; the mean values were then used. The weather were also recorded as sunny (clear sky with occasional clouds), cloudy (little or no visible sun) or the combination of sunny-cloudy. To calculate a sunshine index, sunny was transformed to the value of 10, cloudy to 0, and sunny-cloudy to 5. When the sunshine conditions differed at the start and at end of the behavioural observations, i.e. the two suckling meals, we calculated the mean of the two conditions for the entire observation.

Statistical analysis

Since the data were not normally distributed, statistical significance was tested with the nonparametric Kruskal-Wallis test. The results are presented as means ± SE. The data was also put in groups of three periods during the day, morning, midday and afternoon. Morning consists of observation made between 08:00-10:00 am, the midday of 11:00-14:00 am and the afternoon of 15:00-17:00 am. The correlation was tested with Pearson test to get correlation coefficients and P-values.

RESULTS

The temperature were a little bit lower in the morning and then almost constant during the rest of the day (Fig.1) ($P<0.001$). The humidity had a high peak in the morning and decreased during the day ($P<0.001$). The sunshine index, where 10 was sunny and 0 cloudy, was highest in the morning and decreased over the course of the day ($P<0.001$).

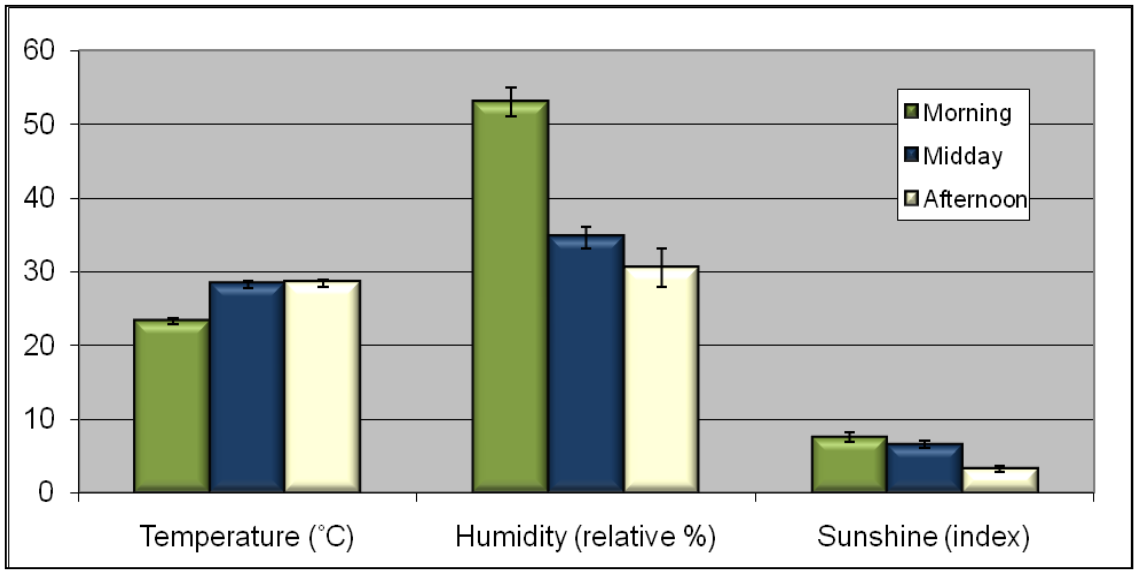

Figure 1. The weather conditions during observation period.

Grazing frequency of zebra mares increased over the course of the day, with a peak in the afternoon (Figure 2, $P=0.003$). Standing ($P=0.038$) and walking ($P=0.014$) frequencies in mares decreased during the day. Lying was almost absent in mares with no differences between time periods of the day.

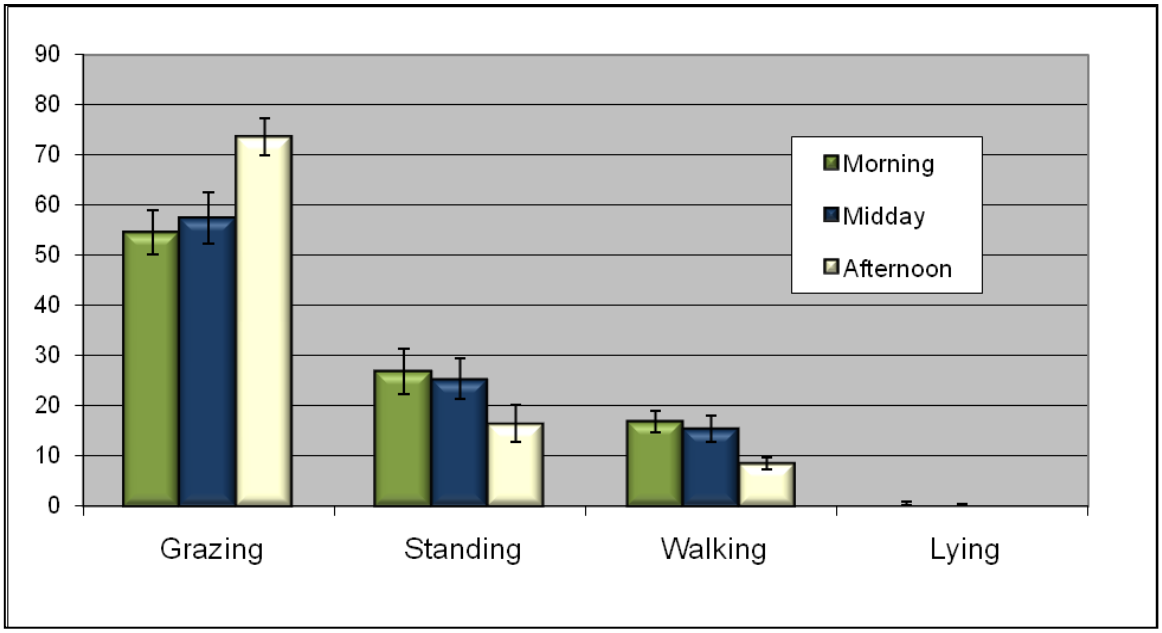

Figure 2. The diurnal behaviour of mares in percentage of observed time.

The grazing frequency of foals increased over the day and peaked in the afternoon ($P<0.001$). Foals were standing mostly at midday ($P=0.043$). They were walking more in the beginning of the day and the frequency decreased during the day ($P=0.032$). Foals were lying more in the morning, then the behaviour were nearly absent in the midday, with a small increase during afternoon. There was a strong statistical tendency ($P=0.056$).

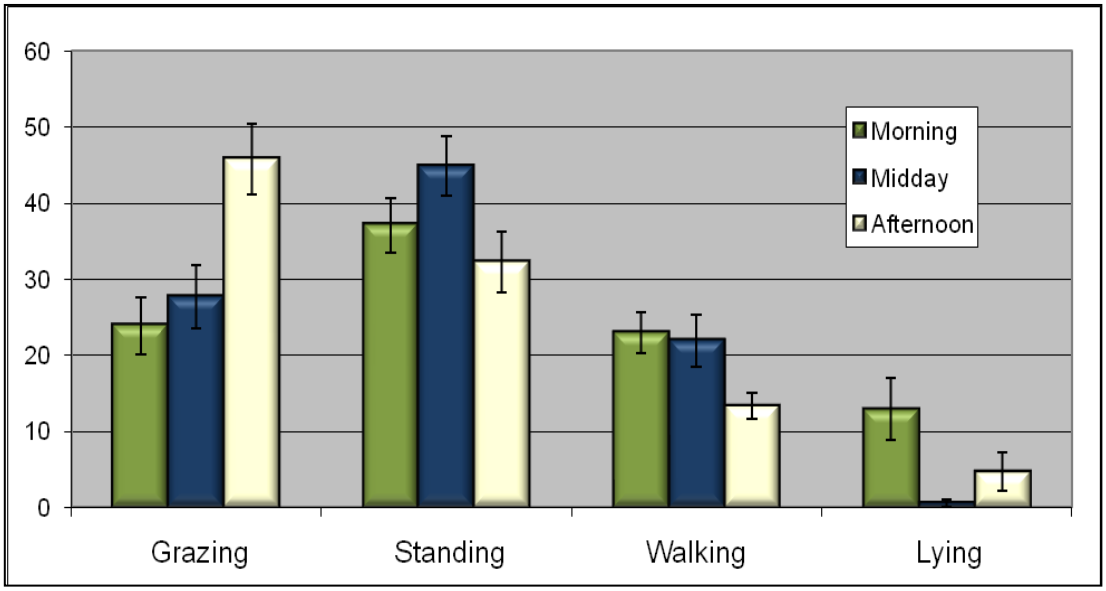

Figure 3. The diurnal behaviours, shown by the foals, in percentage of observed time.

There were no differences in the interval between the foals' sucking meals between different time periods of the day. The duration of meals was longer in the morning and then at a lower, almost constant rate, during the rest of the day ($P=0.022$).

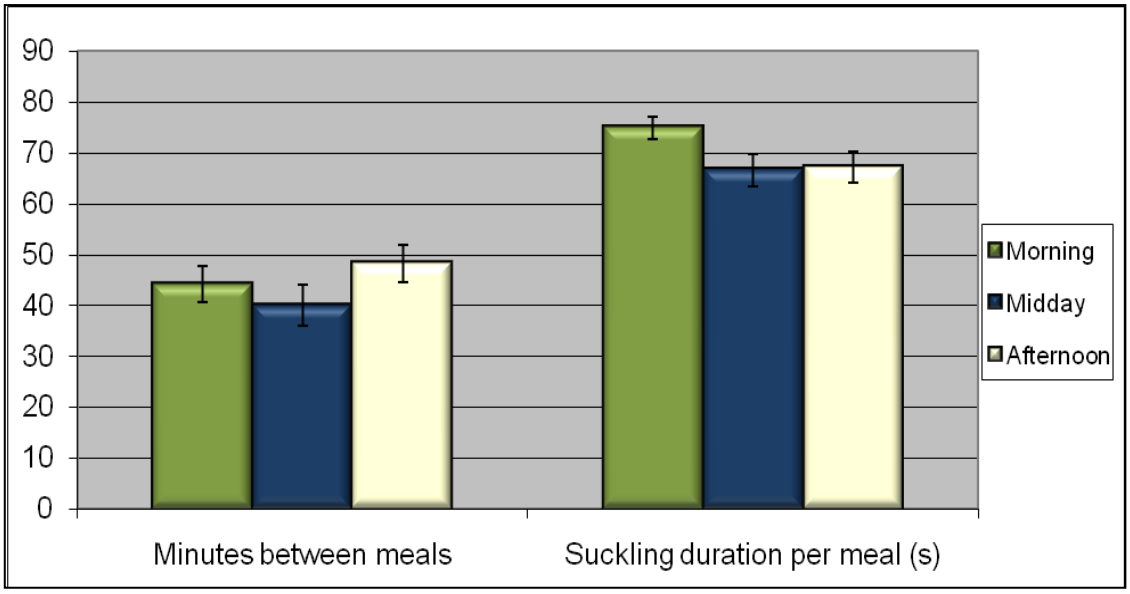

Figure 4. The suckling behaviour of foals.

There were a significant and high correlation (0.737) between mother grazing and foal grazing (P<0.001). A low but significant correlation (0.278) between standing with a P=0.004. The highest correlation were found in the walking with a P<0.001 and a correlation coefficient of 0.877. The lowest correlation were the lying with a correlation coefficient of 0.192 and with a significant tendency of P=0.055.

Table 1. Correlation test of the mare and the foals behaviours.

	Grazing	Walking	Lying	Standing
Correlation coefficient	0.737	0.877	0.192	0.287
P-value	<0.001	<0.001	0.055	0.004

DISCUSSION

The diurnal behaviours

Grazing

I expected the adults zebras to graze more in the midday because of the predation risk, it is the hottest hours and thereby the lions should be more inactive which could be a good time to waylay grazing. Though this was not the results.

The zebra foals in this study synchronizes their behaviour with their mothers, where almost all grazing by foals were done while their mothers were grazing. This consists with Estes (1991) and Crowell-Davis et al. (1985). The foals and mares in my study were grazing significantly more in the afternoon.

Much of the time is generally spent feeding in mammalian herbivores (Beekman & Prins, 1989). Grazing equidae spend up to 18 hours of their time per day to graze (Fowler & Miller, 2003; Houpt et al., 1986; Pratt et al., 1986; Crowell-Davis et al., 1985; Sweeting et al., 1984; Tyler, 1972). Three studies on Plains zebra shows that they devote around 60-70% of their time (out of a 24-h period) to grazing (Beekman & Prins, 1989; Gakahu, 1984; Grogan, 1978). Pratt et al. (1986) studied the horses with 24-h observations over a one-year period and Crowell-Davis et al. (1985) over a two-year period with observations from 05:00-21:00 hours.

According to Joubert (1972) the Hartmann's zebras have two peaks of grazing, one beginning just before dusk and ca 2 hours ahead and then again in the afternoon until sunset. The second peak consists with my results; my study did not include observations around dusk and very early morning since we had to find the zebras first during the first light hours. Fischhoff et al. (2007b) write that zebras prefer woodlands at night. I think it is possible that there is less grass to ingest and by that the efficient grazing decreases. Thereby the zebras might have to graze more in the evening before changing habitat and start grazing again in the morning when they move back to the open grasslands.

In periods when food is scarce, for example in the dry season, the flexibility to regulate its time budget can be a help to maintain intake requirements (Beekman & Prins, 1989). Bell (1971) concluded that the zebra can maintain eating a diet which contains too low level of protein to support a ruminant. The zebra has been seen to select not only the most fibrous part of the plant, but also the tallest (i.e., the oldest) strands (Bell, 1969) which have the highest cell wall content (Bell, 1971). So the zebra is apparently surviving on a diet containing less soluble nutrients and more fiber than is the wildebeest (Janis, 1976). Equidae obtain about 30-70% of their total digestible energy from microbial fermentation (Glinsky et al., 1976) of cellulose and hemicellulose in cecum and large colon (Duncan, et al., 1990; Hintz et al., 1978; Janis, 1976). From the microbial fermentation the highest concentration of VFA are produced (Hintz et al., 1978). To meet energy demands they have to consume food for 60% of their time (Tyler 1972; Bell, 1971) under best conditions and 80% under poor conditions (Bell, 1971). Gwynne & Bell (1968) wrote that the zebras have adapted their grazing by eating only the high-fiber and low protein of the grass. This gives them a lot of habitat in the savanna to graze on and also leaves the more nutritious parts for the wildebeests. Non-ruminants, as zebras, have a low coefficient of dry matter digestibility reaching about 42- 45% (Abaturov, 1995).

When able to harvest fresh green matter (which is of very high nutritional value) mares may decrease grazing time, often in spring- and summer-time (van Dierendonck et al., 1996; Duncan, 1992; Pratt et al., 1986). Beekman & Prins (1989) found that this appeared to fit also for the Manyara zebra, as they increase their grazing time to compensate for reduced food quality in the dry season and therefore the zebra is time-limited in dry season, since they have to work harder to achieve their nutrients.

Joubert (1972) writes that the zebras have a urine concentration ability, by behavioural thermoregulation (to seek shadow) and thereby minimize evaporative water loss.

Walking

Adults and foal zebras in my study walked the most in the morning which decreased during the day. The walking was strongly synchronized between the mares and foals. The mare and foal have a close relationship so it is not surprising to find that they, the most of the time, move together. The peak of walking in morning and midday could be related to walking back to the open grasslands. In the afternoon both foals and mares concentrate on grazing which limits walking frequency. Hartmann's zebras had two peaks of walking; in the morning and in the afternoon (Joubert, 1972). This could also be related to moving between habitats.

Standing

I found that when not grazing the zebras spend most time standing. This, however, does not consist with Joubert's (1972) study on Hartmann's zebra, which spent more time walking then standing. In my study the zebras were standing most in the morning, maybe to raise body temperature as explained before by orientation against the sun to absorb heat. They were standing the least in the afternoon probably due to the higher need of grazing which was shown in the results. The foals though did not show the same patterns as the mares. The foals spent significantly more time standing in the midday, this may be due to the temperature. If it is very hot, as it usually is in the midday, it is easier to cool down while standing. Then the wind covers more body surface standing then while lying down.

Horses prefer to rest standing, while the foals prefer to lie down to rest (Rifá, 1990), maybe because the foals can rise more easy and faster than the adults when needed or simply because they are guarded by their mothers. Bligh & Harthoorn (1965) showed that animals loose body temperature while standing still in the shade, which can be a good reason to do so during the hottest hours. Joubert (1972) observed Hartmann's zebras consistently seeking shade of a tree to rest standing underneath.

Lying

This study shows that young zebras in general spent more time lying than adults, which consists with Penzhorn (1988). This can maybe be explained by for example that the adults take longer time to rise, as mentioned above, the foals are growing and that takes a lot of energy which makes rest lying down an important behaviour or that young animals in general sleep more.

The mares were almost not lying down at all. By not lying down much of the time the harem males may be at look-out for intruding males, but also by being less vulnerable to predators, a behavior which is followed by the lactating females (Neuhaus & Ruckstuhl, 2002). When lying down zebras are more likely to be taken by lions (Estes, 1991). Adult animals have a bigger body size and surface, which in hot weather needs to be cooled down – and that is (as mentioned earlier) easier while standing. It is also not clear whether the

standing animals in this study did so in the shade or direct sunlight. If it were in the shade it could also be explained as resting. Joubert (1972) only observed adult Hartmann's zebra lying down on two occasions (out of observation during a 2-year period!)

Joubert (1972) found similar results as I did according to the lying behaviour of foals. Namely, that they have two peaks in lying during the day, the first and biggest in the morning and the second in the afternoon. This could also be related to the weather. At midday it is hottest and as the results shows the foals were standing the most during this time of day and thereby the behaviour of lying down were almost absent. Joubert (1972) also observed the foals to always lay down in direct sunlight, never seeking shadow. Maybe they did not want to leave their mothers to go away for shadow and then just lied down to rest nearby, sun or not.

Different studies show that adult zebras rarely lie down at all. However, during my time in the Maasai Mara National Reserve I though observed big zebra herds (containing several family groups) were almost one third were lying down. These observations were made at around 06:30 am in March 2009, which also could be seen in pictures from that time. At that time I did not reflect over it but since I have read studies that all says the opposite (including this one) I have to mention it here. Maybe the adults felt safer when being in a bigger herd, maybe because of the colder weather, or they could not recognize any lions in the area. Probably there are a lot of factors that affects the zebras' behaviours all the time, during day as well as night.

Suckling

If we look at the suckling duration per meal the shortest durations were during midday. So the foals prefer to suckle often and shorter times during the midday, probably because of the heat. The longest suckling durations occurred during morning, maybe by being hungry from the past night. Joubert (1972) showed that the foals of Hartmann's zebra suckled with two peaks a day, which were synchronized with the major two peaks in grazing by adult zebra.

Weather conditions

The temperature rose during the day with a mean of 27 ˚C and maybe that is why I found the zebras standing so much during the observed time; temperatures that needed cooling down of body temperature. Joubert (1972) found that the temperature had an influence on the time of the day when the majority of the grazing behaviour took place. During summer and higher temperature the grazing were more erratic then in periods with lower temperatures. The grazing in summer time was mixed with standing in shade, maybe to lower body temperature.

In my study the mean relative air humidity was 39 % but with a big peak in the morning, decreasing from the nights high relative humidity. It then decreased during the day. Joubert (1972) found no influence of the relative humidity in Hartmann's zebras.

My results show that the sun was most present during the morning and declined over the day with more clouds in the afternoon. Higher rates of grazing in the afternoon could therefore be explained by that the sun was not heating as much as in the morning.

Predators

The preys' distribution can be more affected by behavioral effects than direct consumption (Preisser et al., 2005). For large herbivores, like the zebra, increased vigilance behaviour leads to decreased grazing and changing habitat from richer to poorer but safer are long-term effect of anti-predation behaviour (Creel et al., 2007). It is good to be adaptable, as a zebra, and use habitat depending on lion vicinity.

The lion is the primary predator of zebras (Owen-Smith, 2008; Hayward & Kerley, 2005; Grubb, 1981) and should therefore have influence on the zebra's behaviour; especially on habitat use and anti-predator strategy (Valeix et al., 2009).

Valeix et al. (2009) found that the zebras preferred open grass-lands habitat when the lions were in the surrounding area, probably because of greater detection of the lions. That is also a good habitat adaption since the lions prefer to hunt in bushier habitats when they hunt during the day (Elliot et al., 1977). The lions though prefer to hunt at night (Schaller, 1972). Lions use open grasslands more often in the night then during the day, and the zebras do the opposite while choosing the woodlands more in the nights (Fischhoff et al., 2007b). When the lions are in the surrounding area they use the habitat in risk-sensitive ways (Valeix et al., 2009), which consists with the lion hunting strategy of stalk-and-ambush (Hopcraft et al., 2005). About 75 % of the times when a lion meet a zebra it results in the lion hunting the zebra (Mills & Shenk, 1992).

Social behaviours

Penzhorn (1984) found the synchronization of activities also by the Cape mountain zebra (*Equus zebra zebra*). Neuhaus & Ruckstuhl (2002) and Crowell-Davis et al. (1985) suggests this to be a strategy by equidae, the foals adapting the mothers behaviour so they early in life can learn how to optimize their time. By synchronizing their behaviours zebras also perform an effective anti-predator behaviour (Neuhaus & Ruckstuhl, 2002). Zebras rarely flee from predators but rely on stallion defence of a tightly knit harem group (Kruuk, 1972).

Joubert (1972) noticed that foals of Hartmann's zebra played the most when the adults showed most social behaviours in the morning, another example of highly synchronization of behaviours.

CONCLUSIONS

Adult zebras did not graze most in the middle of the day as I expected, but did so in the afternoon, a behaviour that increased over the day. A theory is that they do it to fill up the stomach before the night comes when the grazing would not be as efficient. They walked most during the morning with a decrease during the day, maybe to walk back to the open grasslands. The standing behaviour follows the same pattern and they were rarely lying down, maybe because of the predation risk.

Foals followed the same pattern while looking at grazing and walking. But they were standing more in the middle of the day, perhaps because of hot weather and lying down more in the morning and afternoon. Foals were, as expected, suckling for longer periods in the morning which could be because of the past night with fewer/none sucklings. In the midday and afternoon they suckled for shorter times than in the morning, maybe because of the weather. I thought that the foals would be active, as young usually are but by my results they were standing more than walking, maybe due to energy demands while growing.

I found that the foals and mares to a high degree synchronized their behaviours, maybe as an effect of living in a herd. But maybe as well so the foals learn how to optimize their time-budget.

There are a lot of factors that influences and affects the diurnal behaviours of the zebra. Therefore it is not strange that different studies are finding different results. In my study I believe that the temperature and predation risk had a big influence on the zebra's behaviours. But they can also be affected by other weather index, such as rainfall, light and darkness and humidity. Social behaviours and nutrient requirements are also important factors.

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