Diurnal Behaviour and Utilization of Shade in Masai Giraffes (*Giraffa camelopardalis tippelskirchi*)

Masai Mara, Kenya

Ulrika G Adolfsson

Supervisor: Jens Jung
Department of Animal Enviroment and Health

Sveriges lantbruksuniversitet
Fakulteten för veterinärmedicin och husdjursvetenskap
Veterinärprogrammet

Examensarbete 2009:1
ISSN 1652-8697
Uppsala 2009

Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Sciences
Veterinary Medicine Programme

Degree project 2009:1
ISSN 1652-8697
Uppsala 2009

CONTENTS

ABSTRACT

Observations were carried out in the Masai Mara National Reserve in south-western Kenya, which is the northern part of the Mara-Serengeti ecosystem in Kenya and Tanzania. Activity and behaviour of Masai giraffes (*Giraffa camelopardalis tippelskirchi*) was recorded with one-minute intervals for continuous periods of approximately twelve hours per day for two weeks in February and March 2007. The total observation time was 200 hours in females, 116 hours in males and 99 hours in offspring. The aim of the study was to investigate diurnal behaviour of the Masai giraffe and in particular their use of shade.

Adult giraffes in my study spent more than a third of their daytime foraging. The male giraffes in the study spent about the same time foraging as the females. The giraffes showed a peak of foraging in the late afternoon. Standing was observed mostly in the first half of the day. Lying was observed almost exclusively in offspring, mainly in early afternoon.

The giraffes did not use the shade in a very great extent neither for standing nor foraging. When they did use the shade it was during the hottest hours after noon. I suggest that giraffes save energy by minimizing energy-consuming activities at the most demanding hours of the day in favour of less energy-consuming activities such as standing. The use of shadow in my study was much lower than in other animals in the study area, e.g. wildebeest and zebra.

SAMMANFATTNING

Studien utfördes i sydvästra Kenya, i nationalparken Masai Mara. Parken utgör den norra fortsättningen av Serengetis ekosystem i Tanzania. Studiens syfte var att undersöka Masai giraffens (*Giraffa camelopardalis tippelskirchi*) dygnsrytm och dess nyttjande av skugga. Giraffernas beteende antecknades en gång per minut, under vanligtvis cirka 12 timmar per dag under två veckors tid i februari och mars 2007. Det totala antalet observationstimmar för honor var 200, respektive 115 timmar för hanar samt 99 timmar för avkomman.

Födosök var den dominerande sysselsättningen, vilket hos vuxna giraffer upptog mer än en tredjedel av deras tid och det fanns inga skillnader mellan hanar och honor. På eftermiddagarna sågs en tydlig ökning i andelen tid som lades på födosök. Girafferna använde inte skuggan i någon större utsträckning. När de väl gjorde detta var det under timmarna mitt på dagen när temperaturen är som högst. Det var tydligt att girafferna sparade energi mitt på dagen genom att vila. Giraffernas nyttjande av skugga var avsevärt lägre jämfört med andra djur i samma område, ex. gnu och zebra.

INTRODUCTION

The giraffe (*Giraffa camelopardalis*) is the world's tallest living animal (Baxter 2001). With of its very tall neck uniquely adapted to feed at a height unreachable to all other browsers that are unable to climb on trees. This spectacular mammalian adaptation to browsing has been an object of curiosity since prehistoric times. Even though giraffes are rather easy to observe due to their body size and their unique patterns that make individual identification easier, the knowledge about them is limited. About 10 000 years ago the giraffe was present throughout Africa, from Algeria and Morocco to South Africa (Dagg 1976) but can nowadays only be found at a few locations south of the Sahara desert in savannas, grasslands and open woodlands (Feldhamer 2003).

The giraffe

Taxonomy

The giraffe, the world's largest ruminator (Björnhag 1989), is an artiodactyla (the order of even-toed animals) and belongs to the family *Giraffidae*. This family also includes the okapi (*Okapia johnstoni*) (Feldhamer 2003). All giraffes are currently considered to represent a single species classified into multiple subspecies. The taxonomy of the genus *Giraffa* has been under discussion and is still yet not clear. The most commonly accepted theory up to just recently, included nine subspecies of giraffes distinguished by coat pattern, colour and geographical distribution in Africa. The latest theory, from Brown (2007), based on skin-biopsies and DNA mapping announced that there are *six*[1] different subspecies. However, there is most surely more to come in this debate. Three of these subspecies can be found in Kenya. The Masai Giraffe (*G. c. tippelskirchi)* is the most common specie and is mostly located in the southern parts of Kenya. The Reticulated giraffe, or Somali giraffe (*G. c. reticulata)* is located in the northern part of Kenya and the third one is the Rothschild giraffe (*G. c. rothschildi)* which is very rare in Kenya (Brown et al. 2007).

Status

As mentioned earlier the giraffes nowadays are not as geographically widespread in Africa as they used to be. According to IUCN red list of threatened species the giraffe population in Africa is estimated to more than 100 000 individuals and is classified as of least concern. But the giraffe is currently listed under the assumption that all giraffe populations are considered a single species and therefore also managed as such (Brown et al. 2007). A more recent estimation of the population indicates a decline in the total population and that the species most likely will receive a higher category of threat in a near future (www.iucnredlist.org). This is a very important step with regards to the conservation of giraffes. The West African giraffe, with its 100 remaining individuals, is highly endangered (Brown et al. 2007). Both Broten and Said

[1] West African giraffe (*G c peralta*), Angolan giraffe (*G c angolensis*), South African giraffe (*G c giraffe*), Rothschild giraffe (*G c rothschildi),* Reticulated giraffe or Somali giraffe (*G c reticulata)* and Masai giraffe (*G c tippelskirchi).*

(1995) and Ottichilo (2000) support the theory that the numbers of giraffes are declining. According to Ottichilo (2000) the numbers of giraffes[2] in the Masai Mara ecosystem have declined with 79% between 1977 and 1997. This is also applicable to other species; the total decline of all non-migratory wildlife species in the Mara during the same years was 58%. This is according to Ottichilo (2000) mostly due to climatic effects, habitat changes, competition for forage resources, poaching, counting errors and biases among other factors. The loss of woodlands in the ecosystem may be an important factor for the decline in the giraffe population (Dublin 1990). Leuthold (1978a) showed that a decrease in woody vegetation in Tsavo National Park in Kenya had an adverse and long-term effect on woodland-adapted herbivores, including giraffes.

Diurnal behaviour and time budgets

The pursuit to forage and search for food constitutes a very large portion of the daily activities of giraffes (Dagg 1976). Maintaining a positive energy balance is essential to all mammals and can be achieved by several behavioural factors involved in feeding. These factors include the choice of habitat in which to feed, the selection criteria by which individual food items are selected or rejected and the allocation of time spent on foraging and other energy consuming activities (Pellew 1984b). Activity patterns in animals are, however, not only influenced by the basic needs for food and water but also by thermoregulation, avoidance of predators, reproduction and social status (Leuthold 1977).

It is up to each individual to distribute its time and energy budget in order to maximize its own fitness, for example whether it is more advantageous to be active during day (diurnal species) or night (nocturnal species). The giraffes are, just like most of the other ungulates[3] of the African savannah, in various extents active during both day and night. Periods of activity are interspersed with resting phases spread throughout the 24 hours (Leuthold 1977). Giraffes spend parts of the night lying down, often ruminating but occasionally also sleeping for shorter periods (Pellew 1984a).

Prior research (Leuthold 1978, Pellew 1984a, Ginnet 1997) showed that there exist sex-dependent differences in activity patterns. Males, although much bigger than females and naturally having a larger food bulk requirement, spend less time feeding than females. According to Pellew (1984a) this is true for all times of the year. Shahar and Fairall (1987) explain these sex-dependent variations to the higher energy needs of the female giraffe during pregnancy and lactation

[2] Masai giraffe + reticulated giraffe = giraffe

[3] The meaning of ungulate is "being pawed" or "hoofed animal". They make up several orders of mammals, most of which use the tips of their toes, usually hoofed, to sustain their whole body weight while moving. Zebra, rhinoceros, hippopotamus, antelope, gazelle and giraffe are all examples of ungulate species.

Foraging behaviour and diet

Animal species have two fundamental concerns: to feed and avoid being fed upon. The concern about avoiding being fed upon is not as important in the life of an adult giraffe as it is in a smaller or juvenile ungulates life; a smaller sized animal is off course an easier target for predators. The pursuit to forage and search for food constitutes, on the other hand, as mentioned earlier a very large portion of the daily activities of a giraffe (Dagg 1976).

Herbivores are commonly divided into three sub-groups: grazers, browsers and mixed feeders. Grazers feed entirely on grass and other ground vegetation; browsers feed largely or exclusively on the upper part of vegetation (shrubs and trees) while mixed feeders obtain various proportions of their diet from both categories (Leuthold 1977). The giraffe, which is a browser, is a very selective feeder both from a macro and micro point of view (Pellew 1984a). On a macro scale the giraffe shows a very strong selectivity for specific forage species in a habitat, independently to these particular species' prevalence in the habitat. On a micro scale giraffes select specific plant parts of high nutritional quality. There are large differences in the nutritional qualities of available food items between seasons, species and plant parts of the same species (Pellew 1984a). With this though, the giraffe typically include more than twenty different plant species in to their diet (Leuthold 1972). Giraffes move considerably within their home ranges while eating (Leuthold 1977) which enables them to encounter and forage a wider variety of vegetation types than other browsers (Parker 2005).

The giraffe has small and thick papillae on the tongue and lips to protect the tissue from the thorns of the Acacia and other tree species' physical defence against browsing. The long pointed muzzle and the very mobile and extendable tongue are both adaptations for a highly selective feeding strategy. To my knowledge and available up-to date research there are no known major physiological differences of the gastrointestinal tract of the giraffe compared to other ruminators.

Water and thermoregulation

Giraffes are widespread in areas where the temperature sometimes exceeds 40ºC and possibilities to find water are scarce because of draught and the possibility to find shade is limited. The giraffes are able to cope with environmental factors like these, which otherwise could result in heat stress and dehydration because of several behavioral, physiological and morphological adaptations. The purpose of these adaptations is to maintain body temperature within physiologically acceptable limits, so-called thermoregulation and minimize water loss (Parker 1985, Feldhamer 2003). There are four primary routes of water loss in mammals: cutaneous (through the skin) and pulmonary (through the lungs) evaporation, feces and urine (Cain 2006). The effectiveness of these heat transfer processes depends on the temperature gradient between the animal and its environment (Parker 1985). Lactation is an additional route of water loss for females (Cain 2006).

AIMS OF THE STUDY

The aim of the study was to investigate diurnal behaviour of the Masai giraffe (*G c tippelskirchi)*, in particular their use of shade. I predicted, according to prior studies and available literature, that adult giraffes would spend a great portion of their time foraging and that they would not use the shade to a great extent.

MATERIALS AND METHODS

Study area

My study, with the aim of learning more about the giraffes and their habitat and with this hopefully contributing to preserve the species, was carried out in the Mara Triangle, which accounts for a third of the Masai Mara National Reserve (MMNR), a 1368 km^2 park reserve in south-western Kenya (Ottichilo 2000). MMNR is the northern continuation of the Serengeti ecosystem in Tanzania (Broten 1995). The area is mainly dominated by open savannah, but remnants of Balanites woodland are found mainly along the escarpment at the reserves Western border. Dense forests of different types are found along the Mara River and smaller streams. The park is famous for its exceptional population of wildebeest, zebras and gazelles and their annual migration (Ottichilo 2000); these animals stay in the MMNR during the dry season from July to November. Giraffes as well as elephants, buffaloes and several antelope species live permanently in the MMNR.

Animal observation

Giraffe activity and behaviour was recorded with one-minute intervals for continuous periods of approximately twelve hours per day. Recordings were carried out between 5th and 22nd of March 2007. The methods were developed and tested a week before this. There were five students and three field assistants participating in the study. The data collection could start when we had found a number of suitable giraffes and lasted usually between 8:00 and 18:30. Observations were carried out from a Toyota Hilux pick-up car. We followed the giraffes as closely as possible without disturbing; the distance was usually around 50-200 metres. Binoculars were used if necessary. Typically were four people observing one animal each and one person keeping track of the time and also the general environmental data. Each person filled in their own data-sheet. Every minute the animals' behaviour was noted and written down. We were able to recognize individual giraffes due to their sex, size, and pelage colour; when beginning a new observation we took pictures of the giraffes so that we could identify them as individuals later. The Masai field assistants estimated their age. We observed 63 individual giraffes, of which 21 were male adult giraffes and 34 female adult giraffes (i.e. > four years); of the females where seven lactating and 27 non-lactating. We also observed eight calves from newly born to close to weaning (up to approximately half a year). Juvenile giraffes were not observed. Giraffes usually gather in groups of a few animals, typically three to five, but the group could be much larger. Ideally we observed one male, one non-lactating female, one lactating female and her calf simultaneously. If the group split up we followed the calf and replaced the other focal animals by other giraffes of the

same category. The focal animals were observed during the entire day unless we could not follow them because of the terrain.

Definitions of behavioural recordings

Foraging: The giraffe was gathering, chewing or searching for food. If we were able to recognize the foraged species this was noted. If the giraffe was foraging of an unknown tree, unknown (u) was noted. If we could see that they were eating of a shrub, but the species could not be identified, shrub (sh) was noted. If the giraffe was eating from the ground but we could not see what it was eating, ground (g) was noted. If they were foraging in the shade, with more than 50 % of their body covered with shade, shade (s) was noted additionally to the foraged species. If the giraffe was drinking, water (w) was noted. The results of foraged plant species are presented in detail in Kearey (in press).

Standing: When the giraffe was standing without foraging or performing social behaviour. Standing could be combined with "head near ground" but not foraging, with standing in shade when more than half of body was in the shade, with vigilance when standing rigidly with its attention fixed on something in particular, and with ruminating. We combined this column with the look-column.

Walking: When the giraffe was walking without foraging or performing social behaviour. Walking could be combined with walking in shade when more than half of body was in the shade, with vigilance when walking rigidly with its attention fixed on something in particular, and with ruminating. We combined this column with the look-column.

Running: When the giraffe was moving fast without foraging or performing social behaviour. Running vigilant was recorded when the giraffe was running away from something, for example a predator. Run playfully was recorded when the giraffe was running in a playful way.

Lying: When the giraffe lied down. Lying vigilant was recorded when the giraffe was lying focused on something in particular. Lying could be combined with ruminating and being in the shade.

Missing observation: Recorded when we were not able to see the giraffe, e.g. when hidden behind vegetation. If we had not seen the giraffe for ten minutes we ended the observation of that giraffe and selected a new one.

Watching objects: When the giraffe was watching objects the object was recorded as people, predator, other mammal or avian species, other giraffes of the same group, giraffes of another group or on an object that could not be identified by the observer.

Statistic analysis

All results in the study are presented as means ± standard error of the means (SEM). For statistical reasons did we only use individual giraffes when they had an observation time of at least eight hours. In case animals had less, they were pooled according to their giraffe type. Hence, the 63 original animals resulted in pooled animals with an N of 15 females, 10 males and five offspring. The total observation time was 200 hours in females, 116 hours in males and 99 hours in offspring.

Since the data were not normally distributed, we analysed the frequencies with the non-parametric Kruskal-Wallis test.

RESULTS

The males in my study spent about the same time foraging than females. There were no differences in the frequency of standing between giraffe types. However, there were strong statistical tendencies that offspring spent less time foraging ($H = 5.76$, $P = 0.056$) but more walking ($H = 5.40$, $P = 0.067$) than adults. The frequencies of running were generally low but highest in offspring ($H = 6.15$, $P = 0.046$, all analysis Kruskal-Wallis test). Adult giraffes hardly ever lay down during the time they were observed and the offspring lay down in low extent. When the offspring did lie down it was for short periods during lunch hours. There were no statistical differences in the frequencies of lying or social behavior between giraffe types. Running, lying and socialisation each constituted less than one percent of the time observed.

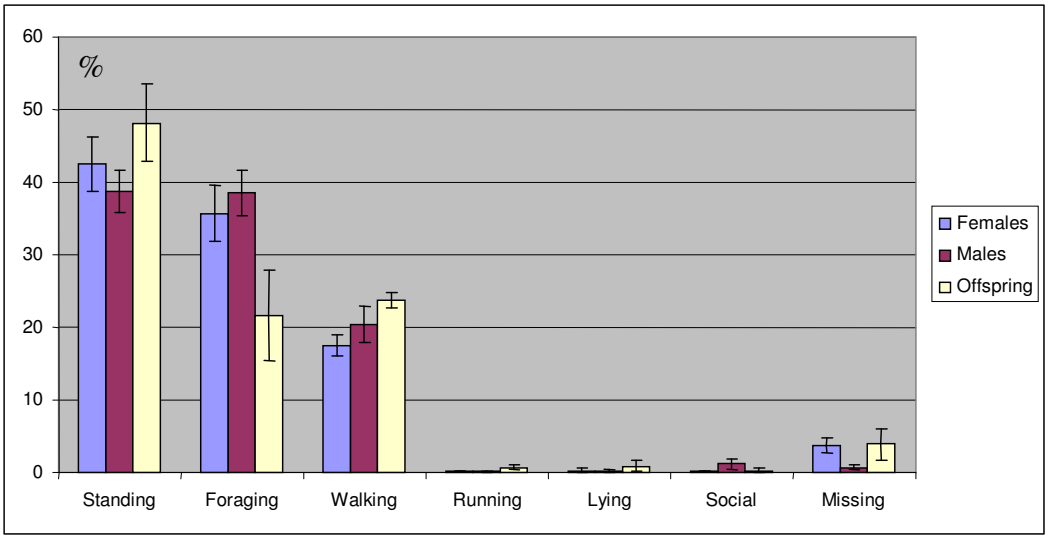

Fig. 1: Frequencies of main behaviours for different giraffe types.

When analysing all giraffe types together, the observation hour affected the frequencies of foraging ($H = 23.13$, $P = 0.010$, Kruskal-Wallis test), standing ($H = 33.37$, $P < 0.001$, Kruskal-Wallis test) and lying ($H = 20.67$, $P = 0.023$, Kruskal-Wallis test adjusted for ties). There was no affect on walking (Kruskal-Wallis test). The giraffes showed a peak of foraging in the late afternoon whereas lying

occurred mostly around noon. Standing occurred mainly in the first half of the observation time.

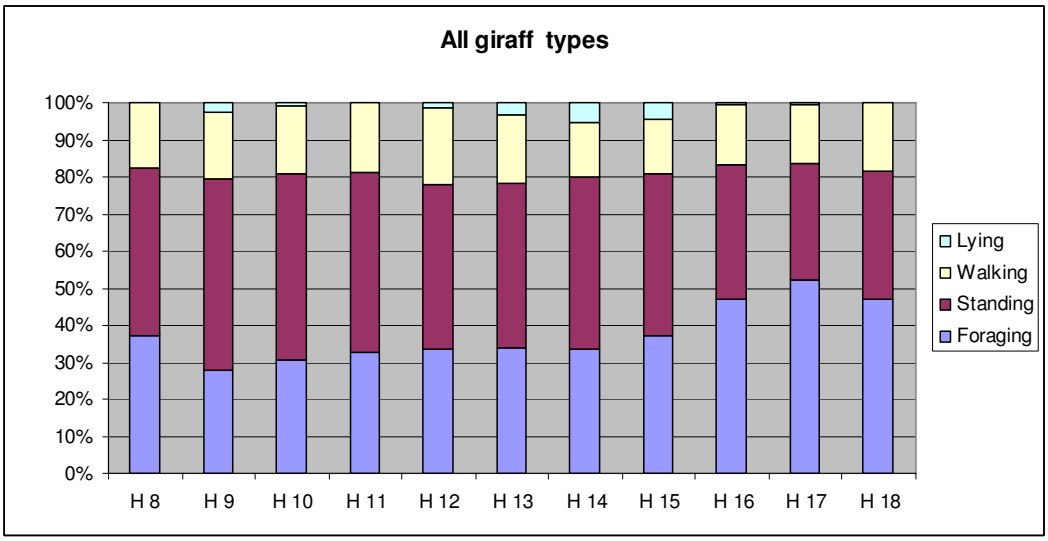

Fig. 2: Frequencies of main behaviours during the observation hours; all giraffe types. H8 (hour 8) ranges from 7:30 to 8:29 etc.

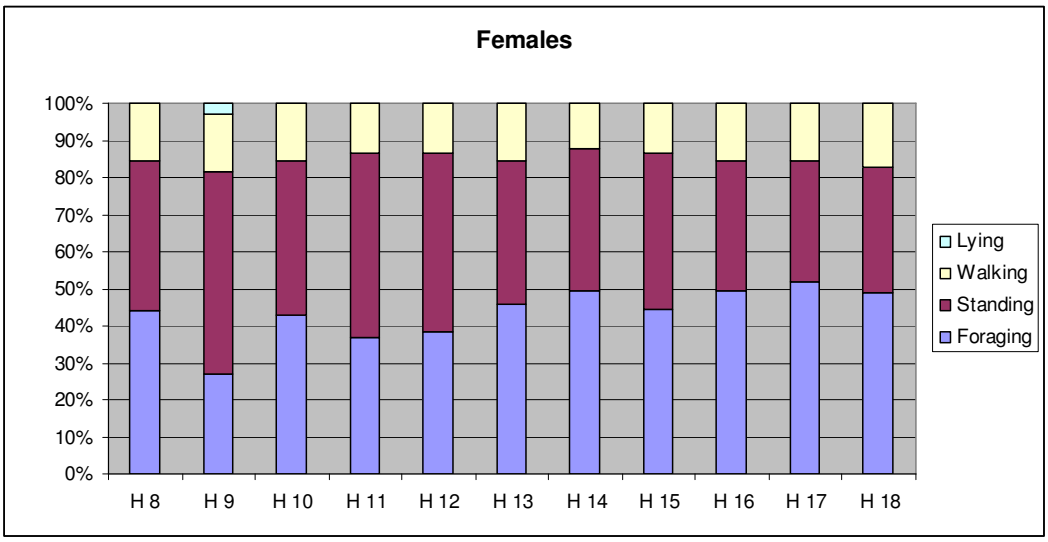

Fig. 3: Frequencies of main behaviours during the observation hours; females only. H8 (hour 8) ranges from 7:30 to 8:29 etc.

Regarding female giraffes only, there was an effect of observation hour on standing ($H = 18.21$, $P = 0.051$, Kruskal-Wallis test, $H = 18.36$, $P = 0.049$, Kruskal-Wallis test adjusted for ties). There were no effects on lying, walking or foraging.

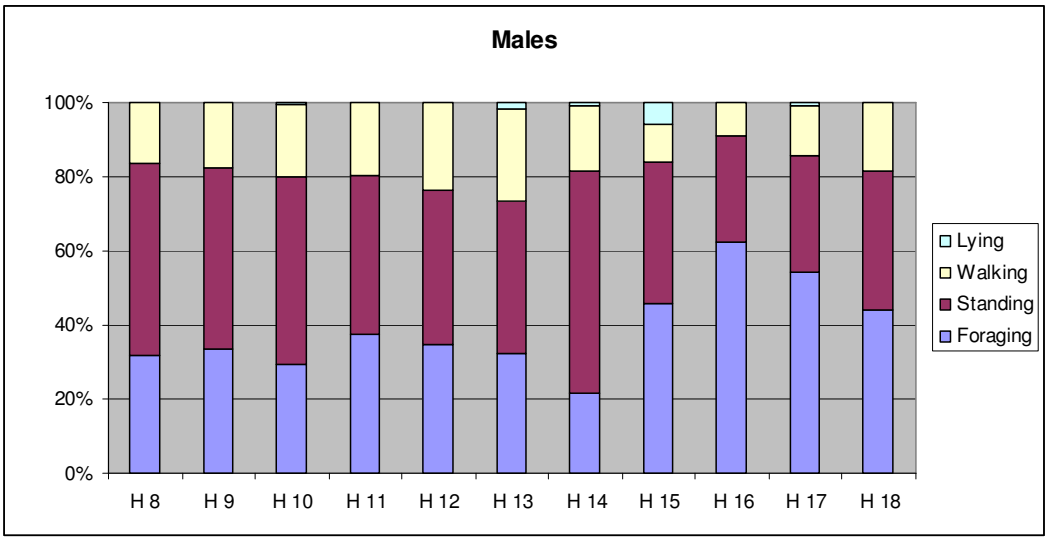

Fig. 4: Frequencies of main behaviours during the observation hours; males only. H8 (hour 8) ranges from 7:30 to 8:29 etc.

In male giraffes, there was tendency that observation hour affected foraging (H = 17.60, P = 0.062, Kruskal-Wallis test) and standing (H = 16.29, P = 0.092, Kruskal-Wallis test, H = 16.86, P = 0.077, Kruskal-Wallis test adjusted for ties).

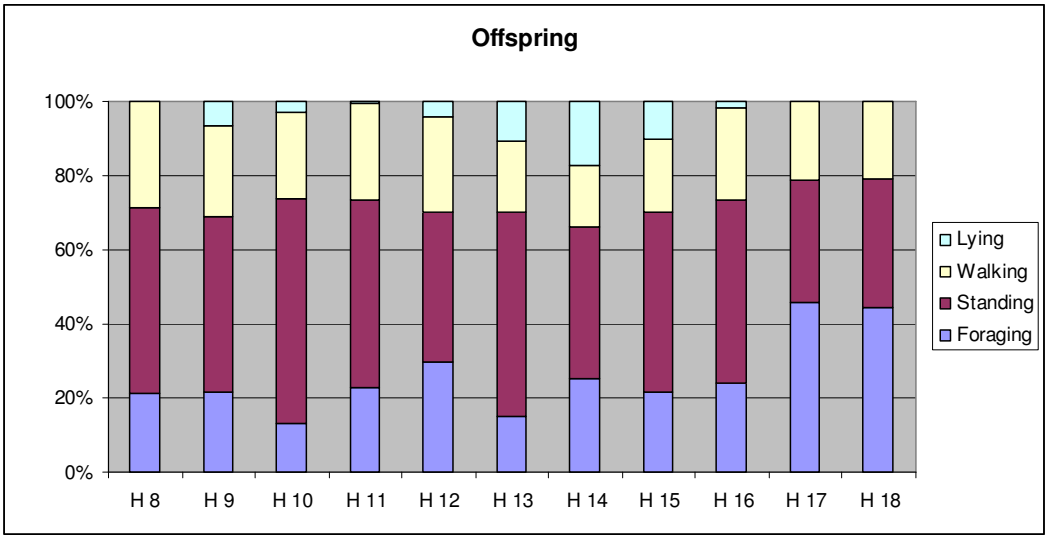

Fig. 5: Frequencies of main behaviours during the observation hours; offspring only. H8 ranges from 7:30 to 8:29 etc.

In offspring, only lying was affected by the observation hour (H = 23.32, P = 0.010, Kruskal-Wallis test adjusted for ties). Offspring were lying down mainly during the first hours after noon.

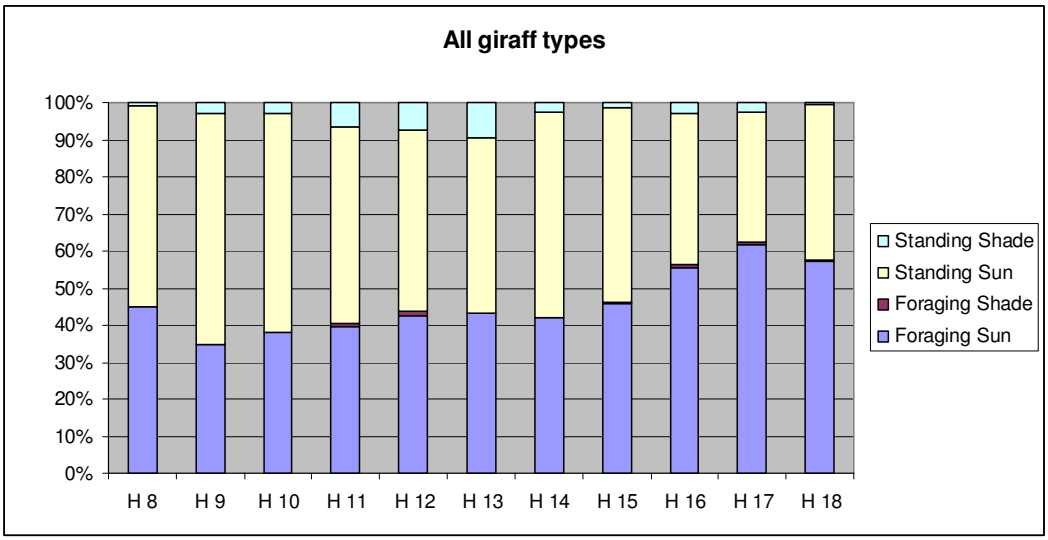

Fig. 6: Use of shade during the observation hours; all giraffe types. H8 ranges from 7:30 to 8:29 etc.

The giraffes did not use the shade to a great extent neither for standing nor foraging. When they did use the shade it was during the hottest hours after noon. The frequency of standing and foraging in the sun versus in the shade was affected by the observation hour ($H = 21.78$, $P = 0.016$, Kruskal-Wallis adjusted for ties).

DISCUSSION

To ensure the daily nutritional intake, which is crucial for surviving, the giraffe must continually modify its feeding behaviour, for example by spending more time foraging when biomass and quality of the ingested food decline in the dry season. According to Ciofolo (2002), the time the giraffes spent feeding during the dry season was twice the time spent during the rainy season. Our data were collected during February and March, which usually is in-between the short and the long rainy season. However, during the year of the data collection occurred very unusual heavy raining before and during our study. Hence, the vegetation was like in the rainy season.

As predicted was feeding a very important and time-consuming part of the daily activities of a giraffe. Adult giraffes in our study spent more than a third of their daytime foraging; females 36% and males 39%. This is very close to the 35 % of a study of van der Jeugd (2000) but inconsistent with Pellew (1984a). Pellew showed that giraffes in Serengeti, Tanzania, spent 65% (females) and 48% (males) of their time feeding in February and March. Possible reasons for this might be that either habitat effectiveness or food intake rate might be higher in the MMNR, Serengeti, Kenya than in the Serengeti, Tanzania. In the MMNR there is generally more rainfall than in the Serengeti, but as mentioned above, heavy raining prior to our study most likely had a positive effect on the growth and quality of the biomass and might have reduced the need of high foraging frequencies.

Contradictory to the results of other studies (Leuthold 1978b, Pellew 1984a, Ginnet 1997), the males in our study spent about the same time foraging than females. This is also inconsistent with studies of other herbivores where the females devote more time to feeding, such as blue wildebeest and red hartebeest (Ben-Shahar and Fairall 1987), waterbuck (Spinage 1968) and gerenuk (Leuthold and Leuthold 1978b). One explanation is that most females in our study were not lactating and did hence not need food to produce milk, although they might have been pregnant. Du Toit (2004) compared four African browsers that differed widely in body size, including giraffe, and found that increasing body size was associated with increasing time spent on feeding and also moving at the cost of less resting. One might expect such a result, increased body mass leads to higher metabolic requirements, also be applicable within the species. The giraffe bulls are bigger than cows and naturally have a larger food bulk requirement.

There are also sex-related differences regarding feeding adaptations. Both sexes spend over half their feeding time above two metres (Pellew 1984a, Leuthold 1972) but du Toit (1990) showed that giraffe bulls fed at an even higher level in the vegetation than cows, often with head and neck extended vertically. He suggested that bulls benefit from this by gaining access to nutritious new shoots in the upper vegetation canopy. Though, in this posture they may suffer an increased predation risk due to reduced vigilance.

The most intense feeding periods for a giraffe are the three-hour periods of post-dawn and pre-dusk. There is a marked decline in browsing activity during the midday period; reaching a minimum in the early afternoon when the ambient temperature is hottest. Ruminating diurnal behaviour reaches its maximum during the hot midday period. Ruminating is in giraffes the most dominant nocturnal behaviour (Dagg 1976, Pellew 1984a). After analyzing our data we could see a clear peak in the late afternoon in the amount of time spent foraging. There was though no corresponding peak during the morning hours, perhaps due to the fact that we could not observe at late afternoon and also not early morning until we had found a suitable number of giraffes. It is likely that the giraffes ruminated more during the most demanding parts of the day because this is less energy-consuming than wandering and searching for food.

Of all available literature I found, all but one showed that the dominant food sources of the giraffe are trees and shrubs of *Acacia spp.* (Parker 2005, Owen-Smith 1985, Dagg 1976). Contradictory to this, Pratt and Anderson (1982) found that acacias, even though present, were an insignificant part of the diet of the giraffe population in Arusha Park in favour of *Croton spp.* Hansen (1985) investigated and compared the botanical composition of the diet of giraffes and other ungulates (gazelles, wildebeest, zebra, buffalo and elephant) in Masai Mara National Reserve by micro histological analyses of faeces. The giraffes' diet was very dissimilar to the other ungulates. According to Hansen (1985) the plants most preferred by the giraffes were *Acacia spp.* (22%) and *Olea spp.* (20 %) in the dry season and *Hibiscus spp.* (17%), *Acacia spp.* (14%), *Grewia spp.* (13%) and *Olea spp.* (10%) in the wet season.

One of the most crucial and important processes for all mammals is to monitor and maintain its own body temperature within physiologically acceptable limits, so-called thermoregulation and if necessary also minimize water loss. If this is not properly obtained the animal will suffer from hyperthermia (heatstroke) and eventually die. As a general response to high temperatures many ungulates, both small and large, seek shade at the most demanding times of day

and/or significantly reduce their overall daytime activity (du Toit 2004). Thermal stress sets the upper limit on how much time a large mammalian herbivore can devote to foraging. Foraging increases thermal load through muscular activity and exposure to direct and indirect solar radiation (Owen-Smith 1998). When ambient temperature exceeds 32ºC giraffe activity level greatly reduces (Leuthold 1978a). Some African species, like wildebeest, gazelles, zebra and elephant takes it further than that and chose to migrate annually with the possible purpose of avoiding high temperatures, limited water availability and meagre forage conditions (Cain 2006). The giraffes never display these large-scale seasonal migrations, but within their individual home-ranges they show a small scale seasonal movement (Pellew 1984a). In the MMNR giraffes are commuting in and out between reserves and the surrounding areas.

It is obvious that the giraffes in our study did not use the shade to a very great extent, even though available, neither for standing nor for foraging. The utilization did increase some during the hottest hours around noon.[4] But why do not the giraffes utilize the shade more? As mentioned earlier the giraffes have several physiological and morphological adaptations enabling them to tolerate heat better than other animals; for example is their large size an advantage in dry and hot areas. Usually, being a large animal in a hot environment is not an advantage since the large animals have relatively less surface area for dissipating heat. But due to the giraffes' long extremities and long necks which greatly increase the effective surface area were heat can dissipate, this is not a negative factor (Dagg 1976).

Another important factor are the qualities of the pelage. While the core temperature of an animal is very closely regulated, the temperature of the skin can vary highly. The most crucial thermal quality of the pelage is its depth, density and color. In warm-climate ungulates decreases the thickness of the pelage with increasing body size and thermal conductance decreases with increasing pelage depth (Hofmeyr 1985). Hofmeyr suggests that natural selection has favoured protection against heat loss rather than protection against heat which is contrary to arctic mammals where heat retention has been favoured as larger arctic mammals also develop a thick pelage. In some ungulate species the thickness of the pelage varies on different parts of the body; the pelage is then thicker on dorsal (the back) than on ventral (the stomach) surfaces and can in some species be entirely lacking on some locations on the body, for example the scrotum, mammary glands and groins. Heat loss can be maximized at these locations (Feldhamer 2003). The color of the pelage is important in the aspect of solar radiation absorption (Hofmeyr 1985). Light-colored pelage reflects more radiation than dark-colored pelage (Cain 2006). So it is seems that the giraffes rather thin and light-coloured pelage is well suited for the environment they live in.

In addition to this the giraffes have a mechanism for cooling the air in the nasal passages before it is exhaled, so that the temperature of the air becomes substantially below body temperature. This helps conserving about half the water that otherwise would be lost if air was exhaled at body temperature (Langman 1989). The effectiveness of this heat transfer between the airstream and nasal mucosa in mammals depends on the dimensions of the nasal passages. When the anatomy of the nasal airways of ordinary cattle were compared to the

[4] Our definition of shade meant that more than half of the giraffes' body were in the shadow and protected from the sun's ray. When it was less than 50% it was not noted at all. The median temperature when our study was performed was XX.

anatomy of the giraffe[5], the cross sections of giraffe showed a much larger diameter and with this, area available for heat exchange (Langman 1979b). The giraffe seems therefore from this point of view anatomically better equipped for nasal heat exchange and water recovery than cattle.

In addition to these physiological and morphological adaptations to tolerate heat better they also have behavioral adaptations, for example body orientation. In 1990 Kuntzsch observed 290 giraffes and their behaviours according to summer (35ºC) or winter (16ºC) temperatures. Four main categories of body orientation were used: lateral (long axis of giraffe at right angles to the sun), anterior (facing the sun directly), posterior (facing away from the sun) and shadow. Only 5 % of the observed giraffes selected shadow at temperatures below 20ºC, 35 % faced the sun with their longitudinal axis (posterior and anterior) and 60 % were standing parallel to the sun's ray. At high temperatures this pattern was reversed. At lower temperatures giraffes tend to position themselves so as to absorb heat over the largest possible body surface, while minimizing heat uptake at high temperature positioning themselves with their longitudinal axis towards the sun or seeking shadow (Kuntzsch 1990).[6]

There is an obvious advantage in being able to survive on very small amounts of water, in case of drought and also from the point of view that the less an animal visits a waterhole the less is the chance of being attacked by predators there, which often awaits their prey near waterholes. Many authors share the common opinion that giraffes can survive many months without ever drinking water (Ciofolo 2002). I tend to agree due to the fact that during our study we hardly ever observed a giraffe drinking water, even though available.

CONCLUSIONS

The giraffe seems to be anatomically and physiologically very well adapted to hot and dry conditions and this in conjunction with their thermoregulatory behaviours could very well explain their success in exploiting open woodland and savannah habitats in Africa. The giraffe saves energy by minimizing energy-consuming activities at the most demanding hours of the day in favour of less energy-consuming activities such as ruminating. The giraffes did not use the shade in a very great extent neither for standing nor foraging. When they did use the shade it was during the hottest hours after noon. The males in our study spent about the same time foraging than females. The giraffes showed a peak of foraging in the late afternoon whereas lying occurred mostly around noon.

[5] The animals that were compared had approximately the same body mass and same head size.

[6] There was a significant deviation from the expected frequency of orientation (i.e. equal number of animals in all directions).

REFERENCES

Baxter E, Plowman A B (2001). The effect of increasing dietary fibre on feeding, rumination and oral stereotypies in captive giraffes (*Giraffe Camelopardalis*). Animal Welfare 10(281-290)

Ben-Shahar R, Fairall N (1987). Comparison of the diurnal patterns of blue wildebest and red hartebeest. South African Journal of wildlife research 17(2).

Björnhag G, Jonsson E, Lindgren E, Malmfors B (1989). Husdjur – ursprung, biologi och avel (209-227)

Broten M D, Said M (1995). Chapter 8 "Population trends of ungulates in and around Kenya´s Masai Mara Reserve" in Serengeti II; Dynamics, management and conservation of an ecosystem, edited by Sinclair and Arcese (1995)(169- 192)

Brown D M, Brenneman R A, Koepfli K, Pollinger J P, Milá B, Hergiadis N J, Louis E L, Grether G F, Jacobs D K, Wayne R K (2007). Extensive population structure in the giraffe www.biomedcentral.com/1741-7007/5/57 (downloaded 2008-11-26)

Cain J W, Jansen B D, Wilson R R, Krausman P R (2008). Potential thermoregulatory advantages of shade use by desert bighorn sheep. Journal of arid environments 72(1518-1525)

Cain J W, Krausman P R, Rosenstock S S, Turner J C (2006). Mechanisms of thermoregulation and water balance in desert ungulates. Wildlife society bulletin 34:3(570-581)

Ciofolo I, Le Pendu Y (2002). The feeding behaviour of giraffe in Niger. Mammalia 66(183-194)

Dagg A, Foster Bristol J (1976). The Giraffe – its biology, behaviour and ecology. Van Nostrand Reinhold Company, New York.

Dublin H T (1990). Does competition regulate ungulate populations? Further evidence from Serengeti, Tanzania. Oecologia 82(283-288)

Du Toit J T, Yetman C A (2004). Effects of body size on the diurnal activity budgets of African browsing ruminants. Oecologia 143(317-325)

Du Toit J T, (1990). Feeding-height stratification among African browsing ruminants. African Journal of Ecology 28(55-61)

Feldhamer, Drickamer, Vessey, Merrit (2003). Mammology: Adaptation, Diversity, Ecology (322-323)

Ginnet T F, Demment M W (1997). Sex differences in giraffe foraging behaviour at two spatial scales. Oecologia 110(291-300)

Hansen R M, Mugambi M M, Bauni S M (1985). Diets and trophic ranking of ungulates of the northern serengeti. The journal of wildlife management. 49:3(823-829)

Hofmeyr M D (1985). Thermal properties of the pelages of selected African ungulates. South African Journal of Zoology 20(179-189)

Kuntzsch V, Nel J A J (1990). Possible thermoregulatory behaviour in Giraffa camelopardalis. Zeitung Säugetierkunde 55(60-62)

Langman V A (1989). Passive obligatory heterothermy of the giraffe. Journal of physiology 415(89)

Langman V A (1979a). Thermoregulation and behaviour in giraffe (giraffa camelopardalis). Dissertation Abstracts International B Sciences and Engineering. 40:5(2070)

Langman V A, Maloiy G M O, Schmidt-Nielsen K, Schroter R C (1979b). Nasal heat exchange in the giraffe and other large mammals. Respiration Physiology 37(325-333)

Langman V A (1977). Cow-calf relationship in Giraffe. Zeitung Tierpsychologie 43(264-286)

Le Pendu Y, Ciofolo I, Gosser A (2000). The social organization of giraffes in Niger. African Journal of Ecology 38:1(78-85)

Leuthold M B (1979). Social organisation and behaviour of giraffe in Tsavo East National Park. African Journal of Ecology 17(19-34)

Leuthold M B, Leuthold W (1978a). Ecology of the giraffe in Tsavo East National Park, Kenya. East African wildlife journal 16(1-20)

Leuthold M B, Leuthold W (1978b). Daytime activity patterns of gerenuk and giraffe in Tsavo National Park, Kenya East African Wildlife Journal 16(231-243)

Leuthold W (1977). African ungulates – a comparative review of their ethology and behavioural ecology. Springer-Verlag Berlin.

Leuthold M B, Leuthold W (1972). Food habitats of giraffe in Tsavo National Park, Kenya. East African wildlife journal 10(129-141)

Oguto J O, Piepho H P, Dublin H T, Bhola N, Reid R S (2008). Rainfall influences on ungulate population abundance in the Mara-Serengeti ecosystem.

Ottichilo W K, Leeuw J D, Skidmore A K, Prins H, Said M (2000). Population trends of large non-migratory wild herbivores and livestock in the Masai Mara ecosystem, Kenya, between 1977 and 1997. African Journal of Ecology 38(202-216)

Owen-Smith N (1998). How high ambient temperature affects the daily activity and foraging time of a subtropical ungulate, the greater kudu (tragelaphus strepsiceros). Journal of zoology 246(183-192)

Owen-Smith N (1985). The ecology of browsing by African wild ungulates. Ecology and management of the world´s savannas.

Parker D M, Bernard R T F (2005). The diet and ecological role of giraffe (giraffa camelopardalis) introduced to the Eastern Cape, South Africa. Journal of Zoology 267(203-210)

Parker K L, Robbins C T (1985). Chapter 8 "Thermoregulation in ungulates" in Bioenergetics of wild herbivores by Hudson and White. (1985) (161-178)

Pellew R A (1984a). The feeding ecology of a selective browser, the giraffe (*Giraffa camelopardalis tippelskirchi*) Journal of zoology 202(57-81)

Pellew R A (1984b). Food consumption and energy budgets of the giraffe. Journal of applied ecology 21(141-159)

Pratt M D, Anderson H V (1985). Giraffe social behaviour. Journal of natural history 19(771-781)

Pratt M D, Anderson H V (1982). Population, distribution and behaviour of giraffe in the Arusha National Park. Journal of natural history 16(481-489)

Spinage C A (1968). A quantitative study of the daily activity of the Uganda defassa waterbuck. East African wildlife journal 6(89-93)

Van der Jeugd H, Prins H (2000). Movements and group structure of giraffe in Lake Manyara National Park, Tanzania. Journal of Zoology 251(15-21)

www.iucnredlist.org (downloaded 2008-10-28)