

**ACTIVITY PATTERNS SHOWN BY MOUNTAIN ZEBRA  
*EQUUS ZEBRA HARTMANNAE* IN SOUTH WEST AFRICA  
WITH REFERENCE TO CLIMATIC FACTORS**

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ABSTRACT

Free-living mountain zebra at the Daan Viljoen Game Reserve, Khomas Hochland, were studied over a two-year period. Attention was given to nutritional, social, comfort and excretory activities and the various activity patterns were determined. Different macro-climatic factors that may influence this behaviour were considered. Although daily activity patterns were variable, a basic pattern was perceivable. Temperature and rainfall were the two climatic factors which had the most marked influence on daily activity. Disturbance caused by insects also followed the seasonal variations of climate regarding temperature and rainfall. The mountain zebra has adapted itself to the climate in its habitat by evolving certain behavioural characteristics.

The daily activity of mammals has, until recently, been somewhat neglected, while other behavioural aspects, such as social behaviour, have attracted more attention. Recently however, the daily activity of the black rhinoceros *Diceros bicornis* was studied in detail in Kenya (Schenkel and Schenkel 1969) and in South West Africa (Joubert and Eloff 1971). In addition three papers have appeared in the East African Wildlife Journal. In the first of these Spinage (1968) advocates the standardisation of procedures for the study of ungulates. In his study of the defassa waterbuck, *Kobus defassa ugandae*, he uses the same method for a quantitative study of activity used for zebu cattle *Bos indicus* by Rollinson, Harker and Taylor (1956). Clough and Hassam (1970) used the same method in their study of the daily activity of the warthog *Phacochoerus aethiopicus*. Both these papers (Spinage as well as Clough and Hassam), however, are based on short observational periods of two to three days and a very limited number of animals (one waterbuck and three warthogs). The third paper by Owen, (1970), however, on the sitatunga, *Tragelaphus spekei*, is based on the number of sightings recorded in each hour of the day during a sample of 284 days over 15 months. Elsewhere, in a study on the Burchell's zebra, Klingel (1967) spent eight days and five nights to work out their activity pattern over 24 hours. During this period he watched a large number of animals and every 15 minutes noted how many of the animals were grazing, standing, lying or walking.

This present paper forms part of a larger research project on the ecology and behaviour of the mountain zebra in South West Africa which was carried out from the latter half of 1968 until June, 1971. For the larger project various study areas throughout the mountain zebra range were used. Most of the information in this paper, however, was collected at the Daan Viljoen Game Reserve.

The Daan Viljoen Game Reserve is located just outside Windhoek (28 km by road). It is approximately 4 000 hectares in extent, but the area in which the mountain zebra are confined is just over 1 100 hectares. It lies on the eastern side of the Khomas Hochland and is severely dissected by the Auegigas River and tributaries which form a part of the upper reaches of the

exoreic drainage system of the Swakop River. The Game Reserve is approximately 1 800 m above sea level in extremely broken, hilly country. The hills are composed of weathered mica-schists with steep slopes, especially on the eastern sides. The steepness of the slopes is mainly due to the geomorphological characteristics of the parent material. The drainage lines are very well marked and run in a series of parallel ravines in a northerly direction, each with lesser side branches from east to west.

The vegetation may be classified as montane savanna (South West Africa vegetation map by W. Giess, Herbarium, Windhoek). The vegetation on the hills is mostly open with scattered trees. Most of the tree growth is restricted to the drainage lines. On the hills the most prominent tree is *Acacia hereroensis*, averaging about 4 m in height. Most of these trees are stunted, although in sheltered areas they grow higher. Other trees on the ridges are *Ozoroa crassinervis* and *Combretum apiculatum*. Both the *Acacia* and *Combretum* show a marked browse line as well as extensive damage caused by kudu *Tragelaphus strepsiceros*. In the drainage lines the dominant tree growth is formed by *Acacia karoo*, *A. graffae* and *Ziziphus mucronata*. The tall shrub layer is formed by *Acacia mellifera* var. *detinens*, *A. hebeclada*, *A. reficiens* and *Euclea undulata*. *Rhus lanceolata* is found in the drainage lines while on the slopes one finds *Rhus marlothii*. The dominant perennial grasses consist mainly of *Anthephora pubescens*; *Enneapogon cenchroides*; *Schmidtia* spp.; *Stipa-grostis uniplumis* and *Aristida meridionalis*.

The area has a strongly seasonal climate with regard to both temperature and precipitation. Winters are almost totally rainless and virtually cloudless, with exceedingly low humidity. Precipitation occurs as summer convectional rainfall, with an annual mean of approximately 375 mm. During the summer months the relative humidity is extremely variable. Marked fluctuations in temperature, both daily and annually, occur. Summers have very high sun temperatures, but strong radiational cooling occurs after sunset. Winter temperatures are fairly low (often near freezing) at dawn but rise rapidly after sunrise.

#### PROCEDURE

The study area at the Daan Viljoen Game Reserve was visited monthly for periods of a week or longer. An attempt was made to visit the area during the two middle weeks of each month. Observations were always made from a vehicle. The procedure normally followed, consisted of locating a group of zebras as shortly as possible after first light; these animals were then observed from the vehicle at distances that varied from approximately 50 to 200 m until last light in the evening. The observer always attempted to have a drainage line between himself and the hill or slope occupied by the zebras, as this seemed to make them more at ease.

Notes on activities were jotted down at five minute intervals. At these times it was noted how many of a chosen group of animals were grazing or performing other activities. At half-hour intervals the irritation caused by insects was measured. For this the number of times an animal twitched its tail in one minute was counted. For accuracy a stopwatch and tally counter were used. This was done with three animals in a group and the average determined. Social behaviour was observed and noted throughout the observation period. The various activities were then divided into half-hour time intervals and the percentage of animals performing a certain activity determined. In other activities the number of observations during a one-hour time interval was

determined. For the figures delineating grazing, only observations made during 1970 are used. Each figure is based on one day each month so that the specific activity, temperature and relative humidity for that particular day could be correlated.

#### GENERAL DAILY ACTIVITY PATTERN

##### a. *Nutritional activities*

###### *Grazing pattern*

This behaviour pattern showed daily variations. It is, however, the activity that filled the best part of each day and when compared with other activities, is relatively stable. It was found that not all the animals were grazing at or shortly after first light. Normally however, from within half an hour after first light the grazing activity intensified to become one of the major feeding periods of the daylight hours. After two to three hours the activity slowed down considerably, with some of the animals grazing while others rested or engaged in other activities.

Even during the rest periods of the day hardly any time passed without some of the animals nibbling for a few minutes. The grazing activity intensified again from about 1500 h and normally reached its highest intensity shortly before last light. During the rest of the day the grazing pattern was rather erratic with feeding activity taking place at a leisurely pace.

From the grazing activity graphs (based on one average day for each month), Figs. 14-25, it will be seen that rarely do more than 90% of the individuals in a family group graze at any one time. This is due to the fact that the activity percentage is based on half-hour time intervals, each figure being an average of six observations. If, however, the five-minute observation periods are analysed independently, it is found that 100% of the family group were observed to be grazing together for 4,8% of the total number of observations per day during February; for October this figure rose to 20,8%. The reason for this dramatic increase during October will be discussed under seasonal variations. The periods when 100% of the family group were grazing were normally during the early morning or late afternoon, viz. during the two major daylight grazing periods. The fact that these animals do not normally all graze together at any one time probably results in increased vigilance.

While the animals are grazing there is a slow but almost continual forward movement. This movement normally takes a zig-zag course. While thus grazing the animal moves a considerable distance to the left and right of its forward direction, the zig-zag legs may be anything up to 100 m. As soon as the animals come to a patch where the grasses are more palatable, the legs of the zig-zag pattern may shorten to a few metres. Sometimes while grazing in this pattern, the animal moves back during the one leg on nearly the same line taken during the other leg. This manoeuvre brings them back to almost the same place where the zig-zag movement was initiated, sometimes as much as an hour earlier. This zig-zag mode of grazing nearly always follows the contours of the area in which the animals are grazing. Despite this, the animals sometimes stand grazing with the head pointed either down or up the slope. While a family group is grazing it is notable how many of the animals are facing the same direction. According to field observations this occurs with an average of 62% per family group under observation. The advantages if any, of this behaviour are not known.

Another very conspicuous trait is the lack of synchronized grazing between the dominant male

and the rest of the family group. Normally he only starts grazing long after the females have started in the morning and always continues some time after they have reduced their grazing intensity. It is doubtful whether this behaviour can be attributed to vigilance on the male's part. During his period of inactivity he always assumes the posture of sleep. When, on a number of occasions during these periods an alarm was given, it nearly always came from one of the females. It is of course possible that the male rests after having been vigilant throughout the night. Indications are, however, that the females have to feed longer owing to the drain of lactation. Sometimes a mare and her foal graze independently, away from the main concentration, sometimes as far as 200 – 300 m distant, before moving back again.

#### *Nutritional activities of foals*

Foals start grazing within a few days of birth although they remain dependent on their mothers until weaned. Fig. 1 shows the daylight suckling pattern of foals. This shows clearly that although suckling occurs throughout the day, two peak periods exist. These are between 0800 and 1000 h and again in the afternoon.

These two peaks coincide with the major feeding periods of the family group. The foals when desirous of suckling show a definite behavioural pattern. The foal approaches the female who is normally grazing and walks under her neck rubbing it against her shoulders (laterally and anteriorly). This normally forces the female to stop her forward movement while grazing. The foal continues with this 'crossing the bows' movement and ends up head to tail alongside the female and starts sucking. During the study period this movement by the foal was initiated in 49% of the time from the right side and in 36% from the left side of the female. On 15% of the occasions the foal tried sucking from behind between the hindlegs of the female. This approach was invariably unsuccessful, while the percentage of success with the former two approaches was quite high. The behaviour described above might be classified, according to Tinbergen (1951), as a social releaser. These are, according to Tinbergen, properties, either of shape and/or colour, or special movements serving to elicit a response in another individual, usually a fellow member of the same species.

New-born foals nurse with a very high frequency throughout the day. On the average about an hour passed between 'feeds'. The actual suckling lasts from 50 to 75 seconds. The foal then waits approximately 10 seconds before nursing again for never longer than 15 seconds. While the foal is suckling the female sometimes sniffs at their anogenital area. As the foals grow older the number of times they suckle during the day declines while the actual time spent suckling shortens to approximately 5–15 seconds. Their attempts to suckle also become less successful. This is especially noticeable from the time they reach the age of approximately six months. This forces them to spend more time grazing. They are weaned when they reach the age of approximately 10 months.

#### *Drinking*

Where the zebra are hunted they normally come down to water during the night, sometimes during late evening, before 2200 h, but more likely during the early morning hours after 0400 h. In areas where they are protected or undisturbed, as at waterholes high in inaccessible mountains, they drink at any time throughout the day. This was observed at the rainwater pans on the Naukluft Mountain plateau, and certain localities along the Kuiseb River, as well as in the Daan Viljoen

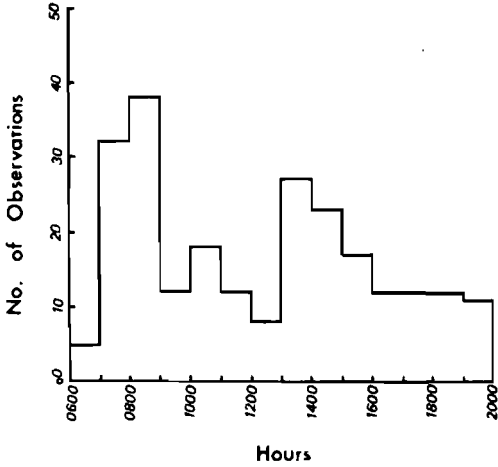


FIGURE 1  
Daylight Suckling Pattern of Mountain Zebra Foals.

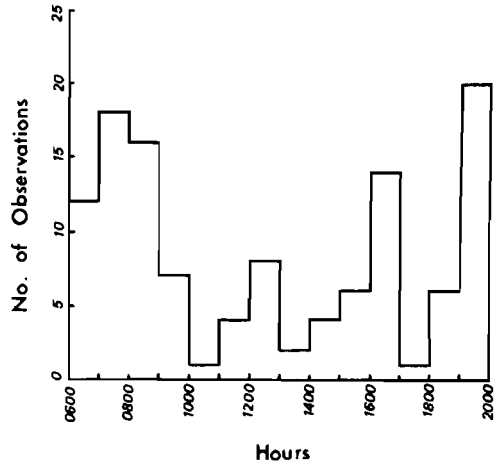


FIGURE 2  
Daylight Drinking Pattern of Mountain Zebra.

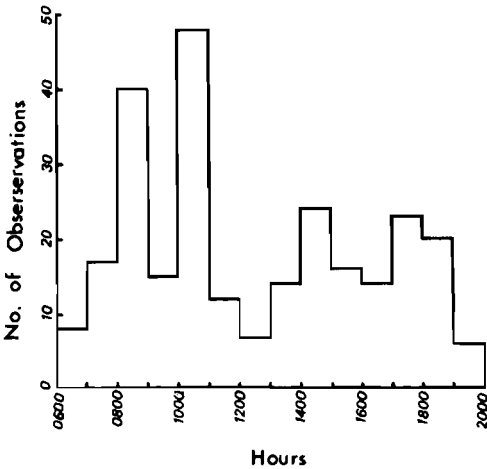


FIGURE 3  
Hierarchical activities of Mountain Zebra Females.

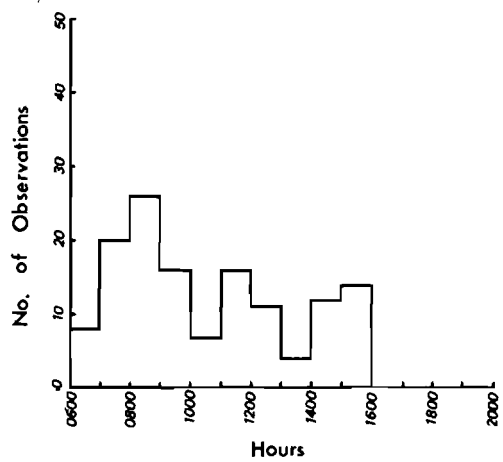


FIGURE 4  
Playing Pattern of Mountain Zebra Foals.

Game Reserve. They may visit the water at any time throughout the daylight hours with peaks from approximately 0700 to 0900 h and again from 1900 h. During the other hours of the day water is, however, also visited with reasonable regularity. When water is available they may drink daily, sometimes even twice daily, viz., early morning and late afternoon. It is not certain how long they can remain without water during the hot dry conditions but during the rainy season they might go two or more days without drinking (See Fig. 2).

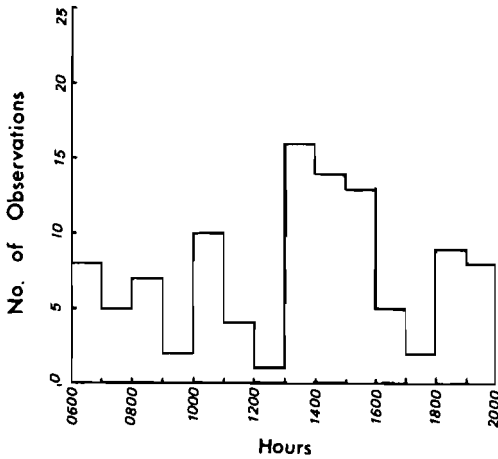


FIGURE 5

Pattern of Mating Behaviour in the Mountain Zebra.

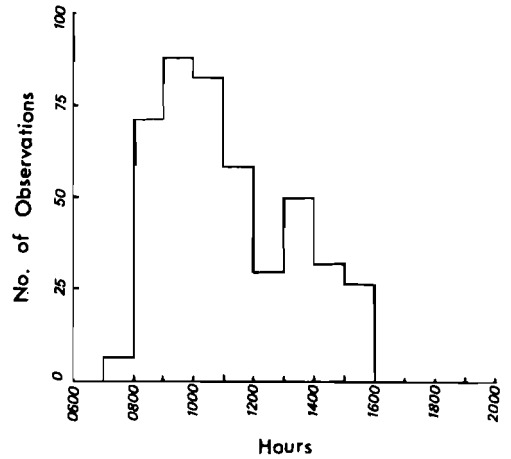


FIGURE 6

Resting in the Shade Pattern of Mountain Zebra.

## b. Social activities

### *Hierarchy*

Activities among the females of a family group to affirm social status occur throughout the day. These activities, however, are low during the high intensity grazing activity of the two major grazing periods. Rivalry activities become more marked as the percentage of animals occupied with grazing activities decreases. Fig. 3 shows a period of social activity of high intensity from approximately 0900 h. The other figures illustrating comfort movements viz. rubbing and rolling also show increased intensity from about the same time. This no doubt increases the competition for the best shade, rubbing posts and a better position in the dust-bathing sequence.

### *Playing*

This activity is indulged in mainly by the foals in a family group and the immature animals in the bachelor groups. In the former, play consists mostly of the running/chasing variety while with the latter it becomes more serious and consists mainly of play fighting. Play occurs almost throughout the day as can be seen in Fig. 4, but with an apparent higher intensity during the morning hours. This high intensity playing form 0700 to 1000 h coincides with the major morning activity period.

### *Mating*

Mating activity occurs throughout the day as shown by Fig. 5. Unlike most other activities, however, it shows a higher intensity during the afternoon from 1300 h.

### *Greeting rituals*

The rituals observed by dominant males whenever two family groups happen to meet do not vary at different times of the day. This behaviour is caused by the chance meeting of groups and no pattern is discernible.

### *c. Comfort activities*

#### *Resting*

This is very noticeable in the mountain zebra. They invariably rest in the shade of a tree. Even during some of the relatively cooler winter months zebras indulge in this activity. As shown in Fig. 6 this happens from as early as 0730 h in the morning, i.e. shortly after first light. No animals were ever recorded standing in the shade later than approximately 1730 h. No clear correlation can be found between the time most animals seek shelter in the shade and the peak of the temperature curve, apart from a small increase in resting between 1330 h and 1500 h. A large percentage of the family groups under observation normally sought shelter in the shade. Usually, however, one or two individuals will stay out in the sun, either resting or grazing.

Resting animals normally adopt the posture shown when in deep sleep, that is hanging their heads low – below shoulder height – with the ears held at right angles to the rest of the body and parallel to the ground. Depending on the amount of disturbance caused by insects the tail is switched in a regular rhythm.

#### *Dust bathing*

Zebras are compulsive dust-bathers. This activity is carried out with a very high frequency throughout the day and throughout the year. There is no clear indication of the advantage to the animal. One can only guess that it might reduce disturbance by insects. However, there is no decline in the rate at which this activity is performed during the winter months when the insects are virtually absent. From Fig. 7 one may see that dust-bathing shows a clear pattern with peaks after the morning's grazing activity declines and then again before the afternoon's grazing activity reaches its peak. Insect irritation did not appear to have any clear peaks. However, there can be no doubt that insects do cause a certain amount of dust-bathing, especially when the animals are resting in the immediate vicinity of dust-bowls.

Dust-bowls are normally located at predictable places, usually on saddlebacks or ridges of mountains or in the bottoms of the valleys that dissect the Khomas Hochland. They are usually situated in sandy or loamy soil and are approximately 2–2,5 m across and anything up to 30 cm deep. Sometimes there are a few located close to one another. Newly graded roads are also used. To lie down, a zebra bends its forelimbs and rest on its knees. It then lowers the hindquarters to the ground. On getting up, it gets onto its knees and then with a jerk pulls the hindquarters up. While lying in the dust-bowl it lies flat on its side, also resting the head on the ground. It then twitches the tail working dust between the higher parts of the hindlegs. It will then roll onto its back and back to the original position – it never rolls over completely. Foals however, sometimes do. After doing this three or four times it will get up and then lie down on the other side. The whole performance is then repeated. Sometimes the animals lie in this position in the dustbowl for several minutes before getting up.

#### *Lying down*

Adults were seldom seen to lie down except when about to indulge in a dust-bath. The only two cases observed were for pregnant mares, heavy in foal. In both instances they did not lie down for longer than 25 minutes. Foals however, lie down very often especially between 0900 and 1800 h with peaks during 0900 – 1200 h and 1600 – 1700 h as illustrated by Fig. 8. The length of time spent lying down varies between 5 and 35 minutes, with an average of 18,2 minutes (102

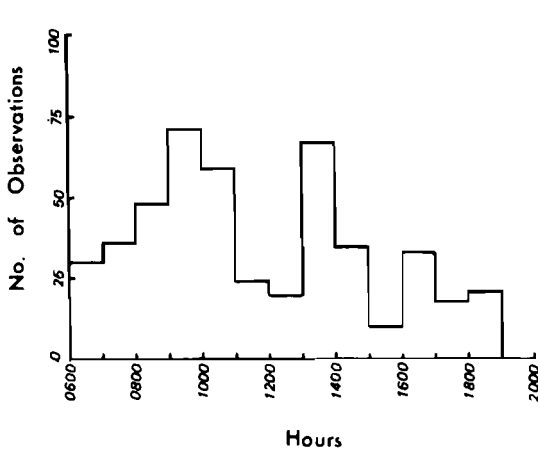


FIGURE 7  
Dust Bathing Pattern of Mountain Zebra.

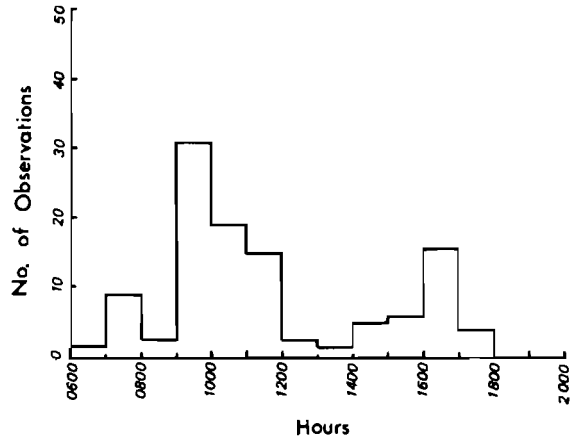


FIGURE 8  
Lying down Pattern of Mountain Zebra.

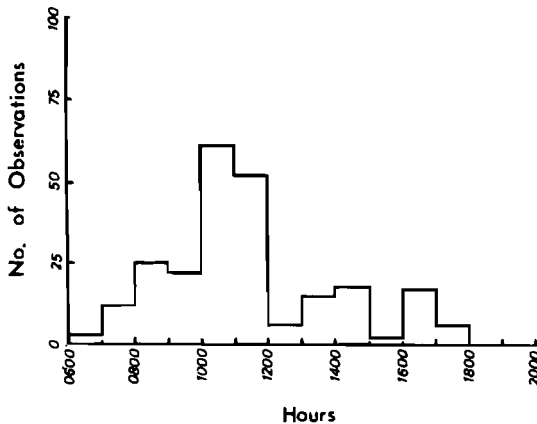


FIGURE 9  
Rubbing Pattern of Mountain Zebra.

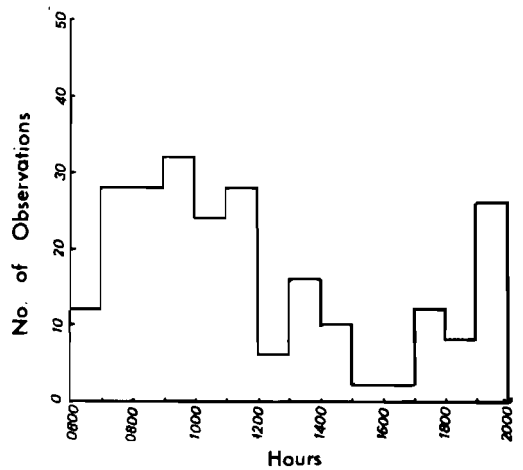


FIGURE 10  
Grooming Pattern of Mountain Zebra.

observations). An interesting aspect is that foals always lie down in direct sunlight and never in the shade. They always lie flat on their sides with their heads on the ground.

### *Rubbing*

This nearly always takes place while the animals are resting in the shade of a tree or under overhanging rocks. Animals were very seldom seen to interrupt their grazing just to rub themselves. The boles of trees were used to a very great extent although rocks were sometimes utilized. The brunt of this rubbing was normally directed at the neck and the side of the body. If the bole grew



at an angle or if a rock was used the animal would try and straddle it to rub the insides of the hindlegs and the rear part of the body. The face itself was very seldom attended to in comparison with the rest of the body. Only when a broken-off branch was available would this be used for scratching around the eyes and ears and sometimes the neck. They sometimes used the hind hooves to scratch their faces (Fig. 9).

#### *Grooming*

No grooming between adults of a family group was noticed and only very seldom by mare to foal. By foal to mare it was noticed with a little more regularity. This amicable behaviour by the foal no doubt serves to promote the maternal instinct in the female and also to inhibit aggressive behaviour. When observed by mare to foal as well as by foal to mare it normally consisted of nibbling the neck and mane. No 'licking' was ever seen such as is common in artiodactyls and certain carnivora (Fig. 10).

#### *Disturbance caused by insects*

That mountain zebra are disturbed by insects is quite obvious from the intensive switching and twitching of their tails at certain times. Observations in the field first led me to believe that insect activity is closely correlated with temperature and not with light. This seemed to be confirmed by the fact that the zebra showed signs of disturbance by insects only an hour or more after first light (i.e. after the air had reached a certain temperature) and continued for a certain length of time after the sun had set (thus not limited by daylight or the lack of it). When the field data was processed and graphs drawn the picture did not seem so clear, especially when viewed on a daily basis. True, insect activity apparently only started after the environmental temperature had reached a certain level. However, instead of the insect disturbance intensifying with the rising temperature it remained very erratic. This may be due to either of the following factors

- certain microclimatic influences which could not be measured.
- insects may be very localized in their distribution and only irritate the animals as they move through these areas.

The latter explanation might be the reason why certain individuals are sometimes much more irritated by insect activity than individuals 50 m away which show hardly any sign of irritation.

#### *d. Excretory activities*

##### *Defecation*

In the field, animals defecate any number of times, varying between three and eight times a day. Fig. 11 shows clearly that although defecation can take place at any time during the day, this activity reaches a peak during the morning high intensity grazing period. It was noticed sometimes that when one animal in a group defecated it acted as an expression movement and nearly all the other animals would then follow suit.

##### *Urination*

Urination does not take place simultaneously with defecation although it can precede or follow it by only a short interval. Fig. 12 shows that an animal urinates throughout the day, normally any number of times between five and thirteen.

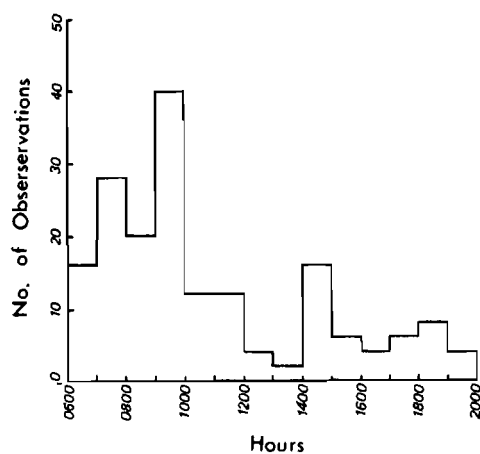


FIGURE 11  
Defecation Pattern of Mountain Zebra.

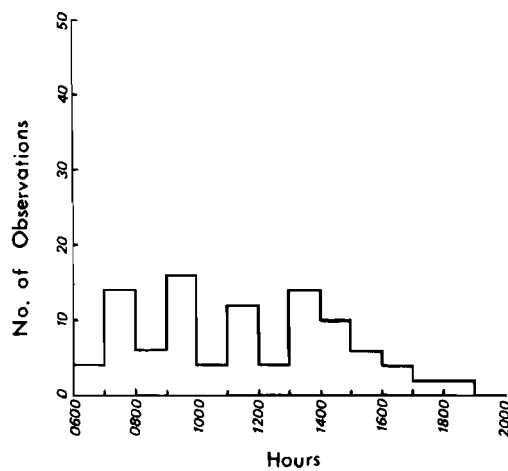


FIGURE 12  
Urination Pattern of Mountain Zebra.

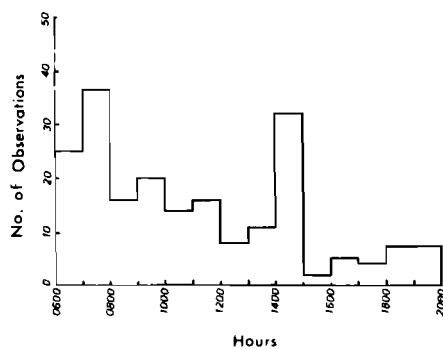


FIGURE 13  
Walking, without grazing, Pattern of Mountain Zebra.

#### e. Other activities

Under this heading all the movements necessary for animals to fulfil their daily needs, additional to those dealt with above, will be discussed.

The major activity here consists of walking while not actively grazing. This takes place throughout the day. From Fig. 13 it may be seen that this activity starts in the morning with a high incidence. It then declines gradually and suddenly intensifies dramatically again to reach a high peak during the period 1500–1600 h. Most of the other activities discussed elsewhere have very low intensity during this time interval with the exception of grazing activity which shows a tendency to increase. It is possible that the peak shown on the graph, together with the peak between 0700 and 0800 h, is caused by the animals moving into better areas for grazing. The high early morning intensity could be attributed partly to movement to, and from, water.

Klingel (1967) found that Burchell's zebra have a specific sleeping place to which they retire every evening. In the morning they leave this sleeping place and walk to the grazing area, sometimes as far as 13 km away. No such behaviour was ever noticed in the mountain zebra, in the Daan Viljoen Game Reserve or any other study area. They would spend their nights anywhere in the Game Reserve and start feeding at that particular place in the morning. The distance covered by day by the mountain zebra varies considerably and depends on such factors as condition of the grazing and season of the year. On the average they cover approximately 1 to 3 km per day grazing and at the most, 5 km going to water. Even at the Naukluft Mountain Zebra Park and in the Khomas Hochland they are remarkably sedentary. Running, caused by fright or other alarms occurs throughout the day with no clear patterns.

#### SEASONAL VARIATIONS DUE TO THE INFLUENCE OF CLIMATE

Owing to the lack of instruments and facilities to measure microclimate it is difficult to assess the influence of climatic factors on the behaviour of the mountain zebra in a more than general way. This paper will therefore deal only briefly with the many possible combinations of physical factors which may have an effect on the behaviour pattern. The mountain zebra is so well adapted to changes in its habitat, brought about by changing physical factors, that only very subtle changes in their activity patterns were observed. Furthermore it is only because of the repetitive nature of some of these 'subtle changes' in behaviour that one can, albeit with a certain amount of trepidation, try to link them to the annual changes in climate. In this regard, the physical factors that cause the most marked change in activities are temperature and rainfall.

##### *a. Nutritional activities*

###### *Grazing*

In Figs. 14 to 25, which depict the grazing patterns and daily temperatures for the various months, no obvious nor dramatic change is clearly evident. On studying the figures more closely, however, certain tendencies regarding temperature emerge.

- i That the grazing patterns during the colder months (June, July and August) are not as irregular as in the warmer months (October, November, December and January). During the warmer months the grazing intensity is initially very high, being over 70% at first light. It then shows a number of peaks during the day, with periods in between of very low grazing intensity. Bligh and Harthoorn (1965) in East Africa have shown with the aid of radiotelemetry that animals lose considerable body heat while standing inactive in the shade (see Fig. 26). The irregular grazing pattern shown by mountain zebra during the hot months may therefore be a form of adaptation; the animals graze in the sun until their body temperature reaches a certain peak, they then retire to the shade to lower their body temperature.
- ii The daily temperature at first light apparently has an effect on the intensity of grazing at this time of the day. During June, July and August the temperatures fell to below 20°C at daybreak. In each case only about 40% of the animals under observation grazed at first light. During the rest of the year the percentage of animals grazing at first light was well over 50%.
- iii Another interesting aspect is the change in the time of highest grazing intensity during the

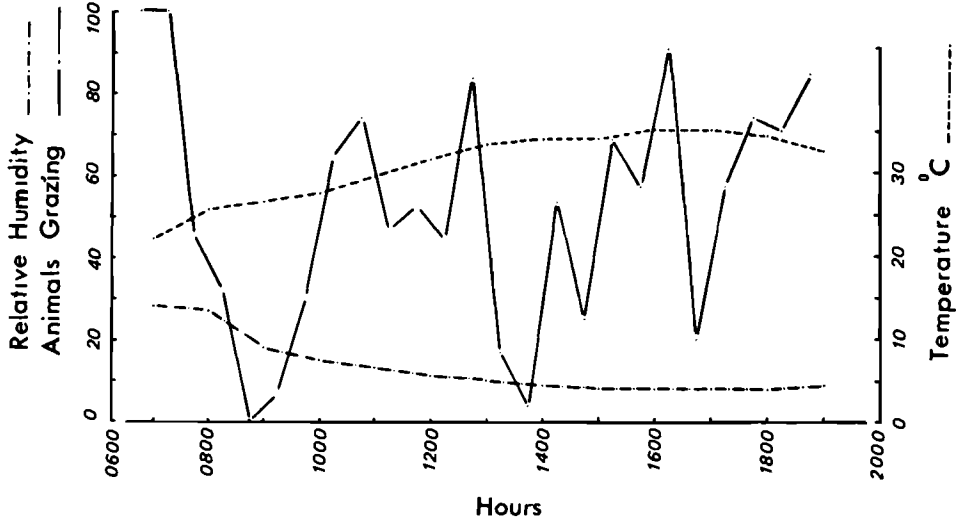


FIGURE 14  
Grazing pattern for January.

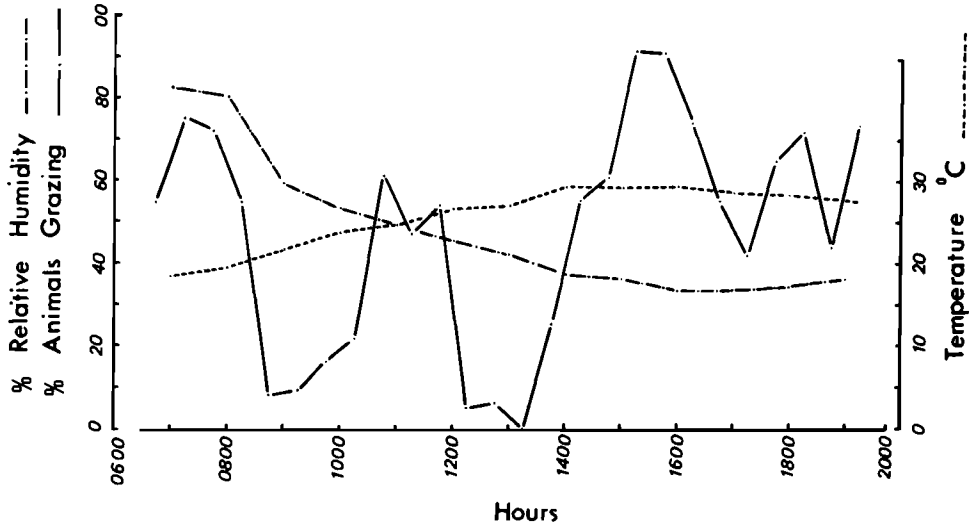


FIGURE 15  
Grazing pattern for February.

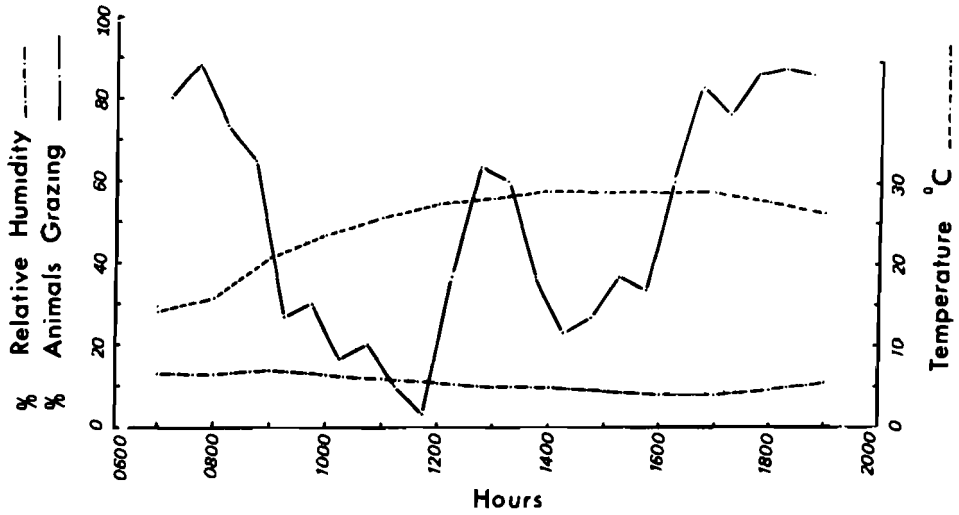


FIGURE 16  
Grazing pattern for March.

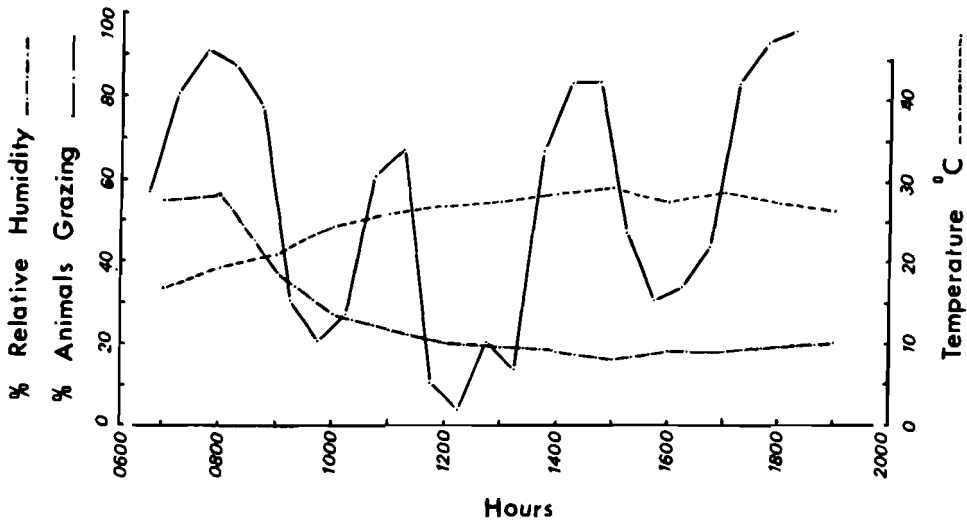


FIGURE 17  
Grazing pattern for April.

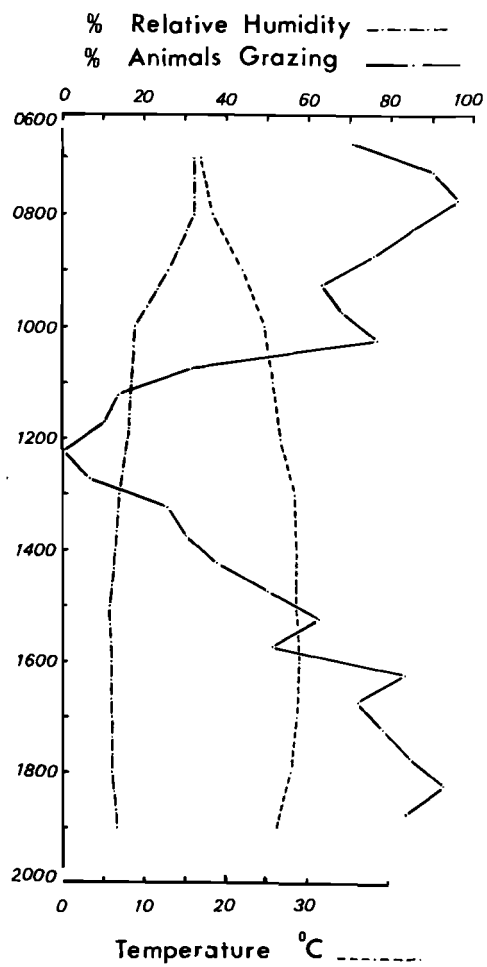


FIGURE 18  
Grazing pattern for May.

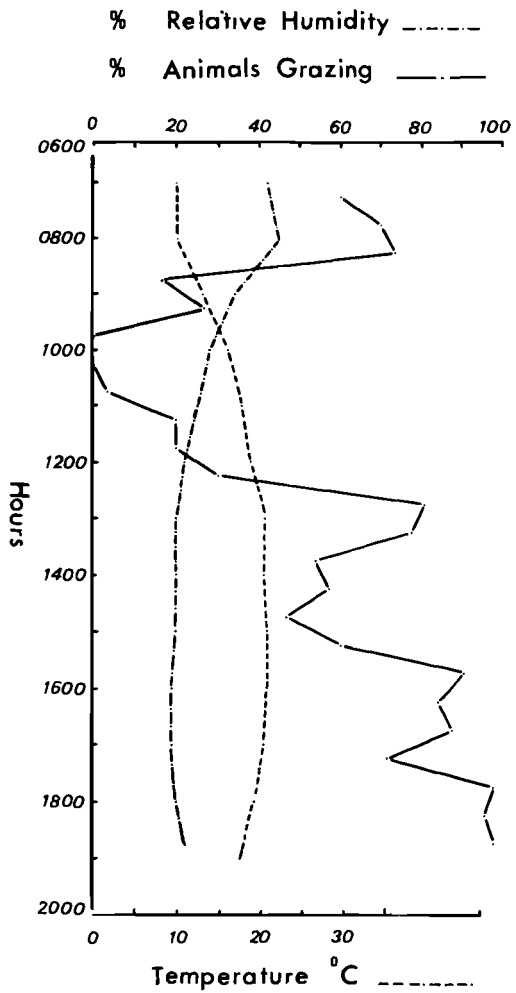


FIGURE 19  
Grazing pattern for June.

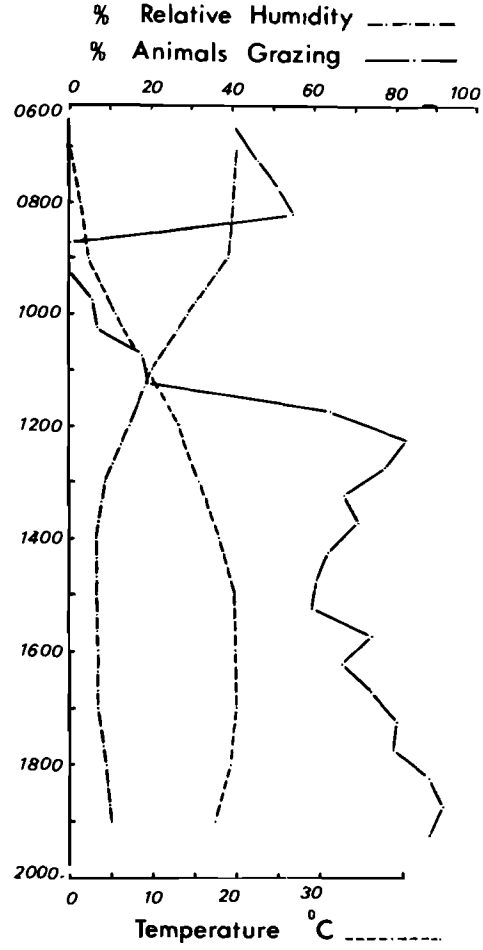


FIGURE 20  
Grazing pattern for July.

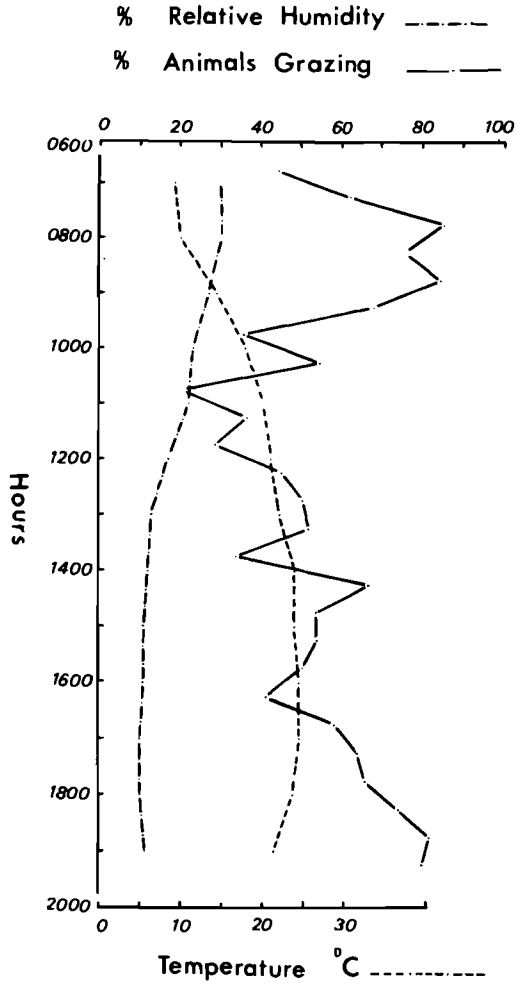


FIGURE 21  
Grazing pattern for August.

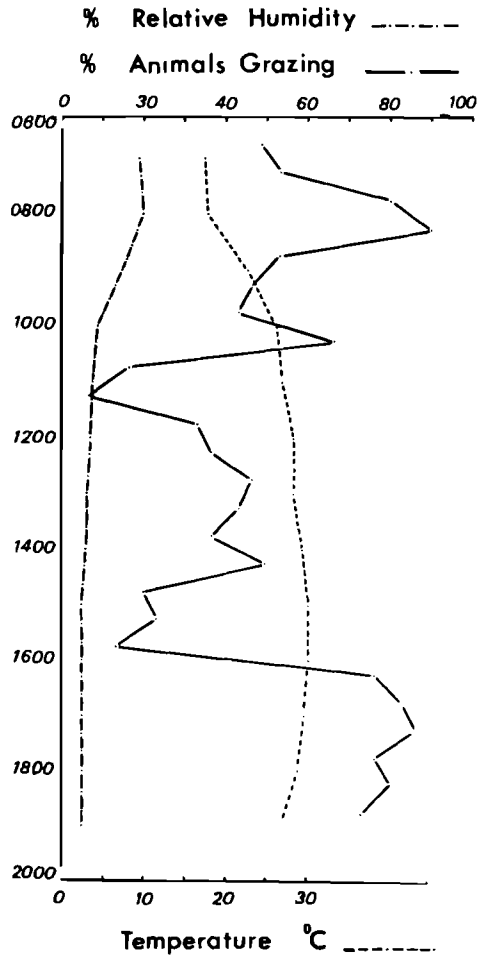


FIGURE 22  
Grazing pattern for September.

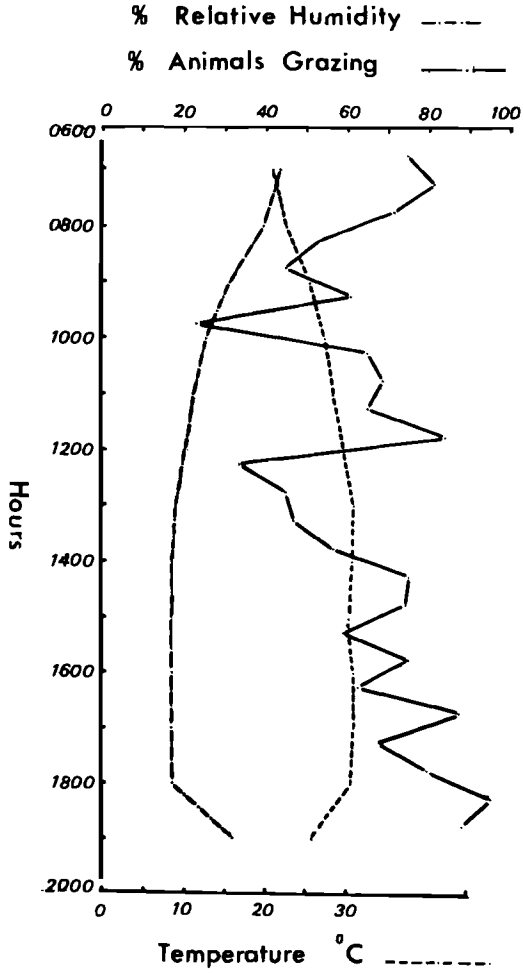


FIGURE 23  
Grazing pattern for October (rain - green flush).



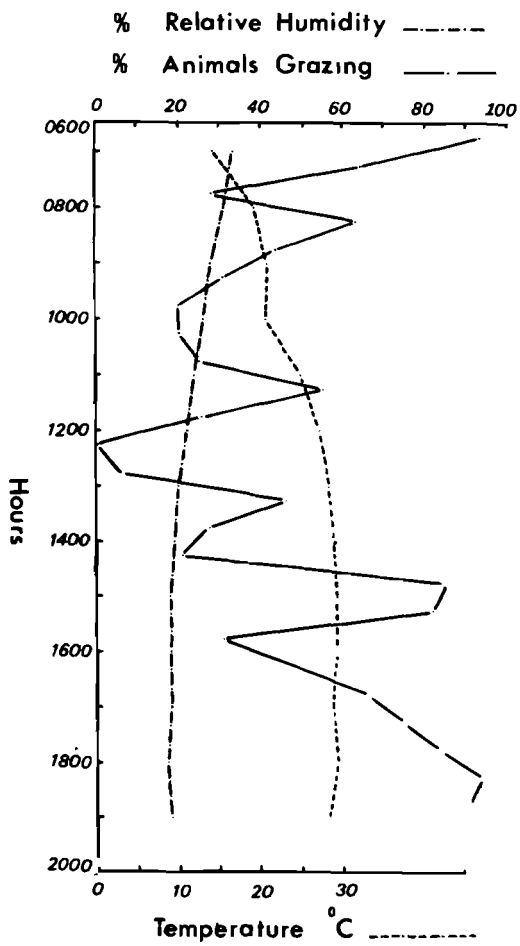


FIGURE 24  
Grazing pattern for November.

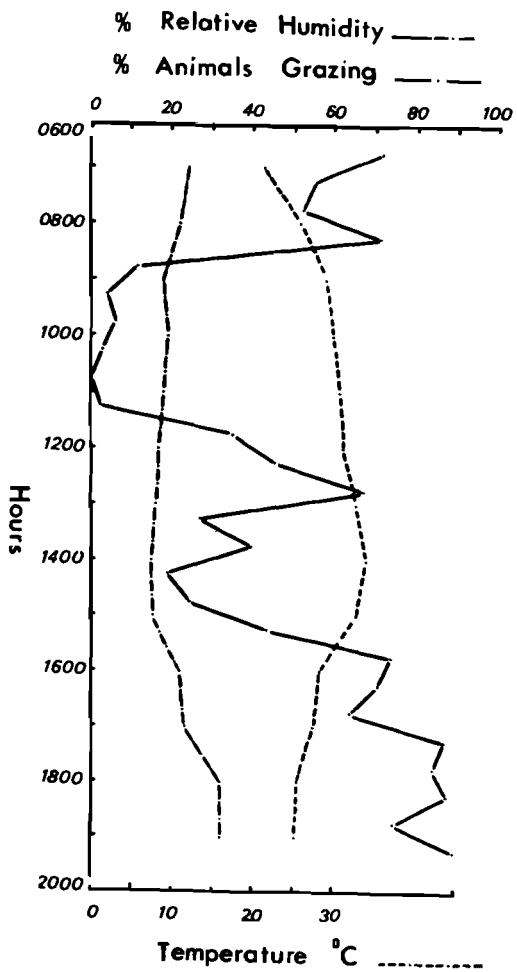


FIGURE 25  
Grazing pattern for December

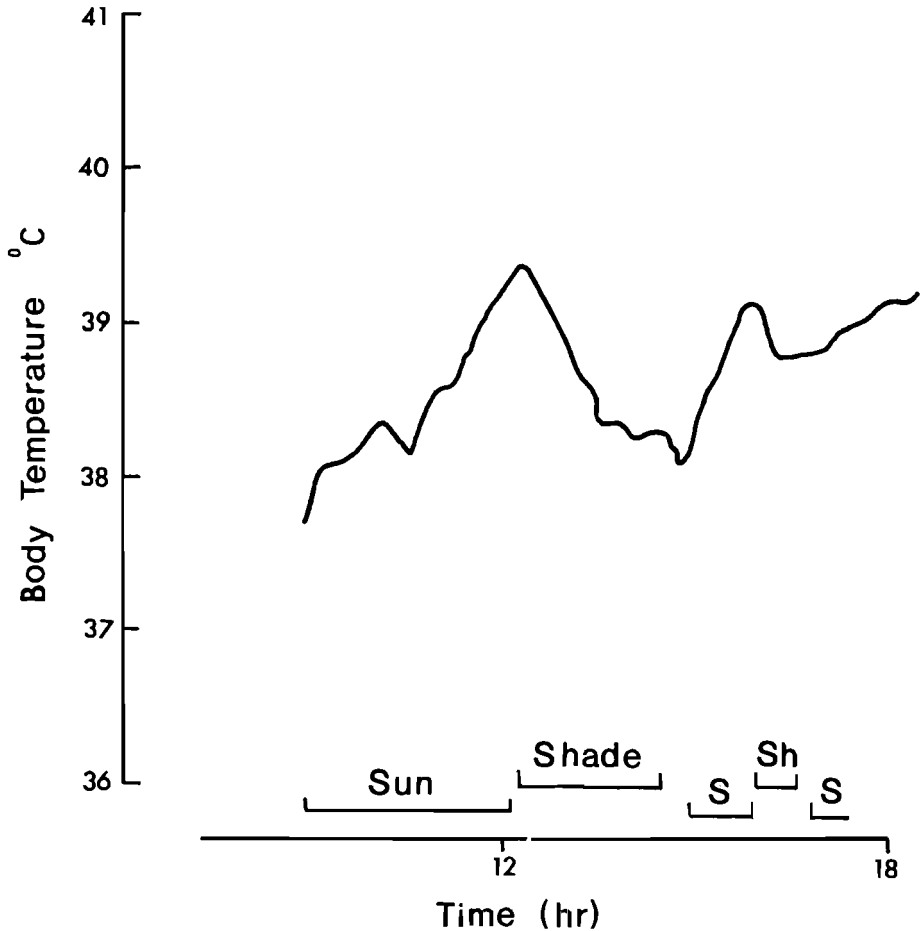


FIGURE 26  
The deep body temperature of a 2-year-old black rhinoceros. (After Bligh and Harthoorn, 1965).

various months of the year. During the more temperate months of April, May and September about an equal amount of very high intensity grazing takes place during the morning and afternoon. During the cold months of June, July and August after an initial burst, apparently just to satisfy immediate needs, the animals stand around sunning themselves. As the temperature rises so the grazing intensity increases. The bulk of the most concentrated grazing takes place during the afternoon.

- iv Despite the fact that the grazing pattern for October is erratic it still has a very high intensity. This was most probably due to the flush of green grass on the veld after some showers of rain fourteen days earlier.

Another behavioural trait modified by climate is the orientation of the body to physical

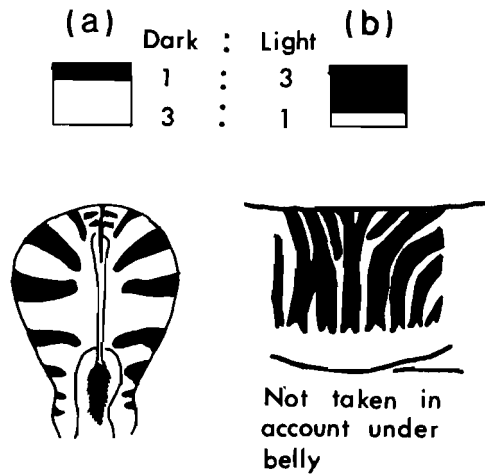


FIGURE 27  
Dark and light ratios in lateral and posterior views.

stimuli. It is a well-known fact that black surfaces absorb more heat than do lighter-coloured or white surfaces. Although no experimental physiological proof exists it appears that this may influence behaviour. As can be seen from Fig. 27 a zebra standing broadside on displays a body surface with a light : dark ratio of approximately 1 : 3. When facing away however, this ratio changes to approximately 3 : 1. This fact, combined with the difference in total body surface when viewed laterally and posteriorly, makes the orientation of body surfaces to physical stimuli an important factor in the adaptation of the mountain zebra to their environment. This behaviour was especially marked during the early mornings of the colder months. During these months they would also frequently sun themselves at regular intervals throughout the day especially if the environmental temperature was below approximately 20°C. The orientation of the body to gain maximum absorption of heat, however, was not limited to the winter months. Even during the early mornings of the summer months they would sometimes orientate themselves laterally to the rising sun. When the environmental temperature, however, rose above approximately 25°C the grazing zebras would normally orientate their bodies with the posterior end towards the sun. This of course means that more of the lighter body surface is presented to the sun, and less heat is absorbed.

Another facet of the effect of temperature is the way in which mountain zebras tend to use the upper third of hill slopes more frequently than the lower two thirds during the heat of the day in warm weather. This is possibly a means of making full use of the cooling effect of breezes. The westerly wind in the study area, sometimes unpleasantly cold, was avoided by grazing on the lee sides of hills. Wind has very little further effect on the grazing pattern and relative humidity, in a macroclimatic sense, has no conspicuous influence on the grazing pattern.

#### *Nutritional activities of foals*

As breeding reaches an apparent peak during the rainy season it follows that most of the foals are

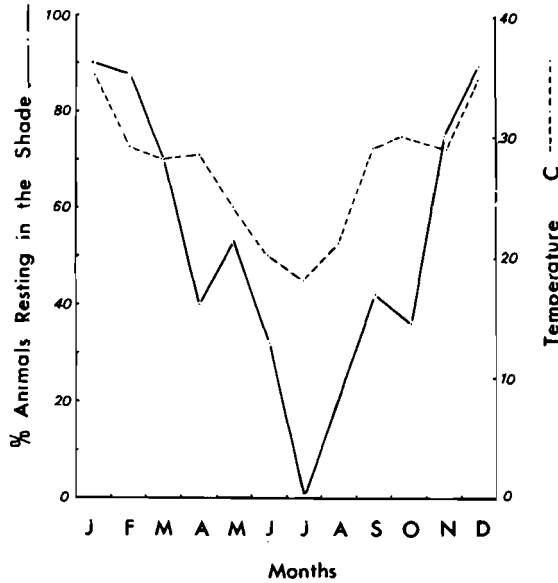


FIGURE 28  
Monthly pattern of animals resting in the shade.

older during the autumn and winter and consequently suckle less. Climatic effects in this case are therefore of an indirect nature.

#### *Drinking*

As already stated the mountain zebra drinks more frequently during the hot, dry months of October, November and sometimes December. During this time they visit the waterholes at least once a day.

#### *b. Social activities*

The social activity patterns of mountain zebras appear to be only slightly affected by the seasonal variation of certain climatic factors. Only two, slightly interrelated aspects, are indirectly influenced by climate. As mountain zebra exhibit peak breeding during the rainy season it stands to reason that mating activity occurs with higher frequency during this period. As a result the foals, as they grow older, indulge more and more in play with other foals in the family group.

#### *c. Comfort activities*

##### *Resting*

There is no significant difference in the total amount of time spent resting during the various seasons of the year. The percentage of animals seeking shelter in the shade of trees during the different months of the year, on the other hand, shows a very marked difference. As can be seen in Fig. 28 the number of animals seeking shade varies from a remarkably high peak during the warmer months of the year to none during July.

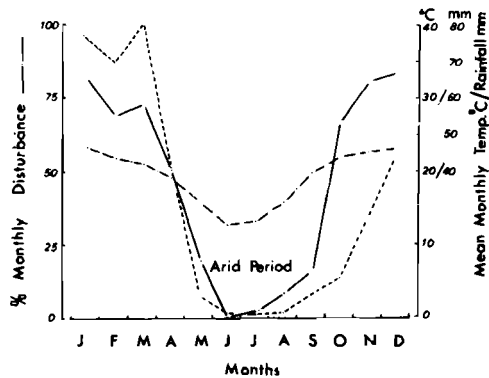


FIGURE 29  
Relationship between percentage disturbance by insects and 'arid' period.

It is interesting to note that animals resting in the shade also show a definite behaviour pattern. They are always distributed, one, or in the case of a female with a foal, two to a tree. They nearly always stand with their rumps close to the tree while facing outwards. Although they are in the shade they still frequently orientate themselves with their rumps towards the sun. This might be to make full use of the denser shade of the bole of the tree.

#### *Disturbance caused by insects*

As already discussed the intensity of disturbance caused by insects does not show a clear pattern on a daily basis, apart from the fact that activity normally only starts after the environmental temperature has reached a suitable level. On a monthly basis, however, a very clear pattern emerges. As may be seen in Fig. 29 the irritation activities caused by insects were very pronounced during the warmer months but decreased until June and July when no irritation was recorded. During August and September irritation is still very limited but suddenly increases in October. This may be due to an increase in the insect population as result of the early October rains. Disturbance by insects thus shows a correlation with temperature and rainfall which can be proved by determining the 'arid' months (Fig. 29). The temperature and rainfall graphs in this figure are based on the mean of 26 years. The graph of insect disturbance is unfortunately only based on two years' observations (1969 and 1970) during which time the area received good rains during October 1970. Coetzee (1967) quoting Gausson (1954) used mean monthly precipitation and temperature to determine the 'arid' months. The 'arid' months are determined by plotting mean monthly temperature and rainfall on the same graph using a scale in which 40 mm mean rainfall corresponds to 20°C mean temperature. As may be seen in Fig. 29 the 'arid' months are May, June, July, August and September.

#### *d. Excretory activities*

No seasonal variations were recorded.

*e. Other movements*

A limited amount of migration still occurs in the Khomas Hochland and in the Kaokoveld. With the onset of the rainy season as soon as the pre-Namib plains receive their first rains the mountain zebra move out of the mountains onto these plains. If unhindered they stay here until the grazing deteriorates after the first cold spells.

#### DISCUSSION AND CONCLUSIONS

Although the daily activity patterns of individual animals and even those of various family groups vary, a basic pattern was perceived. As already mentioned these activity patterns are variable and affected by innumerable possible combinations of such factors as climate, vegetation, time of day, time of year, location and interactions with other individuals or groups. Nevertheless, the normal daily routine can be summarised as follows. A period of high intensity grazing from approximately first light in the morning is followed by dust-bathing and/or resting (either in the shade or not, depending on circumstances). While resting in the shade approximately 80% of all rubbing activity takes place. The question as to whether the animals stand in the shade for shelter or for rubbing activity is easily answered. There are nearly three times as many observations of animals just standing in the shade as there are of animals rubbing themselves. In the middle of the day periods of grazing are alternated with periods of dust-bathing. This is then followed by the build-up of another major grazing period. Most of the other social activities aimed at enforcing the family bond take place throughout the day. The latter activities however, do show a slightly higher incidence during the high intensity grazing periods.

The climatic factors which show the most marked influence on the activity patterns of the mountain zebra are temperature and rainfall. Temperature influences the time of day when the bulk of the grazing activity takes place. During the summer months this activity is very erratic, apparently giving the animals an opportunity to lose body heat in the shade. During the temperate months of Autumn and spring an equal amount of time is spent grazing in the mornings and afternoons. During winter, however, the bulk of the grazing takes place during the afternoons. Field observations show that mountain zebra have also adapted their behaviour to gain full advantage from their colouring pattern. They use their relatively darker-shaded sides for heat absorption on cold mornings and their lighter-coloured rumps for reflection of heat during hot days. Disturbance by insects also seems to follow the seasonal variation of temperature and rainfall.

It may therefore be concluded that the daily activity pattern of mountain zebra is definitely influenced by climatic factors. They have, however, adapted themselves to the climate of their preferred habitat by evolving certain remarkable behavioural traits to ameliorate the more unfavourable climatic effects.

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