

Observations on the grazing habits of Grade and Zebu cattle

II. Their behaviour under favourable conditions in the tropics

BY G. H. LAMPKIN

East African Veterinary Research Organization, Muguga, Box 32, Kikuyu, Kenya

AND J. QUARTERMAN*

East African Agriculture and Forestry Research Organization, Muguga, Box 21, Kikuyu, Kenya

(Received 23 January 1962)

The experiments described in this series of papers were designed to determine how grade and zebu cattle can adapt themselves to their environment by changing their normal pattern of behaviour. The present paper describes their behaviour in the tropics and is a sequel to the observations made by Lampkin, Quarterman & Kidner (1958) on the same grade and zebu steers under temperate conditions at a higher altitude.

The data were collected at the Mariakani Livestock Improvement Centre, 25 miles inland from Mombasa. This centre has a hot and humid climate, being situated at 3° 53' south and 39° 28' east at an altitude of 600–700 ft. The six grade and six zebu on which the earlier observations had been made were moved from Muguga to Mariakani in December 1956 and were given 10 weeks in which to adapt themselves to their environment before the observations were started. They were kept together in fenced paddocks and were not herded by stockmen. The pastures were well developed, contained plenty of shade trees and carried a fair amount of rather stemmy keep, mainly *Eragrostis superba* and *Cenchrus ciliaris*. Water was constantly available, and the steers were therefore given the maximum opportunity to develop a pattern of behaviour that would enable them to thrive best under tropical conditions.

The behaviour of the steers was observed in detail between 15 and 21 February 1957. Throughout the observation period they were grazing a 25-acre field, to which they had been introduced 3 days beforehand. Each animal's activities were divided into grazing, resting and ruminating. It was further noted whether the animal was standing up or lying down to rest or ruminate and whether any of these activities were carried out in shade. A record was also kept of the amount of water drunk and the number of drinks taken by each animal. The activi-

ties recorded were thus the same as at Muguga and the observations were again made at 5 min. intervals. The determination of when an animal was actually in shade was somewhat subjective, as it was necessary to determine whether the sun was actually visible or not. An animal was recorded as 'in shade' if the tree under which it stood or lay threw a clearly defined shadow on the ground and if more than half of the animal was actually in shade. Seeking shade was not recorded before 08.05 hr. or after 17.00 hr. because an animal would not benefit from shade received outside these hours.

During the observation period the weather was fine, and there was no rain recorded. Maximum daily shade temperatures varied between 101.2 and 96.6° F. whilst minimum temperatures were between 72.6 and 67.0° F. Readings for relative humidity were around 90% at night but fell steadily after dawn each day to a level of about 50% at 16.00 hr. The relative humidity would then rise sharply until 20.00 hr. after which it would remain practically constant for the remainder of the night. Sunshine records were not available but generally the early mornings were cloudy. This cloud always cleared towards mid-day and the afternoons were bright. At night the skies were clear until the cloud re-formed in the early hours of each morning. Wind speeds on the Beaufort scale were usually at about Force 1 at 08.30 hr. but rose to between Force 3 and 4 later in the day. This wind always fell again at dusk.

After the behaviour studies on the Muguga steers had been completed, six zebu steers, of similar size to the others but born and bred at Mariakani, were added to the group. The daily fluctuations in body temperature were then determined on all these animals to discover to what extent the Muguga steers had been able to maintain a homothermic state when compared with those completely used to tropical conditions. After a trial period of 3 days, during which the steers were accustomed to being

* Present address: The Rowett Research Institute, Bucksburn, Aberdeen, Scotland.

handled, their temperatures were taken at 07.00, 14.00 and 18.30 hr. daily from 24 to 26 February inclusive. A Zeal half-minute thermometer was used, and was inserted 4 in. into the rectum for 1 min. before the result was read. During this period the climatic conditions remained essentially the same as during the observations on behaviour.

RESULTS

The data collected were analysed by the same methods as were used by Lampkin, Quarterman & Kidner (1958). Each period of 24 hr. was divided into 12 hr. periods which were termed 'day' from 07.05 to 19.00 hr. and 'night' from 19.05 to 07.00 hr. on the following morning. The times used were East African Standard times and, although Mariakani lies some 250 miles east of Muguga, these day and night periods did not differ appreciably from the periods used in the analysis of the second series of the Muguga observations. This may be seen from the times of sunrise, noon and sunset for the relevant dates at Muguga and Mariakani given in Table 1. It was therefore possible to compare the steers' activities at Mariakani with their activities in the corresponding periods at Muguga.

The average time spent on each activity at both stations is shown in Table 2. It should be studied in conjunction with Fig. 1 which shows the same data as a histogram.

As at Muguga, the most noticeable feature was the similarity in the behaviour patterns of the grade and zebu groups. At Mariakani, both groups grazed for about 9½ hr. out of every 24 and spent about 7½ hr. in ruminating. Although the total

time spent grazing was somewhat greater than at Muguga, the time devoted to this activity during daytime periods was very much the same. At Mariakani, however, instead of occurring intermittently throughout the day, grazing was concentrated into two periods around dawn and dusk, which permitted the steers to rest in shade when it was really hot. In addition to this, there was an average of about 2½ hr. night-time grazing at Mariakani, compared with only 40 min. at Muguga. About 40 min. of this comprised an extension of the early morning peak, occurring between 06.05 and 07.00 hr., whilst the evening grazing period was extended for about 15 min. between 19.05 and 20.00 hr. The rest occurred mainly between midnight and 04.00 hr., forming a definite peak of night-time grazing which was completely absent at Muguga.

The morning grazing period usually ended abruptly between 09.00 and 10.00 hr. when all the steers went to water, after which they would rest and ruminate in the shade of nearby trees. Occasionally a steer would leave the group to get another drink but, although it might then graze for some time by itself, it would eventually return to join the other steers. This usually continued until between 14.00 and 16.00 hr. when all the steers would leave the shade to commence the evening grazing period. In all, an average of 159 min. per animal per day was recorded as 'in shade', although the total time actually spent under trees was considerably longer, owing to the difficulty experienced with the definition of when an animal was actually in shade. Even so, these figures may be compared with the average of less than 10 min. per animal per day recorded at

Table 1. *Times of sunrise, noon and sunset*

Place	Position		Date	Sunrise	Noon	Sunset
	Latitude	Longitude				
Muguga	1° 13' S.	36° 38' E.	1.vii.56	06.30	12.31	18.31
Mariakani	3° 53' S.	39° 28' E.	11.ii.57	06.29	12.36	18.43

Table 2. *The average time spent on each activity (min. per day)*

Activity	Day 07.05-19.00 hr.				Night 19.05-07.00 hr.			
	Grades		Zebus		Grades		Zebus	
	Mariakani	Muguga	Mariakani	Muguga	Mariakani	Muguga	Mariakani	Muguga
Grazing	397	401	413	392	167	38	157	37
Resting standing	89	141	88	151	34	70	39	100
Resting lying	80	58	77	57	182	314	218	310
Ruminating standing	38	65	51	65	24	45	36	60
Ruminating lying	116	55	91	55	313	253	270	213
Total standing (excluding grazing)	127	206	139	216	58	115	75	160
Total resting	169	199	165	208	216	384	257	410
Total ruminating	154	120	142	120	337	298	306	273
Total lying	196	113	168	112	495	567	488	523
Time in shade	162	2	156	0	—	—	—	—

Muguga. Furthermore, under the hotter conditions at Mariakani, a day-time average of 58% and a night-time average of 88% of the time not spent in grazing was spent in lying down whereas, under the temperate conditions at Muguga, the comparable figures were only 35 and 80%, respectively.

The similarity in behaviour of the two groups of steers was further demonstrated by the results of the series of variance analyses shown in Table 3. It

will be seen that in the complete 24 hr. analyses significant differences were only established for those activities which involved either lying down or ruminating, or a combination of the two.

The grade steers spent an average of 35 min. longer in lying down than did the zebus. This difference was significant at the 5% level of probability. The same tendency was also noticeable in the separate day- and night-time averages and, al-

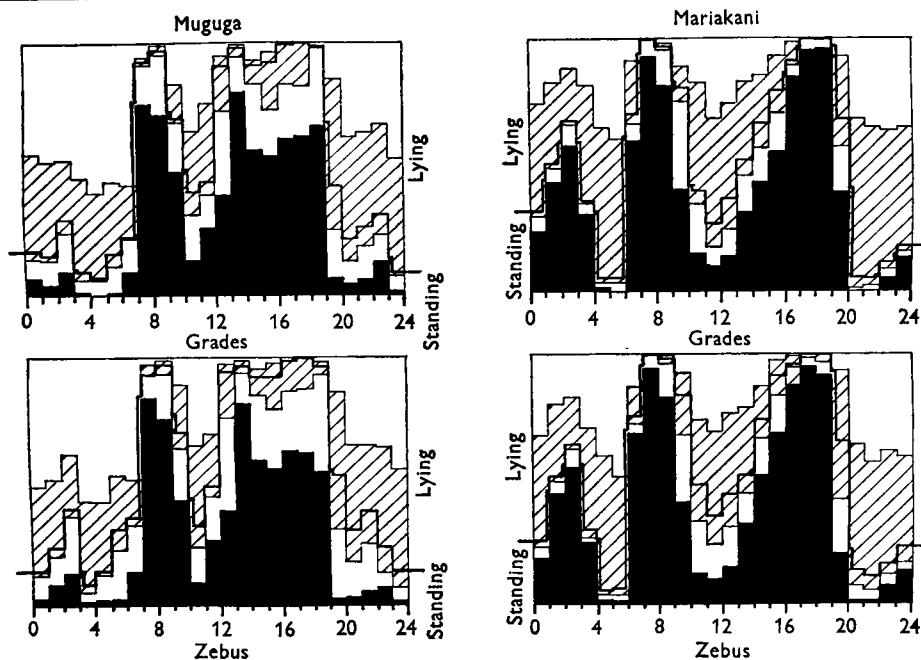


Fig. 1. Histograms comparing the behaviour of grades and zebus at Muguga and Mariakani. ■, Grazing, ▨, ruminating; □, resting.

Table 3. Variance analyses of the time (min.) spent at Mariakani on each activity

Source of variation	D.F.	Activity ... Period	Grazing M.S.	Standing resting M.S.	Lying resting M.S.	Standing rumi-nating M.S.	Lying rumi-nating M.S.	Total standing M.S.	Total resting M.S.	Total rumi-nating M.S.	Total lying M.S.	Time in shade M.S.
Between groups	1	Day	5,344	8	212	3,601	13,376*	3,282	305	3,158	17,000	—
		Night	2,100	577	27,324	2,976	39,217**	6,086*	35,836*	20,586*	1,076	—
		Day and night	744	453	22,671	13,125	98,401**	18,452	29,531	39,650*	26,608*	744
Between animals within groups	10	Day	592	1,192**	1,473**	2,167**	1,994**	2,812**	1,297**	1,026*	3,491**	—
		Night	736	309*	2,934**	777**	3,574**	715**	4,182**	3,658**	1,305**	—
		Day and night	1,187*	1,187**	5,067**	3,966**	9,142**	4,266**	7,543**	6,933**	4,022**	2,011**
Between periods	6	Day	1,036	3,469*	1,361*	431*	3,958**	4,465*	1,309	3,612**	5,753*	—
		Night	4,451**	815*	2,456	489*	1,537	987*	2,645	2,485**	2,874**	—
		Day and night	3,555*	4,492*	1,962	1,107	4,296*	6,853*	4,991	2,185*	4,109*	63,173**
Groups × periods	6	Day	930*	418	304	456	185	646	1,121*	203	770	—
		Night	199	180	1,033	60	418	148	823	267	320	—
		Day and night	638	781	920	510	809	1,001	1,258	380	734	489
Residual	60	Day	322	321	326	288	376	522	398	418	814	—
		Night	1,073	118	516	132	509	199	628	489	234	—
		Day and night	528	397	783	506	820	789	1,003	668	872	480

Significance levels: * $P < 0.05$; ** $P < 0.01$.

though these differences were not in themselves large enough to be significant, they occurred mainly during the heat of the day when the grades lay down for an average of 28 min. more than the zebu, which amounted to 6% of the time not spent in grazing.

The difference in the time spent ruminating was almost twice as large as that found for lying down. In the complete 24 hr. analysis, the grades ruminated for 68 min. longer than the zebu. Both this difference, and that recorded for the night-time figures, was significant at the 5% level of probability. This disparity in the amount of time spent ruminating was not noticed at Muguga, nor could it be accounted for by the difference of only 6 min. between the two groups in the time spent grazing. The longer times spent lying and ruminating by the grades were reflected in the significantly longer standing and resting times for the zebu steers at night.

Table 3 shows that, for many activities, there were also significant differences between individual grade and zebu steers and that, in several cases, there were significant differences between the steers' behaviour during the different day- and night-time periods. It was not found possible to relate either the between-period differences or the two significant group-period interactions to daily variation in the steers' environment.

An analysis of the data on water consumption at Mariakani is shown in Table 4. As at Muguga, the differences between the grades and zebu were highly significant. Figures are also included for the time during which the rectal temperatures were being taken, when three groups of steers were represented. A separate analysis showed that there was no difference between the zebu steers brought from Muguga and those which were reared at Mariakani.

Whilst the steers were at Muguga, water consumption for the grades had averaged 29 qt. per day (2.8 drinks per animal) and 11 qt. per day for the zebu (2.4 drinks per animal). In the hotter climate at Mariakani, the water consumption increased to 37 and 20 qt., respectively, but the number of drinks taken did not alter, being 2.7 and 2.4 per animal in the two groups. Night-time watering occurred on only one occasion. The water consumption of the grades and zebu averaged 4.07 qt./100 lb. and 2.74 qt./100 lb., respectively. The weights used were those obtained before the animals left Muguga, as there were no weighing facilities available at Mariakani.

The average body temperature of the grade steers and the two groups of zebu at 07.00, 14.00 and 18.30 hr. over the 3 days on which temperatures were taken are shown in Table 5, together with an analysis of variance of the data obtained. The

lowest readings were recorded at 07.00 hr., whilst the highest body temperatures were found at 18.30 hr. There was an average increase of 0.29° F. for all animals between 07.00 and 14.00 hr. and a further increase of 0.73° F. between 14.00 and 18.30 hr.

Whilst the analysis showed that there was a significant rise in the temperature of the animals during the day, neither the differences between groups nor the time-group interaction were significant. The higher average for grades compared with the two groups of zebu steers was due largely to the abnormally high body temperatures (104.7, 105.6 and 105.9° F., respectively) of one individual animal, which no doubt also contributed towards the highly significant differences found between animals within groups.

When interpreting these data it should be noted that the animals had to be driven to a crush just outside their field, each time their temperatures were taken. This caused a certain disruption in their normal pattern of behaviour which may or may not have affected the results.

Table 4. *Water consumption at Mariakani*

	Whilst observing behaviour (qt. per day)		Whilst taking temperatures (qt. per day)	
Grades	37.4		37.5	
Muguga zebu	19.9		24.4	
Mariakani zebu	—		23.8	
Analysis of variance	D.F.	M.S.	D.F.	M.S.
Between groups	1	6,484**	2	1,073**
Between animals within groups	10	151**	15	64**
Between days	6	126	2	157**
Days × groups	6	49	34	7
Residual	60	37	30	21

Significance levels: ** $P < 0.01$.

Table 5. *Fluctuations in rectal temperatures*

	Average for 3 days		
	07.00 hr.	14.00 hr.	18.30 hr.
Grades	102.24	102.71	103.19
Muguga zebu	101.53	101.84	102.64
Mariakani zebu	101.59	101.70	102.60
Analysis of variance	D.F.	M.S.	
Between groups	2	3.2085	
Between animals within groups	15	1.8016**	
Between times	2	4.9737**	
Times × groups	4	0.0869	
Residual	30	0.0405	

Significance levels: ** $P = < 0.01$.

DISCUSSION

The various changes that occurred in the behaviour pattern of the steers after they had been moved from the temperate conditions at Muguga indicated that the zebus as well as the grades were affected by the tropical climate found at Mariakani. Increased water consumption and the tendency to lie down for longer periods were natural reactions to the heat. Further evidence of both groups' efforts to relieve this load was found in the fact that they sought shade in the middle of the day and, in order to do so, altered the pattern of intermittent daytime grazing which they had established at Muguga into two intensive peaks about dawn and dusk, and an additional period at night. Although this made the total grazing time of $9\frac{1}{2}$ hr. in each 24 hr. period about 2 hr. longer than at Muguga, it had previously been found there that the same steers had also grazed for periods up to 9 hr. in the daytime when the keep was sparse or stemmy.

The similarity in the behaviour of the grade and zebu steers both at Mariakani as well as at Muguga was perhaps the most striking aspect of this study. Both the grades' general pattern of behaviour and their fluctuation in body temperature followed that of the zebus closely. The only difference suggestive of heat stress was the additional $\frac{1}{2}$ hr. per day which the grades spent lying down. At no time did they appear sufficiently distressed to adopt a pattern of behaviour materially different from that of the zebus. It would therefore appear that, at least in the case of steers, differences in heat tolerance are small by comparison with the high heat loads which animals of both types encounter in the tropics.

The major difference between the two groups, that of ruminating time, would appear to be less directly connected with heat stress. The differential digestive efficiency and fermentation rates found by Phillips (1961) indicated that zebus may be able to make better use of poor materials than grades. It may well be that the difference in ruminating time was connected with these findings and that the ability to thrive on the coarser fodders often found under tropical conditions will prove to be a more critical factor than actual differences in heat tolerance.

In general, this study has shown the need to adopt systems of management in the tropics which will enable cattle to develop a pattern of behaviour suited to the climate. Payne, Laing & Raivoka (1951) have already made this point for European cattle but it is now apparent that this should apply to zebu stock as well. The major factor appears to be the necessity to allow animals to seek shade during the day, but this makes it physically impossible for them to find adequate time for daytime grazing. The opportunity for night-time grazing therefore becomes essential and, although it is realized that lack of fencing and the danger from predators make it difficult to permit this under African conditions, the practice of enclosing either grade or zebu stock at night means that they will be unable fully to adapt themselves to their environment.

SUMMARY

1. The behaviour of six grade and six zebu steers in a temperate environment was compared with their behaviour when moved to a tropical climate.
2. Reaction of both groups to the heat was demonstrated by seeking shade, increased water consumption and an alteration of grazing times. The similarity in their behaviour was, however, the most striking feature. The grades lay down slightly longer than the zebus, but showed no other differences and were not apparently distressed by heat.
3. The greatest difference found was in ruminating times and it is suggested that differences in food conversion may be more important than differences in heat tolerance, provided the animals are given the opportunity to adapt themselves fully to their environment.

Acknowledgements are due to those members of our staff who helped with this investigation, particularly Mr J. G. Rimomo for assistance with recording and Dr K. Lampkin for general help throughout. We are also grateful to the Director of Veterinary Services, Kenya and Mr A. Doyle for permission to use the Mariakani Livestock Improvement Centre and for all the assistance that they gave.

This paper is published by permission of the Directors of E.A.V.R.O. and E.A.A.F.R.O.

REFERENCES

- LAMPKIN, G. H., QUARTERMAN, J. & KIDNER, M. (1958). *J. Agric. Sci.* **50**, 211.
PAYNE, W. J. A., LAING, W. I. & RAIVOKA, E. N. (1951). *Nature, Lond.*, **167**, 610.
PHILLIPS, G. D. (1961). *Res. Vet. Sci.* **2**, 202.