Orientation of wildebeest in relation to sun angle and wind direction

by

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Submitted: 6 December 1982
Accepted: 13 June 1983

ABSTRACT

Response of wildebeest to direct solar radiation and wind was measured at hourly intervals, from sunrise to sunset, during cold and hot seasons in the Etosha National Park. The two-dimensional data were statistically analysed by a computer programme package (DIRECT). The findings indicate that wildebeest orientate significantly in relation to the sun when its altitude is low (< 45°) and that during the midday sector wind influences body position.

CONTENTS

1 INTRODUCTION

The wildebeest *Connochaetes taurinus* in the Etosha National Park, northern South West Africa/Namibia, is exposed to a severe climate, characterised by daily temperature and relative humidity changes of up to 28°C and 85% (Berry, 1980). In addition, desiccating winds and high incoming and reflected solar radiation can be expected to exert considerable influence on the behavioural responses of a large ungulate, such as wildebeest. In order to test whether a significant relationship exists between sun angle, wind direction and the body orientation of wildebeest, our data were subjected to statistical analysis by application of a computer program termed DIRECT which is designed for the interpretation of two-dimensional directional data (Mimmack *et al.*, 1980).

2 METHODS

2.1 In a total of 32 separate, hourly samples of the orientation of 1 962 wildebeest, the following data were recorded during October 1977, May and December 1978.

- 2.1.1 Angle of the long axis of the animal's body in relation to 0° (magnetic North), by allocating one of eight vectors, namely 0° – 45°, 45° – 90°, through 360°, to each animal.
- 2.1.2 Wind direction, using the same vectors, and wind speed as recorded by automatic anemometer at a permanent weather station situated 18 km from where field observaions were made.
- 2.1.3 Unscreened temperature, using a black bulb thermometer to simulate the dark pelage of wildebeest.
- 2.1.4 Direct sunlight or sun obscured by cloud.
- 2.1.5 Wildebeest stationary or moving.

2.2 Data processing and statistical procedures were in accordance with Mimmack *et al.* (1980) using multi-sample tests to determine whether the dispersion parameters were equal. The test to compare modal vectors was performed only if the null hypothesis was accepted.

3 RESULTS

The results and their analyses for a typical behavioural response during October 1977, the so-called "hot, dry season" (Berry, 1980) are given in a complete form in Tables 1 to 3. We then present two further data sets, namely one for May 1978 ("cold, dry season") and one for December 1978 ("hot, dry season"), showing the preferred orientation of wildebeest in relation to sun angel and wind direction (Figs. 1 to 4). The sun azimuth and its angle above the horizon are particularly relevant to our findings for the December summer solstice and they are given in Table 4. The measurement of sun azimuth is shown in Fig. 5.

TABLE 1: General statistics for samples compared when recording orientation of wildebeest in the Etosha National Park to environmental stimuli during the hot, dry season (5 October 1977).

Sample No.	No. in sample	Component 0°	Component 90°	Resultant (length)	R/N	Angle of R (degrees)	Confidence intervals for angles of modal vector			
							95% (degrees)		99% (degrees)	
1	79	43,288	23,375	49,196	0,623	28,369	15,9	40,9	12,8	44,0
2	27	−2,335	5,993	6,439	0,238	111,451	0	0	0	0
3	23	4,346	7,497	8,666	0,377	59,897	0	0	0	0
4	21	4,048	1,497	4,316	0,206	20,290	0	0	0	0
5	68	31,703	−30,062	43,690	0,643	316,522	303,6	329,5	300,3	332,7
6	107	39,425	−31,746	50,618	0,473	321,158	305,6	336,7	301,1	341,2
7	22	2,851	−15,445	15,706	0,714	280,459	260,3	300,6	254,8	306,1
8	14	0,451	−7,291	7,305	0,522	273,540	230,7	316,4	204,6	342,5

TABLE 2: Multi-sample test for orientation data of wildebeest in the Etosha National Park to determine whether the dispersion parameters are the same. The null hypothesis is that $H_0 = k_1 = k_2 = \ldots\ldots\ldots k_5$

Observed value of Z = 52,141

*The test to compare modal vectors was not performed due to the rejection of the null hypothesis.

Critical value	Significant level	Conclusion*
27,204	0,100	Reject H_0
38,144	0,050	Reject H_0
36,191	0,010	Reject H_0
32,852	0,025	Reject H_0
38,582	0,005	Reject H_0

TABLE 3: Difference between the angle of the sun, the direction of the wind, and the preferred angle of orientation of wildebeest in the Etosha National Park during the hot, dry season (5 October 1977).

Sample No.	No. in sample	Sun angle (degrees)	Resultant angle (degrees)	Difference between sun and resultant angles (degrees)	Wind direction (degrees)	Difference between wind and resultant angles (degrees)
1	79	50	28,3	21,7	–	–
2	27	35	111,5	76,5	180	68,5
3	23	35	59,9	24,1	135	75,1
4	21	360	20,3	20,3	45	24,7
5	68	320	316,5	3,5	45	88,5
6	107	320	321,2	1,2	45	83,8
7	22	300	280,5	19,5	45	123,5
8	14	290	273,5	16,5	45	127,5

TABLE 4: Sun azimuth and sun altitude in the Okaukuejo area of the Etosha National Park (latitude 19°S; longitude 16°E) on 19 December 1978.

Time S.A.S.T.	Azimuth	Altitude
0600		−4°05′ (Below horizon)
0700	111°43′	9°15′
0800	108°11′	22°33′
0900	105°35′	36°09′
1000	104°05′	49°54′
1100	104°33′	63°41′
1200	112°26′	77°15′
1300	224°37′	85°09′
1400	251°40′	73°21′
1500	255°55′	59°39′
1600	255°37′	45°52′
1700	253°45′	32°09′
1800	250°53′	18°37′
1900	247°03′	5°28′
2000		−7°41′ (Below horizon)

4 DISCUSSION

4.1 Cold, dry season: 26 May 1978 (Figs. 1 and 2)

Under the prevailing cloudless conditions our hypothesis is that wildebeest will present the long axis of their bodies to the sun when temperatures are low to facilitate heat uptake. Conversely, when temperatures increase, we predicted that wildebeest would orientate their long axis parallel to the incoming radiation, exposing the smallest surface to direct sun rays and thereby compensating for excessive heat load.

In Fig. 1 it is evident that at a temperature of 10°C there was a tendency to orientate laterally. As the temperature rose to 22°C the wildebeest faced increasingly into the sun. However, 3,5 hours after sunrise they moved from the grazing area to drink water and this resulted in a more random orientation in relation to sun angle. Hav-

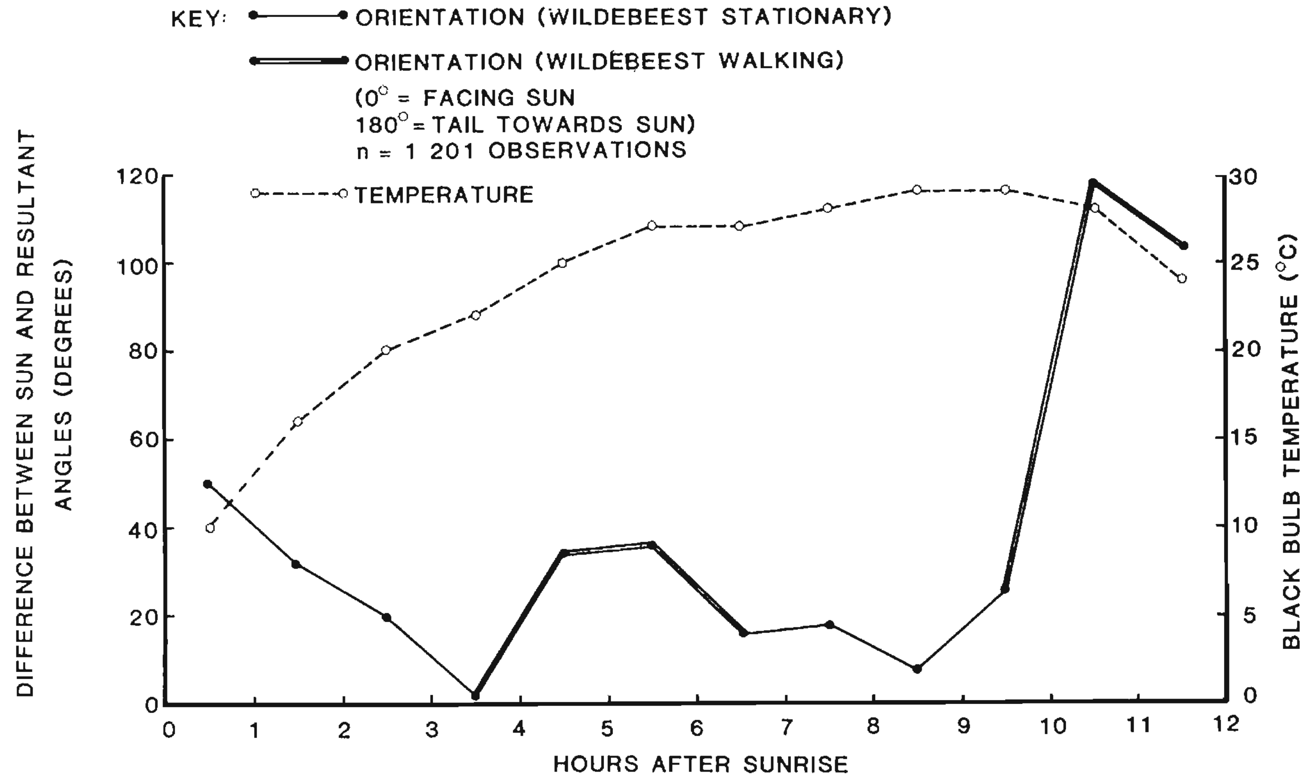

FIGURE 1: Preferred orientation of wildebeest in the Etosha National Park in relation to sun angle during the cold, dry season (26 May 1978).

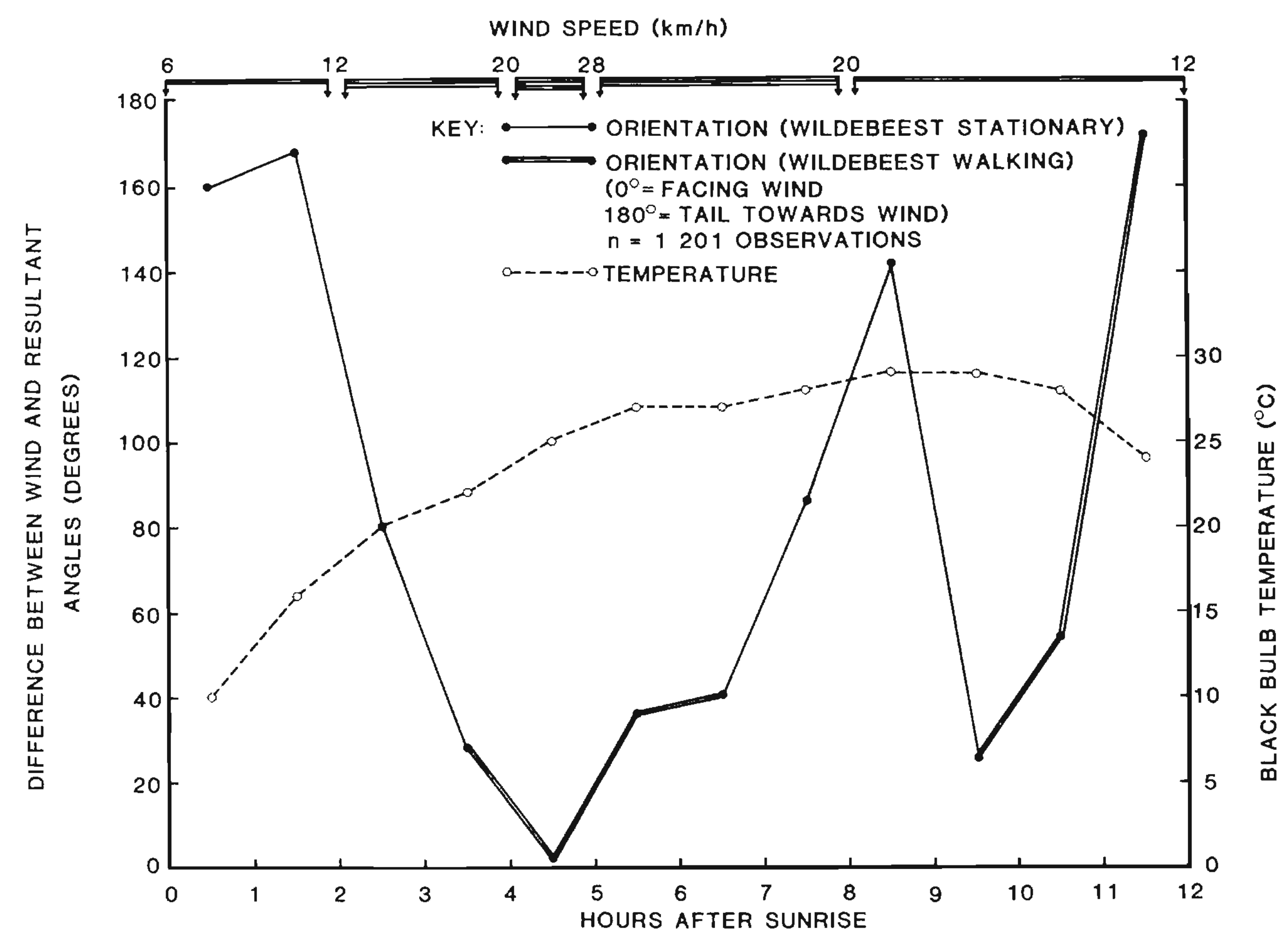

FIGURE 2: Preferred orientation of wildebeest in the Etosha National Park in relation to wind direction during the cold, dry season (26 May 1978).

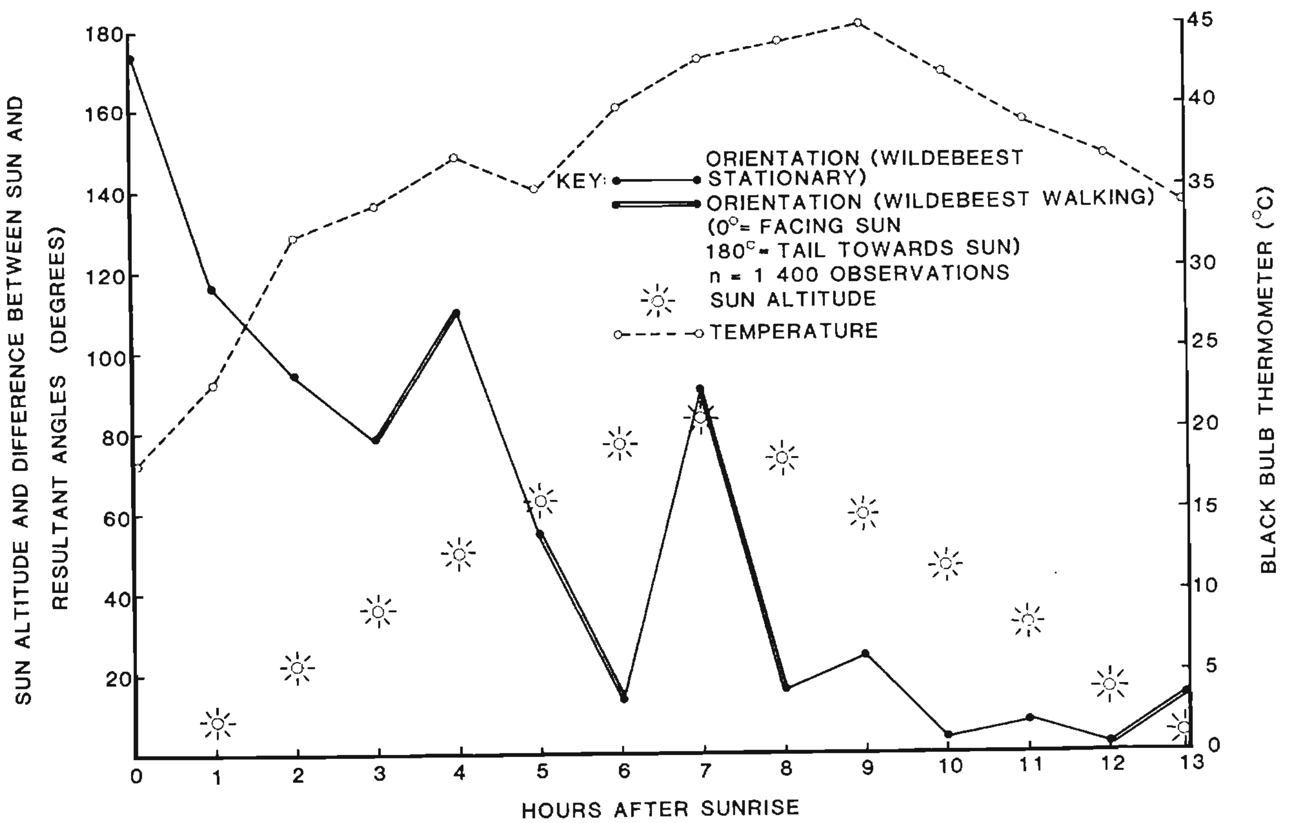

FIGURE 3: Preferred orientation of wildebeest in the Etosha National Park in relation to sun angle during the hot, dry season (19 December 1978).

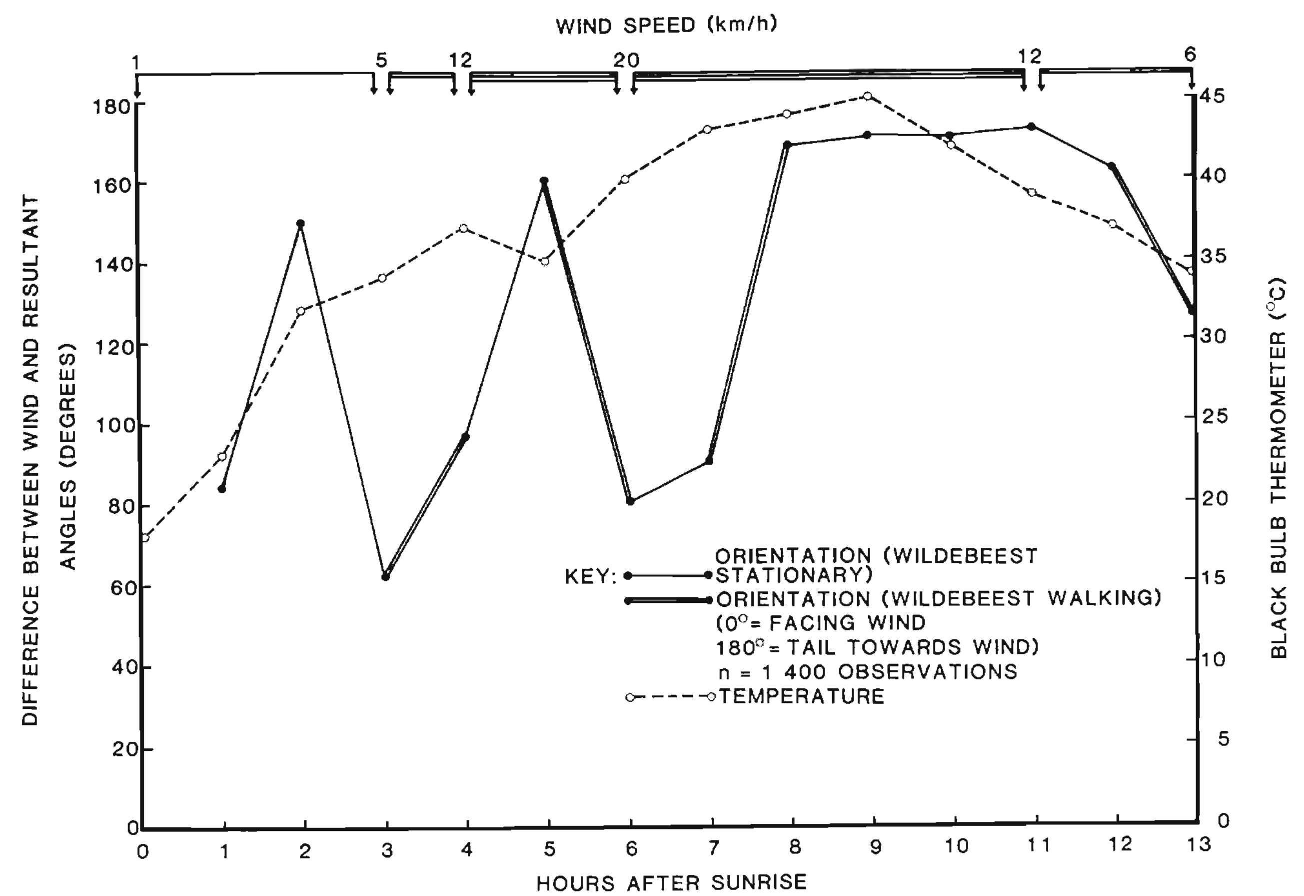

FIGURE 4: Preferred orientation of wildebeest in the Etosha National Park in relation to wind direction during the hot, dry season (19 December 1978).

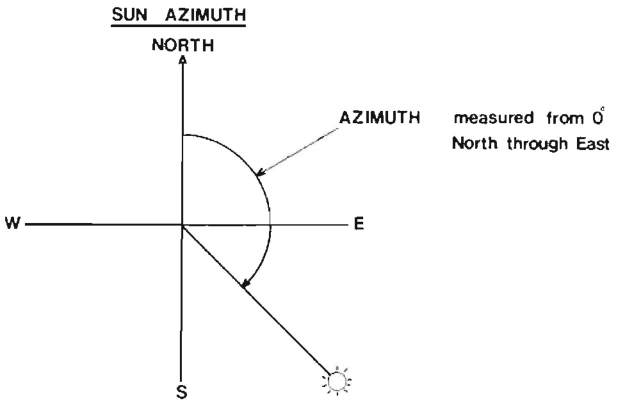

FIGURE 5: Measurement of sun azimuth at latitude 19°S; longitude 16°E in the Etosha National Park. Read this figure in conjunction with Table 4.

ing drunk, they rested and ruminated between 6 to 10 hours after sunrise (Berry *et al.*, 1982), once more displaying a preference to face towards the sun. During the last two hours of daylight sun temperature declined and the wildebeest began moving back to the grazing area, again exposing the greatest body surface to the sun.

Fig. 2 is designed to show the influence of wind on wildebeest body orientation, taking into account the accompanying thermal regime. As wind speed increased to 12 km/h two hours after sunrise, the wildebeest changed from a "tail-to-wind" posture to face into the wind, a position which they maintained whilst walking to water. During this period temperature rose from 10°C to 25°C. Once the herd had drunk (4,5 hours after sunrise) they began the rest-rumination period, during which they orientated broadside to the wind, now reaching a force of up to 28 km/h. This period coincided with the hottest time of the day. The two hours preceding sunset were the period that wildebeest chose to leave the vicinity of the water-hole and move to the night grazing area (Berry *et al.*, 1982). Their body posture in relation to wind direction became random during this period and this may have also been related to the decreasing wind force of 12 – 6 km/h.

Thus it appears that the hottest time of day, when wind speed was also at its highest, caused wildebeest to orientate in such a way that they obtained the greatest amount of airflow over their body surface. Their daily drinking habit partly masked this tendency although it is worth noting that wildebeest preferred to approach water facing into the wind and thereby facilitating their awareness of possible predators which were lying in ambush.

4.2 Hot, dry season: 19 December 1978 (Figs. 3 and 4)

The sampling was done on a hot, cloudless day with wind force gradually increasing to 20 km/h at midday, after which it similarly declined to less than 5 km/h.

Interpretation of these data must be made cautiously since the sun's altitude (Table 4) increases to 85° at this time of year. Consequently, the sun will have little directionality on the horizontal plane between four and eight hours after sunrise.

Wildebeests' response to the sun's angle was only evident during the first hour of sunlight when they faced away from the sun, and 8 to 13 hours after sunrise when a preferred head-to-sun orientation prevailed. The response to wind is also more or less random for the first eight hours of sun with a tendency, however, to present the body surface laterally to the wind. From eight hours after sunrise onwards, wildebeest showed a strong preference for a tail-to-wind orientation which correlates closely with a preferred head-to-sun orientation at the same period.

5 CONCLUSIONS

Wildebeest in Etosha responded predictably to the ambient sun and wind regimes, although two factors appeared to impinge on the basic pattern masking it to some extent. These were first, the daily drinking habit of wildebeest which altered their body orientation as they moved to a watering point and, secondly, the midday altitude of the sun, notably during the summer solstice in December, when body orientation had little bearing on the sun's overhead position.

Sun direction is probably of greatest importance to body orientation in wildebeest towards either end of the day, whilst wind may influence the body position during the midday heat.

6 ACKNOWLEDGEMENTS

We appreciate the assistance of Mr. A. McKenzie, SAFRING, University of Cape Town, in obtaining computer printouts and compiling the tables and figures. The information on sun azimuth and altitude was supplied by Prof. L. P. Adams, Land Survey Department, University of Cape Town.

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