

## Animal behaviour in the sub-tropics. I. Heat tolerance in relation to grazing behaviour in sheep

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### Summary

Thirty ewes of the breeds Ossimi indigenous, Texel, Caucasian Merino and Fleisch Merino were used in this study in order to establish the relation between heat tolerance and grazing behaviour of sheep in the newly reclaimed desert lands of Egypt.

Body temperature, respiration rate and skin temperature of each ewe were measured four times daily, *i.e.* before it left the shed, on arrival at the pasture 5 km away, before leaving the pasture, and finally when it returned to the shed. The air temperature was recorded at the time of each test. The effect of all-day activities was computed as the difference between the initial reaction values and the corresponding values at the end of the grazing day.

The most pronounced breed difference was in the respiration rate. The initial values at morning were only 16 respirations a minute in both Ossimi and Caucasian Merino, whereas the Texel and the Fleisch Merino showed respectively four and five times this value.

The muscular activities of walking to the pasture and the activities during grazing had distinctly different effects on the cardio-respiratory reactions of different breeds, and Ossimi was the least affected.

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### 1. Introduction

Heat tolerance and adaptability to the sub-tropical environmental conditions are very important factors in sheep rearing and production. Different breeds have different physiological features and these features are no doubt reflected in the responses of each breed and in its particular pattern of behaviour during the journey to the pasture and on pasture as regards, grazing in shade, grazing exposed to the sun, lying in the shade, idling and rumination. The studies of the relationship of sheep behaviour and their physiological responses in hot environments are scanty and based mainly on field observations.

LEE (1950) reviewed the mechanisms and factors affecting heat tolerance in sheep; HAFEZ, BADRELDIN and SHARAFELDIN (1956) studied the response of body temperature, respiration rate and skin temperature of the indigenous Ossimi and Rahmani sheep breeds to Egyptian climatic conditions. MEHROTA and MULLICK (1959) studied the

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seasonal variation in body temperature, and respiration and pulse rates in adult mixed sheep breeds in India. FLETCHER and REID (1953) reported the significant value of shearing in the heat balance of sheep. HAFEZ, BADRELDIN and SHARAFELDIN (1956) tested the effect of docking fat-tailed Egyptian sheep.

This experiment was made in an attempt to explain the inter-breed differences in grazing habits by reference to heat tolerance. It was hoped this would add to our knowledge of sheep husbandry under local conditions, with particular reference to the suitability of imported foreign breeds.

## 2. Materials and methods

The experiment was carried out at the Tahreer Province (lat. 30°55', long. 30°42', alt. 8 metres) for five successive days of August 1961 under similar weather conditions. Thirty early-pregnant ewes were used, about the same age of each of the following breeds; Ossimi, a native breed; Texel, introduced from Holland in 1955; Caucasian Merino from the U.S.S.R. in 1956 and Fleisch Merino from East Germany in 1960. Each day at 8 a.m. the thirty ewes of one breed walked to the pasture, 5 km away, and were left to graze for eight hours, after which time they were driven back to the shed by the same route. The heat-tolerance responses, body temperature, skin temperature and respiration rate per minute were recorded for each ewe at 7 a.m. before leaving the shed, on arrival at the pasture, immediately before leaving the pasture and returning to the shed at night. The air temperature was recorded at the same time as the heat-tolerance response records.

## 3. Results and discussion

### 3.1. Breed differences in the heat-tolerance responses

The mean body temperature, skin temperature and respiration rate taken at 7 a.m. at a mean air temperature of 22.5 °C were lowest in the Ossimi ewes (TABLE 1). The

TABLE 1. Heat-tolerance responses of different breeds of sheep at successive grazing times

Time	Breed	Temperature (°C) of		Respiration rate p. minute
		body	skin	
7 a.m.	Ossimi	38.3 ± 0.2	24.1 ± 0.1	16 ± 1
At shed (initial values)	Texel	38.9 ± 0.2	25.6 ± 0.3	58 ± 4
	Fleisch Merino	39.1 ± 0.1	24.8 ± 0.3	80 ± 5
	Caucasian Merino	38.6 ± 0.1	25.6 ± 0.0	16 ± 1
	9 a.m.	Ossimi	38.8 ± 0.1	32.3 ± 0.4
Arriving at pasture	Texel	40.2 ± 0.1	30.1 ± 0.2	140 ± 4
	Fleisch Merino	40.2 ± 0.1	30.4 ± 0.1	142 ± 2
	Caucasian Merino	39.9 ± 0.2	33.0 ± 0.2	58 ± 2
	6 p.m.	Ossimi	39.3 ± 0.0	32.5 ± 0.2
Leaving pasture	Texel	39.8 ± 0.1	31.8 ± 0.1	113 ± 5
	Fleisch Merino	39.5 ± 0.1	32.3 ± 0.4	102 ± 6
	Caucasian Merino	39.5 ± 0.1	30.6 ± 0.6	22 ± 1
	8 p.m.	Ossimi	39.3 ± 0.1	31.4 ± 0.1
Arriving at shed	Texel	40.3 ± 0.1	30.4 ± 0.1	137 ± 3
	Fleisch Merino	40.0 ± 0.1	31.6 ± 0.1	118 ± 6
	Caucasian Merino	40.0 ± 0.1	30.1 ± 0.1	34 ± 2

Fleisch Merino had the highest values in body temperature and respiration rate, the next highest values were for the Texel ewes. The most pronounced breed difference was found in the respiration rate; Fleisch Merino had five times, and the Texel about four times the rate of the Caucasian Merino and Ossimi which had about 16 respirations per minute (TABLE 1). These data reveal that Caucasian Merino is similar to the native breed Ossimi in having a very low initial respiration rate which leaves room for an increase without any risk of alkalosis. On the other hand, the Texel and Fleisch Merino, which had the highest initial respiration-rate values, might contract alkalosis while attempting to dissipate excess heat by increasing their respiration rate.

### 3.2. Effect of muscular activity on heat-tolerance responses

The animals showed a distinctive breed difference in their response to the muscular activity of walking 5 km in an air temperature rising from 22.5 to 26.5 °C. The body temperature of the foreign breeds increased by 1.2—1.3 °C, while the Ossimi showed only a 0.5 °C increase. The skin temperature increased by 34, 29, 23 and 18 % for the Ossimi, Caucasian Merino, Fleisch Merino and Texel breeds respectively. Respiration rate was the item most affected as it increased by 262, 141 and 77 % in Caucasian Merino, Texel and Fleisch Merino respectively, but only by 56 % in Ossimi. Despite the great increase in respiration rate of the Caucasian Merino, its low initial value caused the observed value after walking to be less than half that of the Texel and Fleisch Merino.

When the sheep followed the same route returning from pasture at sundown with an air temperature decreasing from 31 to 28 °C the body temperature of the foreign breeds increased only 0.5 °C, the Ossimi being unaffected. The skin temperature decreased in all the breeds between 0.5—1.4 °C, *i.e.* the least in the Caucasian Merino and the highest in the Texel. Although the increase in the respiration rate of each breed was about one fourth of that occurring in the morning, the proportionality of the breed difference was about the same, the percentage increase being 54, 21, 16 and 11 % for Caucasian Merino, Texel, Fleisch Merino and Ossimi respectively (TABLE 2).

TABLE 2. Differences in the heat-tolerance responses in sheep breeds after covering a distance of 5 km from 7 to 9 a.m. and from 6 to 8 p.m.

Breed	Increase of :		Temperature (°C) of		Respiration rate	
			body		p. minute	
	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
Ossimi .....	0.5	0.0	8.2	—1.1	9	3
Texel .....	1.3	0.5	4.5	—1.4	82	24
Fleisch Merino .....	1.1	0.5	5.6	—0.7	62	16
Caucasian Merino .....	1.3	0.5	7.4	—0.5	42	12

### 3.3. Effect of all-day grazing activities on heat-tolerance responses

The effect of all-day activities on the heat-tolerance responses was estimated by taking the difference between the respiration rate, body-temperature and skin-temperature values at morning in the shed and the corresponding values in the evening before

leaving the pasture (TABLE 3). The body temperature of all breeds exceeded 39 °C, increasing about 1 °C in Ossimi, Texel and Caucasian Merino and about 0,5 °C in Fleisch Merino, which had the highest initial value. The great increase in body temperature in case of the native breed is attributed to its habit of grazing and idling practically all the time in direct sunlight (SHARAFELDIN and SHAFIE, 1962). These all-day activities induced the greatest increase in respiration rate in the Texel, *viz.* 55 per minute, Fleisch Merino being second with 22 per minute, while Ossimi and Caucasian Merino showed a slight increase of 10 and 6 respirations/min. respectively. The Fleisch Merino showed the greatest increase in skin temperature despite the fact that they often avoided direct exposure to solar radiation. This breed showed a unique grazing pattern, as it grazed actively in the sun for 10 to 20 minutes and then sought shade for a while before grazing in the sun again (SHARAFELDIN and SHAFIE, 1962). It seems that this breed has a very sensitive skin which acts as an alarm system against direct exposure to sun; this might be a valuable protective mechanism in the hot, arid tropics and sub-tropics. Further studies of the skin structure, especially the pigmentation, blood vessels and terminations of the nerves are needed in order to explain this mechanism.

TABLE 3. Effect of all-day activities on the heat-tolerance responses in sheep breeds

Breed	Increase of : Temperature (°C) of		Respiration rate p. minute
	body	skin	
Ossimi .....	1.0	8.4	10
Texel .....	0.9	6.2	55
Fleisch Merino .....	0.4	7.5	22
Caucasian Merino .....	0.9	5.0	6

#### 4. Conclusion

Of all the breeds studied the Ossimi breed, being indigenous, proved to be the best adapted to local conditions. It showed highly durable muscular activity, was able to cover the longest distance either on the journey to the pasture, or in wandering about while grazing. This breed showed the most tolerance to direct solar radiation as it remained longest in the sun, either grazing, idling or even lying down. These superior capacities show that the breed is well adapted to the sparse pasture of the newly reclaimed desert lands in Egypt. The Caucasian Merino was the most heat tolerant of the foreign breeds and showed response values very similar to the indigenous Ossimi breed. The Fleisch Merino and the Texel breeds were greatly affected by muscular activity, *viz.* they were not adapted for travelling long distances over vast and sparse pastures.

The Texel showed the utmost signs of fatigue symptomized by panting and inflammation of the mucous membranes of eyelids and nostrils, but it still continued to graze in direct sunlight. The Texel, which lacks any protective mechanism against detrimental conditions, should graze on pastures not far from its sheds, a system similar to that practised in Holland (its country of origin). As a result of the rapid rise in its skin temperature, the Fleisch Merino regularly sought shade showing that its highly sensitive skin acts as a protective mechanism against heat stress. The economic value of the heat-tolerance responses in relation to grazing and food consumption needs further study.

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