

FURTHER OBSERVATIONS ON THE PHYSIOLOGICAL AND BEHAVIOURAL CHARACTERISTICS OF SMALL ANIMALS IN THE SOUTHERN KALAHARI

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Since the publication of my first paper in Koedoe (Bolwig, 1958) on the animal ecology in the Kalahari, further recordings have been made. Unfortunately none of the research done since then has been finished; but as work will be interrupted for about a year it is felt that a brief summary of some observations should be given at this stage. It must however be pointed out that more data would be desirable.

The following account is based on observations made in the Kalahari during a short visit to the Aughrabies falls and to Twee Rivieren in February, 1958 and on material brought home from that trip.

MICROCLIMATE

TEMPERATURE: The weather was at no stage very hot and the temperature did not exceed 38°C. A steady wind was blowing most of the time, causing a great shifting of the air close to the ground and of sand particles. In spite of this, the temperature of the surface of the sand, (measured with a mercury thermometer covered with a very thin layer of sand) rose to 66°C. The lowest temperature of the surface measured was at sunrise being 20°C. At one cm. above the ground the temperature was 2°-3° lower. Below the surface it remained about 10°C. lower at a depth of 2½ cm. during the later half of the morning. In rodent warrens, 48 cm. below the surface, the temperature varied between 31.5°C. and 35°C. during the 24 hour period. The highest temperature was measured at 4 p.m. which was 2 hours after a maximum of 66° on the surface and 2½ hours after the maximum air temperature of 38°C. measured 2 m. above the ground. The time of the lowest temperature in the warrens (31.5°) coincided with the lowest temperature of 21.5°C. for that particular day. This indicates a strong ventilation due to convection.

HUMIDITY: During our stay in the southern Kalahari (6th-15th February, 1958) the first days were dry with no, or only scattered clouds. The last three days, however, it turned cloudy and thunder with heavy showers began on the 13th at 5 p.m. During the 14th it rained. A strong wind which accompanied the storm on the 13th blew sand onto the recorders and set them out of action.

Attempts were made to measure the air humidity at various levels using dew point and psychrometer. The lowest humidity 2 m. above the ground was measured at Aughrabies falls, 7th February, at 3 p.m. being 12.5% RH corresponding to 5.35 g. per m³ at 36.5°C. The actual content of water in the air was always found considerably higher in the morning than during the middle of the day. The morning of the 8th February at 6.30 for example the relative humidity was 60% at 21°C. corresponding to 18.14 g. per m³.

So far no satisfactory method of measuring the air humidity in the warrens has been found. It is unavoidable not to disturb the air in the hole when inserting the hygrometer, and sand falling onto the recorders may cause great errors. Hair hygrometer, wet bulb hygrometer and sampling of air to be analysed for dew point are three methods that have been attempted. The only reading which seemed comparatively reliable was made with a small wet bulb thermometer. It indicated 66% RH at a temperature of 33°C. 45 cm. from the entrance of the very steep passage.

INSECTS

No insects were active near to the ground during the warm hours of the day. Grasshoppers and flies sat immobile on the shaded side of straws and twigs a foot or more above the ground and the black beetles dug themselves down in the sand beneath the shrubs close to where the branches came out of the ground. *Onymachris multistriata* were usually not seen between ca 11 a.m. and ca 5 p.m. but appeared in the light hours before and after this period. The hottest sand an *Onymachris* was seen to traverse on its way from the shade of one bush to another was 53°C. The time was 5.45 p.m. It was noticed that whenever the beetles were forced out in the sun on the hot sand, they lifted their bodies high above the ground. Laboratory experiments with beetles resting on, or moving on, an electrically heated copper plate showed that as long as the plate had a temperature below 40°C. the beetles would rest with their ventral sides touching the plate. When the temperature was brought above 40°C. they soon after lifted themselves up on their legs. The height to which the body was lifted was dependent on the temperature. It could amount to as much as 10 or 11 mm., depending on the size of the beetle. The reaction was not due to the heat sensation in the tarsi but to the increased body temperature. This was proved by the fact that the reaction

was not immediate when the beetle was placed on the hot plate and a pre-heated beetle remained lifted from the ground for a short while when placed on a cool plate.

The temperature of 40°C. corresponds to the body temperature at which the beetle sets in a regulating mechanism which counteracts further increase in body temperature (Bolwig, 1958). Direct observations show an increased ventilation of the cavity under elytra but they also indicate an increased evaporation from the beetle. Experiments with beetles in air with a constant water deficit confirmed the latter observation (Fig. 1).

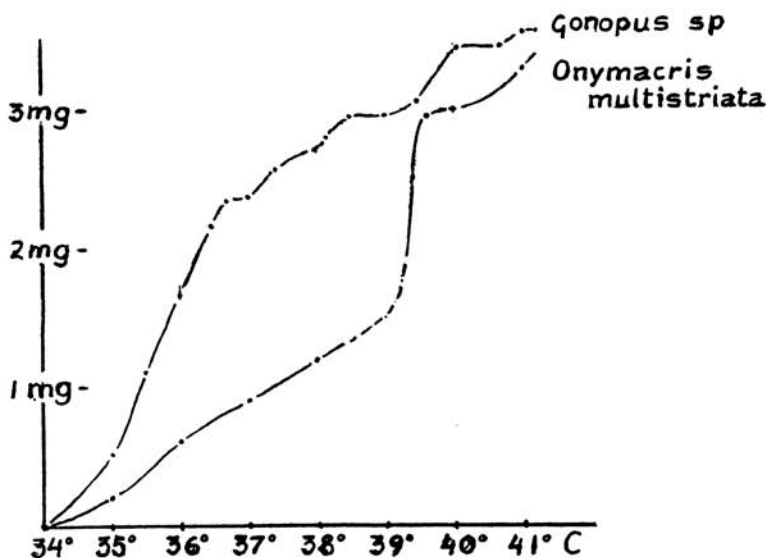


Fig. 1.

Various methods were attempted to measure the evaporation from the beetles. The method of Jakovlev (1957) which consists of measuring the increased dew point of air passed over the beetle was abandoned because of difficulties in reading the exact dew point and because the curves obtained were not well defined. The most exact method was that of measuring the beetles loss of weight at various temperatures. The experiment was carried out as follows:

A beetle was suspended in a piece of wire from a sensitive torsion balance (7 mm. response - 1 mg.). The wire passed through the hole in a rubber stopper down into a small container inside which the beetle was hanging freely. A constant flow of air with a constant water deficit was passed through the container. A deficit of 10 g per m³ was found most practical (Fig. 2). The temperature was increased every 20 minutes. The decrease in weight was plotted on a sheet of graph paper. Fig. 1 shows a graph in which

the loss of weight of the diurnal *Onymachris mutistriata* is plotted together with that of the nocturnal beetle *Gonopus* sp. As will be seen at a temperature of ca. 39°C. the *Onymachris* showed a sudden loss in weight which must be equivalent to a sudden loss of water. *Gonopus* on the other hand which did not have the temperature regulating mechanism showed a different curve. It must, however, be pointed out that the curves are only approximately correct due to technical difficulties in keeping the temperatures and the water deficiency constant.

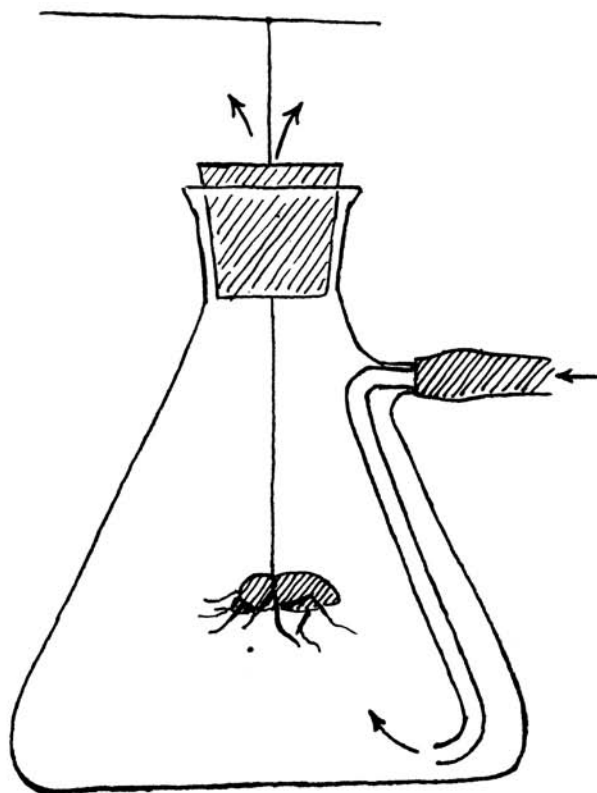


Fig. 2.

In the Kalahari it was remarkable to notice how *Onymachris* immediately ran for shade when placed in the sun. If I walked slowly across a bare stretch of sand the beetles would even follow me keeping within my shadow. To see if it was the sight of something dark (skototaxis) a reaction similar to that known from the Marine shrimp, *Gonodactylus* (Bolwig, 1954) it was tried to place black and white objects on the sand to see if the beetles showed any preference.

There seems to be no preference. Also experiments in the laboratory failed to throw any light on the problem.

RODENTS

As was found with insects the rodents also did not show any activity during the warm hours of the day. Squirrels (*Geosciurus inauris*) and particularly *Parotomys* vanished underground in the middle of the day and did not reappear until shortly before sunset. The nocturnal rodents *Gerbillus poeba* and *Desmodillus auricularis* did not appear until it was almost completely dark; *Gerbillus* always earlier than *Desmodillus*. During the rainy, windy nights *Desmodillus* closed the entrance of their warrens and did not appear above ground. A number of mice were caught and brought home for work in the laboratory. The best way of catching them was by holding them in the beam from a torch and making use of a butterfly net. Trapping was rather unsuccessful.

In the laboratory the food consumption and water intake of *Desmodillus* was measured. This, however, created some problems because the animals refused to drink. If given dry barley or maize and water they refused to consume either and rapidly lost weight showing severe signs of starvation. It was obvious that the animals had a great dislike for being wet at any part of their body. It was therefore necessary to substitute free water with vegetables. Marrow was found the best, containing 96½-97% free water. It was, however, necessary to find a method which reduced or eliminated the error caused by evaporation. After several trials it was found that the question of evaporation could be completely ignored if a cylinder of marrow was cut and fitted into a glass tube, the lower part of which was packed with soaked cotton wool. The tube was just wide enough to permit the head of the mouse to get inside and the marrow was not allowed to project beyond the rim of the glass. (Fig. 3.)

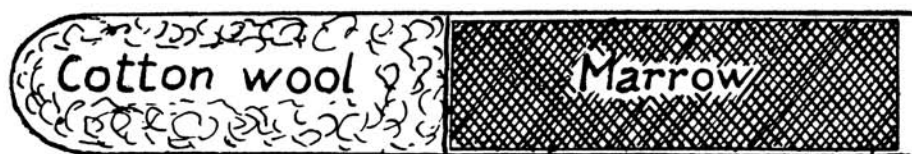


Fig. 3.

A glass with fresh marrow was given to the mice every evening and it was again removed the following morning. The marrow was weighed before given to the mice and after it had been taken away.

The only food given to the mice besides marrow was barley. A portion of 15 g. was given to them every morning. The following morning the faeces and the remaining barley was removed and sorted out. The barley was weighed. If the barley was moist it was spread out on a tray and left to dry in the sun for several hours before being weighed. The faeces was first

dried for 24 hours in an oven at 110°C. and thereafter weighed. The box with the mice was left without grain and marrow for the rest of the day. This was done because it was found that even starved mice refuse to eat during the day and it was hoped to reduce possible errors by not leaving any food lying about.

Another feature of interest was that the mice, when left undisturbed in their box did not pass any faeces and urine during the day. Most urine seemed to be passed in the evening and early in the morning. This coincides with observations in nature where early in the morning it is common to see wet patches in the sand in front of the rodents' holes. This particularly applies to the diurnal *Parotomys* which apparently stores up urine during the night and passes it first thing in the morning outside its hole. Whether *Desmodillus* does the same in the evening as well as in the morning, is not known. Observations of that sort are much hampered by the darkness of the night and the weather conditions for such observations were unfavourable.

The feeding experiment with *Desmodillus* lasted for 26 days in all, but various mishaps reduced the number to be taken into account to 22 days. The average daily consumption can be seen from Table 1.

Also the loss of water through evaporation and faeces was measured but due to various technical difficulties no figures for the loss through urine are available. All that can be said is that the mice produce an amazingly large amount of urine. The figures in Table 1 is not the actual amount of urine measured but the water loss which could not be accounted for in other ways.

The evaporation was measured by placing an animal in a jar and weighing the water absorbed by a piece of filterpaper impregnated with dried calcium chloride. In this experiment a needle attached to the arm of the balance drew the increase in weight onto a chymograph. The result can be seen from Table 1 where also the rate of evaporation of other rodents are entered.

TABLE 1

	Weight of animal	Per 24 hrs.	Evaporated per 24 hrs. per 100 g. animal at 23°—25°C.	Food consumption per 24 hrs. per 100 g. animal	Urine per 24 hrs. per 100 g. animal
<i>Desmodillus</i>	65g	4.80g	7.38g	7.91g	1.57g
White Rat	560g	18.1g	3.23g	2.23g	0.73g
<i>Geosciurus</i>	915g	23.6g	2.58g	1.77g	—

A balance sheet for *Desmodillus* is given in Table 2. It will be seen that the utilization of the food is better than in the rat which produces almost the double amount of faeces per unit of food consumed. (Bolwig, 1958). The amount of water lost by evaporation in proportion to what has been taken in is much smaller and the water retained will thus be available for other purposes. Moreover the requirement for intake of free water will be correspondingly reduced. In proportion to the food consumed the *Desmodillus* takes in only half as much water as does the rat. Judging from the balance sheet it passes only about two thirds the amount of urine compared with the rat. It can therefore be assumed that the *Desmodillus* can concentrate its urine more than the rat. Tests with samples of urine indicated a very high osmotic pressure in the urine of *Desmodillus*. Soon after urine had been sampled crystal needles were formed. Their chemical composition is unknown.

TABLE 2

DESMODILLUS: 65g

Consumption per day	Output per day
Barley: 5.14g (10.5% free H ₂ O)	Faeces: 0.38g dry
= 0.53g free H ₂ O	(fresh faeces contains 55.5% free H ₂ O)
2.59g bound H ₂ O	= 0.47g free H ₂ O
Marrow: 3.48g — 3.38g free H ₂ O	0.21g bound H ₂ O
	Evaporation: 4.80g H ₂ O
<hr/> Total: 6.50g.	<hr/> Total: 5.48g + xg Urine.
Consumption per 100g barley:	
Barley contains: 10.25g free H ₂ O	77.33g dry faeces: 9.14g free H ₂ O
49.86g bound H ₂ O	4.04g bound H ₂ O
Marrow contains: 67.89g free H ₂ O	Evaporation 93.39g H ₂ O
<hr/> Total: 128.89g	<hr/> Total: 106.57g + xg Urine.

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