Preliminary observations on the digestive and renal efficiency of Hartmann's zebra *Equus zebra hartmannae*

by

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ABSTRACT

An investigation of the digestive and renal efficiency of Hartmann's zebra has shown that digestive efficiency in these animals does not differ significantly from the domestic horse. The maximum urine osmolality recorded was 1 4655 mOsm and the mean plasma : urine concentration ratio for eight animals was 4,1, indicating only moderate urine concentrating ability in this species. Behavioural thermo-regulation, particularly shade-seeking and orientation of the long axis of the body to change the light : dark ratio exposed to solar radiation, appears to be an important adaptive trait to minimise evaporative water loss.

1 INTRODUCTION

Typical habitat of Hartmann's zebra, *Equus zebra hartmannae*, is the semi-arid, mountainous transition between the Namib Desert in the west and the inland plateau to the east. A significant number of these animals does, however, periodically move into the eastern section of the Namib Desert and even into the dune streets, south of the Kuiseb River. In fact, the frequent sightings of these animals in true desert habitat have led many to believe that they are physiologically adapted to life in arid regions. Nothing, however, is known of their physiology and the purpose of this investigation was to make preliminary observations on their renal and digestive efficiency in order to evaluate their adaptive ability in these traits to provide guidelines for the conservation of the species.

2 PROCEDURE

2.1 Digestive efficiency

To assess digestive efficiency three Hartmann zebra stallions were kept in individual pens in the quarantine station at the Daan Viljoen Game Reserve, near Windhoek. The pens consisted of an enclosed stable, provided with a concrete floor and feeding trough as well as an open-air enclosure with a connecting door.

During the pre-experimental period the animals were trained to leave the enclosed stable when the connecting door was opened after every defaecation. This procedure allowed the total collection of faeces off the clean concrete floor which was washed every morning. The actual digestion trial lasted 26 days and consisted of a 15-day preliminary period during which the animals were accustomed to both the experimental procedure and the experimental ration of good quality lucerne hay. It could also be safely assumed that any digestive residues from previous feeding had been completely eliminated after this period. The amount of lucerne hay fed to each animal was based on its body mass and the total digestible nutrients (TDN) recommended for horses of similar mass by Morrison (1961).

During the collection period, which lasted 11 days, the animals were fed at 08h00 each morning after the feed had been mass measured and an aliquot taken, and stored for later analysis. Immediately afterwards the faecal matter which had been voided during the previous 24-hour period was weighed and again an aliquot was removed from each daily sample, and stored for later analysis. The moisture content of both the feed and faecal aliquots was determined by oven drying at 80°C. Chemical analyses of both feed and faeces included organic matter, crude protein, crude fibre, ether extract and nitrogen free extract. These analyses were accomplished by standard A.O.A.C. procedures.

2.2 Renal efficiency

During a routine cropping operation in the Khomas Hochland area, an opportunity arose to collect both blood and urine samples from seven freshly-killed zebras. The animals had been prevented from drinking for a 24-hour period prior to being shot and it was thought that a comparison of the composition of the plasma and urine would provide an estimate of the urine concentrating ability of this species.

The blood samples were collected in heparinised syringes from the external jugular within three to four minutes after the animals had been shot. They were immediately centrifuged in the field and the plasma was frozen and stored for later analysis. The urine samples were similarly collected and stored in sterile syringes after puncturing the bladder.

Both blood and urine samples were analysed for osmolality and urea concentrations. Osmolality was determined using an automatic osmometer (Advanced Instruments Model 67 31RAS) and urea was determined enzymatically using the method of Richterich (1968).

2.3 Behavioural adaptations

Observations on behavioural adaptations formed part of a long-term behavioural study on Hartmann's zebra conducted by Joubert (1972 a. and b.)

3 RESULTS AND DISCUSSION

3.1 Digestive efficiency

The total intake of dry matter and the amount voided in the faeces during the eleven-day collection period has been summarised in Table 1. These results show that the two adult stallions (1 and 2) consumed significantly more than the sub-adult, but no really significant differences in digestive efficiency were apparent between the animals. It is also of importance to note that a significant amount of orts remained, indicating that the nutritive requirements of the animals had been well estimated and that they were not being underfed.

The results of the complete digestion trial have been presented in Table 2 together with comparative data for horses, obtained by Fonnesbeck *et al.* (1967) and Van der Noot and Gilbreath (1970). From these results it appears that there are no important differences in digestive efficiency between Hartmann's zebra and the domestic horse. If anything, the ability of the zebras to digest cellulose (crude fibre) is somewhat lower, but the amount of data available does not allow for any refined comparisons. What is important, however, is that these data do allow us to question the popularly-held belief that zebras have a highly superior digestive efficiency which, in turn, is frequently cited as the reason for observing so many zebras in excellent body condition. A more likely explanation is that the nutritional value of the natural grass cover in the semi-arid habitat of Hartmann's zebra is far higher than is generally realised. Many of these grasses are highly palatable and nutritious and because of the prevailing semi-arid conditions mature into naturally cured hays. These observations, although tentative, should receive due consideration in planning the conservation of this species.

TABLE 1

Dry material (DM) offered, taken and voided by *Equus zebra hartmannae* during a period of 11 days

Animal	Offered	Refused (Orts)	Taken	Voided
	kg	kg	kg	kg
1 (Adult)	53,1	3,3	49,8	24,6
2 (Adult)	53,1	5,6	47,6	25,9
3 (Sub-adult)	44,3	2,3	42,0	20,1

TABLE 2

A comparison of the apparent digestibility of various nutrients between horses and *Equus zebra hartmannae*

	Equus zebra hartmannae Animal 1	2	3	Mean	Horses *(1967)	**(1970)	Mean
Dry material %	50,5	45,6	52,1	49,4	52,1	60,8	56,4
Organic material %	54,4	51,5	56,1	54,3	—	56,4	56,4
Crude protein %	71,6	69,1	69,1	70,1	65,2	75,4	70,3
Crude fibre %	28,8	24,5	31,6	28,3	39,5	39,1	39,3
Ether extract %	26,0	31,0	40,0	32,3	5,0	31,2	18,1
NFE %	67,0	64,8	69,0	66,9	72,2	72,3	72,2

x Nitrogen free extract.
* Fonnesbeck *et al* (1967)
** Van der Noot & Gilbreath (1970)

TABLE 3

Urea concentration and osmolality of the blood and urine of seven *Equus zebra hartmannae*

	Plasma $x\geq$	Plasma *Range*	Urine $x\geq$	Urine *Range*	Mean *Plasma:Urine*
Urea concentration (mg/100 ml)	47,98	35,20 – 63,34	2696	2243 – 4044	–
Osmolality (mOsm/kg)	304,00	287,00 – 324,00	1231	1055 – 1465	4,1

3.2 Renal efficiency

The accurate evaluation of renal efficiency or renal concentrating ability is a complex process and should include evaluation of seasonal effects and consideration of the degree of dehydration of the species concerned. Nevertheless, the present investigation was carried out during the dry season when the vegetation contained a minimum amount of moisture and after the animals had been prevented from drinking for at least 24 hours. The comparison, therefore, of the plasma and urine concentrations in Table 3 should reflect the upper range of renal concentrating ability in Hartmann's zebra. These data show that the highest urinary osmolality recorded was 1 465 m Osm and that the mean plasma : urine ratio was 4,1. The maximum urinary urea concentration recorded was 4,04 g per 100 ml. These values represent only moderate concentrating ability of the kidneys and are equivalent to the maximum values obtained for man (Chew, 1965). In contrast, the mean urine : plasma ratio recorded under similar conditions for springbok was 8,2 (Hofmeyr and Louw, 1977) and for the ground squirrel (*Xerus inauris*) 14,9 (Marsh, 1976).

Although it is possible that the maximum urine concentration would exceed the values obtained in the present investigation if the animals were subjected to extreme dehydration, they are unlikely to exceed the 2 000 m Osm level. This contention is supported by our observations both in the Khomas Hochland area and in the Namib Desert where it was found that Hartmann's zebra drink daily under natural field conditions. In fact, in hot, arid conditions the animals will frequently drink twice per day.

It would appear then as if Hartmann's zebra is physiologically dependent on almost daily access to free drinking water and this fact should be carefully considered when planning the conservation of this species.

3.3 Behavioural adaptations

During the course of a long-term behavioural study of Hartmann's zebra (Joubert 1972 a. and b.) it became clear that this species exhibits several interesting behavioural adaptations which assist it in avoiding excessive evaporative water loss, thus partially compensating for its apparently poor renal concentrating ability. For example, during the months when high ambient temperatures are experienced (October to January) grazing intensity is at a peak at first light when the lowest temperatures of the day are experienced. Thereafter grazing intensity becomes irregular as the animals retreat intermittently into the shade of trees to reduce the solar load and consequently the necessity for evaporative cooling. In contrast, the grazing pattern during the cooler months of the year is more regular and the animals spend more time in sun-basking to raise their body temperature, thus reducing the energy requirements for thermogenesis. In doing so they frequently orientate the long axis of the body laterally to the sun, thus not only increasing the surface area for absorption of solar radiation, but also, because of the striped nature of the coat, exposing a surface area with a light : dark ratio of 1 : 3. When facing away from the sun this ratio changes to 3 : 1.

Hartmann's zebra is of course not unique in ameliorating unfavourable environmental influences through behavioural adaptations. Nevertheless, due cognizance should be taken of these behavioural traits and in this regard at least the importance of shade trees in the habitat of this species should be recognised.

4 CONCLUSION

Although this investigation can only be considered of a preliminary nature, it has nevertheless provided sufficient evidence to conclude that it is very unlikely that Hartmann's zebra possesses either superior digestive or renal efficiency. Moreover, it would seem as if the utilization of shade trees plays an important role in ameliorating the effects of unfavourable environmental conditions, by allowing these animals to give full expression to their well-developed repertoire of thermoregulatory behaviour. In our opinion, therefore, these results could assist significantly in planning the conservation of this species.

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