THE PROVISION OF WATER TO DEER IN LAIRAGE

A.L. Hargreaves, L.R Matthews and R.M. McDonald*

Animal Behaviour & Welfare Research Centre,
Ruakura Agricultural Centre, Private Bag 3123, Hamilton.

* Engineering Development Group,
Hort+Research, Ruakura Agricultural Centre, Private Bag 3123, Hamilton.

Introduction

It is a regulatory requirement in many countries that livestock in lairage have access to drinking water. Water consumption in lairage contributes to animal welfare and may improve carcass yield (Gortel et al., 1992). The New Zealand Meat Regulations (1969) specify that water should be provided in troughs. However, there has been some inconsistency in the method of supplying water to deer in lairage. Because of the agility and flightiness of deer, operators are sometimes reluctant to use troughs which might cause damage or injury if the deer collide with them, and in which water might quickly become fouled if deer climb over them. Water provided in lairage will only improve the welfare of deer if the animals have a need for water and the deer readily consume water. The incidence of drinking will therefore depend on both the internal motivation to drink (the need for water) and external factors which may either promote or inhibit drinking. Several aspects of the transferral of deer from the farm to the DSP are likely to influence the state of hydration of deer (eg. climate, stress, period without water, activity) and their propensity to drink in lairage (water quality, design of watering system, familiarity with watering system, social environment, normal daily drinking patterns, stress and the degree of disturbance in lairage; Fletcher, 1988; Lambooy, 1983). The aim of the studies described here was to develop a watering system satisfactory for use in a DSP. In order to do this, several experiments were first undertaken to determine the appropriate physiological and behavioural measures for assessing hydration, and the effects of various environmental and management factors on the incidence of drinking in confined red deer.

Experiment 1: Will deer drink from an unfamiliar trough while confined in yards?

The aims of this experiment were threefold: (1) to determine whether deer in yards will drink when given unrestricted access to water; (2) to assess the effect of water deprivation, such as deer might encounter during short and long journeys to a DSP, on hydration and subsequent drinking; (3) to acquire basic information regarding the appropriate measures of hydration and water consumption in red deer.

Materials and methods

Four groups of 6 non-pregnant non-lactating red deer hinds were deprived of water for 2 or 20 hours, then confined in a pen with access to either a full trough of water or an empty trough for 6 hours. The trough was made of moulded plastic, measured 750 mm long, 350 mm wide and 200 mm deep, was filled automatically and was centred along one wall of a pen measuring 2.4 m x 2.4 m. Each group was exposed to two of the four treatment procedures. Blood samples were collected by venipuncture before and after water deprivation (0, 18, 20 and 26 h) and at the end of the 6-hour observation period. These were used to determine plasma Na^+, Cl^-, K^+ and osmolality. The behaviour of the deer was monitored remotely during the observation period and was recorded on videotape.

Results and discussion

Plasma Na^+ (Fig. 1) increased in response to the longer period of water deprivation (20 h). The elevation of Na^+ was largely offset by access to water during the subsequent 6 hours, whereas concentrations continued to increase in deer without access to water during this period. A similar pattern of changes was recorded for plasma Cl^-. Haematocrit and plasma K^+

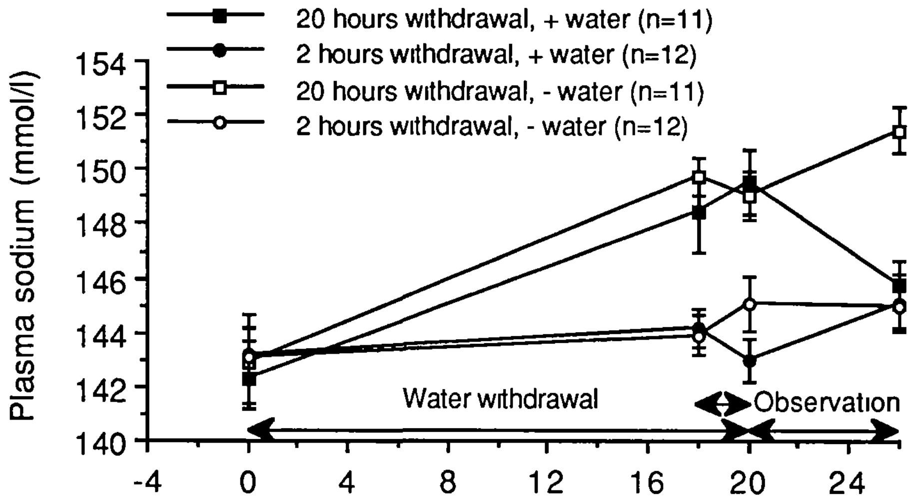

Figure 1. Plasma sodium.

concentrations changed significantly over the course of the experiment (generally declined) but were not affected by the treatment procedures (Table 1).

The changes in plasma Na^+ concentrations were reflected in the behaviour of the deer. When given access to water in the pen after 20 hours without water, deer drank for longer than did animals which had been without water for 2 hours (Fig. 2). A flow meter attached to the water inlet of the trough confirmed that more water was consumed after the longer deprivation period. Although the deer which were without water for 2 hours drank less, they directed more exploratory behaviour (nosing, sniffing, licking) towards the trough than did those deprived of water for 20 hours (146.9 ± 31.1 sec vs. 88.3 ± 26.2 sec over the six hours). Thus the non-drinking behaviour which was directed towards the trough was apparently unrelated to the need for water.

	Plasma potassium (mmol/l)				Haematocrit (percent)			
	0 h	18 h	20 h	26 h	0 h	18 h	20 h	26 h
Water deprivation 18 - 20 h								
+ water 20 - 26 h	5.13 (±0.11)	4.70 (±0.06)	4.46 (±0.16)	4.04 (±0.13)	51.5 (±0.8)	50.9 (±1.2)	48.3 (±1.1)	48.2 (±2.8)
- water 20 - 26 h	4.88 (±0.12)	4.89 (±0.14)	4.32 (±0.11)	4.24 (±0.11)	50.2 (±0.7)	50.5 (±0.8)	48.1 (±1.2)	50.9 (±1.1)
Water deprivation 0 - 20h								
+ water 20 - 26 h	4.99 (±0.11)	4.41 (±0.06)	4.11 (±0.16)	4.04 (0.13)	51.6 (±1.8)	50.3 (±2.0)	48.8 (±1.9)	50.2 (±1.8)
- water 20 - 26 h	4.60 (±0.07)	4.19 (±0.12)	4.00 (±0.13)	4.16 (±0.15)	52.4 (±1.2)	50.8 (±1.2)	50.5 (±1.0)	48.9 (±1.4)

Table 1. Plasma potassium and haematocrit.

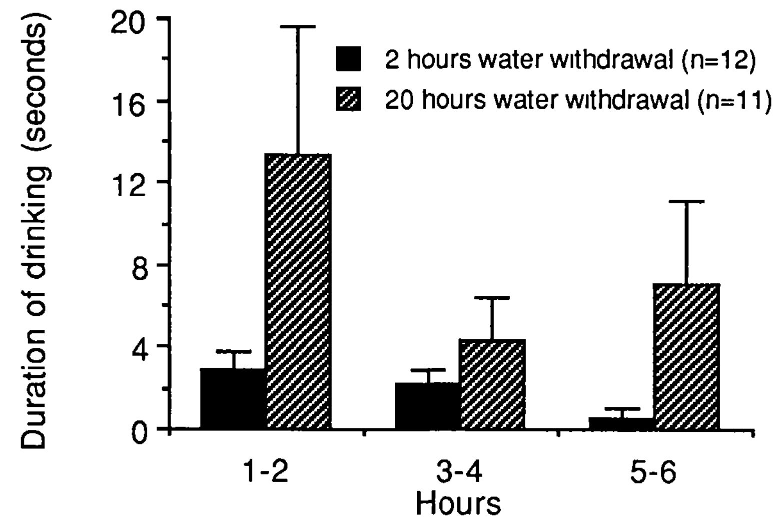

Figure 2. Duration of drinking during the 6-hour observation period.

These results show that the deer which had been without water for 20 hours had a greater need for water, subsequently drank more than did deer deprived of water for 2 hours and apparently drank enough to offset the effects of the 20 hours without water. However further observations when the deer were returned to the paddock at the end of the treatment period revealed that the deer deprived of water for 20 hours spent longer drinking than did those deprived for 2 hours (18.0 ± 4.3 sec vs. 0.1 ± 0.1 sec, respectively), despite the availability of water in the meantime. This is consistent with observations in other livestock species showing that spontaneous drinking cannot always be related to physiological indicators of hydration (Anderson and Houpt, 1990).

In red deer, plasma concentration appears to be a more appropriate measure of hydration than is haemoconcentration. Although the deer in this experiment had been handled frequently, the decline in haematocrit after the initial sample suggests that there was some habituation to the sampling procedure and that in deer, as in sheep, haematocrit is affected more by arousal than by the state of hydration (Parrott et al., 1987; Hargreaves and Hutson, 1990). Likewise the decline in plasma K^+ concentrations over the 26 hours is consistent with the suggestion that plasma K^+ increases in response to stress or activity (Jopson and Fennessy, 1992).

Experiment 2: A comparison of three different methods of water delivery

Although deer drank freely from the trough used in the previous experiment, its rigid structure and protrusion into the pen make it unsuitable for use at a DSP. In this experiment, three very different systems of water delivery were assessed with respect to their efficacy in providing water to deer which had previously been deprived of water. These three systems conformed to the design constraints which operate at a DSP - the water could not readily be fouled and the deer could not injure themselves on the devices. The three systems (which represented experimental treatments) were:

(1) a small trough (200 mm x 280 mm) which was filled automatically. The trough was set into a plywood surround which was positioned across one corner of the pen. To prevent deer climbing above the trough, a length of timber was positioned across the corner of the pen, 750 mm above the trough.
(2) 5 spray nozzles positioned 2.45 m above the pen.
(3) a gentle jet of water which flowed into the centre of the pen from a hose positioned behind a plywood sheet which screened one corner of the pen.

In the fourth treatment procedure (control) deer did not have access to water.

Materials and methods
Four groups of six adult red deer hinds were exposed to one of the four treatments for 2 hours after they had been deprived of water for 20 hours. Each group went through two treatments, according to a partial Latin square design. As before, blood samples were collected before water deprivation and before and after the treatment period and were analysed for Na^+, K^+ and Cl^-. The behaviour of the deer during the 2-hour treatment period was recorded on videotape and monitored remotely. During the treatment period a wider range of behaviours was recorded than in the previous experiment. There were several reasons for doing this. Firstly, we were unsure which behaviours would be associated with water consumption from the jet and the spray. Also, many of the behaviours were unlikely to be comparable between treatments. In addition, we were interested in behaviour which might restrict water consumption (eg. agonistic behaviour and shaking). The behaviours recorded were: drinking, sniffing the watering system, licking (the animals' own muzzles, their own bodies, other deer, the physical environment), entering the section of the pen where the watering systems (trough or jet) were located, agonistic interactions, shaking the head and/or body, lying.

Results and discussion
As in the previous experiment, withdrawal of water for 20 hours resulted in a marked increase in the concentration of plasma Na^+ (Fig. 3). Plasma Na^+ was unchanged over the subsequent 2 hours, regardless of whether the deer were without water or had access to it from the trough or the spray. There was a slight decline in the concentration of plasma Na^+ when water was available from the jet, but this was not sufficient to offset the effects of the deprivation period and was not significant. The treatment period in this experiment (2 hours) was shorter than the one used previously (6 hours). However, in the previous experiment treatment differences in the duration of drinking were already apparent in the first 2 hours of the 6-hour period (Fig. 2). In addition, the 20-hour period without water followed by access to water for 2 hours are comparable with what might occur during transport and lairage.

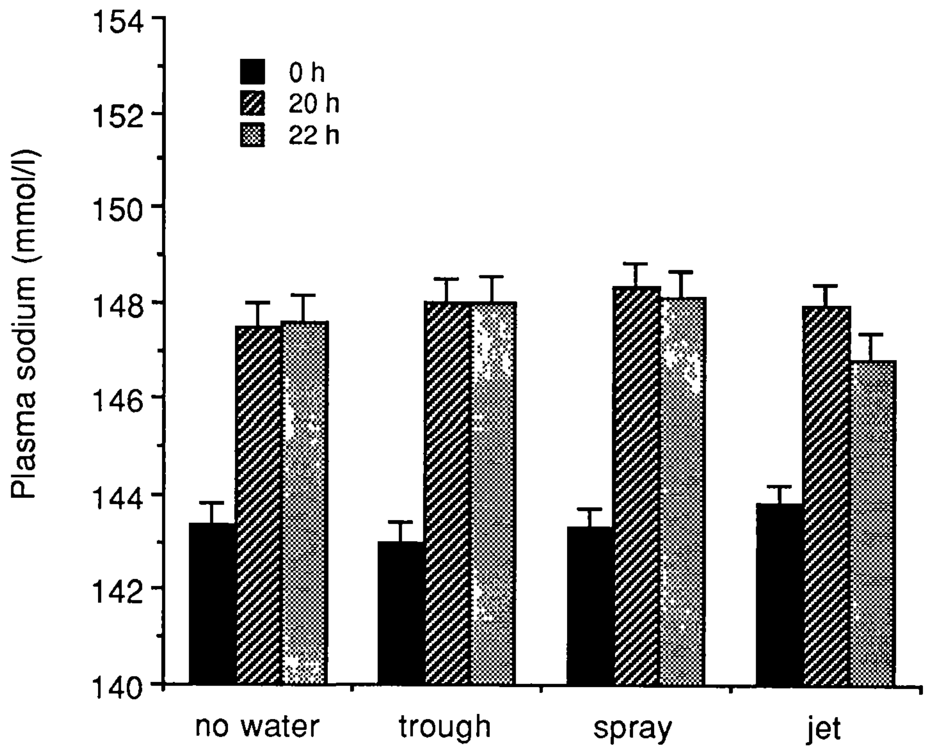

Figure 3. Plasma concentrations of sodium before withdrawal of feed and water (0 h) and before (20 h) and after (22 h) the 2-hour test period (means and SEM calculated by the REML procedure after adjustment for deer and period effects; n=12).

Two deer drank from the trough, on a total of three occasions. This is consistent with the Na^+ data. Because of the failure of any of the watering systems in this experiment to significantly affect the state of hydration of the deer, we are limited in the extent to which various other behaviours can be related to water consumption. However, when certain behaviours were frequent, we can discount them as being important means of obtaining water in this experiment. After adjusting for the effects of individual deer and the treatment period, there was no significant difference between treatments in the frequency or duration of licking other deer, the physical environment or the animal's own muzzle (Table 2). Thus licking these substrates was not affected by them being wet in two of the treatments (spray and jet). Deer licked their own bodies more frequently when they were without water than during the spray or the jet treatments. Thus any water obtained by licking would have been serendipitous and unrelated to demand for water. In addition, the high frequency of shaking the head and/or body by deer exposed to the spray or the jet suggests that deer do not allow water to accumulate on their

	No water	Trough	Spray	Jet
Licking				
Other deer				
frequency (in 2 h)	3.99	0.74	0.01	3.60
duration (s)	31.60	9.91	0.56	21.89
no. animals	7	3	1	3
Environment				
frequency	0.52	0.15	0.06	0.10
duration	2.98	0.09	1.54	0.77
no. animals	5	2	1	1
Muzzle				
frequency	47.47	74.59	85.36	55.41
duration	91.96	77.09	121.67	84.04
no. animals	12	12	11	12
Own body				
frequency	3.10	3.93	0.00	0.24
duration	14.41	21.20	0.00	1.16
no. animals	11	10	1	0
Shake body/head				
frequency	0.60	1.82	18.98	13.85
no. animals	8	7	12	12
Sniffing water system				
frequency	.	2.41	.	0.00
duration	.	5.73	.	0.00
no. animals	.	10	.	12
Agonistic interactions				
aggressive	2.35	5.91	0.90	15.51
submissive	2.83	6.56	0.43	11.44
Drinking in paddock				
frequency (in 2 h)	1.46	1.05	1.70	0.37
duration	10.26	4.45	10.32	1.32
no. animals	4	6	8	3

Table 2. Behaviour during the 2-hour test period and drinking in the two hours after returning to the paddock (means and SEM calculated by the REML procedure after adjustment for deer and period effects; n=12).

coats. The frequency of agonistic acts (biting, butting, kicking) was highest amongst deer given water from the trough or the jet. This suggests that even when a resource is not much used, if it is localizable its presence may elicit some competition between animals.

The frequency of drinking after returning to the paddock was low (Table 2) although the deer were clearly dehydrated (Fig. 3). Because of the shorter treatment period, the deer in this experiment were returned to the paddock four hours earlier than in Experiment 1, and the low incidence of drinking may have been due to the time of day and normal variation in drinking throughout the day.

These data suggest that deer are readily inhibited from drinking, even when they are in water deficit. This inhibition is apparently related to external factors, including the design of the watering system, the social environment and daily drinking habits of the deer. Our results indicate that deer are most likely to drink from standing water which is readily accessible. Ready access may limit the agonistic behaviour which arises when access is restricted. Furthermore, if the visual field is restricted during drinking (eg. by a corner trough or one recessed into a wall) deer may avoid it, especially when the incidence of agonistic behaviour is high.

Development: Devising a trough suitable for use in a DSP

The results of the previous experiments suggest that there is a conflict between the dual aims of producing a system from which deer will readily drink and one which is suitable for use in a DSP. In order to reconcile these two aims, a prototype trough was developed, based on the knowledge of deer drinking behaviour gained from the preceding experiments. This trough is made of tear-resistant rubber sheet formed into a long pouch. It has a capacity of about 25 litres and presents a water surface approximately 1500 mm long, 200 mm wide at the centre and tapering to a width of 150 mm at the ends. The trough can be mounted on one wall of a lairage pen and is filled by a continuous flow of 2 l/min. The construction allows the trough to collapse towards the wall when under pressure from an animal. However, most of the water is retained, because the lip of the trough moves upwards on pressure.

In preliminary observations at a DSP, the behaviour of deer was recorded on videotape when they had access to water from the collapsible trough. After a journey lasting 6 hours the mean frequency of drinking was 0.39 bouts/head/h during 10.9 hours in lairage overnight and the mean duration of drinking was 2.5 sec/head/h. A similar group of 8 deer had 0.8 bouts/head/h and drank for 5.68 sec/head/h during 14 hours in lairage overnight. Daytime figures for a group of 9 deer observed for 4.5 hours were similar - 0.4 bouts/head/hour and 2.7 sec/head/hour. Although these figures are lower than those recorded in Experiment 1, they may have been sufficient for the deer to rehydrate, given that the drinking was sustained over a long period and the deer may not have been deprived of water for a long as were the experimental animals. In these observations, most deer were seen to drink from the trough on at least one occasion. Work is continuing on the development of the "soft" trough, and it promises to be a satisfactory basis for the development of a trough suitable for use under commercial conditions.

Acknowledgment

These studies were funded by the Foundation for Research, Science, and Technology and the NZ Game Industry Board.

References

Anderson, C.R. and Houpt, T.R. (1990). Hypertonic and hypovolemic thirst in pigs. Am. J. Physiol. **258**: R149-R154.

Fletcher, T.J. (1988). The transport of deer. In: Reid, H.W. (ed), The Management and Health of Farmed Deer. Curr. Topics in Vet. Med. Anim. Sci. Kluwer Academic Publishers, Dordrecht.

Gortel, K., Schaefer, A.L., Young, B.A. and Kawamoto, S.C. (1992). Effects of transport stress and electrolyte supplementation on body fluids and weights of bulls. Can. J. Anim. Sci. **72**: 547-553.

Hargreaves, A.L. and Hutson, G.D. (1990). Changes in heart rate, plasma cortisol and haematocrit of sheep during a shearing procedure. Appl. Anim. Behav. Sci. **26**: 91-101.

Jopson, N.B. and Fennessey, P.F. (1992). A pattern of plasma potassium concentration in adult red deer stags. In: Brown, R.D. (ed), The Biology of Deer. Springer-Verlag, New York.

Lambooy, E. (1983). Watering pigs during road transport through Europe. Fleischwirtsch **63**: 1456-1458.

Parrott, R.F., Thornton, S.N., Forsling, M.L. and Delaney, C.E. (1987). Endocrine and behavioural factors affecting water balance in sheep subjected to isolation stress. J. Endocr. **112**: 305-310.

The Meat Regulations. (1969). New Zealand Government, Wellington, New Zealand.