Ruminoreticular Motility in red deer

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INTRODUCTION

Ruminoreticular motility is an important component of ruminant digestion and is used as a clinical sign by veterinarians. The contractions of the ruminoreticulum have been classified into two major types, namely A sequences (AS) which are concerned with the mixing of digesta and ingesta and B sequences (BS) concerned with the eructation of gases (Reid, 1963) During rumination an extra reticular contraction occurring immediately before an A sequence (A3) assists the regurgitation of material for chewing (Phillipson, 1939, Schalk and Amadon, 1928).

Ruminoreticular motility has been studied in several of the domesticated ruminants but only in two wild species, the White Tailed Deer (*Odocoileus virginianus*) (Dziuk *et al*, 1963) and the American Bison *(Bison bison*) (Dziuk, 1965). The recent addition of Red Deer *(Cervus elaphus)* to the list of domesticated ruminants has encouraged research into the digestive functions of this species (Maloiy *et al*, 1970; Hofmann, 1985; Domingue, 1989; Domingue *et al* , 1991a; 1991b, 1992). Ruminoreticular motility of red deer has not been reported.

This paper reports the monitoring of reticulorumenal motility in caged Red Deer fed chaffed lucerne hay *ad libitum* during November and December 1991. This study is part of an investigation into the seasonality of forestomach motility in red deer.

MATERIALS AND METHODS

Animals

Four, hand-reared, adult castrated stags each with a 10cm diameter permanent fistula in the dorsal rumen sac were studied. They were accustomed to being held in cages and were easy to handle

Holding Cages

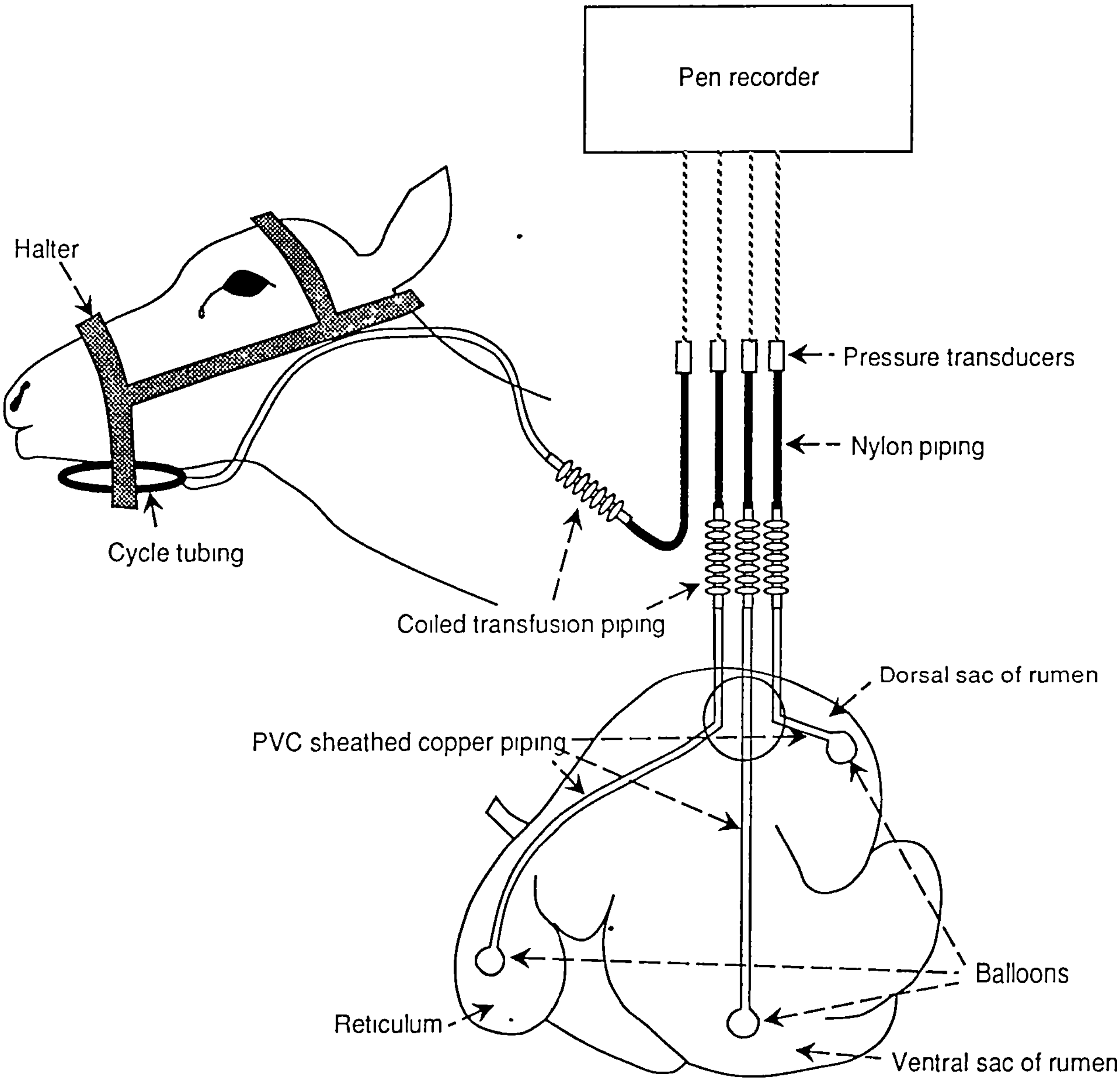
The animals were placed in individual steel cages about 1 4m high with a wire mesh roof, especially designed for deer (Domingue, 1989). One wall was moveable and could be used to "squeeze" the deer to one side of the cage for ease of handling. Detachable feeding bins were attached to the front of the cage and water buckets were attached to one side.

Recording Technique

Ruminoreticular contractions were monitored by recording pressure changes in the reticulum, dorsal rumen sac and ventral rumen sac using partially inflated balloons connected by piping to pressure transducers (Figure 1). The balloons were positioned and held in place in the compartments by suitably bent lengths of copper tubing clad with PVC sheathing. The piping was anchored by a cork with notches cut out of its edge and fitted tightly into the cannula. A piece of 12cm plumbing piping with a castellated edge tied to the rumen cannula copper ring helped to stabilize the piping. Coiled rubber transfusion tubing (Expandiate i/v tubing, Cenvet, Aust) linked the copper piping from outside the rumen cannula to nylon tubing tied to the cage roof

Jaw activity was recorded using a partially inflated section of bicycle tube held under the jaw by a halter and connected using coiled transfusion piping and nylon tubing to a pressure transducer linked to a pen-recorder (Figure 1). Outputs of the transducers fed into 4 channel recorders. One recorder was used for each animal to record simultaneously jaw activity and pressure changes in the reticulum, dorsal and ventral rumen sacs.

Figure 1. The recording apparatus used to monitor ruminoreticular movements and jaw activity in red deer



During recording sessions the mobile cage wall was used to restrict the animals just sufficiently to stop them turning around.

Recording Sessions

Jaw activity and pressure changes in the reticulum, dorsal and ventral sac of the rumen were recorded for 7 days continuously. At least 4 full 24 hour periods of recording suitable for analysis were obtained from each animal. The deer and the recording systems were checked at regular intervals throughout the day from 0600 to midnight.

Feeding

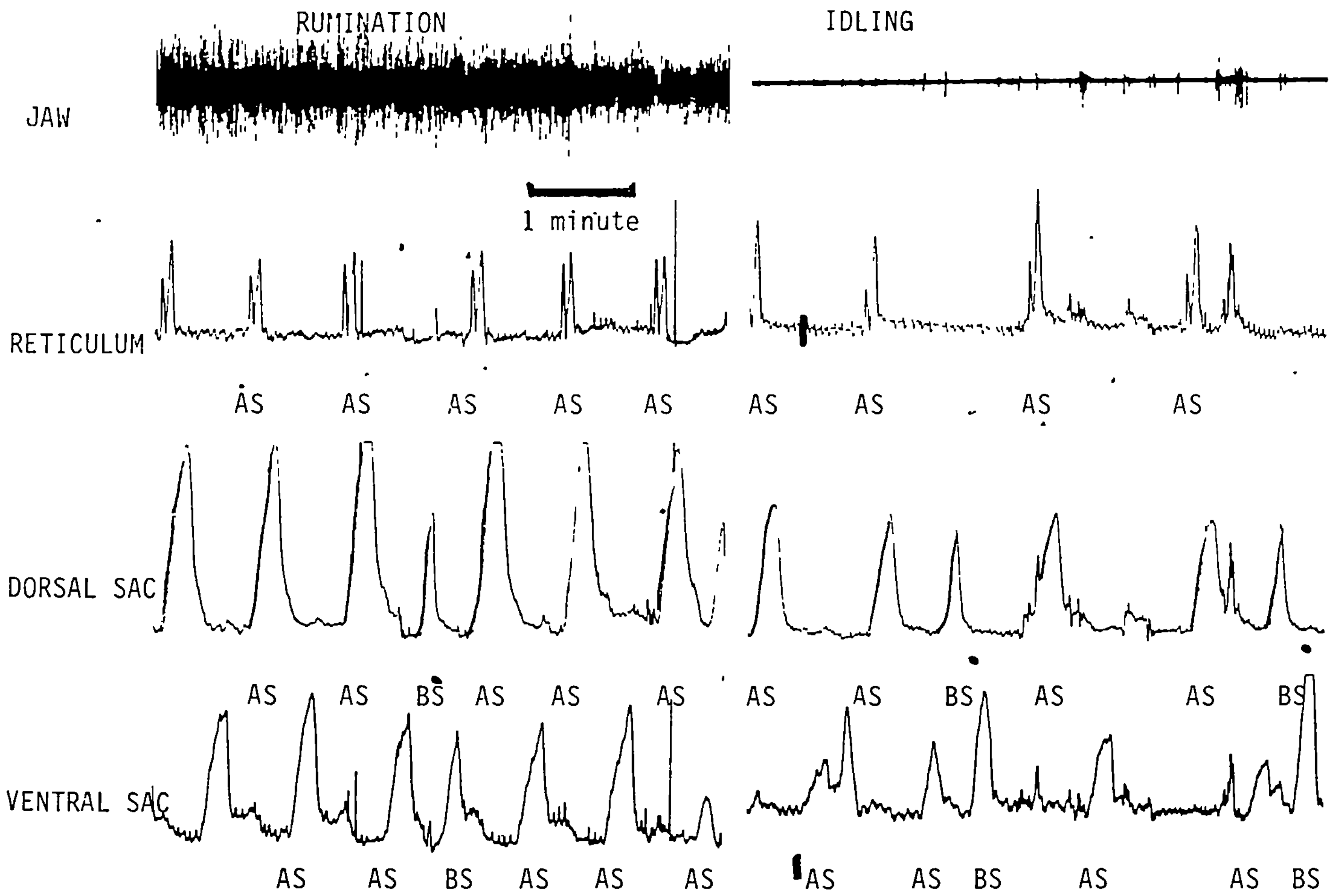
The diet was chaffed lucerne hay given once daily at 1000 hours. Each animal was offered 25% more hay than it ate the previous 24 hours. The deer were allowed 2 weeks to become accustomed to the diet. Water and a salt block were available at all times. The water was replenished several times during each 24 hour period

Record Interpretation

Records were removed from the pen-recorders at 1000 hours each day. They were identified with the animals number and the date. Time marks were scribed on the records several times during each 24 hour period

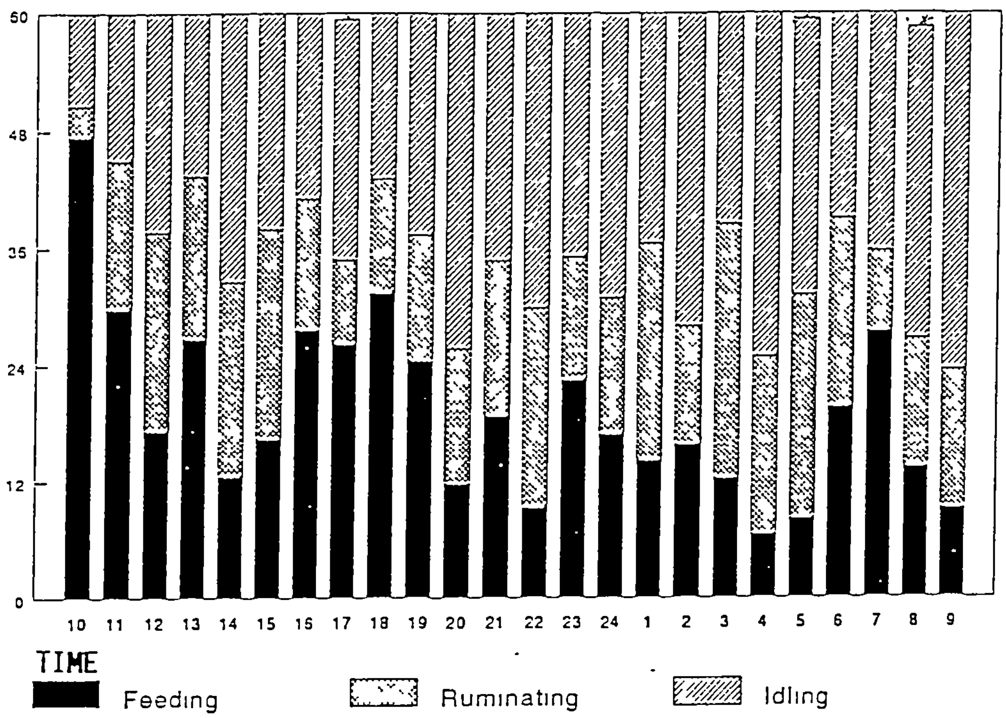
The pressure changes in the three compartments were used to identify A sequences (AS), B sequences (BS) and the extra reticular contraction of regurgitation (A1). AS were identified as a biphasic reticular contraction followed by a dorsal sac and ventral sac contraction (Figure 2). BS were identified as contraction of the dorsal and ventral sacs independent of a reticular contraction The extra reticular contraction of rumination (A1) usually occurred immediately before the biphasic contraction of an AS (A3, Figure 5).

Figure 2. **Recording of jaw activity and pressure changes in the reticulum, dorsal rumen sac and ventral rumen sac during feeding and idling.**



The jaw record was used to identify the activity of the animal as feeding, ruminating or idling (neither feeding nor rumination,NFR) (Figure 3; Figure 5). Feeding sessions which sometimes lasted for several hours were considered as continuous feeding unless interrupted by grooming, rumination or bouts of idling lasting more than 10 minutes.This procedure was adapted because although feeding was intense when fresh food was first given it became progressively more desultory with more time being spent turning over feed in the bin Rumination bouts were identified as having a minimum of three boluses regurgitated. Bouts of rumination lasting longer than 30 minutes were common. During NFR the deer either had no jaw activity or were involved in grooming or rubbing.

Figure 3. The circadian pattern of feeding and rumination in red deer. Mean data collected from 4 red deer recorded from 4 days.

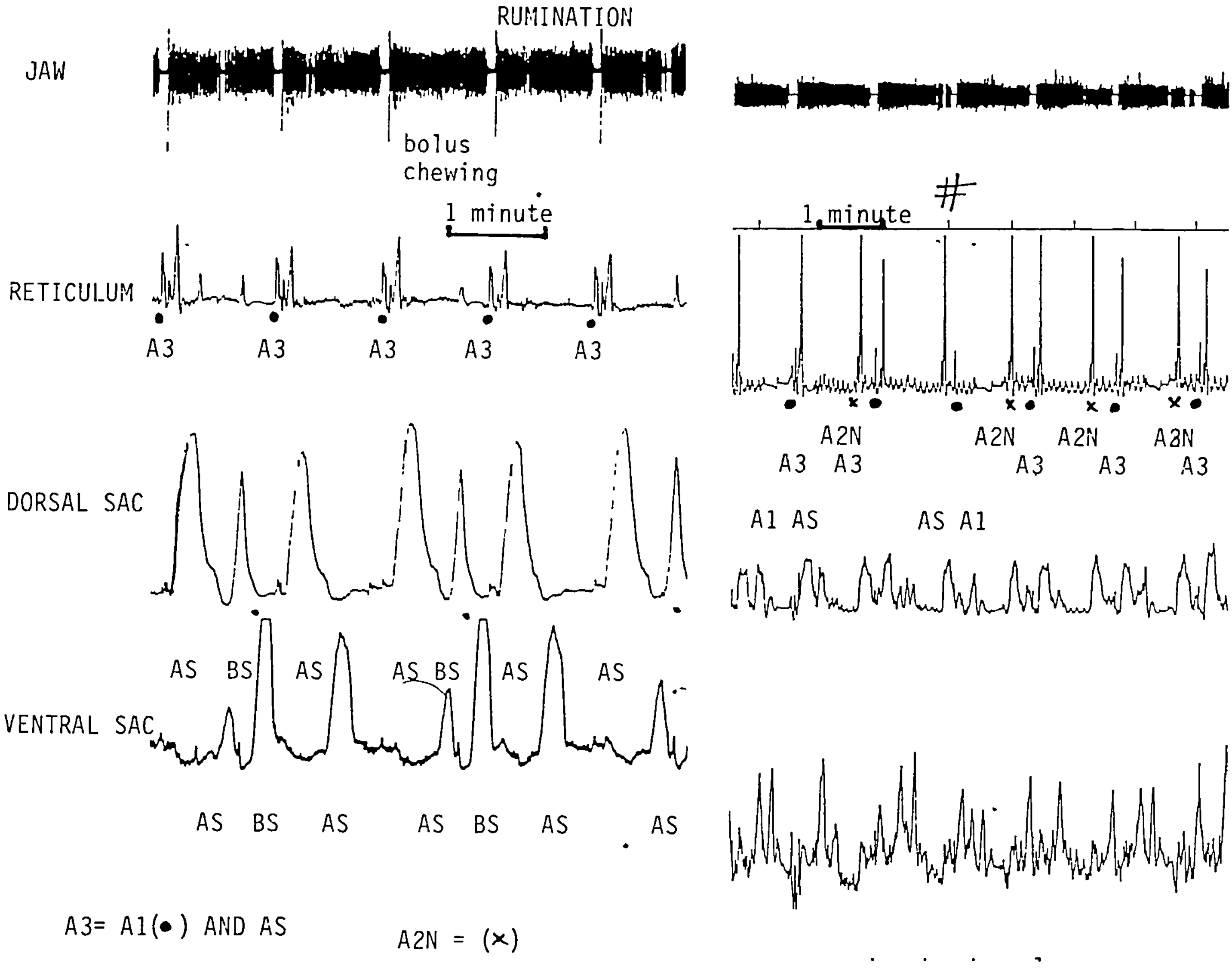


SUNRISE 5.48

SUNSET 20.52

Figure 4. Recording of jaw activity and pressure changes in the dorsal rumen sac and ventral rumen sac during rumination in red deer.

The usual sequence is an A1 contraction (extra reticular contraction) followed by a biphasic reticular contraction (AS). However in red deer this order is sometimes reversed as at position (#). There are also extra AS contractions during the chewing of a bolus (A2N).



RESULTS

The four best 24 hour records from each animal were analysed. The choice was based on normal behaviour of the animal and ease of analysing record. The mean voluntary food intake and dry matter intake of the deer during the days when ruminoreticular motility was analysed are shown in Table 1. One animal was restless when people were in the deer shed but the piping was not interfered with. It had been covered with "Stop Curb" a paste to stop horses cribbiting(Vet Search, NSW). The balloons lasted about 7 days before starting to leak.

Table 1. **Mean liveweight, food intake, daily feeding and ruminating time, AS and BS contraction frequencies and rumination boluses and bout length in red deer. Data (mean plus standard deviation) presented is based on the daily means for 4 X 24 h recording periods for each of 4 red deer.**

Liveweight (kg)		116.6	±	17 9
Voluntary Food Intake (g/d)		2797.7	±	502 8
Dry Matter Intake (g/d)		2407.8	±	411.2
Feeding	Time (m/d)	465	±	?
	AS (contractions/m)	1.3	±	0.3
	BS (contractions/m)	0.42	±	0.13
Ruminating	Time (m/d)	377.7	±	32 1
	AS (contractions/m)	0.92	±	0.16
	BS (contractions/m)	0 38	±	0 12
	Bouts (number/d)	14 0	±	3 16
	Boluses (number/d)	34.8	±	63.4
	Bouts length (m)	28.5	±	9.3
	length (boluses)	25.3	±	4 0
	Bolus length (m)	0.92	±	0 17
Idling (NFR)	Time (m/d)	597	±	104.7
	AS (contractions/m)	1.18	±	0.18
	BS (contractions/m)	0.29	±	0.06
Ratio AS BS	Feeding	3.7	±	1.13:1
	Ruminating	2.55	±	0.73·1
	Idling (NFR)	4 22	±	1.27·1

Recording Technique

Recording jaw activity and ruminoreticular motility in the red deer was carried out successfully on all 4 deer. Initially when introducing and placing the balloons the deer had to be sedated with xylazine (10-20 mg) but with constant handling it became possible to reposition balloons and remove them from 3 of the 4 animals without sedation However during these manipulations the deer were usually squeezed to one side of the cage and this restricted their movement. The positioning of balloons within the different compartments was easily accomplished through the 10cm diameter rumen cannulas. Maintaining the position of the balloons within the different compartments proved less easy and in some deer occasionally the balloon in the ventral sac moved dorsally over the cranial pillar. When the balloons were positioned and their location confirmed by the record the moveable crate wall was released to the normal position.

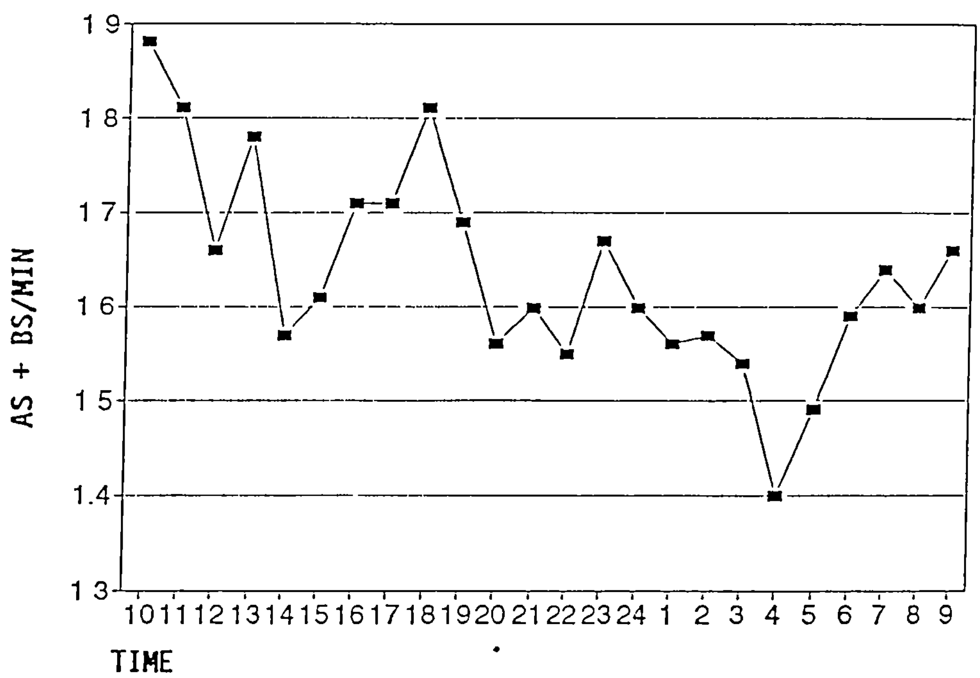
The coiled transfusion piping which elongated when the animal lay down and then contracted when deer stood up was very useful as it meant that there was no loose piping hanging in the cages. The deer accepted the halters. A head band across the forehead was found necessary to stop the halter sliding down along the neck.

Feeding and ruminating.

Jaw records were easily interpreted. The mean time spent feeding, ruminating and NFR of the 4 animals during 4 24 hour periods are shown in Table 1. The 24 hour pattern of feeding and rumination derived from all four animals over 4 days are shown in Figure 3.

The mean number of AS and BS per minute during feeding, rumination and NFR for the 4 X 24 hour periods analysed are shown in Table 1. The frequency of AS and BS during the 24 hours are shown in Figure 5. The ratio of AS:BS during feeding, ruminating and NFR are shown in Table 1.

Figure 5. The circadian pattern of AS and BS in red deer. Mean data derived from records from 4 deer recorded from for 4 days.



During ruminating in cattle and sheep it is usual for one A3 sequence (Figure 5) to initiate regurgitation and chewing and for there to be a 1:1 relationship between A3 sequence and rumination boluses (Reid and Cornwall, 1959; Dziuk and McCauley, 1965). In red deer extra AS were monitored during the chewing of boluses (A2N). The time elapsing between the extra reticular contraction and the AS of rumination was variable and on occasion the extra reticular contraction occurred after the AS (Figure 4). The mean number of rumination bouts and boluses for each animal are shown in Table 1.

DISCUSSION

Feeding and Ruminating

The overall DMI of the deer was 2408g which was 2.1% of the mean liveweight of the deer. This intake as a % of liveweight was similar to that of sheep and cattle (2.12%) (Waghorn and Reid, 1977). The red deer fed for a mean of 465 minutes per day and the mean rumination time was 378 minutes. Cattle and sheep fed chaffed lucerne hay fed for 231 and 207 minutes per day, respectively, and had mean daily rumination times of 349 and 516 minutes, respectively (Waghorn and Reid, 1983). Thus deer fed for almost twice as long as sheep and cattle but sheep ruminated for a much longer period than deer. The longer feeding time of deer reported here may in part be due to the method of record analysis. Feeding bouts were considered to be continuous unless interrupted by rumination, grooming or bouts of idling of longer than 10 minutes. Thus the short breaks commonly seen during a feeding bout were recorded as feeding. However, even with this in mind the deer certainly fed for much longer than sheep and cattle fed a similar diet.

Rumination occurred in about 14 bouts per day. The circadian pattern of rumination was remarkably constant throughout the 24 hours which contrasts with the pattern in sheep where a large % of rumination is carried out at nigh (Gordon, 1958;Ulyatt et al., 1984).

The monitoring of ruminoreticular motility and jaw activity in red deer was possible. Such work requires hand reared deer and a period of gentling is necessary. The recording methodology is similar to that used in sheep and cattle.

Ruminoreticular motility

The sequence of ruminoreticular pressure changes recorded during these trials were essentially similar to those seen in cattle, goats and sheep (Reid and Cornwall,1959; Reid, 1963;Dziuk and McCauley, 1965). Thus AS and BS could usually be identified and counted The main problems were snorting, which occurred in one animal during feeding and restlessness which affected one animal during NFR. The loose temporal relationship between the extra reticular contraction of regurgitation (A1) and the AS of rumination seen regularly in these deer was reported by Dziuk *et al* (1963) as occurring in white tailed deer. This loose temporal relationship may be physiologically normal or may be influenced by the recording apparatus in the forestomach compartments. Dziuk *et al* (1963) used open ended water filled piping held in location by lead weights or wire. The extra AS seen during rumination (A2N) in deer have been observed in sheep and cattle during rumination on occasion (Carr, D.H.). This extra AS (A2N) were not reported by Dziuk *et al* (1965) in white tailed deer.

The overall mean frequency of AS and BS in deer during feeding, rumination and NFR were 1.35, 0.43; 0.92, 0.38 and 1.19 and 0.30 contractions per minute. The frequency of BS was much lower in red deer than in sheep or cattle (Table 2).

Table 2. The mean frequency of AS and BS contractions (contractions/m) in deer, cattle and sheep during feeding, ruminating and idling when fed on a diet of shaffed lucerne hay.

	AS			BS		
	Feeding	Ruminating	Idling	Feeding	Ruminating	Idling
Deer	1.4	0.9	1.2	0.4	0.4	0.3
Cattle	1.5	1.0	1.1	0.8	0.6	0.6
Sheep	1.5	1.1	0.8	1.1	0.5	0.5

*Waghorn and Reid, 1983)

The hourly frequency of AS and BS throughout the day in red deer was more constant than that reported in sheep or cattle. In these latter animals there was a high frequency of AS and BS after feeding at 0900 and this declined over the rest of the 24 hour period (Waghorn and Reid, 1983). The overall ratio of BS to AS was lower in deer (0.28) than in sheep and cattle (0.57) (Waghorn and Reid, 1977).

Forestomach motility is commonly used as a clinical sign in ruminants. In deer fed chaffed lucerne hay AS occurred at a mean interval of 52 seconds. BS were less frequent at one every 213 seconds (3 5m). The frequency of forestomach contraction varies with diet and deer coming in off pasture may have very different AS and BS frequencies. To date these have not been reported.

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