AUTOMATIC MEASUREMENT OF THE JAW MOVEMENTS OF DAIRY COWS DURING GRAZING AND RUMINATION

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ABSTRACT

A simple compact recorder of the jaw movements of dairy cows during grazing and rumination is described. The device, which is attached to a halter, consists of a micro-switch which operates with movement of the jaw and registers both the total number of bites and bites during grazing on a numerical recorder assembly. A mercury switch, positioned to allow current to flow when the animal's head is in a grazing position, permits jaw movements during grazing to be recorded.

Observed and automatically recorded jaw movements on four tropical pasture feeds during grazing and rumination were correlated ($r = 0.968$) and varied by less than 1%. Preliminary data recorded with this equipment showed that there was considerable variation in total jaw movements and the number of bites recorded during grazing and rumination when cows grazed swards of different structure and composition.

INTRODUCTION

One of the major factors determining forage quality is the quantity eaten. This is controlled by many factors including the ease with which herbage can be harvested from a sward (Arnold and Dudzinski 1967, Allden and Whittaker 1970; Stobbs 1970) and the fibrous load in the rumen which affects both consumption (Balch and Campling 1962) and rumination time (Welsh and Smith 1969). Therefore in studies of the nutrition of the grazing animal some automatic method is required for measuring jaw movements in order that rate of biting and rumination by grazing animals can be determined.

Jaw movements have been automatically recorded with sheep fed in pens. Sensing devices using pneumatic impulses from a thin-walled rubber tube placed under the jaw have been used by Balch (1952), Oltjen, Sirny and Tillman (1962), Young (1966) and Welsh and Smith (1969). Such a method has numerous practical limitations (Welsh and Smith, 1969), particularly when used with grazing animals. Kydd and Mullins (1963) successfully used a pressure transducer of very small dimensions fitted to a tooth and a transmitter embedded in a toothborne partial denture but this equipment is difficult to fit and not readily interchangeable between animals. The electrical potentials of a sheep's jaw muscle during grazing and cudding have been collected by special electrodes, amplified and transmitted by a small portable transmitter (Nichols, 1966) but the number of bites were not measured.

This paper reports a simple device for recording the number of jaw movements during grazing and rumination.

THE INSTRUMENT

The complete assembly is shown in Fig. 1. It consists of a jaw switch attached to a halter with a cable under the jaw for recording movement, a mercury switch and a recorder assembly for recording the number of jaw movements when grazing and when grazing and ruminating.

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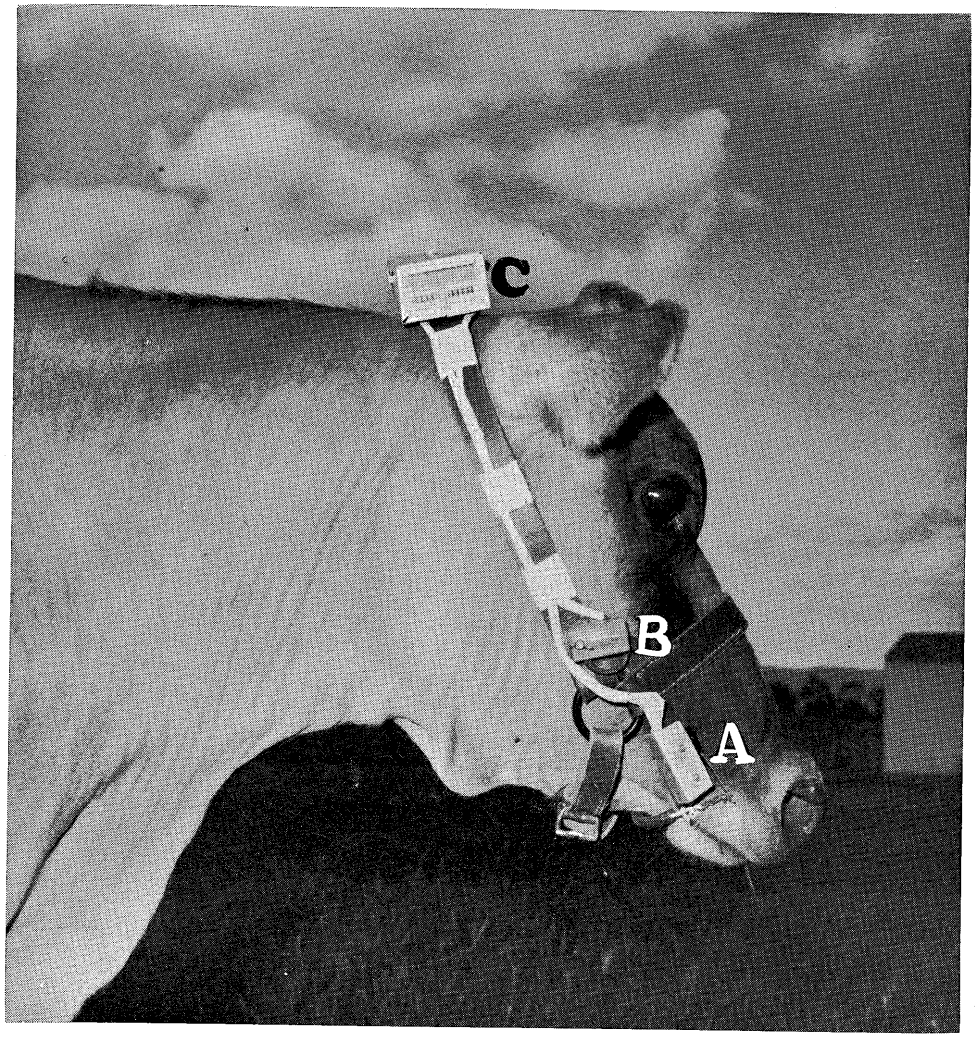


FIGURE 1
Photograph showing the position of the recorder for measuring jaw movements of dairy cattle during grazing and rumination.
A—jaw switch, B—mercury switch, C—recorder assembly.

Jaw switch

A micro switch was mounted on a leather halter 8 cm from the animal's nose by means of leather extensions 15 cm long, 13 cm wide and 0.5 cm thick (Fig. 1). The chinstrap was 35 cm of plastic coated wire (10/10) attached to the micro switch on one side and to the leather extension on the opposite side. A 15 cm piece of 1 cm diameter plastic tubing was placed over the chinstrap to prevent chaffing of the ventral surface of the jaw. An additional coil spring was inserted between the switch and the arm of the switch, a force of 200 g weight being required to operate the switch. The switch was protected by an aluminium cover and connected directly to one counter and via a mercury switch to a second counter.

Mercury switch

A mercury switch in a 4.5 × 2.5 × 1.2 mm perspex container was fixed to the side of the halter. The switch was adjusted to a position where it was "on" when the animal's head was lowered for grazing, thus allowing the current to flow from the jaw switch to the second counter.

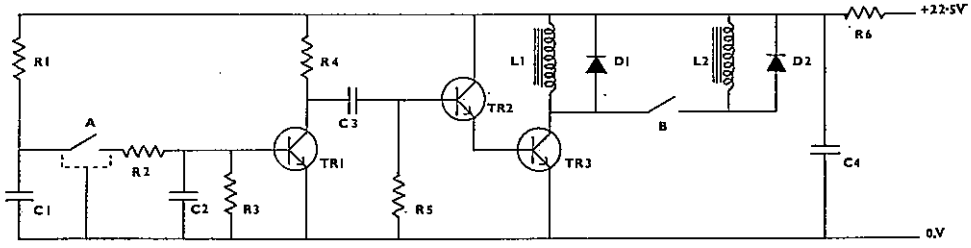
Recorder assembly

The two impulse counters were mounted in a box (56 mm × 80 mm × 40 mm) made of 3.5 mm polystyrene with a clear perspex end. The counters were positioned at the bottom of the box with their faces hard up against the perspex. Two batteries (22.5 volt photoflash) filled the remaining space directly above the counters. The electronic circuit was assembled on printed circuit board 55 mm × 40 mm and fitted in the box at the rear of the counters. The whole assembly was protected by an aluminium box which was attached to the top of the halter, behind the animal's head. The complete unit including halter weighed 1.2 kg.

The circuit

The circuit (shown in Fig. 2) is essentially a pulse generator which produces an output pulse of defined length every time switch A is opened. When switch A is open

FIGURE 2
Circuit diagram for the complete assembly.



Components:

R1 — 1M	C1 — .001	TR1 — BC107	L1 & L2 —	'Elmeg' impulse counter type Q25–24VDC 10 impulses per second
R2 — 100K	C2 — 100 pf	TR2 — BC109		
R3 — 4.7M	C3 — .01	TR3 — BC107		
R4 — 1M	C4 — 100 mfd 25V	D1 — OA202	A	— Honeywell micro switch type BZ2RW8OA2
R5 — 1M		D2 — OA202		
R6 — 220			B	— Honeywell mercury switch AS417B1

All resistors .5W 5% tolerance.

capacitor C1 is charged via resistor R1, at this time all the transistors are in the off or nonconducting state so that the current drain from the batteries is small; typically less than 3 μa. Closing switch A discharges capacitor C3 through transistor TR1. When switch A is opened capacitor C3 receives a charge via resistor R4 producing a pulse in transistor TR2 which is further amplified by transistor TR3 and recorded by one or both of the impulse counters depending on the position of switch B. Resistor R6 and capacitor C4 limit the load on the batteries when the impulse counters are recording.

Two major problems which occurred during the testing period were the short effective life of the batteries and moisture entering the circuit at the mercury switch when it rained. The former was overcome by using an impulse counter with a 10 mili sec pulse. The life of the batteries varied considerably within and between makes but the modified circuit shown in Fig. 2 allowed an average of 400,000 jaw movements to be recorded which was sufficient for a minimum of 3 days accurate recording. Moisture was excluded from the circuit by sealing the mercury switch with acrylic cement.

TESTING THE INSTRUMENT

During the period July to November, 1971, the instrument was tested, modified to overcome structural weakness and the accuracy of recording determined by comparison with visual counts of jaw movements. Twenty to thirty records of 80-190 visuably recorded bites were made during rumination and when grazing Rhodes grass (*Chloris gayana*), pangola (*Digitaria decumbens*), setaria (*Setaria sphacelata*), and lucerne hay (*Medicago sativa*) and these were compared with jaw movements recorded on the instrument.

After an initial period of minor modification the instrument proved to be reliable for measuring jaw movements during grazing and rumination. A total of 10,368 bites were recorded on the instrument compared with 10,484 observed during the comparison period; the correlation coefficient between observed and automatically recorded bites for the four feeds was $r = 0.97$ which was significant at the $P < 0.001$ level. Jaw movements were extremely regular during rumination and were most accurately recorded on the instrument although attempts to measure rumination bites directly by altering the position of the mercury switch were unsuccessful. The lowest correlation coefficient between observed and measured counts ($r = 0.86$, $P < 0.001$) was for the 25 measuring periods when lucerne hay was fed. Occasional large mouthfuls of this feed were chewed without recording all jaw movements. This never occurred when cows were grazing.

Jaw movements during grazing were slightly underestimated by recording biting only when the cow's head was in a grazing position since occasionally, on easily harvested feed, such as forage oats, the cow occasionally ate a large mouthful of feed and then proceeded to lift her head before biting it into smaller pieces prior to ingestion. A simple system of telemetry would probably reduce this source of error by removing the disturbance caused by an observer being in close proximity when conducting short-term studies. Numerical recorders could not be read at a distance greater than six metres.

A preliminary comparison was also made, over a four day period, of grazing behaviour on two contrasting swards; a fairly mature pasture of Algerian forage oats (3500 kg/ha of dried green material of 60% *in vitro* digestibility) and a setaria pasture which was starting to show some spring growth (900 kg/ha of dried green material of 66% *in vitro* digestibility).

TABLE 1

Total, grazing and rumination bites when grazing oats and Setaria sphacelata

Pasture	Period	Number of bites		
		Total	Grazing	Rumination
Setaria	8.30–16.30	19,327*	18,088	1,239
	16.30– 8.30	31,551	17,264	14,287
	8.30– 8.30	50,878	35,352	15,526
Oats	8.30–16.30	16,569	9,422	7,147
	16.30– 8.30	27,963	14,287	13,676
	8.30– 8.30	44,532	23,709	20,823

* mean of 2 days recording.

The biting and rumination data presented in Table 1, although from only one cow grazing each pasture for two consecutive days suggests that there is considerable variation in grazing behaviour on the different swards. The large number of bites per day at low pasture availability is in agreement with previous findings (Allden and

Whittaker, 1970) and the greater rumination on coarse feeds agrees with the findings of Hancock (1954) and Welsh and Smith (1969). The instrument is proving particularly valuable for short-term studies to identify characteristics of the sward which influence intake by the grazing animal; intake being measured using oesophageal fistulated animals modified to obtain complete recovery of herbage (Stobbs, unpublished data).

CONCLUSIONS

The instrument provided a useful means for accurately recording jaw movements of cattle. Since jaw movements were recorded by means of an electrical micro-switch rather than a pneumatic device, it was used successfully in the field. This recorder had the added advantage of differentiating between total bites and grazing bites.

ACKNOWLEDGEMENTS

The authors wish to thank Dr. R. F. Thornton for ideas for the development of the instrument and Messrs. C. Ross, R. F. Needham and B. Smith for skilled technical assistance when testing in the field.

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(Accepted for publication January 11, 1972)