OBSERVATIONS ON THE MOTILITY OF THE SMALL INTESTINE IN SHEEP

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Summary

Intestinal motility was studied in two sheep by electronically recording pressure changes using open-ended p.v.c. tubes placed in the lumen of the intestine and connected to pressure transducers. Flow in the duodenum and ileum was studied concurrently with motility.

Both duodenum and ileum showed two types of activity, one progressive and associated with a flow of digesta, and the other localized and not associated with flow.

Changes in diet markedly affected intestinal motility. Increasing faecal output was associated with a change in the duodenum from predominantly non-propulsive to propulsive activity, and with an increase in both types of activity in the ileum. Eating stimulated propulsive activity in the duodenum, but was associated with some reduction in both types of activity in the ileum.

I. INTRODUCTION

Although various workers have measured flow rates of digesta in, or the rate of passage of digesta through, the intestines of ruminants (Castle 1956; Hogan and Phillipson 1960; Singleton 1961; Harrison and Hill 1962; Smith 1964; Coombe and Kay 1965), few studies of the motility of the intestines in ruminants have been made. This paper describes experiments in which motility was studied by recording pressure changes in the small intestines of fistulated sheep, fed different roughage diets.

II. MATERIALS AND METHODS

Two Blackface wethers, of liveweights 44.0 and 37.0 kg at the beginning of the experiments, were fed different diets of dried grass (15% crude protein) or

TABLE 1
Details of intakes and faecal outputs of sheep on the experimental diets

Sheep	Diet	Mean Daily D.M. Intake (g)	Mean Daily Faecal W.M. Output (g)	Mean Daily Faecal D.M. Output (g)
1	Dried grass	504	131	86
	Dried grass	1,008	844	267
	Hay	333	257	130
	Hay	486	440	243
	Hay	649	561	331
2	Dried grass	504	298	124
	Dried grass	1,008	627	254
	Hay	333	221	119
	Hay	486	463	222
	Hay	649	573	258

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meadow hay (8% crude protein), as described in Table 1, to give a range of dry matter intakes and faecal outputs. In each case, the daily ration was fed in two equal portions, at 8.30 a.m. and 3.30 p.m., and each feed was consumed in ¾ hour or less. Water was always freely available. Sheep 1 was fitted with re-entrant duodenal cannulae, while sheep 2 was fitted with a simple duodenal cannula, and re-entrant ileal cannulae.

After at least 7 days' preliminary feeding, continuous records of pressure changes in the small intestine were made, using open-ended p.v.c. tubes placed inside the lumen of the duodenum and ileum. These tubes were connected to electrical transducers, and the resulting currents amplified and recorded electronically.† A slow, continuous drip of physiological saline was kept running through each tube to keep the end free from blockage by intestinal contents. Catheters were placed 20-30 cm proximal to the re-entrant cannulae, which were disconnected during each run. In this way, a flow of intestinal contents could be collected and measured, and related to pressure changes occurring in the gut proximal to the cannula. After the volume of each flow was measured, the contents were re-introduced into the animal via the distal arm of the cannula. In some cases, two catheters were placed in the gut in series with their tips 7.5-10 cm apart, to establish whether pressure changes were transmitted along the gut, or localized.

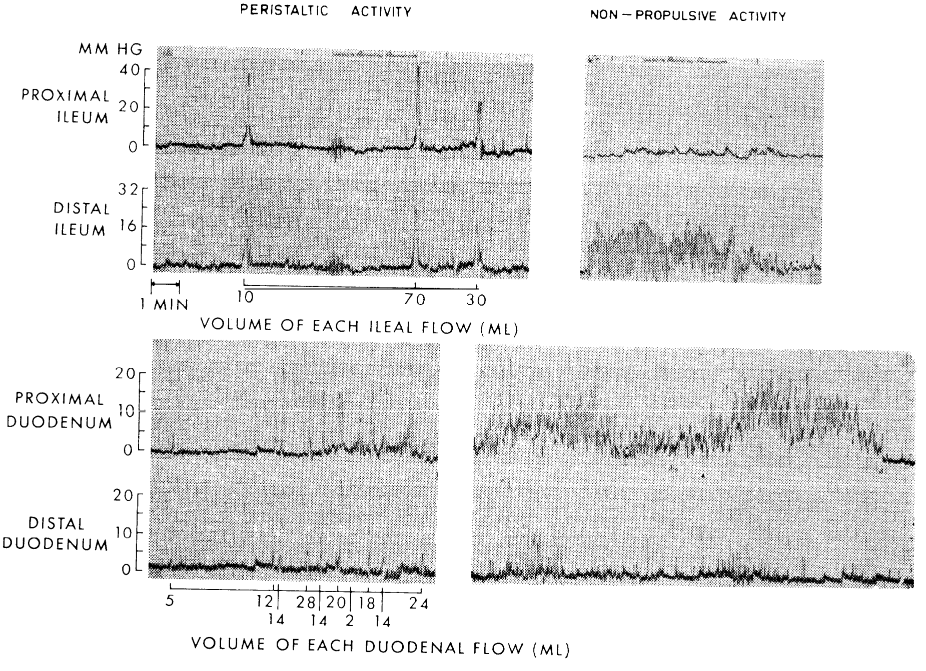

Fig. 1.—Pressure changes in the duodenum and ileum of sheep, showing peristaltic activity and non-propulsive activity.
"Proximal ileum"-catheter 20 cm proximal to ileal cannula.
"Distal ileum"-catheter 12.5 cm proximal to ileal cannula.
"Proximal duodenum"-catheter 17.5 cm proximal to duodenal cannula.
"Distal duodenum"-catheter 10 cm proximal to duodenal cannula.

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III. RESULTS AND DISCUSSION

Figure 1 shows pressure recordings from the duodenum and ileum, and the flow of digesta in these two regions. Two types of activity occurred in both the duodenum and ileum:

(a) single peaks of high pressure, occurring at intervals, and apparently progressive in nature, shown on left side of figure;

(b) phases of localized intense activity, with pressure changes occurring in extremely rapid succession, as shown on right side of figure.

It can be seen from Figure 1 that a flow of intestinal contents was associated with activity of type (a). The interpretation of these recordings was based on the direct observations of Dukes and Sampson (1937), who described three types of activity in the small intestine of sheep, viz. peristalsis, rhythmic segmentation, and pendular movements. Thus, activity of type (a) has been taken as representing peristalsis, and type (b) as non-propulsive activity. In the ileum, the two types of activity were frequently associated, a period of peristalsis being followed by non-propulsive activity. This association was rarely seen in the duodenum. Both parts of the intestine showed periods of quiescence; up to 20 min. duration in the duodenum, and 1.5 hr. in the ileum.

The effect of dietary changes on motility is shown in Table 2, in which the diets are arranged in order of increasing faecal output. In both the duodenum and ileum, increased faecal output was accompanied by increased peristaltic activity. This was associated with a marked decrease in non-propulsive activity in the duodenum.

Table 3 shows changes in motility induced by eating. This was accompanied by increased peristalsis, with a concurrent reduction in non-propulsive activity, in the duodenum, and by a reduction in both peristaltic and non-propulsive activity in the ileum.

Increased flow in the duodenum following a meal has also been reported by Harris and Phillipson (1962) and Harrison and Hill (1962).

It appears that, except at low intakes of roughage, the predominant form of activity in the small intestine of the sheep is peristalsis. According to Davenport (1962), segmenting activity predominates in the small intestines of most monogastric animals, particularly omnivores or carnivores such as man, dogs and cats, which are common subjects for physiological studies of intestinal motility. These observations thus indicate differences between these animals and ruminants in the normal patterns of motility of the small intestine. Further differences exist in reactions to eating, which, in the monogastric non-herbivore, is accompanied by reduced flow in the duodenum and increased peristaltic activity in the ileum (Davenport 1962). It is suggested that studies of digestive physiology of the small intestine in non-ruminants may not be applicable to ruminants.

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TABLE 2

The effect of diet on the motility of the duodenum and ileum of sheep

Diet (gDM/day)	Duodenum: Peristaltic Activity: Flow Rate (ml/hr)	Duodenum: Peristaltic Activity: Contraction Rate (no./hr)	Duodenum: Non-propulsive Activity: Time Involved (%)	Duodenum: Non-propulsive Activity: Contraction† Rate (no./hr)	Ileum: Peristaltic Activity: Flow Rate (ml/hr)	Ileum: Peristaltic Activity: Contraction Rate (no./hr)	Ileum: Non-propulsive Activity: Time Involved (%)	Ileum: Non-propulsive Activity: Contraction† Rate (no./hr)
504DG*	67.0	7.7	48.2	380.2	58.5	1.3	7.3	60.8
333H	41.7	13.8	20.0	228.7	74.2	1.7	3.8	32.8
486H	281.3	20.3	6.2	58.8	114.5	3.9	8.0	57.4
649H	241.0	18.7	3.7	34.3	181.5	5.0	13.2	99.6
1,008DG	626.0	37.0	2.2	21.8	153.8	6.9	21.2	167.8

*DG—dried grass; H—hay.

†This rate is an average for the whole period, not just during periods of non-propulsive activity.

TABLE 3

The effect of eating on motility of the duodenum and ileum of sheep
(means of five diets)

	Period Excluding Eating				Period Including Eating*			
	Peristaltic Activity		Non-propulsive Activity		Peristaltic Activity		Non-propulsive Activity	
	Flow Rate (ml/hr)	Contraction Rate (no./hr)	Time Involved (%)	Contraction Rate (no./hr)	Flow Rate (ml/hr)	Contraction Rate (no./hr)	Time Involved (%)	Contraction Rate (no./hr)
Duodenum	243.0	19.2	18.5	166.7	290.4	21.6	10.2	99.2
Ileum	156.6	4.1	10.9	86.7	98.5	2.2	8.5	62.4

*This period includes the time of actual eating followed by a period of 1 hr.

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