Technical Report No. 11

A COMPARISON OF THE ESOPHAGEAL FISTULA WITH RUMEN SAMPLES FOR THE DETERMINATION OF THE BOTANICAL AND CHEMICAL COMPOSITION OF THE DIET OF HERBIVORES

R. W. Rice, D. R. Cundy, and P. R. Weyerts

University of Wyoming

GRASSLANDS BIOME

U. S. International Biological Program

December 1969

ABSTRACT

Bifistulated wethers (esophageal and rumen) were used to collect samples of the diet while grazing shortgrass native range. The esophageal and rumen grab samples were different botanically. There were fewer forbs and more grasses found in rumen samples. The nitrogen content of rumen samples was higher than that of esophageal samples. Rumen samples were lower in *in vitro* dry matter digestibility than esophageal samples. Rumen grab samples cannot be expected to yield quantitative botanical information on grazing animals diet or on nitrogen content and dry matter digestibility.

The accurate determination of the chemical and botanical composition of the diet of grazing animals is essential for proper evaluation and management of grazing lands. Many workers have examined the stomach contents of foraging animals to determine what the animals are eating (for review see Martin and Korschgen, 1963). In recent years the esophageal fistula has been used to obtain diet samples of grazing domestic livestock (for review see Van Dyne and Torell, 1964). Esophageal fistulated animals must be managed carefully and must be easily caught and handled for successful sample collection. This technique does not lend itself well to wild herbivores where close management is not usually possible.

The purpose of this study was to compare the botanical and chemical composition of the diet of sheep as determined from rumen or esophageal samples obtained from grazing sheep.

Procedure

The study area was a native range located approximately 4 km. west of Laramie, Wyoming. The vegetation was composed mainly of blue grama (Bouteloua gracilis) with native midgrasses such as western wheatgrass (Agropyron smithii), Sandberg bluegrass (Poa secunda), prairie junegrass (Koleria cristata) and sedges (Carex spp). There were also some introduced grasses consisting of crested wheatgrass (Agropyron cristatum) and smooth brome (Bromus inermis). The forbs present were vetches (Astragalus missouriensis and striatis), Foothill bladderpod (Lesquerella ludoviciana), Lewis flax (Linum lewissi) and scarlet globemallow (Sphaeralcea coccinea). The shrub species were a minor component and were fringed sagewort (Artemisia frigida), rabbitbrushes (Chrysothamnus nauseosus and viscidiflorus) and winter fat (Eurotia lanata)(Table 1).

Two bifistulated wethers (esophageal and rumen) were placed on a two hectare pasture in May and allowed to adjust to the area for two weeks. Rumen and esophageal samples were collected weekly from June 7 through August 22, 1968. For collections the animals were caught and the esophageal plugs removed. A bag was placed around the neck and the animals allowed to graze for approximately one hour. Then the animals were caught and the esophageal bags removed. The rumen fistula plugs were removed and rumen contents sampled by obtaining ingesta from the top layer of rumen contents. A total of 18 esophageal and rumen samples were obtained. The samples were transported to the laboratory where they were rinsed with cold water and frozen.

Botanical analyses were accomplished by thawing the samples and spreading them evenly over a 28 x 28 cm. tray. The tray was placed on a peg board and a systematic point method followed for locating plant fragments to be identified. The analyses were similar to that described by Van Dyne and Heady (1965).

The esophageal and rumen samples were dried at 60°C, ground through a 40 mesh screen and the digestibility estimated by an *in vitro* artificial rumen procedure (Tilley and Terry, 1963). The nitrogen in the samples was determined by the AOAC Kjeldahl procedure (1960).

Statistical analyses were by a paired t-test. Probabilities of $P \leq .05$ were accepted as significant.

Results and Discussion

number of points per sample

The number of points necessary to estimate the botanical composition of the diet has been examined by several investigators. Lesperance *et al.* (1960) read 100 points, Harker *et al.*(1964) read 400 microscopic points

per sample, and Van Dyne and Heady (1965) read 200 points. Galt et al. (1968) indicated that 400 points were inadequate for estimating the composition of the diet samples at the 5% confidence level. They illustrated that the accuracy of the estimation of the sample mean increased with increased sample intensity, but that the improvement was gradual.

In this study 200 points were identified in the esophageal samples. The first 100 points were recorded and then the tray was rotated 90° and a second 100 points recorded. The agreement between the first and second 100 points was very good (Table 1). There were no significant ($P > .05$) differences in the proportion of plants identified when the two groups were compared. Consequently, the botanical composition of the rumen samples was estimated with the identification of 100 points.

esophageal vs. rumen samples: botanical data

Rumen and esophageal samples are shown in Table 2. Rumen samples had a significantly higher proportion of grass species than esophageal samples. Six of the 11 individual grass species were present in higher proportions in the rumen samples. Conversely there was a significantly lower proportion of forbs and shrubs present in rumen samples. The botanical composition of rumen grab samples was different from esophageal samples. This could be due to a differential rate of rumen digestion of different species of plants. It is also possible that a layering of rumen contents occurred whereby grass species were more likely to float to the top in the rumen than shrubs or forbs. If the esophageal sample can be considered as the standard of comparison, it must be concluded that sampling via a rumen fistula grab sample from top of the rumen will lead to erroneous results in the proportion of botanical species found in the diet.

A seasonal trend was exhibited when the proportion of grass species was graphed relative to time of sampling (Fig. 1). There was a wide difference in the proportion of grass species found in rumen versus esophageal samples for the first three sampling dates. Subsequent to this time there was relatively little difference in the proportion of grasses found by the two sampling methods.

The opposite trend was found relative to the proportion of forb species in rumen and esophageal samples. For the first three sampling dates, forbs made up a much greater proportion of the esophageal sample than of the rumen sample (Fig. 2). The shrubs made up a minor proportion of the diet by both sampling methods but tended to be higher in esophageal than in rumen samples especially early in the grazing period (Fig. 3).

During the early part of the grazing season forbs were in a green growing stage. At this time they would be expected to have the highest digestibility and supposedly the most rapid rate of digestibility. The preferential rumen digestion of forbs relative to grass would make rumen samples higher in proportion of grasses than esophageal samples which had not been subjected to rumen digestion.

The rumen sampling technique does note the presence or absence of plant species in ruminant diets, but cannot be used to express quantitative relationships among plant species grazed where considerable variety is possible in the diet.

esophageal vs. rumen samples: chemical data.

The nitrogen content of esophageal samples was less than rumen samples for all but the earliest sampling date (Fig. 4). This would be expected since the contribution of rumen microflora and microbial activity would tend to compensate for declining nitrogen in the diet as the grazing

season progressed. There was a steady decline in the nitrogen content of esophageal samples, reflecting the changing botanical composition of the diet as well as a change in the nitrogen content of the plants eaten with advancing maturity. The shift towards more grass species in the diet (Fig. 1) and the more mature plants eaten would result in lower nitrogen value. The decline in nitrogen was not so pronounced with the rumen sample. This was probably due to the contribution of rumen microflora to the total nitrogen found in rumen samples.

esophageal vs. rumen samples: digestibility.

The esophageal samples were higher in *in vitro* digestibility than rumen samples (Fig. 5). There was a tendency for esophageal samples to have a constant digestibility throughout the grazing season. This illustrates the ability of sheep grazing mixed vegetation to select plant species which were digestible. The animal apparently selected plant portions which were highly digestible thus maintaining a rather constant dry matter digestibility. If the grazing season had extended into fall where all plants had reached a mature stage the digestibility of the diet would be expected to decline. The lower digestibility of rumen samples is undoubtedly due to the action of rumen microflora on ingested plants. They probably make use of the readily digestible portions of plants rather rapidly. The material remaining in the rumen at sampling then represents partially digested plant material. There was a more pronounced seasonal decline in the digestibility of rumen samples than esophageal samples. The decline was probably related to more mature plants and the accumulation of slowly digested residues as the maturity of the diet increased.

Literature Cited

AOAC. 1960. Official methods of analysis (9th. ed.) Assoc. of Official Agr. Chemists. Wash., D. C. 832 p.

Galt, H. D., P. R. Ogden, J. H. Ehrenreich, B. Theurer and S. C. Martin. 1968. Estimation botanical composition of forage samples from fistulated steers by a microscopic point method. J. Range Manage. 21: 391-401.

Harker, K. W., D. T. Torell and G. M. Van Dyne. 1964. Botanical examination of forage from esophageal fistulas in cattle. J. Anim. Sci. 23: 468-469.

Lesperance, A. L., V. R. Bohman and D. W. Marble. 1960. Development of techniques for evaluating grazed forage. J. Dairy Sci. 43: 682-689.

Martin, A. C. and L. J. Korschgen. 1963. Food Habits Procedures. Wildlife Investigational Techniques. The Wildlife Soc., Wash. D.C. p. 320-333.

Tilley, J. M. A. and R. A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. British Grassland Soc. 18: 104-111.

Van Dyne, G. M. and H. F. Heady. 1965. Botanical composition of sheep and cattle diets on a mature animal range. Hilgardia 36: 465-492.

Van Dyne, G. M. and D. T. Torell. 1964. Development and use of the esophageal fistula. J. Range Manage. 17: 7-17.

TABLE 1. COMPOSITION OF DUPLICATE ESOPHAGEAL SAMPLES[1/]

Forage Species	Means[2/] First 100 pts.		Second 100 pts.	
Agropyron dasystachyum	10		12	
Agropyron desertorum	14		12	
Agropyron smithii	10		11	
Agropyron smithii molle	3		2	
Bouteloua gracilis	2		2	
Bromus inermis	11		10	
Koeleria cristata	9		9	
Oryzopsis hymenoides	2		3	
Poa canbyi	4		4	
Stipa comata	15		14	
Carex filifolia[3/]	2		2	
Grass Total		82		81
Astragalus missouriensis	4		3	
Astragalus striatus	3		3	
Lesquerella ludoviciana	4		4	
Linum lewisii	0		<1	
Sphaeralcea coccinea	4		5	
Forb Total		15		15
Artemisia frigida	2		2	
Atriplex nuttallii gardneri	0		<1	
Chrysothamnus nauseosus	<1		<1	
Chrysothamnus viscidiflorus	1		1	
Eurotia lanata	<1		<1	
Phlox bryoides	<1		<1	
Shrub Total		3		4
Parmelia mollinscula	<1		<1	
Lichen Total		<1		<1
Total		100		100

1/ All values expressed as percents.

2/ Based on 18 samples.

3/ Not a grass species but considered with this group for convenience.

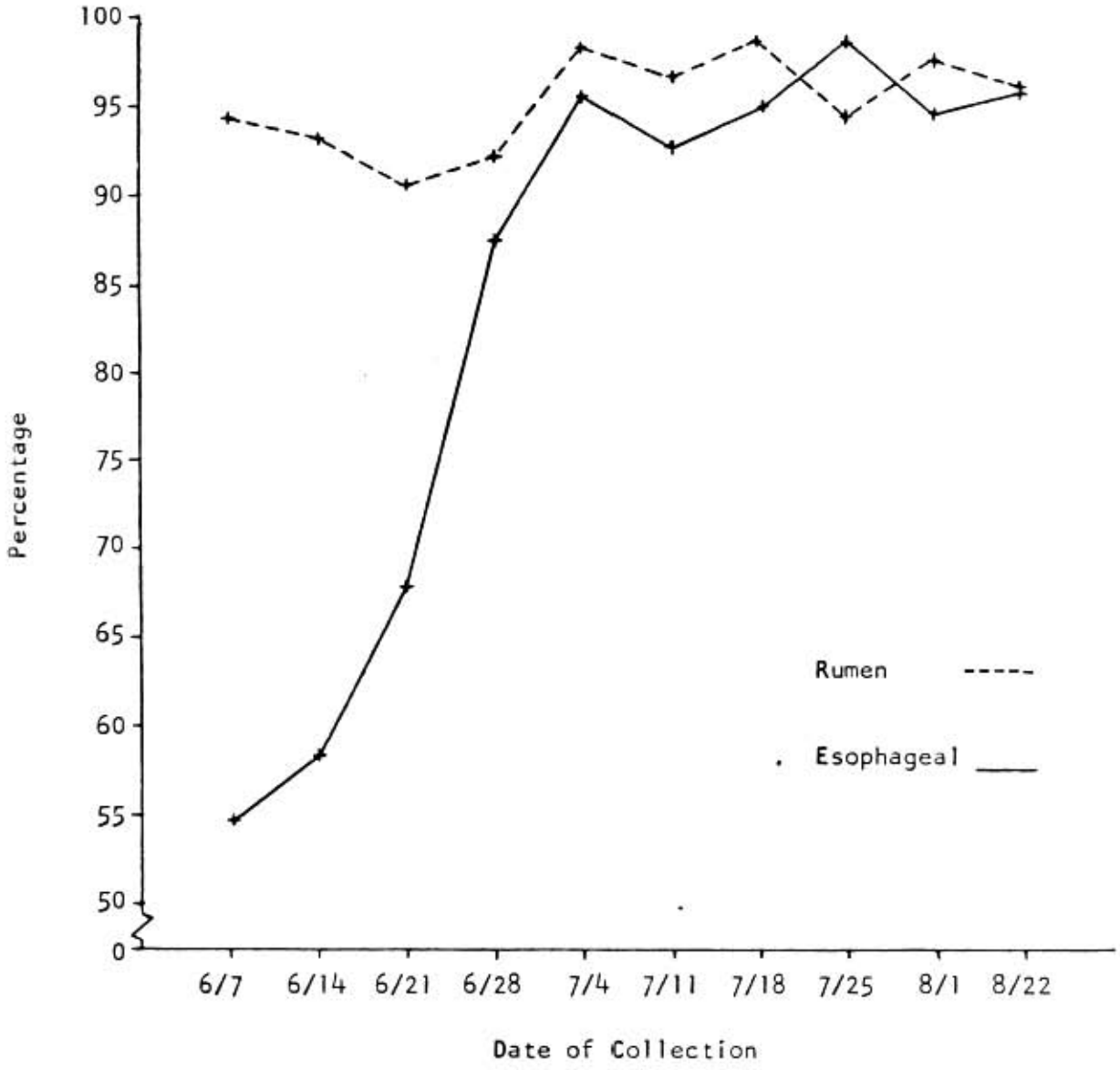

Figure 1. Total Percent of Grass Species in Rumen and Esophageal Samples Versus Date of Collection

TABLE 2. COMPOSITION COMPARISON OF RUMEN AND ESOPHAGEAL SAMPLES[1]

Forage Species	Means[2] Rumen Sample		Esophageal Sample[3]	
Agropyron dasystachyum	15*		10	
Agropyron desertorum	18		14	
Agropyron smithii	11		10	
Agropyron smithii molle	3		3	
Bouteloua gracilis	5*		2	
Bromus inermis	11		11	
Koeleria cristata	7*		9	
Oryzopsis hymenoides	3*		2	
Poa canbyi	6*		4	
Stipa comata	14		15	
Carex filifolia [4]	2		2	
Grass Total		95*		82
Astragalus missouriensis	1*		4	
Astragalus striatus	<1*		3	
Lesquerella ludoviciana	1*		4	
Linum lewisii	0		0	
Sphaeralcea coccinea	2		3	
Forb Total		4*		14
Artemisia frigida	1*		1	
Atriplex nuttallii gardneri	0		0	
Chrysothamnus nauseosus	0		<1	
Chrysothamnus viscidiflorus	<1*		1	
Eurotia lanata	0		<1	
Phlox bryoides	0		<1	
Shrub Total		1*		4
Parmelia mollinscula	0		<1	
Lichen Total		0		0
Total		100		100

[1] All values expressed as percents.

[2] Based on 17 samples.

[3] Values of first reading.

[4] Not a grass species but considered with this group for convenience.

* Rumen samples significantly different ($P<.05$) from esophageal samples.

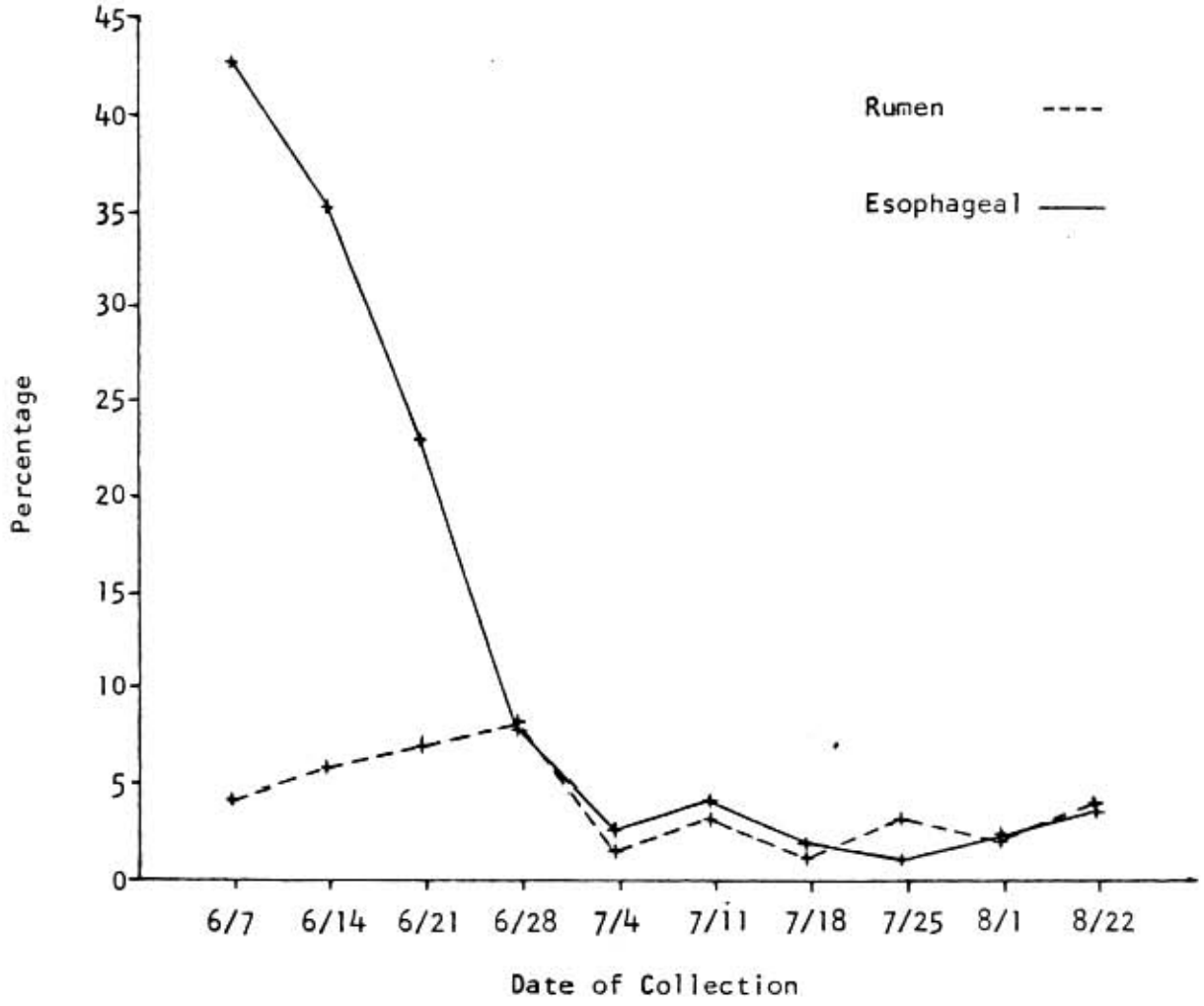

Figure 2. Total Percent of Forb Species in Rumen and Esophageal Samples Versus Date of Collection

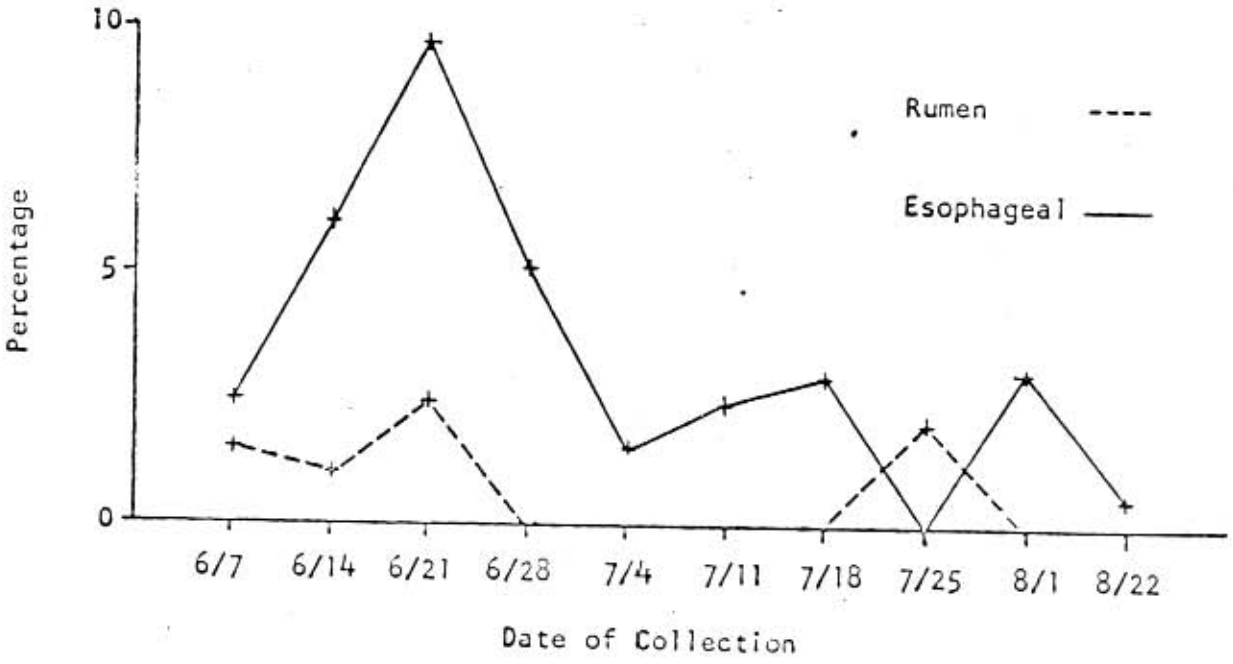

Figure 3. Total Percent of Shrub Species in Rumen and Esophageal Samples Versus Date of Collection

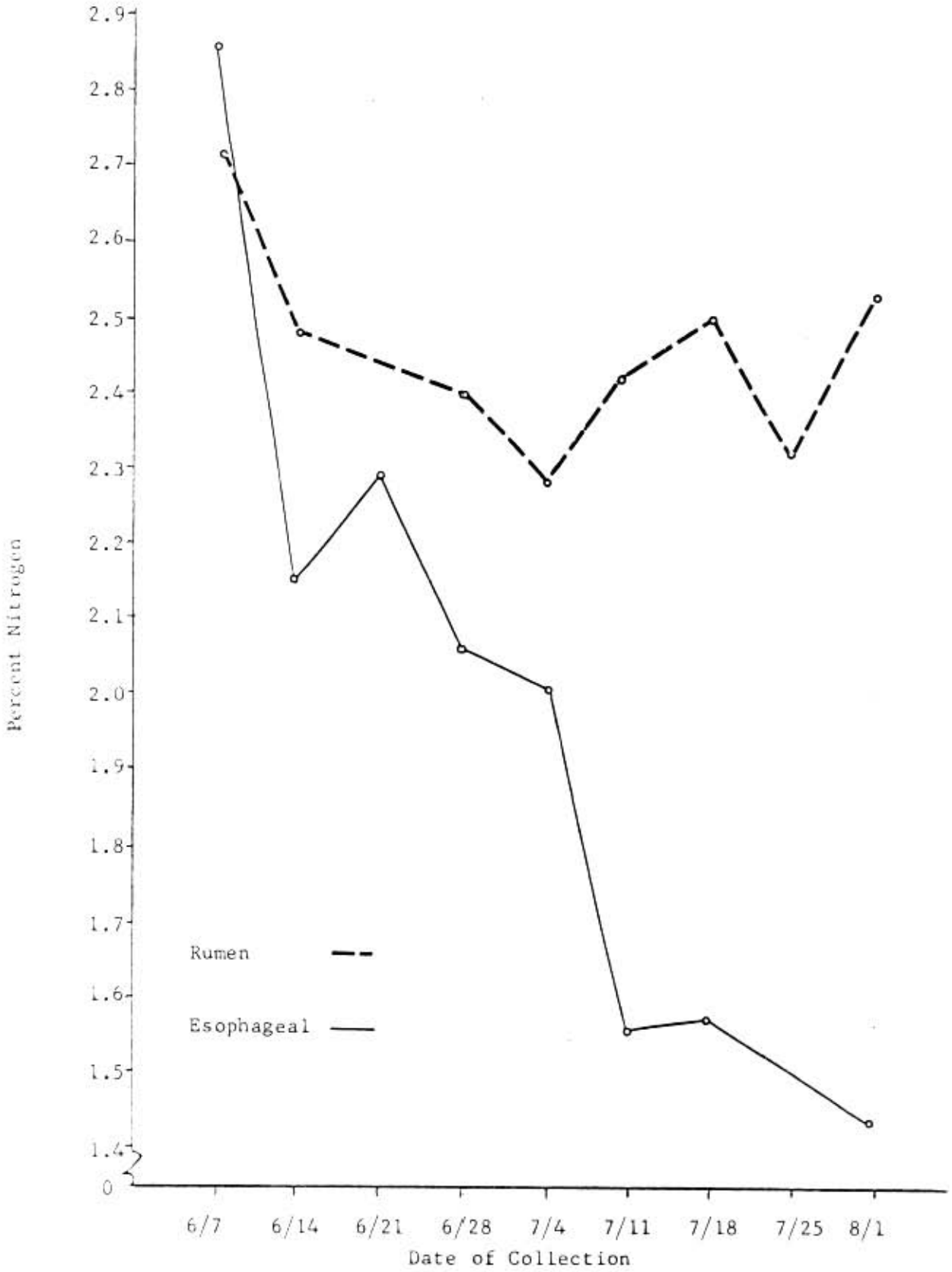

Figure 4. Nitrogen Content of Rumen and Esophageal Samples Versus Date of Collection.

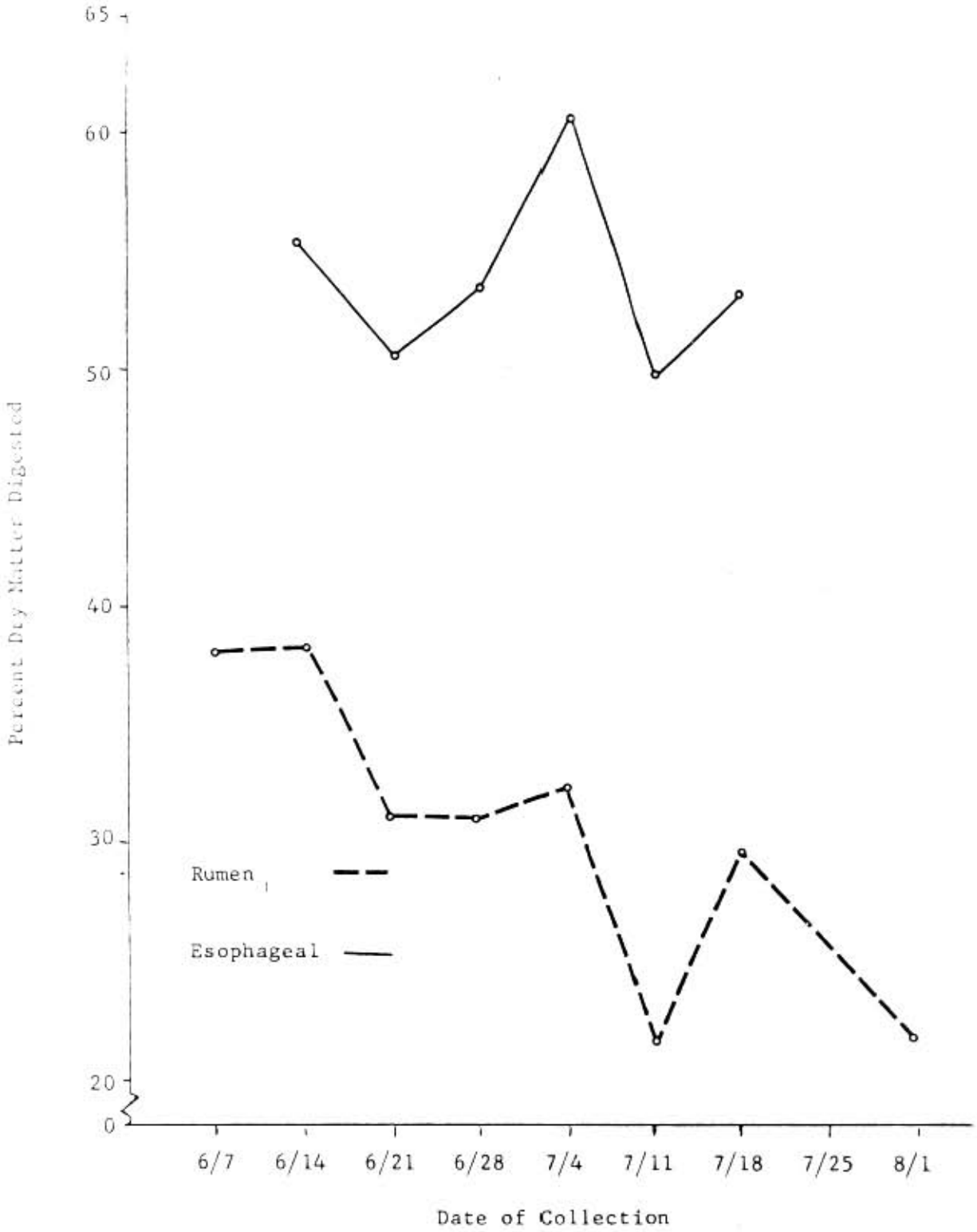

Figure 5. In Vitro Dry Matter Digestibility Values of Rumen and Esophageal Samples Versus Days of Collection.