Comparison of the diets of goats and sheep on a Casuarina cristata - Heterodendrum oleifolium woodland community in western New South Wales

A.D. Wilson, J.H. Leigh, N.L. Hindley and W.E. Mulham

Summary—The diets of sheep and feral goats grazing a semi-arid woodland in western New South Wales were assessed using oesophageal fistulated animals. The diet of the goats consisted largely of browse, with the leaves of *Heterodendrum oleifolium* (rosewood) a consistent component, although a large proportion of herbaceous material (mainly *Bassia* spp.) was eaten on occasions. The sheep showed a preference for the pasture species *Stipa variabilis* (spear grass) and *Bassia* spp. (copper burrs). When these plants were not available they were replaced in the diet by a higher proportion of browse, mainly of the tree *Casuarina cristata* (belah).

Nitrogen contents of the diets ranged from 1.6 per cent to 3.0 per cent, with that of the goats generally being greater than that of the sheep. *In vitro* digestibility data indicated comparable values for both animal species, with lower values occurring under higher stocking pressures.

The woody weed *Eremophila sturtii* (turpentine) was ignored by both sheep and goats at all stocking rates. Another weed shrub *Cassia eremophila* var. *platypoda* (punty) was browsed very sparingly. This indicates that the use of goats in an attempt to eliminate established stands of these species is unlikely to be successful at low to moderate stocking rates.

Feral goats are common in the woodland and tall shrubland areas of arid Australia. They survive and reproduce despite regular shooting and capture, and droughts that decimate sheep populations.

The goats have, on the one hand, been regarded as vermin because of their competition with sheep for forage and because of their reputation as destroyers of vegetation. On the other hand, they are regarded in some quarters as a useful source of income from their sale for meat, as a source of animals for angora cross breeding programs and as a means of eliminating, or at least reducing, bush encroachment on grasslands.

These conflicting views have persisted because of the absence of reliable observations or experimentation under Australian conditions. Overseas results suggest that most cases of degradation from goat grazing have occurred under conditions of uncontrolled grazing by large numbers of animals. There have been a number of field studies, chiefly in Africa and the U.S.A., which indicate that goats can be an economic source of meat and fibre and a useful tool in range management.

In a number of instances browsing by goats has resulted in a marked improvement in range condition. This has been shown in Africa (Staples, Hornby and Hornby 1942; Oates 1956; du Toit 1972) and in southern North America (Magee 1957; Huss 1972). In these trials goats were observed to prune and stunt bushes, so encouraging the growth of grasses, whereas with cattle or sheep, bush thickets remained or resprouted after initial clearing.

This paper reports on the comparative dietary preferences of oesophageal fistulated goats and sheep on a belah (*Casuarina cristata*)—rosewood (*Heterodendrum oleifolium*) community at Ivanhoe, N.S.W. This community contains a number of shrub species, two of which (*Eremophila sturtii* (turpentine) and

The Authors—Dr. A. D. Wilson, Mr. N. L. Hindley and Mr. W. E. Mulham, C.S.I.R.O., Division of Land Resources Management, Rangelands Research Unit, Riverina Laboratory, Deniliquin, New South Wales, and Dr. J. H. Leigh, C.S.I.R.O., Division of Plant Industry, Canberra, A.C.T.

Cassia eremophila var. *platypoda* (punty)) are of concern because of their encroachment on grazing land (Anon. 1969).

Methods

Vegetation

The belah-rosewood vegetation has been described by Beadle (1948) and Stannard (1963). It is a low woodland type which covers extensive areas in semi-arid New South Wales and which carries a scattered population of feral goats. The community under study contained a variety of trees and shrubs (listed in table 1) for which only qualitative estimates of accessibility for grazing are given, as no measurements were made of the amount of browse available. The availability and botanical composition of herbaceous species were obtained by hand clipping 64 × ½ m² quadrats in each plot.

TABLE 1

Occurrence of tree and shrub species on the experimental area and their accessibility for grazing.

Species	Frequency of occurrence	Accessibility of forage†
Acacia aneura (mulga)	Rare	Low
A. colletioides (pin bush)	Occasional	High
A. homalophylla (yarran)	Abundant	High
Amyema quandang (mistletoe)	Occasional	Low
Apophyllum anomalum (warrior bush)	Occasional	Low
Cassia eremophila var. *coriacea* (desert cassia)	Occasional	High
C. eremophila var. *platypoda* (punty)	Abundant	High
Casuarina cristata (belah)	Abundant	High
Eremophila glabra (black fuchsia)	Rare	High
E. sturtii (turpentine)	Very abundant	High
Geijera parviflora (wilga)	Occasional	High
Heterodendrum oleifolium (rosewood)	Abundant	Low
Kochia pyramidata (black bluebush)	Rare	High
Myoporum platycarpum (sugarwood)	Rare	Low
Templetonia egena (broombush)	Rare	High

† As assessed for sheep when first admitted to the plots.

Oesophageal fistula collections

Young feral goats were captured near Ivanhoe and quietened by hand feeding over a period of six months. These and a number of Merino wether sheep were fitted with oesophageal fistulae in the manner described for sheep by Van Dyne and Torell (1964).

Collections of oesophageal samples were made in May 1971, November 1971, February 1972 and June 1972. The fistulated animals were admitted to the plots approximately one week prior to each series of collections. For the first sampling period five fistulated goats were used; for subsequent collections only four were available. Five or six fistulated sheep were grazed with the goats in all collections. In each plot, collections were made on two consecutive days. The animals were then moved to the next plot and three days were allowed before further samples were collected. The sheep and goats were yarded (water and salt provided) from late in the evening until early the following morning and released for collection for approximately one hour. Although released together they grazed as separate groups.

For the first series of samplings (May 1971) the animals grazed successively in plots of 10, 20 and 30 ha. These plots were stocked continuously with sheep at 0.5, 0.25 and 0.17 sheep ha^{-1} from August 1969, and were designated high, medium and low, respectively. District stocking rate for this vegetation is of the order of 0.25 sheep ha^{-1}. For subsequent sampling periods only the low and medium plots were sampled. There was a decline in availability of forage between the first and last collections and in the last collection (June 1972) the availability of forage on the medium plot was similar to that on the high plot in the first collection. In addition, after the first sampling, collections were made in a plot that was stocked continuously with goats at 0.45 ha^{-1} from January 1971. No pasture measurements were made in this plot.

Analyses

Sub-samples were removed for determination of botanical composition, nitrogen content and *in vitro* digestibility. The sub-sample for botanical analysis was mixed and washed in a large volume of water to

aid further sub-sampling and to remove saliva and fine particles. Between 1 and 2 g dry-weight was separated by hand into plant species, only a small proportion remaining unidentified.

The sub-sample for nitrogen content and *in vitro* digestibility was frozen, freeze dried, and ground in a Wiley mill. Nitrogen was determined by an automated Kjeldahl method. *In vitro* digestibility was determined by the method of Van Soest, Wine and Moore (1966).

Results

Botanical composition

The mean botanical composition of the forage eaten by the goats and sheep for the four collection periods is shown in tables 2 to 5. Up to 30 plant species were eaten but only those comprising more than 5 per cent of the diet in at least one plot have been included in these tables.

The composition of samples collected from the same plot was not always consistent for the two days of collection. The different plant species were not evenly distributed throughout the plots so that the diet eaten was partly determined by the area in which the animals grazed during collection. Standard errors and the statistical significance (*t* test) of the difference between goats and sheep is shown for the total amount of tree and shrub species (and *vice versa* for herbaceous species) eaten. These totals include plants that were eaten in small quantities and are therefore not shown individually.

The most common constituent of the goat diets was the leaves, both green and dry (leaf fall) of *Heterodendrum oleifolium*. Other trees eaten in significant

TABLE 2

Botanical composition of goat and sheep diets on plots permanently grazed by sheep May 1971.

Plant Species	Stocking rate: Low			Medium			High		
	Availability	Composition		Availability	Composition		Availability	Composition	
		Goats	Sheep		Goats	Sheep		Goats	Sheep
Trees and shrubs	*kg ha*$^{-1}$	%		*kg ha*$^{-1}$	%		*kg ha*$^{-1}$	%	
Acacia homalophylla		13	0		1	0		4	4
Amyema quandang		0	0		7	0		13	0
Apophyllum anomalum		1	0		0	0		1	16
Cassia eremophila									
var. *coriacea*		0	3		0	1		0	1
var. *platypoda*		10	5		0	0		0	0
Casuarina cristata		10	15		2	0		28	57
Geijera parviflora		0	0		0	0		0	9
Heterodendrum oleifolium		22	1		0	0		40	5
Herbaceous plants									
Bassia spp.†	280	8	22	160	29	32	1	6	1
Erodium crinitum	Tr‡	0	0	Tr	10	0	0	0	0
Stipa variabilis—green	7	2	30	15	29	23	Tr	0	1
Stipa variabilis—dry	50	1	19	65	4	42	0	2	5
Total									
Tree and shrub		79 ± 7	26 ± 7**		10 ± 3	1 ± 1*		85 ± 6	90 ± 2
Herbaceous		19 ± 7	74 ± 7		89 ± 3	89 ± 1		12 ± 6	10 ± 3

† Mainly *Bassia diacantha*, includes *Enchylaena tomentosa* which is difficult to distinguish from *Bassia* in fistula samples.

‡ Trace.

* $P < 0.05$, ** $P < 0.01$.

amounts were *Casuarina cristata*, *Apophyllum anomalum*, *Acacia homalophylla* and *Geijera parviflora*. *Amyema quandang*, *Acacia aneura*, and *Eremophila glabra* were significant constituents on some occasions, but were not present at other times, probably because of their low occurrence in the experimental areas (only one bush of *E. glabra* was known to occur within the sampled plots).

In comparison to the goats, the sheep ate only small amounts of *H. oleifolium*. This may be attributed to the different browsing habits of the two animals, sheep rarely seeking browse at heights above 1 m (unless forced to by conditions) whereas goats quite readily browse to a height of 2 m (A. D. Wilson, J. H. Leigh, N. L. Hindley and W. E. Mulham, unpublished data). Sheep also ate *C. cristata*, *A. anomalum* and other trees and shrubs when the availability of ground forage approached zero. However, in most collections the proportion of tree and shrub species eaten was quite small in comparison to that eaten by goats. The high stocking rate was more severe than normal grazing practice and it is apparent that sheep normally consume only small amounts of trees and shrubs.

Small amounts of the leaves of the *Cassia* species were eaten by both sheep and goats, as were the green pods when these were available. No *Eremophila sturtii* was eaten by either sheep or goats.

The sheep ate mainly *Stipa variabilis* (spear grass) and *Bassia* spp. (copper burrs) when available. The goats also ate a high proportion of *Bassia* spp. on some occasions, but generally ate little *S. variabilis*. This was particularly noticeable in November 1971, when

TABLE 3

Botanical composition of goat and sheep diets November 1971.

Plant Species	Sheep grazed plots						Goat grazed plot Composition	
	Low stocking rate			Medium stocking rate				
	Availability	Composition		Availability	Composition			
		Goats	Sheep		Goats	Sheep	Goats	Sheep
Trees and shrubs	*kg ha*$^{-1}$	%		*kg ha*$^{-1}$	%		%	
Acacia homalophylla		5	3		0	2	2	1
Apophyllum anomalum		0	0		3	0	11	0
Cassia eremophila								
var. *coriacea*		0	0		2	3	0	0
var. *platypoda*		3	0		0	2	9	0
Cassia pods		0	3		7	2	1	0
Casuarina cristata		0	16		8	5	1	3
Eremophila glabra		30	0		1	0	0	0
Heterodendrum oleifolium		27	0		67	0	20	3
Kochia pyramidata		0	0		8	0	0	0
Herbaceous plants								
Bassia spp.	150	7	40	4	0	24	39	29
Rhagodia nutans	Tr†	10	3	Tr	0	0	0	0
Stipa variabilis—green	8	0	0	Tr	0	1	7	61
Stipa variabilis—dry	80	1	18	22	0	58	5	0
Dead matter		10	5		2	0	2	0
Total								
Tree and shrub		67 ± 10	21 ± 6**		97 ± 1	16 ± 6**	47 ± 11	9 ± 3**
Herbaceous		22 ± 6	70 ± 6		1 ± 1	83 ± 6	51 ± 11	90 ± 3

† Trace. ** $P < 0.01$.

the fistulated sheep ate 61 per cent *S. variabilis* on the plot permanently grazed by goats, but only 1 per cent on the sheep grazed plots, from which it had already been removed by the plot sheep. Other herbaceous plants were eaten by sheep when they were present, but as their availability was generally low, no conclusion can be drawn from their low occurrence in the goat diets.

On occasions the goats ate considerable quantities of material that was apparently ignored by the sheep, e.g. *Eremophila glabra* (November 1971) and the fruits of *Apophyllum anomalum* (February 1972).

Chemical composition

The nitrogen content of the sheep and goat diets is shown in table 6. On eight occasions the nitrogen content of the goat diets was higher than that of the sheep diets. The reverse occurred only once. Values were generally within the range of 2 to 3 per cent

TABLE 4

Botanical composition of goat and sheep diets February 1972.

Plant Species	Sheep grazed plots						Goat grazed plot Composition	
	Low stocking rate			Medium stocking rate				
	Availability	Composition		Availability	Composition			
		Goats	Sheep		Goats	Sheep	Goats	Sheep
Trees and shrubs	*kg ha*$^{-1}$	%		*kg ha*$^{-1}$	%		%	
Acacia colletioides		0	0		7	0	0	0
A. homalophylla		0	2		4	9	3	0
Amyema quandang		0	0		7	0	0	0
Apophyllum anomalum								
branchlets		5	0		0	0	0	0
fruit		59	0		12	0	0	0
Cassia eremophila								
var. *coriacea*		0	3		0	5	4	0
var. *platypoda*		0	0		0	0	7	1
Casuarina cristata		4	5		3	23	1	2
Geijera parviflora								
green		0	0		0	0	26	0
leaf fall		0	0		0	0	2	0
Heterodendrum oleifolium		11	1		47	2	3	0
Herbaceous plants								
Bassia spp.	129	1	26	6	0	19	26	10
Oxalis corniculata	1	5	5	0	0	0	0	0
Rhyncharrhena quinquepartita	Tr†	6	0	Tr	1	4	0	0
Stipa variabilis								
green	2	2	14	Tr	2	7	18	79
dry	Tr	0	3	Tr	0	2	3	4
Dead matter	10	2	3	Tr	3	5	3	0
Total								
Tree and shrub		78 ± 6	10 ± 3**		79 ± 8	45 ± 8**	43 ± 10	3 ± 1**
Herbaceous		18 ± 5	83 ± 4		14 ± 5	48 ± 7	51 ± 9	96 ± 2

† Trace. ** $P < 0.01$.

nitrogen. The lowest nitrogen contents were 1.6 per cent and 1.7 per cent for the sheep in November 1971.

In vitro *digestibility*

The *in vitro* digestibility values of the sheep and goat diets are also shown in table 6. The method by which they were determined has given acceptable results with herbaceous forages (Van Soest, Wine and Moore 1966). A. D. Wilson (unpublished data) has found the method to give satisfactory results with several tree and shrub forages but the *in vitro* values for some tree forages, including *H. oleifolium*, were overestimated by this method in comparison to *in vivo* results. Nevertheless, samples containing a high proportion of *H. oleifolium* (goat samples from the medium stocking rate in November 1971 and June 1972) gave *in vitro* digestibility figures close to *in vivo* values, which suggests that mixed forage samples containing high levels of *H. oleifolium* were not overestimated and required no further correction. Therefore, the results are presented as determined (with correction according to a standard herbaceous forage), with the reservation that variability from *in vivo* results may be greater than usual. Values were generally in the range 50 to 60 per cent digestibility, but lower values occurred at the higher stocking rates. On four occasions the *in vitro* digestibility of the sheep diets was significantly higher than that of the goat diets, and the reverse occurred once. There were no significant differences on seven occasions.

TABLE 5

Botanical composition of goat and sheep diets June 1972.

Plant Species	Sheep grazed plots						Goat grazed plot Composition	
	Low stocking rate			Medium stocking rate				
	Availability	Composition		Availability	Composition			
		Goats	Sheep		Goats	Sheep	Goats	Sheep
Trees and shrubs	*kg ha*$^{-1}$	%		*kg ha*$^{-1}$	%		%	
Acacia aneura		39	0		0	0	0	0
Apophyllum anomalum		0	0		3	20	3	0
Cassia eremophila								
var. *coriacea*		0	1		0	13	2	0
var. *platypoda*		0	1		0	0	17	2
Casuarina cristata		0	0		0	0	8	0
Geijera parviflora		0	0		0	12	0	0
Heterodendrum oleifolium								
green		41	1		68	14	19	0
leaf fall		0	0		0	4	1	0
Herbaceous plants								
Bassia spp.	95	6	48	Tr	0	0	42	41
Chenopodium anidiophyllum	4	0	5	0	0	0	0	0
Zygophyllum aurantiacum	1	2	20	0	0	0	0	0
Stipa variabilis								
green	Tr†	0	0	Tr	0	1	1	11
dry	28	0	1	Tr	0	3	0	41
Dead matter	Tr	2	3	Tr	1	5	3	1
Total								
Tree and shrub		87 ± 6	19 ± 4**		99 ± 1	76 ± 5**	52 ± 5	3 ± 2**
Herbaceous		10 ± 5	78 ± 3		0	16 ± 4	43 ± 5	95 ± 2

† Trace. ** $P < 0.01$.

TABLE 6

Nitrogen contents and digestibility (in vitro) *of goat and sheep diets.*

Date and Animal	Sheep grazed plots						Goat grazed plot	
	Low stocking rate		Medium stocking rate		High stocking rate			
	Nitrogen	Digestibility	Nitrogen	Digestibility	Nitrogen	Digestibility	Nitrogen	Digestibility
May 1971	%		%		%		%	
Goat	2.64 ± 0.10	55.5 ± 0.9	3.09 ± 0.06	61.9 ± 1.3	2.36 ± 0.09	44.5 ± 1.2		
Sheep	2.55 ± 0.05	59.0 ± 0.04	2.17 ± 0.05	61.0 ± 0.8	1.92 ± 0.09	42.1 ± 2.6		
Difference	0.09	−3.5**	0.92**	0.09	0.44**	2.4		
November 1971								
Goat	2.26 ± 0.05	56.1 ± 0.08	2.32 ± 0.05	45.6 ± 1.2			2.12 ± 0.06	52.7 ± 0.8
Sheep	2.02 ± 0.07	53.7 ± 1.3	1.61 ± 0.07	53.8 ± 2.0			1.70 ± 0.04	52.3 ± 1.5
Difference	0.24*	2.4	0.71**	−7.2**			0.42**	0.4
February 1972								
Goat	2.97 ± 0.09	57.6 ± 0.09	2.91 ± 0.09	56.2 ± 1.2			2.73 ± 0.12	56.4 ± 3.5
Sheep	2.60 ± 0.10	64.0 ± 1.3	2.44 ± 0.08	50.8 ± 1.6			2.58 ± 0.07	58.1 ± 1.6
Difference	0.37*	−6.6**	0.47**	5.4**			0.15	−1.7
June 1972								
Goat	2.19 ± 0.03	51.3 ± 0.9	2.12 ± 0.08	41.8 ± 1.8			2.47 ± 0.06	48.4 ± 1.7
Sheep	2.56 ± 0.07	54.0 ± 0.8	1.96 ± 0.04	39.0 ± 1.6			2.12 ± 0.09	46.9 ± 1.0
Difference	−0.37**	−2.7**	0.16	2.8			0.35**	1.5

* $P < 0.05$. ** $P < 0.01$.

Discussion

From this study it is apparent that goats grazing this vegetation community had a much greater preference for browse than did sheep. The selectivity of species by the goats, however, was no less than that of sheep, both animals eating some plants that were rare in preference to others that were more plentiful.

Differences between goats and sheep in preference for individual species were discernible. The goats ate large amounts of *H. oleifolium* and also selected *A. anomalum* (including the fruits when available), *C. cristata*, *A. homalophylla*, *A. quandang*, *Bassia* spp., *E. glabra*, *G. parviflora*, *S. variabilis* and *A. aneura*. In comparison, the sheep ate no *A. quandang*, *E. glabra*, *A. aneura* or the fruits of *A. anomalum*. They ate much less *H. oleifolium* and much more *S. variabilis*. However, many of these differences must be interpreted with caution as factors other than dietary preference (such as availability) could have influenced the amounts eaten. *A. quandang*, *E. glabra* and *A. aneura* were all rare and may not have been encountered by the sheep during the collection periods. However, they were also equally rare for the goats and their consumption in significant amounts on some occasions indicates a distinct preference for them. The difference in amount of *H. oleifolium* eaten was certainly influenced by accessibility as the leaves were generally out of reach of sheep but within reach of goats. The difference in the amount of green *S. variabilis* eaten, particularly in the goat grazed plot in November 1971 and February 1972 was not subject to any qualifications.

The influence of availability is also apparent when comparison is made of results from the goat grazed plot with those from the sheep grazed plots. On the goat grazed plot the goat diets contained only about 50 per cent browse compared with 70–90 per cent browse in most observations on the sheep grazed plots, apparently because the accessibility of foliage on trees such as *H. oleifolium* had been reduced by permanent goat grazing. The sheep and goat diets, although competitive for some herbaceous plants such as *Bassia* spp., were partly complementary, indicating that animal productivity from the present

vegetation could be improved by grazing these animals together.

The plant species eaten by both sheep and goats were also sensitive to grazing pressure. Tree species such as *C. cristata*, *A. homalophylla* and *G. parviflora* were eaten by sheep and goats mainly when other forage was in short supply. The principal difference between sheep and goats in this respect is that goats ate considerable amounts of tree and shrub leaves at low grazing pressures and could obtain more of these leaves at high grazing pressures because of their ability to graze up to 2 m from the ground. It is significant that even at high grazing pressures, no *E. sturtii* was eaten by either goats or sheep, even though it was abundant and accessible. *C. eremophila* var. *platypoda*, also abundant and accessible, was eaten sparingly.

Although the major proportion of the goats' diet consisted of trees and shrubs, there were occasions when herbaceous material contributed substantially. Only once (November 1971), when ground vegetation was scarce, did the diet of the goats contain browse only. Generally, when the goats' diet consisted of a high proportion of herbaceous species, dicotyledons contributed more than grasses.

The higher nitrogen levels in the goats' diet are partly explicable in terms of the high nitrogen content of most browse species and the herbaceous *Bassias*, and the low nitrogen content of the dry *S. variabilis*. These differences may not be of nutritional significance, because although the crude protein content of all diets appears adequate in relation to their energy availability, Moir and Swain (1972) have shown the leaves of one tree species (*Acacia aneura*) to have a low true digestibility of nitrogen and this may also be the case for some of the trees in the present study. The differences in *in vitro* digestibility between the goat and sheep diets were inconsistent and not readily explicable in terms of botanical composition. It may be concluded that in general the nutritive value of the goat diets was similar to that of the sheep diets. This suggests that the success of feral goats in these regions arises from their ability to eat material that is unpalatable or inaccessible to sheep, rather than to a difference in the quality of the diet.

Conclusions from these data on the effect of goat grazing on shrub vegetation can only be tentative, but they are sufficient to present guidelines for future investigations. Goats appear to eat a wider range of the available vegetation than do sheep and should make better use of the vegetation as a whole. At the same time the quality of their diet is equivalent to that of sheep so that greater production from the land should be obtained from goats than sheep.

In terms of scrub control, it appears unlikely that goats will control *E. sturtii* and *C. eremophila* var. *platypoda* at low stocking rates. However, they may be effective against seedlings or coppice growth, as it has been noted overseas that goats may check reversion to bush after clearing even though they do not destroy mature shrubs (du Toit 1972). Most of the tree species were eaten readily so that long-term grazing by goats would alter the community considerably by the suppression of seedlings and sucker growth. It is clear that the effect of goats on the woody species in a community will be dependent on the acceptability to goats of the particular species present. Some will be readily eliminated while others will be relatively untouched and so encouraged to become more dominant.

Present indications are that goat grazing may become an alternative industry to sheep grazing in parts of western New South Wales. Because of the selective grazing of goats the long-term effects on the vegetation cannot be predicted. There is an immediate need for research into the carrying capacity of scrubland for goats and on the long-term effects of goat grazing on community composition and productivity.

REFERENCES

Anon. (1969)—Report of the Inter-Departmental Committee on scrub and timber regrowth in the Cobar-Byrock district and other areas of the Western Division of N.S.W. (Government Printer: Sydney.)

Beadle, N. C. W. (1948)—"The Vegetation and Pastures of Western New South Wales". (Government Printer: Sydney.)

du Toit, P. F. (1972)—The goat in a bush-grass community. *Proceedings of the Grassland Society of South Africa* **7** : 44.

Huss, D. L. (1972)—Goat response to use of shrubs as forage. *In* "Wildland Shrubs—Their Biology and Utilization." (Utah State University: Logan.)

Magee, A. C. (1957)—Goats pay for clearing Grand Prairie rangelands. Miscellaneous publication. Texas Agricultural Experiment Station MP206.

Moir, K. W., and Swain, A. J. (1972)—The metabolic excretion and true digestibilities of nitrogen and fat by cattle and sheep with particular reference to forage–faeces relationships. *Australian Journal of Agricultural Research* **23** : 879.

Oates, A. U. (1956)—Goats as a possible weapon in the control of thorn bush. *Rhodesia Agricultural Journal* **53** : 68.

Stannard, M. E. (1963)—Erosion survey of the Central East-Darling region of N.S.W. 3. Vegetation. *Journal of the Soil Conservation Service of New South Wales* **19** : 17.

Staples, R. R., Hornby, H. E., and Hornby, R. M. (1942)—A study of the comparative effects of goats and cattle on a mixed grass-bush pasture. *East African Agricultural Journal* **8** : 62.

Van Dyne, G. M., and Torell, D. T. (1964)—Development and use of the esophageal fistula: a review. *Journal of Range Management* **17** : 7.

Van Soest, P. J., Wine, R. H., and Moore, L. A. (1966)—Estimation of the true digestibility of forages by the *in vitro* digestion of cell walls. Proceedings of the Tenth International Grassland Congress: p. 438.

Received for publication July 26, 1974