"Composition of Camel Diets in Central Somalia"

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Nomadic Peoples, Number 31, 1992

Nomadic Peoples 31:1992, Elmi & Thurow & Box, pp.51–63

Composition of Camel Diets in Central Somalia

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The composition of camel diets was studied in Ceeldheer District in central Somalia in 1986/1987. Foliage cover and composition of herbaceous and shrubby forage plants were determined by line transact method. Forage species representation and proportion in camel diets were also correlated. Percentage of each individual plant species and its proportion in camel diets was calculated from actual bite counts. Nine forage classes were identified based on species physical and lifeform characteristics. Milking and non-milking camel diets were determined in both dry and wet seasons. Both types of camels consumed almost the same kinds of plants in any given seasons. Camels consume a wide variety of available forage but not in the same proportion as availability. The proportion of a species in camel diets increased as its representation in the community increased for both milking and non-milking camels in dry seasons. Even though milking camels seemed more selective than dry camels, the animals were extremely flexible and opportunistic in diet selection and foraging behaviour.

Camels have a reputation for adaptability to harsh arid and semi-arid rangelands. This adaptability may be due in part to unique dietary selection. Other factors include drought resistance, spreading behaviour when foraging and travelling long distances between one foraging area and another (Mares, 1954; Mc Knight, 1969; Dahl and Hjort, 1979; Farid et al., 1979; Shalash, 1979; Knoess, 1979; Gauthier-Pilters and Dagg, 1981; Morton, 1984; McDowell, 1984; Yagil and Etzion, 1985; Hjort, 1988). Almost all authors agree that camels make minimal impact on desert vegetation because of their free movement while foraging. Camels may repeatedly browse some plant species season after season and may eventually kill them (McKnight, 1969; Gauthier-Pilters and Dagg, 1981). In Ceeldheer district, camels browsed certain evergreen shrubs and trees heavily such as Cadaba longifolia and Balanites rotundifolia.

Camels utilise a diversity of vegetation in various ecosystems (Coughenour et al., 1985). Trees and shrubs are converted to milk more efficiently by camels than any other domestic livestock *(ibid.)*. When browse species shed their leaves and cease growth of new twigs in the dry seasons or drought periods, camels eat grasses and other herbaceous species in eastern Africa (Field, 1978) and in northwest Africa (Gauthier-Pilters and Dagg, 1981).

Camels browse forage species not within reach of other domestic livestock. They can browse trees up to 3 or 5 meters high (Richards, 1979; Gauthier-Pilters and Dagg, 1981). Due to their long neck, adaptive features of their mouth (including slit upper lip, small tongue, hard upper gum and obliquely protruding lower teeth camels browse thorny shrubs, trees, young twigs hidden inside hedged bushes and nibble leaves from spiny stems (El-Amin, 1979; Gauthier-Pilters and Dagg, 1981; Wilson, 1984).

Few investigations have examined the diets of camels. Field (1978) reported camel diets of 77% woody plants, 11% grasses and 1% vines. Newman (1979) found that in Australia camel diets consisted of 70% and 90% shrubs and forbs, in winter and summer respectively.

The objective of this study was to determine botanical composition of camel diets in different seasons and to evaluate foraging strategy of milking and non-milking camels.

The Study Area

The study was conducted in Ceeldheer District, Galguduud Region, central Somalia, in 1986/87. Ceeldheer District is located at 4°N latitude and 47°E longitude. Its eastern boundary is the Indian Ocean and it covers an area of about 9000 km. Three physiognomic regions form the major camel habitat (Elmi, 1989a): (1) grass-shrubland zone: adjacent to an extensive grass plain, about 30 km wide, usually level to gently undulating and extending along the coast; (2) Central Ridge: about 40 km wide and occupies the centre of the District at an elevation of up to 300 m. It has gentle slopes forming gullies on the eastern slopes which carry seasonal streams through the transitional zone and disappear in the grassland plain before reaching the coast, and (3) Western inland shrubland: a plateau with level to gently undulating slopes with stabilised, sometimes large, sandhills at an elevation of about 150m rising gently to the west inland. Rainfall, soil, vegetation and its classification, land-use system and overall geomorphologic characteristics of the District have been extensively studied by Herlochre and Ahmed (1985, 1986), Herlocher, Ahmed and Thurow (1987, 1988), Holt (1985), Kuchar and Herlocher (1985), Kuchar (1986) and Behnke (1988). Detailed descriptions of the study area are available in these publications.

Methods

Foliage cover and composition of herbaceous and shrubby vegetation were determined by the line transact method (Pieper, 1978). A 100m transact was used. For herbaceous vegetation, species point interceptions at 0.5m interval were recorded. The canopy interceptions of woody plants of each species within the reach of a camel (2.5m) was recorded in centimetres on the same transact. Ten transacts were taken at each location where 10 camels were herded. The total number of point interceptions for herbaceous and canopy contact on shrub species of all 10 transacts were summed and the total amount was divided by 10 to obtain percent foliage cover and species composition.

Percentage of each individual plant species and its proportion (%) in camel diet was calculated from bite counts taken in the field. Percentages of all plant species in camel diets of similar physical characteristics (thorny, spiny, fleshy) or lifeform (evergreen, deciduous, grass, vines, forbs, succulents) were subjectively assembled to form a forage class. Nine such forage classes were identified. Sorensen's species presence or absence similarity index (Sorensen, 1948) was used to determine forage class similarities in different seasons within respective location an percentage diet similarities for milking and non-milking camels on a seasonal basis.

The major forage classes and their definitions are as follows:

1. Deciduous non-spiny (non-thorny) — (e.g. Cordia sp., Dalbergia sp., Grewia sp., etc.)
2. Deciduous spiny (thorny)—(e.g. Acacia sp., Commiphora sp., Dichrostacys sp., etc.)
3. Evergreen non-spiny (non-thorny)— (e.g. Boscia sp., Boswellia sp., Cordia sp., Cadaba sp., Maerua sp., Combretum sp., Terminalia sp., Albizia sp., etc.)
4. Evergreen spiny (thorny)—(e.g. Balanites sp., Terminalia sp., Ximenia sp., and Zyziphus sp.,)
5. Suffrutescents—(e.g. Crotalaria sp., Indiofera sp., etc.)
6. Grasses—(e.g. Aristida sp., Brachiaria sp., Cenchrus sp. Heteropogon sp. etc.)
7. Vines—(e.g. Iphionopsis sp., Merremia sp., Pentatropis sp., Rhynchosia sp., etc.)
8. Forbs—(e.g. Blepharis sp., Commelina sp., etc.)
9. Succulent—(Kleina sp., Capitanya sp., etc.)

Results

The number of plant species consumed by camels during each season is illustrated in Table 1. Scientific and local Somali names of all plant species are from Kuchar and Herlocher (1985) and Kuchar (1986).

Woody shrub and tree plants were the dominant component of the available forage on a seasonal basis. Suffrutescent plants, vines and grasses were consumed in all seasons but in much smaller numbers than woody species (Tables 4 and 5). The most abundant plant species in deciduous non-spiny forage class in dry seasons were Cordia somalensis, Crotalaria sp., and Delbergia uarandensis. Evergreen non-spiny plants such as Terminalia polycarpa, Maurua crassifolia, and Combretum contractum constituted a large portion of camels' diets. Relatively low abundance species such as Cassia ellisae were substantially consumed by animals. Forage species like Solunum jubae with fairly high abundance did not constitute a large part of the camels' diets.

Wet season camel diets were composed largely from Allophyllus sp., several Commiphora, Grewia and Euphorbia sp., Albizia anthelmintica, A. obbiadensis and Sterculia rhyncocarpa were also important wet season forage plants.

The most important forage plants are those consumed by the animal in both wet and dry seasons. Acacia sp. were the favourite forage plants of camels in all seasons, because they stay green longer in the dry season or green up long before the onset of the rainy season. Dichrostachys kirkii and evergreen spiny plants such as Balanites rotundifolia and Terminalia spinosa were major forage plants in camel diets in both dry and wet seasons.

Herbaceous plant species, Indigofera intricata and Cenchrus ciliaris, Heteropogon contortus grasses, were eaten in relatively large amounts during the dry seasons. Pentatropis spralis and Rynchosia velutina vines were consumed in all seasons despite their low abundance in foraging areas. Crotalaria sp., Euphobia matabelensis, Acacia nilotica, A. refeciens, Dichrostachys kirkii, Albizia obbiadensis, Teminalia polycarpa, T. spinosa, Balanites rutondifolia, Indigofera intricata, Cenchrus ciliaris, Heteropogon contortus were among few species that constitute the bulk of camel diets in one season or another. They comprise from 10% to 50% of the total diets of the animal. A total of 47 forage species composed 94% and 90% of the total diet in dry and wet seasons, respectively (Table 2; Elmi, 1989b).

Both types of camel consumed almost the same kinds of plants in any particular season (Table 3; Fig. 1). Camels took advantage of sparsely available green forage in the dry season (Mares, 1954; Pratt and Gwynne, 1977; Farid, Shawki and Abdelrahman, 1979; Field, 1978; Bosticco, 1981; Gauthier-Pilters and Dagg, 1981; Coughenour *et al.* 1985). Dry camels shifted more to grass consumption than milking animals. Largely ignored grass species became an important dietary component in the winter, long hot dry season, for both types of camels (14% for milking, 22% for non-milking; Fig. 1). Similar findings were reported by Field (1978) in eastern Africa and by Gauthier-Pilters and Dagg (1981) in norhtwest Africa.

Camel diets consisted of 80.9% shrubs and trees, 10.7% suffrutescents, 5.8% grasses, 2.2% vines, 0.5% forbs and 0.1% succulents (Table 4). In the dry seasons, milking camels ate less ($p<0.05$) suffrutescent plants than non-milking camels. No difference ($p<0.05$) was found for the remaining forage classes between the two camel types (Table 5; Fig. 2). In the wet seasons, milking camels ate less ($p<0.05$) deciduous spiny plants, more evergreen spiny species and more succulents than non-milking camels. Camels selected less grass in the wet seasons than in the dry seasons (Table 5; Fig. 2). Overall, milking camels consumed less ($p<0.05$) deciduous spiny plants and significantly more evergreen non-spiny species than non-milking camels. No differences were detected among the remaining forage classes for the camels (Fig. 3).

Camels selected different diets in dry seasons than in wet seasons (Fig. 4). Deciduous non-spiny plants, evergreen non-spiny species, evergreen spiny plants and succulents were consumed significantly less in the dry seasons than in the wet seasons. Deciduous spiny plants, suffrutescent species and grasses were eaten by camels significantly more in the dry seasons than wet seasons. There was no significant difference detected for the amount of vines and forbs consumed ($p<0.05$). These results indicate that camels consume whatever is available to them but not in the same proportion as availability. Forage quantity seems more limiting than quality especially in the dry seasons. Species composition and its proportion in camel diets were correlated. The proportion of a species in camel diets increased as the representation of species in the community increased for both milking ($r=0.798$) and non-milking animals ($r=0.888$) in the dry seasons. In the wet seasons, however, significant correlation between species representation and its presence in camel diet was not detected for milking ($r=0.507$) or non-milking ($r=0.633$) camels.

For all seasons, percentage species representation of the plant community and its presence in milking camels diet was not statistically significant ($r=0.618$). for non-milking camels, however, the proportion of species in camel diets significantly increased ($r=0.744$) as its representation increased. This indicates that milking camels were more selective than dry ones.

For all camels, percentage of plant species in diets increased significantly ($r=0.856$) with increased representation in the community in the dry season. In the wet season, however, no statistical significance was detected ($r=0.598$); but the proportion of individual species in diets increased as its representation increased.

Discussion

Like other animals, camels display a great innate sensitivity to changing foraging conditions (Arnold and Dudzinski, 1978). They are able to adjust their forage selections according to changes in availability through time and remember where good pasture is available (Gauthier-Pilters and Dagg, 1981); Morton 1984). Species like Indigofera intricata was a crucial dietary element (45.5%) in summer 1986. Camels were attracted also by flowers and fruits (pods) even though they represented a very small fraction of the diet in the dry seasons. They were observed eating leaves and pods shed by deciduous shrubs and trees.

Animal's dietary habits (Emlen, 1966) or grazing selectivity (Westoby, 1974; and others) have been theoretically considered to be an optimisation process involving time and effort in relation to energy harvested or optimisation of total nutrient balance. Zahorik and Houpt (1977) and Jarman and Sinclair (1979) considered domestic and wild ungulates, respectively, the most efficient feeders in any given environment. Based on their theories, Van Soest (1982) classified camels as "feeders" preferring browse to grasses. Camels are more efficient users of woody shrub and tree species than any other domestic livestock (Coughenour *et al.*, 1985). Whether the optimisation theories are applicable to camels and other domestic animals is difficult to prove because of man's intervention. Domestic livestock, including camels, are controlled by man through herding and relocating from one place to another in search of better pastures.

A relatively small number of plants comprised the bulk of the camel diet. In the dry season, more than 50% of the camel diet came from one or few plant species. Similarly, very few plant species comprised more than 20% of the camel diet in the wet seasons. Gauthier-Pilters and Dagg (1981) reported similar observations in which very few plants were the source of camel food in one or two seasons in northwest Africa.

Green plant species are selectively eaten by the study camels throughout the year. The steady weight loss of camels in the dry season or drought periods could be due to limited browse species availability and not directly related to quality. Camels were

selectively feeding on green deciduous and evergreen shrubs and trees and perhaps, satisfied most of their nutrient requirements but could not obtain sufficient energy.

The optimal foraging model of Owen-Smith and Novellie (1982) for foraging ungulates predicts that animals widen the range of acceptable plant species as food resource decline. The results obtained in this research study with camels support this prediction. Camels expended the range of acceptable plant species in the dry season. Fewer plant species were available for selection in the dry season than in the wet seasons (Table 1). However, camels included more grasses and suffrutescents in their diet. These species were largely ignored in the wet seasons.

Owen-Smith and Novellie (1982) found that availability of acceptable plant species was as important a limitation to the selection process as was diet quality. The number of plant species consumed by camels in the dry seasons was not much less than those selected in the wet seasons (Table 1). Camels widen their dietary acceptance range in the dry seasons apparently to compensate the declining forage abundance by eating more grasses, litter, leaves, vines and lignified twigs. Some plant species consumed rarely in the wet season were eaten in the dry season. Most of these plant species were deciduous shrubs and trees which stayed green late in the dry seasons.

The climbing vines (Pentatropis spiralis, Rhynchosia velutina, Merremia sp.) were important dietary components during most of the year. Acacia nilotica, A. senegal, A. horrida, A. reficiens (all thorny deciduous shrubs and trees); Rhynchosia velutina, Pentatropis spiralis (vines); and Cenchrys cilaris (grass) were consumed throughout the year.

The proportion of forage species in camel diets varied according to its proportional presence in the habitat. Rate of harvest is considered to have an important influence on the feeding preference of large herbivores (Malechek and Balph, 1987). For browsing ruminants this rate is reduced by structural plant features such as spinescense, thorniness, and twiggy growth form (Owen-Smith, 1982). However, it was found in this study that structurally defended plants such as Acacias, Balanites, etc., were relatively preferred forage plants of camels. Whether this preference is due to the camel's ability to harvest these plants for their quality or whether they simply acquired adaptability mechanisms to overcome structural defence of forage plants needs more investigation.

There was no evidence whether spinescense, thorniness or other anatomical defence structures of plants reduce leaf and shoot losses to camels. But the type of thorns or spines, certainly, lower eating rates (Gauthier-Pilters and Dagg, 1981). For example, leaves of Acacia melliferia, A. reficiens, A. senegal, Terminalaia spinosa, among others, which possess small hooked thorns, were nibbled more than other Acacia sp. and Balanites sp. with long pointed thorns and spines. Camels took matured twigs with thorns or spines carefully and chewed slowly with an open mouth (Gauthier-Pilters and Dagg, 1981).

The physical characteristics of a plant did not seem to affect the consumption of that plant by camels. Due to the camels anatomical mouth structure (slit upper lip, small tongue, horny mouth) they easily nibbled leaves from thorns or spines or matured twigs (Wilson, 1957; El-Amin, 1979; Gauthier-Pilters and Dagg, 1981).

Camels had exclusive access to upper canopies of many shrubs and trees unreachable to other domestic livestock (Richards, 1979). To feed on these relatively abundant plant parts was perhaps more beneficial for the camels than to search for new shoots within the feeding height range of other domestic animals herded together with them in the dry season.

Camels prefer certain plant species (McKnight, 1969; Gauthier-Pilters and Dagg, 1981) and if they browse year after year they recognised them. Gadaba longifolia (an evergreen non-spiny shrub) and Balanites rotundifolia (an evergreen spiny) were among those species severely browsed.

Conclusions

Camels on natural range ate a variety of mixed vegetation. The dietary acceptance range was widened in the dry seasons apparently to compensate to some extent for declining forage availability. The diets of milking and non-milking camels were similar on a seasonal basis, probably because they were herded together and foraged in the same location in any given season. Milking camels consumed more green forage than non-milking camels in the dry seasons apparently to satisfy lactation requirements. Deciduous shrubs and trees were the major components of the animal's diet (more than 80%) in all seasons.

Forage plant species consumption was not affected by physical defence structures or by leaf size in relation to bite dimensions of the animal at any given time. Small leafed deciduous spiny (thorny) plants were equally utilised (if not more) as large leafed deciduous or evergreen plants. Camels were extremely flexible and opportunistic in their diet selection and foraging behaviour.

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APPENDIX: Tables and Figures

Table 1. *Number of plant species consumed by camels in different seasons and locations*

Season	Camel Type	Woody Sh./Tr. sp.	Su. sp.	Fo. sp.	Vi. sp.	Suc. sp.	Gr. sp.	Total sp.
Summer 1986	M	17	2	0	3	1	2	25
(dry)	NM	16	3	0	5	1	2	27
Fall 1986	M	20	3	0	3	3	2	31
(wet)	NM	29	4	0	4	1	2	40
Winter 1987	M	19	3	0	2	0	6	30
(dry)	NM	17	5	0	3	0	6	31
Spring 1987	M	30	1	0	7	0	1	39
(wet)	NM	33	1	0	6	0		40
Summer 1987	M	26	5	4	4	0	3	42
(dry)	NM	25	6	5	4	0	4	44
Fall 1987	M	38	7	6	3	0	4	58
(wet)	NM	37	6	6	3	0	5	57

Sh=shrub Tr=tree Su=suffrutescent Fo=forb Vi=vine Suc=succulent Gr=grass sp=species M=milking NM=non-milking

Table 2. *Percentage of the forage species in overall camel diet on seasonal basis*

Percentage forage species in diet		
Season	Milking camels	Non-milking
Dry – Summer, 1986	96.4	98.8
– Winter, 1987	92.0	88.5
– Summer, 1987	95.3	96.0
	average 94.6	average 94.5
Wet – Fall, 1986	97.2	92.5
– Spring, 1987	90.2	93.8
– Fall, 1987	83.8	81.8
	average 90.4	average 89.4

Table 3. *Diet similarity within season, based on species present diet*

Seasons	Camel Type	Woody shrub/ tree species	Suffrut-escent species	Vine species	Grass species
Dry seasons	M	87.4	81.9	73.9	85.7
	NM				
Wet seasons	M	82.2	83.5	78.0	46.3
	NM				
All seasons	M	84.8	82.7	75.9	66.0

M=milking camels
NM=non-milking camels

Table 4. *Dietary selection (%) by camels and foliage cover (%) of all species comprising each forage class in all seasons*

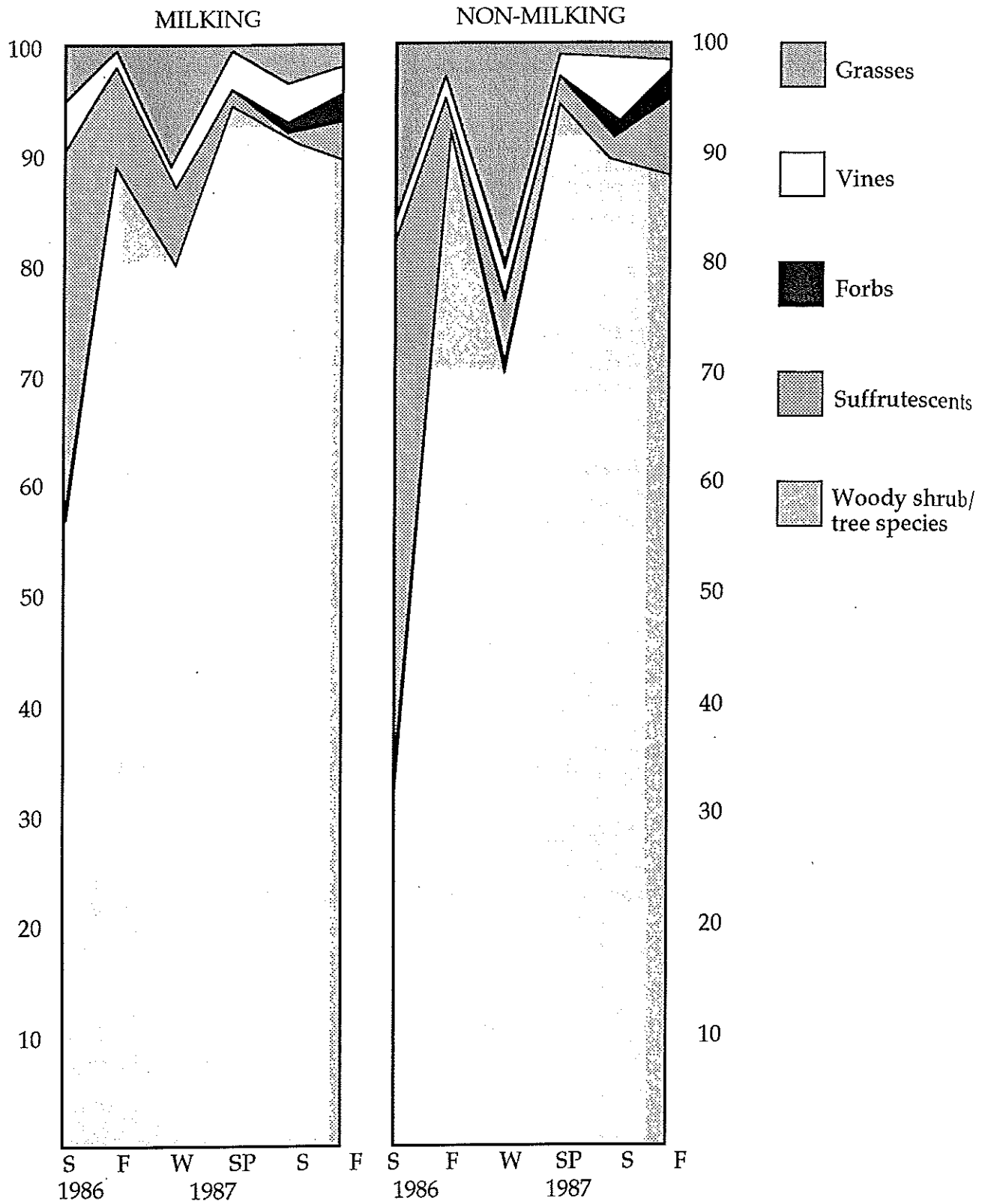
Forage Class	Foliage Cover (%)	Camel Type		
		Milking	Non-milking	Average
Trees/Shrubs	30.0	83.2	78.5	80.9
Suffrutescents	6.4	9.5	11.9	10.7
Grasses	14.6	4.6	7.0	5.8
Vines	2.8	2.2	2.1	2.2
Forbs	1.4	0.5	0.4	0.5
Succulents	0.1	0.1	0.01	0.1

Table 5. *Composition of forage classes (%) and proportion in diet (%) of milking and non-milking camels in wet and dry seasons*

Forage Class	Wet Season			Dry Season		
	% Comp	M % Diet	NM % Diet	% Comp	M % Diet	NM % Diet
Deciduous non-spiny	21.3	35.8	39.9	15.4	14.0	10.9
Deciduous spiny	17.8	13.2	31.1	28.8	39.5	31.8
Evergreen non-spiny	11.9	17.2	12.7	4.9	8.1	5.7
Evergreen spiny	5.8	14.9	3.7	4.9	4.7	6.4
Suffrutescents	8.8	3.7	3.4	17.2	11.4	20.4
Grasses	23.4	1.5	1.2	21.8	5.4	9.9
Vines	4.2	2.5	1.3	2.0	2.9	2.5
Forbs	6.1	0.8	0.5	5.0	0.2	0.3
Succulents	0.3	0.1	0.0	0.0	0.0	0.0

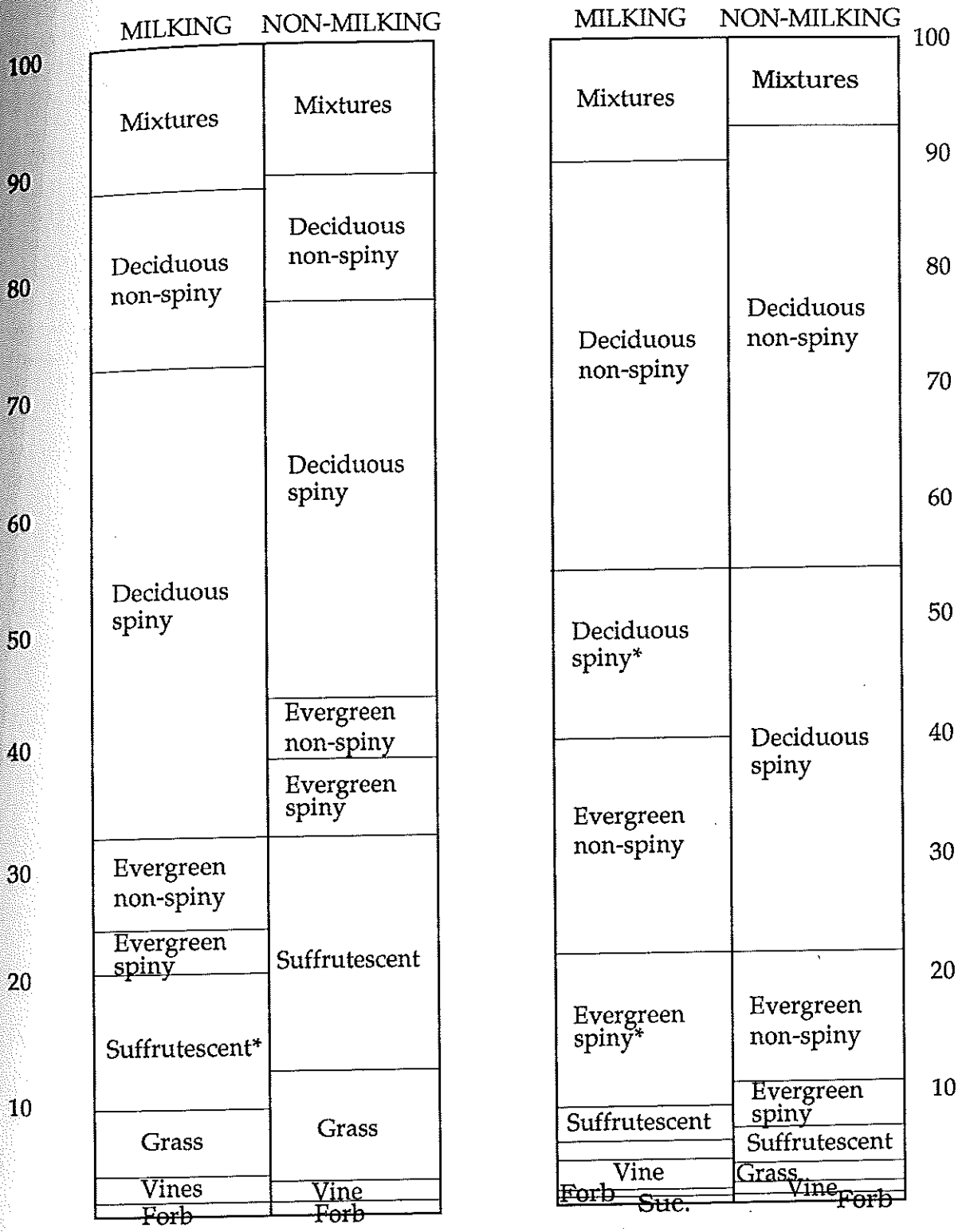
M=milking camels NM=non-milking camels

Figure 1. *Dietary selection (in percentage) by camels during dry and wet seasons*



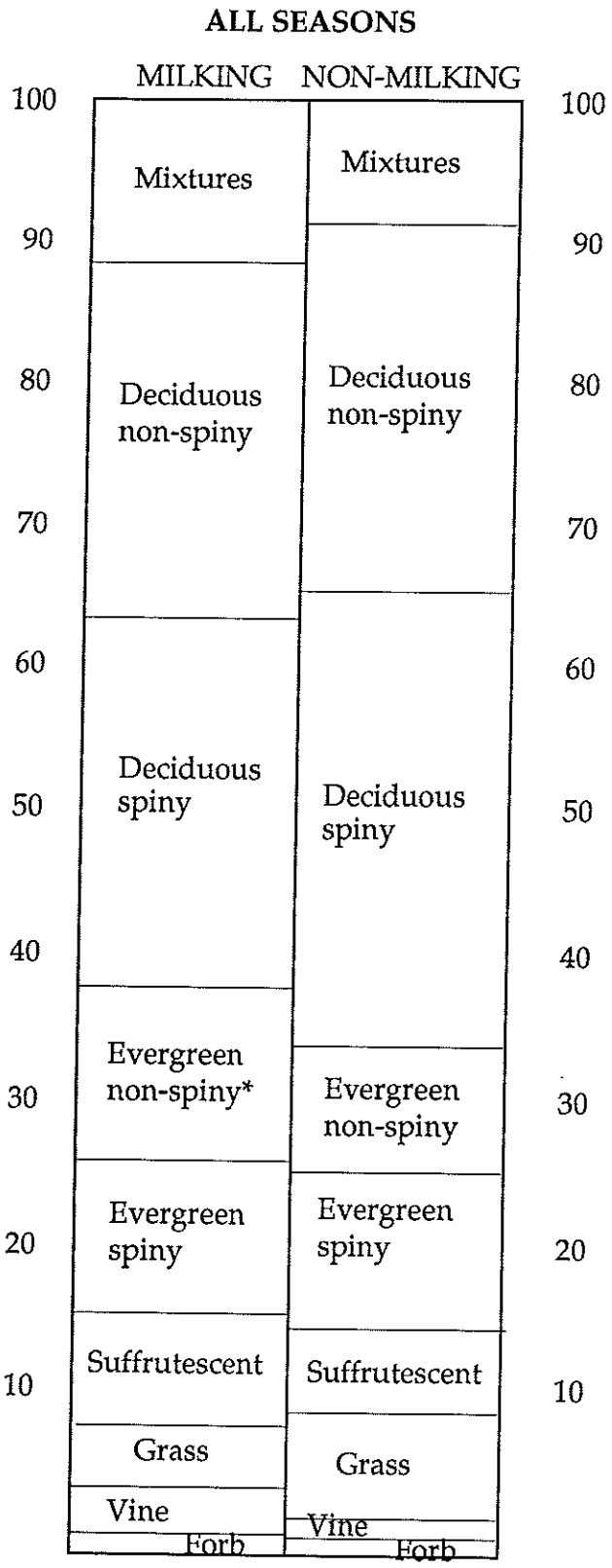
Dry: Summer (S)1986, Winter (W)1987, Summer 1987;
Wet: Fall (F)1986, Spring (SP) 1987, Fall 1987.

Figure 2. *Dietary selection (percentage) by camels in dry and wet seasons*



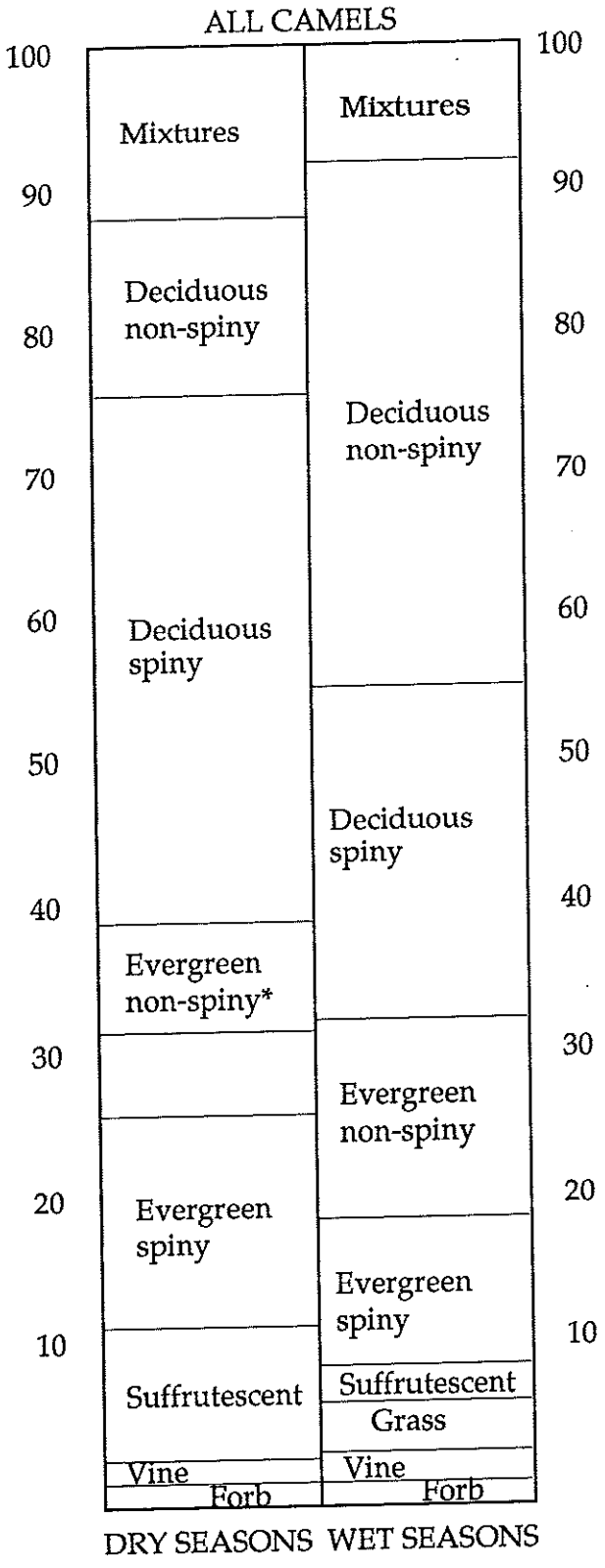
*Indicates statistical significance ($P<0.05$)

Figure 3. *Dietary selection (percentage) by camels in all seasons*



*Indicates statistical significance ($P<0.05$)

Figure 4. *Dietary selection (percentage) by camels in dry and wet seasons*



* Indicates statistical significance ($P<0.05$)