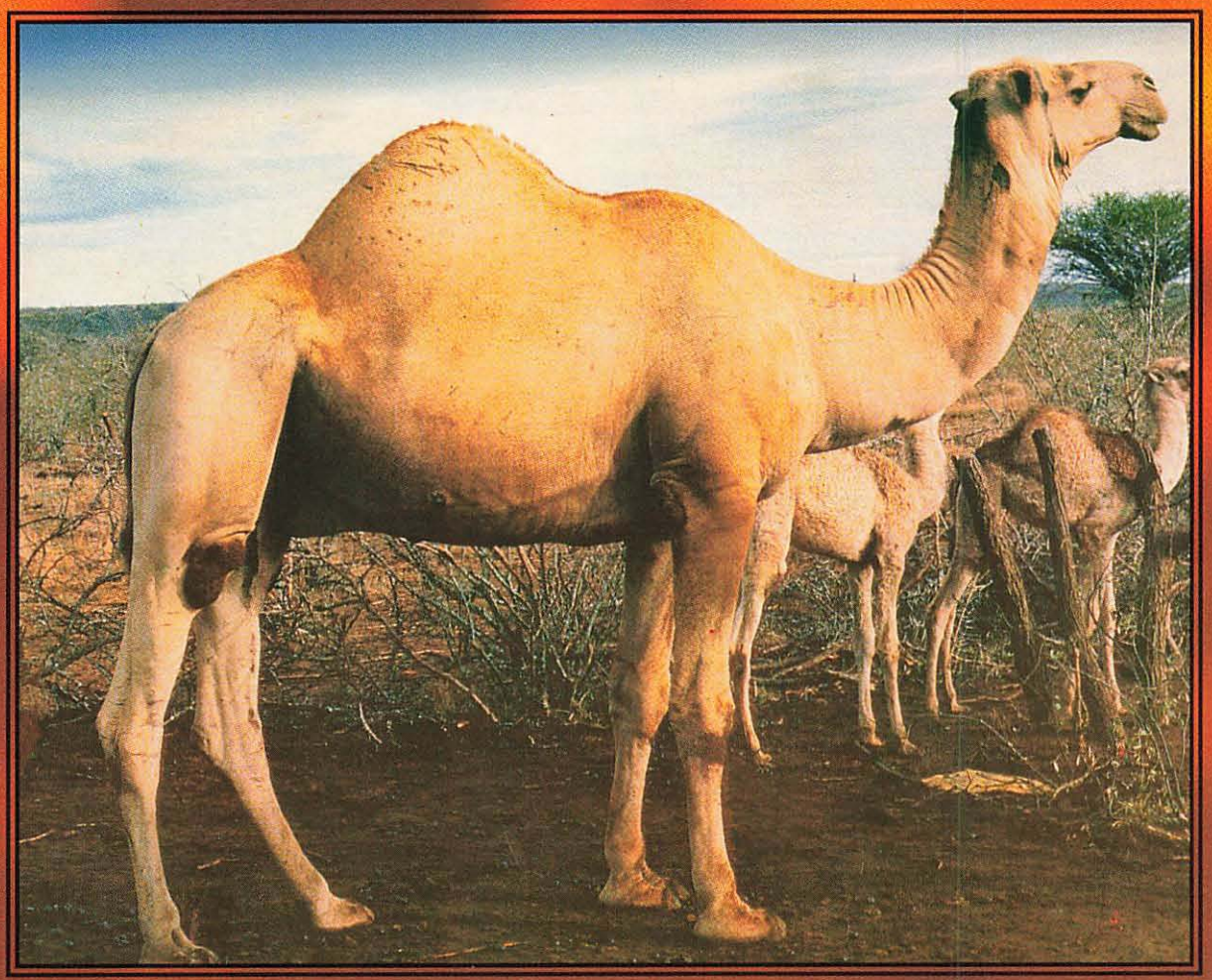
Republic of Kenya
Ministry of Agriculture, Livestock Development and Marketing

CAMEL

KEEPING ✧ IN ✧ KENYA



COMPILED AND EDITED BY JASPER O. EVANS, S. PIERS SIMPKIN AND DEBBIE J. AITKINS

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CAMEL KEEPING IN KENYA

Range Management Handbook of Kenya

Volume III,8

Compiled and edited by
Jasper O. Evans, S. Piers Simpkin** and Debbie J. Atkins**

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Nairobi 1995

Range Management Handbook of Kenya
Volume III,8

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Foreword

Camel husbandry is becoming increasingly important in Kenya. The camel has long been the mainstay of pastoral societies in arid northern and eastern Kenya because of its drought tolerance, reliable milk yield and ability to feed on a wide variety of plants. Now, however, camels are also seen more and more in semi-arid rangelands, especially where overgrazing has depleted the grasses and increased the relative importance of shrubs.

Camel Keeping in Kenya is a compilation of a number of papers by different authors on various aspects of camel ecology and husbandry. The papers are placed in a loose leaf binder so that reprints and photocopies of other camel papers-or of handwritten notes for that matter-can be added in the future if needed. Thus, the binder can serve as a small library.

It is my hope that *Camel Keeping in Kenya* will become a useful reference for those in Kenya and elsewhere who are interested in and/or deal with camels.

C. Ayiga

Chief
Range Management Division
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Introduction

The threat posed by increasing and prolonged spells of drought in many arid and semi-arid regions of the world is certainly forcing inhabitants of those areas to pay to more attention to camel keeping than ever before. Without exception Kenya has realised the camel (*Camelus dromedarius*) has its place in the livestock industry as a unique resource adapted and able to utilise hot and arid environments which comprise more than 70% (seventy percent) of this country.

It is in the light of this realisation that the database being created in the Range Management Handbook of Kenya would be incomplete without a section on camel keeping. The database is therefore not only intended for policy makers but for the public at large particularly the pastoralists, teachers and students. An opening has therefore been created in this direction — at least for this country — and it is up to all those involved in meaningful development to make use of this useful information for the promotion of camel keeping and hence economic development.

Recent estimates place the camel population in Kenya between 700,000 and 800,000 animals. This represents approximately 6% of the total domestic herbivore biomass in the country, but more than 25% in the arid lands where they are kept.

Most of these animals are kept by pastoralists in the arid and semi arid areas of Northern Kenya. This is primarily for subsistence as camels are more reliable for milk production than other classes of livestock during dry seasons and drought years. It is worth noting that milk contributes about half of the nutrient intake of some of our camel keepers. Although camel milk is not normally marketed it has been demonstrated that cheese can actually be produced from it (J. Evans). If this product can be further developed pastoralists can be introduced to this market venture to enhance their incomes and stave off hunger.

The importance of camels in this country cannot be overemphasized. During prolonged droughts where milk from cattle, sheep and goats is unavailable, camels are the mainstay for human survival.

Camel meat is becoming more and more popular. Although traditionally slaughtered for ritual occasions there are now increasing numbers of camel butcheries in northern towns and more recently in Nairobi itself. Due to improved husbandry Kenyan camels have been traded across the Somali border and found their way to the Arabian peninsula for slaughter. This is a potential foreign exchange earner if further developed. It is estimated that as many as 20,000 camels may be traded for export annually.

Locally, pastoralists have used adult male castrates for transport where road infrastructure is not developed. The same animals are used for drawing water from wells, rivers, and dams for domestic use. Camels are also used by pastoralists for bride prices and settlement of disputes.

As a result of lessons learned during past droughts camel keeping is picking up fast. In the last two decades commercial ranches located at 1500m elevation in sub-humid regions south of the equator have started keeping camels. They are used for internal transport and milk production for on -ranch consumption. Although a ready market for camel meat has not yet been developed locally, there is no doubt it will do so as prices for beef, mutton, chicken and fish continue to rise.

On some ranches the herb layer has been destroyed by overstocking with cattle and small ruminants during droughts, hence the camel is an attractive alternative. Demand for camels is thus increasing and we have cause to believe that numbers have increased. However, in sub-humid regions exposure of the camel to contagious diseases as well as endo and ectoparasites is higher than its original arid range. Thus, the potential for mortality is higher.

Little attention has been paid to the improvement of camel husbandry to increase the production of milk and meat. However, it is high time that it was realised that well planned use of our fragile ecosystem for both camel and domestic ruminants will not only be a complementary but also more

economic use of our land. The relationship between the changing role of the camel and the deteriorating environment needs to be fully understood and appreciated in the development planning of this country.

Research, training and development activities involving the camel have been neglected by nearly all regions where the animal is kept. Therefore much more needs to be done in this area to revive and boost production of this useful animal.

"Camel Keeping in Kenya" is a timely asset for the promotion of camel production as well as land utilisation for the benefit of all.

Arthur Meshack Chege
Former Director
Department of Livestock Production
MALDM

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This manual was compiled at the request of Mr Arthur Chege, Director, Livestock Production, Ministry of Agriculture, Livestock Development and Marketing (MALDM) and Dierk Walther, lately Manager of GTZ/MALDM Kenya Range Management Handbook Project.

The editors would like to thank GTZ and MALDM for the assistance provided them and particularly the help and encouragement given by Dr Dennis Herlocker and Mr Salim B. Shaabani.

The object of the manual is to provide a readily available source of information and ideas to help government officers stationed in camel keeping areas, as well as to help camel owners, to a better understanding of this most versatile animal.

This work could not have been achieved without the most generous support of all the contributors who have supplied articles free for this manual, many of whom made time to write special contributions. To each we give grateful thanks.

Special thanks are due to Piers Simpkin who has spent many laborious hours typing and arranging the whole production, to Debbie Atkins for photographs, diagrams and help. We are grateful to Dr Trevor Wilson, the author, and Messrs Longman's the publishers, for permission to use the article on Anatomy, first published in "The Camel" (1994).

We are also grateful to Dr Tom Dolan, editor of the "Kenya Veterinary Journal, and the authors, for permission to reprint "The Camel and its Place in Pastoral Life" by Dr Chris Field and "Trypanosomiasis in the Camel" by Dr D Rottcher and Dr E Zweygarth (K.V.J. Vol 10. No.1. 1986).

Information supplied by many camel-keeping pastoralists is acknowledged with thanks. It is hoped that this information will give other people a better understanding of their uses, methods and customs regarding camels.

This manual has been produced as a file so that new articles may be included in future when new information becomes available. Some repetition of information may be noted between sections but this is necessary to the development of each author's subject.

Farm-Africa have generously agreed to keep a mailing list of those people keeping a copy of this manual, and to produce and circulate up-dates and new articles for inclusion in the manual. Please complete the cut-out on the next page, if you wish to receive these, and send it to:-

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J.O. Evans
23rd March 1994

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SECTION 1

AN INTRODUCTION TO THE CAMEL

CHAPTER 1.1

The camel and its place in pastoral life — a desert dairy

by Dr C R Field

Introduction

Since the camel *(Camelus dromedarius)* was domesticated about 3,000 years ago in the Middle East, it has spread throughout the arid zone of north and eastern Africa. According to Bulliet (1975) there were two waves of introduction. The first, into the Horn of Africa (eventually reaching eastern Uganda), occurred soon after it was domesticated and before the Arabs had perfected a riding saddle. Hence all (traditional) camel cultures in Eastern Africa use their camels for milk, meat and pack purposes, and not for riding. By contrast, in North Africa and the Sahel as far as the west coast, camels are ridden and are also important as transport animals. The theory is that they were introduced at a later date into the northern areas, during the Roman influence, by which time the Arabs had perfected their riding technique.

Within Kenya there is a gradation or cline in the development of the use of the camel, being most sophisticated among the people of Somali origin who have a much larger breed of camels and train them to commands from an early age. The Turkana people by contrast, have small animals and do not use males for transport, preferring donkeys for this purpose. It is believed that the Turkana acquired camels only recently, perhaps as little as 150 years ago, from the Gabra and Rendille whom they drove out of what is now known as Turkana District.

Camel research and development

Until recently camels have been rather neglected by scientists. Interest has centred on their remarkable physiological adaptations particularly of their thermal ability (Schmidt-Nielsen 1964) and to a certain extent on their use of rangelands (Gauthier-Pilters and Dagg 1981), but little was known about their importance to man. The camel has been affectionately known as the ship of the desert and jokingly as a race horse designed by a committee! Recent research however, has suggested that a more apt title would be "desert dairy" and an exceptionally talented committee would have been necessary to anticipate all the advantages that a camel has over other livestock in the arid zone.

In the past decade there has been an upsurge of interest in the camel in the arid zone of Africa, and Kenya has been in the forefront of research and development. The first International Workshop on Camels was held in Khartoum in 1979 where Kenya was well represented. There are bibliographies and newsletters produced by the International Livestock Centre for Africa (Mukassa-Mugerwa 1981) and Arab Centre for Studies of Arid Zones and Dry Lands (Farid 1981) and last year the Scandinavian Institute of African Studies produced another bibliography (Ross-Cockrill 1985). A workshop on the Significance and Prospects of Camel Pastoralism in Kenya was organised by the Institute of Development Studies and held in Marsabit, two years ago (Migot-Adholla 1985). The Kenya Camel Forum convened regularly to discuss progress in camel research and development and there are now more than twenty camel projects either underway or planned in Kenya.

An average population of 630,000 camels has been estimated by Kenya Range and Ecological Monitoring Unit (Peden 1984) for the rangelands of Kenya and this represents about 5% of the population of Africa.

The place of the camel in the arid zone

Why all this sudden interest in camels? Certainly the two Sahelian 'droughts'in the past ten years have focused attention on the desperate plight of the people living in the arid zone of Africa. To date this vast area has yielded little in the way of natural resources to support its increasing human population other than forage and livestock. Cultivation and crop production is rarely successful and is generally inadvisable as it leads to further desert encroachment.

Throughout all the tragedies of the 'droughts' one bright hope which has emerged is the camel. Despite very high losses of cattle, sheep and goats, there are few if any records of serious losses of camels. In fact true camel cultures have suffered less than cattle cultures, although they are living in a much harsher environment.

During the 'drought' of 1984 the Samburu people living just north of Laikipia District faced an awful dilemma. Their only way to obtain food was to trade their skeletal cattle for maize, but those cattle were their livelihood. In the same area, in stark contrast to the Samburu, were the Rendille people herding camels who were still getting up to 5 litres of milk a day from each of their beasts (Anon 1985). At the same time in Laikipia, the owner of Ol Maisor ranch (J. Evans) was obliged to move all his cattle towards Nanyuki and later the Uaso Nyiro, as only 180mm (7in) of rain had fallen on the ranch in 14 months. Many of these cattle died from the combined effects of drought and East Coast Fever because there was no tick control in use when the cattle were grazing the roadside. His camels remained on the ranch without loss and continued to produce milk. They had no detrimental effect on the vegetation. According to Evans, Laikipia has 600,000 acres of unused land suitable for camels.

On a larger scale the UNESCO-Integrated Project on Arid Lands (personal communication) found that 40% of the area they covered in a series of aerial surveys of Marsabit District was virtually never used by livestock because of insecurity and lack of water. This amounts to 9,200km^2. Neither of these constraints is insurmountable. There is no reason to believe that the rest of rangeland Kenya (75% of the surface area of the country) is being used any more intensively.

The great success of the camel in relation to other livestock may be attributed to its physiological adaptations and their advantage in ecological terms. In short, during the dry season a lactating camel can go for 12 days without drinking, while small stock must drink three times more frequently and cattle four times more frequently. This means that camels are able to reach distant pastures between watering while cattle and small stock must repeatedly use the same pasture, near to water. These pastures rapidly become exhausted in arid areas as the main grasses and herbs are annuals. Shrubs and trees are used for 'boma' material, fuel and houses. Desert is an inevitable consequence of the creation of a permanent water supply in pastoral Africa as control of stocking rates within the land's carrying capacity has not been achieved except on an experimental basis.

The role of the camel in pastoral subsistence

The importance of camels to subsistence pastoralists has been referred to in many reports by anthropologists (Spencer 1973; Torry 1973) and summarised by Dahl and Hjort (1976). They produce milk, meat, blood and hides. A detailed study carried out by Field and Simpkin (1985) among the Rendille identified the importance of different livestock categories in providing subsistence food requirements. They monitored the productivities of all categories of livestock (except donkeys) both with (Table 1.1.1) and without a veterinary health programme (Table 1.1.2).

Table 1.1.1: Daily yields of livestock under the veterinary health programme

	CAMELS	CATTLE	SMALL STOCK
Energy from milk (Kcal)	3581	1040	970
Energy from meat (Kcal)	519	1404	3645
% of required minimum	27	16	31
Protein from milk (gm)	199	52	51
Protein from meat (gm)	110	86	223
% of required minimum	73	33	65

Table 1.1.2: Daily yields of livestock under traditional management

	CAMELS	CATTLE	SMALLSTOCK
Energy from milk (Kcal)	2541	940	902
Energy from meat (Kcal)	327	1478	3035
% of required minimum	19	16	26
Protein from milk (gm)	142	47	48
Protein from meat (gm)	69	91	187
% of required diet	50	33	56

The most important findings were:

a) an average family of eight owns 12 camels, 11 cattle and 101 small stock and
b) in terms of livestock units adjusted for the area, camels comprise 46% of the total and small stock 31%.

The daily household requirements for energy for a family of eight range from 15,000kcal and about 422 grams of protein.

Thus under traditional management there is clearly adequate protein but insufficient energy available from livestock (Table 1.1.2). Even with the health programme the household herds were insufficient to supply energy needs, but again more than adequate for protein needs (Table 1.1.1).

The importance of the camel as a food producer is evident. Unlike the other livestock it achieves this without serious damage to the environment by virtue of its extended range. Small stock are important, particularly as meat producers in dry seasons, but their milk off-take is insignificant. They are of a convenient size for minor trade negotiations and are often used to obtain cash for the purchase of maize or sugar. These rich sources of energy help fulfil the dietary needs and remove the reliance of people on milk in an environment which is hostile for milk production. However this strategy should be developed cautiously as small stock are quite destructive to desert vegetation, in particular through trampling, and, in serious droughts grain and sugar may be unavailable.

Overall the camel would appear to be the most reliable source of food for the nomadic pastoralist. The more than 40% increase in energy production from camels within the health programme compared with only 17% improvement in small stock is particularly important. It shows that a simple health package comprising acaracide, anthelminthic, trypanocidal drug and occasional antibiotics, together with adequate salt, can yield a very considerable increase in energy in the diet of the Rendille. No wonder they virtually never sell their breeding female camels!

In addition to the introduction of a health programme, the exploitation of the genetic potential of different breeds of camels is worth consideration. Studies in Kenya involving the direct comparison of the performance of Somali and Rendille/Gabra breeds are now underway, but results from indirect comparisons under similar management conditions show that the Somali breed is the more promising in terms of growth rate (Schwartz et al. 1983) and milk production (Simpkin 1985). At one year of age the Somali animals were twice the weight of the others and although there was a tendency to compensate later, at four years a Somali camel of either sex averaged 520kg, while a Rendille\Turkana camel averaged 280kg under traditional management and 320kg under ranch conditions. Despite these differences attempts to introduce the Somali breed to the Rendille and Gabra people have been unsuccessful, although they live in adjacent areas. The Rendille and Gabra give the following reasons; the Somali breed cannot cope with the rough terrain, it requires more woody shrubs than are available in the area and as it is so much larger, complications of parturition in the crossbred animals are a risk.

We are taking these objections seriously, but hope that the hybrid offspring of the two breeds will combine adaptations and advantages from both genetic lines and yield a higher-producing animal. Already ranchers are convinced of this, although their environment is not so testing as that further north. Therefore even if the more productive Pakistani breed is to be tried in Kenya it should be through the agency of the ranches initially which can provide a more gentle introduction.

Camels as transport animals

Camels are used widely in the arid zone of Kenya as pack animals but not for riding purposes. One of the major problems facing the development of remote parts of Kenya is the lack of communications. Government officers do not have a good knowledge of their areas because of a lack of vehicles and fuel. Never the less the opportunity is there to use the camel. There are many social and psychological barriers to using camels for these purposes but a good example of the value of the camel is the experience of Davies (1957) who was an administrator (DC) in the Kordofan and Darfur Provinces in the Sudan for twenty years. He averaged 1600km on camel back per year and as a result, his contact with the people he was serving was intimate and highly successful.

Conclusions and future

Camels are potentially the most valuable species of livestock for the 75% of Kenya which is arid and

semi-arid and which is degrading rapidly towards desert. Their value is seen both in their productivity and in ensuring the long term viability of the range. Constraints to their usage are disease and the inhibitions of the people which prevent the rapid assimilation of the species.

After a decade of research on camels I am now working on livestock development in Marsabit and Samburu. We plan to involve the people in running their own simple veterinary clinics. Already 16 Gabra "animators" (extension workers) have been trained. The introduction of non-prescribed drugs is straightforward, but I would like this meeting to suggest how the control of trypanosomiasis can be achieved at the pastoral level as the government veterinary service does not reach the people, yet the drugs are under the control of the Veterinary Department. Of 150 Turkana interviewees who owned camels, only 13% had received some veterinary in put or advice for their camels and some were referring to instances as long ago as 1968 (Field et al. 1985).

With regard to the introduction of new breeds we should study closely the introduction of the Somali camel to other parts of Kenya identifying any problems perceived by the people before moving on to the large-scale introduction of this and other less well-tried breeds.

Finally, the use of camels for transport has relevance to the KVA as Government veterinarians are not reaching their target population through lack of vehicular transport. In Turkana it has been proposed that animal health assistants should use camels to take drugs to the people for their livestock and this should become a widespread practice.

CHAPTER 1.2

The advantages of camels over other livestock in Drylands

by D Stiles

Introduction

Camels were probably first introduced to Kenya by Somali speakers moving south out of the Horn at least 1000 years ago. These early camel pastoralists also had cattle, sheep and goats, but camels were important because they were better adapted to the dry climate and deteriorating rangeland of northern Kenya. This area had been inhabited by cattle pastoralists since at least 4500 BP., as indicated by C-14 dates at archaeological sites east of Lake Turkana. As the climate became drier overgrazing occurred, resulting in land degradation.

Historically, camel pastoralism arrived in a region only *after* the desert had been created. Perhaps if the camel were to arrive *before*, the desert would not follow. The camel is a poorly understood and highly underestimated animal by everyone except the pastoralists who have had experience with them. The camel has significant advantages over other livestock species in the following areas:

1. food production
2. consumption of and extent of damage to vegetation
3. human population control

Table 1.2.1 Compares and contrasts camels and cattle in these important areas.

Food Production

The average female camel produces from five to ten times as much milk per lactation as a cow, it

Table 1.2.1: Comparison of camels and cattle regarding food production, impact on vegetation and on human population control

	CAMEL	CATTLE
Annual milk production for human use, one cow	1300[1]-2500[2] litres	112-420[2] litres
Lactation period	47-72 weeks[1],[2]	16-60 weeks[2,3]
Annual production[4] from herd of 100,		
milk	24,820 kg	6,615 kg
meat	675 kg	960 kg
blood	356 kg	480 kg
total protein	1,100 kg	410 kg
total energy	18,730,000 KCAL	7,882,500 KCAL
Dry matter intake	10 kg/day[1]-3,650 kg/year	7.5 kg/day[3]-2,737.5 kg/year
Typical herd annual growth rate[4]	1.5%	3.4%
Maximum herd annual growth rate	7.5%[4]	15.0%[5,6]
Herd size necessary to sustain[4] average family of 6 people	28	64
Diet	Trees & Shrubs[7] 70%	Grass[3] 80%
Mobility	High[8]	Moderate[5,9]
Trampling affects	Light[8]	Heavy[3,5]
Pastoralist degree of polygyny	Low[5,8]	High[5,9]
Human population growth	Low[10,11]	High[5,10]

Sources: [1]Field, 1979a ; [2] Pratt and Gwynne, 1977 ; [3] Lewis, 1977 ; [4] Dahl and Hjort, 1976 ; [5] Spencer, 1973; [6] Schneider, 1981; [7] Field, 1979b ; [8]Torry, 1973 ; [9] Gulliver, 1955 ; [10] Sobania, 1979 ; [11] Rainy,1976

can produce up to a maximum of 21 litres of milk a day, while 5 litres is a very large amount for a northern Kenya cow, and the total amount of protein and energy produced annually by a herd of one hundred camels under traditional management methods is about two and a half times the quantity produced by one hundred cattle. With changes in herd structure and management techniques it would be possible to increase significantly food production from camels.

The camel also has advantages over the cow in that its life span and milk-giving period is much longer, thus fewer calves will give rise to more milk-givers (Dahl and Hjort, 1976, p.95). The average lactation period of a female camel is about one year, of the cow about nine months or less (though variability is great); and the camel continues to produce adequately through the dry season while the cow dries up to a trickle. This means that annual reliability of milk production is much higher with camels, an extremely important point if food requirements are going to be maintained while reducing herd sizes.

In general, one can say that cattle in semi-arid and arid lands under traditional herd management methods are very poor food producers (Pratt and Gwynne, 1977).

Effects on vegetation

The camel has a much more varied diet than the cow. It prefers shrubs and trees, but can also do very well on grass (Field, 1979b). The camel is better adapted to browsing, and because of its great height it can feed at all stories of vegetation up to about 2.5 metres. Camels can travel much further to graze in a day than cattle, thus utilising the vegetation surrounding a settlement with lower intensity. Camels also tend to disperse over great areas while feeding, another factor preventing overgrazing of pastures. Camel dispersal also means that the effects of trampling will be minimal, thus allowing growth of grass and seedlings in the understory.

Cattle feed primarily on grass, though they will also eat herbs and tender leaves in the lower vegetation stories. They cannot travel as far as camels to graze and they tend to stay grouped together. Cattle intensely utilise and trample grass and the understory in a relatively short radius around the settlement and between settlement and watering place. Because cattle must be watered at least every third day a settlement with cattle is rarely located more than 40 km from water, and 10 to 20 km is normal. Camels can be located up to 80 km from water when the pasture is good (Torry, 1973). Camel pastoralists can therefore exploit a much larger proportion of the available range than cattle pastoralists, thus lowering the probability of overgrazing any given area.

A more even distribution of pastoral settlements over the land also means that woody plants will not be over-exploited by man. When settlements congregate near permanent water sources localised barren lands are created. Trees and shrubs are cut down to make stock enclosures, cooking fires, houses, etc., and the exploited area moves out concentrically with time. There is no possibility of plant regeneration because utilisation rates are too high.

The camel is much more efficient than the cow in terms of vegetation consumed for milk produced. Given average grazing conditions, a camel can produce 1900 litres of milk for human consumption a year (the average of the range in Table 1.2.1). The cow will produce about 300 litres under the same conditions for human consumption. A 400 kg camel will consume on average 10 kg of vegetation, dry matter a day, or 3650 kg a year (Field, 1979b), while the 300 kg cow will consume about 7.5 kg a day, or 2737.5 kg a year (Lewis, 1977). This calculates to approximately 1.9 kg of dry matter to produce one litre of milk for family use with the camel as compared to about 9.1 kg of dry matter for that same litre with the cow. The camel is almost five times more efficient in converting vegetation to milk for human use on an annual basis.

Since far fewer camels are needed to feed the reference family of six than are cattle (28:64), one can estimate that the impact of a subsistence camel herd on the environment would be of the order of a third to a quarter less than a subsistence cattle herd, since each camel is also much less destructive on the vegetation than each cow or bull.

Population control

If there is a high correlation in a linear relationship between the number of animals necessary to feed one person, then human population growth cannot exceed herd growth, unless there are supplemental sources of food. Except for the Turkana

and Pokot, grain did not form a significant part of the diet of northern Kenya pastoralists until the 20th Century.

The growth potential of cattle herds is double that of camel herds, though the rates vary with conditions. Spencer (1973) and others have stated that cattle herds can double in five years under favourable conditions, while it would take more than ten years for the camel herd, though even twenty years would be considered fast by most camel herders. These vastly different growth rates have implications for social institutions related to human reproduction.

Cattle people are highly polygynous (>90%), camel men rarely have more than one wife (<10%). This creates a transference of women from camel societies to cattle societies, hence raising population growth in the latter (Spencer, 1973). When a cattle man dies, his herd is distributed to all of his sons, each son receiving his allocation upon marrying. Each one then rapidly builds a family herd of his own. When the camel man dies, the herd is nominally inherited by the eldest married son, as it is considered unpropitious to divide camel herds. Other family members have stock rights, but the herd will only be partitioned between married brothers when it is large enough to operate as two or more independent subsistence herds. This slows marriage and family growth (Table 1.2.1).

Camel people promote more rigorous birth spacing and sexual abstention rules than cattle people, the men marry later, and there are more situations when infanticide will be practised. The Rendille practise a system of delayed marriage for about one-third of the female population (**Sepadi**) (Rainy, 1976).

Amongst the Gabra, a man is not allowed to have a child until his mother has ceased childbearing.

Kenyan population census statistics support the contention that there is a significant difference in growth rates between cattle and camel people. In 1979 the Samburu numbered 73,625 and in 1969 the figure was 54,796. This made an overall growth of 34.4%, or about 2.9% annually. The Rendille grew from 18,729 in 1969 to 21,794 in 1979, an overall growth of only 16.4% and an annual growth rate of about 1.6%, one of the lowest in Kenya. The Samburu, living in a poor area for cattle, still grew at almost double that of the Rendille. Even the absolute numbers of these two peoples, both long resident in Kenya, illustrate that cattle people sustain larger populations than camel people (Table 1.2.1).

The actual situation is obviously much more complex than the above discussion suggests since all northern Kenya pastoralists have large numbers of sheep and goats, many households have both cattle and camels, and grain can be bought in villages and towns. These complications do not alter the general thesis that camels are better food producers and are better for the environment than the other stock animals.

In regions of highly variable climatic and environmental seasonal changes a multi-species herd strategy is usually considered to ensure the highest potential for an uninterrupted food supply. This conventional wisdom can be questioned, however, on the grounds that more camels and fewer cattle and small stock would result in healthier rangeland entering a drought period, thus animals would be better fed and the fewer animals would produce more milk. Even with no cattle at all a relatively small number of milch camels could supply most of the nutrition needs of a family, supplemented by meat from small stock. If people depended on camels during extended drought periods, people would suffer much less from the high degree of herd size fluctuations common to cattle and small stock.

Sheep and goats probably do more damage to the environment than any other animal except man. Their milk production is pitiful. Field (1979a) estimates that a sheep will produce about 59 litres of milk and a goat about 88 litres of milk for human consumption in a year. One camel can produce as much as the annual total of one of both in two weeks. The real value of small stock is to provide meat and money, but the cost to the rangelands is extremely high. Trading in goats and sheep for camels would improve both the economic security of pastoralists and the condition of the land, insuring pasture for future generations. Smaller herds would still supply the meat and money needs of people, and still provide the tea milk.

It is currently almost impossible to obtain a camel for sheep or goats, and even with cattle it is not easy. The Rendille and Gabra have traditions against selling camels, and it is considered highly unpropitious to give or trade camels with cattle people. The Turkana are the main suppliers of camels to the Pokot (who raid them) and Samburu (who buy them), but the supply does not meet the demand and as a consequence camels are expensive. The only way to provide enough camels would be to raise them under controlled conditions on a breeding station(s). Camel production rates could be increased substantially with proper feeding and veterinary care of the young.

SECTION 2

THE MULTI-PURPOSE CAMEL

CHAPTER 2.1

Camels as a source of energy

by Dr T J Bergin

Power and draft

The role of camels in long distance transport has been largely superseded by rail and motor transport, which are faster and more economical on long journeys. However, the camel is cheaper to buy and maintain than a motor vehicle, and where used for local distribution of goods or in small scale farming it has a distinct economic advantage. The precise point at which camels become more economic cannot be defined on a generalised basis. The calculation must be based on the prevailing local price of camels, feed, labour, vehicles, fuel, spare parts and finance available, all of which differ markedly between countries and regions. The value of by-products of the camel (meat, milk, dung) must also be taken into account.

As an approximate guide, camels could be expected to be more economic than trucks or tractors where

(i) land holdings are less than 5 ha
(ii) loads are less than 3 tonnes
(iii) distance is less than 30 km or roads are not suitable for trucks
(iv) loading and unloading time is high
(v) there are many collection (e.g. garbage) or distribution points (e.g. milk, vegetable oil) (Ramaswamy 1985).

Pack camels

Cross (1917) stated that 19-22.4 km/day was an ideal day's march for a pack camel, Leese (1927) put the figure at 24 km/day. (Leese 1927). In 1977 it was demonstrated that even with light (180-220kg) loads, pack camels showed marked deterioration in condition after 6-8 weeks when marched at 35 km/day (Bergin 1981). Pathak (1984) recommended 6-8 hours work/day at 4 km/hour, or 24-32 km/day, with a standard load for pack camels of 200kg.

Heavier loads up to 350 kg can be tolerated for periods of up to two weeks, but a decrease in condition will become apparent. Conversely, lighter loads (150 kg) may be carried up to 50 km per day.

The heaviest recorded lift by a camel was 865 kg, but there is no suggestion that this load was carried any distance.

Camels of 600-700 kg body weight are selected as 'baggers' or pack animals. Where only lighter animals are available, as in parts of North Africa, the load should be decreased accordingly.

Draught camels

Where formed roads are available, draught camels may be used to haul carts. These two-wheeled carts are usually towed by a single camel, although in Australia 20 tonne wagons have been harnessed to a string of 16 camels (Barker 1961).

Camels in India were observed to haul, on a continuing basis, from 0.8 to 1.4 tonnes, 1.2 tonnes being considered the standard load for an 8 to 10 hour day at 2.5-4 km/hour (Bergin, unpubl. obs.).

Camels can exert tremendous force over a brief period; a single camel pulling heavy vehicles out of a bog for example (McKnight 1969).

Camels are also used to pull ploughs, and it has been estimated that a camel develops one hp compared with 0.75 hp or less for cattle or buffalo (Wilson 1984).

Taller camels are at a disadvantage for draught purposes becausea greater proportion of the "pull"

is dissipated as a vertical rather than a horizontal force. For this reason short, stocky camels are preferred. Body weights vary enormously, with some draught camels in Egypt having a calculated body weight of 450 kg or less compared to 750 kg or more for Indian draught animals (Bergin, unpubl. obs.)

The draught power of camels has been put to an amazing variety of uses by man, to tow chariots, barges, artillery, ploughs, wagons, to turn water wheels, oil presses or even ore-crushers. A combination of cultural, ecological and economic factors will decide the future of the draught camel. (see Plates 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5 & 2.1.6)

Riding or saddle camels

Saddles are of two basic types, the African Maklufa, a light saddle in front of the hump or over it, and the Indian saddle where the rider sits behind the hump.

The centre of gravity in the camel appears to lie further forward than in other species, about 15 cm above and behind the elbow. For prolonged work it is probably preferable to mount a rider in front of the hump, and in this position the rider has more immediate control over the camel.

The position at the rear of the hump is lower and the rider, if thrown forward, is protected by the hump, so that this position is favoured for racing or for training novice riders.

Caution is required when interpreting historical accounts of the capability of riding camels. Many early accounts exaggerate distances travelled either to emphasise the novelty of camels to a naive European audience or simply because the distance could not be accurately measured. McKnight for example, wrote that in the last century rides of 60 miles per day (100km/day) were "commonplace" (McKnight 1967). He did not mention that such rides were in fact journeys of only a few days at best after which the camel would be spelled out for several days.

Many explorers' accounts, although accurate as to the distance travelled, fail to detail the condition of the camels at the end of the journey. The Australian explorers Peter Warburton and Ernest Giles were notable exceptions and each described the terrible suffering of their exhausted camels.

Accounts of traditional camel caravan routes often fail to note the fact that the camels were changed at each town along the route. One of the most famous caravans was the 1400 km journey from Khartoum to Al Fashir which was covered in 9 days. Wilson (1984) points out that this was achieved by relays of camels.

It is possible, however, to establish the maximum capability of riding camels from records of journeys over known distances.

McKnight (1967) stated that the longest authenticated distance covered in one day was 224km, and described a 3 day journey covered at 149 km/day. Dorman (1984) stated that camels can sustain up to 70 km/day for 14 days, and 50 km/day for long periods. Mukasa-Mugerwa (1981) stated that 48 km/day could be sustained for long periods and that 80km/day was sustainable for 14 days. Gauthier-Pilters and Dagg (1981) reviewed the accounts of outstanding performances by camels in the Sahara and cited rides of 150 km in one day, 640 km in 4 days and 800 km in 11 days. (Rates of 150, 160 and 72 km respectively.)

The most accurate records of camel journeys are those kept by the defence forces of various countries. The standard patrol of the Australian Camel Corps was 55 km/day for 5 days and there were instances where this rate was sustained for over a month. Today, saddle camels are still regularly used in long distance patrols by the Frontier Service of the Egyptian army and by the Border Security Force of the Indian Army. Egyptian camels patrol for 40-50 km/day (Bergin, unpubl. obs.). Both services stress the need to rest camels for a few days after each patrol of 7-14 days. The Sudan Camel Corps maintained a rate of 65 km/day for five days, and there are earlier records of 14 day journeys covered at 65-80 km/day, followed by a week's rest (Wilson 1984).

When all authenticated distances are plotted on a graph as "rate of travel versus period sustained", it is apparent that riding camels could be expected to maintain an average rate of not more than 50 km/day for long journeys. (Figure 2.1.1). This is equivalent to ten hours work a day at the camel's normal walking pace of 5 km/hour. This distance will often be covered by trotting the camel at about 12 km/hour for a shorter period each day (4.5 - 5 hours) (Hjort and Dahl 1984).

Riding camels usually carry a total weight of less than 160 kg which includes saddle, rider, provisions, water, blankets and firearms.

Long-legged, lean animals of 350-500 kg are usually selected for riding. Males, castrate males or females are used depending on the local custom; rarely if ever are camels of different sexes used together. Saddle camels require months of training.

Management of working camels

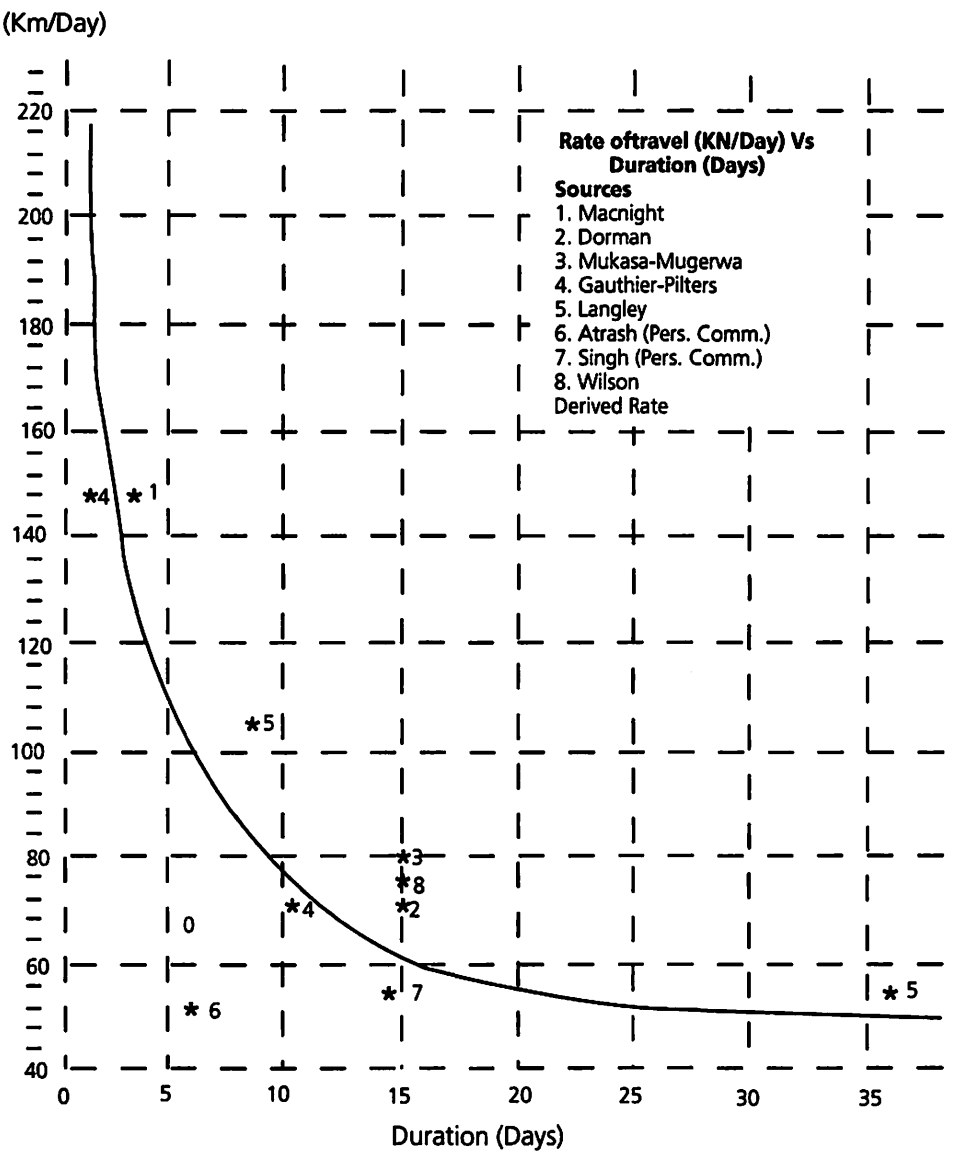
The camel does not usually reach its full body weight until around seven years of age, and it has generally been recommended that camels should not be worked until at least six years of age (Pathak 1984, Wilson 1984).

In Australia, with plenty of good browsing and relative disease freedom, camels appear to reach full adult size more rapidly, and have been brought into service as early as 3 years of age. It is probably wiser, however, to delay heavy work until after the central permanent incisors have erupted i.e. 5 years in males, 51/2 years in females, (R.K. Purohit, pers. comm.) by which time the epiphyses of the bones have completed development.

A camel will not be able to perform unless it is conditioned to work, just as athletes require a build-up period.

Conditioning should commence with a general test for soundness, drenching for gastrointestinal worms and treatment for any other ailment.

Figure 2.1.1: Rate of travel (km/day) vs. duration (days).



Camel products

(Editors note: For information on milk production see Section 2.3)

Meat Production

The camel is probably the most efficient producer of meat in arid and drier semi-arid zones, and causes less damage to the environment than other animals. Camels will move 50 km a day browsing (Newman 1984) and need water on average every 5 days, giving them a potential browsing radius from a single water source of 125 km, compared with cattle which need water every 1-2 days and have a grazing radius of some 14 km. Thus, in theory, the grazing impact of a camel is spread over an area of some 49,000 km², compared with an area of 615 km² for cattle.

Under arid zone conditions in central Australia, when grazed intensively alongside cattle, camels averaged 1.1 kg weight gain per day, whereas the cattle averaged 0.8 kg (Newman 1984). Obviously, this advantage diminishes in higher rainfall areas, and in semi-arid (550-580 mm) areas of Kenya, cattle are the more economic meat producer (Evans and Powys 1984).

In both the Australian and Kenyan studies the major finding was that the primary browsing habits of the camel meant that it did not compete for grazing with cattle, and in fact may have enhanced grass growth by opening up the upper and middle plant canopies.

The Kenyan study showed that the major restraining factors in camel meat production were a prolonged (22 month) calving interval and a low (6-8 year) maturation rate.

It may be possible to reduce the calving interval to 18 months (Knoess 1977), and the Chinese work on reproduction (Chen et al 1984) has laid the foundation for inducing ovulation, artificial insemination and possibly embryo transplantation which could reduce the calving interval still further.

Liveweight

There is evidence that the growth rate could be significantly enhanced by genetic, nutritional and management improvements. Of some 400 camels ready for slaughter in Egypt in 1985, the estimated liveweight average was 400 kg (Bergin, unpubl. obs.) This accords with other liveweight records for North Africa (Field 1984b, Shalash 1984). These body weights compare poorly with the heaviest known recorded liveweight of a dromedary, 1025 kg, recorded in the New York zoo (Crandell 1964), and with recorded liveweights of 970 kg from the Soviet Union (Terentjev 1963), 800 kg from China (Dong Wei 1979), and 780 kg from Australia (Bergin, unpubl.). The difference in body weight appears to be at least partly genetic as it is reflected in birth weight differences also (Field 1984b).

(Editors note:-The heaviest weights recorded on Ol Maisor ranch in Kenya were 997 kg and 1035 kg).

Growth rate

Daily weight gains also depend on nutrition, young camels gaining up to 0.58 kg/day under intensive conditions compared with 0.14 kg/day for genetically similar animals on drought stricken rangelands (Field 1984b).

It has long been recognised that camels have an amazing capacity to recover body condition when good seasons follow droughts. For example, camels arriving in Egypt after being walked across country from the Sudan are often in very poor condition, with estimated body weights as low as 200 kg. They gain up to 150 kg in 6 months, or 0.82 kg/day when fed on high energy diet of 'Barseem' (a cotton seed, rice, molasses and mineral mix) (Said, pers. comm.).

This suggests that meat production from camels can be greatly increased by introducing a feedlotting or finishing-off period using camels bred and raised on a low cost rangelands system.

It has also been shown that camels can utilise urea, alum, molasses, dried sugar tar ('Jagagee') and poor quality foodstuffs treated with formalin (C.S. Mathur, pers. comm.) and this will make feed-lotting of camels more cost effective. The nutrition of camels is dealt with in detail later in this volume.

Slaughter

The extreme mobility of the camel's head makes slaughter difficult using either the capture bolt or a rifle. In addition, religious custom in most of the camel's range requires that the throat be cut ('Halal' in Islamic countries, 'Kosher' in Israel and 'Jkata' for Sikhs). A single slash across the base of the neck and slightly to one side severs the carotid artery and jugular vein in a standing camel, which die in 2-5 minutes. In Egypt the lower limbs are then removed at the knee and hock joints and the

carcass suspended by the Achilles tendons to be processed in the same way as oxen. In Ethiopia the skin is flayed along the backline, rather than down along the abdominal midline (Wilson 1984). The backline flensing system is preferable where the carcass is to be butchered on the ground.

Meat inspection

Normal meat inspection routines are used on camels. Of interest is the absence of a gall-bladder, a serrated median surface of the liver and the presence of a bone in the crux of the diaphragm, the *Os diaphragmaticus*.

Common meat inspection findings include hydatid cysts, sarcocystis, caseous lymphadenitis and (rarely) tuberculosis.

Dressing percentage

The available information on dressing percentages have been summarised by previous workers, (Field 1984b, Shalash 1984, Wilson 1984, Mukasa-Mugerwa 1981). Recorded yields were approximately 48% of liveweight for females (range 41.3-53.5) and 51.4% for males (range 46.2-55.6) (Wilson 1984). Camels in very poor condition would yield well below these percentages, and this is often the case where sick or old animals are slaughtered. (see Plate 2.1.7)

Meat quality

As with beef, the quality of camel meat varies with age, sex and nutritional status. The protein content of camel meat is virtually the same as beef (20-22% vs 20-21%), while the crude fat (at about 1%) and ash (about 0.8%) are lower (Shalash 1984).

Major markets today are Egypt, Libya, the Arabian Peninsula, Nigeria, Iran and Kenya. Many of the animals for slaughter originate in Ethiopia, Somalia or the Sudan, countries whose pastoral communities consider camel meat a rare luxury (Mukasa-Mugerwa 1981).

However, the present quality of camel meat is poor, and the product will continue to find acceptance only at the bottom end of the market while it derives from sick, old, stressed or undernourished animals.

The meat of camels becomes increasingly tough with age and slaughter at 2.5-3 years of age would provide a tender and marketable product. (Mukasa-Mugerwa 1981.)

The superior properties of camel meat for sausage and kebab manufacture has been demonstrated (Shalash 1984), and co-ordinated research should be encouraged towards producing and promoting a distinctive camel-meat sausage. As the camel is absent from most parts of the world, camel meat is not traditionally eaten in those areas, and would face strong cultural aversion were it to be offered for sale. However, by stressing positive attributes (e.g. low fat content) and instituting strict quality controls, the meat could be marketed first as a novelty and later to a return market. The Australian buffalo meat and New Zealand venison industries are examples of such market developments.

The gradual acceptance of gamma irradiation treatment of foods for quarantine purposes will mean that camel breeding countries where foot and mouth disease occurs may yet gain access to large game meat markets such as Germany and Scandinavia.

Blood

Blood forms about 5% of the liveweight of a camel, or about 25 kg in a 500 kg animal. The Koran forbids human consumption of blood, and in Egypt the blood is occasionally collected, dried and fed to chickens or mixed with bonemeal and made into fertiliser.

The systematic collection of blood, bone and manure and their processing into fertiliser is an important economic resource ignored or unknown at the village level in many camel raising areas.

In northern Kenya blood is taken from the jugular vein or the facial vein for human consumption. Yields of 5 litres are obtained once or twice a month (Wilson 1984).

Fat

There is little intra-muscular fat (marbling) in the camel, most being stored in the hump, around the kidneys and, in animals in good condition, as a subcutaneous layer. It has been estimated that up to 200 kg of fat can be stored in the hump of a camel (Newman 1984), and humps weigh from 3-93 kg (mean 18 kg) in camel carcasses averaging 270 kg (Wilson 1984). This is about 7% of carcass weight. While camel fat is considered a delicacy in Kenya, in the USSR it is predominantly used for making soap.

Hides

Camel hides weigh between 22.5 and 47 kg, or 8.5 to 11.8 percent of liveweight.

To date, camel hide has found little use for leather (Mukasa-Mugerwa 1981), although

Faulkner (cited by Wilson) contended that fine quality leather can be manufactured from camels.

Research is urgently needed to reassess the qualities of camel leather, particularly in the light of modern leather treatment processes.

Wool

There is a great deal of confusion in the literature between wool (solid fibre) and hair (medullated fibre) production and usage, most sources failing to differentiate between the two. Wool yield and quality are influenced by age, sex, breed and environment.

The most sought after wool in the world comes from the South American camelids, especially the Vicuna. The finest wool from old-world camelids is from bactrian yearlings measuring 16-18 u and yielding 85% non-medullated wool (Terentjev 1963).

In Mongolia, adult bactrian males produce up to 18 kg of wool, 5 kg being the average yield. Of this 26% is long coarse wool (46-74 um) collected from the knees, elbows and chest, and 75% fine wool (21-29 um) from the body and the sides of the neck. (Chapman 1985.)

Wool from adult male dromedaries is more coarse 31-35 u, (Bergin and Mclaren, unpubl.). However, it is known that yearling dromedaries produce fine wool, with yields of 1.15-5.4 kg (Mukasa-Mugerwa 1981).

The wool yield of dromedaries is considerably lower than bactrians, about 3.5 kg for male dromedaries in Turkestan (Dorman 1984).

Camel wool production is the primary goal of camel-keeping in China, Mongolia and the eastern regions of the USSR, areas occupied by bactrians. In other areas it is a by-product. Coarse wool is used for making tents, carpets and blankets, while fine wool is sought for coat manufacture.

Conclusion

The diversity of camel types means that with selective breeding and modern reproductive technology, camels can be produced which will greatly out perform today's camels.

To enable optimal selection, accurate data from throughout the camel's range is needed on body weight, meat yield, milk yield, wool quality and yield and work capability.

At the same time more information is required to relate production figures to causal factors such as rainfall, (fertiliser usage) grazing intensity, and frequency of worming.

As the resources available for camel research in any one country are limited, international co-operation and exchange of information will be essential for the development of camel husbandry and medicine.

Plate 2.1.1: Camels are widely used for transport, and can carry heavy and bulky loads. (Christof Hahn)

Plate 2.1.2: Camel pulling a cart - note the position of the harness in front of the withers. (Chris Field)

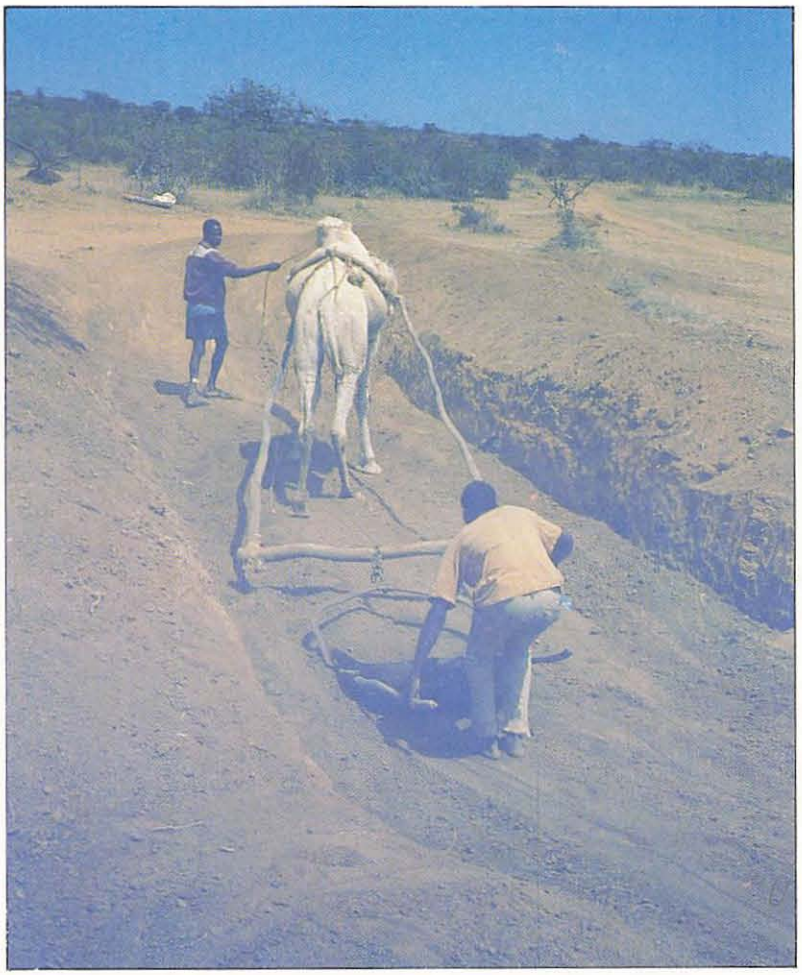


Plate 2.1.3: Camel Dam-scoop for desilting dams and pans. (Debbie Atkins)

Plate 2.1.4: Harrowing by camel. (Debbie Atkins)

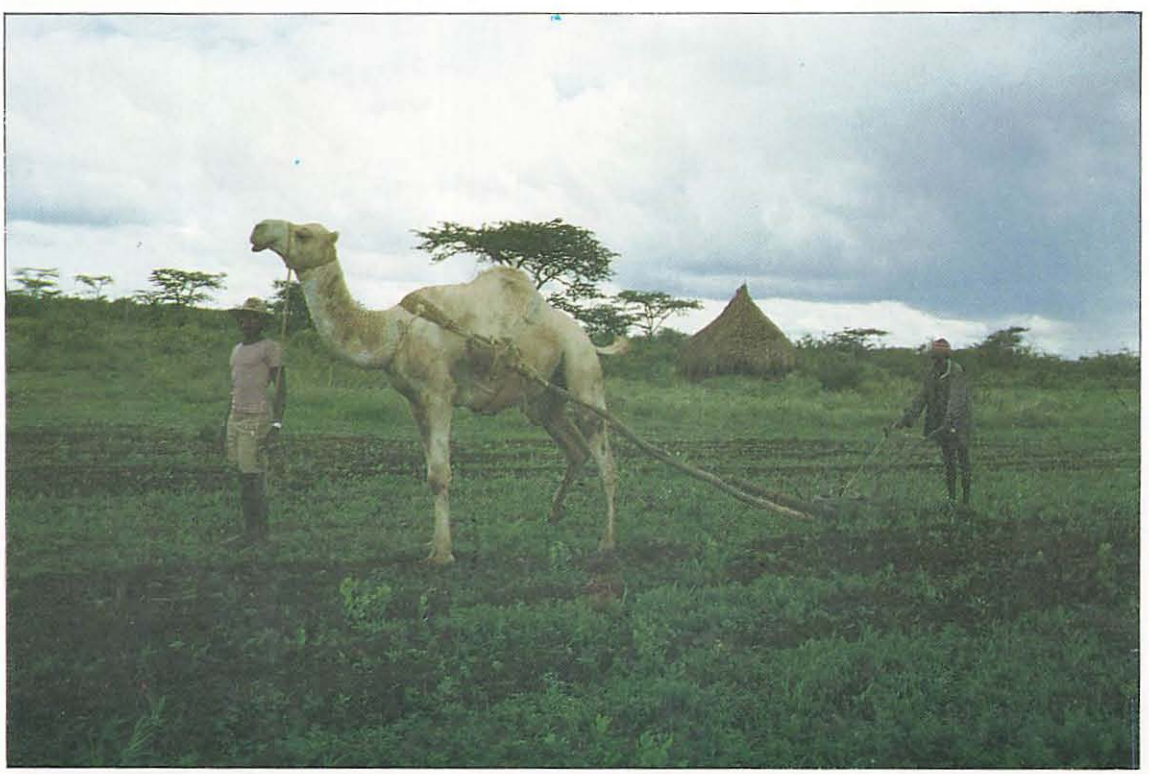


Plate 2.1.5: Transporting firewood. (Chris Field)

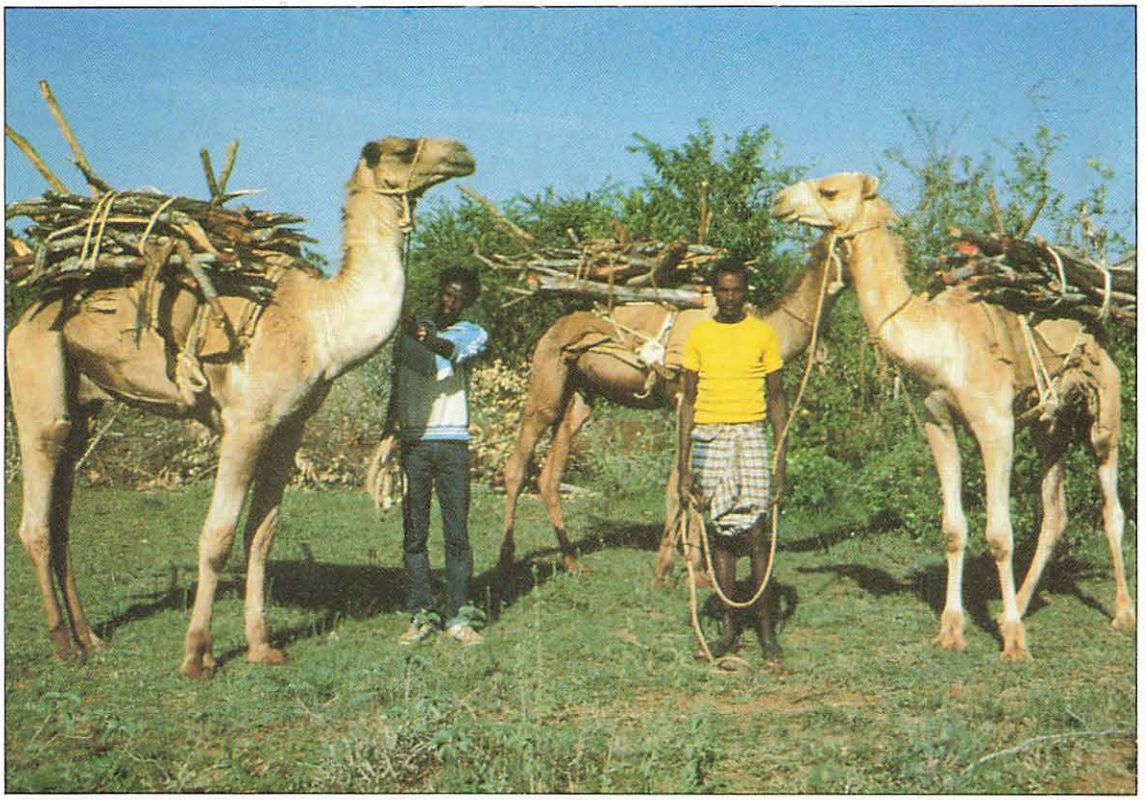
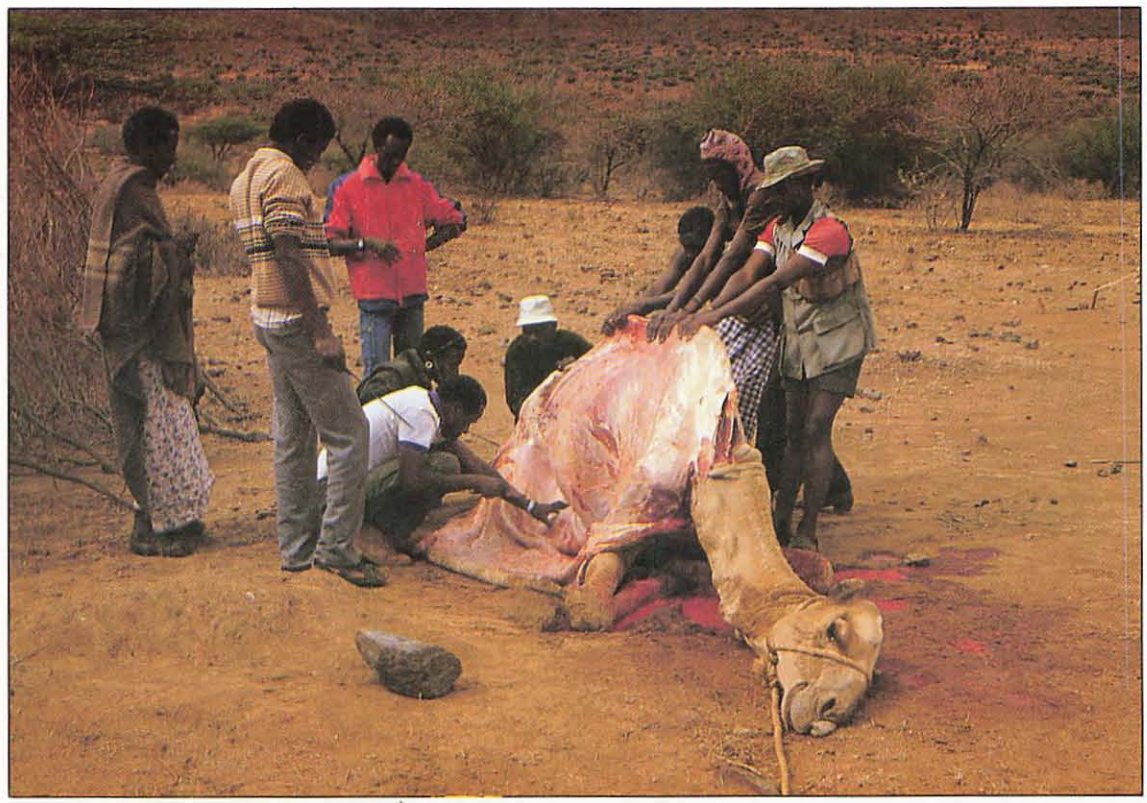


Plate 2.1.6: Gabra use camels for carrying houses and possessions, enabling a nomadic lifestyle. (Chris Field)

Plate 2.1.7: The carcass is usually flayed from the backline. (Chris Field)



CHAPTER 2.2

Utilisation of camel meat in human nourishment

by M R Shalash

Introduction

Developing nations have at present about three-quarters of the total world human population and nearly 60% of agricultural land area. At the same time about 60-70% of livestock resources are found in the third world countries.

However the productivity of this large number of animals is depressingly low. For instance, it is estimated that the 70% of the world cattle and buffalo population in the developing countries only yield 21% of the world milk production and 34% of the world beef production (FAO 1970). Within these overall figures, average per capita meat and milk production varies widely between the regions.

There has been a substantial increase in the global quantity of milk and meat produced over the period 1950 to 1970. But, by and large, per capita production in the developing countries has been relatively stagnant and this is due to the continuing low productivity of the animals in these regions. Although total production in the developing countries has increased, this is mainly attributable to an increase in the numbers of animals.

Nutritional aspects may be important in certain developing countries that are concerned with improving food intake. In this respect the high quality protein content of animal products provides an opportunity to supply a very valuable component to low-protein diets particularly for vulnerable groups like children and pregnant women.

In reviewing the role of animal production in the developing countries, it may, therefore, be concluded that in the foreseeable future there are considerable opportunities to increase domestic animal production to meet the rapidly growing demand for animal products. Such an expansion of domestic production can be achieved through a better utilisation of grassland, improved pastures, and fodder production, as well as through the feeding of concentrates where high marginal returns make this input economic. But in the long term perspective, to meet the rising demands for animal products and to economise on the increasingly scarce land and feed resources, it will be extremely important to improve the production capacity of the animals themselves. It is in this context that we should view the role of genetic improvement.

Moreover, the majority of livestock in the tropics and subtropics live under natural unimproved conditions. They are subjected to various environmental stresses, to which they have been adapted through natural selection. The best example is the camel, which is wonderfully adapted, both anatomically and physiologically, to the hot and dry climate of subtropical desert.

The primary uses of camels are for transport of goods and passengers in desert and semi-desert areas. Wool, milk, meat and hide are by-products of this main function.

Obviously the productivity of camels can be improved by selection of high productive potentials and providing a better environment.

Meat production

Camel's meat is relished by the desert inhabitants. In certain areas camel meat replaces beef and mutton although it is not considered very palatable. However, about twenty thousand metric tonnes are consumed annually in Egypt, and it

Table 2.2.1: Slaughtering data on 32 camels in Kenya

The following table was compiled by Dr.J.G. Grootenhuis from data collected by Dr. Wachira Maina of Ciba Geigy/ Kenya Swiss (ID No:110 - 144), and Mr. Phil Tilley of Game Ranching (ID No:a - h).

(LW = Liveweight, DW = Dead weight (LW-blood), CW = Carcase weight and DO% = Dressing out percentage calculated as CW/LW x 100), NR = Not recorded

ID No.	LW in Kg	DW in Kg	CW in Kg	DO%
110	742	720	470	63
79	695	672	425	61
105	607	600	340	56
55	607	601	340	51
137	649	615	355	55
99	620	615	355	57
124	613	595	340	55
78	613	678	390	64
112	575	560	335	58
136	567	550	330	58
133	566	545	320	57
135	562	515	300	53
17	558	500	300	54
102	556	545	320	57
168	545	485	290	53
119	538	490	295	55
138	534	510	320	60
121	533	500	300	56
9	511	440	260	51
186	490	485	290	60
169	463	460	275	59
140	463	462	280	59
149	420	406	260	62
144	518	485	295	57
a	530	NR	345	65
b	550	NR	350	64
c	473	NR	280	59
d	430	NR	255	59
e	425	NR	240	56
f	520	NR	320	62
g	580	NR	300	52
h	525	NR	245	43

Mean dressing out percentage = 57% (mean of 32 animals)

constitutes an important source of animal protein especially for the lower income group. Moreover, the fat depot in the hump is commonly used as a substitute for butter in cooking.

Abmediev and Pravendnev (1964) stated that 260-500 kg can be obtained per animal. Kulaeva (1964) also found that the dressing percentage varied from 56-70%, and camel meat resembles beef in taste. Slaughtering weight on 32 camels in Kenya is presented in Table 2.2.1.

Shalash et al. (unpub) found that the meat obtained from camels varies in amount according to age, sex and feeding; it varies from 182-545 kg, and the dressing percentage varies from 55-70%.

Meat varies in composition according to type and condition; also the fat content of different fatty tissues varies greatly (Bailey 1951). Abdel Baki et al. (1957), Hamman et al. (1972), Nasr et al. (1965) studied the chemical composition of camel meat and the results are shown in Table 2.2.2.

The results in Table 2.2.2 show that sex has no marked effect on the composition of camel meat whether in young or aged animals. On the other hand, age proved to have an influence on the chemical composition of camel's meat. In conclusion there is a significant difference in the content of the protein, crude fat and ash, and the amounts of these three main components are comparatively lower in camels below 5 years old.

Considering the variations in the main components found in the different cuts examined, it is evident that no marked difference could be detected between males and females of the same age except in the case of crude fat content in aged animals where the fat content was comparatively higher in the sternum of females than in that of males. The fat depot in the thigh is nearly always lower than that in the sternum or shoulder.

Table 2.2.2: Mean value of the different components of camel meat

AGE	CUT OF MEAT	PROTEIN %		WATER %		FAT %		ASH %	
		M	F	M	F	M	F	M	F
5 years or over	Sternum	22.00	22.03	76.30	75.82	0.96	1.60	0.86	0.77
	Shoulder	22.28	21.65	76.14	76.41	0.95	1.00	0.79	1.05
	Thigh	22.39	21.77	76.10	76.68	0.86	0.69	0.72	1.01
	Longismus dorsi	19.43		76.23		2.61		1.05	
	Round	19.80		78.29		3.81			
Less than 5 years old	Sternum	19.88	20.26	78.09	77.85	1.00	0.98	0.98	0.88
	Shoulder	19.95	20.02	78.72	78.41	0.78	0.98	0.63	0.62
	Thigh	20.33	19.98	78.04	78.54	0.96	0.83	0.78	0.69

Comparing the previous results with those of the bull, cow and steer, (Hisashi 1961), shown in Table 2.2.3, it is evident that the meat of camels below 5 years of age has nearly the same percentage of crude protein as in the steer; while the meat of camels 5 years old or over contains a higher percentage of crude protein than that of the bull, cow or steer. On the other hand, crude fat and ash contents of camel meat are comparatively lower than that of beef. Abdel-Baki et al. (1957) observed that after 9 days of cold storage camel meat became slightly darker due to oxidation of haemoglobin.The results indicate that the total protein and total fat remained nearly constant. The soluble protein increased during cold storage, while coagulable protein decreased. The alkali insoluble protein decreased gradually during the period of cold storage. The lactic acid content increased and the pH value of the meat decreased, the rancidity of the fat content as measured by the increase in the acid value and the peroxide value showed a slight increase and the iodine number decreased gradually during cold storage. However the meat remained edible during the cold storage period.

Camel meat is supposed to be one of the toughest kinds of meats and it appeared of interest to test the tenderness of different cuts. In this respect, Abdel-Baki et al. (1957) found that the location of the cut determined to a great extent the tenderness of the meat (Table 2.2.4).

The alkali insoluble protein of the round cut was nearly twice that of the tenderloin. In other words the amount of alkali insoluble protein, the shearing value and the diameter of the fibres were inversely proportional to the tenderness of meat. The number of fibres were directly proportional to the tenderness.

Table 2.2.3: Mean value of the different components of bull, cow, steer and camel meats. (Nasr et al. 1965)

TYPE OF ANIMAL	WATER %	PROTEIN %	FAT %	ASH %
Bull	76.41	20.95	1.20	1.05
Cow	75.52	21.19	3.99	1.02
Steer	72.98	20.41	4.88	0.97
Camels< 5 years	76.24	22.02	1.01	0.86
Camels> 5 years	78.27	20.07	0.92	0.76

Camel depot fat

The fat derived from the camel is naturally of extraordinary importance in meeting human needs for fats. In Arabia the camels hump is boiled down for grease (Leese 1927). The edible fats are obtained from the hump, pre-nephric and pre-mesenteric parts.

The characteristics of the depot fat in the camel have been investigated by few workers. However, previous data reported by Armstrong and Allan (1924), showed that only the major component acids, palmitic (37%), stearic (16%) and oleic (47%), could be recognised. Later Shourbagy et al. (1952) reported the relationship between the age and both iodine and saponification values of depot fat in camel's hump. Gunstone and Paton (1953) investigated the fat characteristics of a male bactrian camel and considered it rich in stearic acid.

Nasr et al. (1965) found that moisture and ash contents of the fat depot in the hump and around the kidneys increases with age while crude fat percentage decreases. However, in all ages they found that the fatty tissues around the kidneys contain more crude fat percentage than that in the hump.

The mean refractive index value of prenephric camel fat is 1.456 while the melting-point mean value is 51°C for the kidney fat and 50°C for hump fat. It is evident that camel fat has a comparatively higher melting point than that of ox and buffalo body fat (Moursy et al. 1966).

Shourbagy et al. (1952) and Moursy et al. (1966) found that the iodine value of hump fat was 35.3 and 34.77 respectively. The former authors reported that the iodine value is affected by age and that the formation of oleic acid series decreased as the age increased but only to a certain limit. Gunstone and Paton (1953) stated that camel fat is more saturated than both sheep and ox tallow, and this is reflected mainly on the increased content of stearic acid and decreased amount of oleic acid. Moursy et al. (1966) found that the mean saponification value of the prenephric camel fat was 192.1 and that of the

Table 2.2.4: Effect of location of cuts on tenderness of camel meat (Abdel-Baki et al. 1957)

CUT	ALKALI INSOL.PROTEIN		SHEARING VALUE		DIAMETER OF FIBRES		NUMBER OF FIBRES		PANEL-TEST
	Fresh	Cooked	Fresh	Cooked	Fresh	Cooked	Fresh	Cooked	
Round	3.90	0.9871	160	75	46.80	40.40	18.40	20.05	-
Tender Loin	2.12	0.1012	100	55	45.04	20.04	20.50	25.05	+

hump fat was 193.5. Shourbagy et al. (1952) stated that as the age increased the acids of high molecular weight were formed in the composition of glycerides in hump fat. Moreover, the content of water-insoluble volatile fatty acids given as Polenske number (P.N.) is higher for hump fat (0.70) than for prenephric fat (0.35) (Moursy et al. 1966).

The acidity of fats either expressed as acid value or percentage of free fatty acids is considered as a measure of the hydrolysis that has occurred in the fat. Therefore, the determination of acidity in edible animal fat is important and necessary, as any percentage of free fatty acids in excess of 0.5 calculated as oleic (William 1950) will lead to a burning sensation in the throat when the fat is eaten and will render it unpalatable. In this respect Moursy et al. (1966) found that the percentage of free fatty acid for prenephric fat and hump fat is 0.2256 and 0.2820% respectively.

The use of camel meat for the preparation of sausages

Sadek (1966) found that the conversion of camel meat to sausages eliminates its toughness, reduced its cooking time, and can be served as a delicious ready-cooked meal and could be offered either as a dish or as a snack especially to schoolboys or labourers. Camel's meat also proved to be the best example for quality as starting material for cured meat. It has highly desirable features as a sausage constituent, - its superior performance, pigmentation and water-binding capacities, tempt kebab makers to incorporate it in other meats. It was also discovered that the prepared camel sausage had nearly the same chemical composition as that of beef and proved to be free from coliforms as well as potential food-poisoning organisms. Being cheaper in price it could be recommended as a good source of animal protein.

The digestion coefficient of camel meat proteins

Previous work showed that camel meat is the cheapest in the developing countries when compared with veal, beef or mutton. The chemical composition was also proved to be more or less similar to some kinds of beef. Nasr et al. (1965) in an attempt to evaluate the digestion coefficient of camel meat protein found that the mean value is 91.96%. Various workers however reported that the digestion coefficient of beef ranges between 96-99% (Ando 1955). A great deal of work is yet to be done before reaching a sound conclusion. It is imperative to compare camel proteins with those of cattle of the same age. There is no doubt that the digestibility coefficient would be influenced by sex, age, plane of nutrition, structure of tissues and also methods of preparation and preservation. In the light of the available data on the chemical composition of camel meat and its digestion coefficient it may be warranted to advocate camel meat as a cheap substitute for other proteins.

CHAPTER 2.3

Camel milk

by Z Farah

Importance

In many arid areas camels play a central role as a milk supplier. The comparative advantage of the camel as a dairy animal over the other species in the same environment is shown by the continuity of supply even during long droughts when other animals cease to produce. It is widely recognised that in absolute terms the camel produces more milk and for a longer period of time than other species maintained in the same environment.

In East Africa, where 60% of the world camel population is kept, the consumption of camel milk is not limited just to the pastoral nomads, but is also commercialised and sold in the urban areas.

Milking process

The milking of camels is a process which varies according to the different pastoral groups. Camels may be milked once or several times a day. In general, it is normal practice among most nomadic tribes to milk their camels in the early morning before animals are taken to grazing and at night when they return from grazing.

Before milking, the calf is allowed to suckle until the milk is flowing and then the camel can be milked. Without this stimulation, the dam cannot be milked.

The milker stands on one leg, puts the milk pot on the upper part of the leg, and milks with one or two hands. Sometimes, milking may be done by two persons, each milking two teats.

To prevent calves from suckling while at pasture, it is a usual practice to tie up one or more teats with special strings.

Milk yields and lactation length

It is difficult to estimate the daily milk yield of the camel under pastoralist conditions owing to the inconsistency of milking frequency. Milk yield also varies with species, breed, stage of lactation, feeding and management conditions.(see plate 2.3.1 and 2.3.2)

The length of lactation can vary from 9-18 months. This depends mainly on the husbandry practices, which are largely determined by the need for milk, more being required in the dry months than in the wet months when other sources of food are available.

Estimates of milk yields from various countries are given in Table 2.3.1. The data are highly speculative and should be considered as guidelines for milk yields under pastoral conditions. It must also be noted that throughout lactation the calves are still suckling and therefore the actual volumes of milk secreted are higher than the figures presented in the table.

Table 2.3.1: Milk yields of camels reported from various sources

Country	Average daily yield in kg	Lactation length in months	Calculated yield kg per 365 days
Algeria	4	9 - 16	1460
Ethiopia	5	12 - 18	1825
India	6.8	18	2482
Kenya	4.5	11 - 16	1643
Pakistan	8	16 - 18	2920
Somalia	5	9 - 18	1825
Tunisia	4	9 - 16	1460

Milk quality

Camel milk is generally opaque white. It has a sweet and sharp taste, but sometimes it is salty.

The taste generally depends on the type of fodder and availability of drinking water. The pH of camel milk ranges from 6.3 to 6.7 and the density from 1.026 to 1.035. Both density and pH are lower than those of cow milk.

Compared to cow milk, camel milk sours very slowly and can be kept longer without refrigeration.

The first milk, the colostrum, is white and slightly diluted as compared with the colostrum of cow milk. In Somalia, the colostrum (**dambar**) is used as a laxative. However, in most countries, where camels are kept, the colostrum is considered unsuitable for drinking. Some pastoral groups consider it unsuitable even for the calves and milk it on to the ground. Because of its immunological properties colostrum is essential for the new-born calves.

Composition

The composition of camel milk quoted from various sources and the corresponding values from other animal species are presented in Table 2.3.2 below.

There are greater variations in constituents of camel milk than in cow milk. Camels are known to produce a diluted milk in hot weather when water is scarce. The main difference between cow and camel milk lies in the different physico-chemical characteristics of the individual components (protein, lipids, ash etc.).

Milk proteins

The proteins in milk represent one of the greatest contributions of milk to human nutrition. They perform a variety of functions in living organisms ranging from providing structure to reproduction.

The main components of milk proteins are casein and whey proteins. Casein is found in no products other than milk. Casein is precipitated when the milk sours or when acid or rennin is added. In cheese-making, most of the casein is recovered with the milk fat. In camel milk, the value of casein is the lower limit of casein content of cow milk.

Casein is present in milk in the form of finely divided particles similar to clay in muddy water. The particles contain, beside the protein, considerable amounts of calcium phosphate. The most observed particles in cow milk casein have a diameter from 40 to 160 nanometer (1 nanometer = 10^{-7} cm). In camel milk casein the most numerous particles range in diameter from less than 20 to more than 300 nanometer.

The fat and casein are removed to leave whey which contains the soluble milk salts, milk sugar and the whey proteins. The whey protein content in camel milk varies between 22 and 28% of total protein. This is slightly more than the whey protein content in cow milk.

As it is shown in Table 2.3.3, both casein and whey protein are made up of a number of protein fractions. Some of these fractions have been found in camel milk. However, they differ in their physico-chemical properties from cow milk casein fractions.

Table 2.3.3: Milk protein factions

PROTEINS	
CASEINS	WHEY PROTEINS
as1 - caseins	ß - lactoglobuline
ß - caseins	a - lactalbumine
k - caseins	immunoglobulins
as2 - casein	serum albumine
	proteose peptones

Milk Fat

Milk fat serves nutritionally as an energy source, acts as a solvent for the fat-soluble vitamins and supplies essential fatty acids. About 99% of milk fat is a mixture of fatty acids (triglycerides) of varying chain length from 4 to 20 carbon atoms.

Table 2.3.2: Gross composition of milk from various animal species

SPECIES	PERCENTAGE COMPOSITION				
	MOISTURE	FAT	LACTOSE	PROTEIN	ASH
Camel *(Camelus dromedarius)*	86.0 - 88.0	2.9 - 5.4	3.3 - 5.8	3.0 - 3.9	0.6 - 0.8
Cow *(Bos taurus)*	86.0 - 88.0	3.7 - 4.4	4.8 - 4.9	3.2 - 3.8	0.7 - 0.8
Goat	87.1 - 88.2	4.0 - 4.5	3.6 - 4.2	2.9 - 3.7	0.8 - 0.9
Sheep	79.5 - 82.0	6.9 - 8.6	4.3 - 4.7	5.6 - 6.7	0.9 - 1.0
Human	88.0 - 88.4	3.3 - 4.7	6.8 - 6.9	1.1 - 1.3	0.2 - 0.3

The fatty acids are divided according to the linkage of the carbon atoms into saturated and unsaturated fatty acids. In saturated fatty acids the carbon atoms are linked in chain by single bonds, in unsaturated fatty acids by one or more double bonds.

The bulk of the fat in milk exists in the form of small spherical globules of varying sizes. The surface of these fat globules is coated with a thin layer known as a fat globule membrane, which acts as the emulsifying agent for the fat suspended in milk. The membrane protects the fat and prevents the globules coalescing into butter grains. The fat membrane can be broken by mechanical action.

The fat content of camel milk varies between 2.9 and 5.4% and the average size of the fat globules is about the same as cow milk fat globules. According to present knowledge, the main differences between the fat in cow milk and camel milk are as follows:

- Natural creaming of camel milk differs markedly from that of cow milk. On standing, camel milk creams less rapidly and completely than cow milk and no skimmable cream can be obtained even after standing for several days.
- Compared to cow milk fat, camel milk fat contains less short-chain fatty acids. Long-chain unsaturated fatty acids occur to about the same extents in both.
- Butter can be obtained from camel milk only at high churning temperature (between 20-25°C). These values are considerably higher than that of cow milk which normally vary between 8 and 12°C.
- The mean melting point of camel butter is around 41.5°C and is on average 8°C higher than that of corresponding values in cow milk butter.

Lactose

Lactose is the major carbohydrate fraction in milk and is a source of energy for the young calf. It is made up of two sugars, glucose and galactose which are fermented to lactic acid when milk goes sour.

The lactose content in camel milk ranges from 4.8 to 5.8% and is slightly higher than the lactose in cow milk. It is reported that the lactose content in camel milk is relatively constant throughout lactation.

Mineral salts and vitamins

Milk mineral salts are mainly chlorides, phosphates and citrates of sodium, calcium and magnesium. Although salts comprise less than 1% of the milk they influence its rates of coagulation and other functional properties. The mineral content of camel milk expressed in ash ranges from 0.6 to 0.8%. Little information is known about the mineral content of camel milk. Data available however, indicate that camel milk is rich in chloride, and phosphorous, and low in calcium.

Vitamin C content in camel milk is twice as high as in cow milk, while A and B complex vitamins are comparable with levels in the milk of other domestic animals.

Plate 2.3.1: A milking camel with good udder conformation (Pakistan). (Debbie Atkins)

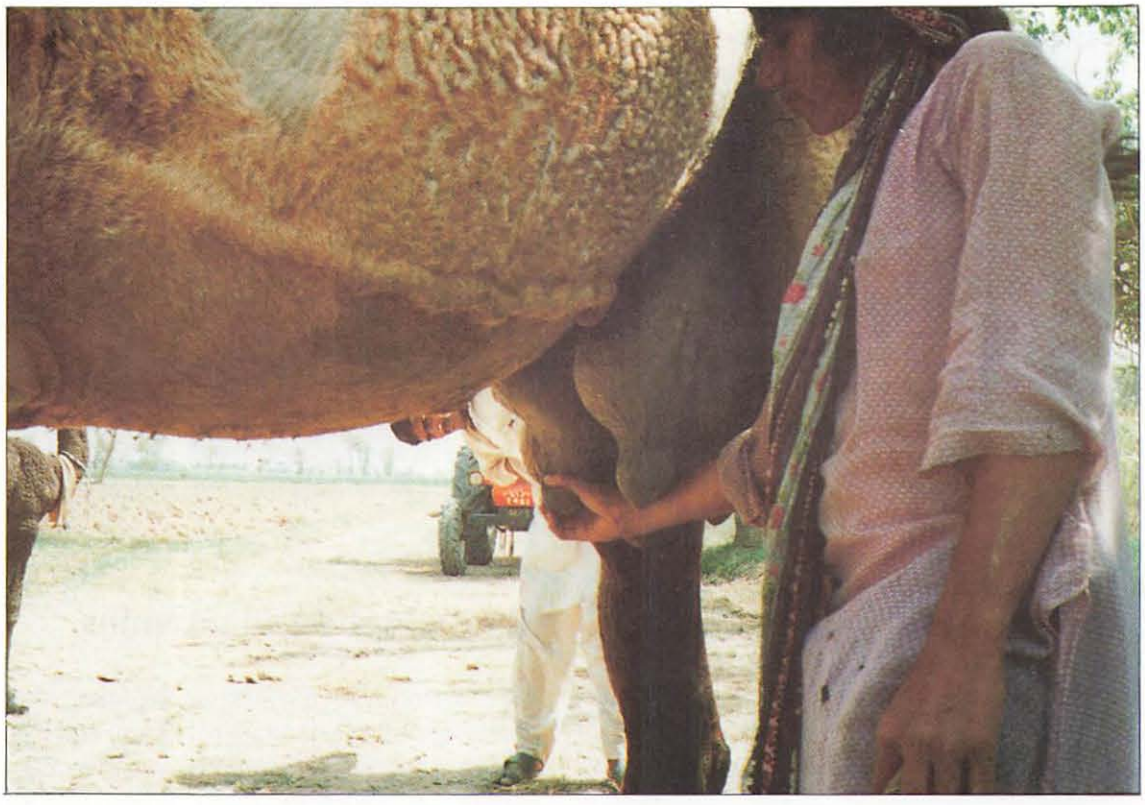
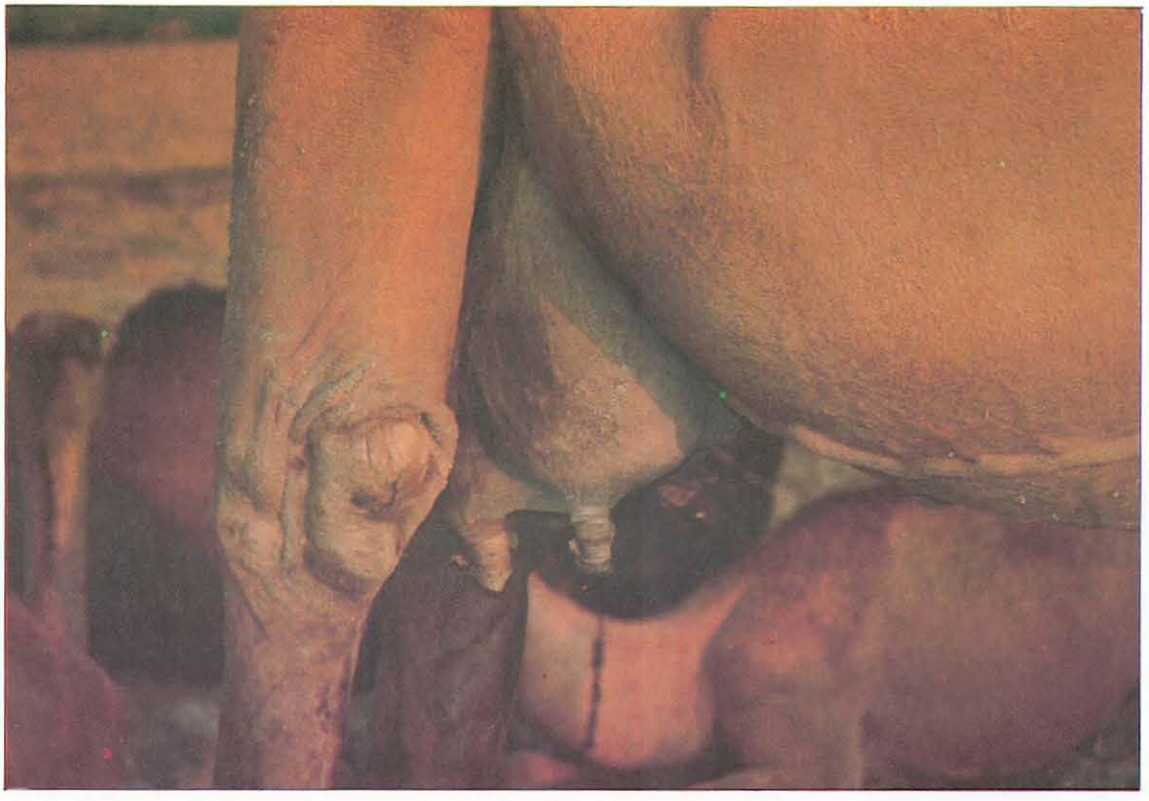


Plate 2.3.2: Two teats may be tied with bark or string to prevent suckling. (Debbie Atkins)



CHAPTER 2.4

Camel milking methods in Kenya

by S P Simpkin

Introduction

The preceeding article by Farah on camel milk provides a comprehensive background to camel milk production. This paper is intended to look at the subject in more detail with special emphasis on the situation in Kenya.

Milk is probably the most important camel product for most camel owners in Kenya. There is however considerable variation in the manner in which camel owners manage their milch animals, leading to differences in production.

It should be noted that the duration of lactation is of equal importance to the pastoralist as the actual mean daily yield. This is because all the other livestock have relatively short lactations, and in the long dry season it is often only camels that are able to produce milk.

Many of the reports in the literature comment on the high milk yields obtained from camels and compare them to yields from other livestock. A survey of the literature provides mean daily yields from as low as 0.1 litres per day in north Africa (Nicolaisen 1963), up to 35 litres per day in Pakistan (Knoess 1979). This considerable range in actual mean yields for camels can be put down to many factors, but one of the major reasons is that many of the reported yields are only based on short-term observations and are estimates rather than accurately and routinely collated milk records.

Camel milk yields in Kenya

Table 2.4.1 below summarises documented and published milk yields for camels in Kenya. These yields are at the lower end of the range quoted in the literature. The reasons for this are as follows:-

1. Camels in Kenya are kept in the marginal areas and receive no feed supplement.
2. Management levels are primitive.
3. There is little or no disease control.
4. Camels have been kept for subsistence rather than commercial purposes, hence there has

Table 2.4.1: Camel milk yields in Kenya

LOCATION	TRIBE/MANAGEMENT	MEAN DAILY YIELD (LITRES)	MAXIMUM DAILY YIELD (LITRES)	TOTAL LACTATION YIELD (LITRES)	DURATION OF LACTATION (MONTHS)	SOURCE
North	Not stated	4	12		12	Hartley 1979
North	Not stated	2.2		1897	11-16	Field 1979a
Marsabit	Not stated	2.7-4		1019-1975	13	Field 1979b
Marsabit	Gabra		10		10-24	Bremaud 1969
Mandera	Somali		9		10-24	Bremaud 1969
Wajir	Somali		9		10-24	Bremaud 1969
Marsabit	Rendille	2.6			20	Sato 1976
Marsabit	Gabra		11			Torry 1973
Marsabit	Rendille	4.5		1660	12	Spencer 1973
North	Boran	4	12		18	Dahl & Hjort 1976
Marsabit	Rendille Treatment	2.84		1146	13.1	Simpkin 1985
Marsabit	Rendille Traditional	2.37		687	9.4	Simpkin 1985
Laikipia	Ol Maisor Ranch	2.83		1033	12	Simpkin 1985
Tana River	Galana Ranch	5.33		1945	12	Simpkin 1985

been little quality control. Quantity rather than quality of animal was important.

Milking management

Table 2.4.2. summarises the different management techniques adopted by the different camel keeping peoples in Kenya. It only includes the factors that may have an effect on milk yields.

Factors affecting yields

The variables that affect milk production are the same for all ruminants, but some of the effects are more obvious in camels due to the more extreme conditions and management methods that they have to endure.

The major factors that affect camel milk yields include:-

- Forage - Quantity and quality
- Watering frequency
- Climate
- Breed
- Parity
- Milking frequency
- Calf survival and presence of the calf
- Milking method - hand or machine milking
- Speed of milking
- Health status
- Reproductive status

Since this paper is intended to concentrate on the different milking management methods, some of the other factors are only discussed briefly despite the fact that they may have a more noticeable effect on yields than the actual milking methods adopted by the different pastoral groups.

Many of the factors are interdependant; for example climate affects both forage availability and quality, water availability, and indirectly the reproductive status.

Forage

Both the quantity and quality of forage are important. The majority of camels in Kenya are managed in a nomadic or semi-nomadic manner, in order to make optimum use of the available forage. There are however, still periods when forage is in short supply and milk yields decrease. There appear to be two peaks in the lactation curve - the first is very marked and occurs in the first few weeks of lactation; the second corresponds to the following wet season when forage is again plentiful.

It is interesting that even on ranches where the forage is often more plentiful than in the northern grazing lands, camel herds are still rotated around the ranch to make more even use of the vegetation - a small scale equivalent to nomadism.

A feeding trial where lactating camels received a fodder supplement of poor quality millet and sorghum, showed that there was no statistically significant increase in milk yield (Atkins 1987).

Table 2.4.2: Milking management techniques in Kenya

MANAGEMENT VARIABLE	SOMALI	GABRA	RENDILLE	SAMBURU	TURKANA	POKOT	RANCH
Management system	nomadic	nomadic	nomadic	semi-nomadic/ sedentary	nomadic	sedentary/ semi-nomadic	rotational
Watering frequency	7 days	7-10 days	10-14 days	2-7 days	free access	free access	free access
Milking frequency	2-4	2	2	2-4	2-4	2-4	2
Calf access	free	restricted	restricted	restricted	restricted	restricted	free
Number of teats milked	2	2	4	4	4	2	2
Who milks	men	men	boys/men	men/women	women	men/boys	men/women
Number of hands used to milk	2	2	2	1	1	1	varies

The camels' anatomical and physiological adaptations to the arid environment enable it to fill a feeding niche that would make supplementary feeding or zero grazing economically viable in only a few situations. It would only be worth implementing in the more arid areas, using high producing animals, in locations where supplementary fodder is locally available, and where there is a local market for the milk.

Watering frequency

During dry seasons in the arid rangelands, camels may be watered at intervals of up to two weeks. Water intake affects milk yields in most ruminants, although camels can suffer 7 days of dehydration without affecting milk yield (Yagil 1982). However 10 days, dehydration did significantly decrease milk yield in camels in Marsabit District (Simpkin 1985). Water deprivation over the long term may adversely affect yields, since dehydrated camels stop feeding and seek shade earlier in the day, thus limiting the food intake.

Climate

Climate, primarily rainfall and temperature, affects productivity in many ways - forage availability and quality; water availability and intake; ambient temperature and reproductive status.

Breed

It is widely recognised that the three different breeds of camel found in Kenya all have different milk-producing capabilities. The only documented results of studies to determine their relative productivities are from the feeding trials on Ol Maisor ranch (Atkins 1987) and are shown below.

Table 2.4.3: Mean weekly yield per camel during pre-trial and trial periods according to different camel types (Kg). (Atkins 1987)

	FEED GROUP		CONTROL GROUP	
Camel Type	Pre-trial	Trial	Pre-trial	Trial
Somali	10.4**	9.9**	6.6	6.3
Turkana	6.8	6.3	6.1	5.7
Cross-breed	5.8	5.5	5.6	6.0

** - significant at P = 0.01.

Somali breed camels had significantly higher weekly yields than other breeds in the feed group.

The Somali pastoralists recognise different milk-producing capabilities in camels of the Somali breed. (see Breeds, this manual)

As in other livestock there are also considerable differences in milking potential between individuals.

Parity

There has been no research on how parity affects milk yields in camels; it is likely that the same trends that occur in other ruminants also apply to camels.

Milking frequency

The size and anatomy of the camel udder limits milk secretion rates. Unlike the cow there are no large storage cisterns or sinuses in the camel udder. This is likely to lead to a build-up in intramammary pressure and slow down the secretion rate. Frequency of milking or suckling is therefore likely to have a considerable effect on milk production. Shalash (1984) and Evans and Powys (1984) have shown that increasing milking frequency increases milk yields.

Table 2.4.2 shows that some tribes allow the calf free access to suckle, whilst others severely restrict suckling to morning and evening only. Some of the tribes that restrict calf access do, as a result, milk the camel more often, whereas others only milk the camel the usual two times per day. The effects of these different milking regimes on milk production are presently being investigated in order to determine which method proves the most suitable to ensure sufficient milk offtake for human consumption whilst not jeopardising the survival chances of the calf.

Calf survival and presence of the calf

The importance of the presence of the calf on milk letdown is well understood by camel owners, and in most circumstances the calves are always present to initiate milk letdown before the camels are milked.

Camels whose calves survived past weaning had mean daily yields 65% higher than camels whose calves died before weaning. Mean lactational yields were 2.9 times higher.

These considerable differences are no doubt due to increased suckling frequency in camels with surviving calves, and the action of suckling releases the hormones responsible for milk ejection which may also have an effect on milk secretion.

Pastoralists go to considerable effort to foster orphan calves on to productive females, and to force the mothering instinct in difficult camels that may otherwise reject their calves.(see Plate 2.4.1 & 2.4.2)

Milking method — hand or machine milking

All camels in Kenya are milked by hand. Machine milking of camels in Russia obtained higher yields in a shorter milking time than hand milking (Musaev 1982).

Skill and speed of milking

The experience of the milker has an important effect on yields. In the absence of the calf the strength of the milk letdown reflex depends on the skill of the milker, and if only poor milk letdown is achieved the amount of milk obtained at milking will be reduced. If the udder is not emptied completely it can have a negative effect on secretion rates.

Speed of milking increases milk output. Atkins (1987) suggests that camels may withold milk if not milked-out rapidly.

In Table 2.4.2, the tribes that allowed calves to suckle two teats whilst the herder milks two teats are likely to achieve better letdown, a higher degree of milking out, and proportionally a higher yield of milk than tribes who allow the calf to initiate milk letdown but then restrain the calf from suckling and milk all four teats by hand.

Similarly the tribes that balance the milking bowl on their leg and milk using both hands are likely to achieve a better milking rate than those who hold the bowl in one hand and milk with the other hand. (see Plates 2.4.3 — 2.4.6)

Health status

Camels suffer from a number of diseases, all of which affect production. In Kenya trypanosomiasis, internal helminths, external parasites (ticks and mange mites) are some of the most common conditions or diseases that affect production. The effects can be direct, such as mortality (both adult and calf), morbidity and general unthriftiness; or indirect, such as abortion and loss of feeding opportunities etc.

A study carried out in Marsabit District comparing the milk production from traditionally managed camels with a herd receiving routine veterinary input showed that veterinary input significantly increased mean daily yield by 463 ml, and total lactational yield by 66.7% (Simpkin 1985).

A cost benefit analysis proved that the use of veterinary drugs was economic in its effect of increasing milk production, meat production and calf survival.

Reproductive status

Field (1979b) records that lactation declines after a successful mating occurs and ceases about 6 weeks later. He also noted that in dry years when the breeding pattern is interrupted and camels do not become pregnant, the lactation can continue for up to two years.

Plate 2.4.1: Fostering — the skin of a calf that has died, is put over a live calf, and the mother of the dead calf may then accept the live calf. (Debbie Atkins)

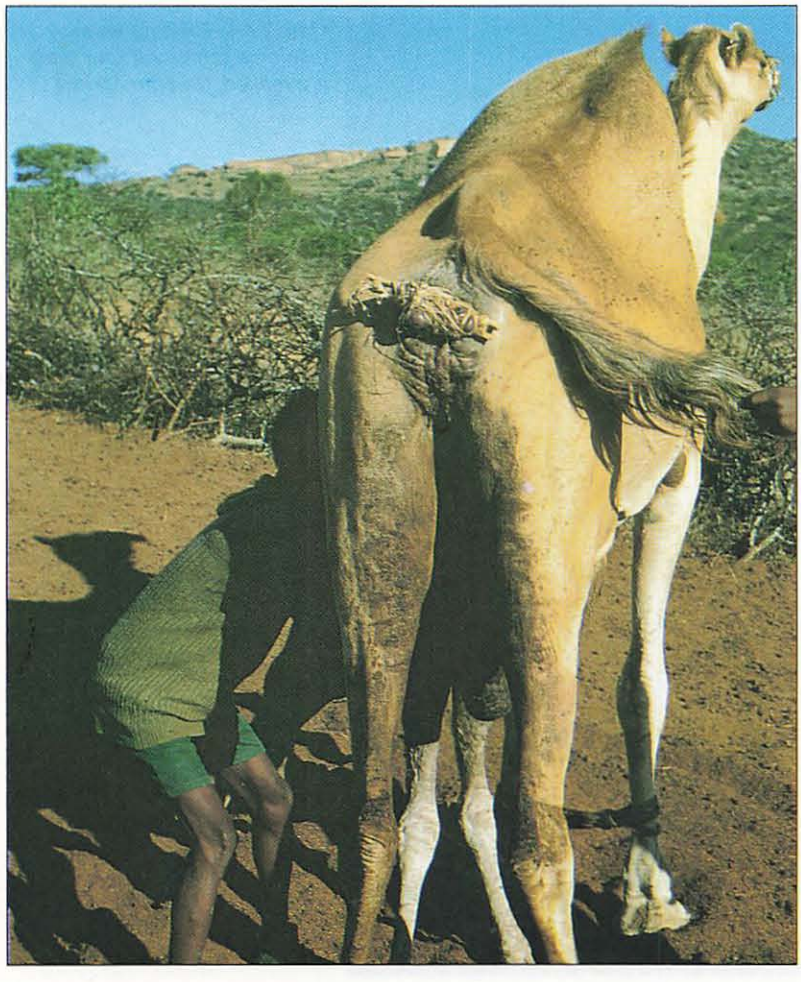
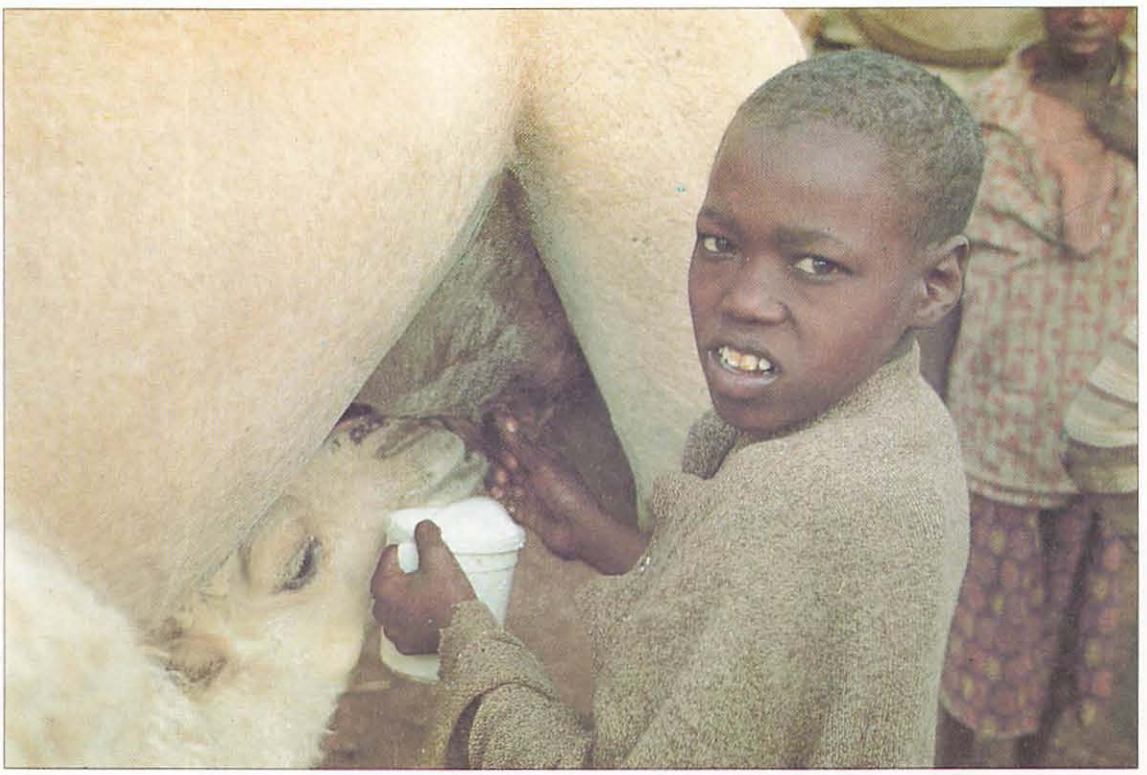


Plate 2.4.2: The anus is closed by the use of two sticks tightly bound together. After several hours the pain is so great that the camel accepts the new calf. (Debbie Atkins)

Plate 2.4.3: The presence of the calf suckling greatly increases the milk letdown reflex, and subsequently milk yield. (Debbie Atkins)



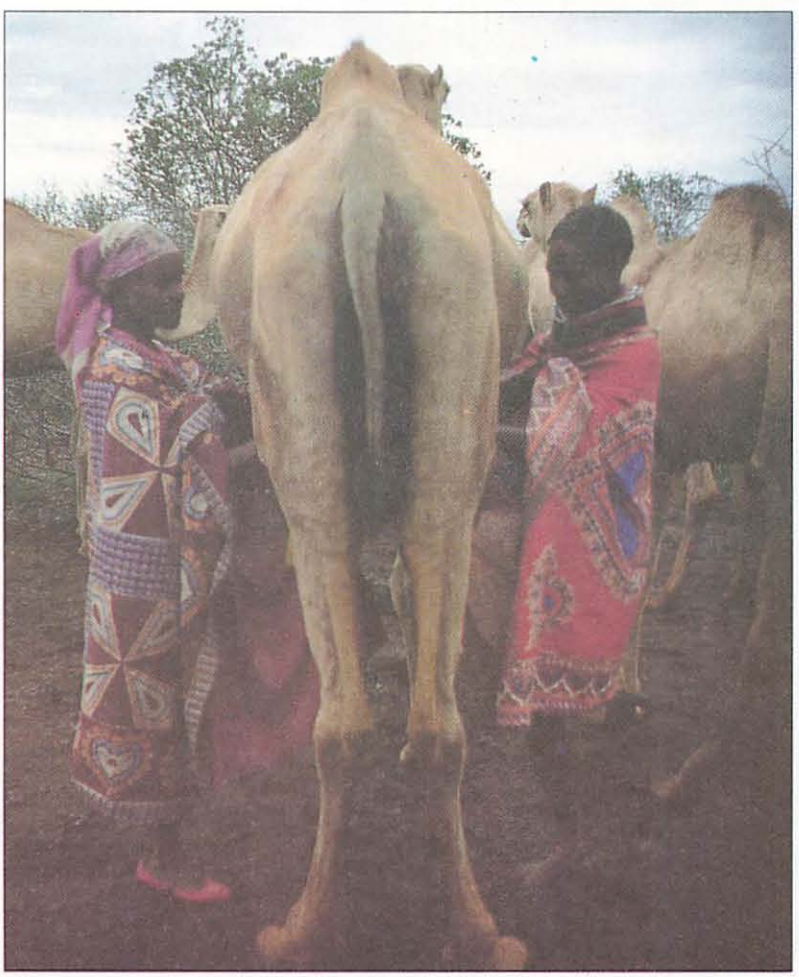
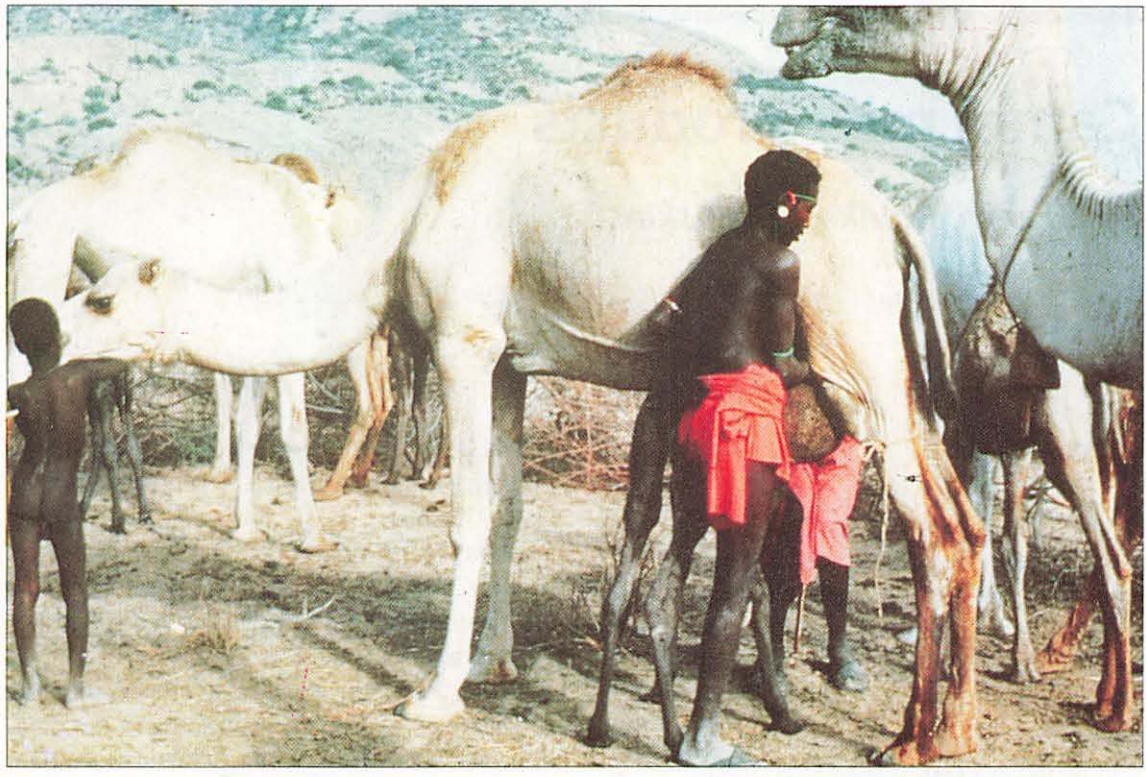


Plate 2.4.4: Turkana women milking a camel. All four teats are milked. (Debbie Atkins)

Plate 2.4.5: In Rendille society only young boys or ritually cleansed men milk the camels. The calf initiates letdown but then all four teats are milked. (Piers Simpkin)



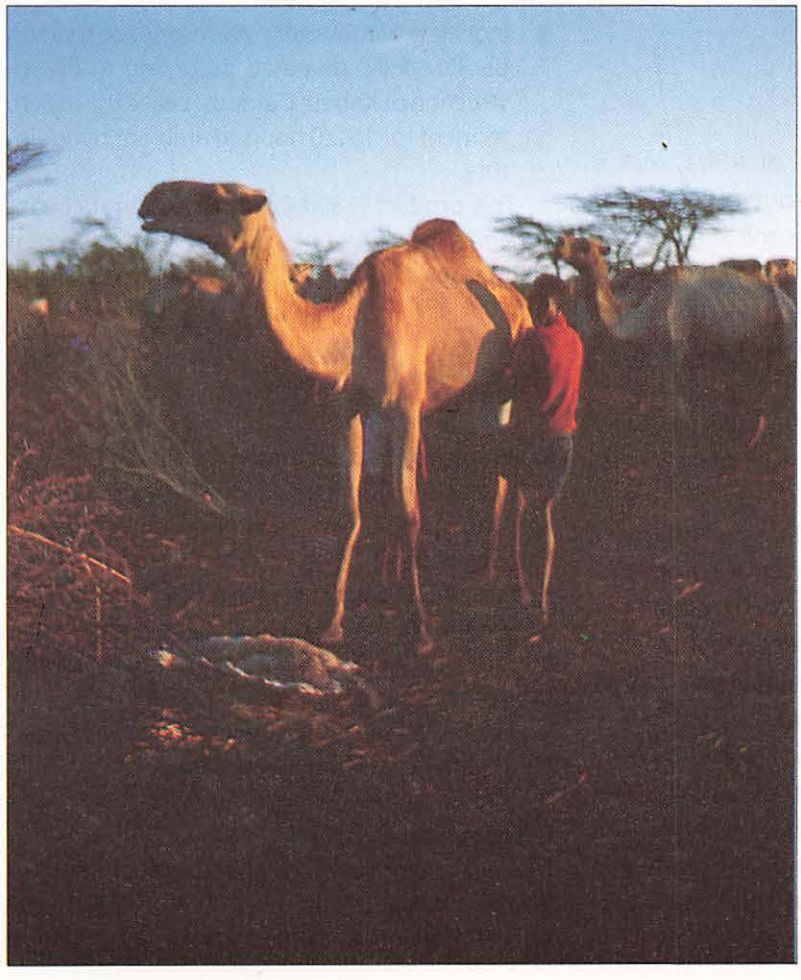


Plate 2.4.6: Somali herdsmen only milk two teats whilst the calf suckles the other two teats. Note the bowl balanced on one knee, leaving both hands free to milk. (Debbie Atkins)

CHAPTER 2.5

Camel milk products

by Z Farah, M Vikas, D J Atkins

Introduction

In the traditional pastoral communities camel milk is consumed either fresh or sour. The manufacture of butter, ghee and cheese from camel milk is still not well developed and accepted. In the following report methods are given which allow small-scale manufacture of fermented milk, butter and cheese from camel milk. These methods were developed and tested in Kenya during field studies.

Fermented milk

In the animal-rearing societies of Africa, milk is traditionally consumed in the form of fermented milk. The milk is left to stand for one to three days until it becomes sour. Because of the high ambient temperature and high contamination rates, acidification proceeds spontaneously and products with varying sour taste result. Fermented milk products produced in this way in Kenya are called 'Maziwa lala' or 'Mala' in the case of cow milk, and 'Susa' for camel milk.

Due to the spontaneous nature of the fermentation, this traditional method results in a product with varying taste and flavour and is often of poor hygienic quality. In addition, because of the limited scale of production the product can be sold only in the immediate vicinity of the herd.

The fermented milk described here is made by controlled fermentation using commercially available starter culture. The culture is the same used for Mala production in Kenya and can be obtained from the Department of Food Technology and Nutrition at the University Campus, Kabete.

PROCEDURE:

1. Place the churn of milk in an oil drum filled with water.
2. Heat on an open fire until the milk attains 85°C and maintain that temperature for 30 minutes; or heat to boiling, and hold for 5 to 10 minutes.
3. Cool the milk in a water bath (river, irrigation channel, water basin) to ambient temperature (18 to 25°C). This may take between 30 minutes and one hour.
4. Inoculate with starter culture (one soup spoon per litre milk) prepared according to the instruction of Kabete Campus. Leave the milk to ferment for 15-20 hours at ambient temperature.

This product is suitable for sale in retail containers as well as for open delivery and can be kept without refrigeration for at least one week.

Butter

Principle of butter manufacture

Processes for butter making are based on two working steps, cream separation and churning. The objective of using cream for butter making instead of churning the whole milk directly, is to reduce the volume of the milk to be churned and to obtain milk rich in butter fat which requires a shorter time for churning.

Cream can be obtained either by gravity separation or by centrifugal separation.

Gravity separation

This can be done by allowing the milk to stand for several hours in a setting can. The fat rises to the surface forming a layer of cream because it is

lighter that the other liquid and solid constituents of the milk. This natural creaming however cannot be used for camel milk.

Centrifugal preparation

The separation of cream from milk in the centrifugal separator is based on the fact that when liquids of different specific gravity revolve around the same centre at the same distance with the same velocity, a greater centrifugal force is exerted on the heavier liquid than on the lighter one. Milk consists of two liquids of different specific gravity: the fat and milk serum.

Manufacture of camel butter

The presented method is developed and tested in rural areas in North Eastern Kenya. The equipment used is a hand centrifuge of an average hourly capacity of 100 litres and a hand churn, both manufactured in Kenya.

PROCEDURE:

1. Heat the milk to 60°C and separate the cream with the hand centrifuge.
2. Put the cream in a vessel and allow to cool in a water bath to 22-25°C.
3. Put the cream in a churn slowly. The amount of cream to be churned should not exceed one half the volumetric capacity of the churn.
4. Churn the cream till butter grains as large as small wheat grains are obtained.
5. Drain the butter milk off and wash the butter several times with water. Each washing is done by adding only as much water as it is needed to float the butter, then turning the churn a few times and draining the water off.
6. Continue the washing till the water comes away clear.
7. Spread the butter on butter worker or tub or keeler, which has been soaked previously with water.
8. Salt the butter at a rate of 16 g salt per 1 kg. The salt should be dry and evenly ground.
9. Roll the butter several times until it seems dry and solid.
10. Pack the butter in a clean container.

Cheese manufacture

Reports on the possibility of obtaining cheese from camel milk are scarce and often contradictory. Some authors report the existence of rennet coagulated cheese made from camel milk while others categorically state that cheese cannot be made from camel milk. From our own investigation we can conclude that both calf and camel rennet react with camel milk. The coagulum obtained from camel milk is a precipitate in form of flocks and it is difficult to get a clot with firm coagulum. Depending on the experimental condition, the coagulation time can be the same as in cow milk or sometimes even longer. As in cow milk the coagulation time in camel milk can be reduced with decreasing pH, with increasing temperature and with added calcium. The following procedure for making cheese from camel milk has been developed on Ol Maisor Farm in Rumuruti (Kenya) and gave a cheese with good consistence and keeping quality.

PROCEDURE: *(Manufacture of a semi-hard cheese)*

1. Filter milk through a sieve.
2. Heat milk to 65°C and keep the temperature for 30 minutes.
3. Cool milk to 35°C.
4. Add culture, e.g. Mala.
5. Add citric acid until milk reaches pH 5.6 to 5.7 (about 0.25g/l milk).
6. Add rennet according to the manufacturer's direction, while stirring the milk.
7. Hold the milk at 35°C until the curd sets (about 40 min.).
8. Check for setting of the curd by applying pressure to the edge of the milk, where it comes in contact with the vat using a spatula or a knife. If the curd is set, it comes away clean from the wall of the vat.
9. Cut the curd into small pieces (maize corn size).
10. Stir carefully and heat the vat to 45°C in 20 to 30 minutes.
11. Drain the whey and scoop out the curd into a hoop lined with cheese cloths.
12. Press the curd.
13. Turn the curd three times during the first hour, each time changing cheese cloth.
14. Press the curd overnight.
15. Put the fresh cheese into brine solution (10% cooking salt) for 2 hours.
16. Put the fresh cheese in a ripening room (18°C and 95% relative humidity) and brush the cheese with a brine solution twice a day for two weeks, then once a day until consumption.

Ghee or clarified butter

Ghee may be made by boiling butter gently, skimming off the solids that rise to the surface. When the fat is clear, carefully pour it off into a container, leaving any residue in the boiling pan.

Alternatively ghee may be made without the time-consuming effort of making butter by boiling the cream. This produces more skimmed residues, but the butter fat comes away just the same.

Those qualified to judge say that camel ghee has a slightly different flavour to cow ghee. The melting point of camel fat is approx. 42°C whereas cow fat melts at approx. 28°C.

Condensed milk

A very useful way to preserve camel milk is to evaporate it with sugar:-

Mix 4 parts of milk to 1 part sugar and boil it gently until it reduces to 2 parts. (Milk and white sugar have equivalent weight and volume and so may either be measured in a container by volume or weighed on a scale).

Milk has approximately 4.5% lactose, therefore x 4 = 18%. Add 50% sucrose (sugar) gives the final product 68% sugars, which makes a very good preservative.

Stored in sterilised containers, filled to the top to exclude air, it should keep for a year without refrigeration.

The lactose may crystallise after a time, which gives the condensed milk a gritty feel if eaten, but of course the crystals melt when used in tea. It has an excellent flavour.

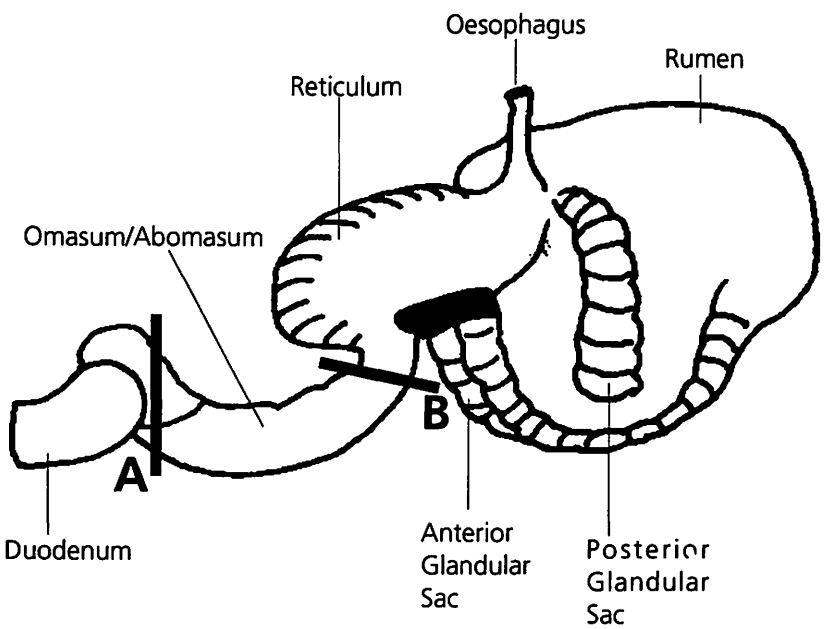
A note on how to obtain natural rennet

Rennet is the coagulant used in cheese-making to curd the milk.

Young ruminants require the milk that they drink to be converted into curd so that they may digest it. This is achieved by enzymes in the omasum. Rennet for cheese-making is acquired by using the omasum of calves before they have eaten any solid food.

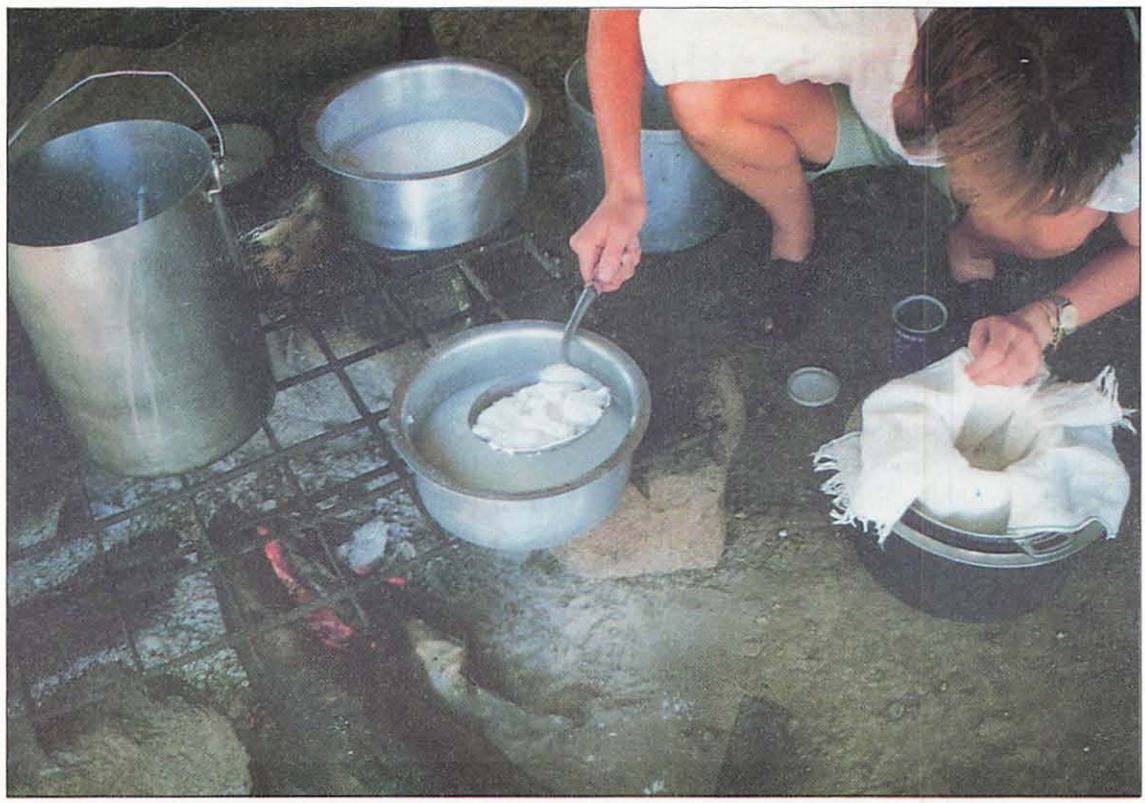
Remove the omasum. Turn it inside out. Rub off any curds or mucus with the fingers - do NOT use water. Salt it all over with fine salt. Turn it back the right way round and salt it all over. Tie one end tightly and blow it up like a balloon and tie it off tightly. Hang it up to dry. The contained enzymes will remain active for a long time and small pieces cut from it may be ground up and used for curdling milk for cheese-making.

Figure 2.5.1: Position of abomasum for collection of rennet.



Cut at A and B

Plate 2.5.1: Camel cheese making, illustrating separation of curds and whey using simple equipment. (Zacharia Farrah)



CHAPTER 2.6

History of leather production

by A G Combos

Prehistoric man developed primitive methods of treating hides and skins so that they could be used for clothing. Although at first the raw hides were merely dried and preserved by smoking, the tanning effects of various plants were later discovered. There is evidence to suggest that the technology for dyeing leather has been available for several thousand years. From these early beginnings there developed, with the advance of civilisation and science, a craft and later an industry. Although cattle hides and goat and sheep skins are the most common raw materials for tanning, camel hide is also an important raw material for leather industry. Camel hide is available in Africa and Asia. In Asia, the raw hides are preserved by dry salting, which, properly done, produces a stable finished product. In Africa, camel hides are preserved by air- drying; the resulting product is not as satisfactory as dry salted hides.

The common defects found on camel hides prior to slaughter include brand marks, thorn scratches, injuries from goads, parasitic fungus infections and acid burns caused by dung and urine. Defects which are caused after slaughter include cuts on the hide due to poor flaying, and rotting of the hide as a result of bad preservation or subsequent water damage. All these defects reduce the value of hide.

An average raw camel hide weighs 18-20 kgs. To convert a raw hide into finished leather the following process should be adopted.

1. Soaking
2. Unhairing/Liming
3. Fleshing
4. Deliming/Bating
5. Pickling/Tanning
6. Sam/Setting
7. Splitting
8. Shaving
9. Dyeing/Fatliquoring
10. Sam/Setting
11. Drying
12. Condition/Staking
13. Buffing
14. Finishing

Camel hide is thicker than cow hide and can be split into three or four layers. The upper (hair side) can be used for shoe, bag and furniture leather. The splits can be used for shoe uppers.

Note by J O Evans

In Pakistan they commend camel skin suede for the uppers of their shoes and slippers, but say that it is not good for soles as it becomes stiff after becoming wet.

The Turkana people say that ropes made from camel skin become brittle on drying after becoming wet, unless well oiled. They use camel skin to make very useful and artistic containers, particularly for storing fat.

CHAPTER 2.7

Felt using camel wool

by L Bromell

Introduction

Felt has been made in Asia and Europe for several thousand years (Burkett 1979). It is still an essential article of clothing, tentage, and decoration in many parts of the world. It can be made by anyone using sheep, camel and goat wool since it needs no spinning or weaving equipment.

In eastern Africa adult camels do not have suitable wool for felting, but camel calves often have a fine soft wool. This is usually rather short for use alone, but the findings at Ol Maisor, Rumuruti, by Lucy Bromell were as follows:-

- Camel calf wool alone did not bind well, being too short.
- Mixed with Merino wool, camel calf wool made a very fine soft felt suitable for clothing.
- Mixed with Angora mohair, it made a strong felt suitable for blankets and rugs.
- With kempy Dorper-type wool the soft luxuriant nature of the camel wool was lost and wasted, but produced a hard wearing course felt.
- Felt can be made to any required thickness. It does not fray or unravel. During the making, it can be moulded into shapes such as hats, slippers or cloaks, and stitching is not required.

Method

The wool is carded to straighten out fibres and to obtain an even thickness of material. This is laid out in lines to cover the required area or shape. For a flat piece, lay it out on a clean floor, mat, sacking or plastic mosquito gauze. Lay another layer on top at right angles to the first. Repeat until the right thickness is achieved.

Patterns can be made by using different coloured wools.

Wet the whole with water, hot water being much the best. Sprinkle it all with soap or detergent powder. Pat it all over until it begins to bind, then rub it in all directions, gently at first with the hands, a smooth stone, or board. The material will firm up quite quickly. Then roll it up tightly with the sacking or gauze and tie the bundle. Roll it backwards and forwards with pressure applied, for a short while.

Undo the bundle and roll it up again at right angles. Repeat until the felt is firm. Smack it flat and trim.

Hard felt for hats is pressed on a mould. Slippers can be moulded on your feet.

SECTION 3

CAMEL NUTRITION

CHAPTER 3.1

Camel nutrition

by Dr C R Field

Summarised from a paper presented to the Kenya Veterinary Association meeting, Meru, February 25th 1993.

Introduction

The one-humped camel or dromedary (*Camelus dromedarius, Linnaeus*) is arguably the most remarkable domestic animal since it enables man to survive in areas of extreme aridity and heat. Desert areas have low human densities and are little known and rarely visited.This explains why the camel has hitherto been neglected. More attention is now being paid to the camel as man intensifies his use of the earth's resources.

The nutrition and breeding behaviour of the camel are fundamental to production of milk, meat, hides and hair. As the camel expands its range in Kenya (it is now found in Kajiado and Narok districts) it befits us to know more about these basic functions.

Nutrition

Food habits

The camel lives in rangelands where plants struggle to survive potential evapo-transpiration rates in excess of 2,000 mm per year. In consequence plants have adopted one or more of the following strategies.

(i) Annuals, which rapidly flower, produce seed and die.
(ii) Deciduous woody perennials
(iii) Evergreen woody perennials with thick cuticular layers to reduce evaporation.
(iv) Succulents

Many of the plants are armed for protection against browsers. The camel is a facultative browser preferring leafy dwarf shrubs if available. Extensive observations of camel feeding habits have been made in north and west Africa (Gauthier-Pilters and Dagg 1981) and in Kenya by Field (1979a, 1984a) and more recently by the FARM-Africa range team (unpublished).

Over much of the more arid camel range in Kenya the preferred food plant is the dwarf leguminous shrub called *Indigofera spinosa* (**Emekwi** - Turkana; **Ilkitagesi** - Samburu; **Khoro** - Rendille; and **Korati Gala** - Boran/Gabbra). It is semi-deciduous and during drought there is a tendency for camels to concentrate on more evergreen shrubs and trees such as *Maerua crassifolia,* the halophytes *Salvadora persica* and *Sueda monoica*. The latter are partly chosen for their high mineral content which camels require. During drought camels may also eat certain *Euphorbia* species and even grow fat on them.

Food availability is important and in areas where dwarf shrubs are absent such as the extensive volcanic fields of Marsabit District, one can find camels concentrating on annual grasses which form swards of good quality hay.

The proportion of some key food plants in camel diets in northern Kenya is shown below (see Table 3.1.1 Plate 3.1.1)

Feed preferences

Actual food preferences of camels have been determined by comparing the composition of the diet with that of food on offer in the range. The preference index so calculated ranges from -1 to +1 depending on whether it is avoided or actively selected. This is illustrated in Table 3.1.2. (Masibho, unpublished)

Table 3.1.1: Key food plants in camel diets in selected parts of northern Kenya (% of diet)

SPECIES	TYPE	FEEDING AREA 1	2	3	4	5	6	7	8	9	10
Acacia brevispica	Deciduous tree	-	8	-	-	29	-	-	-	-	-
A.mellifera	Deciduous tree	-	-	18	-	1	-	-	-	-	-
A.nilotica	Deciduous tree	23	-	-	-	12	-	-	-	-	-
Balanites glabra	Evergreen tree	-	-	16	-	-	-	-	-	-	-
Grewia similis	Deciduous shrub	7	17	-	-	-	-	7	-	-	-
Barleria proxima	Dwarf shrub	18	31	43	-	7	-	5	-	-	-
B.argential acanthoides	Dwarf shrub	-	-	-	-	-	-	13	18	6	54
Duosperma eremophilum	Dwarf shrub	-	-	-	-	-	58	5	27	14	1
Heliotropium albohispidum	Dwarf shrub	-	-	-	-	-	-	12	-	-	-
Indigofera cliffordiana	Dwarf shrub	-	-	-	32	3	-	-	-	2	-
I.spinosa	Dwarf shrub	-	-	-	16	2	27	17	35	31	3
Annual grasses		-	-	-	-	-	-	--	-	-	32
Total %		48	56	77	48	54	85	59	80	53	90

KEY FEEDING AREAS

1. Kiloriti,	Kisima	Samburu District	6. Tuum,	Nyiro	Samburu District
2. Sora Adoru,	Lodokejek	Samburu District	7. Andere,	S.Horr	Samburu District
3. Leraite,	Parsaloi	Samburu District	8. Kete,	Gus	Marsabit District
4. Suiyan,	Parsaloi	Samburu District	9. Lelenchumeni,	Kulal	Marsabit District
5. Embukoi,	Marti	Samburu District	10.Chariasie,	Gus	Marsabit District

Table 3.1.2: Camel preference indices for some selected range plants

SPECIES	PLANT TYPE	29.10.91 PREFERENCE INDEX	29.10.91 % IN DIET	26.11.91 PREFERENCE INDEX	26.11.91 % IN DIET
Acacia reficiens	Deciduous tree	-1	0	-1	0
Acacia mellifera	Deciduous tree	-1	0	-1	0
Boswellia hildebrantii	Deciduous tree	+1	1	N.P.	N.P.
Grewia tenax	Deciduous tree	+1	3	+0.4	12
Cordia sinensis	Evergreen tree	N.P.	N.P	+0.6	10
Barleria argentia	Dwarf shrub	0.7	3	0	0.2
Heliotropium albohispidum	Dwarf shrub	+0.6	19	0	0.4
Indigofera spinosa	Dwarf shrub	+0.2	64	+0.3	12

N.P. = Not Present

The above shows that during both observations the two *Acacia* species were present in the range, but not eaten. By contrast the other tree species (*Boswellia, Cordia,* and *Grewia*) were selected when they were available. Among the dwarf shrubs *Heliotropium* and *Indigofera* were preferred when available while *Barleria* was eaten less than expected from its availability. Clearly camels exercise distinct preferences for food.

Camels do not however, always show nutritional wisdom. They appear unable to detect that the fruits and flowers of *Capparis tormentosa* are poisonous and they sometimes die. Early in the rains they may suffer from bloat after eating *Indigofera cliffordiana* or *Blepharis linariifolia* in excess.

Quality of the diet

Monthly feeding observations over three years coupled with chemical analyses of key food plants has enabled the reconstitution of diets taking into account the proportions of the key plant species ingested and their chemical composition. During the three year study there was no measurable rain for 20 months which included two periods of five months each. Nevertheless the protein content of the diet only once fell below 10%. Peaks of protein intake coincided with two monthly running totals of rainfall and were between 15 and 21%. When compared with other livestock, camel protein intake was consistently higher than that of sheep and cattle (the latter only once exceeded 10% protein intake) and on two thirds of the occasions higher than that of goats grazing in the same area.

A feeding trial at Ol Maisor ranch in Kenya failed to show significant improvements with feed

supplement owing to the fact that its quality was no better than the range food on offer. (Atkins, unpublished).

Food and water intake

Comparative studies between camels and other livestock show that the camel has a lower food and water intake when expressed in relation to the weight of the animal. (Table 3.1.3).

Table 3.1.3: Food and water intake of different livestock species

SPECIES	DRY MATTER FOOD INTAKE AS % OF LIVEWEIGHT	DAILY DRINKING WATER INTAKE IN ML PER KG.
Camel	1.3 - 2.2	3.4 - 25.2
Goat	1.8 - 3.4	24.7 - 76.0
Sheep	2.1 - 3.2	
Cow	2.6 - 3.1	71.0

The higher figures for food intake refer to immature and young camels and the lower figures to adults. The higher figures for water intake refer to dry seasons and the lower figures to wet seasons.

Reasons for the observed differences in food intake for camels and other livestock may relate to their lower metabolic rate and their more nutritious diet. Slower metabolism is also a factor in minimising water intake, but the camel has many more mechanisms for conserving water than other livestock to the extent that it does not need to drink when forage is green and requires only one third of intake needed by other species. This enables the camel to reach good quality ungrazed pasture 40 km or more from water between watering sessions and thus confers a tremendous advantage on this species.

Ingestion

When foraging, camels move in loose herds, selecting small quantities of browse as they pass. Thus they are more concentrate feeders rather than bulk feeders like cattle. A camel's mobile, split upper-lip enables it to remove leaves from stems and pick up *Acacia* pods from the ground. Although it may eat some thorns it avoids the larger ones which only the giraffe and elephant can handle.

The teeth of the camel are normally 34, the most characteristic features are the presence of incisors in the upper jaw and canine teeth in both jaws, a deviation from the ruminant type which the camel shares with the llama (Leese 1927). The dental formulae are:-

	DECIDUOUS TEETH				PERMANENT TEETH				
	incisor	canine	pre-molar		incisor	canine	pre-molar	molar	
Upper	2	2	6		2	2	6	6	
Lower	6	2	4	= 22	6	2	4	6	= 34

Although bearing incisors in the upper jaw their function is rudimentary and vegetation is broken off by grasping with the lower incisors against the hard dental pad of the upper jaw.

The camel ruminates, chewing the cud mostly at night between its premolars and molars.

Digestion

The salivary glands of the camel are similar to those of cattle and sheep (Kay and Maloiy, 1988a), but although there are some analogies in stomach morphology between camels and other ruminants the functions of the compartments differ. A camel's stomach has only three distinct chambers with no clear division between the omasum and abomasum (Wilson, 1988a). There are glandular sac-like areas of the rumen which appear to hold water and assist in digestion and absorption. The stomach can hold up to one third of the total body fluids and acts as a dynamic reservoir (Kay and Maloiy, 1988).

Fermentation is by bacteria and protozoa in the first compartment. Studies show that camels digest cellulose better than other ruminants (Jouany and Kayouli, 1988). Most of the water is reabsorbed in the intestine and the faeces are dry pellets.

The camel may recycle nitrogen as urea. The kidney is very efficient and the urine highly concentrated.

Conclusion

Although the camel has many similarities to true ruminants with respect to its nutrition it also has many differences. These confer on it a greater ability to survive on poor quality desert pastures. The forage is utilised for both maintenance and reproduction and its milk makes it invaluable for pastoral nomads. Seasonal variations in food intake and quality exist and have an effect on reproduction.

Successful breeding programmes should take into account nutritional requirements, especially if higher-yielding breeds are introduced.

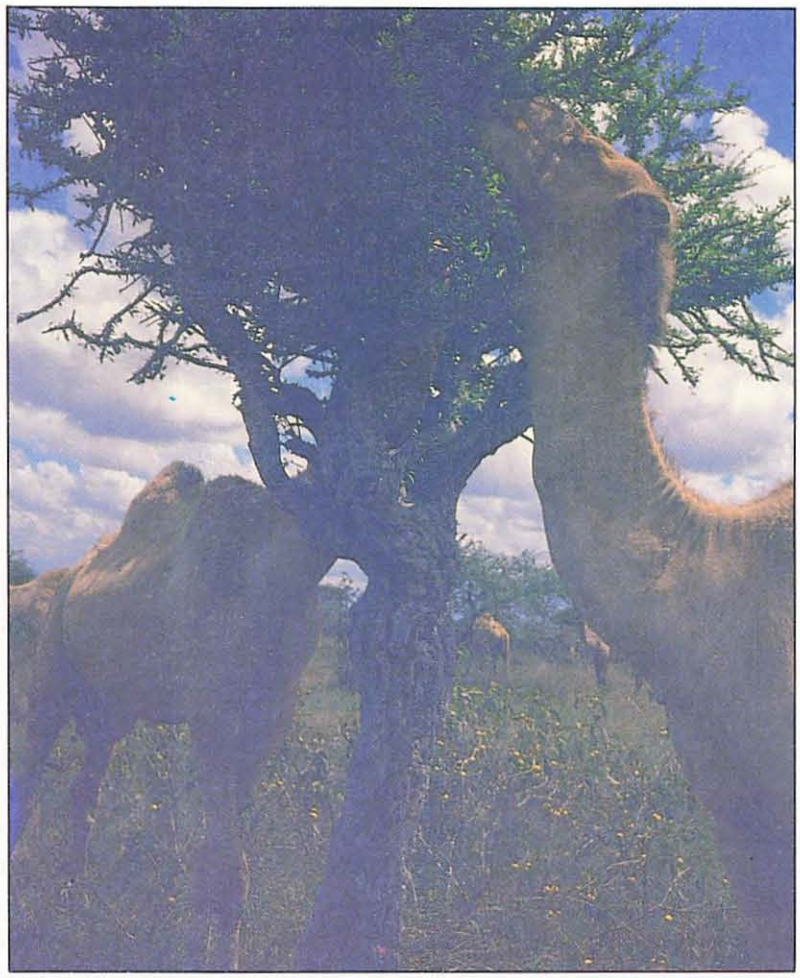
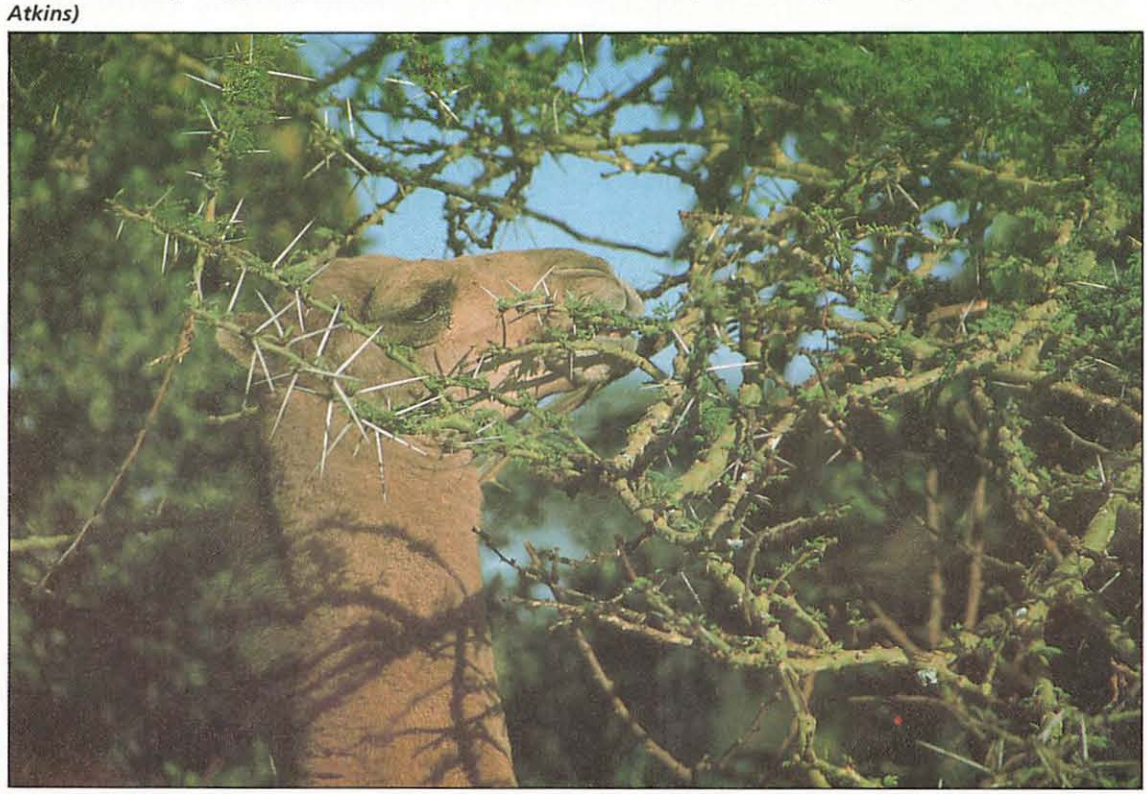


Plate 3.1.1: The camel is predominantly a browser. (Chris Field)

Plate 3.1.2: The split upper-lip enables camels to feed on leaves and pods avoiding the larger thorns. (Debbie Atkins)



CHAPTER 3.2

Feeding camels

by J O Evans

In some circumstances when camel browse is insufficient or not available it may be necessary to feed them from external sources. Camels are extraordinarily versatile in what they can use, but it must be remembered that they have to be induced to accept that to which they are not accustomed.

Leitch (1940) suggests that camels fed entirely on dry rations frequently suffer from Vitamin A deficiency. Note that lack of phosphorous may also induce vitamin A deficiency even if green feed is available (Tilman pers com.).

Salt deficiency predisposes camels to some diseases. Leitch quotes Peck (1938) as recommending not less than 5 oz of salt per day.

Nearly all cut green feed such as maize, millet, sorghum, legumes, grass and loppings from trees and branches are excellent fodder.

Dry stover, straw, hay, legume stalks, pods, dried leaves of bushes and trees are eaten but need supplementing.

Grains, beans and grams are usually the main supplementary feeds. These should be gristed before feeding.

Oilseeds and oilseed cakes are valuable feed.

Dates and crushed date stones are used as additives. Jagari or goor (brown sugar) are used, mixed up with other ingredients, as tonics. Molasses mixed with other feed is nutritious.

Camels also eat other seemingly strange things. Wilfred Thesiger (1957) says 'many of them (the camels) were being hand fed with sardines, and the penetrating stench of the half dried fish hung around our camp for days until the last sardine had been eaten'. Rathore (1985) writes 'and a very few lucky ones are also fed meat pickles prepared of jackal's or fox's flesh in winter and attain excellent condition and their hump becomes fat and big'. Atkins and Evans have fed "biltong" (dried strips of meat) and dried mince meat to camels with apparent good results. Dagg (in Gauthier-Pilters and Dagg 1981) says 'camels like other ruminants, are not necessarily entirely vegetarian. Gauthier-Pilters often saw camels eating charcoal, bones or even mummified young gazelles, heads and all.

Some ration formulas from Leese (1927) are as follows:-

1. For Baggagers, Somaliland conditions
   Millet 7.5 lbs
   Hay 25 lbs
   Gur 1 lbs
   Salt 1.5 oz
2. Baggagers with several hours grazing
   Gram 4 lbs
   Parched barley 2 lbs
3. Working Somali camels
   Gram 4 lbs
   Hay 20 lbs
   Salt 1.5 oz
4. Working baggagers
   Barley meal dough 7 lbs
   Chopped straw 40 - 50 lbs
   Salt 1.5 oz
5. Riding camels hard worked
   Crunched beans 6 - 8 lbs
   Millet 4 lbs
   Gram 4 lbs
   Hay 12 lbs
6. Resting camels
   Oats and other grain 2 - 3 lbs
   Good hay 20 - 30 lbs
   Salt 1.5 oz
7. Riding camels with grazing
   Matama (Sorghum) 4 lbs
   Mahindi (maize) 2 lbs
   SimSim oilcake 2 lbs
   Salt 1.5 oz

CHAPTER 3.3

Water requirements

by J O Evans

Introduction

Camels, like all other animals, must have water. However, they are incredibly tolerant of long periods of deprivation. Schmidt-Nielsen (1964) poses the question of whether a camel drinks for future need or to replenish past expenditure. He states explicitly that a camel drinks to make up its deficit. Steele (1890) describes camel men drenching their camels before a journey and says that most of the water was wasted.

It is a myth that camels store water in their humps or in pouches in their stomachs.

Water conservation methods

Camels have remarkable mechanisms for conserving water. The urine can carry away excess salts in very high concentration nearly twice that of sea water, thereby wasting very little water. They are able to re-cycle almost 100% of urea, unlike other domestic ruminants who pass out much urea in the urine. Yagil (1985) states that the urea has two most important functions:

1. "The re-absorbed urea passes into all body cells, taking water with it. The passage of urea into the alimentary tract of ruminants carries water with it. Re-cycling of urea begins in the salivary glands but the most important site is in the stomachs".
2. "The urea reaching the rumen, be it for the need for water or protein, is utilised for microbial protein synthesis". Urea stimulates the cellulose digesting organisms in the rumen, whose action produces nutrients available to the animal from indigestible material.

The dung of camels may be extremely dry, containing only 1/5 of the moisture of that of cow dung.

Yagil is also quoted as stating that moisture in the exhaled breath is re-absorbed within the nasal passages.

Sweating is retarded until the body temperature reaches 40.5°C (approx. 34°C to 40°C). A camel's hair stands slightly away from the body allowing air circulation so that when sweating takes place the evaporation and cooling is next to the skin and so cools the body. At the same time the hair provides some protection from the environment. In other animals with thick close hair, sweat evaporation takes place from the hair itself so is less efficient at cooling the body. More sweat, more water. (Schmidt-Nielsen, 1964).

It is noticed that in hot weather urination is often down the back legs. The evaporation must have a cooling effect. This may look a mess, but is regarded as a healthy sign by camel-men. In cold weather the hind legs are splayed apart during urination and so are not made wet.

Because of a camel's ability to excrete high concentration of salts they are able to drink water noxious to humans or other domestic stock.

Camels have the ability to drink an amazing quantity of water in a very short time: 25%, or more, of their body weight in a few minutes. A proportional amount drunk by humans or other livestock would be lethal. Camels achieve this by rapid absorption of water into the bloodstream, which is quickly distributed throughout the body. Yagil states "The camel's red blood cells are exceptional in every respect when compared to the red cells of other mammals". "Four hours after rapid rehydration the red cell area increased to 41μ. The changes in shape and area that occurred after drinking can only be due to water entering the cells" (Yagil, 1985). When very dehydrated, camels should, if possible, be allowed to

"top up" with water an hour or two after their initial first drink.

Watering intervals

The question is always asked "How long can a camel go without water?". There is no simple answer. With other livestock one might confidently say at most 3 or 4 days without serious consequences. With camels there are many factors involved:-

1. The camel itself, if used to frequent drinking, needs to become accustomed to longer periods without water.
2. The succulence and availability of the feed.
3. The air temperature.
4. The amount of hard exertion required of the camel.

However, camel-men say that as long as a camel continues to feed it will not die of thirst. This is hard on the camel if it does not have a chance to feed properly!

We have seen camels from the Dida Galgalla, in very dry conditions, watering at Koroli springs only once every two weeks. A Rendille herd, in a drought, travelled for 15 days to get water but found the river dry and had to go another 15 days to reach water but did not lose an animal.

Somalis say that when the browse is green after the rain they go to water every 20 days, otherwise every 10 to 11 days. Thesiger (1990) states (referring to Sudan) "Since the Kababish, when on the "jizu" require no water - the milk from their herds sufficing them, and the succulent green herbage satisfying the camels - they could remain throughout the winter wherever there was "jizu"." Gauthier-Pilters & Dagg (1981) reported that during the six or seven cool months in the Sahara region camels do not drink even if water is offered to them. However, it must be assumed that in these latter instances the camels have all day, and perhaps all night as well, to feed and are not doing hard work.

Conclusion

Working and lactating camels in good condition with adequate feed and time in which to browse should be watered every six days, preferably on a rest day. More frequent watering may be advantageous so long as the camels are not being deprived of feed by being taken to water.

CHAPTER 3.4

Techniques of mineral research for ruminants

by L R McDowell, J G Conrad, A L Ellis and J K Loosli

Editors note
Since time immemorial camel owners have recognised the need for salt for their camels. They expend enormous effort in periodically taking their animals to saline deposits or saline water, or transporting salt to their animals, often at great risk during troubled times. However, the need for the more obscure mineral elements is little understood and even less practised. Many of these requirements could be comparatively easily and cheaply supplied to the enormous advantage of all livestock and their owners in terms of growth, fertility and general health. But different areas have different requirements. There is urgent need to put into practice what is already known (much perhaps recorded in dusty obscure places) and for further research into those areas that are not known.

Recommended reading:-
"Minerals for Grazing Ruminants in Tropical Regions" by L. R. McDowell, J.H. Conrad, G.L. Ellis, J. K. Loosli, University of Florida, Gainsville, Florida, USA.
"Feeds and Feeding" by B. Morrison, Morrison Publishing Co, Ithaca, New York
"Notes on Animal Diseases, XXII - Deficiency Diseases" by J.R.Hudson (E.A. Ag Journal Vol. 10 July 1944)

The following article is taken from a lecture by L. R. McDowell, J.H. Conrad and A. L. Ellis from the Department of Animal Science at the University of Florida, presented during an FSSP/ILCA Seminar (24-27 June 85, Addis Ababa) entitled "Livestock in the system of mixed exploitation - methods of research and priorities".

Introduction

Deficiencies or mineral imbalances are often responsible for poor performance and fertility problems in domestic ruminants in tropical zones.

Animals fed on pastures very deficient in phosphorus, cobalt or copper suffer more from the absence of these trace elements than from energy or proteins.

Research carried out in tropical zones has shown that mineral supplements can raise total births from 20 to more than 100 per cent, speed of growth from 10 to 25 per cent and significantly reduce mortality (McDowell and Conrad 1977).

Fifteen elements are essential for ruminants:
macro-elements: Ca, P, K, Na, Cl, Mg and S (7)
trace elements: Fe, I, Zn, Cu, Mn, Co, Mo, Mn, and Se (8)

In certain regions, toxic concentration of Cu, Fe and Mo can limit production of ruminants.

The role of supplementary toxic elements (arsenic, lead, cadmium, mercury or aluminium) for ruminants as well as the possible role for new essential elements (chrome, vanadium, nickel, tin, silicon, arsenic) is also reported.

The practical importance of 'new' trace elements for ruminants has not yet been found. The essential evidence is only based on their effects on the growth of animals receiving rations which are strongly deficient. The discussion emphasises the effect of mineral excess or deficiency for herbivores, a well as methods of diagnosis including the use of radioisotopes.

Factors influencing mineral needs

Numerous factors intervene on the level of mineral needs, in particular the type and level of production, the age of the animals, the level and chemical presentation of the elements, interactions with other foods, mineral ration and the animal species and its hardiness.

A sufficient consumption of fodder for ruminants is indispensable to cover the animals' mineral needs. Factors which reduce the level of

ingestion of dry matter, like a very low protein value or a high amount of lignin, diminish the value of the mineral content.

As tropical fodder crops contain less minerals during the dry season, one could think that the animal lacked most minerals in this period. However, numerous reports from Kenya (Hudson, 1944), Brazil (Correa, 1957) and South Africa (Van Niekerk, 1979) indicate that mineral deficiencies appear more often during the wet season. Ruminants tend to show P and Ca deficiencies more severely after the rains when the pastures are green and abundant.

Van Niekerk (1979) notes that a P supplement is essential during the rainy season whereas the amount of P in plants is maximum. The reason for the rise in mineral deficiencies during the rainy season is less connected with the mineral concentration of fodder crops than with the raised level of the animal's mineral needs at this time. The rapid weight gain from the time when energy protein needs are covered, causes an important mineral demand whereas during the dry season the low energy and protein level of the food causes a loss of weight and very low mineral needs.

Mineral sources for grazing animals

Usually, ruminants in tropical regions do not receive mineral supplements other than salt, therefore they depend on the pastures for their mineral needs.

It is rare that these fodder crops can cover all their needs. Out of 2615 South American samples, McDowell et al (1979) state the number of deficiencies as 43 per cent of the samples in Co, 47 per cent in Cu, 35 per cent in Mg, 73 per cent in P, 60 per cent in Na, and 75 per cent in Zn.

Animals often consume a considerable amount of earth but mineral amounts in soils are extremely variable.

In New Zealand, Healy (1978), reports that the annual consumption of soil can reach 75 kg for sheep and 600 kg for milk animals.

Factors influencing the amount of minerals in plants

The amount of minerals in plants depends on the interactions of numerous factors including the soil, species of vegetation, phenological stage, yield, method of exploitation and the climate. Most mineral deficiencies observed in ruminants are connected with a given region and its soil characteristics.

Yellow basic soils are richer in trace elements than old acid soils. Wet soils tend to have more trace elements. When the pH of a soil goes up, the availability of Fe, Mn, Zn, Cu and Co goes down whereas the concentrations of Mo and Se go up (Pfander, 1971).

Malnutrition of the plant causes a lowering in the amount of minerals by dilution and migration of the elements towards the root system.

The raising of fodder yields often causes a depletion of soil mineral reserve, which explains the deficiencies often observed on the most intensive farms.

Very heavy use of nitrate fertiliser and potash raises the level of grass tetany considerably by reducing the amount of Na in the fodder.

Mineral deficiencies or excesses in tropical regions

An exhaustive study of tropical countries reveals that P is the element most often insufficient for ruminants followed by Cu and Co. Deficiencies in Na and I are as widespread as those in Cu and Co, but in most cases, the deficiency in Co and Cu is much more harmful to the animal than that in Na or I.

Toxicity in Se and Fe is often found together in the whole tropical zone.

Diagnoses of mineral deficiencies

The expression of mineral deficiencies is very variable, going from extreme cases presenting irrefutable clinical signs, to transient drops in performance which are difficult to diagnose. The latter case is certainly the most important as it affects a large number of animals over vast regions and can be confused with an energy or protein deficiency or a parasitic infection (Underwood, 1981).

Different techniques have been used (clinical examinations, pathological and biochemical, analyses of soil, water and animal tissue) with more or

less success in evaluating mineral deficiencies or excesses.

The most reliable method of diagnosing a mineral deficiency is still the response to a supplement of a specific mineral. But apart from the fact that these studies are long and costly, "it is not always possible to obtain a satisfactory result". It is therefore necessary to turn to biological and chemical analyses.

Analyses of minerals in soil can sometimes provide interesting information, but generally they remain very difficult to interpret. Finds in Brazil (Conrad et al, 1980), Bolivia (McDowell et al, 1982) and the United States (Florida) (Kiatoko et al, 1980) show that correlations of amounts of minerals in soil, plants and animals are extremely variable according to regions and often very weak or non-existent. The most significant fodder-soil correlations recorded in Brazil are for Fe ($r = 0$-0.12), Mn ($r = 0.12$) and Zn ($r = 0.30$) (Conrad et al, 1980)

Difficulties in evaluating mineral rations consumed by ruminants are as follows:

1. The sample is not necessarily representative of what the animal consumes.
2. Estimation of the quantity of food ingested is difficult.
3. There is variation in the availability of the fodder's mineral elements.
4. The possibility of sample contamination by the soil is considerable.

In spite of this, fodder analysis remains preferable to soil analysis. The analysis of animal tissue, mineral level, secretions associated with the study of the concentration of "particular" enzymes of certain metabolites and organic composition are excellent indicators of an animal's mineral status.

Blood, serum or plasma are widely used for this type of study. Amounts below or above the 'normal' level indicate a deficiency or excess of the element being considered.

However, precautions must be taken in the interpretation of blood analysis; factors influencing mineral content of plasma or serum are not always easy to evaluate in Latin America (McDowell et al, 1983) and Africa (Mtimuni, 1982). These factors are stress, physical activity, temperature, time of haemolysis and separation of serum (Fick et al, 1979). The amount of P in the bones seems to be a much more reliable method than the amount in the serum.

In Africa, an increase of 21 per cent in the productivity of cows was obtained due to a supplement of P even though the level of P in the plasma was normal.

As these analyses are costly and sophisticated, it is more convenient to choose a minimum of vegetable and animal tissues which are most representative of mineral feeding.

A mapping technique for determining mineral deficiencies and excesses

At present, the University of Florida in co-operation with Latin American, African and South East Asian centres, is leading research into mineral feeding of animals by systematic prospecting including bromatological analysis, analysis of animal tissue and analysis of the response to mineral supplements. These techniques have been widely used in Colombia (Laredo, 1981), Costa Rica (Vargas et al, 1980) and Venezuela (Velasquez, 1979).

The current practice is to locate 2 or 3 regions where livestock productivity is low. In each region 2 to 4 farms are taken and on each farm 2 classes of animals are studied (pregnant or lactating females and growing animals). For these animals, biopsies of the liver and bones are carried out as well as samples of blood and faeces. Soil and plant samples complete the analysis.

Often samples are taken twice a year on the same farm to take account of the season.

For the rest of the country, samples are taken at the abattoir but the farm and region of the animal are visited. In order to quantify the mineral deficiency or excess these analysis are indispensable.

The use of radioactive isotopes gives a very accurate analysis for the great majority of minerals and moreover is a non-coercive method. Table 3.4.1 gives the geographical locations of principal mineral deficiencies and excesses in ruminants in tropical countries of Latin America, Africa and Asia. E. African countries are in bold type.

In conclusion, the authors show the problems in formulating mineral complements, their method of distribution and the control of their efficiency. Finally, they draw our attention to the possible drawbacks which may exist from available commercial products.

As a low cost insurance to provide adequate mineral nutrition, "complete" mineral supplements should be available "free choice" to livestock (Cunha et al, 1964). A "complete" mineral mixture usually includes salt, a low F-Phosphate source, Ca, Co, Cu, I, Mn and Zn. Selenium, Mg, K, S, Fe or additional elements can be incorporated into a mineral supplement as new information suggests a need.

In the case of Mg, an oral supplement would only be of value during the seasonal occurrences of grass tetany.

Calcium, Cu or Se, when in excess, can be more detrimental to ruminant production than any benefit derived by providing a mineral supplement.

In regions where high forage Mo predominates, three to five times the Cu content in mineral mixtures is needed to counteract Mo toxicity. Thus, the exact level of Cu to use in counteracting Mo toxicity is a complex problem and should be worked out for each area.

A serious problem with "free choice" supplements is individual variation in mineral consumption. Research has shown that ruminants have no particular desire for minerals other than common salt. Palatability and appetite stimulators such as cottonseed meal, dried molasses, dried yeast culture and fat help achieve more uniform, herd-wide consumption. Some of these products not only give the supplement a dust-free, moist and

Table 3.4.1: Geographical distribution of mineral deficiencies or excesses for ruminants in the tropical countries of Latin American, Africa and Asia. (Adapted from: McDowell (1976); Fick (1978); McDowell et al (1983); Mtimuni (1982))

DEFICIENCIES	
CALCIUM:	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Salvador, Guatemala, Guyana, India, Malawi, Mexico, Panama, Peru, Philippines, Senegal, Surinam, **Uganda**, Venezuela, Zaire.
MAGNESIUM:	Argentina, Brazil, Chile, Colombia, Costa Rica, Guatemala, Guyana, Haiti, Honduras, Jamaica, **Kenya**, Malawi, Peru, Surinam, Trinidad, **Uganda**, South Africa, Uruguay, Venezuela.
PHOSPHORUS:	Antigua, Argentina, Bolivia, Botswana, Brazil, Ceylon, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Salvador, Egypt, Ghana, Guatemala, Guy ana, Haiti, Honduras, India, Indonesia, Jamaica, **Kenya**, Madagascar, Malawi, Malaysia, Mexico, Nicaragua, Nigeria, Panama, Paraguay, Peru, Philippines, Puerto Rico, Senegal, **Somalia**, South Africa, Surinam, Swaziland, Tanzania, Trinidad, **Uganda**, Uruguay, Venezuela, Zaire, Zimbabwe.
POTASSIUM:	Brazil, Haiti, Panama, Swaziland, **Uganda**, Venezuela.
SODIUM:	Bolivia, Brazil, Chad, Colombia, Dominican Republic, Guatemala, **Kenya**, Malawi, New Guinea, Nigeria, Panama, Philippines, Senegal, **Somalia**, South Africa, Surinam, Swaziland, Thailand, **Uganda**, Uruguay, Venezuela.
SULPHUR:	Brazil, Colombia, Ecuador, **Uganda**.
COBALT:	Argentina, Brazil, Colombia, Costa Rica, Cuba, Egypt, El Salvador, Guyana, Haiti, India,Indonesia, Katanga, **Kenya**, Malaysia, Mexico, Nicaragua, North Africa, Peru, Philippines, South Africa, Surinam, **Uganda**, Uruguay, Zaire.
COPPER (OR TOXICITY OF MOLYBDENUM):	Argentina, Bolivia, Brazil, Columbia, Costa Rica, Cuba Dominican Republic, Ecuador, El Salvador, **Ethiopia**, Guatemala, Guyana, Haiti, Honduras, India, Indonesia, **Kenya**, Malaysia, Malawi, Mexico, Panama, Peru, Philippines, Senegal, South Africa, Sudan, Surinam, Swaziland, **Tanzania**, Trinidad, Uruguay, Venezuela, Zaire, Zimbabwe.
IRON:	Brazil, Costa Rica, India, Panama.
MANGANESE:	Argentina, Brazil, Burma, Costa Rica, Panama, South Africa, **Uganda**.
SELENIUM:	Bahamas, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, Guyana, Honduras, Indonesia, Malawi, Mexico, Paraguay, Peru, South Africa, Swaziland, Thailand,**Uganda**, Uruguay, Venezuela.
ZINC:	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, Salvador, Guatemala, Guyana, India, Indonesia, **Kenya**, Malawi, Mexico, Panama, Peru, Philippines, Puerto Rico, South Africa, Sudan, Swaziland, **Uganda**, Uru guay, Venezuela.
TOXIC ELEMENTS	
FLUORIDE:	Algeria, Argentina, Ecuador, Guyana, India, Mexico, Morocco, Saudi Arabia, South Africa, **Tanzania**.
MANGANESE:	Brazil, Costa Rica, Indonesia, Peru, Surinam.
SELENIUM:	Argentina, Brazil, Central Africa, Chad, Chile, Colombia, Ecuador, Honduras, India, Iran, **Kenya**, Madagascar, Mexico, Nigeria, North Africa, Peru, Puerto Rico, South Africa, Sudan, Upper Volta, Venezuela.

free-flowing character but also provide energy and protein.

An acceptable cattle mineral supplement should have the following characteristics:

1. Final mixture containing a minimum of 6 - 8% total P. In areas where forages are consistently lower than 0.20%, mineral supplements in the 8 - 10% P range are preferred.

2. Ca: P ration, not substantially over 2:1.

3. Provide a significant proportion (i.e. 50%) of the trace mineral requirements of Co, Cu, I, Mn and Zn. In known trace mineral deficient regions, 100% of specific trace minerals should be provided.

4. Composed of high quality mineral salts that provide the biologically availabe forms of each mineral element. Avoidance or minimal inclusion of mineral salts containing toxic elements (i.e. phosphates containing high F concentrations).

5. Formulated to be sufficiently palatable to allow adequate consumption in relation to requirements.

6. Backed by a reputable manufacturer with quality control guarantees as to accuracy of mineral supplement label.

7. An acceptable particle size which will allow adequate mixing without smaller size particles settling out.

Table 3.4.2: Atomic weights of elements in common fertiliser materials

NAME	SYMBOL	ATOMIC WEIGHT
Aluminium	Al	26.97
Boron	B	10.82
Calcium	Ca	40.08
Carbon	C	12.01
Chlorine	Cl	35.457
Cobalt	Co	58.94
Copper	Cu	63.57
Fluorine	F	19.00
Hydrogen	H	1.008
Iodine	I	126.92
Iron	Fe	55.85
Magnesium	Mg	24.32
Manganese	Mn	54.93
Molybdenum	Mo	95.95
Nitrogen	N	14.008
Nickel	Ni	58.69
Oxygen	O	16.000
Phosphorus	P	30.98
Potassium	K	39.096
Sodium	Na	22.997
Sulphur	S	32.06
Zinc	Zn	65.38

Table 3.4.3: Percent of mineral element in some sources commonly used in mineral supplements and relative bioavailability

ELEMENT	SOURCE COMPOUND	% OF ELEMENT IN COMPOUND	BIOAVAILABILITY
Calcium	steamed bonemeal	29.0 (23-37)	high
	defluorinated rock phosphate	29.2 (19.9-35.7)	intermediate
	Calcium Carbonate	40.0	intermediate
	soft phosphate	18.9	low
	ground limestone	38.5	intermediate
	dolomitic limestone	22.3	intermediate
	monocalcium phosphate	16.2	high
	tricalcium phosphate	31.0 - 34.0	
	dicalcium phosphate	23.3	high
	hay sources		low
Cobalt	cobalt carbonate	46.0 - 55.0	critical tests
	cobalt sulphate	21.0	not done but
	cobalt chloride	24.7	compound effective
Copper	cupric sulphate	25.0	high
	cupric carbonate	53.0	intermediate
	cupric chloride	37.2	high
	cupric oxide	80.0	low
	cupric nitrate	33.9	intermediate
Iodine	calcium iodate	63.5	available
	EDDI	80.0	but unstable
	potassium iodide stabilised	69.0	high
	pentacalcium orthoperiodate		
Iron	iron oxide	46.0 - 60.0	unavailable
	ferrous sulphate	20.0 - 30.0	high
	ferrous carbonate	36.0 - 42.0	low
Magnesium	magnesium carbonate	21.0 - 28.0	high
	magnesium chloride	12.0	high
	magnesium oxide	54.0 - 60.0	high
	magnesium sulphate	9.8 - 17.0	
	potassium and magnesium sulphate	11.0	
Manganese	manganous sulphate	27.0	high
	manganous oxide	52.0 - 62.0	high
Phosphorus	defluorinated rock phosphate	13.3 (8.7 - 21.0)	intermediate
	calcium phosphate	18.6 - 21.0	high
	dicalcium phosphate	18.5	intermediate
	tricalcium phosphate	18.0	
	phosphoric acid*	23.0 - 25.0	high
	sodium phosphate	21.0 - 25.0	high
	potassium phosphate	22.8	
	soft phosphate	9.0	low
	steamed bonemeal	12.6 (8 - 18)	high
Potassium	potassium chloride	50.0	high
	potassium sulphate	41.0	high
	potassium and magnesium sulphate	18.0	high
Selenium	sodium selenate	40.0	high
	sodium selenite	45.6	high

continued over

ELEMENT	SOURCE COMPOUND	% OF ELEMENT IN COMPOUND	BIOAVAILABILITY
Sulphur	calcium sulphate (gypsum)	12.0 - 20.1	low
	potassium sulphate	28.0	high
	potassium and magnesium sulphate	22.0	high
	sodium sulphate	10.0	intermediate
	anhydrous sodium sulphate	22.0	
	sulphur, flowers of	96.0	low
Zinc	zinc carbonate	52.0	high
	zinc chloride	48.0	intermediate
	zinc sulphate	22.0 - 36.0	high
	zinc oxide	46.0 - 73.0	high

* To convert P_2O_5 to P, multiply x 0.4369

Plate 3.4.1: An old tyre used as a trough for feeding minerals and salt for camels. (Debbie Atkins)

SECTION 4

PURCHASE AND MANAGEMENT

CHAPTER 4.1

Examination and selection of camels for purchase

by S P Simpkin

Introduction

The following article on how to select and examine a camel when purchasing camels has been copied from an article written by P.B.E. Acland in ' Notes on the camel in the eastern Sudan ' published in 1932 in Sudan Notes Record 15, pp 123-125. Despite the fact that Acland was writing about buying riding and baggage camels in the Sudan, the principles and problems faced are the same as those for selecting and purchasing camels in Kenya.

Examination for purchase

"First look over the camel generally, as he is standing up, to see if he is of the right make and shape and in good condition. A camel in bad condition should not be bought unless the, cause is definitely known."

Note any marks of firing which on the legs and round the joints, should nearly always lead to immediate rejection.

A camel is often fired on the chest behind the point of the elbow for what the natives call **khasila**. This is generally some form of shoulder lameness. If the fire marks are simple dots and the camel is quite sound he need not be rejected; but if there are signs that he has been fired more than once, or if the marks are in the shape of crosses, it is safer not to buy him, as he will have been badly lame at some time or other. Fire marks on the front of the chest for **haddad** (a form of simple shoulder stiffness) are no defect in themselves.

Stand straight behind him and make him lie down - as he does so, watch to see that his hindquarters do not shiver and that he shows no great reluctance to go down in front. If he does not wish to put his boss on the ground, or if when sitting he leans over to one side, he probably has a wound or bruise in the boss.

When he is lying down age him (see Wilson this manual), and then examine his head and eyes. If the nostril is torn it may mean that he is a "runaway". Fire marks across the nose means that he has had difficulty in breathing, and it is better to reject him. The eyes should be bright and clear, and a white spot in either should lead to rejection. Place the finger before each eye to see if he is blind, but be careful neither to touch the eyelash nor to allow a shadow to come before the eye.

Then examine his withers, hump and back for bruises, sores and old wounds.

Firing over the withers should lead to rejection; scars of old wounds, provided the scar tissue is flat and can be worked loosely up and down with the surrounding skin, are not necessarily a great detraction. Always handle the withers and back, as wounds may be hidden by hair, artificial or natural. Old wounds, swellings or firemarks on the short ribs should generally lead to rejection. Once a wound has been caused here it will nearly always come up again: though, if the camel is to be used purely for riding and with a native saddle, this is not such a serious defect, as the back bid should not come down as far as the short rib.

Make the camel get up and note whether he does so with any effort. If you are not sure put two men on his back and then see whether he can get up easily.

Now examine him carefully from front to back and up and down each leg.

If you have not been able to notice while he was getting down or up, examine the soles of his feet which should not appear worn or definitely cracked.

Examine the pads on fore and hind legs and the boss for wounds or bruises.

Note whether there are signs of rubbing on the inside of the forearm from the boss and along the side of the chest from the elbow. Examine the hocks for signs of rubbing and for enlarged bony prominences on the inside. These defects should lead to rejection.

Examine the inside of the fetlocks, front and back, for signs of brushing. This may be caused by a stumble or too close hobbling, but if there are any signs, watch the camel carefully when he is moving.

Examine the armpit for loose pads or rolls of skin. Any considerable amount should lead to his rejection.

Take care that the sheath of the penis and testicles are not swollen or injured in any way.

When examining the camel do not get too close to his hind legs, as he can kick both forwards and sideways.

Next have the camel walked and trotted away, towards and past you. It is better that he should be ridden than led, as the man leading him will nearly always get in your line of vision.

The camel should have a long easy stride, whether walking or trotting; and his legs should move straight backwards and forwards. A camel who "dishes" or moves so close that either leg appears to cross the other should not be bought.

Note whether he goes close in front or behind and whether there is plenty of room between the boss and inside of the forearm. Any jerky action of the fore or hind limb should result in rejection.

Watch for any sign of lameness. Note whether he is smooth or rough. The owner will nearly always have watered him just before as it will make him appear to be in better condition and considerably smoother than when he is thirsty.

Finally, remember that the Arab is as clever as a horse-coper in concealing defects and in showing off his camel to the best advantage, that any defect which shows when the camel is in good condition will become much worse when he loses condition through work, and that if you have rejected a number of really inferior camels your eye may be put out, and you may purchase a very mediocre animal because it looks good in comparison to the others." (Acland 1932).

Notes on purchasing

Acland was primarily interested in purchasing camels for baggage purposes, the principles however, apply equally to all categories of camel. When purchasing breeding camels the following points are worth keeping in mind :

1. Check the temperament by handling the camel.
2. Generally the camels that are brought to the market place are for sale because they have some defect. In order to obtain the best stock one has to go out to the herds where they are grazing on the range and be prepared to bargain for animals that the owner may not have considered selling.
3. Most stockmen will not sell their best breeding stock, and therefor only bring their culls or poor stock to the recognised market-places.
4. Camel-buying requires a great deal of patience, and is a long, slow process. Buyers must have plenty of time and not be limited to a tight schedule. Try to advertise well in advance. Inform pastoralists as to what categories of camel you are interested in buying.
5. Try to authenticate that the camel you are buying actually belongs to the person selling it to you.

When buying females:-

(i) Check the udder, ensure that all four teats are present and, if lactating - in working order . Ask the owner to milk any lactating camels that are for sale.

(ii) Look at the size of the milk vein. A large vein often infers a good yield.

(iii) It is safer to purchase heifers, as they are unproven, and therefor the owner will not be selling them due to a defect. If buying older females ask how many calves it has given birth to, and how many are still alive, compare this with its dentition to give an insight into its past fertility and future potential for bearing calves.

(iv) Check for signs of pregnancy - lifting of the tail when approached.

(v) If the rest of the herd are in the proximity, ask to see the mother or other siblings of the camel that is for sale. Compare these with others in the herd.

When buying males:

(i) Breeding bulls are potent from eight years, and breed up to about twenty years old.

(ii) Ask to see offspring sired by the bull, or if it is a young bull, ask to see its sire.

Baggage or riding camels should be tested before being bought. If they are to be trained, it is best to buy young males of 3-4 years of age. It may be best to buy young castrates as this ensures that there will not be any losses due to death, or time lost during recuperation from injury caused at the time of castration.

CHAPTER 4.2

Restraining a camel

by J O Evans and D J Atkins

A small camel may be held by gripping the top and bottom lips with two hands, or the lower jaw and ear (one man).

Larger animals should have a head rope fitted (Figure 4.2.1) and be hobbled (Figure 4.2.2) by one front leg and the lips gripped (two men). Further restraint by pulling and twisting the tail (three men) sometimes may be necessary. If in a crush, the leg need not be hobbled and the tail should be bent vertically upwards from the base over the rump, like a jug handle, and pressed firmly forwards (Figure 4.2.3). This quietens the animal and is said to reduce pain (of, say, an injection) by squeezing the nerves.

To immobilise a standing animal temporarily, a rope from one back fetlock is passed over the withers in front of the hump and pulled from the opposite side until the foot rests against the belly (Figure 4.2.4).

For complete immobilisation, the animal should be sat down. Both front legs should be hobbled and the hobbles joined tightly across the top of the neck. A strong rope must be passed behind the hind heels (this is most easily achieved as the animal sits down). The rope is brought up inside the hocks and tied with an overhand knot above the rump and both ends led around the hump each side and tied tightly together around the

Figure 4.2.1: Fitting a head rope.

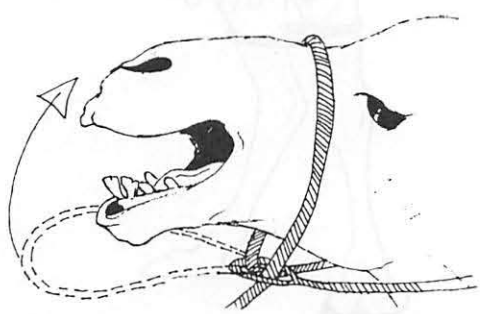


Figure 4.2.2: Hobbling the foreleg.

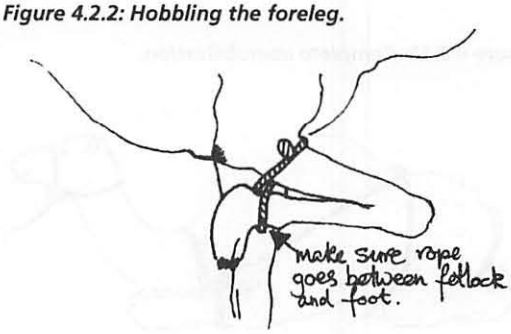


Figure 4.2.3: Bending the tail upwards is said to reduce pain, and quietens the animal.

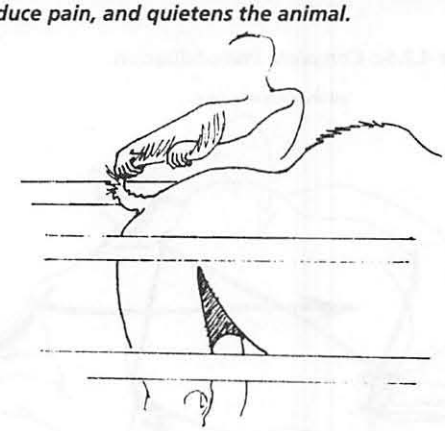


Figure 4.2.4: Rope over withers and foot is against belly.

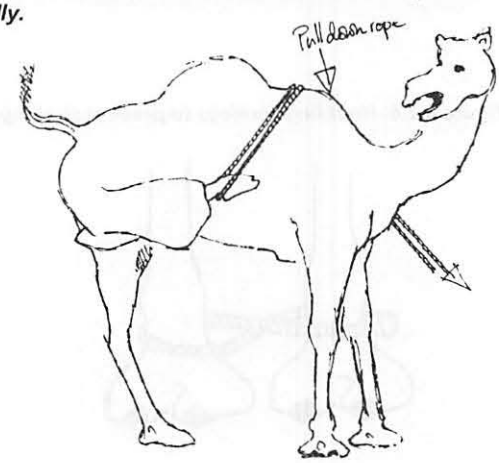


Figure 4.2.5a: Complete immobilisation.

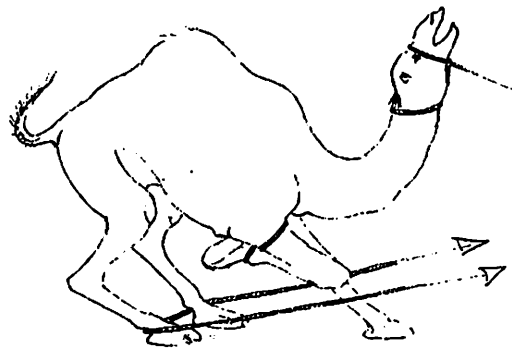


Figure 4.2.5b: Complete immobilisation.

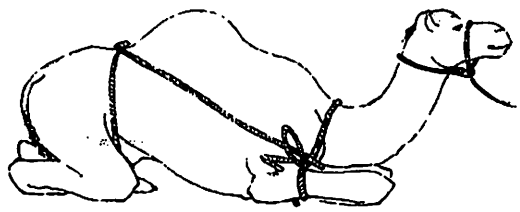


Figure 4.2.5c: Complete immobilisation.

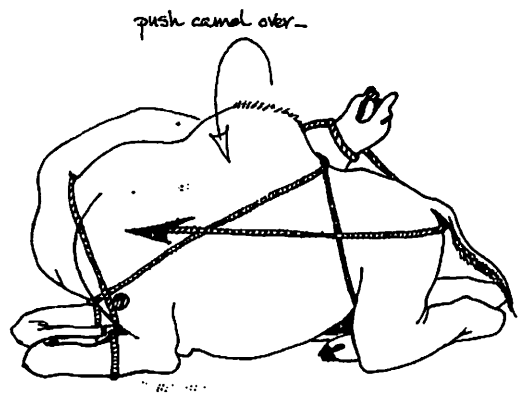
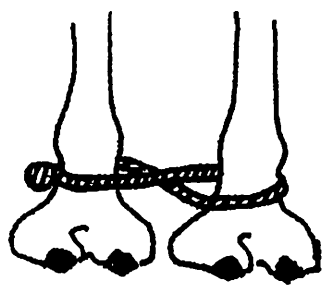


Figure 4.2.6: Hobbling forelegs to prevent straying.



front of the chest (Figure 4.2.5). If the animal is to be laid on its side the head should be pulled back behind the hump and the animal rolled over, head uppermost.

For hobbling overnight when no enclosure is available, both front legs should be hobbled and joined across the top of the neck. A camel can move a long way on its knees unless this is done.

To prevent a browsing animal from straying too far the two front legs may be hobbled together with rope or a strap, about 14" apart (Figure 4.2.6). Front and back legs may be hobbled together but this is less efficient and more difficult to fit. Bulls in rut are most likely to wander and may lead the other camels off, unless they are being closely herded. Should this happen in the desert and you are left without camels you may perish.

Camels that will not stand being milked may be restrained by a rope or strap binding the hind legs together above the hock, and also if necessary by hobbling up one front foot (Figure 4.2.7).

A crush for handling camels for dosing, inoculations, branding etc., is most convenient. It saves very much labour and saves both animals and men from a lot of stress. This should be 30" to 36" wide, 5' high and at least 16' long (to take two large camels). 'There should be a clear view from the holding pen through the crush to the outside to encourage the animals to pass through. If possible, take the camels every day to the crush while it is being built so that they are familiar with it and not frightened of it when they have to use it later. A platform 18" high should be made each side of the crush for people to stand on in order to reach the camels more easily (Figure 4.2.8).

Figure 4.2.7: Hobbling rear legs.

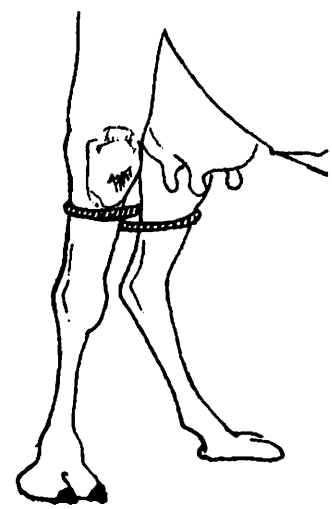
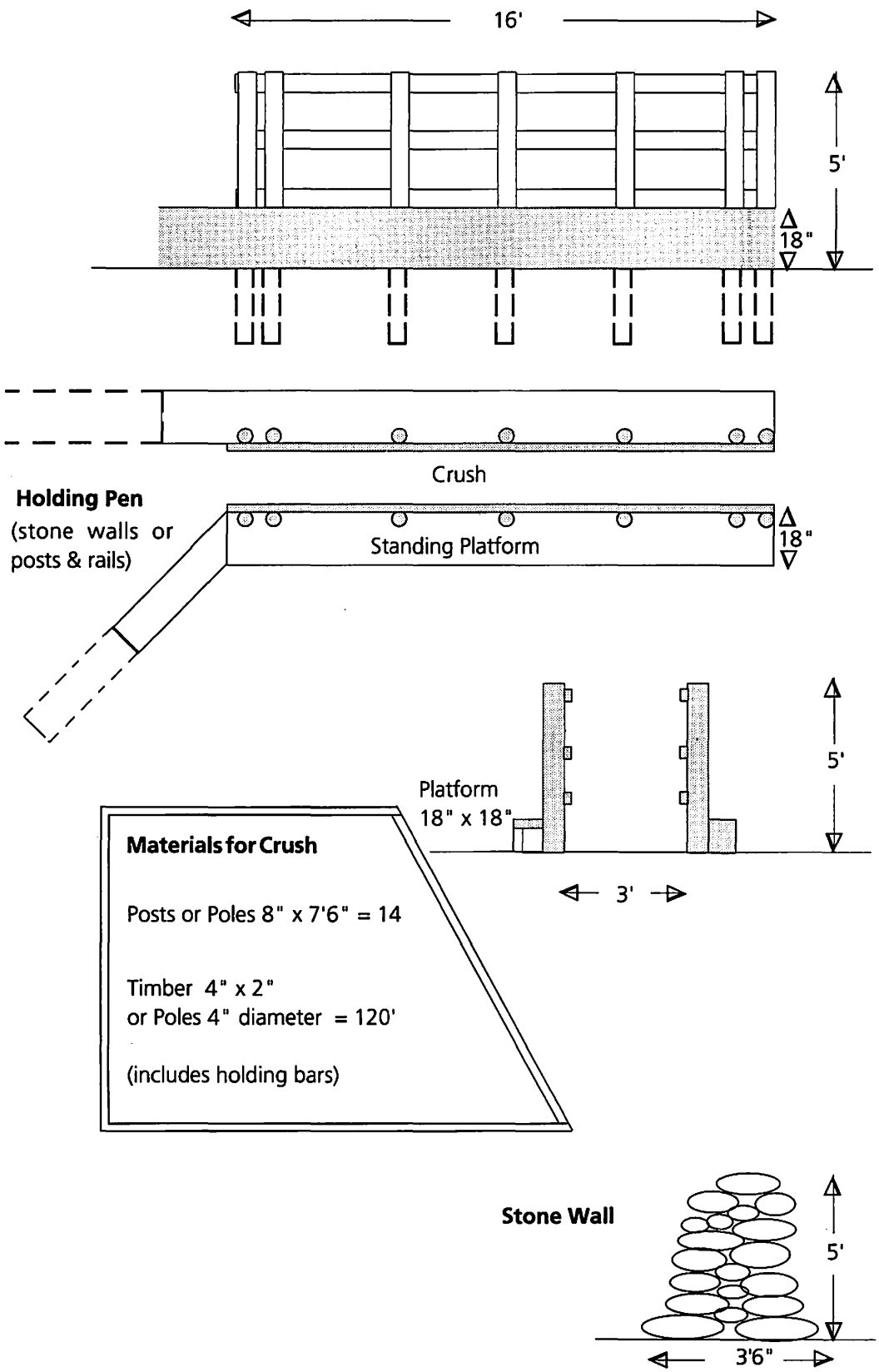


Figure 4.2.8: Crush designed for use with camels.



CHAPTER 4.3

Branding

by S P Simpkin

Introduction

The branding of camels is an important tool in camel management. All traditional camel owners brand their animals with either clan, family or individual markings. Branding includes burning with hot stones or irons; or clipping or cutting ears, and occasionally nostrils.

Ranched camels normally bear the ranch brand and an identification number or ear-tag. Ranch brands should be registered with the Ministry of Livestock Development. The presence of an officially registered brand greatly facilitates in the recovery of lost and stolen stock, especially if one has to resort to the law courts in order to recover stray or stolen stock.

Branding or permanent marking should be carried out at weaning, or in the case of bought camels - as soon after purchase as possible.

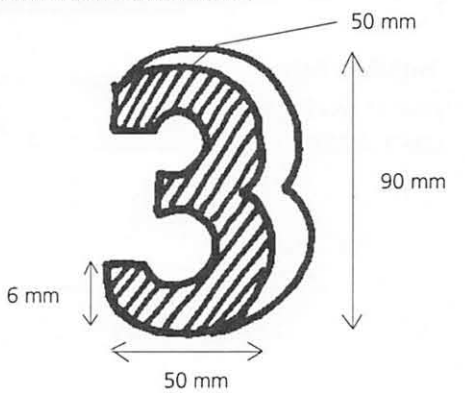
Hot branding

Ranch brands and identification numbers (and letters if necessary) should be branded on the same side for all animals i.e. all on the left side OR all on the right side. This makes it easier to count and identify animals as they leave or enter the boma (or crush) morning and evening.

The best places for brands are either on the hind-leg, or on the neck. Some ranchers put the ranch brand on the hind-leg and the individual (ID number) brand on the neck; others brand the ID number on the neck for male animals and on the hind-leg for females.

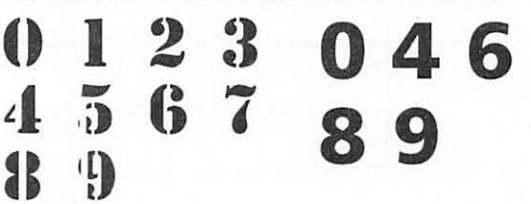
All branding irons should be the same size. The brands used for cattle are suitable for camels. Typical sizes are 90mm X 50mm with the actual print surface of 6mm (see below). The depth of the brand should not be less than 50mm so that it holds the heat sufficiently. If the actual digit or number is attached to the handle by more than just one point, this strengthens the iron and also helps retain the heat.

Figure 4.3.1: Brand dimensions.



Stainless steel brands are best, but iron brands can also be used. Branding numbers should be open (not closed) as they are less likely to slip over the skin, and do not singe the hair within the enclosed iron.

Figure 4.3.2: Examples of open and closed brands.

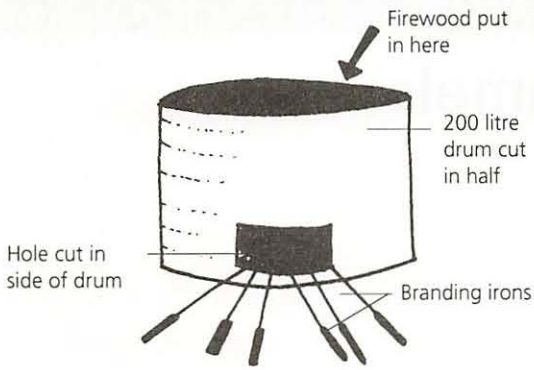


Open brands *Closed brands*

The handles should be long enough, or suitably insulated, so that the person branding does not burn his/her fingers.

The brand number should be stamped on the end of the handle so that the individual branding numbers can be identified without having to

Figure 4.3.3: System for heating branding irons.



remove the irons from the fire.

The irons should be glowing dull white before they are removed from the fire. If the iron is glowing red it is too hot and will either be unclear or burn too deeply.

The animal should be securely restrained and in the correct position before the branding iron is even removed from the fire.

A good way of heating the irons is to use a metal oil/petrol drum, (some people cut the drum in half, but a complete drum is best) with an opening in the side (see diagram above). This helps to keep the embers and heat concentrated and reduces the amount of firewood required, it also protects the operator from excessive heat.

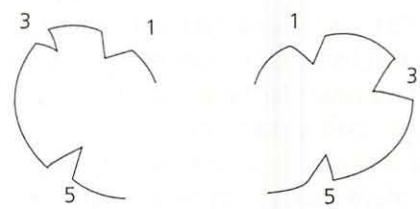
If the camel has a lot of hair at the branding site, the hair should either be clipped off or dampened with a wet cloth to prevent over-burning which causes excess scarring and makes the brand difficult to read.

Earnotching

A system similar to that for cattle can be used for camels. Since camels' ears are relatively small the amount of notching has to be small. Some ranchers only use ear notching to indicate the month and year of birth.(See Diagram below).

Notches on the left ear indicate year of birth (1-9); notches on the right ear indicate month of birth.

Figure 4.3.4: Ear notches.



Left ear = Year

Right ear = Month

Plate 4.3.1: Hot branding. The camel should be restrained securely. (Hamish Wilson)

CHAPTER 4.4

Transportation of camels

by J O Evans

Camels behave amazingly well while being transported, once the trauma of being loaded is over. Difficult animals for loading can be sedated with a small dose of Xylazine (Rompun, Narcoxyl, 1 ml for a large camel). The sedative should be given while they are still quiet because once they become excited the drug is not so effective. If the dose has to be increased it has a delayed response which can complicate loading. Once loaded and quiet they adapt to the situation very quickly.

Never load camels onto a truck with metal "tarpaulin-hoops" across the top. Hoops can cause grave damage to their heads, necks and humps.

Large camels loaded into an open truck will occupy approximately 10' x 3'6" (3.1m x 1.1m). If loaded into closed transport in a couched position, which could be on pallets, their dimensions are approximately as follows:

CAMEL	LENGTH (TOTAL) (M)	LENGTH (KNEES TO TAIL) (M)	HEIGHT (HEAD) (M)	HEIGHT (HUMP) (M)	WIDTH (M)
Large Bull	3.1	2.8	1.6	1.3	1.1
Medium female	2.6	2.2	1.6	1.3	1.1
Weaner	2.2	1.9	1.3	1.0	0.8

Lorries or pick-ups should be well floored with grass, straw, sawdust, or dry boma manure. If possible this should be covered with matting, tarpaulin or sacks to help prevent their knees from being jolted through the bedding onto the hard floor.

A single camel in a pick-up should have haybales or stuffed sacks on each side to keep it upright and to prevent damage to its flanks.

It is easier to load a camel into a vehicle backwards from a bank or ramp. This also allows free movement of its head while travelling. Loading is made easier if a tarpaulin or sacks are stretched under the knees and hind-feet to enable people to lift and slide the animal into the truck. A camel can remain tied down couched for 24 hours without undue hardship.

For transport by air, the couched animal should also be netted down securely to ensure that it cannot break loose.

CHAPTER 4.5

Training

by J O Evans and D J Atkins

Introduction

The main attribute of a camel handler is to be fearless but friendly. Camels are most intelligent and recognise emotions very quickly, and usually respond very soon.

Camel-keeping people understand very well their own methods and uses of camels - always for milking and usually for loading - but it is most important that people training camels in a new role, such as damscooping, and particularly people unused to camels should fully understand what both they and the camel should be doing.

Training - breaking in

It is best to separate two or three animals for training and send the rest of the herd out of sight so that they are not distracted. A camel left on its own will probably feel lost and want to get away to rejoin the herd.

The first thing a work-camel has to be taught is to accept a headrope. In some places, jaw nooses and nose-pegs are used instead of head ropes or halters. Both these are painful to the camel and should not be necessary. A jaw noose may result in a broken jaw and a nose-peg can split the nostril, both difficult to heal and causing the camel unnecessary suffering.

Hobble up one front foot first to facilitate putting on the head-rope: until the animal accepts it. The head-rope should be put on gently so that the camel does not rear its head, and do not fight the camel by excessive pulling. The animal may be led round for a bit with a second man following to keep it moving.

Next the camel must learn to sit down on command (in East Africa the command "Tu" is usually used). One front foot is hobbled up and the other foot is tapped with a stick while giving the command until it sits down.

Sometimes a recalcitrant camel, usually because it has not been trained young enough, has to be fought to obedience. This will require courage and endurance by the trainer, but he must win or the camel will remain unmanageable. In these circumstances the camel should never be beaten on the head, but only on the neck or shoulders.

Loading and saddling

Saddles or harness may be put on even on the first day of training. Saddles and harness must fit and be fitted properly. Nothing upsets an animal more than constant stopping and starting and fiddling with his gear. Saddle or harness should be worn for a day without any attachment to accustom the animal to the feel of it.

NOTE: Untrained camels who have never seen a loaded camel may easily panic at the sight, even though he is one of their own herd. Either the newly saddled camel must be hobbled or the herd confined until they recognise their fellow, or they may run for many miles, chased by their bewildered friend!

When loading a camel, make quite sure that everything is very securely tied down. Anything loose or flapping may cause him to panic.

Draught and traction

For starting draught work, first attach a light pole or withy on each side and let him pull them round. If he kicks at them, it should not hurt him. Then attach some light object-like a thorn bush and pull

it up and down a road or open space for a few hours. After that, attach something that clatters and makes a noise. After that, start work. Not too heavy to start with or the camel gets disillusioned. Once they are used to pulling they are most patient and determined. From pulling a dam-scoop or harrow, a camel will pull a cart with very little trouble (see saddles and harness).

Training camels for riding

Once a camel is used to a saddle and words of command it can be mounted by one person and led by another until it is used to being ridden, then the lead rope should be used as a rein. The man who led should now go behind to keep it moving. Thereafter the camel should be made to run and obey directions. Camels are happier training in the company of others. They must be made to move side by side and not nose-to-tail, therefore in the initial training the camel should not be led tied to the tail of another. If they become used to this it is very difficult to make them overtake another camel in a race. Camels do not seem to have a competitive spirit! Once a camel is under control it should be taken out singly to get used to being on its own.

If a camel is initially difficult about obeying commands when the rider is alone, a simple 'hand- brake' for the rider may be used. This is a thin rope attached to one front fetlock and the other end tied to the saddle. The foot can then be pulled clear of the ground to induce the animal to stop or sit.

The training of professional racing camels is a full subject on its own, not understood by this writer!

Conclusion

Camels may be trained to head rope and commands at any age, the younger the better. They should not do sustained work until at least 4 years old, loads increasing until they reach full strength at about 6 years old. They will continue to work sometimes up to 20 years old. 25% of the camel's body weight is a reasonable load to carry for a full day over a period of many days, when the camel is in good condition and practice; up to 30% of his body weight for short hauls. Camels, like men, get out of training if not worked regularly and so need hardening up for prolonged work.

Camels in work must have a least 6 hours browsing time per day and should have one day per week complete rest.

Plate 4.5.1: Breaking in a camel - a gentler quieter approach is normally more effective. (Hamish Wilson)

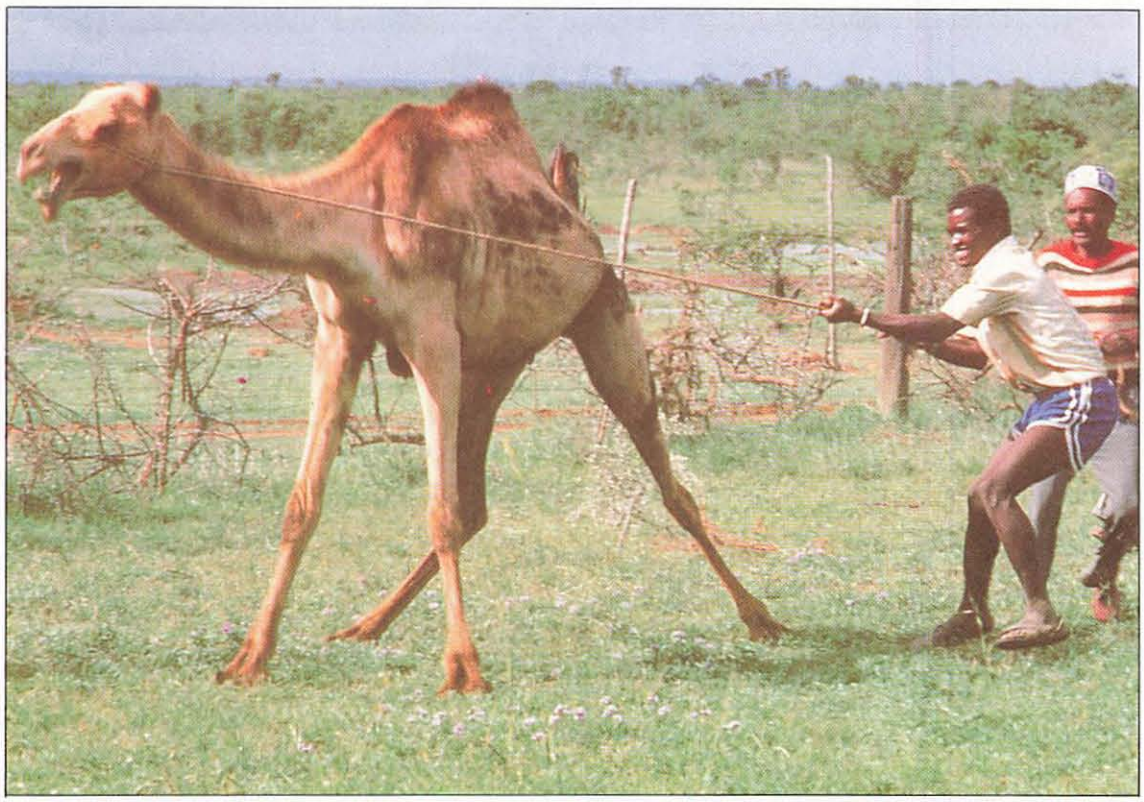


Plate 4.5.2: Putting a saddle on a newly trained camel. Note the two-stick Somali type saddle. (Hamish Wilson)

CHAPTER 4.6

Harnesses and saddles

by D J Atkins

Introduction

Traditionally the camel has not been used for riding in Kenya. On the occasions that sick or infirm people have been carried by camels, the animal has always been led by a man on foot. It is only relatively recently that the camel has become popular as a riding animal, used by anti-poaching and stock theft units or for tourism. As a result saddle and harness design and development in Kenya have in the past been restricted to carrying household goods and water containers rather than people.

The traditional saddles used by the Somali, Rendille and Gabbra people are largely comprised of the integral parts of the luggage to be carried. Most of the loading occurs when a camp or household is moving, and subsequently all the household materials and possessions are packed onto one or two camels. The skins, mats and sacks that cover the house, are used as numnahs or padding between the camel and the load. Next the poles that support the house are tied onto the camel to form a frame to which other articles can be tied. The Somali people often base a saddle on only two poles (see Plate 4.5.2 in Chapter 4.5) tied together over the thorax, alternatively they use a 4 pole version akin to that of the Rendille and Gabbra. The Rendille and Gabbra saddles comprise 4 poles tied further back across the abdomen of the camel. (See Plate 4.6.1 and 4.6.2)

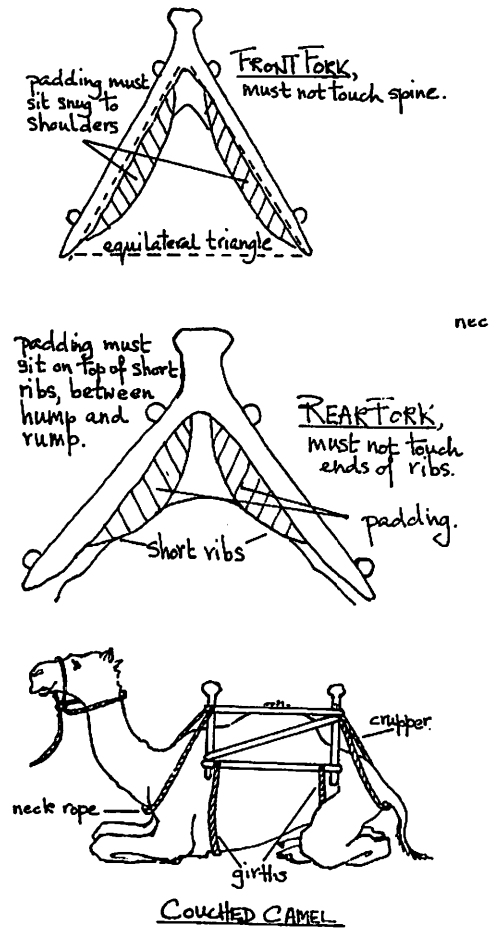
It appears that only the Rendille and Gabbra women specifically manufacture articles for use on camel saddles; they make panniers from bent sticks tied together with leather, and use them for carrying water containers and jerrycans.

Constructing these traditional saddles is time consuming, requires skill, and if not done properly can slip or injure the camel through chafing and rubbing. The incorporation of camels onto commercial ranches has led to more attention being paid to harnessing and saddling camels. The Indian or Bikaner camel saddle was one of the first to be used; however they tended to be quite heavy and expensive. Other saddles, including horse saddles, have also been used. A number of different camel saddle designs are available from neighbouring countries such as the Sudan, right up to North Africa and Arabia. Riding and saddle positions vary, some people prefer to ride behind the hump, others in front of, or on top of the hump.

Perhaps one of the most versatile saddles in Kenya today is the one developed by Jasper Evans on Ol Maisor Ranch near Rumuruti. Based on the northern Arabian pack saddle, it is cheap and easy to make, and can be used for either riding or loading. The saddle consists of two inverted forks of a tree, (usually *Acacia spp.* or *Cordia sinensis*), connected by two wooden crossbars on each side of the hump. The tree forks should be as close to an equilateral triangle as possible. A third diagonal crossbar can be added for increased stability. The crossbars have a diameter of 2-3", and the length is determined by the size of the camel. The inside of the inverted V is then pared down and padded with cloth, wool, sacking etc. On the front fork, there should be enough padding to sit snug to the shoulders. The rear fork must not touch the ends of the ribs, and there must be sufficient padding on top of the short ribs and between the hump and rump. The saddle sits over the hump. One girth rope is tied around the camel just behind the pedestal, and another around the abdomen, but in front of the penis sheath. A rope 'crupper' passes under the root of the tail; and a neck rope passes around the base of the neck. (Figure 4.6.1, Plate 4.6.3)

This saddle is multipurpose and can be used for riding - by the addition of a padded seat and stirrups; to carry saddlebags - boxes with ropes

Figure 4.6.1: Diagrammatic representation and guidelines for making a simple saddle.



that hook over the pommels; "baromils" - 40–60 litre copper or metal water containers; firewood (or maize and sorghum stover, building sticks, thatching grass etc.) by the simple attachment of four forked sticks - two hanging down each side (Figure. 4.6.2). Loads must be firmly tied with ropes once properly packed and balanced. This saddle can also be adapted for use in pulling carts, ploughing etc.

The important factors in selecting or making a saddle are to ensure that:-

1. there is sufficient padding between any hard frames or parts of the load and the camel itself.
2. there is no movement of the saddle that can chafe and blister a camel through friction burns.
3. the weight of the load sits on the ribs and not on top of the hump.
4. the girths are firmly tied and the load does not slip or slide.
5. padding is soft and absorbent; nylon or rubber tends to make the skin sweat and chafe.
6. the camel is comfortable, and the load well-balanced.

Flat, sisal or hemp ropes are preferred to round, nylon ropes. Girth, crupper and neck ropes can be padded with skin or wool to reduce rubbing.

Camels can be controlled by the use of a nose peg, but they are quick to learn and the use of a head rope or bridle is recommended (see restraint and handling in this manual).

Draught harness

There are many ways of harnessing camels for draught work. In some places traditional European horse-collars have been used. From our observations of the camel, these seem to be unsuitable due to the very forward position of the shoulders and the very pronounced backward and forward motion while walking. Some harnesses are fitted on top of the withers which throws the pull onto the hump — this is also undesirable.

We have found that a very simple, effective and cheap harness can be made with two iron rings (about 6" diameter) and three sacks with ropes attached (Figure 4.6.3.). The sacks should be rolled up and tacked to stop them from unrolling. Short lengths of rope should be attached to each end of the rolled sacks, and each sack tied to the iron rings. The rings should be positioned on either side of the camel, about half way down the rib cage. The pull is then taken by the front roll lying on top of the neck in front of the withers. The hind roll goes behind the hump to prevent the harness slipping forward. The third roll is a girth pulled tight under the chest behind the pedestal, which keeps everything in position. A pad or small cushion should be tacked onto the inside of the iron ring to prevent chafing or bruising the camel. A small rope may be required under the bottom of the neck and attached to the front roll to stop it riding up over the withers, but this should not take any pull of the load. When working in a cart a small saddle should be fitted on the withers to take the weight of the cart shafts.

Traces may be used from the iron ring to the object being pulled, but these are inclined to get tangled in the animal's back legs. A better method is to use long thin poles.

Two camels may be used side by side using a yoke similar to an ox yoke .

Figure 4.6.2: Simple saddle made from tree fork for carrying firewood, stover etc.

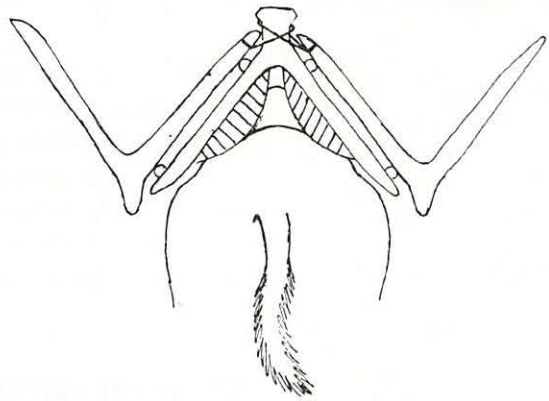


Figure 4.6.3: Draught harnesses made from rolled sacks.

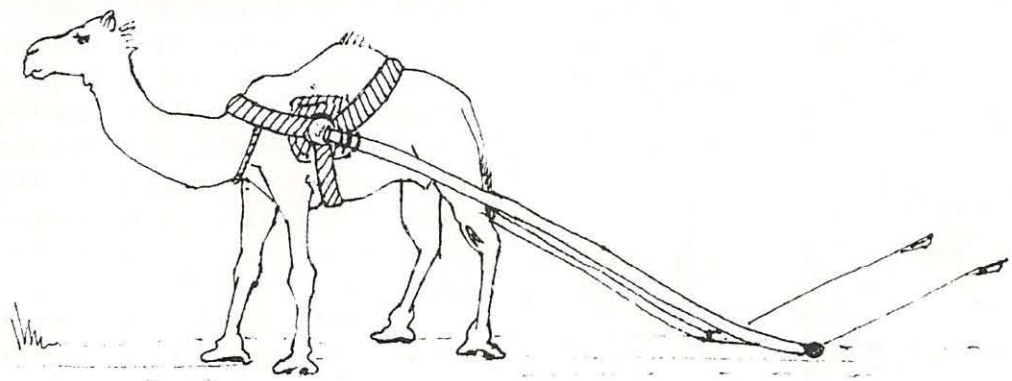


Plate 4.6.1: Gabbra loading houses onto camels. Note the four stick frame visible on the camel on the right. (Chris Field)

Plate 4.6.2: The Somali style four stick saddle. (Chris Field)

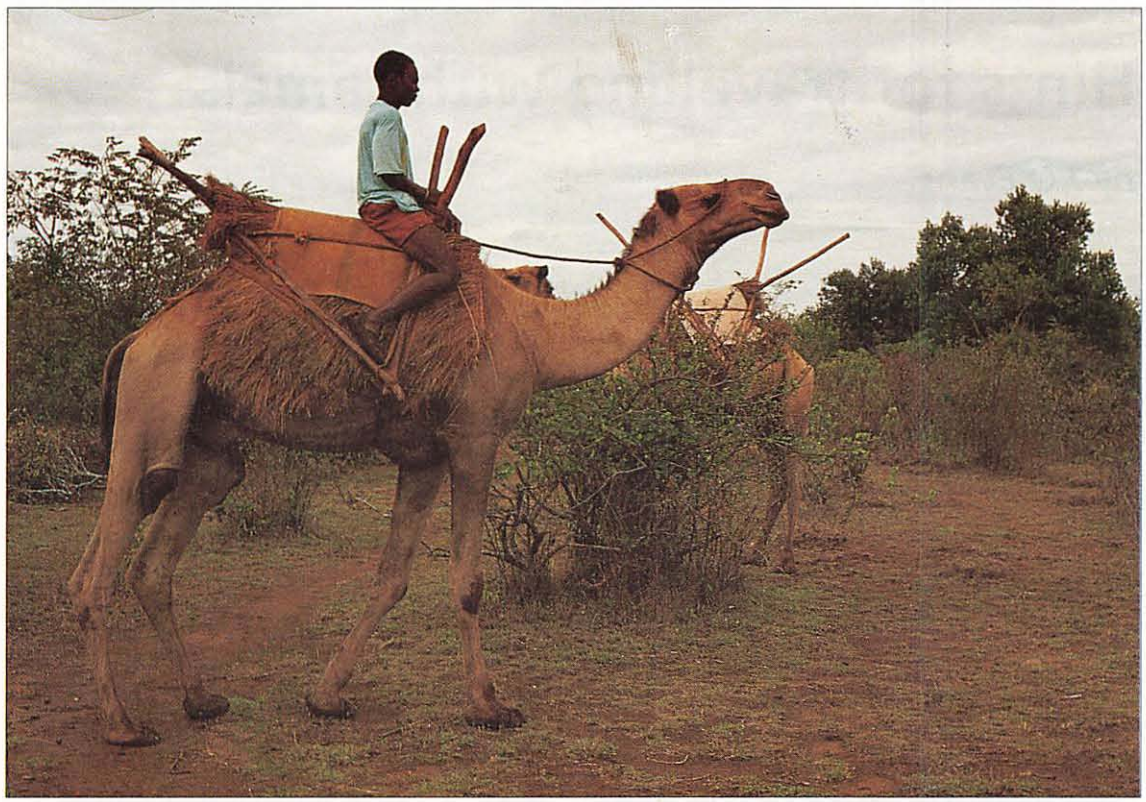


Plate 4.6.3: Saddle designed on Ol Maisor ranch and now in common use in northern Kenya. Made out of inverted tree forks, it is easy and quick to fit. (Chris Field)

CHAPTER 4.7

Hints for travelling with camels

by J O Evans

This article is aimed to help non-pastoral travellers. Pastoralists know their own country and have evolved their own ways of travelling with stock and families from place to place.

Planning the trip

The period each side of full moon facilities travelling at night which is desirable if in a hot country.

It is essential to take watering points into account. You cannot travel without water. Time between watering points depends on the number of camels you have to carry water. Camels should have water at least once a week, preferably on a rest day. Watering camels from wells is an arduous task requiring fit men. Most wells are privately or communally owned and must be treated with respect. Their use may even be denied in unfortunate circumstances, perhaps putting you in a dangerous situation. Free standing water should be found if possible.

Water may be carried in "baromils" (see 4.6 Harnesses & Saddles) but it is difficult to control the amount of water used and it slops when part-full. 20 litre, flat-sided jerrycans are more convenient (round cans can be difficult to load). Metal cans are heavy. Plastic cans are liable to damage so need careful handling. 5 litre cans in wooden boxes are convenient. Motor tyre inner-tubes can be useful but need a special cap for filling. They have an advantage in taking up little space when empty. A funnel for filling is useful. Water containers should be stacked beside the leader's sleeping place and water issued in an organised manner to prevent discord and unauthorised usage.

Similarly when water is short the cook or leader should issue tea etc., with the same mug so that everybody gets the same ration. Thirst is very provoking.

To collect clean water a small drum (5 to 20 litres) opened at both ends may be sunk into the bottom of a sandy water hole or edge of a stream. Dig out the sand as far as possible below the water level. Bail out the muddy water carefully until the water comes clean. This method will give you clean water for the duration of your stay, but it will not work in mud. Water from muddy pools may be cleared by paring the root of *Courbonia* sp. ["***Dumaizo***, ***Dubasso***" (Boran), "***Megag***" (Somali), "***Yabuluswa***" (Tugen), "***Erot***" (Turkana), "***Erut***" (Pokot)] and with it stir the water in a bucket for a minute or two and then allow it to settle.

A section of tractor or lorry inner-tube stitched onto a wire circle makes a good, easily-packed, bucket for drawing water from a well.

One gallon, or 5 litres, per man per day is adequate, half of which will be needed for cooking, tea etc. At least twice that for comfort.

Adequate tea drunk before the start of a march is most important and it is best not to drink again until the final halt. One person should brew tea, in a utensil large enough for the whole party while the rest load the camels so not to delay departure or lose sleep. (Tannin in the tea helps absorption of water. Milk and sugar are nutritious). Stopping the march to give people water should not be allowed. It upsets the camels and men alike. If people have to drink on the march, they should carry their own.

Food

Dry food such as maize meal, rice, spaghetti and flour are convenient. Beans are nutritious but take a long time to cook and need more water. Meat can be dried, smoked, salted (salted meat needs

soaking in water to remove excess salt, but the water can be used in cooking other things). Meat boiled in fat will keep a long time, even in high temperatures. Cut meat into 1" cubes and boil in fat (preferably camel hump fat which has a high melting point) for an hour or two, with salt, herbs and spices to taste, until all moisture has been driven off. Lift out the meat and pack tightly into a tin. Pour the boiling fat on top. To use, dig out the meat, melt off the fat and pour this fat back on to the remainder to re-seal it. (Debbie Atkins formula.) Somali and Turkana people use a similar system and claim to store meat for a year.

Potatoes, onions, carrots and hard cabbages all travel well. Cooking fat is better in tins than plastic pots, which tend to get squashed and leak. Tea, sugar and milk are essential (see "Camel Milk Products" for condensed milk). Country tobacco and boiled sweets are helpful on the march and with a brew of tea are good for entertaining visitors to your camp. This is important for good relations when passing through other peoples' territory. A sheep or goat bought from local people is a welcome addition to the rations and cements good relations with one's hosts/neighbours. If travelling through unoccupied territory, a goat will very soon become part of a "safari", to become rations at a later date. A camel in milk, with calf big enough to keep up, is a very useful. adjunct.

Adequate rations for 4 men per day are:-

2 kg maize meal (or equivalent)
100 gm cooking fat
50 gm tea
1/2 Lt milk or equiv. powder or condensed
30 gm "Mchuzi mix"
10 gm curry powder
4 large potatoes
1/2 cabbage
2 large onions
4 "wads" tobacco
meat when available
20 gm salt
Sweets

Saddles

Traditional "herios" and sticks are admirable for their own use, since they are part of the dwelling and protect the camel from damage by awkward loads. However, they are heavy (at least 25 kg), hot for the camel, need skilful fitting, are difficult to load and need a lot of rope. Fitted saddles are quicker, lighter, cooler and easier to load, especially if saddle bags and boxes are used (see 4.6 Harnesses and Saddles).

Distance and load

Fifteen miles is a reasonable distance . This can be done twice in a day if necessary, but not too often. On long stages, it is good to do half of it at night (moonlight makes this easier and more interesting). Camels move well at night. The change from moonlight to dawn and daylight is enchanting. Night walking gives the camels more browsing time in daylight.

Baggage camels will average 2.5 miles per hour over a day's march in reasonable country. Camels need at least 6 hours browsing time per day to keep in good condition. They should have one day's rest per week, preferably near water.

On the march, they may be tied head to tail or driven in a drove, depending on the country. At least some should be led to show the way and in case of panic they are more controllable. They should be halted every few hours to urinate as they do not urinate while walking.

While feeding, they should have a man keeping an eye on them to prevent them going off. Any camel that has a tendency to wander or head off should be hobbled (see "Restraining a Camel"). If you are left without camels in the desert you are put at grave risk.

A reasonable load on a long journey is 100 kg. More for a short haul, but it all depends on the size and fitness of the camel. Perhaps 25% to 30% of its body weight could be taken as a guide. It also depends very much on how well the saddle fits and how well it is packed. Loads should be evenly balanced both sides, as high as possible and well secured with nothing flapping.

Camping places should have an area of flat, preferably soft, ground for the camels to rest on. Rocks and stones should be cleared away so that the camels do not hurt themselves. It is best to site camp some little distance away from water and thick riverine bush in hot country because of mosquitoes, midges and tsetse fly, and preferably in a breezy place. In cold places some shelter from the wind is advantageous.

Walking at night is cool and the camels are not inclined to try and wander in search of food. Early arrival in camp allows longer daylight hours for the camels to browse. It is much easier on the people walking through the cool of dawn or sunset.

Camels cannot jump, so steep gullies and ditches are difficult to cross. Slippery mud is also dangerous for camels as they may damage themselves if their legs skid apart and they "do the splits."

If a camel refuses to cross an obstacle, such as a bridge, it can usually be moved by attaching a rope to each fetlock and pulling one foot forward at a time.

Lifting a stuck camel (see misc. treatment)

A camel stuck in mud can be pulled out backwards or forwards, (best done with a rope all the way round the chest and rump;) and if necessary lying on its side. Another camel may be harnessed to help pull.

Camel gear to be carried

This should include spare rope and spare sacks. Equipment for repairing saddles, including a hammer, nails, packing needle and twine, rubber tubing and a panga (machette).

Substitute padding can usually be found in the bush, such as grass, *Sanseveria* (must be well beaten and soft), *Acer persica* [***"Masageta"*** (Samburu)] very good, and *Psiadia spp* [***"Labai"*** (Samburu)] leaves which stick together to form a kind of felt.

A veterinary kit box should be taken which includes: Hydrogen Peroxide 2%, Negusunt powder, Tetracycline spray, Neguvon, Healing oil, Tetracycline L.A. injection, Penicillin L.A. injection, anti-Tryps drug, eye ointment (see "Misc. Treatment").

Personal kit

Good footwear, and a spare pair of shoes are essential. If you can't walk you are a confounded nuisance to your companions, or you get left behind. Gym shoes and stout sandals or "chaplis" are good. Carry sticking plaster in your pocket for blisters.

Sheepskins are both cool to sleep on and warm to sleep under and can be used as numnahs under the saddles. A thin foam mattress also makes a comfortable numnah. If you do not have a tent, plastic sheet is light and waterproof. Mosquito nets should be carried if possible.

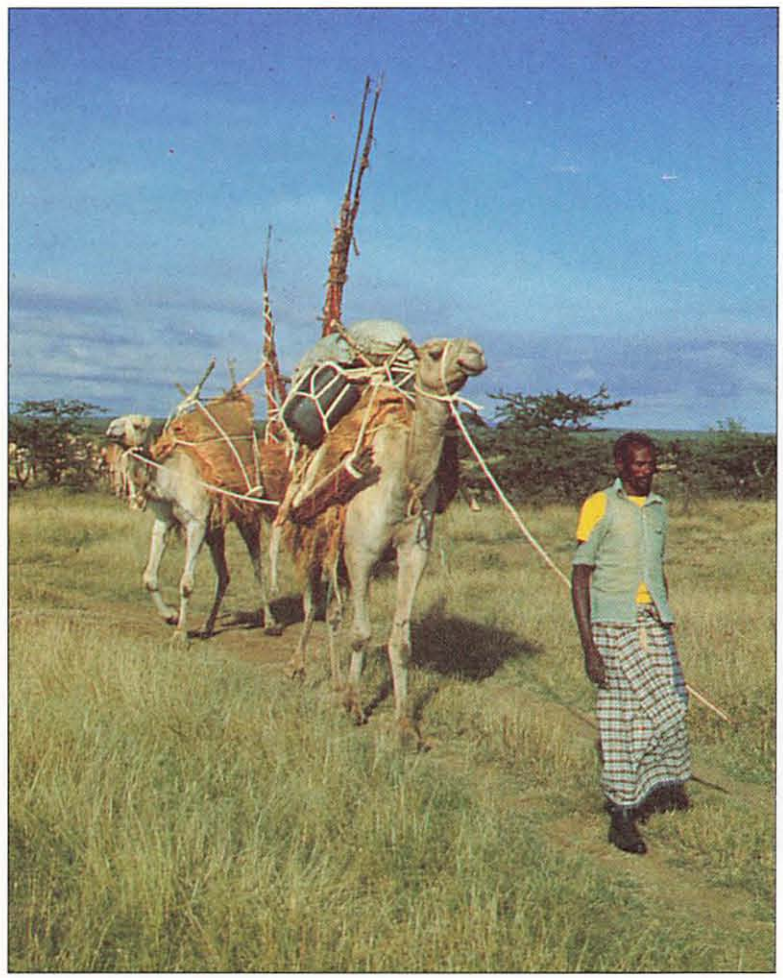


Plate 4.7.1: Camels can be used in caravans, transporting house and camping equipment. (Chris Field)

Plate 4.7.2: There are an increasing number of camels being trained for riding or racing in Kenya. (Chris Field)

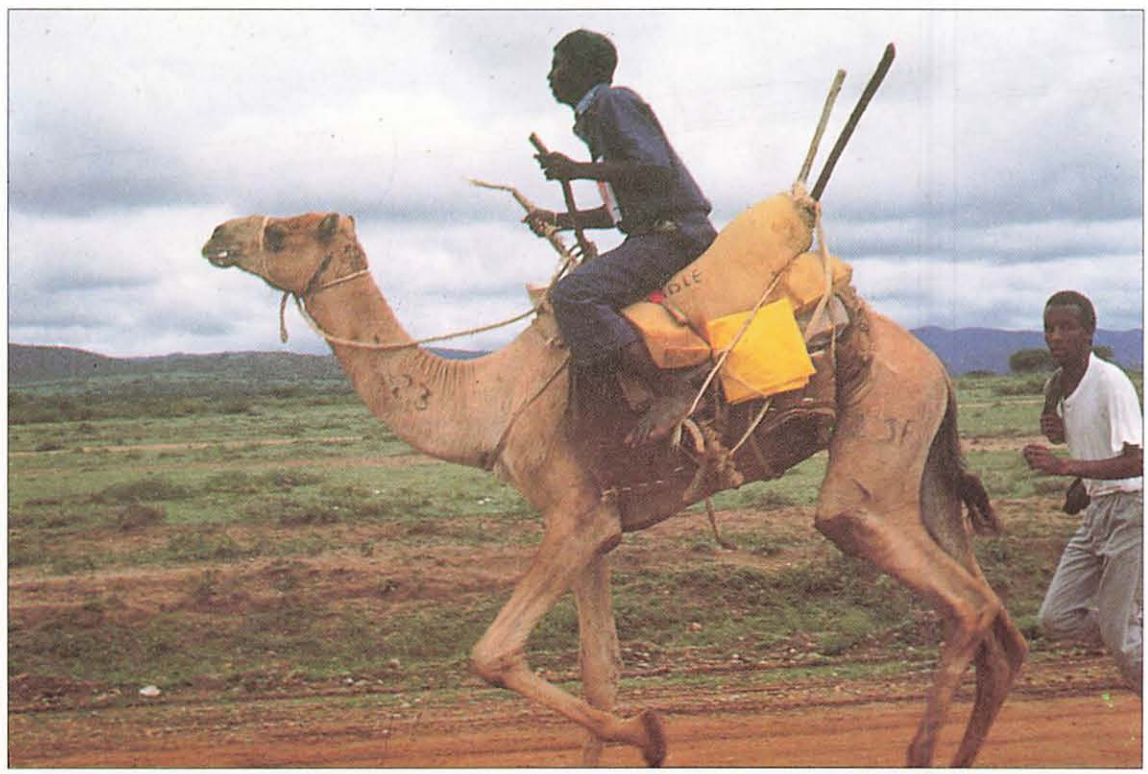


Plate 4.7.3: Trained load camels being used to transport camel calves that are too young to walk far. (Chris Field)

SECTION 5

LOCAL BREEDS AND MANAGEMENT STRATEGIES

CHAPTER 5.1

Camel breeds in Kenya

by S P Simpkin

Introduction

All of the camelids endemic to Kenya are dromedaries or the one-humped Arabian camel (*Camelus dromedarius*). There are no records of the two-humped or Bactrian camel (*Camelus bactrianus*) being introduced to Kenya. Some of the new world camelids, notably lamas (*Llama glama*) have been introduced to Kenya in the Nanyuki area, but purely in private collections or as zoo animals, and have not been included in this manual. The recent introduction into Kenya of dromedaries from Pakistan should be born in mind in future classification.

Camels in Kenya are normally classified into three classes or breeds: Somali, Rendille/Gabbra, and Turkana. The names used for this classification are primarily based on the ethnic group and distribution of the camels, however some distinguishing anatomical and physiological differences are apparent.

General classification systems

There are a number of systems for the classification of camels into breeds or types.

Leese (1927) divided camels into Pack (baggage) or Riding camels, he further divided pack animals into hill or plains animals. This system has further been used in conjunction with tribal and territorial divisions, conformation, size and colour. Pack camels tend to be heavier than riding camels (El Amin 1984). In recent times the riding (and racing) camel has received more attention and therefore undergone more intense selection.

Leupold (1968) classified camels into Mountain and Lowland types. The mountain types are smaller; more compact and coarser-boned than the lowland types. Lowland types were further subdivided into the fine boned, thin-skinned desert types and the massive river types.

Hjort and Dahl (1984) classified camels in Sudan by the tribe keeping them and the pasture type.

Crossbreeding between types is common and subsequently reduces the usefulness of these classifications.

A more modern system used by Wardeh *et al* (1991) is to divide camels by their use: Beef, Dairy, Dual-purpose and Racing.

Wardeh et al (1990) gives the following descriptions for the various categories:-

Beef camels have well-developed hindquarters, large hump, rigid body, relatively short neck and large head, heavy bones and muscles.

Dairy camels have a high milk production, >2500 kg under natural grazing conditions; well-developed udders and milk veins; small hump, less beefy body and relatively big abdomen.

Dual purpose camels are of medium body size, average milk production (1000-1500kg per year), a medium size hump, and relatively high rate of gain when food is available.

Racing camels have a small head and ears; alert eyes; a fine and supple neck joined low on the trunk; long and fine shoulders; a very deep chest; well-sprung ribs right to the back and terminating not far from the pelvic bone. The legs are straight with fairly close forelegs, straight and well spaced hindlegs; well muscled quarters; medium sized feet; and supple skin; easy and tireless pace (Wardeh 1989).

A combination of this modern system and the tribal distribution is probably the most applicable situation in Kenya; it is proposed however that the

term Meat camel should be used instead of the term Beef camel.

Classification of camels in Kenya

The three main types of camel found in Kenya are classified as **Somali** breed, **Rendille/Gabbra** breed, and **Turkana** breed. Crossbreeding is common and, despite making it very difficult to distinguish separate breeds, can result in very favourable characteristics.

Somali breed

As the name suggests these camels are primarily owned by the Somali peoples of North-Eastern Province. The Somali breed camels are generally much larger than the other breeds found in the country. Adult females average 550-600 kg and males 600-700kg, and they may even reach 1000kg when in top condition. Birthweights are in the region of 30-35kg. They often have a better temperament than other local breeds, probably as a result of the better management techniques and capabilities of the Somali camel owners rather than any other inherent characteristic. Being larger they are able to carry larger loads, and they also seem to have a slower gait than other breeds.

Camel owners claim that they require more food than other types, and prefer browsing although they do graze grass in certain areas in certain seasons. They are often restricted to a weekly watering interval during dry periods.

Due to their greater height they have a higher centre of gravity and are more at home on flat sandy areas than rocky hillsides.

The Somalis further sub-divide their camels into three, or sometimes four, sub-types:-

(a) Siftarr;
(b) Hoor
(c) Gelab

The fourth category sometimes identified is Aidimo. The different types of camel can also be associated to some extent with different Somali clans or families.

Siftarr

Siftarr (sifdar, sifdar) in Kenya have been described as tall, light coloured camels, relatively heavy and second to Hoor (Horr) for milk production. On milking they release all of their milk at letdown and do not hold back any milk.

Wardeh (1991) classifies these Siftarr camels that are found in Somalia as dual-purpose animals. According to Hussain (1987) the Siftarr camels are commonly found in the lower Shabelle region of Somalia and are tall, light, and reddish-grey in colour, and mature at 5-6 years but breed at 6-7 years. They are resistant to biting flies and only lose weight slowly during the dry season. Mares (1954) give average daily milk yields of 6kg per day over a 12 month lactation, resulting in total yield of 1500kg.

Aidimo

Aidimo (Edimo, Eyddimo) camels are also considered as being dual-purpose animals (Wardeh 1991) and are often considered as being a result of cross breeding Siftarr and Hoor camels. Hussein (1987) describes these camels as being very tall, heavily built, big humped, long neck, white colour, and a Roman nose. They are slow to both lose and gain weight. They mature at 7-8 years, and produce 1000kg of milk during a lactation of 6-10 months (4kg/day), and are very susceptible to biting flies.

Hoor

Hoor (Horr) camels are considered to be the best milk producing camels in Kenya. They are large and broad, with a lot of meat but not much fat. The skin is thin and often has very little hair or very short hair. The coat can be rough. The lips are often black in colour and hairless. The stomach is large. Horr camels may have drooping or floppy lips, especially the lower lip. Horr bulls may salivate more profusely than the other breeds.

Wardeh in Somalia has classified them as dairy camels and describes them as having a small size, short legs and white colour. They are adapted to the more arid regions. They mature at 3-5 years and breed at 5-6 years. They lose weight rapidly in the dry season but have fast compensatory growth. They are susceptible to biting flies.

Average daily yields are based on Mares' (1954) estimates of 7-8kg (range 2-20kg), and a total yield of 2050kg (800-2800kg) during a lactation of 8-16 months.

A typical or pure Horr camel is sometimes called 'Moruk' or 'Morrup', is virtually hairless and requires lots of food to maintain condition.

Gelab

The Gelab (gelub) type camel has not been included in Wardeh's or Hussein's classification of breeds. It is described in Kenya as being the smallest of the Somali-type camels, akin to the Rendille/Gabbra type. It is shorter, narrower, and produces less milk than the Hoor or Siftarr, but is more drought resistant, losing weight less quickly than other types during the dry season. It has thick skin and long hair on the neck, back, and shoulders, and tufts of hair behind the toenails.

There are a number of names for the various Somali crossbreeds, but it would be too difficult to try and classify camels into all of these sub-types, and they may only be differentiated through the owner knowing the breeding history of his herd.

Rendille/Gabbra breed

The Rendille/Gabbra breed is found mainly in Marsabit district amongst the Rendille and Gabbra tribes. It is generally smaller than Somali breed camels. Liveweights average 350-450kg and 400-500kg for females and males respectively. Birthweights average 30kg.

The colours vary from white to light-grey, fawn and red-brown. This type is quite drought-resistant and is trained to go for long periods without water (up to 14 days during the dry season). Milk yields average 3-4kg, and total lactations of 1000kg over a 12 month lactation. It matures at 4-5 years and first calves at 5-6 years.

Turkana breed

The Turkana breed is the smallest camel found in Kenya averaging 350 kg for females, and 400-450kgs for males. Birthweight is around 25kg. It is commonly found in Turkana district as well as Samburu and Pokot. Turkana camels are generally darker in colour: some are totally black with white nose flashes, but others are pure white. Milk yields are much lower than other breeds : 2-3kg per day over a 9-10 month lactation, giving a total lactation yield of 700-1000kg.

The small body size, small feet and low centre of gravity make Turkana camels very agile and able to climb steep lava hills. Due to the wide distribution of water in Turkana District, and the tendency of the camels to roam freely with little active herding, they often drink more frequently than other camels, every 3-4 days.

Conclusions

The classification of camel breeds in general requires further investigation. Production parameters such as milk yield, body weight, and duration of lactation are influenced significantly by factors other than genotype or inherent characteristics, and may vary considerably from area to area, season to season and between individuals. The management strategies adopted by the various pastoralist groups, and indeed between individual camel owners, influence production, and it is these external or environmental factors that may have led to differentiation between the 'breeds'. It is commonly thought that the Turkana originally obtained their camels by stealing or trading with the Rendille and Gabbra, but over the last few centuries the harshness of the environment and the excessive exploitation of milk and blood from the camel by the owners has led to a smaller, stunted animal.

Each type of camel has its advantages and its drawbacks - Hoor camels for example are famed for their milk output, but lose condition rapidly during the dry seasons. A careful breeding plan could well produce camels that are more drought-tolerant without adversely affecting their productivity. Turkana x Somali breed camels appear to have good conformation, stamina, temperament and drought tolerance but need to be evaluated for performance.

Plate 5.1.1: Somali breed bull (Debbie Atkins).

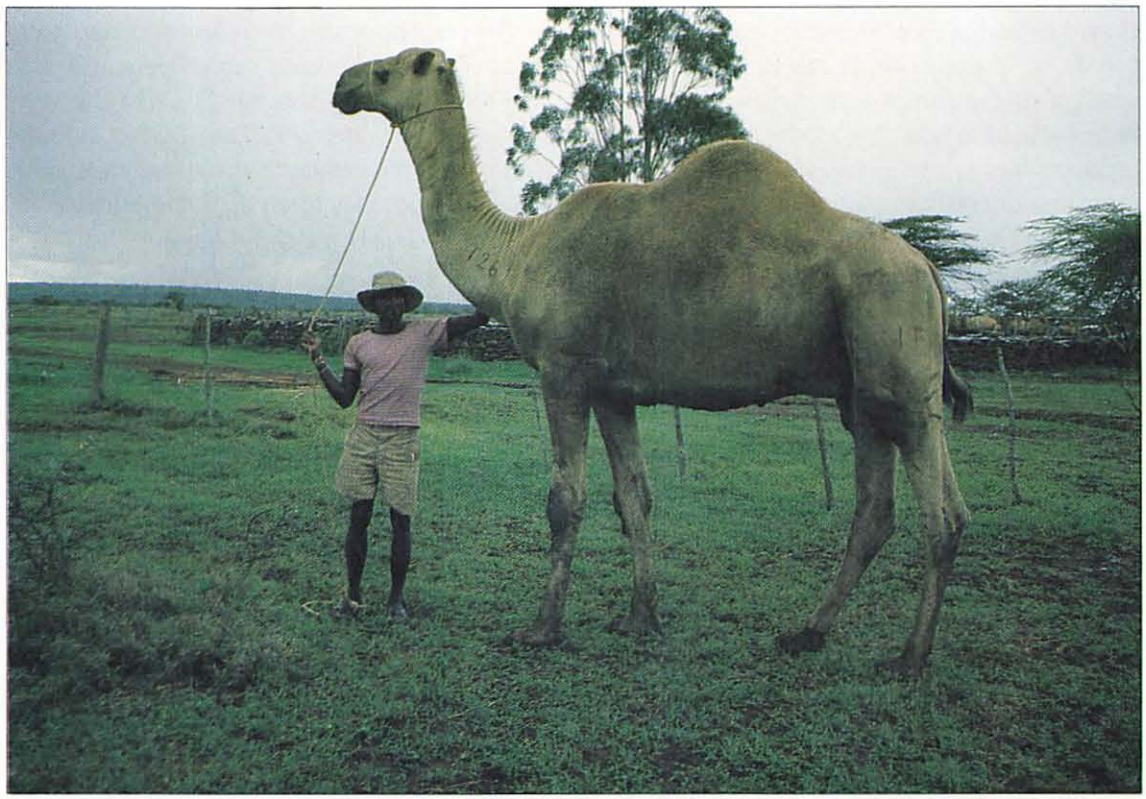


Plate 5.1.2: Turkana (L) and Somali (R) breed bulls. (Debbie Atkins)

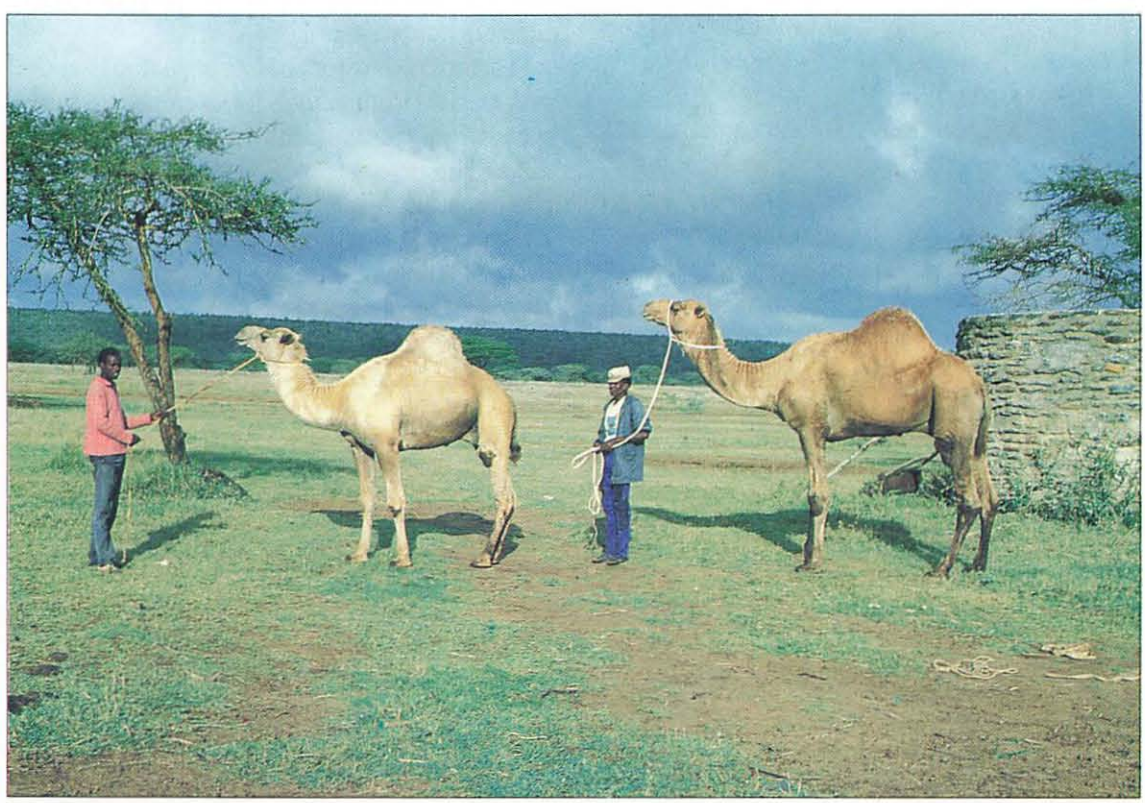


Plate 5.1.3: Crossbred Somali x Turkana bull. (Debbie Atkins)

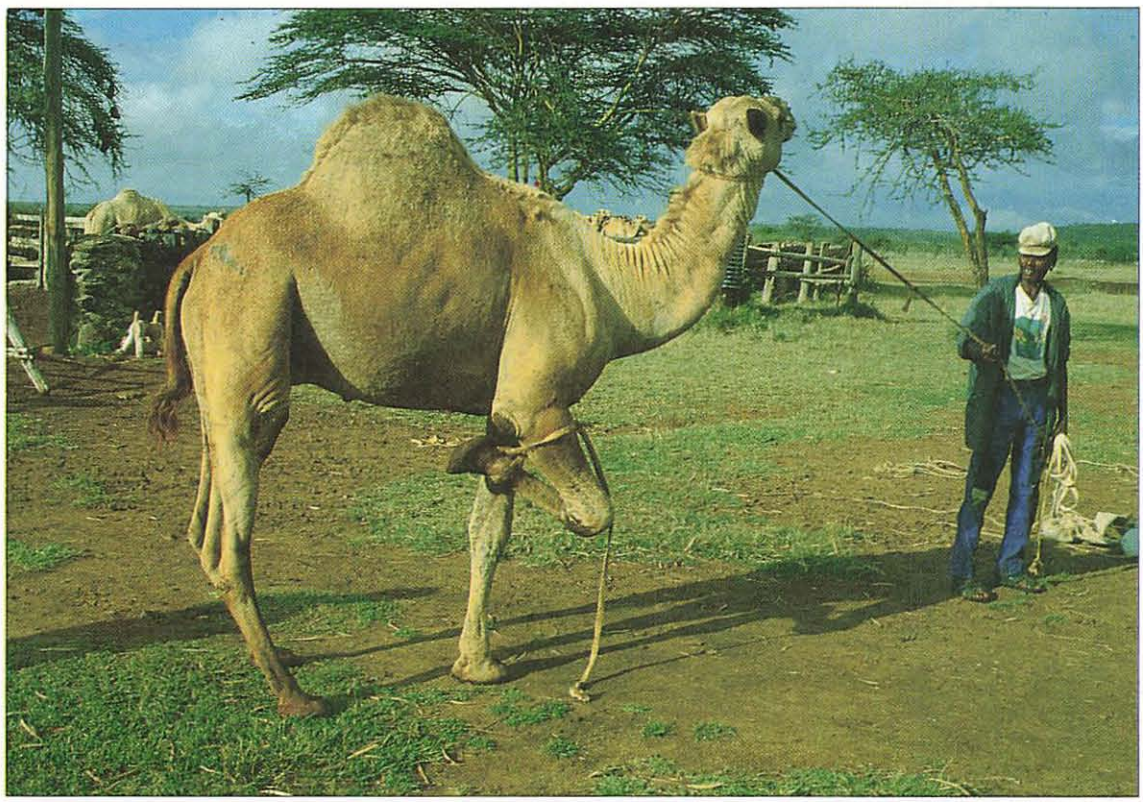


Plate 5.1.4: Breeding bulls - Somali (R), 2 Turkana breed bulls in centre, and Crossbred Somali x Turkana (L). (Debbie Atkins)

Plate 5.1.5: Pakistan breed bull. (Debbie Atkins)

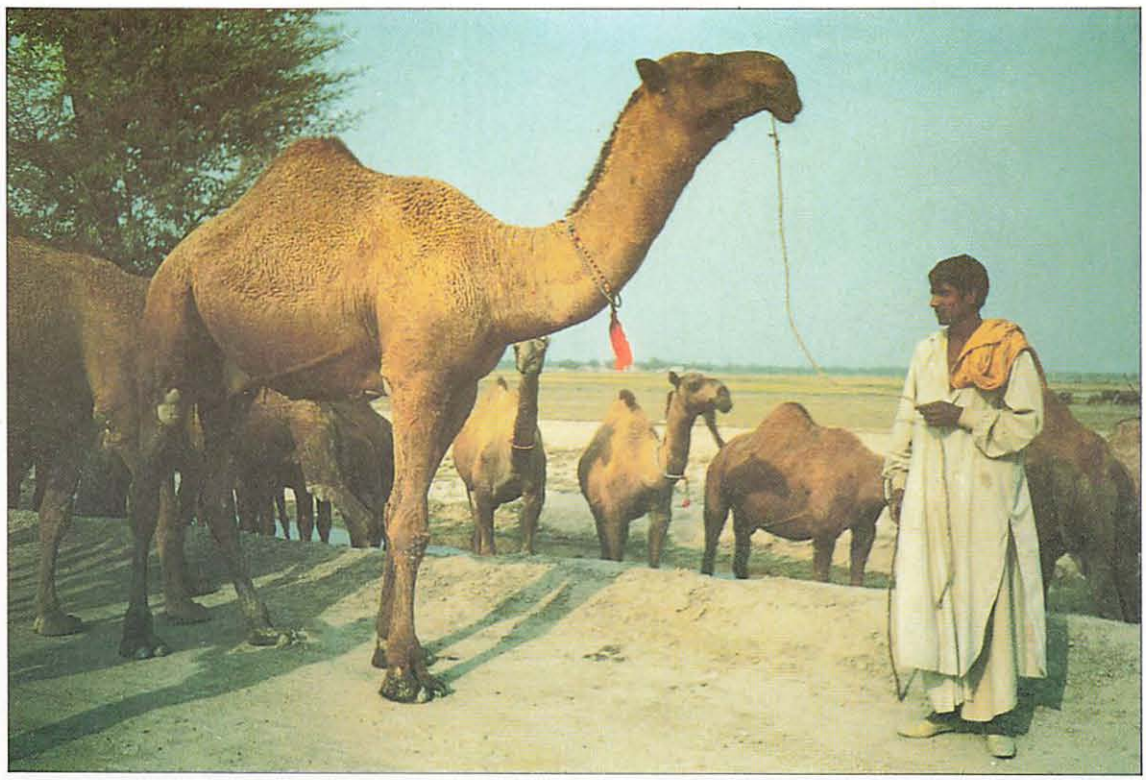


Plate 5.1.6: Pregnant Somali heifer (L) and pregnant mature Rendille/Gabbra female (R). (Chris Field)

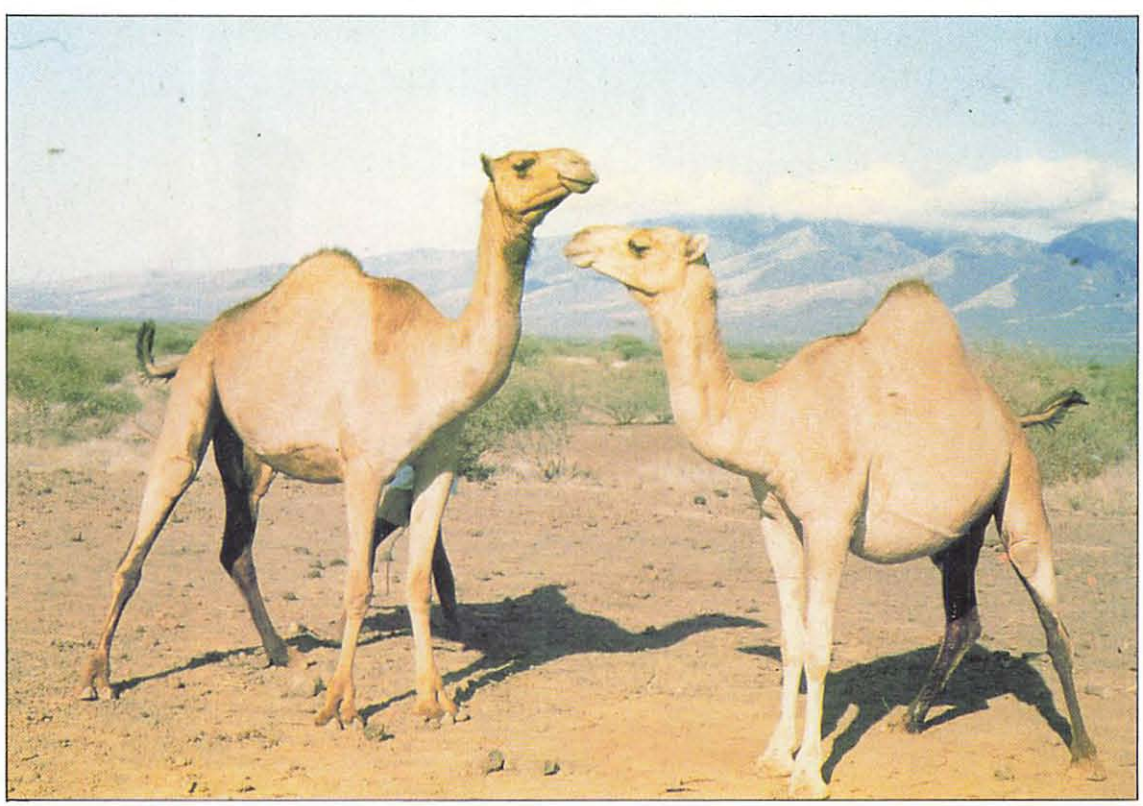


Plate 5.1.7: Somali breed heifer with calf. (Piers Simpkin)

Plate 5.1.8: Turkana breed heifer with calf. (Piers Simpkin)

Plate 5.1.9: Adult female Somali breed. (Piers Simpkin)

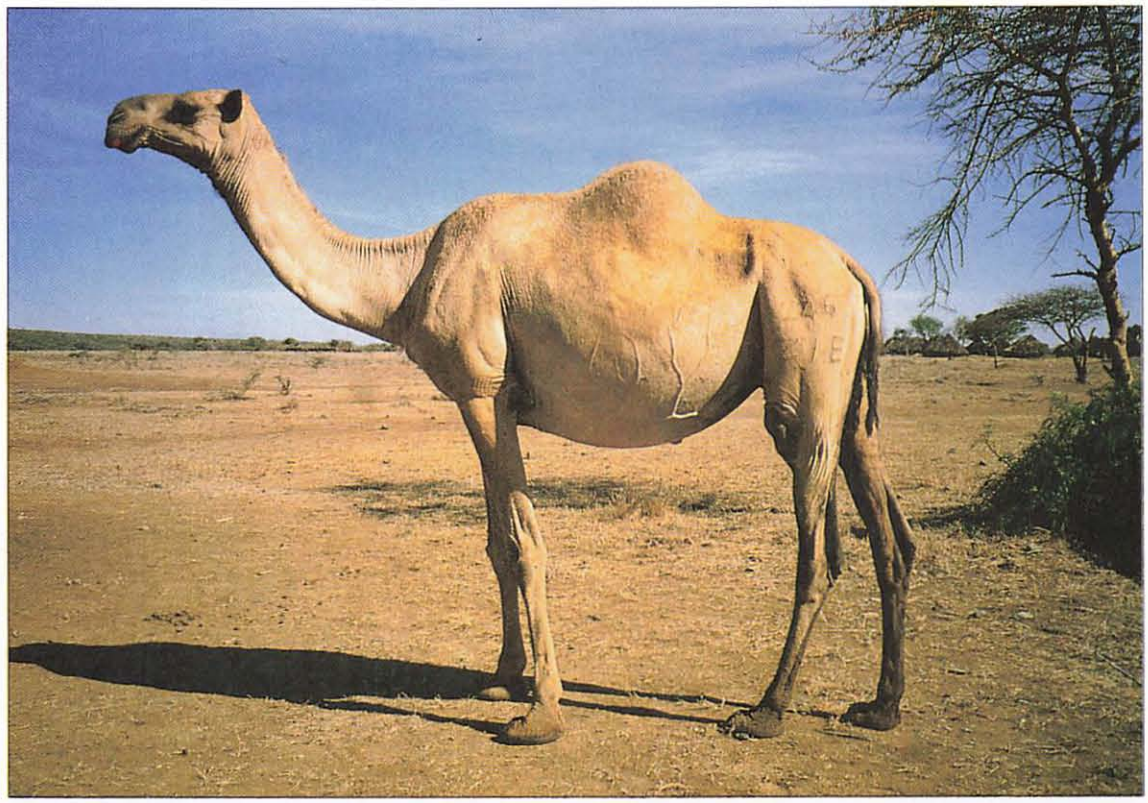


Plate 5.1.10: Adult female Turkana breed. (Piers Simpkin)

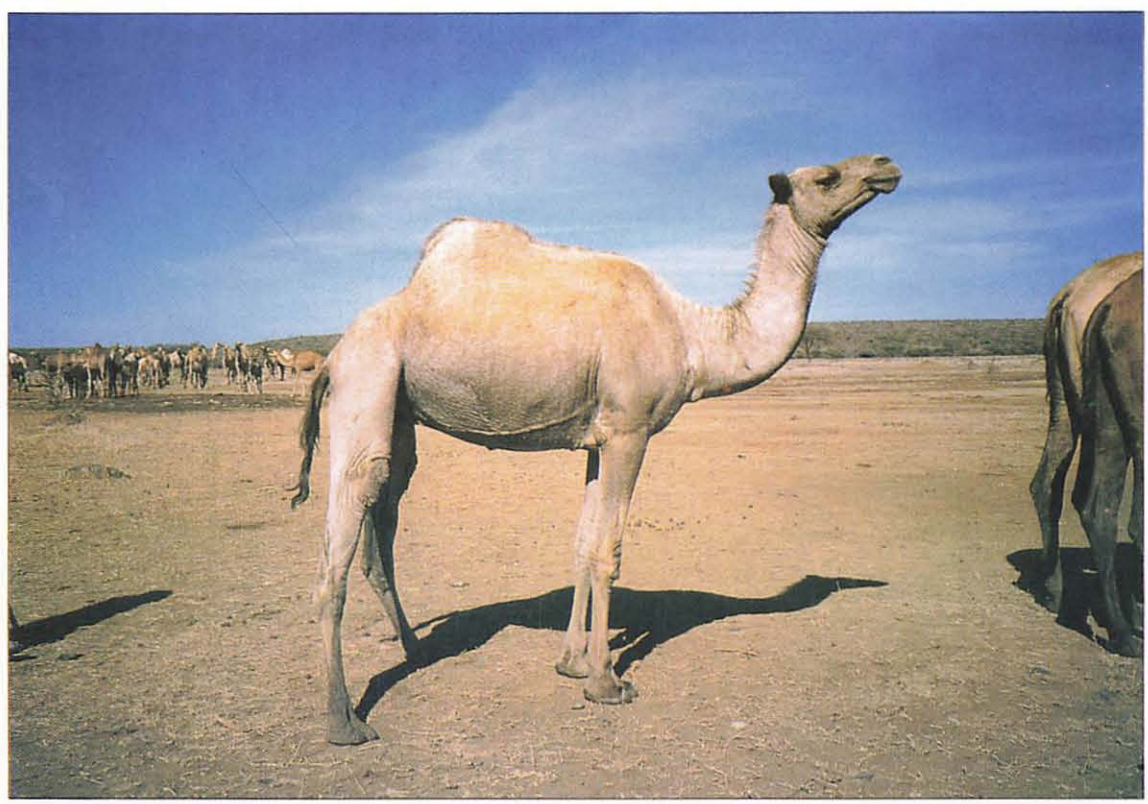


Plate 5.1.11: Adult female Somali x Turkana crossbred. (Piers Simpkin)

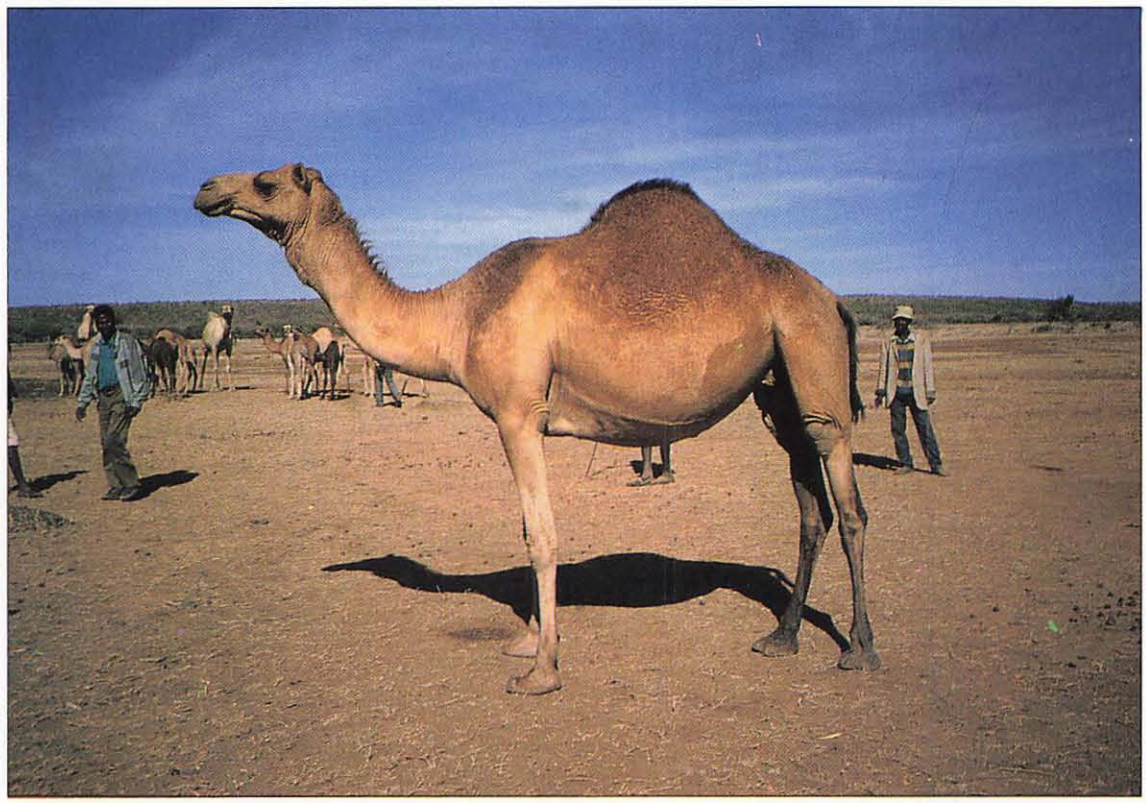


Plate 5.1.12: Adult female Pakistan breed. (Piers Simpkin)

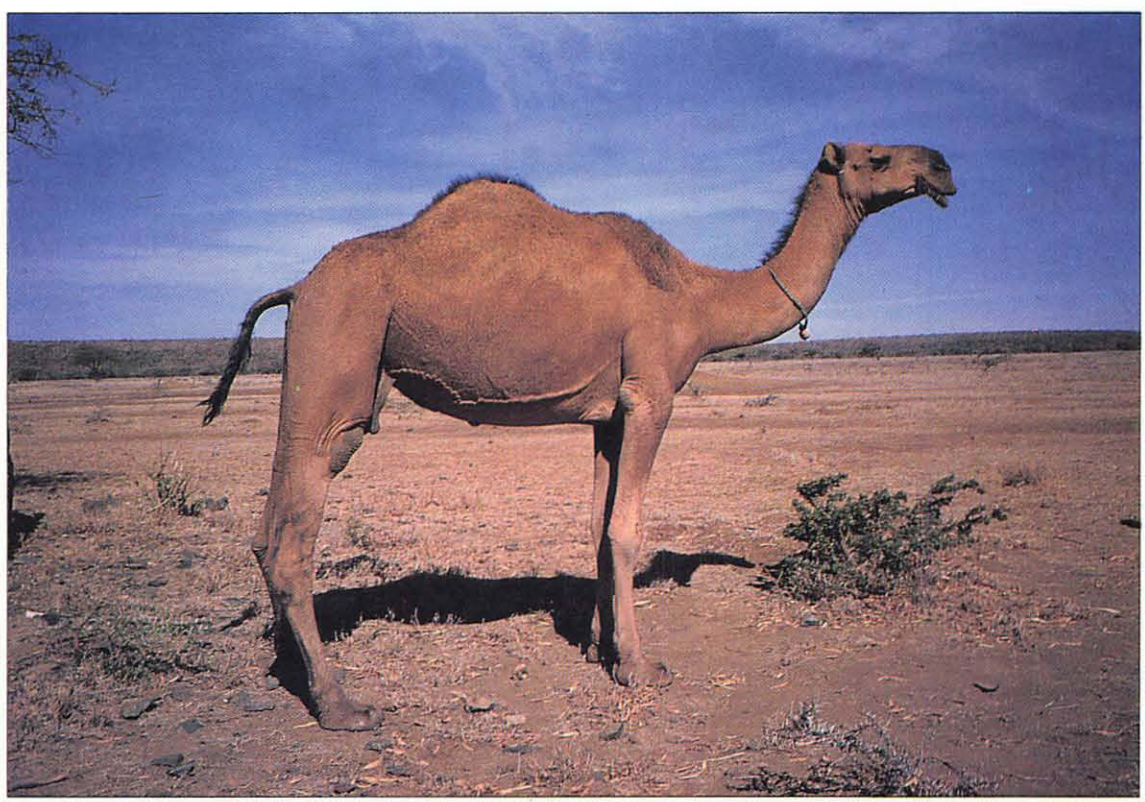
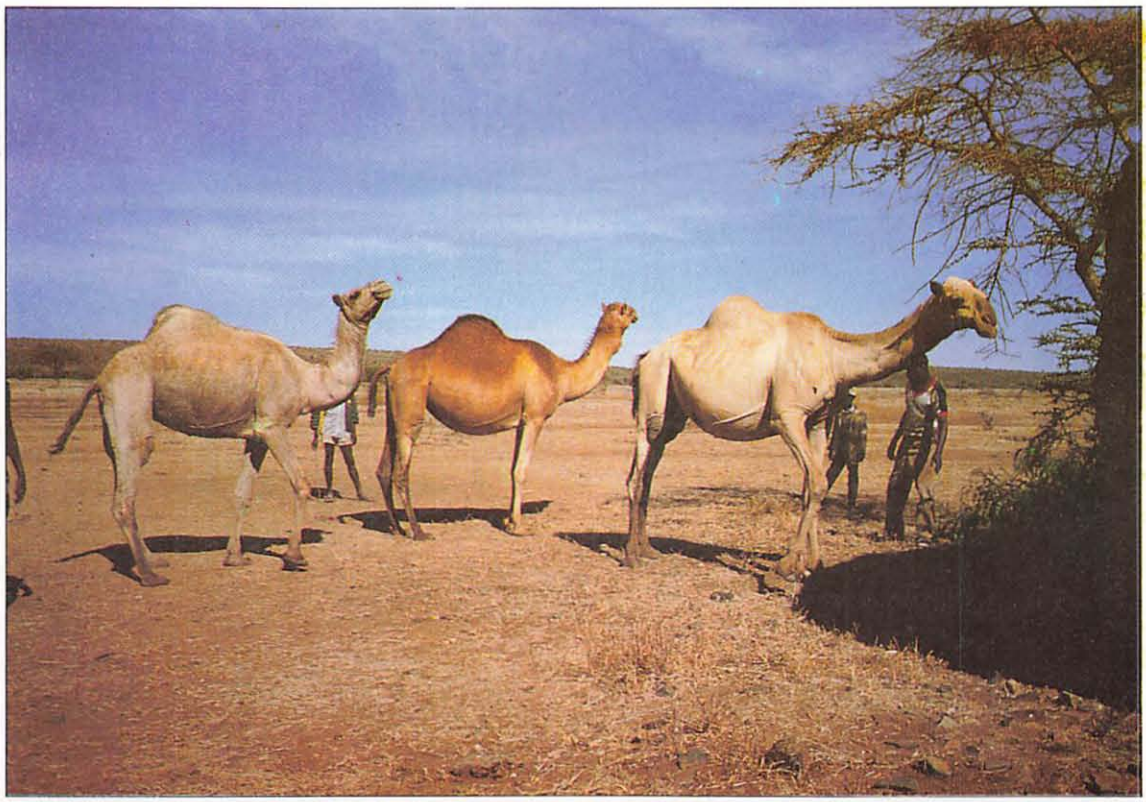


Plate 5.1.13: Adult females: Turkana (L), crossbred S x T (C), and Somali (R). (Piers Simpkin)



CHAPTER 5.2

Camel management system of the Gabra pastoralists

by S P Simpkin

Introduction

The Gabra live in a harsher environment than many of the other pastoralists; most of the area is classified as ecological zones V and VI. The Gabra number at least 20,000 people, 20% whom live in Ethiopia (Torry 1973). Their home range extends over about 35- 45,000km^2 from Lake Turkana in the west to Mt. Marsabit in the east, and northwards into Ethiopia.

The Gabra, like the Rendille, are primarily camel-keepers and have been keeping camels for generations. Many of their management strategies are similar to those of the Rendille.

O'Leary (1984) states that the Gabra 'use the rangelands available to them more extensively than the Rendille', suggesting that they are more mobile. A recent survey showed that most households move 15 or more times per annum. The Gabra send their camels to dry season camps *(fora)* less often than Rendille, and the camels remain closer to the main homestead than the cattle and small-stock, but the homesteads *(wora)* are smaller, more widely distributed over the range, and change location more often than Rendille homesteads. Gabra homesteads tend to be smaller family units than Rendille homesteads which are based on clan relationship.

In 1979 Gabra household sizes were 4.74 persons O'Leary (1984). Each homestead has access to 23.4 camels (Torry 1973). Many of them may not be owned by the head of the household, but he has rights to them. Only a few very wealthy men own more than 80 camels. The total number of camels owned by the Gabra was estimated at 52000 by Torry (1973)

Average herd sizes estimated by Torry in 1973 were 43-50 camels, 150-200 cattle, and 300-400 small-stock. These herd sizes were not those actually owned by one person. A more recent survey in 1992 of 120 households in the North Horr and Gus areas found a livestock breakdown of 18 camels, 19 cattle and 330 small-stock per household. Average household size was 2 adults and 4 children.

Camels are vital to the Gabra way of life, providing the majority of their milk supply, transportation of houses and water, as well as meat. The Gabra also bleed their camels and mix the blood with milk to supplement the diet.

Daily management

Gabra camels are normally kept at or near the main camp. They are released to graze at 9.00am and return at sunset. Due to the lack of predators and building/fencing materials, only small calf pens *(mona)* are built and the camels are left to sleep in the vicinity of the homestead, not necessarily confined to a pen.

Camels are watered at 8-12 day intervals in the dry season. Calves less than 3 months are not taken to water.

Food plants

Stiles and Kassam (1991) list the following plants as "very important" food plants for camels: shiisha (*Barleria acanthoides*), called "food of the camel" by the Gabra, saariima (*Duosperma eremophilum*), d'uurtee (*Suaeda monoica / Salsola dendroides*), and aadde *(Salvadora persica)*. The genus *Indigofera* can be added to this class by combining agaggaro (several *Indigofera species*) and k'ilt'ip'p'e (*I. spinosa*). Twenty species (14 Gabra taxa) were rated as "moderately important in the camel diet.

Table 5.2.1: Important food plants for camel

VERY IMPORTANT (+++):	MODERATELY IMPORTANT (++):
Barleria acanthoides	*Blepharis ciliaris/linariifolia*
Duosperma eremophilum	*Digera muricata*
Suaeda monoica (Salsola dendroides?)	*Sericocomopsis hildebrandtii*
Salvadora persica	*Heliotropium albohispidum*
Indigofera (all species)	*Cadaba farinosa*
	C. gilletti
	Maerua sp.
	Fadenia zygophylloides
	Kedrostis gijef
	Aristida adscensionis/ A. mutabilis
	Indigofera (many species)
	Acacia reficiens
	A. tortilis

Milking management

Breeding and milking management is the same as that for Rendille, except according to Torry (1973) mating is only allowed to occur in the boma during the morning or evening, when the herdsmen assist the bull with penetration.

Calves from 0-3 months old are called hirman, 4-13 month calves are called chonole. Mothers of hirman calves are milked at 9-10 pm, then the calf is allowed to suckle until 2-3 am when it is separated. The camel is milked at 9 am just before being released to graze, and the calf allowed to suckle for a short period. During the day the hirman calf is kept in the pen all day whilst the mother is grazing. Weaning starts in the third month and the chonole calves are allowed to graze in a nursery herd, but are not allowed to suckle in the evening.

Milking of hirman is carried out by boys, but chonole mothers can be milked by older men who are abstaining from sex. Milking is only carried out in the morning and evening.

Daily milk yields peak at 10 litres, and are between 0.5-2 litres in dry seasons.

Sociological role of the camel

Soriu ceremonies are practised similar to those of the Rendille, and during these three months of the year, all camels return to the ola and it is at these times that they may be sacrificed, branded, castrated or gifted (Torry 1973).

Sunday (Ahad) is again sacred to the Gabra and certain limitations as to camel use and management are observed. One factor different to Rendille custom is that Gabra do not use camels for paying fines or penalties.

Certain camels are revered or have certain traditions and restrictions to their use e.g. Doro (progeny of first camels acquired), Fugu (breach birth animals) and Sarma (camels from raids).

The Gabra also include camels as part of the bride price (Karata), normally 2 immature male camels and one immature female. Camels are used for loans and as gifts cementing friendships.

Diseases

Table 5.2.2: Gabra names for some camel diseases and associated flies

DISEASE	VERNACULAR NAME
Trypanosomiasis	Dukan, Ghandi,
Ticks	Yakala
Mange	Chitto
Camel pox	Aftara
Anthrax	Chirrmalle
Nasal bot	Yirrid
Camel flies	Ketan

In their study on plant use, Stiles and Kassam list the following as important medical plants used in the traditional treatment of camel diseases: "Barataa (*Blepharis*) is burned and the ashes are spread over camel wounds: the resin (aamp'e) from (h) ameesaa (*Commiphora africana*) is mixed with milk and applied to camels to remove ticks when they are in highland areas; k'umbi (*Commiphora myrha/ellenbeckii*) the myrrh tree, yields a resin which has many uses. One use practised by several clans is as a ritual cure for anthrax. The resin is chewed and then spat all around the animal enclosure. Aaddaama (*Euphorbia candelabrum*) is used to cure a camel disease called, gaal malaa. A traditional doctor (c'iressa) must prepare and administer the medicine. Araddo (*Commicarpus helnae*) is chewed and spat into the nose of a calf as a decongestant; k'ors nyaata (*Pseudosopubia hildebrandtii*) leaves are chewed up and the saliva put into the animal's mouth to protect it from a curse by a budaa (person with an evil eye); and iddi araddo (the small or young *Solanum coagulans*) is used to treat a throat-swelling disease called c'ilmale by burning it and passing the smoke under the animal's throat."

CHAPTER 5.3

Indigenous camel management of the Gare tribe of Somali people in northern Kenya

by Mohamud Sheikh Adan

Introduction

This paper attempts to provide a record of traditional camel management by the Gare section of the Somali tribe. The paper documents herd management, the names and inter-relationships between the herd and the natural resources (e.g. vegetation types).

Use and ownership of the herd

The camels are used for milk, meat, transport, trade, skins and bride-wealth.

Camels are given to a child at birth (Andura) and later at his circumcision (Dagniqaban). Camels can be purchased for cash (Inbitan), or some people obtain them by working (herding) for a rich man and receive one camel per year as payment. Others acquire camels through friendships and gifts.

Physical environment

The Gare herders describe their physical environment according to the soil types and vegetation, of which there are three main types:

a) Black cotton soil with salt bushes (Kotich). This area is mainly grazed during the wet season when the camels require salt.
b) Woodland on red soil areas (Woyam). An area which provides good forage and shade for all livestock species at all times of the year. It is rich in plant species including *Commiphora spp. Delonix elata, Acacia tortilis* and *Grewia villosa*. After 2-3 weeks in the Kotich areas, herders move to the Woyam areas where the animals flourish and put on weight.
c) Grassland and dwarf shrubs on sandy soil (Ramat). These areas are good for cattle and small-stock, but are not recommended for camels due to the lack of suitable browse.

The camel boma (pen)

The siting of a boma (mona) is one of the very important aspects of camel management. Since a camel spends about three-quarters of its life in the boma, the herders take a lot of features into consideration when selecting a boma site including the soil type, size or space required, surface characteristics (rockiness), the slope and, depending on the season, degree of exposure. In windy areas they look for natural windbreaks.

Herd management systems

The management varies within the same tribe and is determined by the season and the availability of pasture.

The milk herd

The milking herd (Galwara-kaanani) is normally the herd left behind to provide milk for the family. The new-born calves are called Irman and at one year of age are called Chonole. The herd is normally managed by elderly men, women and the young children in the home. When the lactating mothers and calves get weak they are taken to the mobile herd and replaced by camels in better condition.

The dry or mobile herd

The dry or mobile herd (Gal-guase) moves around extensively and is managed by young men (qero).

This herd is composed of pregnant females, immature animals, castrated males (qubl) and the breeding bull (korm).

Loading camels are very important to Somali herders, and are used for moving the village and collecting water. They are also used for carrying camel calves, kids and lambs, and trade-goods. There are two types of load camel - Intact males (Rocho) and Castrated males (Qubl).

The general name for load camels is Oro-faile. Loading camels are managed by the women, herded separately and the two front legs are hobbled so that they cannot wander far from the village. The other herds generally browse 5-6km from the village.

Selection and breeding

Breeding selection helps improve camel productivity; it is important therefore for the herder to know the bull well before allowing it to serve his camels. Herdsmen consider both the dam and sire of the bull, and during selection take into account such factors as hardiness, milk-yield, growth rate, physical appearance and conformation.

The Gare categorise their camels into three breeds:-

- Horki - high milk producers
- Sifdar - meat producers
- Gelab - which are small in size but are hardy and can survive harsh conditions.

Good camel men try to keep a mixture of all three breeds to benefit from all the different capabilities.

Fostering (Gayole)

The process of fostering a calf onto a lactating female other than its dam is called Itigayasan or Itimidan. It is often carried out if the calf dies and its mother refuses to be milked, or if an old female gives birth to a female and cannot bring up the calf. In the latter case a young camel with a male calf is selected, the male calf is slaughtered and the female calf fostered onto the younger camel. The Gare try to maximise the number of females in the herd because females are more valuable and produce milk, whilst males have a lower value as there is no market and they are only useful for loading.

Editors note on Somali camel management

Introduction

The Somali people are generally considered to be the most able and experienced of the camel-keeping tribes in Kenya, but the management systems vary from clan to clan, and indeed there are a number of clans that do not consider camels their most important livestock species. Due to the wide distribution of camels in North-Eastern Province and across into Somalia itself, the management patterns will vary depending on the prevailing conditions of climate and culture. The following notes are general comments based on a limited number of observations, a paper by Mares (1954) and some other articles found in the literature, most of which concern camel management in Somalia itself.

A household survey by Merryman (1987) of pastoral Somalis and settled Somali farmers in Garissa district in 1979, gave a livestock breakdown per household as shown in Figure 5.3.1.

Table 5.3.1: Livestock breakdown by household

STOCK-HOLDING	PASTORAL SOMALIS		SETTLED SOMALI FARMERS	
	1963	1980	1963	1980
Camels	12.4	5.3	20.4	1.1
Cattle	86.3	74.4	69.6	9.0
Sheep/Goats	161.4	117.5	179.5	41.0
Livestock units per household	129.1	99.9	127.1	16.9
Livestock units per capita	11.2	8.6	17.8	2.7

Surprisingly it was the people who had the largest camel herds before the Shifta Uprising and drought who became destitute; but Merryman explained that the cause was not due to the death of the camels through starvation or theft, but due to confiscation and destruction by the warring factions. In both situations the losses of camels and small-stock from punitive actions were larger than losses incurred due to drought. Conversely more cattle died due to starvation than the Shifta conflict.

Camel management

Somali herdsmen release camels to graze at about 8.00 am, but often do not return to the boma until well after dark. On moonlit nights and areas

where there is no predation they may not return until 11.00 pm. The mobile dry herds cover large distances looking for sufficient pasture for the camels. Watering frequency is between 7-10 days during dry seasons.

One of the major differences in daily management between the Somali people and other tribes is the milking management. The Somalis allow calves to accompany their mothers during the day and are only separated for a relatively short period at night. The availability of colostrum to the calf is still restricted, but the calves are seldom separated from the mother. To restrict the flow of milk to the calf the teats are sometimes tied by strings made of *Acacia* bark.

Camels are milked early in the morning and late at night, at least two hours after the camels have returned to the boma. Normally only two teats are milked whilst the calf suckles the other two teats. The herdsmen often milk the camels during the day while they are grazing.

Herdsmen take great care of the calves, ensuring a satisfactory milk intake and picking off ticks and parasites.

Camel diseases

Table 5.3.2: Camel diseases with their vernacular (Gare) names and comments

DISEASE	VERNACULAR NAME	COMMENTS
Anthrax	Kud	
Trypanosomiasis	Dukkan, Gindi	The symptoms of the drooping head (Afarro, ar'arro) and restless pawing (Augsullah) are also used to describe trypanosomiasis. Gudho, Atteh and Melig are other syndromes describing trypanosomiasis.
Ringworm	Ambarr	(The word ambarr also covers any other skin thickenings)
Mange	Ado	(*Euphorbia spp.* gum is used to treat mange)
Camel pox	Furuk, Afrur	
Ticks	Shilin	
Tick paralysis	Gubdo	
Hereditary leg weakness in calves	Haglo	
Calf diarrhoea	Dab	
Helminthiasis	Al, aal	
Undiagnosed mental disorder	Shimber	
Lice	Damijo	
Contagious skin necrosis	Dallehan	
Elbow brushing	Haggagaito	
Camel bot-fly	Sangali	
Biting flies -	Doug - *Pangonia rupellii* Tacarta - *Hippoboscida sp.* Tackar Bal - *Tabanus sp.*	

CHAPTER 5.4

Camels in the Pokot economy and environment

by S McGovern

Pokot as camel-keepers

The pastoral Pokot, with a population of about 40,000, live in the semi-arid land from Lake Baringo to the Kerio river (Ecological Zone VI). Except for a very small group around the Churo area, close to the Laikipia escarpment, the pastoral Pokot live entirely on their livestock. Cattle are traditionally their main concern, with goats and sheep of secondary social importance.

The pastoral Pokot came to their present lands in North Baringo not much more than a hundred and fifty years ago. They came from their immediate former home in the Cherangani Hills, where they had formed a group from several different backgrounds. Mervan Beech, describing their livestock in 1911, mentions cattle, goats and sheep but not camels. Von Hoenhel, however, who passed through Pokot in 1888 does mention camels when describing their livestock. He goes on to relate a relevant and interesting conversation. "We had asked these nomads to bring animals for sale .... they replied, "Your words are sweet to our ears . . . we have plenty of oxen, goats, sheep, camels and ivory. We on our part want medicines and donkeys, lose no time and come to us'". Sadly the ivory is long since gone and the donkey lives on, devouring a dwindling environment. Happily the camel survives and may be a vital factor in the environment's rehabilitation.'

Several Pokot family names are specifically indicative of a camel-keeping tradition e.g. *Chepleke*, *Chepekaterik*, *Chemuswo*, *Chepochepchowo* and therefore it would appear that they came from camel-owning backgrounds before coming to Baringo. The entire *Oro* clan claims its origins in *Kongosis* - the East. The story goes that a man of the clan wandered off one day and got lost. He walked until he reached "the seas". Eventually he came across a camel browsing in the wilderness. He followed it until it led him back to his home. From that day the clan kept camels and they changed their totem from the tree lizard to the camel. One of the clan songs makes clear reference to them having kept camels at Mount Nyiro. Still, today, men of whatever clan who bring camels to water encourage them to drink more by repeating the clan name "*Oro . . . Oro . . . Oro*" in a most enticing fashion.

Thus it seems clear that though the Pokot are not camel-keeping people in the long traditional sense of the Somali, Rendille and Gabra, they do have deep roots and traditions in camel husbandry.

At present there are about 3,000 camels in East Pokot (pastoral Pokot lands). There are a few large herds, the biggest being about thirty camels. The usual herd size is about ten but several people keep about three or four camels. The number of families which own camels is about 250.

There are many families whose fathers or grandfathers kept camels (indeed large herds are mentioned), but who now do not have any. In one evening I spoke to three men near Kositei who are in just such circumstances. One said his father had 200 camels about twenty years ago. Many died in a "cholera" epidemic and the remainder were stolen by the *Ngoroko* (rustlers) in 1978. A second man had inherited ten camels from his father and all were stolen by the Ngoroko in the mid 1970's. The third kept camels but he inherited none. He bought one from Turkana when he married in 1970. He eventually built the herd up to five. Three died in the mid 1980's, he sold one to buy beads for his daughter's initiation in 1987 and the last one, an old female beyond calving age, was slaughtered in February 1991. His wife too had

come from a large camel-owning family (50 camels) but, of course, she inherited nothing on marriage.

I meet similar examples daily. So there is a large percentage of the people of East Pokot with a sound camel-keeping tradition and experience but who now have none.

Camels in the Pokot economy

In Beech's time, 1911, cattle were clearly thriving, but he does mention that overgrazing was becoming evident. Since then the land has obviously deteriorated, especially the grassland. The main sufferers have been the cattle. Browse, however, remains reasonably abundant, the majority of which is *Acacia* species, including *A. tortilis*, *A. elatior*, *A. nubica*, *A. mellifera* and *A. senegal*, to name but some. These are widespread and very palatable to camels. However, *A. reficiens* has also become extremely aggressive over large areas e.g. Nginyang and Kolloa, and is inhibiting grass growth.

In recent dry years the advantages of camel-keeping over cattle and even small-stock have become more and more evident. This is reflected in the increasing number of Pokot who are returning to camels. The main reason for this preference is milk-availability to the family. In the dry season which is regularly six months (October to March), and often more in Pokot, cattle and goats dry up. In more severe dry seasons like 1984 and 1990-1991, they are reduced to unmarketable weights or death. Camels on the other hand maintain their weight, and while their milk production is not big it certainly is sufficient for calves and household. Pokot camels are generally low milkers, (about 2 litres a day to the family is usual) but even in the very severe dry season it continues at only a slightly reduced rate.

Camels are also used for slaughter, sale and capital increase. While I have said that cattle are traditionally the main concern of the Pokot and receive the most attention in songs and ceremonies, camels are very highly regarded and their owners have an aristocratic pride in their status. From an economic point of view they are the most valuable animal, fetching 8-12 goats in exchange, as opposed to 6 for a cow.

Cattle are rarely if ever butchered for sale but camels are and fetch 25/- per kilo in local markets. Camels are frequently ceremoniously killed in the "*Sapana*" celebration (male initiation rite). They are also a very important currency in bride-wealth which is a means of spreading the animal to other clans.

The evident advantages of such an animal are very clear to the Pokot. In the past six years the East Pokot Agricultural Project and the Kenya Freedom from Hunger Council have made over 200 camels available to the people on exchange, purchase and loan basis. The exchange rate is either a large steer or 10 goats; the purchase price is between Ksh. 3,000/- and Ksh. 5,000/-, usually on an instalment arrangement; the loan of a camel helps poorer families with young children over a difficult period. Generally some background of camel-keeping is required but, from what has been said above, this is usually readily available, at least within the extended family.

The Environment

It has been well said that even a camel needs to eat to stay healthy. A major requirement for good camel husbandry is availability of suitable browse. The limiting factors of water and grass availability, which necessitate the movement of cattle, often over long distances, causing stress, hard labour and most of all absence from the home where children are, are much less applicable to camels. Good browse however is vital and this is readily available in Pokot over relatively short distances.

In Nginyang location, where most Pokot camels are herded, a wide variety of very palatable species of browse is available even in very harsh times. The following is a sample of the variety of browse species available in Pokot:-

BOTANICAL NAME	POKOT NAME
Boscia coriacea	Sorichon
Boscia augustifolia	Likwon
Cadaba farinosa	Arerenyon
Maerua crassifolia	Tuwo
Maerua crassifolia	Chepuluswo
Cordia sinensis	Adomeyon
Balanites pedicellaris	Lomion
Balanites aegyptica	Tuyunwo
Salvadoro persica	Asiokonyon
Terminalia spinosa	Tigit
Grewia bicolor	Sitot
Grewia villosa	Mokuwo

Zimenia americana	Kinyotwa
Dobera glabra	Kerisiyon
Vesperis glomerata	Manam pelion

There is also a wide variety of *Acacia* species that either remain green (e.g. *A. mellifera*)- Tulomogh) or shed nutritious seed pods (e. *A. tortilis* - Ses) in the depth of drought.

A very important item of diet is Paratarit - *Loranthus ugogensis*. This is carefully searched for by all camel owners in Pokot. It is a parasite on several trees (e.g. *Grewia spp. Acacia spp.* and *Ximenia americana*).

Of course the rainy season offers less hardship on camel and herdsmen. If the grass germinates, camels are more than partial to a sampling e.g. *Cenchrus ciliaris* - Amerikwo, and *Erogrostis suberba* - Churukechir.

The lack of competition with camels for the higher browse is a major advantage for the animal. A very obvious indication of this is the consistency which major species like *Dobera glabra, Balanites aegyptica* and *Maerua crassifolia* are eaten right back to full camel neck-stretch height.

A not uncommon sight is a large bull pulling a branch often, unfortunately, until it breaks, thus enabling smaller camels to also eat. Whether this is done out of altruistic motives is questionable but it is certainly functional, even if environmentally not very sound.

Management

To get the necessary variety of browse, camels are taken to a different variety of trees every four days. This is usually planned by the household head in the morning. A route is given to the herdsman to enable the animals to avail themselves of a properly balanced diet

The Pokot do not think it very important to move camels is very early in the morning. 8 am. is the usual time to leave the boma, and they even delay up to 9 am. in the rainy season. This seems rather strange given the fact that by eight o'clock it is already getting quite hot. However the Pokots say that the camels do not mind the heat of the day, and are lazy in the morning preferring to lie around the boma. Even if they are out early they are not enthusiastic about eating. I have frequently tried to encourage them to get in an extra hour of browsing early in the morning but no amount of persuasion will change the current practice. They do tend, however, to delay quite late in the evening, often up to 7 pm. they say that they should be back earlier, about 6 pm. for milking and checking for lost camels. This is rarely adhered to though lost camels are a real problem and a common occurrence. If not chased up quickly, certainly by next morning, they get seriously lost as they can ramble off quite some distance from the homestead. This is not infrequently the case with camels about to give birth. In this case the further problems of difficult birth, weak calves, or mothers refusing to suckle the new-born adds to the crisis. This last problem of refusal is quite common especially in first calvers. The Pokot have several strategies for dealing with it. The mother is coaxed gently and slowly to first of all lick the calf. If after an hour or two the calf does not stand up, it is lifted and balanced until it finds its feet. Then it is brought close to the mother's udder and helped to suckle. The teats are pulled till the milk flows. All this can take several hours and considerable patience, which the Pokots possess in abundance. If all this fails and the mother remains nervous and stubborn she is blindfolded with a shuka. This usually quietens her sufficiently to be handled more easily.

In the early weeks of lactation camels are frequently tethered while milking. Usually it is sufficient to tie up a foreleg but if that fails the back legs are bound together high up to stabilise her. In the case of a particularly stubborn mother another person will stand at her head to attract her attention and even wield a long stick to dissuade her from snapping at the milker. All the while the camel's name is called and a variety of clicks and enticements uttered. Badly aimed spits to the face are frequently exchanged between the combatants.

In the case of late abortions and calf deaths, the practice of stuffing the skin of the dead animal with grass is employed. The mother, thus deceived is milked, often for several months, but always in the presence of the stuffed skin. It is usually much easier to milk such a camel, even first calvers, than one with a live calf.

As is reported with the Somali, the Pokot do not practice the culling of calves at birth in order for increased milk availability to the family or the reduction of male numbers in the herd. This is clearly because the number of Pokot camels is much smaller than among their northern neighbours. Indeed every effort is made to keep all camels alive even in seemingly hopeless cases.

Numbers are clearly very important. However some camels - the better milkers - are not put back into calf quickly, and are left to lactate for up to a year, preferring more milk for the household, over quicker birth rates. On the other hand where four or more camels give birth within the same period of time, the less good milkers are put back into calf after a few months. This is sometimes achieved with lots of persuasion and even force by the herdsmen.

Camel herd structure, as with cattle, is decidedly biased in favour of females; usually up to three quarters of the total herd, 40% of which are mature females. Surplus males are disposed of either by slaughter or in ceremonies. Not every herd has a breeding bull. One is usually shared between several herds.

Castration is also practised by special people with "cool hands" for the operation., the corollary being that there are many with "hot hands" who do not do a good job and are forbidden to practice.

The inheritance of camels is unlike that for other animals. A young man when he marries will leave his home, taking with him his cattle and small-stock but frequently not his camels. These are left in the care of his mother, who has the milk use-until the numbers are larger or his father dies. In the latter eventually he then takes his own camels and those of this patrimony. The young man's mother will usually go with him also. In the case of a wife who has no sons, though she may have daughters, she will inherit some camels on the old man's death. This practice is partly allowing for milk availability, but also acts as a labour-saving device. An extension of the arrangement is that, frequently, smaller herds of camels are joined with those of a kinsman or a friend to save on the number of herders required.

Regular availability of salt is important to keep camels in good condition. This is recognised by the Pokot who take their camels to a natural salt patch for "Ngeny" about once per week in the wet season and once or twice a month in the dry season. There are several such places in the district where "Ngeny" is readily available, the most commonly used being "*Lamasinziko*" near to Nginyang centre. If the journey from the home to the salt area is very far and may seriously disrupt the browsing pattern, the salt is often carried to the herd by donkey.

As has been pointed out, milk, though not the only reason why Pokot keep camels, is by far the most important one. Therefore all females return at sun-set to a boma stationed just out of sight of the dwelling houses. The main reason for this positioning, which is scrupulously adhered to, is fear of the "evil eye" which can cause camels in milk to dry up or even die. People of the lineages Kahepuno, Kasetin, and Kamgea possess this unfortunate ability and by no means may they be allowed to see camels with calves. Besides the fear of the "evil eye" (Wutot) the Pokot give, several other reasons for the specific position of the camel boma. Some say that the reason, for the distance from the homestead is that camels intensely dislike the smell of human urine. A most discriminating nicety for an animal not exactly prized for its own perfume!

Other Pokot say that the boma should be out of sight of the women's houses. This probably stems from the many taboos associated with menstruation. During this period women are most certainly forbidden to milk. They are further forbidden to drink camel's or cow's milk, though they may drink that of the goat's. Menstruating women must not put their bare feet in the footprints of a camel. With shoes on they may. Most particularly, not even the shadow of a woman during this period should fall across a camel, especially one in milk, as it may cause it to dry up.

In violation of any of these taboos a cleansing rite must be performed. The first rite to address the problem is called "Kiwotoi Tamasai". Red earth is mixed with water in a wooden dish (Otupo) and the mixture sprinkled on the camel with a branch from the Tuit tree (*Diosportis scalra).*

If this does not produce the desired effect a further rite is performed. In this, a goat is slaughtered and lifted four times back and forth over the camels hump. Then the goat's stomach contents are smeared all over the camel, by the women. Finally part of the skin of the slaughtered animal is tied around the camel's neck, where it remains until it falls off, by which time the exorcism is complete. This rite is essential if the offence was committed by a woman who had aborted in the recent past.

The most important function of all, milking, is performed by both men and women. Milking is done with one hand, the calabash being held in the other. Only a few have mastered the art of two handed milking, balancing the calabash on a raised knee.

Milking can take place up to four times a day in the peak yield time. Early in the morning, about

midday, 7 pm. and once during the night. However, in very dry times when water is scarce and browse less readily available, the milking times are reduced, eventually to only the evening milking.

Calves are kept in a separate shaded boma during the day where they rest and nibble on young branches cut for them. The mothers browse locally. As the weeks go by they wander further from the calf-boma for variety of browse.

Eventually they re-join the herd in their daily routine, returning in the evening for suckling. During the night young calves and mothers sleep in the same boma.

If the number of calves warrant it, they are herded together until weaning time when they too join the herd.

Indigenous veterinary practice

There is a lively trade in a wide variety of roots and barks at Nginyang market every Monday for the preparation of various concoctions for the treatment of human and animal ailments. This is indicative of the depth and wealth of knowledge possessed by the Pokot about their environment.

A few examples of the mixture for some camel ailments follow:

Coughing: Songoghowio - *Xantoxylum chalyberum.*

The fruits and bark of this tree are soaked either separately or together in water and a half litre administered.

"Sokwon" a highland tree found around Churo and Tiati (altitude 2,000 metres). The bark is soaked in half a litre of water and given as a drink.

Diarrhoea: "Chepkogh" - *Capparis cartilagenea*

For calves with scour, this plant is soaked in half litre of water and given as a drench. In mature animals with severe diarrhoea the bark of the "Sungululwa", *Boswellia hildebrantis,* is given soaked in two litres of water.

The bark of "Tilomwa", *Ziziphus mauritania,* is also used for mature animals but this is boiled in one litre of water and given cool as a drench.

Retained Placenta:

"Tilomwa" is again used but a much stronger drench of three litres of the bark, boiled and cooled, is administered.

"Ewais", a type of local sisal, is the more common treatment for this problem. Three or four shoots of the plant are crushed and boiled in three litres of water. When cooled it is given to the animal.

The bark of "Sitot"(*Grewia bicolor),* "Ses"(*Acacia tortilis),* can be similarly prepared and used for this problem.

Fostering

Some strategies for dealing with the case of a mother who refuses to suckle her calf have been mentioned previously. The plant "Sirkonokapsakong", *Cissis quadrangularis,* which is a creeper on seberial trees (e.g. *Boscia and Acacia species*) is employed. The long stems are crushed and applied to the teats. People say that the juice of the plant irritates the udder and the sucking of the calf soothes it. The camel very likely finds the sucking the lesser of two evils and accedes.

Worms: "Kamakiten" - *Albizia anthelmintica*

The bark of this tree is soaked in a little water overnight and used as a drench. As little as 10cc for a calf and 100cc for a mature animal is used.

The Pokot generally do not regard worms as a serious problem in mature camels. Tapeworm, however, is common in calves and can be very debilitating if neglected.

Orf: "Kinyotwo" - *Zimenia americana*

Two handfuls of the seed of this tree are crushed and boiled and then pasted on the mouth of the animal. For *Orf* (Ngirimen) branding with hot irons around the face is believed to curtail the disease.

Trypanosomiasis

Unfortunately the Pokot know of no traditional treatment for "Lokurucho". The closest I could get to their addressing the problem was the use of a cleansing rite and the administration of "Chpkogh" for a high fever. In general the Pokot are fatalistic about this very serious problem.

Testing for Trypanosomiasis was carried out in Kositei in 1987 on three herds of camels. The results showed:

- Herd A, with 11 camels, was 95% positive, the average P.C.V. was 29.
- Herd B, 15 camels, was 75% positive, average P.C.V. 24.
- Herd C, 8 camels, was 25% positive, average P.C.V. 24.

Small camels with a P.C.V. of 27 or over proved positive for trypanosomiasis. It certainly demonstrates that the disease is widespread. 'In otherwise very strong animals, 38% of the total camels tested were positive. High P.C.V. as a "free-from tryps" indicator, would have been very misleading indeed.

One herd in Kositei was given Naganol every six months for three years. During that time no deaths occurred. On reputable advice that this practice reduced the natural resistance of the camel to the disease, Naganol was discontinued. During the following year four camels died. While it is not conclusive proof, it is at least a very strong indicator that Naganol was being effective. It must be pointed out that several other people have advised strongly against discontinuing the treatment. They would seem to be vindicated.

The question of the economics of the practice is important. All the treatments are expensive but the value of the animal is also very high. The loss of one camel, or an abortion, a common result of the disease, would offset the cost of treatment of any herd of camels in Pokot.

The overall conclusion from talking to camel owners is that the disease in general is a much bigger problem than it was in the time of their grandfathers. This was confirmed in 1985 by a survey carried out by the East Pokot Agricultural Project which showed that for those owners who lost camels in the previous generations, 2 out of 3 blamed the disease, rather than rustling by the Ngoroko, for their losses. Clearly a lot needs to be done.

The future

While it is not known exactly how long the Pokot have been keeping camels in their present homeland, it is quite clear that many families have a considerable history of association with camels. For whatever reason, better conditions for cattle, disease or rustling, the Pokot had only very small numbers of camels in the early part of this century. But conditions have changed today and it is evident that the camel must form a substantial part of the answer to the present food security and environment problems. Furthermore the Pokot are admirably equipped to take to such an adjustment. They are used to camels and skilled handlers. Families that do not have the background knowledge can turn to other members of the community for it. Sharing of labour with the herds is a common practice.

It may seem self-evident, but is worth stating that a certain feeling for the animal and pride in their possession are prerequisites for good camel-keeping. It was pointed out to me in no uncertain terms that some of those who lost camels did so from a lack of proper concern and love for the animal. Undoubtedly the vast majority possess such pride and love in abundance.

If planners, development workers and livestock officers play to that strength then the fragile environment of the Pokot will be protected and their contribution to their own economy and hence that of the nation will be great.

CHAPTER 5.5

Camel management amongst the Rendille

by S P Simpkin and F S Guturo

Introduction

The Rendille people are concentrated in the south-west quarter of Marsabit district, with a home range of approximately 13,000km^2. The district is classified as arid to semi-arid (eco-climate zone IV), with a mean annual rainfall of 200-400mm, rising to 800mm on the mountains. The area constitutes a large undulating plain sloping down to the Chalbi desert in the north, and bordered by the Matthews and Ndoto/Oldonyo Mara ranges in the south and west.

The Rendille are cushitic in origin, and approximate 25,000 in number. Together with the Somali and Gabra they can be considered one of the true camel-keeping peoples of Kenya. The environmental conditions are mainly suited to nomadic pastoralism, and until recently the very existence of the Rendille has been totally dependant on their herds of camels and cattle and flocks of sheep and goats, which in a survey during the 1980's numbered 19,000, 24,000 and 107,547 respectively.

Camels play an integral role in the Rendille economy. They are primarily kept for their milk production capabilities, but are also important as beasts of burden. They also provide meat, blood, and skins. The skins are used as sleeping mats, and can be made into sandals, ropes and containers. The Rendille culture is sometimes called the camel culture, and is inextricably linked to the camel.

The religious and sociological importance of the camel

Before the Rendille camel management strategy can be explained, it is imperative to try and understand just how important the camel is to the world-view of the Rendille.

The camel is a sacred animal to the Rendille, almost a demi-god. Camels are the subjects of songs and prayers, and are widely used in cementing friendships and relationships. In the past they have been used to pay "blood-money" in the event of death. The pet name of the camel literally means 'the other half of God'

Camels are the only acceptable currency in dowry (bride-wealth). Even today a Rendille youth has to give the bride's father a total of eight camels (4 males and 4 females) as dowry. In Rendille society a girl is sometimes referred to as 'bringer of camels'.

The whole age-set system is based on the generation time of the camel, a cycle of fourteen years. Until recently it was taboo for any camels to be sold outside the tribe; this taboo is so deeply ingrained that it is still virtually impossible to buy female camels from the Rendille.

Sunday (Ahadh) is the day of the camel. On Sundays all camel products should be kept within the goob (manyatta) i.e. no milk should be sold; camels should not be sold, given out, or watered (especially if there are palm trees *Hyphaenae spp.* in the vicinity of the wells); any raids on neighbouring camel-owning tribes will be successful.

There are various ceremonies at different times of the year, the most important being Soriu and Almadho, when all the camels have to be brought to the homestead (goob) to be blessed. At the ceremonies all male members of the family are supposed to be present - especially the eldest son who inherits the camel herd on the death of his father.

Unlike other societies, e.g. Samburu, where the family herds are split amongst the male members of the family, the camel herd remains the property of the eldest son, and it is not split up into smaller family holdings. Camels within the herd are owned

by individuals but herded on a family basis.

Only men are allowed to deal with the camels. Women are only allowed to enter the camel boma if they are taking the load camels to fetch water or move camp. The women are responsible for loading and leading the load camels, otherwise they are forbidden to have anything to do with the herd.

Daily Management

The camels are kept as part of a mixed herd. In areas with good grazing, or at certain times of the year, the camels remain at the homestead (gob). When times are hard and forage is depleted, only a few milk animals remain at the homestead and the bulk of the herd is sent to 'fora' - a mobile dry season grazing or satellite camp. Fora herds are often away from the gob for more than 9 months of the year, and stay at least 20 km away from the heavily trampled and overgrazed watering points. Due to the large distances covered, and the discomfort of the lifestyle, it is only the young boys and warriors (and some older men) who herd the camels.

By remaining away from the watering points the camels benefit from forage that is largely unutilised by any other stock. Milch animals that remain at the homestead are called Alohi-moora and are periodically swapped between goob and fora in order to keep them as well nourished as possible.

If camels are at home they are only milked after the cattle and small-stock have been milked and released. Cattle are the first animals to be released, followed shortly afterwards by the small-stock. Camels are normally retained in the boma until 8.30 - 9.00am. The camels may be walked up to 10 kilometres from the homestead before they start feeding. The herdsmen try to avoid taking the camels to exactly the same site as they grazed the day before. The camels are brought back to the boma at dusk (7.00 - 8.00pm)

When at fora the camels may be released earlier, but the herdsmen still keep them in the boma until relatively late. If the forage is good near the fora boma, they will graze nearby. Fora camps are mobile, and may move every few days or remain for a period of weeks. There are no houses or cover at the fora camps, the herdsmen sleep outside and survive off a diet of blood and milk from the camels. If the camels are taken to water and return to the same area to graze after watering, they seldom return to exactly the same boma site. The herdsmen construct a new boma nearby; this helps avoid the build-up of parasites, but has a negative impact on the fodder bank. Conversely the very mobile nature of Rendille camel management does have a positive contribution to range management and conservation, since it prevents overgrazing in any one area.

Watering intervals vary depending on the season and degree of greenness of the forage. If the forage is green and there has been recent rain the camels may not be watered for up to two months and obtain all the moisture they need from the vegetation. In very dry periods the camels are watered every 10-14 days (average 11 days). The herdsmen themselves do not drink water during this period, and the camels may be grazing up to 60 km from the nearest water source. Young calves, and sometimes their mothers, are never given water for the first 1-2 months of life. The herdsmen and calves obtain all the water and nourishment they require from the camel milk.

The major camel watering-points of the Rendille are Koroli springs in the Chalbi desert near Kargi, and the south-eastern shores of Lake Turkana. Large numbers of camels are also watered at Ilaut, Ngurunit, Korr, Halisurwa, Logologo and Laisamis.

Ecologically the camel is becoming increasingly important to the Rendille. Their home range has diminished from 57,600 to 13,000km^2 due to large tracts of land being gazetted as national parks or reserves, the settlement and annexation of the higher potential land on Mt. Marsabit for farming, and due to periodic insecurity between neighbouring tribes and countries. Their remaining land is being increasingly overgrazed by cattle and small-stock, especially around the watering-points. There are however, a few areas in the Rendille home range that are accessible to camels only. Other livestock are unable to use these areas at certain times of the year due to their dependence on water.

The breakdown of vegetation types in the Rendille area (Herlocker, 1979) follows:-

Annual grassland	33%
Dwarf shrubs	28%
Shrubland	20%
Bushland	6%
Woodland	4%

The camels can utilise all these range types. Although they are mainly browsers, Rendille camels do occasionally graze (grass) in certain areas and in certain seasons. Camels also browse the *Acacia* woodland, but rarely use the mountain woodland due to the colder temperatures and the risk of tick infestation.

Productivity

Household and herd structure

The Rendille enjoy the privileges of a polygamous lifestyle, however due to the long generation time, and their dependence on the camel for bridewealth, monogamy is more usual. Average household or family size is 7-8 people. Gobs are often comprised of members of one clan, but not exclusively.

The table below shows the average livestock holding of a Rendille household, determined from the results of aerial survey and household data (Field 1979a).

AERIAL SURVEY		HOUSEHOLD SURVEY
12	Camels	12
15	Cattle	11
67	Small-stock	101

A survey carried out amongst camel-owning Rendille households (as opposed to all Rendille households presented in the table above) found that the average number of camels owned per household was 15. In terms of livestock units, camels comprise 40 -46% of the Rendille livestock holding.

The composition of the Rendille camel herd determined from surveys by five different authors is:

Mature entire males	5.2%
Castrated males	12.0%
Mature females	55.0%
Immature camels and calves	27.8%

There is on average one working or load camel per household. The ratio of stud bulls to adult females ranges from 1:5 to 1:18.

Reproductive potential

The female camels mature at the age of 4-5 years, and first calve at 5-6 years. Gestation lasts 390 days on average. There are peaks in calving in December/January and May/June/July, corresponding to the wet seasons. Calving intervals are usually between 24 - 27 months. Abortion rates can be as high as 26%, giving a calving rate of only 21% per annum. The Rendille estimate that one female camel can produce between 8-12 calves in its lifetime.

Male camels mature at 6-7 years and can be used for breeding up to 15 years. Stud bulls (**orr**) generally come into rut during the wet seasons, but if conditions are good they remain in rut even when the rain is over. The stud bulls are selected on a number of characteristics including temperament, past health history, size and colour. White stud bull camels are favoured.

The herdsmen assist the bull with penetration at mating. Male camels that are not selected for breeding are castrated between 3-6 years old. Castration is carried out by open incision, and may be done by recognised elders or respected camel owners.

Not all Rendille camel owners are confident enough to castrate their own camels. The wound is often washed with either human or camel urine to sterilise it. Castrated camels are either trained for loading/baggage purposes (haal/dufan), or fattened for slaughter (folas/dufan).

When a female camel shows signs of parturition she is often brought back to the boma. The herdsmen also assist at parturition. Average birthweights of calves were found to be 25-30kg, with male calves being generally heavier than female calves. The young calf (Nyirigi) remains with the mother both night and day during the first few days, and it is assisted to suckle. Colostrum (dambar) is considered as being bad for the calf, and most of it is milked onto the ground. A camel that is early in lactation is called irban.

Milk

60-90% of the Rendille's diet is milk; 80% of this milk is camel milk. The Rendille generally milk their camels twice a day, once in the morning at about 8.00am, and after they have returned to the boma at about 9.00pm. Some camels may be milked more often, including individual camels with high yields and others at times when a flush of forage has resulted in high productivity (for example after rain early in the lactation). In such cases they may be milked 3-4 times, - morning, noon, and twice in the evening.

Calves are separated from their mothers when still very young, sometimes when only weeks old. They remain in a pen throughout the day. Older

calves are allowed to browse in the vicinity of the boma, but are always rounded up and returned to their pen before their mothers return in the evening. Calves only suckle after all four teats have been milked. They are allowed to suckle during the night, and are again separated from their mothers at 4.00 - 5.00 am. The calves are often thin and suffer high calf mortality during the first year - largely due to complications and diseases arising from poor nutrition.

Only young uncircumcised boys, old or ritually cleansed men are permitted to milk the camels that have young calves. The milking bowl (**urub**) is balanced on one knee, and the camel milked by two people, both milking with both hands. Some milk is left in the udder for the calf.

Mean yields are 2-3 litres per day over a lactation of 41-57 weeks. Total lactation yields are between 680 - 1146 litres. For camels with calves that survive to weaning, daily yields are 3 - 3.5 litres per day. The maximum daily yield recorded was 17 litres, recorded at the peak of lactation in the first three weeks after parturition. Weaning occurs between 8-12 months.

If a camel dies, or refuses its calf, the calf is fostered onto another female. Two methods are used:- a wire or rope is tied tightly to the top lip of the camel, and the camel tied by this method to either the calf, or a tree; or the anus is sewn together or clamped with wood if the camel is particularly stubborn.

If a calf dies it is skinned, and the skin is then put in front of the camel to induce milk let-down at subsequent milking.

Camel milk is drunk either fresh (hannu/keera) or soured (hiy) .

Meat

Average adult liveweights of Rendille camels are 350 - 400kg. Adult bodyweights are reached at 9 years. Adult shoulder heights are 1.7 - 1.85 metres.

The Rendille seldom slaughter camels except in times of drought, celebration, or worship e.g. Soriu or Ilmughit (*a ceremony carried out by the Ariaal Rendille); animals slaughtered in most cases tend to be old. Sick animals are slaughtered just before they would die naturally. Stud bull camels are never slaughtered for human consumption.

The camels are usually killed by slitting the neck in the Muslim fashion; some Rendille sever the spinal column by inserting a spear or knife just behind the head before they cut the throat.

The skin is flayed from the midline down the back.

Certain cuts or joints of meat are reserved for certain sections or age-groups within the community.

Blood

Camels are usually bled from the facial vein, or occasionally from the jugular vein. The blood is drunk fresh, or mixed with milk; and is drunk more often in times of hardship than plenty. All ages and sexes can be bled, but immature males tend to be bled more than others. Stud bulls are never bled for human consumption. On average 3 litres are taken from each animal, and the same animal is seldom bled again within a period of one month, but the frequency really depends on the number of camels in the herd and the number of mouths to feed.

Transport

The use of the camel for both milk and transport has ensured the survival of the Rendille over the past decades. As the Rendille become less nomadic, they are training fewer and fewer load camels, a syndrome that could well lead to a catastrophe in the near future. In order to utilise the rangeland to its full, the Rendille need to retain their mobility. It is only through their possession of load camels that they might move to better pastures and ensure a regular delivery of water.

The Rendille use a 'saddle' or 'pack-frame' made from four *Cordia sp* sticks, tied together at the apex both fore and aft of the hump, and tied at the base on either side and just behind the pedestal. The camel is led by the means of a rope tied to the lower jaw, behind the incisor teeth. They are hobbled by tying up one or both front legs, using a rope from the fetlock (ankle) to the forearm just below the elbow pad.

Most journeys are to collect water, and cover a distance of 20km every 3-4 days. Rendille camels generally carry 4 twenty litre plastic jerrycans, plus assorted smaller containers, a load of approximately 100kg.

Mortality

Calf mortality is very high - up to 60% during the first year has been recorded, and 50% losses are not unusual. Subsequent mortality rates are much lower, approximately 2 - 6% per annum. Death is usually due to disease, although predation can be a problem in some areas.

Diseases

The commonest diseases in Rendille camels are shown in the Table 5.5.1 below, more details about these diseases are given in a later section.

Table 5.5.1: Common diseases in Rendille camels

DISEASE	VERNACULAR NAME	TRADITIONAL TREATMENT USED
Trypanosomiasis	Omar	Bleeding
Helminthiasis		
Ticks	Chillim	Moving boma, shaving calf and washing with roots of *Khedrostis* sp. (Sarhudu) boiled with tobacco.
Swollen Glands	Khanid	
Mange	Haddo	Taken to Koroli to drink salt water, and roll on the saltpans.
Camel pox	Afturro	Branding sub-maxillary gland

Other less important diseases include:

Coughing (Dahassi) which the Rendille again try to cure by bleeding. Abscesses (Malah) which are treated using soup and sheep fat. Blackquarter (Khadit).

A list of medicinal plants, and forage plants favoured by the Rendille can be found in a later section.

Conclusions

The importance of the camel to Rendille survival is well appreciated. There is a proverb that says "when a man dies, his brother sheds tears with one eye, and counts the camels with his other eye". Despite the fact that the Rendille are totally dependant on their camels as a source of food, esteem, and well-being, there is a trend towards cattle-keeping in preference to camel-keeping. In such an arid and unsuitable climate, this trend can only lead to heavy losses and destitution in the long-term. The apparent reason for this trend is that cattle are more marketable than camels, and with an ever increasing involvement in the cash economy, the Rendille are being forced to adopt this high-risk investment policy. In order to prevent the threat to their future, one of the requirements the Rendille need most urgently is a suitable market or outlet for their mature male camels. A balance between marketing males for meat, and training them for load-carrying, will ensure a safer future for these very capable camel pastoralists.

CHAPTER 5.6

Samburu camel management strategies

by S P Simpkin

Introduction

The Samburu people are a Maa - speaking society often considered an offshoot of the Maasai. Similar to the Maasai they are pastoralists who, historically, largely depended on cattle and mixed herds of sheep and goats for their survival. In recent years however, due to a number of natural catastrophes, the Samburu have had to look for alternative forms of income-generation including wage labour and diversifying their activities into sedentarised agriculture and camel husbandry.

Samburu district is in Rift Valley Province, and covers an area of 20,804 sq. km. from the southern shores of Lake Turkana across to Isiolo. 84% of the area is described as low potential and is semi-arid; rainfall averages 200-450mm for most of the district, rising to 700mm in the higher areas of Leroghi division. The rainfall is bimodal - peaking in April and November for most areas, and with a single peak in August for highland areas. Altitude varies from 100 - 2,000m.

Human and livestock population

The estimated human population for Samburu was 98,000 in 1988, 75% of whom were ethnic Samburu, and 17% ethnic Turkana. The population in 1984 was estimated as 67,000, and in 1991 as 125,000 (Pavitt 1991). The 1990 average household size in the district was 7.9 people per household (Iles 1990). A more recent survey of Samburu camel-owning households found the average household consisted of 3 adults and 6 children.

Similar to the Maasai the Samburu were largely dependant on cattle for their existence. The whole traditional structure of tribal life revolved around the cow. The 1984 cattle population was estimated to be 117,483. In 1983 the average herd size was estimated as 35 cattle per household.

In 1922 the cow:person ratio was 15:1; the 1984 cow:person ratio was less than 2:1 (Sperling 1987). This dramatic reduction in numbers is due to a number of causes:-

1. Raiding by ngoroko and shifta bandits from 1964-1980.
2. Foot and Mouth disease epidemics in 1970 and 1976.
3. East Coast Fever in the highland grazing areas since 1976.
4. A series of droughts, the most recent being 1959-61, 1965, 1971, 1979-80, and 1983-84.
5. In the last 25 years alone it is estimated that the Samburu have lost between 20-55% of their traditional grazing areas.
6. An increasing rise in population growth rate both naturally and, since 1915, through immigration from Turkana district and, more recently from the highly populated agricultural districts.

In a livestock census in 1983 there were a reported 10,282 camels in Samburu district, but Sperling (1987) calculates that only 5,404 would have actually belonged to Samburu owners, the remainder being owned by Turkana people living in Samburu district. Estimates of the number of camels in the district in 1990 were in the region of 15,000.

The breakdown of livestock ownership from a recent survey of Samburu camel-owning households is presented in the table below:-

SPECIES	MEAN	MEDIAN	RANGE
Camels	14	11	1-115
Cattle	50	33	0-400
Small stock	144	100	2-2,000

The figure for the number of camels owned, compare favourably with those found by Sperling in Wamba division, where the mean camel herd size was 14, but the mode was only 8 camels.

Reasons for and methods of obtaining camels

The trend towards camel-keeping is primarily a response to the recent extended dry periods or droughts, and a realisation that the cow can no longer supply all the food requirements of an increased human population.

The Samburu have been in contact with camels for a long time, especially those who have lived alongside the Rendille or Turkana. Many Samburu clans have links with Rendille clans or families, and from time to time in history individuals have gone to live with their Rendille neighbours. Similarly with the Turkana, despite a certain past enmity between the tribes there have been periods in their histories when they integrated closely, particularly as wage-labourers for each other.

Camels became more common in Samburuland following the first recorded migration of Turkana into Baragoi division in 1915. In a survey in Leroghi division in 1928, a total of 189 camels were counted, all of them male pack animals. Numbers increased in the 1950's but it was only in the 1960's that a large number of Samburu people started buying camels from the Turkana at Baragoi. Further peaks in purchasing of camels by the Samburu occurred in 1971 and 1985, years following drought periods. 63% of Samburu camel-owners interviewed had obtained their camels within the last 15 years; only 7% of families had owned camels before 1950.

The table below shows where they had obtained their camels:-

Bought from Turkana	59%
Bought from Pokot	3%
Bought from Rendille	8%
Bought from Somali	12%
Bought from other Samburu	8%
Inherited	5%
Received as dowry	5%

Bride-wealth is becoming an increasingly important means of obtaining camels.

In the survey carried out in six selected communities in Baragoi division, between 15-84% of heads of household owned camels. Overall 39% of Samburu households and 28% of Turkana households possessed camels (Iles 1990). It was found that the Samburu who first obtained camels tended to be the wealthier individuals in the community.

The Samburu are much less nomadic than their neighbours, and therefore their camels tend to herded in a similar manner to their cattle. In fact the majority of Samburu camel-owners obtained camels for their milk producing capabilities. Spencer (1973) claims that camels produce more than 4 times the yield of milk than cattle in these areas, whilst Stiles (1983) claims the figure to be 5-10 times more. Many owners state that they obtained camels to provide for the family, enabling them to release their cattle from the homestead and go to satellite grazing camps (lélé) earlier in the dry season. In effect the camels are kept in a sedentary manner in order for the cattle herd to be more mobile - a bit of an anachronism since camels are better adapted than cattle to be mobile in an arid environment.

Camel meat is often eaten in Samburu homesteads but, compared to goat and cow meat, it is not a preferred component of the diet, especially amongst Samburu in the highlands of Leroghi division where camels are not so common.

Very few Samburu use camels for transport, primarily due to a lack of knowledge about training them, but many owners express an interest in owning pack camels.

Daily management

As mentioned above camels are mainly kept for milk, secondly for meat, but rarely for transport, and Samburu camel management strategies are comparable to those of Samburu cattle management.

Camel-herds are released at about 8.00am and return to the *boma* at about 6.30 - 7.00pm. Young calves are often separated from their mothers during the day, but the practice varies from place to place. Herding is usually done by young boys or girls, or by the owner's wife.

Camels are milked 3-4 times per day, with milking often carried out by the women. Milking imitates the style favoured by the Turkana - the camel has one side of the udder milked whilst the calf suckles the other two teats. This is the same manner in which the Samburu milk their cattle; they milk with one hand and hold the milk container with the other hand.

This relatively slow and inefficient method of milking probably results in a lower milk output to the people, and enables the calf to obtain a better proportion of the yield, and subsequently the lower calf mortality rates recorded in Samburu herds when compared to Rendille herds.

Camel watering intervals are shorter than those of Rendille camels, some camels are allowed free access to water, many are watered at weekly intervals, others may only be watered at fortnightly intervals. The main constraint appears

to be water availability rather than actual need by the camel.

Only 11% of owners had camels at dry season camps (lélé), away from the homestead (engang).

Present role of camels

Out of 261 camel owners interviewed in Samburu district, 35% of owners obtained most of their milk from their camels; 63% of owners still relied on their cattle to fulfil their milk requirements.

It is interesting to note that the camel is now increasingly included in bridewealth payments amongst the Samburu. In the past year, 10% of owners interviewed had received camels as bridewealth, and 15% had given camels in bridewealth.

The survey found herd composition to be:

Stud bull	5%
Castrates	12%
Adult females	40%
Immatures	26%
Calves	18%

This herd composition is exactly the same as for adult male camels of Rendille herds, but the Samburu owners have a lower percentage of breeding females and a higher percentage of immature and young stock - an indication of a growing herd that has not yet reached equilibrium.

Constraints to camel keeping in Samburu district

The major constraints to camel keeping include:

1. A lack of traditional knowledge or past experience. Many owners for example do not know how to castrate camels and are dependant on the few owners who have kept camels for a longer period, or will ask advice from any Rendille or Somali people living in their immediate area.
2. Lack of experienced manpower for herding and caring for the camels. Some herds receive a minimal input, and some animals are not actively herded.
3. Lack of mobility, and subsequent high infestation levels of ticks and worms.
4. The highland environment of Leroghi Division and cool damp conditions and lack of salt, lead to skin problems especially mange.
5. Widespread distribution of *Capparis tomentosa* (Laturdei) a plant well-known for its toxicity to camels.
6. Lack of available breeding stock, and lack of markets for excess male stock.

Despite the many advantages of camel-keeping identified by Samburu, until such a time as there is a readily available market for camels and a reliable source of advice and veterinary back-up, many Samburu will not build up significant herds of camels because the investment costs and risks are high, and there is very little opportunity for selling stock once numbers have built up. The lack of market for camels has kept prices artificially low within the district.

Common diseases

DISEASE	VERNACULAR NAME	TRADITIONAL TREATMENT USED
Trypanosomiasis	Saar	Segetet
Helminthiasis	Kinyoot (in small-stock)	Lmugwatan
Ticks	Lmanjeri	Tobacco
Swollen Glands	Nangarigar	(lit:gland) Branding
Mange	Lbebedo	Salt, Engine oil
Camel pox	Afturro	Branding sub-maxillary gland
Capparis poisoning	Laturdei	Lmugwatan
Diarrhoea	Ngorotit	
Other conditions often quoted as being a problem:-		
Cough	Lchama	
Retained afterbirth	Modong	Drenching with roots of *Salvadora persica* (Sokotei) boiled in water
Anthrax	Lokuchum	
Spider web	Lderepenya	
Tapeworm	Ltuma	Lmugwatan

Popular traditional remedies include branding and administering brews concocted from the bark and seeds of local trees and shrubs such as:

- *Myrsine africana* (Segetet)
- *Xanthophyllum spp* (Loisuk)
- *Albizia anthelmintica* (Lmugwatan)

A mixture of sheep fat, soup, and the burnt skin of a sheep (Saar) is often regarded as having medicinal properties.

The actual effectiveness of these remedies are untested and may be of limited value. The use of the roots of *Salvadora Persica* (Sokotei) however, are very effective in expelling retained afterbirth, and have often been used by the author with great success.

CHAPTER 5.7

Turkana camel management

by Dr M Dioli

Introduction

Turkana are mainly cattle-keepers originating from the Karimojong area of Uganda. They have acquired camels through intertribal raids with neighbouring camel-keeping tribes notably the Rendille and Gabra. Due to this fact their management of the camel is very poor and camels are kept as some sort of cattle.

This is also facilitated by the fact that in Turkana District there is a relative abundance of watering points and so real management of the camel, as an animal capable of utilising arid areas, has not been developed.

Management

Camels are kept solely for milk and blood. They are not used as baggage animals. Milking is done by women from just after delivery (colostrum is milked and utilised) up to two or three months before the next delivery. Milking is controlled by keeping the calf and its mother separate, starting a few weeks after birth.

Calf and mother are allowed to be together only when the mother has to be milked and after she has been milked (but just for a few hours). The milking frequency is very variable, often four times a day, but even reaching seven times a day during the rainy season. Normally a Turkana camel (not a heifer) is able to produce a mean daily yield of about two litres of milk in a lactation 16-18 months long.

Calf weight at delivery is around 23-25 kg. Adult females weigh around 400 kg with a height at the wither of 1.8 m. Bulls are of course bigger but usually not over 600 kg and not over 2 m tall.

Bleeding is done on both male (bulls and immature) and female (adult, lactating, heifer, pregnant) camels through the jugular vein. The volume collected is variable, but 5 litres and even 7 litres have been recorded from an adult female.

Often the herd is not herded: in the morning the camels are just pushed in one direction, while later in the day somebody will go and bring back the animals to the camp. If herding is done, it is often a young boy or a woman who herds.

The grazing time is variable, usually from 8 - 9 am. to 5 - 6 pm. During the main rain season the herd is brought back to the camp at midday so that animals can be milked. In Turkana, camel herds are never allowed to graze during the night.

The camel enclosure is quite simple, just a circular area surrounded by a wall of *Acacia* thorn branches. Only the adult females are penned in the *boma* during the night, the other adult camels in the herd, immature males and calves are just left out, so losses due to predators (hyena) are quite common.

The watering interval in the dry season is normally 3 - 4 days and in case of open watering points the camels are allowed to stand in it and contaminate the water with their urine and faeces.

Herd size is commonly around 15 - 20 animals. Bulls are not controlled and they usually wander for long periods and over large areas when they are rutting. Very often herds do not have a permanent breeding bull but use wandering bulls or young bulls (4-5 years) that are not fully developed.

Males are castrated for fattening when they approach 3 - 4 years. Slaughtering is done through spearing the chest and after the animal has collapsed and died the carcass is dismembered by women, but in no particular method or order.

Traditional veterinary treatments

The main traditional medicine against diseases is branding. The chest is branded against pneumonia; the abdomen and the pedestal area against trypanosomiasis; the parotid lymph node against camel pox and other localised swelling. To rid the young calf of tick infestation (by nymphs) mud is applied in thick layers to suffocate the ticks and facilitate their removal. Sometimes the hairs are cut in body areas the ticks (nymphs) are commonly known to infest (chest and shoulder) .

Castration techniques

1. Castration technique is very crude. Two cuts are made on the scrotum (on the top of each testis), the testis is pulled out, the vaginale is cut and the testis extracted and then cut (open method). Nothing is done to avoid haemorrhage and there is no ligation. Sometimes immediately after the testis are cut, fresh faeces, from the same camel, are smeared on the wound (the faeces are diarrhoic). In case of infection chewing tobacco is put in the wound.
2. Another technique sometimes used: a rope is tied around both the testes at the base of the scrotum, then the rope is pulled so that the testes are pulled as far as possible from the body, then a piece of smooth wood is placed under the cords and a smooth wooden "hammer" used to beat the cord several times.

Castration is mainly done on animals 4 - 5 years old. It is not done for pack animals, since Turkana do not use camels for loading, but just for having fatter and more manageable animals.

DISEASE	TURKANA NAMES FOR CAMEL DISEASES
Trypanosomiasis	Lokiri
Haemorrhagic septicaemia	Lorarrurei
Pneumonia	Loukoi
Mange	Emitina
Dermatomycosis	Akiserit
Pox/Contagious ecthyma	Ettune'
Diarrhoea	Loleo/colera
Ticks	Emadang
Abscess	Abus
Abortion	Akiecium

CHAPTER 5.8

Ranch management of camels

by J O Evans

Introduction

Most ranchers have learnt much camel lore from traditional camel pastoralists, to whom thanks and appreciation are due. Most ranchers follow traditional methods fairly closely.

Daily management

The camels are herded out by day and brought into enclosures at night, either adjacent to other types of stock or in a camel-camp. This is necessary to guard against predators, theft and loss from the sometimes wandering habits of camels. The *manyattas* (camps) are moved to new locations from time to time, according to the weather and forage and hygiene of the camp.

Compared with the northern rangelands, watering camels on a ranch is no problem, due to their mobility and the comparatively short distances involved.

The main differences between ranching camels and pastoral herds are:-

1. Ranched camels are confined to rather limited boundaries, whereas pastoralists can usually move to better feeding areas as conditions demand, sometimes many hundreds of miles.
2. Ranchers employ paid herdsmen who may not have the same personal interest in the animals as a nomadic herdsman living with his herd, resulting in shorter browsing hours and less attention to individual animals. This probably also applies to demonstration herds kept by aid organisations. This aspect needs as much attention as possible as it puts the camels at a disadvantage.
3. Ranchers should have an advantage in access to more sophisticated veterinary input and advice and a regular supply of salt and minerals. Also easier access to literature.

Advantage of camel ranching

The advantages of ranching camels are numerous:-

1. Camels do not compete for forage with cattle or sheep and only do so marginally with goats. They browse on bushes and weeds almost exclusively, using a great variety of plants that are otherwise unused. This improves the grazing for other animals. They also eat a lot of flowers and seeds of species that would otherwise encroach on grazing land.
2. Camels produce milk for the ranch throughout the year. They even produce milk in bad times when the cattle scarcely produce enough milk for their calves. Most ranchers have an urgent need to increase milk production from their herds, since their original stock was bought from pastoralists who, quite rightly, do not sell their better animals. Improvement can only be achieved by selection (a very slow process taking many generations) or the introduction of "milky bulls". There is nowhere in east Africa where proven bulls are obtainable. Even if such bulls could be identified it is still a long process to improve a herd, due to the camels rather slow breeding rate. Artificial insemination is still in the experimental stages.
3. Work camels contribute considerably to the economy of the ranch. They carry salt and food and water to the *manyattas*. Riding camels patrol boundaries and fences, and follow lost or stolen stock. Draught camels are used with dam-scoops for cleaning and making dams, particularly where tractors cannot reach or get bogged-down. They pull har-

rows, scutches and carts. One camel will pull as much as two large work-oxen or four small ones. They are patient and determined, and steady in a cart. One camel will pull half a ton in a two-wheeled cart on rough ground (see "Saddles and harnesses").

In Pakistan one camel pulls 2 tons in four-wheeled rubber-tyred carts (personal observation). In Australia, harnessed in teams, each camel can pull half a ton in a wagon over rough ground (Barker (1961), Bergin (Chapter 2.1). Our camels have dredged a canal three feet deep in water, and have pulled stuck vehicles out of mud. They are also used for pulling thorn trees to build *bomas*. Trained baggage and riding camels can be hired out.

There is an increasing demand for camel breeding-stock from cattle-keeping pastoralists who have now realised the importance of camels. (We sold the first camels in Masai-land to Salaton in 1987, and they have been a great success). Commercial beef ranches are also interested.

Marketing of camel meat and fat is needed for a better appreciation of its excellent qualities. The price is generally lower than that of beef even though on average the quality is probably better. The growth rate of camels in range conditions is better than that of cattle, but it is offset by their slower breeding rate. When marketing improves there is a big potential for buying and growing out young males, which will in turn augment bush control in suitable areas.

Camel hides tan well and make good leather, but need market appreciation. (See Chapter 2.6).

Camel wool is insufficient to create a market. Calf wool needs mixing with sheep wool for spinning and can be rather rough (see Chapter 2.7).

Disease control

The programme of inoculations and treatments given on Ol Maisor is as follows:

- Young camels are inoculated against "Orf" with sheep 'orf' vaccine made by the veterinary laboratories, Kabete.
- Calves are ear-clipped to show month and year of birth.
- Weaners are inoculated against Blackquarter and Anthrax (Blanthrax), and drenched against worms. They are branded with the ranch registered brand, and are branded with their individual identification number.

All camels are inoculated with Haemorrhagic septicaemia vaccine when necessary. Trypanosomiasis drugs are administered when this is suspected (see Chapter 7.1). Worm drench is given to "bad doers".

"Neguvon" or "Ranide" is used against nasal bots *(Cephalopina titillator)* when detected.

Skin disease, wounds and abscesses are treated (see Chapter 7.2).

Salt and minerals are constantly fed (see Chapter 3.4).

Detailed records and data are collected on every camel (see Chapter 8.1).

SECTION 6

PHYSIOLOGY AND REPRODUCTION

CHAPTER 6.1

Anatomy of the camel

by R T Wilson

"The Camel's hump is an ugly lump
Which well you may see at the zoo."

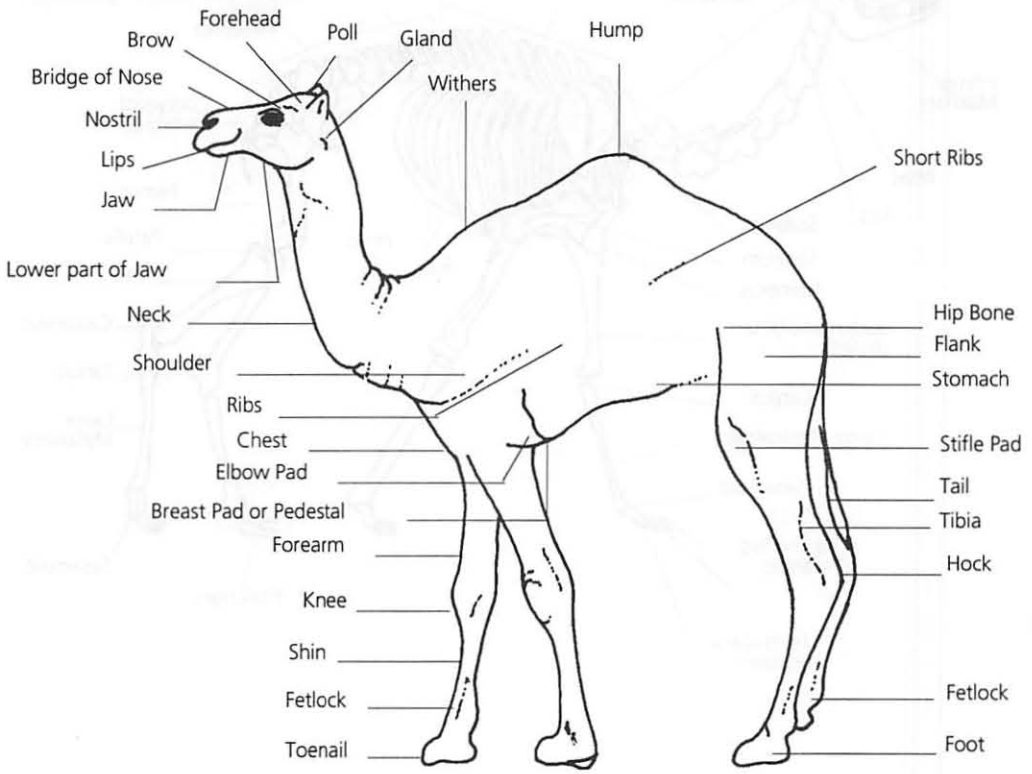
The Hump by Rudyard Kipling.

A morphological sketch

The camel is the most distinctive of domestic animals; the hump and the long, curved neck are its most noticeable feature. Another striking feature is the presence of the peculiar horny pads on the elbows, stifle and chest (Figure 6.1.1). The legs are relatively long and slender, an adaptation, perhaps, to a long easy gait and to adaptive cooling, and terminate in large disc-like feet. The weight of the head and neck have resulted in very heavy forequarters to support this burden: more than 65 per cent of the camel's total weight is supported by the front limbs (Kingdon, 1979). The chest is deep and narrow which allows the balance to be shifted easily so that it is directly over the weight-bearing foreleg during locomotion. The waist slopes sharply upwards and is very constricted, appearing to be loosely connected to the long thin hind legs. The generally rather weak hind-quarters are accentuated in riding types.

The head, while often appearing large and ungainly on the end of the long neck, is small in comparison to that of other animals. It bears no horns and has small bluntly-pointed ears. The eyes

Figure 6.1.1: Morphology of the camel (Source: Acland, P.B.E. (1932). Notes on the camel in the eastern Sudan. Sudan Notes Rec. 15, 119-149.



are large and prominent but the massive supra-orbital processes give some protection and there are long lashes. The nostrils are long slits which can be closed as a protection against sand. The upper lip is split and hairy, extensible and slightly prehensile; it is very sensitive. The lower lip is large and pendulous. The male and female both have two glands behind the poll.

The skin is supple, covered over the most part of the body with short fine hairs, which may be longer in cooler climates or during the cooler season in hot areas. The longer hair is usually confined to the hump and the shoulders but this varies between individuals. The hair colour is generally brown, varying from deep chocolate (almost black), through reds, rusts and fawns to almost white in some types. Some two-coloured animals occur, particularly in the western Sudan and Chad. The tail is short and hairless except for a row of hairs down each side and a less noticeable row along the upper surface.

The female has a four-quartered udder. The testicles of the male are positioned high up in the groin (as in the pig or dog) and the opening of the sheath is directed backwards.

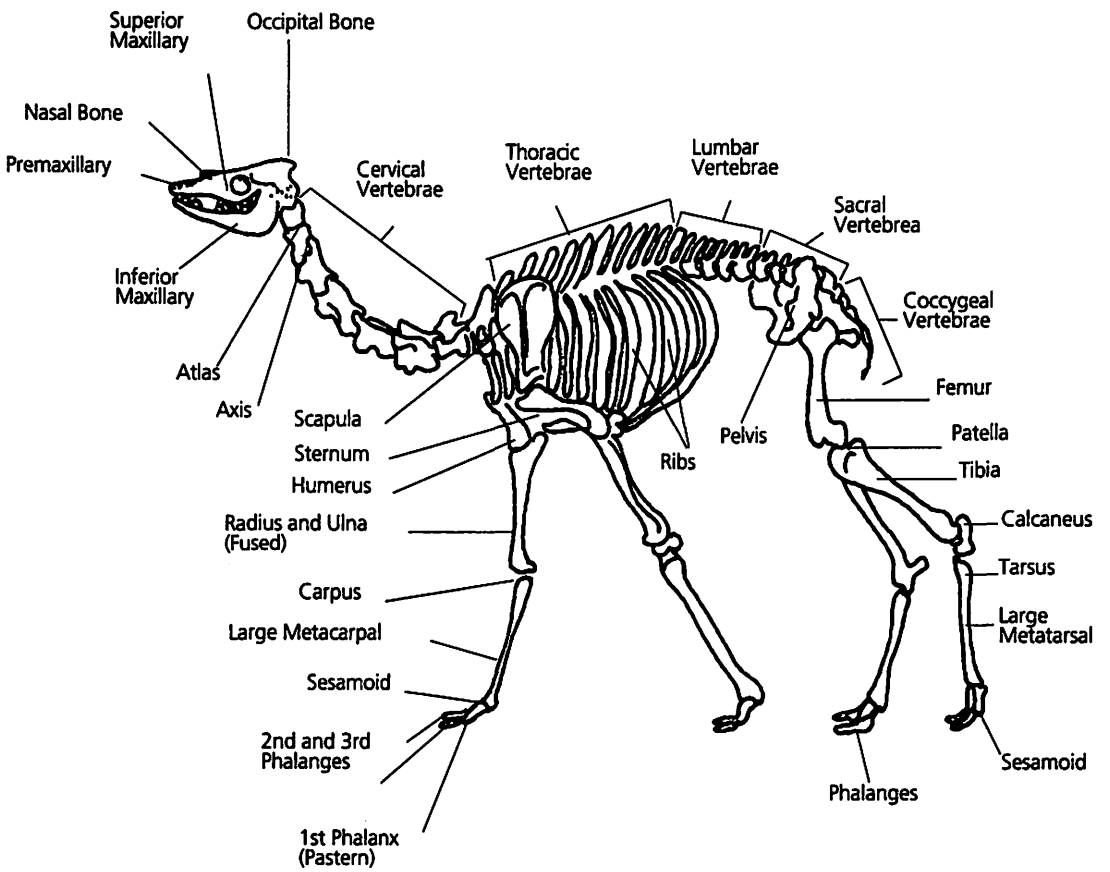
General Anatomy

This section deals with the anatomy of the hard and soft parts. The digestive system and dentition, the lower limbs, feet and locomotion are rather peculiar in the camel and are treated separately below.

The Skeleton

The skeleton of the camel is shown in Fig. 6.1.2.

Figure 6.1.2: The Skeleton of the camel (Source: Kingdon, J. (1979). East African Mammals, Vol. III, Part B Large mammals, Academic Press: London).



The Head

The skull of the camel is more nearly comparable with that of the horse than with that of any other domestic animal (Leese, 1927). The occipital crest is prominent and is responsible for the peak-shaped poll of the camel; the bone is massive, up to 7 mm thick between the apex of the crest and the cranial cavity. The posterior surface of the occipital bone has a rough projection to which the strong ligament, the ligamentum nuchae is attached: this ligament is largely responsible for supporting the weight of the head and neck. The temporal fossa is very wide; the width of the frontal bones is responsible for the 'beetling brows' above the eyes. The frontal sinus, in which are often found the larvae of the camel bot fly, lies immediately below the facial portion of the frontal bone. Each sinus is triangular in shape. The orbital cavity (the eye socket) is very deep.

The bone structure of the face results in the hollow between the bridge of the nose and the eye socket seen in the living animal. The nasal bone is often convex giving rise to the bulge or Roman nose. The nasal cavities are narrow. The socket of the upper incisor or canine tooth is in the premaxillary bone and the rest of the teeth are lodged in the superior maxillary bone. The hard palate is narrow, in particular behind the first premolars. The inferior maxillary is long and constricted, and carries the lower teeth.

The vertebral column, ribs and sternum

The vertebral anatomy of *Camelus spp.* is similar to that of most of the other domestic species of mammal with the exception of the horse in which the thoracic vertebrae are more numerous. The comparative formulae are shown in Table 6.1.1. The formula for the camel is based on the work of Kanan (1960) as are the descriptions which follow in this section. In fact, most sources are in agreement on the anatomy although there is occasionally dispute as to the number of coccygeal vertebrae, this being given as 15-18 for example by Leese (1927).

The bones of the cervical vertebrae are massive, elongated and narrow which, of course, accounts for the length of the neck. It needs to be noted, however, that, as in a giraffe, they are the same in number as the majority of other animals. The neural spines (or supra-spinous processes) on these vertebrae are low, resembling those of the horse, but the transverse process of the sixth vertebra bears a quadrilateral boney plate directed downwards, as in bovines. The atlas (the first cervical vertebra) is shorter than the others while the axis, or second vertebra, is intermediate in length. The anterior articular surfaces are less convex and the posterior ones less concave than in short-necked animals which, together with strong inter-vertebral discs, allows very large lateral movements of the neck.

Table 6.1.1: Comparative vertebral formulae of the common domestic animals. (Source: Kanan, C.V. (1960). Notes on the vertebral column, ribs and sternum of the camel. Sudan J. Vet. Sci. Anim. Husb., 1, 84-91; Sisson, S. and Grossman, J.D. (1975). The anatomy of the domestic animals. L.B. Saunders: London

	NUMBER OF VERTEBRAE				
Animal species	Cervical	Thoracic	Lumbar	Sacral	Coccygeal
Camel	7	12	7	4	14 -9
Cattle	7	13	6	5	20-18
Sheep	7	13	6-7	4	18-16
Pig	7	14-15	6-7	4	22-20
Horse	7	18	6	5	21-15

The thoracic vertebrae are short, although still longer than the horse, and constricted in the middle. The neural spines are long, laterally compressed and with a distinct backward slope. The spines of all the vertebrae are similar in length. Neither these nor the lumbar vertebrae take any part in the formation of the *hump* which consists entirely of soft tissue.

The lumbar vertebrae are rather long and thick, constricted in the middle and dorsally flattened. With the exception of the first of them the neural spines are all directed forwards and become successively shorter towards the rear. The oblique processes are strong and impart considerable rigidity to the spine. The transverse processes are long and occasionally suffer necrosis from the pressure of the pack or saddle.

The four sacral vertebrae are fused into a single body but the neural spines are relatively free of each other and quite short.

The coccygeal vertebrae have complete arches but lack articular processes.

There are 12 pairs of soft ribs of which 8 are sternal and 4 asternal. They show very little curvature which accounts for the lack of the barrel chest in the camel. The rib bones are laterally compressed so that the intercostal spaces are narrow. A rudimentary thirteenth rib is sometimes present (Leese, 1927) but does not articulate with a vertebra. Articulated ribs are thus always 12 in number in the camel.

The sternum is large with 7 sternebrae, increasing in size from front to rear, except for the last which is about equal in size to the fifth.

The limbs

In the forelegs the upper edge of the shoulder blade, the scapula, is very convex with a marked constriction just above the shoulder joint. The humerus is similar to that of other domestic animals. The radius and ulna are unusual in that they are bound together to form a single bone - the long bone - except for a small division near the lower end where the two bones are distinguishable. This long bone is often over 0.5 m long and very slender for its length and the weight it has to bear. The toes are reduced to two, there being no vestigial digits behind the leg. There are three phalanges in each digit; there is only one in the short pastern, the other two being horizontally disposed in the foot.

The pelvis of the camel is very short, the ileum has a flat upper surface and the socket of the hip joint is very deep. The femur is slender and slightly bowed forward, the large trochanter is not prominent. The patella is long and narrow but is not rudimentary. The tibia is long and slender but otherwise normal while the fibula is a small irregularly-shaped bone. The tarsus of the camel is peculiar in that it has two ginglymoid or hinge joints, rather than the usual one. This adaptation allows very free movement, necessary not only for keeping the foot flat on shifting sand but also for fixing the limb when the camel is moving into or out of the sitting position. The phalanges are similar to those of the foreleg but slightly smaller.

Musculature and tendons

These parts exhibit few special peculiarities. The muscles of the neck are weakly developed, as are those of the hindquarters. In the latter the adductor muscles are particularly weak.

The extensor muscles of the limbs are rather special with one for each digit and one common to both digits. The flexor is a tendonous band from the posterior of the carpus which bifurcates behind the metacarpus to the first phalange of the digit. The musculature of the hind limbs is more or less analogous to that of the fore limbs. In the couched position the Achilles tendon is exposed over the end of the tibia before it enters the hock; a tendency for this tendon to slip over the outer side sometimes causes lameness.

The lateral swaying of the camel due to its gait is minimised by the narrow chest; the trapezius and deltoid muscles thus require little contraction to shift the animal's centre of gravity over the limb which is on the ground at any given moment. The powerful nuchal ligament which supports the head and neck, continues over the withers and to the sacrum.

The hump

Most of the fatty tissue of camels is stored in the hump rather than being diffused throughout the body. This is an adaptation to heat transmission; similar systems can be found in the fat tails or rumps of certain desert sheep. In addition there are fat deposits on occasions under the skin, around the heart and the kidneys and sometimes under the peritoneum, behind the eye, and in the temperal fossa. The fat is very white and soft.

The hump is composed of fibrous and fatty tissue. The fibrous part is more noticeable in front and along the vertebrae, where it largely consists of the cervical ligament. In the upper part of the hump the tissue is mostly fat but this depends on the state of health of the camel. Thus the camel's hump does not resemble that of the zebu which is basically muscular. The hump tissue is covered by a very dense aponeurotic layer which attaches it to the vertebrae; this is followed by a layer of lamella cells and finally by the skin which is very elastic over the hump itself. The size and shape of the hump varies from animal to animal and depends considerably on its condition: the skin expands or contracts easily with the hump.

In very fat camels there is some subcutaneous fat deposited over the withers and this may be regarded as the rudiment of a second hump.

Nervous, lymphatic and circulatory systems

These are similar to those of other domestic animals. The brain is longer (150 mm) and narrower than those of ruminants in general and is thus similar in shape to that of the horse; it weighs about 450 g.

The lymphatic system is characterised by few ganglia with conglomerations in the usual areas (Figure 6.1.3). The peculiarities here are the location of the external thoracic and lower cervical ganglia in the front of the chest. The mesenteric ganglia have a particular distribution in the abdomen. The cervical glands are very small and there is a large kidney-shaped iliac lymph gland instead of the normal group of such glands.

The camel's heart is slightly pointed at the apex and has only two ventricular grooves. It contains a floating bone. The jugular veins are of very large diameter and lie on the underside of the neck for three-quarters of its length, being protected by the transverse processes of the cervical vertebrae. Sacrificing the camel by the usual method of cutting the jugular high on the throat is thus not possible and it is necessary to cut these veins at the junction of the chest and throat. The posterior tibial artery is very exposed when the camel is couched, this being the easiest artery to use when counting the heartbeat. The red corpuscles of the camel are elliptical and biconvex and measure about 8 μ in length.

The blood volume of camels, of which some details are given in Table 6.1.2, appears to be in the same range as that found in other domestic animals, equivalent to just under 10 per cent of the liveweight (Hassan, 1968) with a specific-gravity in the region of 1.05. These determinations were carried out using radioactive iodine as a tracer and must be considered to be more realistic figures than earlier reports of 4.2-4.5 per cent for young animals and 3.4-3.6 per cent for older animals (Boue, 1948) which were estimated on the amount of blood collected at slaughter.

Figure 6.1.3: The lymphatic system of the camel. Source: Curasson, G. (1947). Le chameau et ses maladies. Vigot Freres: Paris, France. Leese, A.S. (1927). A treatise on the one-humped camel in health and disease. Haynes and Son: Stamford, Lincs, UK.)

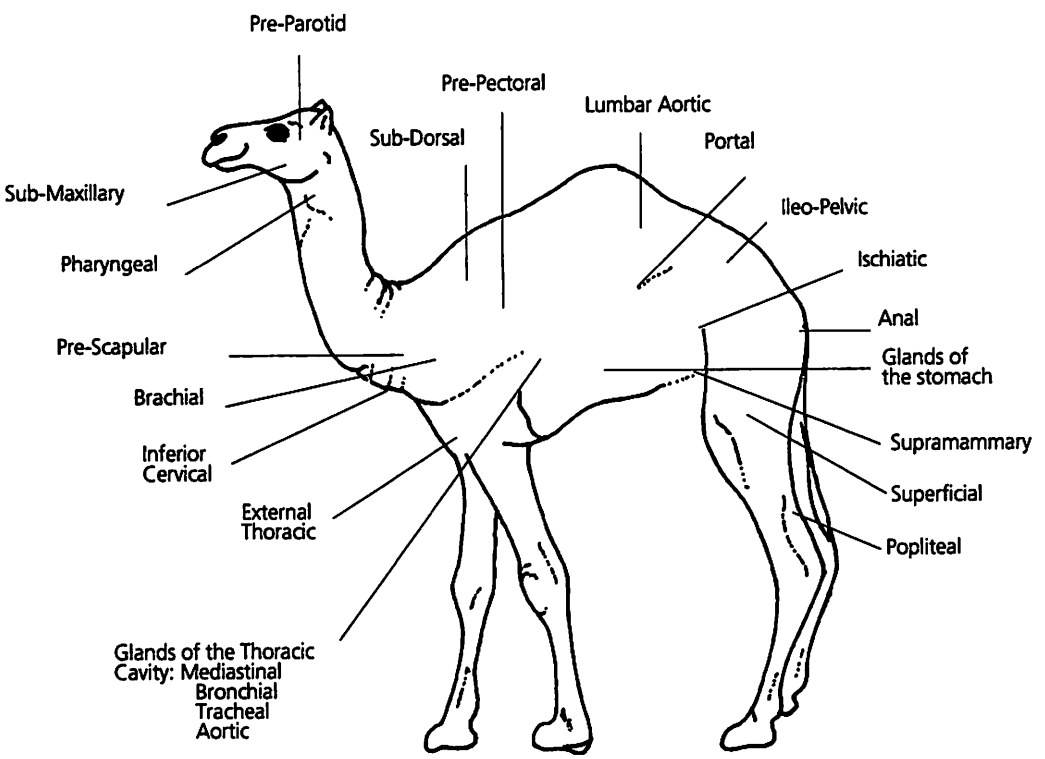


Table 6.1.2: Blood volume of camels (Source: Hassan, Y.M. (1968). Blood volume determination in camels. (Camelus dromedarius). Isotopenpraxis, 4 (2): 73

FEMALE CAMEL AGE (YRS)	TOTAL PLASMA VOLUME (ML)	HAEMATOCRIT VALUE (%)	TOTAL BLOOD (ML)	BLOOD VOLUME (ML PER KILOGRAM)	IMPLIED LIVEWEIGHT (KG)
2	18210	30	26014	93.23	280
10	22053	32	32430	92.65	350
13	20733	34	31414	94.00	335

The respiratory system

The nostrils are long, slit-like and set obliquely; they can be closed at will. The sinuses are well separated from each other and are subdivided in themselves. The frontal sinus communicates with the superior meatus of the nasal cavity by a curved slit. The larynx is long, with a large opening into the epiglottis; the thyroid is domed in shape. The larynx is a rather simple organ which accounts for the limited voice range of the camel. The trachea is 130-150 cm in length, narrow and cylindrical. It lies in the lower part of the neck on the right side; it is wholly cartilaginous in the neck. A third small bronchus is present on the right side.

The lungs are entire and not lobed; large amounts of connective tissue occur between the lobules. The top of the right lung which takes its bronchus direct from the trachea is more developed than the left one. The pleural cavities do not inter-connect.

The diaphragm has well-developed pillars and is attached to the tenth, eleventh and twelfth ribs. It contains a floating bone against the opening of the vena cava.

The skin, skin glands and pads

The skin is attached rather tightly to the underlying tissue and is relatively immobile.

This is a disadvantage when the animal is attacked by biting and flying insects, particularly in view of its short and ineffectual tail. The animal is thus reduced to stamping, kicking and throwing its head about in the effort to remain comfortable, apparently often without much success. The skin is thicker over the back than elsewhere and particularly over the hump when this is in decline. The epidermis is well developed; the dermis is compact and hard and is rich in elastic-fibres which have long papillae; the sub-epidermal tissue is very hard. Sweat glands occur sparsely all over the body but sweating is restricted to very hot periods and to times when the animal is excessively tired.

The poll glands are more active under conditions of heat and fatigue than at any other time except when the male is in rut. They are thus probably modified sweat glands. Contrary to general belief, they are found in both sexes although they are less active in castrated males and females than in full males and the fluid emitted has a much less noticeable odour. The glands are situated towards the top of the back of the neck and cover an area of about 6 cm by 4 cm. They can be distinguished from the surrounding skin, particularly in males, by their slight elevation, their colour and the comparatively few hairs they carry.

The pads are modified skin and occur at the points where the camel is in contact with the ground when couched. The dark horny membrane which they consist of is generally about 7 mm thick. It is elastic and grows from a vascular secreting membrane beneath which there is a foundation of fibro-cartilaginous tissue. The largest pad is generally referred to as the pedestal and is on the chest below the sternum; there are in addition pads on the elbows and stifles and less important ones on the knees and outside the hocks. In young animals the pads are less developed and covered with short hair which wears sway after a few months.

The digestive system

The buccal cavity

The upper lip is split, hairy, extensible and slightly prehensile. The lower one, more so in older animals, is pendulous. The upper dental pad is tough and horny, the lining membrane of the cheeks is covered with long conical papillae, directed towards the rear. The hard palate is long, while the soft palate is protrusible and this has been attributed to its distension by ruminal gases (Leese, 1927). It forms part of the sexual display of the male during rut. The tongue is small in relation to the overall size of the camel. It is very mobile and furnished with between five and seven large-diameter papillae along each side.

The salivary glands are little different from those of other ruminating animals. They have been best described by Tayeb (1950). The parotid gland is small and the Stenson's duct opens behind the third upper premolar. The maxillary gland lies under the parotid and beneath the jugular vein but over the pharyngeal lymph gland. The sublingual gland is very small, the molar glands are well-developed and there are additional minute glands at the bases of the cheek papillae.

The pharynx and oesophagus

The pharynx is very long and narrow, partly divided into two chambers. The oesophagus is a long tube (1-2 m) of large capacity. The lining has secreting glands which apparently serve the purpose of moistening the often rough forage which is the normal diet of the camel.

The stomachs

As early as 1890 it was considered that the stomach of the tylopods was more primitive than the typical ruminant (Boas, 1890) and it was compared with that of certain of the Suiformes (Cordier, 1893). Boas also made the fundamental point that the reticulum of the Tylopoda is not homologous with that of the Ruminantia; since that time the question of terminology has often assumed dominance over the anatomical problems themselves.

Modern authorities (Hansen and Schmidt-Neilsen, 1957; Bohlken, 1960) are in agreement that the compartments of the stomach are not homologous in the Tylopoda and Ruminantia but that it is convenient, where possible, to use the conventional terminology for the different compartments. A further point of controversy is the function and terminology of the water cells of the rumen, first recognised by Pliny in his Historia Natura over 2000 years ago. Hansen and Schmidt-Neilsen (1964) states that they do not, and indeed are not large enough, to function as water-storage compartments. These glandular sac areas, shown in one view of the stomach in Figure 6.1.4, are diverticula which are divided into a number of smaller chambers by folds of mucosa. This mucosa is covered for the greater part by a simple columnar epithelium containing short, straight tubular glands; the number of glands is estimated to be of the order of 100 million.

The area of the rumen in the region of the glandular sacs has strong bands of muscle; these were once thought to act as sphincters but this is now known not to be the case. Similar mucosa are found in almost the whole of the reticulum and the whole of the omasum. It is suggested that these glands are for absorption of the fermentation products of the rumen. Alternatively, they may be areas of secretion to augment the functions of salivary glands and may produce much of the fluid of the rumen. The two functions may not, of course, be mutually exclusive and could be complementary. The interior of the rumen of the Ruminantia contains no analogous structures.

The fact that the parts of the stomach of the Tylopoda and the Ruminantia may not be homologous has been used not only to justify the systematic position of the former but also to support a hypothesis of separate evolution of the ruminating function (Bohlken, 1960). In addition it has been suggested that the actual processes of rumination and of digestion may be different. The

Figure 6.1.4: The camel's stomach

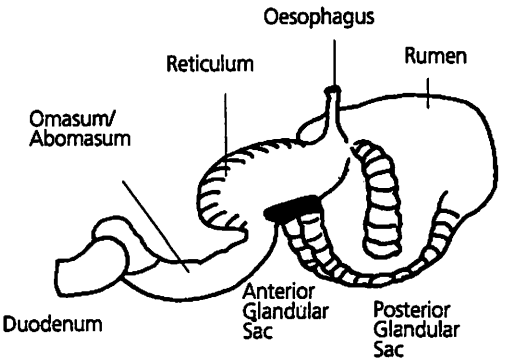
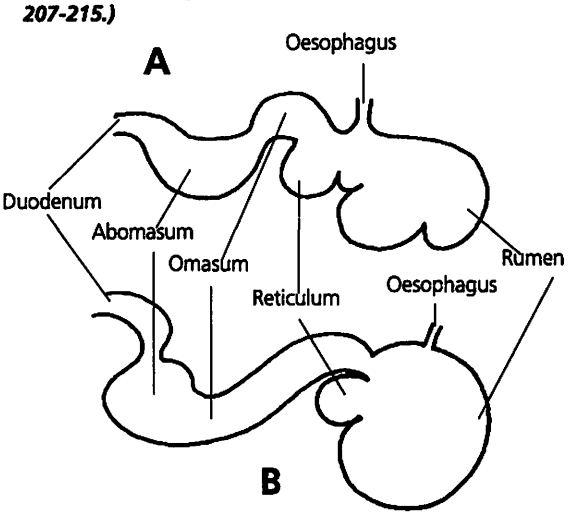


Figure 6.1.5: A comparison between the stomachs of Ruminantia (A) and Tylopoda (B). (Source: Bohlken, H. (1960). Remarks on the stomach and the systematic position of the Tylopoda. Proc. Zool. Soc. Lond. 134, 207-215.)



comparative morphology of the two types of stomach is shown in Figure 6.1.5.

The rumen is of no concern in this argument as it is agreed that it is nothing more than a container for initial storage and fermentation by bacteria and protozoa of the cellulose of the ingested food. The fluid in the stomach of the Ruminantia consists of salivary secretions but that in the camel's rumen derives from both the salivary glands and the glandular sacs. In general, the rumen contents are equivalent to 11-15 per cent of body weight (Schmidt-Neilsen, 1964) although levels of up to 20 per cent have been recorded (Wilson, 1978). These figures are of a similar order to those for cattle.

There are other minor differences between the tylopod and ruminant stomachs. In tylopods the oesophagus discharges directly into the rumen while in ruminants it joins the stomach between the rumen and the reticulum. A further difference is that of the exterior surface of the rumen in

tylopods is smooth except for the glandular sac areas, while the rumen of ruminants has strong muscular pillars.

The typical ruminant reticulum has an appearance strongly resembling a honeycomb, covered with horny papillae. The tylopod reticulum shows a structure similar to that of glandular sacs. This fact has been used to provide further support to the theory of water storage but in fact its volume is only about 2 litres.

The omasum of the Ruminantia is sharply separated from the abomasum and contains a large number of leaves or laminae covered with horny papillae. It is kidney-shaped. The omasum of the tylopod is long and cylindrical and externally cannot be distinguished from the abomasum. Internally, the division is marked by the cessation of the folds of the omasum which contain the tubular secreting glands. In the Ruminantia the abomasum is the only section of the stomach which contains glands, they are mounted on longitudinal ridges or folds. The abomasum of the Tylopoda is very small and has no ridges except in the foetus; it contains two different areas of mucosa, the front two-thirds having fundus glands, the last third having pyloric glands and gastric pits. The stomach occupies much of the left side of the abdomen in adult camels, but as might be expected, is proportionately smaller in young calves before the ruminating function has developed.

Intestines

The small intestine

This measures about 40 m in length in a fully grown camel. The duodenum starts with a dilation and then forms a loop. A common duct from the pancreas and liver opens into this duodenal loop slightly more than 0.5 m from the pyloric constriction of the abomasum. The jejunum occupies most of the abdomen and is situated along the mesentery on the right side. A chain of mesenteric lymph nodes is found along the length of the jejunum and there is a large group of nodes round the anterior mesenteric artery. The lymph nodes of the final part of the small intestine, the ileum, are associated with those of the large intestine.

The large intestine

This measures about 20 m in length. The caecum is blind, and is attached to the mesentery at the blind end. For the length of about 4 m the colon is large in diameter and coiled into a mass consisting of a concentric and an eccentric spiral. The colon is on the left side of the abdomen in a special mesenteric fold. The colon narrows as it enters the tight part of the spiral, the walls become thicker and it is in this portion that much of the water is re-absorbed from the faeces. The colon bends in the lumbar region before becoming the rectum. The lymph supply is concentrated at the entry of the large intestine between the ileum and the caecum with further lymph glands near the terminal portion of the colon and the rectum

Liver, pancreas and spleen

The liver is highly lobulated, particularly on the rear lower part. There is a considerable amount of interlobular tissue; this has the appearance of cirrhosis. As in the horse there is no gall bladder; the bile duct is common with the pancreatic duct before entry to the duodenum. The pancreas has only the single duct. The spleen is attached not to the diaphragm but high on the left side of the rumen by its front lower surface. It is crescent shaped and wider at the rear end than the front; in the healthy camel it weighs 1.0-1.5 kg. The peritoneum is similar to that of cattle.

Dentition

In common with other members of the order Artiodactyla, the Suiformes excepted, the camel has reduced dentition. The typical mammal, of which the pig is representative, has 32 deciduous temporary or milk teeth and 44 permanent ones. In the camel some are absent or modified so that there are 22 deciduous teeth and 34 permanent teeth. The molars are selenodont, that is, with crescent-shaped ridges on their crowns. The standard study of camel dentition is that of Rabagliati (1924) from which much of the information in this section is drawn.

Deciduous, temporary or milk teeth

These teeth in the camel are 22 in number, the dental formula is:

$\frac{1-1}{3-3}$	$\frac{1-1}{1-1}$	$\frac{3-3}{2-2}$	$=22$
incisors	canines	pre-molars	

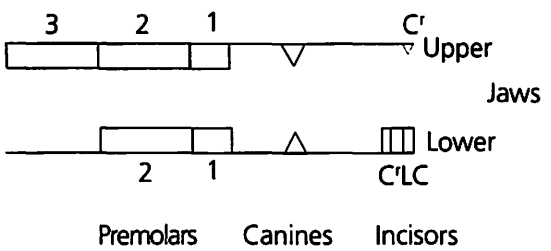
or in short form as: $2\,\frac{1-1-3}{3-1-2}=22$

The relative placement of the teeth in the upper and lower jaws is shown diagrammatically in Figure 6.1.5 and comparison with the dental formulae of the other sub-orders of the Artiodactyla and with the horse are shown in Table 6.1.3. The camel differs in dentition from the other ruminating animals by the possession of incisors in the upper jaw and of canine teeth in both the upper and lower jaws.

Table 6.1.3: Comparative deciduous dental formulae of sub-orders of the Artiodactyla and of the horse (Perissodactyla)

Species	Dental Formula
Suiformes- pig	$2\frac{3-1-4}{3-1-4} = 32$
Tylopoda - camel	$2\frac{1-1-3}{3-1-2} = 22$
Ruminantia - sheep	$2\frac{0-0-3}{4-0-3} = 20$
Perissodactyla - horse	$2\frac{3-0-3}{3-0-3} = 24$

Figure 6.1.5 : Diagrammatic representation of the deciduous teeth of the camel. (Source : Rabagliati, D.S. (1924) The dentition of the camel. Government Press: Cairo, Egypt).



Upper jaw

The incisor teeth are much modified they are just visible through the dental pad and represent the corner incisors of the full mammalian mouth. A pair of lateral incisors may be represented by alveoli, but these never break through the pad and are ignored in the dental formula. There is never any sign of the central incisors.

The incisors are carried on the premaxillary bone. The canines are carried on the superior maxillary bone as are the premolars. The deciduous canines are small, blunt and point backwards slightly; they are somewhat rudimentary although they have very large roots.

The first premolars are single teeth; they erupt with sharp cutting edges which subsequently wear to a flat surface with double bumps; these teeth are not replaced by permanent ones. The second premolars are double with marked necks and three fangs with triangular-shaped wearing surfaces. The enamel is folded and shaped rather like the letter B. The second premolars erupt at the same time as the first while the third pair come through later. The third and last pair are larger than the second and have square tables, less well-marked necks and four fangs. The enamel is similarly arranged in B-like folds.

Lower jaw

The three pairs of temporary incisors overlap in echelon when newly erupted but separate out into line after wear; in a very worn condition they may be represented by stumps with large gaps between. They have well-developed necks and form an angle of about 45° with the jaw. The centrals are the largest and erupt first. The lateral are next largest and erupt second to be followed by the smaller corners.

The canines are peculiar as when they erupt they are the same shape as the corner incisors and lie right up against them. As the jaw grows they separate from the incisors and become triangular in shape; they are much more developed than the canines of the upper jaw. The lower jaw has only two pairs of temporary premolars; the first or front pair are very small for grinding teeth but the second pair are the largest of all the temporary set. The first pair, which erupt slightly before the second, are single with the table surfaces longer than broad when in wear; the front fangs are small and occasionally not even embedded in the jaw. The second pair are typical molar teeth with a crown of three divisions and the enamel arranged like the letter B. The necks of these teeth are poorly developed and they have large double fangs.

Permanent teeth

The permanent teeth number 34 and, following the example given for deciduous teeth, the dental formula is written as:

$$\frac{1-1}{3-3}\ \frac{1-1}{1-1}\ \frac{3-3}{2-2}\ \frac{3-3}{3-3} = 34$$

incisors canines premolars molars

or in shortened form as-

$$2\frac{1-1-3-3}{3-1-2-3} = 34$$

A diagrammatic representation of these teeth is given in Figure 6.1.6 and comparison with some other animals in Table 6.1.4. Differences similar to those in the formulae for temporary teeth are apparent in the ones for permanent teeth.

Figure 6.1.6 : Diagrammatic representation of the permanent teeth of the camel (Source: as for Figure 29.5).

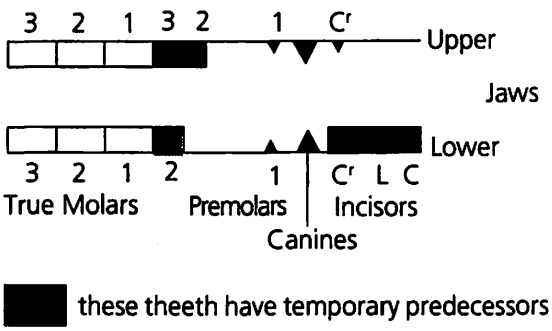


Table 6.1.4: Comparative permanent dental formula of the sub-orders of the Artiodactyla and the horse

Species	Dental formula
Suiformes - pig	$2\frac{3-1-4-3}{3-1-4-3} = 44$
Tylopoda - camel	$2\frac{1-1-3-3}{3-1-2-3} = 34$
Ruminantia - sheep	$2\frac{0-0-3-3}{4-0-3-3} = 32$
Perissodactyla - horse	$2\frac{3-0-3/4-3}{3-0-3-3} = 40 - 42$

Upper jaw

There are no central incisors and for all practical purposes there are no laterals either. The corner incisors are carried on the premaxillary bone but are much modified, being thick rather than pointed and curling backwards slightly. To some extent they resemble the canines (although they are much smaller) and are often referred to as the first pair of "tushes". There is no neck between the crown and fangs. The true canines are large, inclined slightly forwards and may be up to 4 cm in length, They are narrow laterally and are sharp both in front and behind. The canines have no neck and the fangs are enormous, as indeed they need to be to fulfil their function of tearing heavy food from trees and as fighting weapons, particularly in males.

The upper jaw has three pairs of premolars, the first pair being set apart, forward and resembling the canines to some extent. They are set in the arch of the superior maxillary and do not contact the lower first premolars. They are usually blackish in colour. This first pair may be absent, especially in females. The second pair are single teeth with triangular wearing surfaces, the apex of the triangle to the front. There are well-developed necks between the crowns and the three fangs. The third set of premolars are also single teeth but much larger than the second pair. They also have three fangs. The tables are semi-circular or elliptic but wear to a triangle.

There are three pairs of permanent true molar teeth, normally lying immediately behind the premolars although there is sometimes a gap. All the true molars are double teeth and they increase in size from first to third, the first pair themselves being double the size of the last premolars.

All the teeth are longer than broad when new, the tables of the first pair becoming square with use. All the teeth have four fangs, the ones on the third pair being broader lower down giving a pyramid shape to the tooth. The necks are absent in the third pair and are less distinct in the second than in the first pair. The enamel in all the molars is arranged in the shape of a B.

Lower jaw

The lower incisors overlap when new and come up behind their temporary predecessors. On wear they become separated and may eventually remain as stumps. The centrals are broad and leaf-shaped, with slightly serrated sharp edges. They are convex from top to bottom and laterally, when viewed from the front, and have ridged anterior surfaces. The cutting edges are higher on the inner side than on the outer. The necks between the crown and the fangs, which are single, are not very evident. The laterals are similar but more convex, smaller and with a more marked neck. The corners are again smaller with a well-marked neck and are the least convex of all the incisors.

There is one pair of canines which are shorter and thicker than those of the upper jaw. The lower canines have less massive fangs and may be placed a little in front of the upper ones. They are often filed or cut off by the camel's owner.

There are two pairs of premolars with the first,

as in the upper jaw, being placed well forward. The first premolars are often referred to as 'tushes'. They are dark, thick, and shorter than those of the upper jaw. Occasionally they may be duplicated or, particularly in females, absent. They are further forward than the corresponding first premolars in the upper jaw. The second premolars are single teeth with two fangs as opposed to the three fangs of those in the upper jaw. They are the smallest teeth of the lower jaw and have flat wearing surfaces, and a well-marked neck.

The first pair of molars in the lower jaw are the smallest of the true molars found in either jaw. They are smaller than the corresponding pair in the upper jaw, very long from front to back and do not become square on wearing. The necks are distinct and there are only two fangs. The second molars are much bigger than the first but again smaller than the corresponding pair above. They are long with a poorly developed neck and double fangs. The third true molars are the largest teeth in the head. The crowns are divided into three sections, like the second lower deciduous premolars, the last division being smallest. This last pair are very narrow with-no neck and have three fangs. All the molars have the enamel in the characteristic B shape.

Occasionally the first temporary premolars in the upper jaw persist. In this case they lie between the first and second pairs of permanent premolars.

While the dental formula generally accepted for camels is 34 there have been occasional efforts to propose a species with 36 teeth (Cauvet, 1929).

Eruption patterns and ageing

The chronology of eruption of the temporary and permanent teeth is outlined in Tables 6.1.5 and 6.1.6. The first permanent teeth to appear are the first pair of molars in the upper and lower jaws at 12-15 months of age and there are no other permanent teeth until the animal reaches at least two and half years of age.

The upper temporary corner incisors are the weakest in the whole head and have usually disappeared by the time the camel is one year old. The upper canines persist until they are replaced by the permanent ones, growing alongside them at 6 to 7 years-old. The second premolars usually disappear at about 5 years, before the eruption of the permanent ones, the third premolars disappear at about the same time.

In the lower jaw the incisors are well up and in wear by the time the camel is 1 year old. By the age of 2, they are worn and separate, at 3 years they are well worn. At 4 years the incisors are well worn, irregular and loose and may be reduced to stumps. The central persist until about 4 years, the laterals until 5-5 1/2 years and the corners normally until 6-6 1/2 years but these may be lost before the eruption of the permanent ones. All the incisors are replaced from behind. The lower canines persist in excess of 6 years and do not become excessively worn until very late in their life. The first lower premolars persist until 4 1/2 years and are not replaced: the second lower premolars persist to about 5 1/2 years

The state of wear of the permanent teeth to 7 years of age is shown in general terms in Table 6.1.6. At 8 years all the teeth are in wear including the last to erupt, the lower corner incisors. At this stage the first pair of premolars in each jaw (the second tushes) are nearly at full size and are very dark due to the accumulation of tartar. The true tushes or canines are very large and powerful. In the female the true and false tushes are not as prominent and the first premolars may be absent.

From 9 years onwards all teeth are more or less worn but actual age can only be determined on the basis of considerable knowledge and local experience. As in other animals, the type of fodder and various other factors influence the rate of wear. The incisors do not separate until about 15 years and the gaps gradually increase from this age. From this time the useful life of the camel is limited if it has to fend for itself off natural hard feed. The principal problem in determining the age of a camel using its teeth alone lies in the fact that almost all the milk teeth are badly worn at 4 1/2 to 5 1/2 years old, and this may be taken to indicate considerable age. However, the milk teeth are always smaller than the permanent ones and the experienced observer should have no difficulty in telling the age of a camel from its teeth. General stature and condition can also indicate a camel's age.

Camels may live to 40 years or so but their useful working life, at least as transport or pack animals is from 6 to 15-20 years. Before 6 years of age they are immature and still have to undergo the difficult period of the change from temporary to permanent dentition. Beyond the age of about 20 years, worn teeth and increasing debility limit their overall usefulness.

Table 6.1.5: The eruption pattern of the temporary teeth of the camel. (Source: as for Figure 6.1.5)

JAW AND TEETH	BIRTH	1 WEEK	2 WEEKS	1 MONTH	3 MONTHS	6 MONTHS
UPPER JAW						
incisors -						
corner					just	up
canines					small	up
premolars 1	gum	just	through	up	up	up
premolars 2	gum	just	through	up	up	up
premolars 3	gum	gum	gum	through	up	up
LOWER JAW						
incisors -						
centre	gum	just	through	up	sharp-	in-wear
lateral	gum	gum	just	through	overlap	
corner	gum	gum	gum	just		
canines					incisor-like	up
premolars 1	gum	just	through	up	up	up
premolars 2	gum	gum	gum	through	up	up

Table 6.1.6: The eruption pattern of the permanent teeth of the camel. (Source: as for Table 6.1.5)

JAW AND TEETH	12-15 MONTHS	2 1/2 YEARS	3 YEARS	4 1/2 YEARS	5 YEARS	5 1/2 YEARS	6 YEARS	6 1/2 YEARS	7 YEARS
UPPER JAW									
incisors									
corner							through	up	up
canine							through	up	large
premolars 1								through	dark
premolars 2					gum or	through	up	up	wear
premolars 3					just	through	up	up	wear
molars 1	through	up	up	up	wear	wear	wear	wear	wear
molars 2		just	through	up	wear	wear	wear	wear	wear
molars 3					gum	through	up	up	wear
LOWER JAW									
incisors-									
centre				just	through	up	wear	wear	worn
lateral						gum	up	wear	wearing
corner								through	up
canines							through	up	large
premolars 1								through	dark
premolars 2					just	through	up	up	wear
molars 1	through	up	up	up	wear	wear	wear	wear	wear
molars 2		just	through	up	wear	wear	wear	wear	wear
molars 3					gum	through	up	up	wear

The foot and locomotion

The foot of the camel is well designed to cope with the loose sandy soils of the desert. The bearing surface of the foot is like a large plate. This plate is able to maintain flat contact with the ground throughout the duration of the stride due to exceptional rotation at the first digital joint. The foot splays out on taking the weight of the camel and thus acts as a firm base for levering the weight forward to the next stride.

The front foot is about 18 cm long by 16 cm broad and covers an area of about 300 cm^2. The hind foot is smaller and measures about 16 cm long by 14 cm broad, covering an area of about 220 cm^2. The front feet are straight but the hind feet are usually slightly turned out. The stance of the camel is unique for the Artiodactyla in that it is digitigrade and not unguligrade (Dagg, 1974).

The anatomy of the foot

The foot is comprised of only two digits, the third and fourth. All trace of the other digits has disappeared. The foot bones are united to form a cannon bone as in the horse. The first (proximal) phalanx is the only bone in the short pastern of the camel and is rather flattened. The second and third phalanges are the foundation of the foot and both are almost horizontal. The second phalanx is wide and flattened and embedded in the cutaneous pad which forms the sole (Figure 6.1.7 and 6.1.8). The third (distal) phalanx is a small triangular bone, not flattened on the inner surface and not bearing a hoof. It carries a nail on the upper side only. The digits are joined by the cushion and the foot does not appear very cloven.

The foot has been described as resembling a tyre but filled with fat instead of air (Bligh, et al., 1976). The cushion is made up of a number of fatty pads which are soft, semifluid and of a lighter-coloured tissue than the general body tissues. These pads, or balls are separated by cartilage and surrounded by a sheath of collagen; towards the rear of the foot elastin forms a major component of the tissue. The pads are largely composed of neutral triglycerides containing about 75 per cent unsaturated fatty acids.

The fatty pads are covered by a fibrous rubbery sheath up to 10 mm thick (Figure 6.1.8). This is essentially composed of an outer hard and inner soft layer of epidermis about 5 mm thick separated from the dermis by a layer of glands which serve to moisten the pad. The whole serves as a horny but supple sole for the foot.

The camel's foot is excellent for movement on sand. It is less suitable for traversing stony desert although some hardening occurs in animals habituated to this kind of country. It is equally unsuitable, in principle, for travel on slippery or muddy surfaces but some camels become adept at traversing even this kind of terrain.

Locomotion

The exceptional degree of rotation achieved at the fetlock is essential not only for keeping the foot flat on the ground but also in order for the camel to effect its normal gait. The camel is peculiar among domestic animals in that both legs on one side of the body move in unison (and not in opposition as is more normal), a type of locomotion which involves the hind foot being placed well in front of the forefoot on the same side.

Walking stride

The long synchronised stride (Figure 6.1.9 (a)) involves the whole weight of the body being supported for a very considerable part of the time on either the two right or the two left legs (Dagg, 1974). This pacing gait is normal at the walk and is long and slow, averaging 38-43 steps per minute in the adult animal and economy is achieved both in covering distance and in the energy used to attain this.

Figure 6.1.7: The camels foot (Source: Droandi, I. (1936). Il cammello. Istituto Agricolo Coloniale Italiano: Florence, Italy).

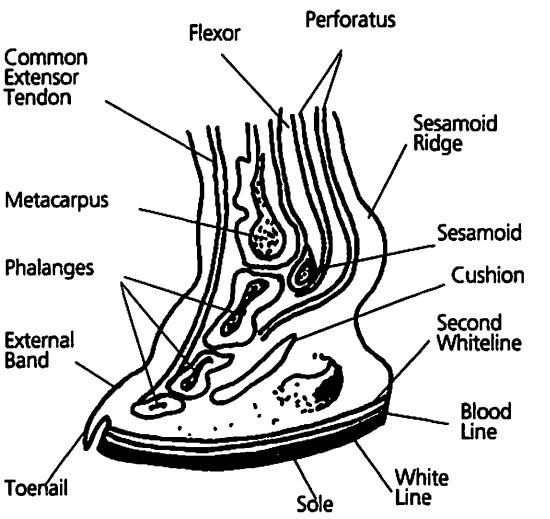
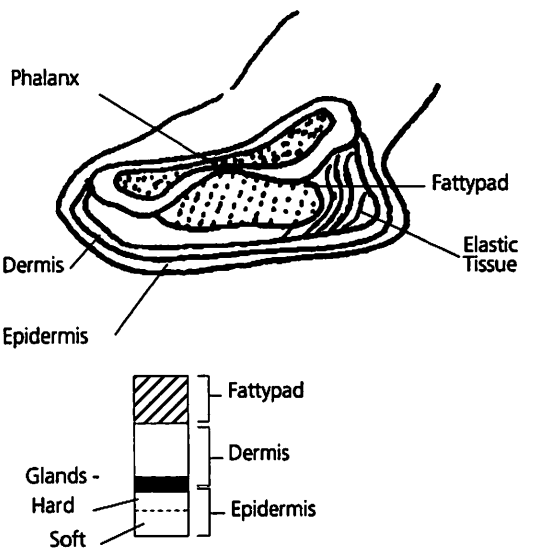


Figure 6.1.8: Section through the foot of the camel (Source: Bligh, J., Cloudsley-Thompson, J.L. and MacDonald, A.G. (1976) Environmental physiology of farm animals. Blackwood Scientific Publications: Oxford, UK).



Pacing gait

The pace at trotting speed (Figure 6.1.9 (b)) is known to horsemen as the pace or rack but called by Leese (1927) the jog. It is an unstable gait and is only suitable for flat terrain. This type of gait is not universal in the *Camelidae* - the vicuna, for example, has the more normal pattern of locomotion (Dagg, 1974).

Significant differences have been noted between the movements of young and old animals and of various trotting actions (Dagg, 1974). The fast run or gallop (Figure 6.1.9 (c) is not a normal gait for the camel and is rarely used except for exhibitions, races and such. Dagg noted it only in animals chased away from watering points.

The quantitative data on speeds shown in Table 6.1.7, which are largely calculated from analysis of moving films, are in broad agreement with the earlier less scientific measurements of speed recorded by, for example, Leese (1927) in India and Somalia, and by Gillespie (1962) in Sudan. If my calculations from Dagg's data are correct they also show another unusual fact about the camel which does not appear to have been noticed before - it increases speed mainly by increasing the speed of limb movement and not by lengthening its stride.

Rising and couching

The camel thrusts its head forward with a jerk, rises to its knees and then lifts the hind-quarters to the full extent. One foreleg is then lifted until that foot is flat on the ground; this leg is then used to lever up the whole animal until it is erect, the opposite foreleg being the last to touch the ground.

When couching one knee is lowered to the ground, followed almost simultaneously by the other. The hind legs are then bent until the stifle pads touch the ground, the forelimbs are settled and finally the bulk of the weight is taken on the breast pad.

Figure 6.1.9: Diagrammatic representation of three gaits of the camel (Source: a (Dagg, A.I. (1974). Locomotion of the camel, Camelus dromedarius. J. Zool. Lond., 174, 67-68; b and c, Cauvet, G. (1925). Le chameau. Bailliere: Paris, France).

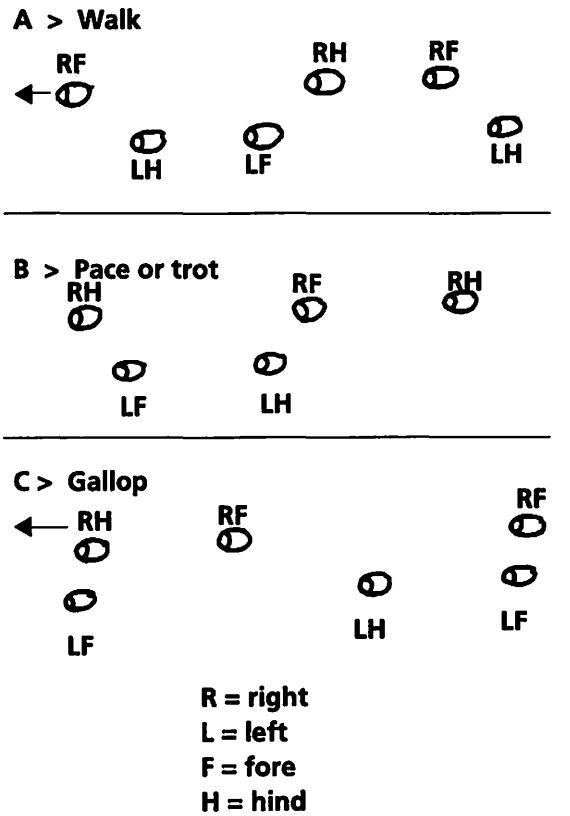


Table 6.1.7: Data on speed, duration and length of stride at various camel gaits. (Source: Dagg, A.I. (1974). Locomotion of the camel, Camelus dromedarius, J. Zool. Lond. 174, 67-78)

GAIT	SPEED		DURATION OF STRIDE (SECONDS)	STRIDES PER MINUTE	IMPLIED LENGTH OF STRIDE (metres)
	METRES PER SECOND	KM PER HOUR			
Walk	1.76	6.3	1.67	35.9	2.93
Pace (trot)	3.31	11.9	0.97	61.8	3.21
Gallop	5.20	18.7	0.56	107.1	2.91

CHAPTER 6.2

Camel reproduction

by R T Wilson

Introduction

Much research on the camel in recent years has concentrated on the anatomy and physiology of reproduction. Little emphasis has been given to the practical aspects of reproductive performance. The one-humped camel is generally considered to achieve puberty at relatively advanced stages in both sexes, particularly under traditional management. Parturition intervals are long in most areas and the pattern of births is often markedly seasonal and is probably related to nutritional and management factors.

Male fitness

Anatomy

The sheath or prepuce is large, fleshy, triangular in shape and laterally compressed. A well developed lateral preputial muscle, with assistance from the normal caudal and cranial muscles, directs the penis towards the rear when urinating but towards the front during erection for copulation. The internal lamina of the prepuce is fused to the penis by loose connective tissue. At maturity the penis comes free of the prepuce under the action of testosterone, usually at about three years of age.

The scrotum is small, both absolutely and relative to the camel's size. It is attached high in the perineal region, is not pendulous and not distinctly divided into compartments. An important role of the vascular, as opposed to the muscular, tissue is implied for testicular cooling by this arrangement. The testes have already descended into the scrotum at birth, but are very small up to three years of age after which a spectacular increase in weight and volume occurs (Table 6.2.1). In addition to age changes in weight there are seasonal ones related to the breeding period (Table 6.2.2).

Table 6.2.1: Testicular development in Israeli camels (Source : Degen' A.A. and Lee, D.G. (1982))

PARAMETER	AGE AND TESTIS POSITION					
	< 3 yr		3-5 yr		> 6 yr	
	Left	Right	Left	Right	Left	Right
Weight (g)	2.3	2.4	38.7	43.1	114.2	129.2
Circumference (mm)	38.7	38.7	94.8	112.7	145.2	154.6

The seminiferous tubules are divided into three zones. The major part is tightly coiled and is the site of sperm production. There are seasonal changes in the diameter of these tubules. The epididymus is attached to both ends of the testes and is the site of sperm maturation in its initial and middle parts, and of sperm storage in its terminal part. The camel has no seminal vesicles.

The penis is of the fibro-elastic type with a marked prescrotal sigmoid flexure. The erectile tissue comprises venous spaces of various sizes, which contain elastic fibre but no muscular tissue. The cranial end of the penis is curved and sickle shaped and measures 17-26 mm in length; there is no true glans penis. Total penis length is about 60 cm; its diameter is some 2.2 cm at the root, 1.6 in the middle and 0.4 cm at the extreme end.

Table 6.2.2: Seasonal changes in testicular weight (g) of Indian camels. (Source: Singh, U.B. and Bhardwaj, M.D.(1978)

	SEASON AND TESTIS POSITION					
	August-November (moderate summer)		December-March (winter)		April-July (extreme summer)	
	left	right	left	right	left	right
Age (years)						
4 - 8	60.8	58.8	78.4	70.8	58.6	56.2
9 - 14	168.2	162.2	194.7	186.3	159.8	146.5
16 - 20	168.0	166.0	199.0	186.0	143.0	123.5

Physiology

Under most conditions male camels reach puberty at 3-4 years but in exceptional cases this can be achieved at two years or less. Spermatogenesis is continuous throughout the year but in many areas the activity varies with season. Sperm production is about 41 x 10^6 per gram of tissue at 3-4 years and rises to a peak of 120 x 10^6 at 6-7 years.

Male camels show a strong rut when they are in breeding condition; the expression of rut may, and usually does, vary with season. The physiological changes associated with the physical signs of rut are an increase in androgens in the blood, from a basal level of less than 3.8 ng/ml to one of 17-35 ng/ml.

Mating behaviour

The rut induces a radical change in the male camel's behaviour, resulting in aggressiveness towards other camels and often to his handlers. A rutting male grinds his teeth, waves his head and neck about, moves restlessly, froths at the mouth, lashes his tail, and urinates frequently with the urine being splashed about the camel and anything in the vicinity of the tail. Diarrhoea is often an accompaniment to the rut and may contribute to the loss of condition that male camels experience at this time. There is a strong dominance hierarchy in camels, one male imposing supremacy over subordinate animals which quickly lose libido and go out of rut. Poll glands in males increase in size during the rut and secrete a sticky dark fluid which has an androgen concentration similar to that of the blood.

A characteristic feature of the rut is the extension of the soft palate or 'dulaa'. The palate is filled with air from the lungs and it is possible that its protrusion and the accompanying gurgling sounds are attractive to the female.

Male camels sniff and bite the vulva and other parts of the body of females prior to attempting coitus. Copulation in the camel takes place in a recumbent position. Females in oestrus often couch readily but may have to be forced down by the male who usually achieves this by pressure on the neck and hump. Many traditional camel-owning societies sometimes assist the male with intromission but this is usually effected naturally by rotational movements of the penis until the vulva is found. Penal strokes are not violent. The sex act, which lasts as long as 35 minutes, comprises several entries and males may exhaust themselves on one female if not restrained. Both sexes are noisy during the act, males particularly so.

Semen

Camel semen is usually creamy white in colour but varies from light grey to milky. Ejaculates up to 15 ml in volume have been obtained at natural mating but those using artificial vagina or an electro-ejaculator are less (Table 6.2.3). Motility is low, about 60 per cent, in early ejaculations following a non-breeding period, but increases to more than 80 per cent very rapidly,

The total length of camel spermatozoa is short compared to that of other domestic animals and is usually less than 50um. The head is elliptical rather than ovoid which is the usual shape in other artiodactyla. The incidence of abnormal sperm is not uncommon. Bending of the forward part of the acrosome and tail defects are the most obvious and the most usual aberrations.

Table 6.2.3: Some characteristics of the semen of one-humped camels. (Source: adapted from Abdel Raouf, M. and El-Naggar, M.A. (1976), and Tingari, M.D., El-Manna, M.M., Rahim, A.T.A., Ahmed, A.K., and Hamad, M.H. (1986))

PARAMETER	ARTIFICIAL VAGINA		ELECTROEJACULATION	
	Mean	Range	Mean	Range
Volume (ml)	8.5	4.3-12.6	3.9	1.0-9.0
pH	8.6	8.1- 8.7	7.8	7.6-8.0
Live sperm (%)	55	40 - 80	43	25 - 66
Normal sperm (%)	-	-	84	60 - 92
Sperm concentration x 10^3/ml	396	140 - 763	800	400 - 1300
Total sperm x 10^6/ejaculate	3248	655 -5693	-	-

Semen collection using an artificial vagina is not always successful due to the limited protrusion of the penis. It is sometimes possible to induce ejaculation by massage of the penis or the pelvic genitalia but electro-ejaculation is a surer way of obtaining semen.

Female fitness

Anatomy

The vulva is 3-5 cm deep with thick velvety lips, the clitoris being very small. The urethra is short and the opening of the urinary meatus is narrow. The hymen, or its remnants, marks the separation

between the vulva and the vagina. The cervix consists of out-growth ridges arranged in three or four rows. The vagina is some 30-40 cm in length and lined with mucosal folds; it is wide and extensible and with advancing pregnancy the uterine weight tends to stretch the mucosal folds.

The oviducts, which are 17-28 cm in length, follow a tortuous course to the horns but more so in the ovarian part of the Fallopian tube and the ampulla than in the isthmus. They are soft and flabby except in the area of the isthmus where there is a thick, fibrous muscle layer. Unlike other mammals, the oviducts are enlarged at the uterine end, this unique arrangement allowing prolonged storage of large numbers of spermatozoa.

The camel has a bicornate uterus which is T- rather than the normal Y-shaped. The body is short, reddish in colour and smooth, the left horn being longer than the right. The uterus is usually abdominal in position and increases in weight during follicular activity. The placenta, as in all *Camelidae*, is diffuse and epitheliochorial in nature, without cotyledons.

The ovaries are flattened, lobulated and reddish brown in colour and each is enclosed in an ovarian bursa which is similar in structure to that of other domestic animals but unlike buffaloes and cows, medullary tubes (normally seen only in the embryos of these two species) are present in four out of five camel ovaries. The size of the ovary is 15mm x 30mm and its weight 5-15g. Non-functioning ovaries may weigh as little as 3.7g, those with graafian follicles 5.5g and those containing a corpus luteum of pregnancy about 8g.

Graafian follicles occasionally persist into pregnancy but in non-pregnant females are distributed randomly over the ovarian surface. They are opaque and spherical and up to 18mm diameter. Ovarian activity is follicular rather than luteal and a corpus luteum is usually seen only during pregnancy.

The udder has four quarters, the front two being separated more distinctly from each other than they are from the two smaller rear quarters. The udder is covered by a thin black skin. The teats are small and have three small openings.

Physiology

The follicular wave

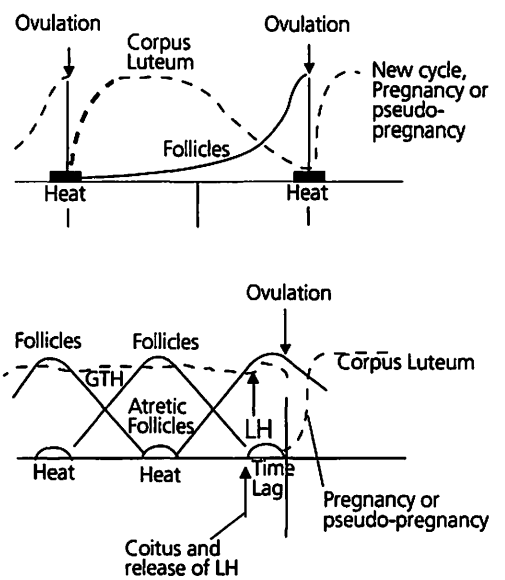
The regular and recurring hormonally controlled sequence of events which culminates in the spontaneous release of an ovum (or of ova) is known as the oestrus cycle. The term oestrus cycle, properly used, thus refers to animals which are spontaneous ovulators, this type of ovulation being the norm in the majority of animals.

In some mammals including cats, rabbits and the camel, rupture of the follicle does not occur spontaneously, a stimulus being required to induce release of the ova (Figure 6.2.1). This type of cycle, involving reflex or induced ovulation is properly known as a follicular wave.

In spontaneous ovulators the oestrus cycle occurs in four distinct phases which are known as pro-oestrus, oestrus, meta-oestrus and di-oestrus. In induced ovulators, and specifically in the camel, there are also four distinct phases but normal terminology is not appropriate. The four phases of the follicular wave in camels are:

- The mature follicular stage, equivalent to oestrus or heat (the camel should not be considered to be in continuous oestrus in spite of the fact that ovarian maturity is follicular. Unlike the rabbit, which will accept the male at any time, the female camel will accept the male only during the mature follicular stage. There is no normal luteal phase);
- The atretic follicular stage, during which the follicle regresses, commences after a varying period of time if mating does not occur;
- The non-follicular stage; and
- The growing follicular stage.

Figure 6.2.1: Comparative events in spontaneous (top) and induced ovulators (bottom). (Source Nalbandov (1976))



Progesterone levels in camels at oestrus are about 0.5 ng/ml while oestrogens are at a peak of 75 pg/ml. The level of oestrogen rises to 3.5 ng/ml at day 3-6 and then to a peak of 4.5 ng/ml at day nine in mated camels, before falling rapidly: oestrogen levels drop to 15.1 pg/ml at the first stage and remain low. The concentration of luteinizing hormone rises rapidly to a maximum of 6.9 ng/ml from a basal level of 2.7 ng/ml, starting one hour after coital (or other) stimulation, reaching a peak at three hours and remaining high for about 10 hours: ovulation occurs 36-48 hours after mating.

Duration of the wave, polyoestrous and seasonality

It has long been accepted that camels are polyoestrous, but it was also thought that oestrus occurred only at certain times of the year. In most areas follicular wave activity does occur all the year round but the length of the whole wave, the phasing and duration of oestrus vary considerably. In areas where seasons are strongly expressed, follicular activity is at its greatest in winter and spring and the total cycle is longer at this period (Figure 6.2.2). During the summer, mature follicles are found in only a few animals (i.e. the phase lasts for only a very short time) and the growing follicular stage is relatively prolonged.

In Egypt, the mean duration of the follicular wave is 24.2 days with oestrus lasting 4.6 days within a range of 0-15 days. These figures are confirmed by work both in Sudan where the length of the wave is 28 days with oestrus normally lasting 4-6 days within a range of 1-7 days and in India where wave duration is 23.4 days and oestrous averaged 5.0 days within a range of 3-6 days.

Pregnancy and parturition

After successful mating the corpus luteum develops rapidly, and is greatest in weight and size at 60 days, then remaining about this size throughout pregnancy. It appears that the corpus luteum is required in order for pregnancy to be maintained. The left ovary is usually more active than the right and about 55% of all eggs shed are from this ovary. The site of pregnancy, however, is almost invariably in the left ovary, indicating that migrations of at least some of the ova or of the embryos does occur.

Double (about 13-15 per cent) and triple (about 1-2 per cent) ovulations are not uncommon but two foetuses are rarely supported longer than a few days. The early embryonic loss is of the order of 15 per cent.

Figure 6.2.2: Seasonal duration and proportional time of different phases of the follicular wave in camels in Egypt. (Adapted from: Nawito et al (1967).

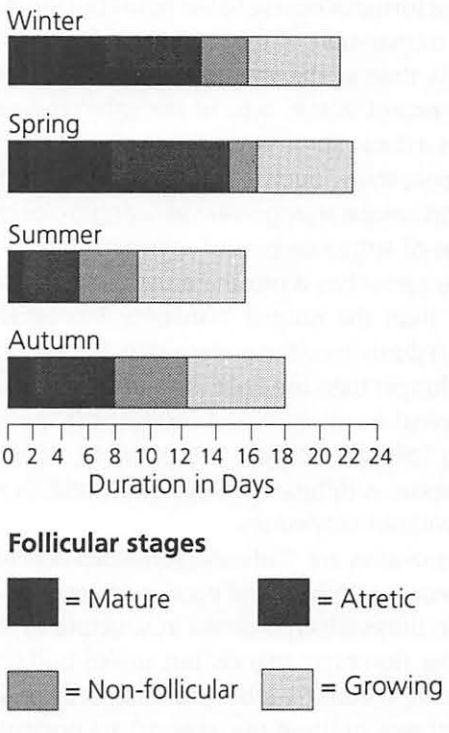
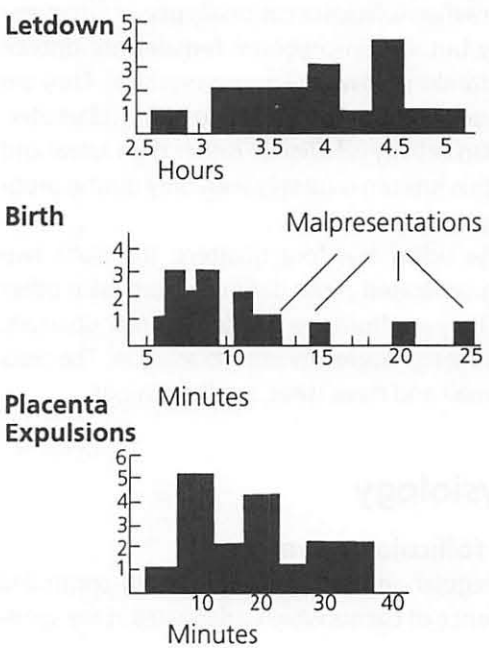


Fig. 6.2.3: Duration of events associated with pregnancy in 17 camel births in southern Tunisia. (Source Burgemeister (1975)).



Early data on gestation length were conflicting, different reports being anywhere between 345 and 405 days. It is now established that pregnancy in the one-humped camel lasts about 387 days. The hormonal mechanisms causing parturition are not well-known. The parturition process lasts about 5-6 hours but is usually shorter in animals dropping their first young. The initial stage, or let-down, is the longest (Figure 6.2.3). The actual birth is usually rapid, the time taken for expulsion of the placenta being about 30 minutes.

Camels do not lick their young following birth nor do they eat the placenta. Uterine involution is sooner in primiparous than in older females, in which it is about 40 days. The timing of the first post-partum oestrus and its intensity are very variable and probably related to the time of year, nutritional status and management.

Mating behaviour

Anatomical, physiological and behavioural signs of heat can be discerned. The intensity of heat varies both among individuals and seasons. In India, for example, 14, 31 and 55 per cent of female camels exhibit weak, moderate or intense signs respectively.

Camels in heat become restless, bleat continuously and associate with the male; the tail is lifted and flapped and they urinate little and often. The lips of the vulva swell, and they open and close irregularly. There is usually a more or less copious flow of mucous, foul smelling to humans but presumably a powerful and attractive olfactory stimulus for the male camel.

The vagina is pink-coloured and moist, although the degree of wetness decreases as heat progresses. The cervix is moist and relaxed. Rectal examination shows the uterine horns are turgid at the beginning of heat, although not so much as in the cow.

Reproductive performance

Age at first parturition

Data from retrospective surveys to establish the reproductive careers of female camels have provided indications of ages at first parturition. In traditionally managed Kenya herds, an age of 58 months has been estimated. Two different studies from Niger give estimates of 63.4 months on a sample of 2,610 camels and 58.8 ± 19.2 months for 215 females. In the first Niger study, 3-80 percent of females (varying with ethnic group and management type) first gave birth at 4-5 years. About 95 per cent had produced at least one young at six years, except in one transhumant group where a level of 95 per cent having given birth at least once was not reached until the 8-9 year age-group. In the latter Niger study the age range at first parturition was 2-11 years.

Animals of a known age gave birth for the first time at 61 months in an experimental herd in Kenya. In ranch herds in Kenya the average age at first parturition of 37 camels which had run freely with a male from birth was 54.2 ± 2.8 months, varying among ranches from 48.6 to 56.1 months. The youngest animal first gave birth at 45.6 months and the oldest at 71.3 months.

Average age at first parturition of 105 Bikaneri camels on a breeding farm in Rajasthan was 61.0 ± 0.98 months (1,838 ± 29.7 days) but it is not clear if there was control over the age at first service.

Parturition intervals

The conventional wisdom is that the interval between successive births in camels is about two years. Retrospective studies in traditional systems tend to confirm this period but intervals vary considerably and are often spread over a very long period. In Mali, in a study in which 43 cases were reported in a Touareg herd, nine were between 13 and 15 months, twelve between 16 and 19 months, nineteen of about 24 months and three of longer than 24 months. An early study in Kenya showed that only four of 26 intervals were of less than 24 months, fourteen were around 24 months and eight were 25 months or longer. In Kenya an interval of 26.8 months in traditional herds was reduced to 20.8 months when a veterinary package was introduced. This comprised routine treatment of tick and worm infestations; vaccination against anthrax and blackquarter; treatment of trypanosomiasis and other diseases; and a regular supplement of salt. A second traditional herd in Kenya had an interval of 28.4 months.

In Niger the average interval between births in three eastern provinces was 30 months with variations between sedentary herds (25 months in Maradi, 27 months in Zinder, 38 months in Diffa) and transhumant ones (24, 30 and 27 months in the three areas). Further north in the Air region of Niger, in a Touareg traditional system, an interval

of 26.2 ± 10.56 months was established for a total of 329 intervals, with the interval varying among different parities. In southern Morocco there were peaks in intervals at 12 monthly intervals (Figure 30.4), with an overall range of 24.0 ± 8.24 months.

Under commercial ranch management in Kenya the mean of 460 intervals was 18.7 ± 0.38 months. Parity did not influence the interval although there did appear to be shorter intervals in higher parities (Table 30.4). An abortion or the death of the young before weaning led to a shorter interval to the next birth than if the young survived to weaning, probably due to lactation effects on the reproductive hormones. Intervals were clustered about 18 months, there being few of longer than 30 months. In other studies the parturition interval was established at 14.3 months (434 days). In Najdi camels in Saudi Arabia and in commercial milk herds in the Al-Jouf region a calving interval of 14-15 months has been achieved.

Table 6.2.4: Effect of parity on birth intervals (months) in traditional and modern camel production systems

PARITY	NIGER TRADITIONAL			KENYA MODERN		
	NO.	MEAN	S.D.	NO.	MEAN	S.D.
1	144	28.6	9.10	190	19.3	.48
2	97	24.0	9.63	149	18.3	0.51
3	54	25.8	8.89	77	18.8	0.66
>4	34	20.1	7.55	44	18.6	0.87

In Israel it is said that intervals of less than one year can be obtained: an actual time of 365-395 days (mean = 380) was shown on a very few intervals after hormonal treatments had been used. Note that these short intervals were coupled with a reported gestation period of 345-360 days.

Annual reproductive rate

In northern Kenya calving rates of 21.1 and 47.4 per cent have been given for 'treatment' and 'non-treatment' herds. Calculated from the calving interval provided the APR would be 0.45 and 0.58 young per female per year. On the same basis the APR on commercial ranches in Kenya would be 0.64. In southern Somalia an APR of 0.78 in 1984 implies an interval of 15.4 months. For three Kenya populations, when using aerial surveys an APR of 0.47 was calculated with an implied birth interval of 25.5 months. In Darfur in Sudan a calving percentage of 70 was estimated in 1977, an implied interval of 17.1 months (APR = 0.70). In retrospect, it seems this rate was due to rainfall fluctuations over earlier years and probably represented a productivity peak.

In northern Niger the APR was calculated as 0.46 young per female. In eastern Niger age-specific fertility rates varied from 0.01 to 0.57 at different ages (Figure 6.2.6).

Total lifetime production

In Niger a total of 215 camels had given birth to 573 young or an average of 2.7 per female. Calculated from the age at first parturition and the average interval between parturitions, a female culled after 2.7 young would be aged about 10.8 years. In Kenya the average lifetime production of young was 3.5 per female on commercial ranches.

Similar calculations of average production of young in eastern Niger showed that in nine different types of herd the average age and productivity of a breeding female varied from 7.6 years, having given birth to 1.9 young, to 8.6 years, having produced a maximum of 2.4 young.

Seasonality

Early empirical observations of the seasonality of breeding have been supplemented by abattoir studies and more recently by retrospective career histories and complete records. A summary of the literature data (Table 6.2.5) indicates a marked seasonality with most activity in winter in the northern hemisphere. Extended and irregular seasons are not uncommon however, particularly when the camel is moved to areas outside its normal environment and range. (Figure 6.2.5).

In Somalia there are two main breeding seasons related to the bimodal rainfall pattern but births occur all year. In Djibouti, the little information available also indicates opportunistic breeding, perhaps related to the proximity of both the low and erratic rainfall of the Red Sea winter precipitation zone and of the inland and highland summer zone of Ethiopia.

Table 6.2.5: Breeding seasons of the one-humped camel in various countries

COUNTRY	BREEDING SEASON
Pakistan	December-March
India	November-February
Somalia	April-May; June & September-November
Egypt	December-April; May-August
Sudan	March-August
Mali	February/March & August/September
Morocco	May-June

In Kenya, in traditional herds there is some breeding all the year round (as indeed there usually is elsewhere) but with apparently greater activity in

December/January and May which is possibly associated with better nutritional status at conception. On Kenyan commercial ranches, in spite of there being breeding all the year round, there are significant monthly differences in the number of births with most taking place in May/June and November to January.

In northern Niger there were also significant monthly differences in the number of births but the pattern was more pronounced, with a distinct peak in the short rainy season. The best correlations between assumed conception (12 months prior to parturition) and climatic variables were with minimum, average and maximum temperatures, and with day-length. Rainfall was again not significantly correlated with conception but it did improve the correlation when taken in conjunction with the minimum temperature.

Figure 6.2.4: Distribution of parturition intervals in Kenya and Morocco.

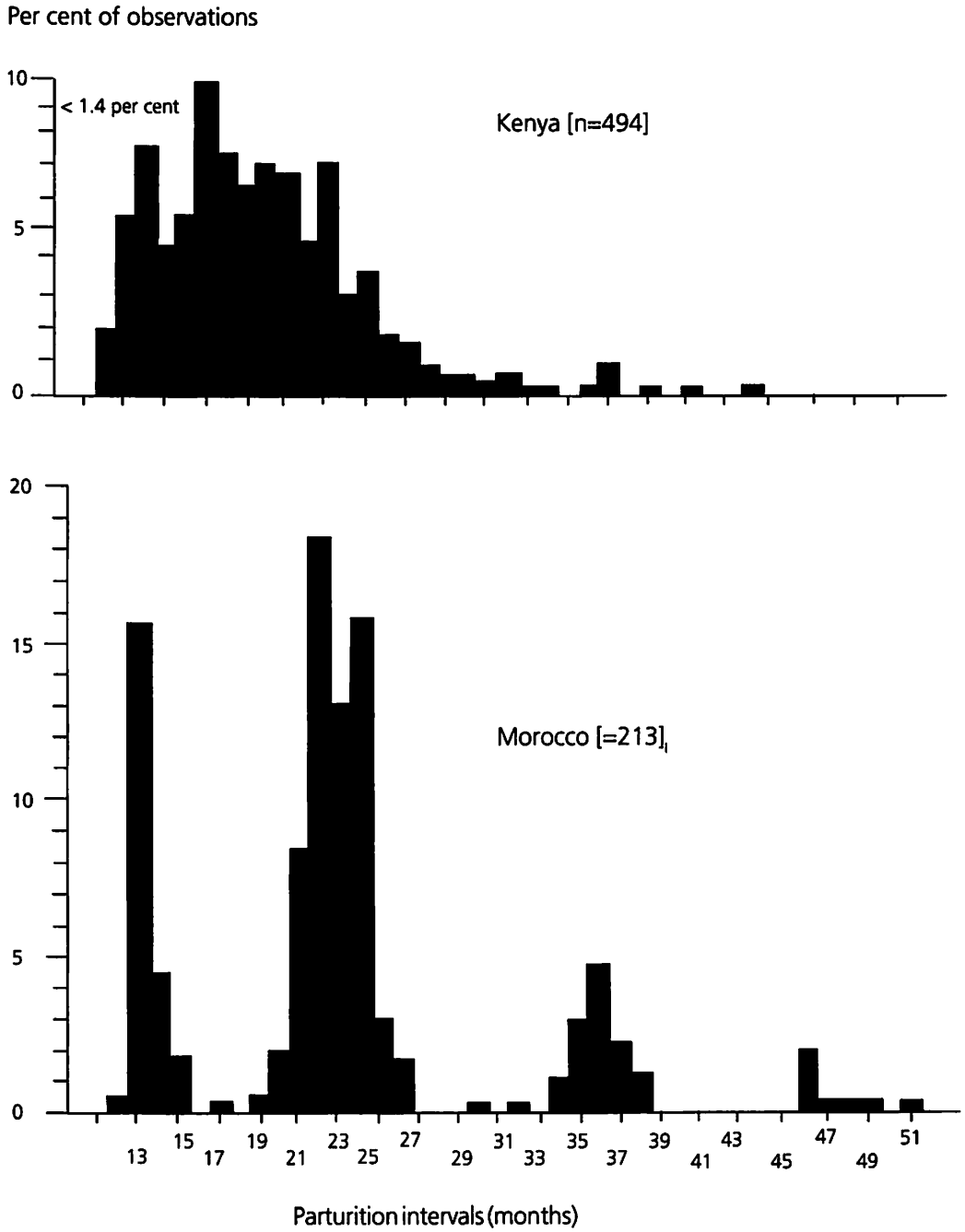


Figure 6.2.5: Monthly distribution of births by camels in various countries.

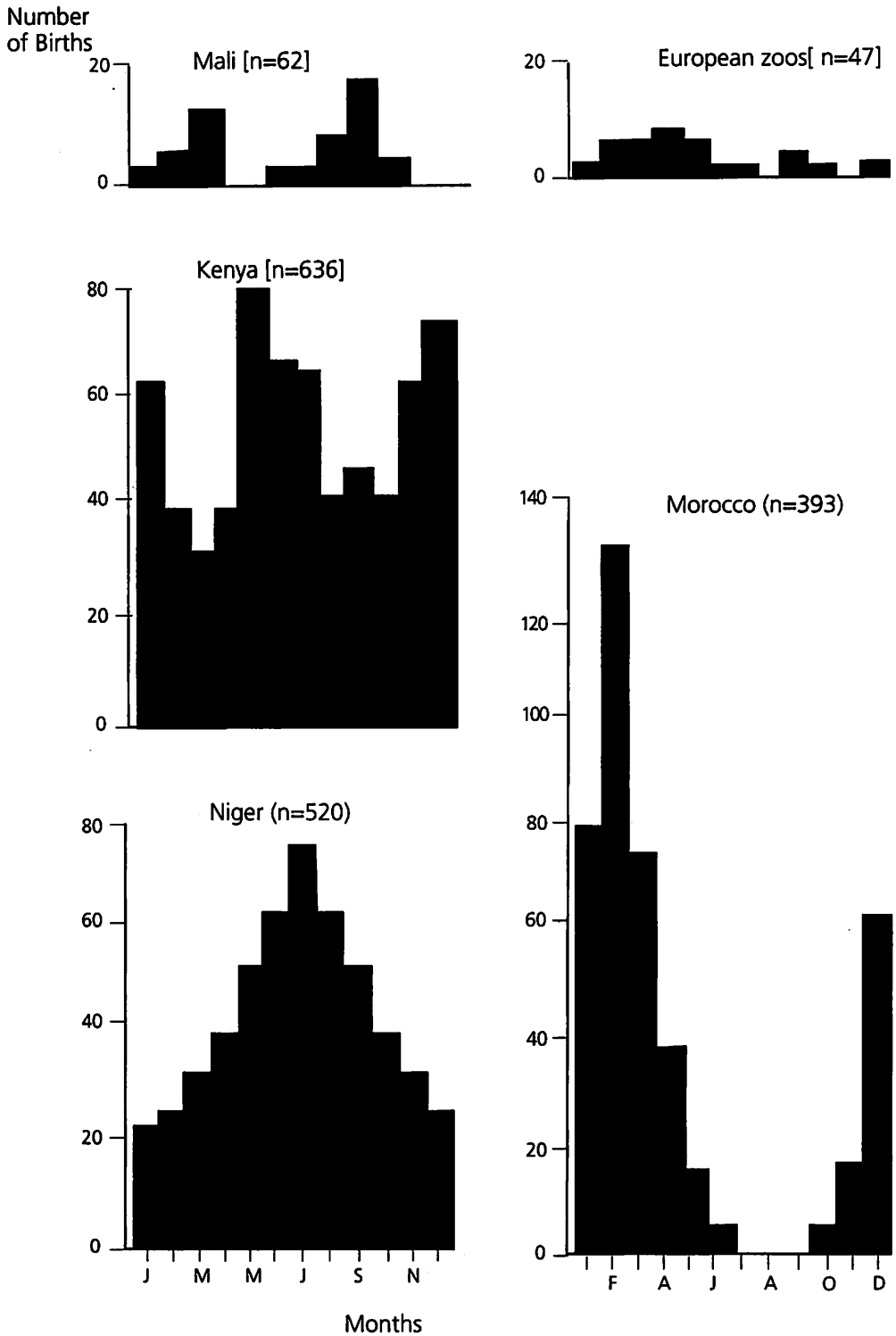


Plate 6.2.1: Male camel in rut, displaying inflated soft palate (dulaa). (Debbie Atkins)

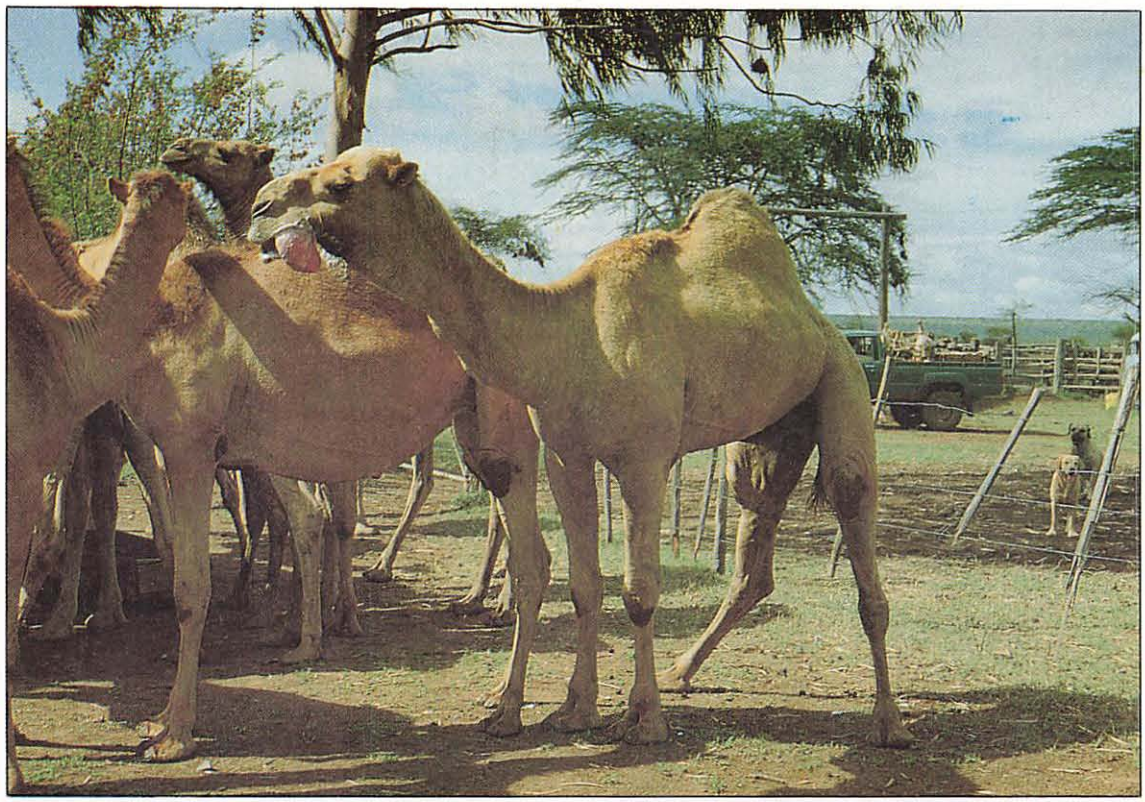


Plate 6.2.2: Copulation occurs in a recumbent position, often attracting the attention of other curious females. (Debbie Atkins)

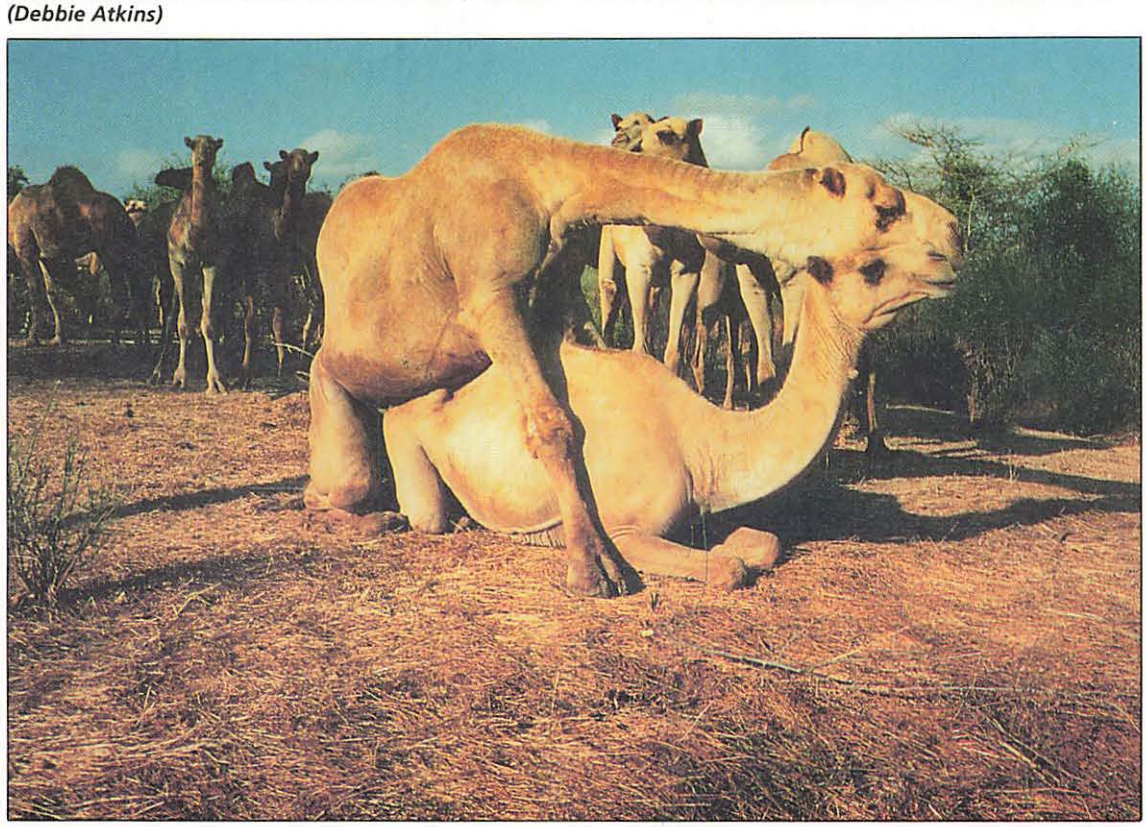


Plate 6.2.3: Approaching parturition is characterised by swollen udder, milk ejection, restlessness and a tendency to wander. (Chris Field)

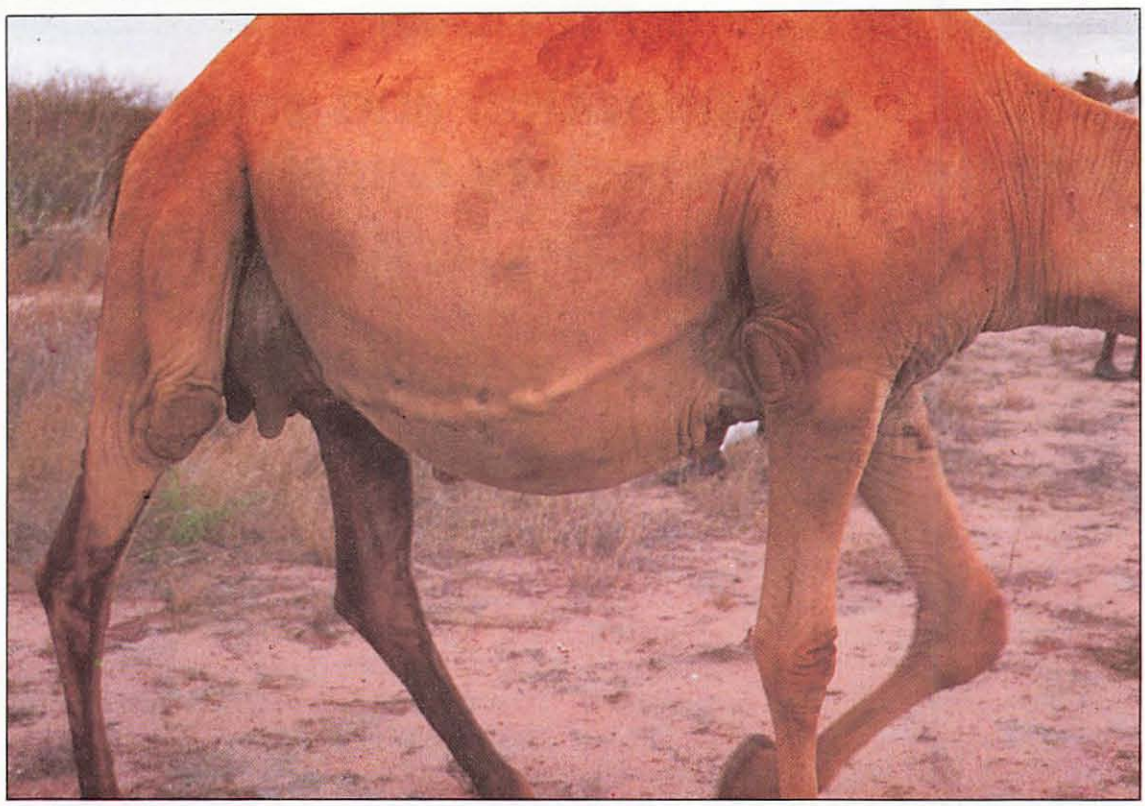
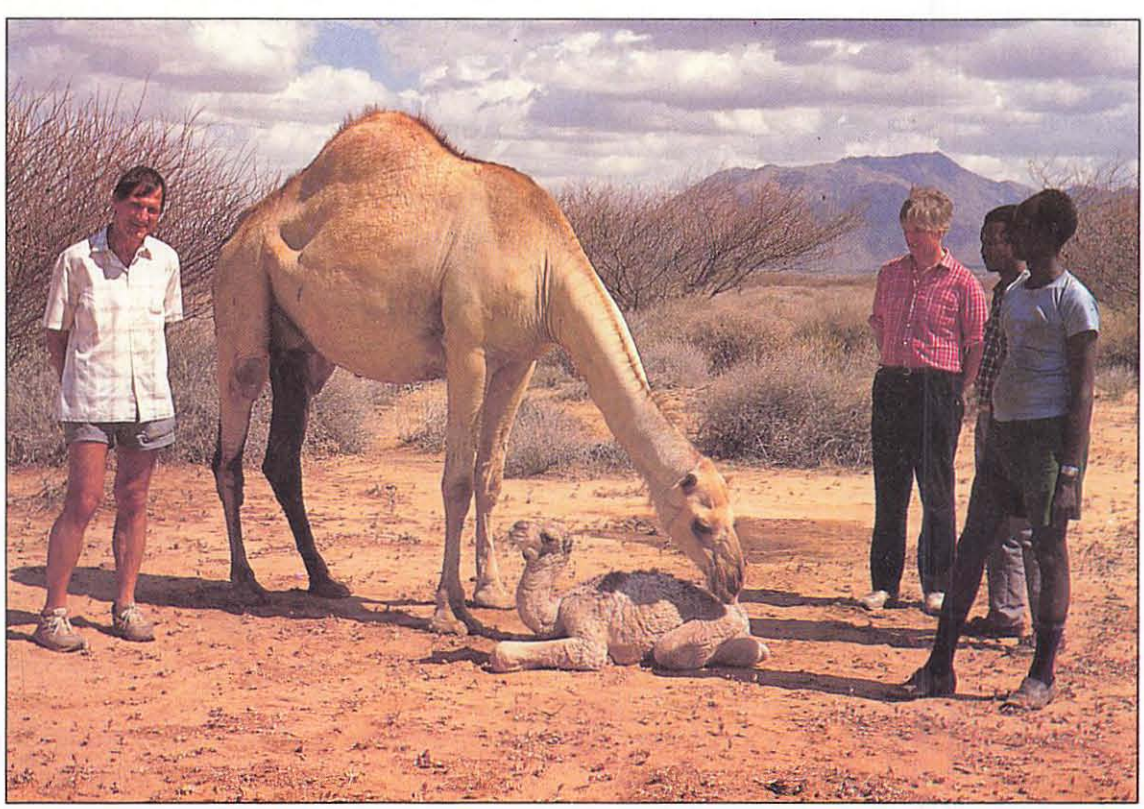


Plate 6.2.4: After parturition the female smells her calf, but does not lick it. (Chris Field)



CHAPTER 6.3

Artificial insemination and embryo transfer in dromedary camels

by Dr R Kamber

Artificial Insemination (AI) is a very useful tool in animal production and has been used for a long time to improve breeding stock, especially cattle, all over the world. In fact, AI has become the most important technique in modern animal production by providing good genetic material for breeding at comparatively low costs with easy availability to all cattle farmers.

There have been attempts to introduce AI in camels. If successful, it will not only improve the breeding, but also help in disease control as animal transport could be reduced a great deal and only semen would have to be transported from the chosen bull to the female. More importantly, with the camel being a very slow breeder, it takes several years to evaluate the breeding qualities of a bull. A bull, proved to be of value by its descendants, will by that stage be at least 10 years old and as a result much of its valuable breeding life will have passed without it having been utilised to the full. However, finding a technique for storing semen over a long period of time will solve this problem and the semen can continue to be used for decades to come, as is the situation with cattle.

In a series of experiments carried out in Khartoum and Hanover, a system for AI in camels has been developed (Musa et al 1992).

Semen collection in camel bulls can be done either by using an artificial vagina or by electroejaculation.

The evaluation of the semen is carried out by macroscopic and microscopic examination, evaluating the same characteristics used in bovine semen.

For short-term preservation of camel semen, an extender is added (3 parts extender to 1 part semen). The optimal insemination dose has not been found yet, though a minimum of 400 million spermatozoa must be obtained. The extender contains egg yolk and lactose; semen preserved in this way must be used within 36 hours. For long-term preservation, the semen, after being extended and divided into doses, must be deep-frozen and stored at a temperature between -120 and -196°C in liquid Nitrogen.

A main difference between cattle and camels is the fact that the camel is an induced ovulator. Ovulation can be induced by depositing semen in the uterus (Chen et al. 1990; Musa et al. 1990). It has been demonstrated in bactrian camels, that an ovulation-inducing factor, probably a protein, is contained in the seminal plasma (Zhao et al. 1990). This means that AI can be used in the female camel, during a spontaneous ovarian cycle or when oestrus is induced by treatment with exogenous hormones (hCG, eCG or pFSH).

With fresh semen, the optimum time for insemination is on the first day that the camel shows oestrous (on-heat) signs (restlessness, bleating, vulval swelling and vaginal mucus). Ovulation usually occurs 24-36 hours later. However, when using frozen semen, it might be advisable to inseminate twice, 24 hours apart, in order to supply enough of the ovulation-inducing factor. When ovulation is induced, by treatment with exogenous hormones, insemination should take place 24 hours later in order to achieve synchronisation of insemination and ovulation.

Insemination into the cranial part of the cervix or the body of the uterus is preferable. The technique used is similar to that in cattle (passing the insemination gun into the vagina and through the cervix with one hand in the rectum holding the cervix).

Embryo transfer has also been successfully carried out in camels, but it is more difficult than

in cattle because of the camels lack of cyclical corpora lutea, and because they do not ovulate spontaneously (Arthur 1992).

AI and embryo transfer will only become more widespread once the induction and synchronisation of oestrus in camels has been satisfactorily and reliably achieved, either by the use of exogenous hormones (the response to which there is considerable variation between individuals) or teaser bulls (Skidmore et al (1992). The anatomy and temperament of camels also make the whole process more difficult.

SECTION 7

VETERINARY AND HEALTH MANAGEMENT

CHAPTER 7.1

Trypanosomiasis in the camel

by D Rottcher and E Zweygarth

Introduction

Most people associate trypanosomiasis with tsetse flies (*Glossina spp.*) and tropical Africa. Camel trypanosomiasis is an exception. Most camels live outside Africa's tsetse belt, and suffer from trypanosomiasis caused by *Trypanosoma evansi*, which is transmitted mechanically and is not dependent on the presence of tsetse flies. This trypanosome species probably causes the most widespread and the most important disease in camels.

Camels are also affected to a lesser extent by the tsetse-transmitted trypanosome species, *T. brucei* (Wenyon 1926; Leese 1927; Stephen 1970; Leach and Roberts 1981; Harter *et al* 1985) and *T.congolense* (Leese 1927; Bennett 1933; Harter *et al* 1985). The latter species causes an acute disease with very high mortality. Tsetse flies may have prevented the movement of camels into Central Africa and thus impeded an Arab advance, considerably influencing the history of the African continent. Reports on the pathogenicity of *T.vivax* (Bennett 1933; Pellegrini 1950; Harter *et al* 1985) and *T.simiae* (Pellegrini 1948; Zweygarth *et al* 1986) in camels are contradictory.

The term camel in this paper refers to the dromedary (*Camelus dromedarius).*

Historical observations, distribution and origin

Trypanosoma evansi was discovered more than a hundred years ago by Evans (1880) in India in horses, mules and camels suffering from a disease known locally as "surra". Subsequently, numerous reports of trypanosomiasis in horses and camels were recorded from North Africa, the Americas and Eurasia. Many different scientific names were used for the parasite until it was found that all these non-tsetse transmitted organisms of the subgenus *Trypanozoon*, except *T.equiperdum* were *T. evansi* (Hoare 1956).

Trypanosoma evansi might have originated in Africa, evolving from *T.brucei* (Hoare 1972) when camels entered the tsetse belt south of the Sahara, and the disease spread through camel herds as a result of transmission by biting flies. Continuous mechanical transmission by blood-sucking flies in the absence of *Glossina* caused the loss of cyclical transmissibility and gave rise to a predominance of slender parasite forms.

The transmission by blood sucking insects, other than *Glossina,* has enabled *T. evansi* to extend its range into African areas north of the Sahara desert, into Asia Minor, Pakistan, India, the USSR, China, Sumatra, Java, the Philippines, Mauritius, Madagascar, and South and Central America. It was introduced with camels into Australia, North America and South West Africa. In these three localities, however, it was eradicated as a result of major control measures.

Trypanosoma evansi produces the mildest and most chronic disease syndrome in places where it has occurred for a long time, such as in the southern periphery of the great Sahara desert. Here the parasite-host relationship is relatively well balanced. When the parasite is newly introduced to susceptible livestock it causes enormous losses. One might speculate that another few hundred years of frequent and widespread trypanosome infections in camels of the Sahel region might have allowed selection of a trypanotolerant dromedary population. However, the advent of modern chemotherapy has probably altered this trend and the economic implications for these marginal zones exclude waiting for this selection to occur.

Transmission and hosts

Trypanosoma evansi is transmitted mechanically by haematophagus biting flies and no developmental stage in a vector has been demonstrated. This differentiates the parasite from *T.brucei.* Tabanids (horse flies) play the major role in transmission, while *Stomoxys spp.* and *Lyperiosia spp.* may also transmit it. An interrupted feed on an infected host leaves the fly hungry and when it moves to another host it can transmit the infection through its trypanosome-contaminated mouth parts. Trypanosomes remain infective on the proboscis only for a short period.

There is a build-up-of tabanid populations during the rains due to the favourable humid conditions for breeding. This results in a seasonal increase in new infections. Towards the end of the dry season, when there is a shortage of grass and browse, herders are forced to move stock into riverine or swampy areas which are also favourable for the development of these flies. Although the animal owners know that certain areas and certain seasons produce an increase of such infections they cannot avoid them in the search for fresh pastures.

The parasite replicates in camels, horses, donkeys, dogs, cattle, water-buffaloes and elephants. Equines and dogs are very susceptible and usually die of an acute disease. Dogs may also become infected by eating meat from a trypanosome-infected carcass (Leese 1927). Cattle, sheep, goats and antelopes often become infected and act as asymptomatic reservoirs.

Parasite morphology and biology

Trypanosoma evansi is morphologically identical with, and indistinguishable from, slender forms of other members of the subgenus *Trypanozoon.* Akinetoplastic populations are relatively common, particularly after drug exposure (Ray and Malhotra 1960; Killick-Kendrick 1964). *Trypanosoma evansi* can be distinguished from *T. brucei* by isoenzyme electrophoresis (Gibson *et al* 1983). *Trypanosoma evansi* is not restricted to the bloodstream and, like other members of the subgenus *Trypanozoon,* enters tissue compartments or other body fluids. It may cross the blood-brain barrier (Leese 1927) or enter the joint fluids (Rottcher and Schillinger unpublished results), thus being less accessible to chemotherapy. This situation is comparable to chronic *T. brucei* infections in mice (Jennings *et al* 1977) or to the late stage of human sleeping sickness.

Clinical signs and the course of the disease

Surra affects camels of all ages, with a higher incidence of disease in sub-adult camels shortly after weaning. Numerous environmental and host factors influence the course of the disease, such as other infections, nutritional status, age, pregnancy, previous exposure or immuno-suppression by other diseases and stress.

In a typical case the dromedary loses weight, develops a drooping hump, is unable to walk long distances, may or may not develop oedema on the feet, brisket, underbelly and eyelids and has a rough coat. The initial fever may be accompanied by lacrimation, shivering, reduced appetite and a mild diarrhoea. The animal shows a progressive anaemia and fluctuating body temperature with initial peaks of fever up to 41°C. Later the appetite is relatively unimpaired and the temperature may be normal or slightly elevated.

The mucous membranes are pale and the packed cell volume (PCV) drops to below 25%, sometimes as low as 10%. The herders may detect a characteristic odour of the camel's urine and identify infected animals by this sign (Leese 1927). The odour of the urine might be a result of ketone bodies which were found to be elevated in trypanosome-infected camels (Schillinger unpublished results). Abortion in all stages of pregnancy is common (Knut and DuToit 1921; Leese 1927). If the foetus is full-term it may be born alive but weak with a parasitaemia (Sergent *et al* 1920). Death of the new-born calf ensues within two weeks. Lactating females show a marked reduction in milk production, and cases of blindness and central nervous lesions have been reported.

The herd may eventually reach an endemically stable disease situation. Some animals may carry trypanosomes for years, some never do and within such a group there are all forms and stages of surra from new infections to sub-clinical and chronic conditions. The course of the disease varies widely. A small percentage of animals (in Kenya) die within 2-5 months of contracting the

disease. Some live for up to four years with subclinical infections and some eventually recover and eliminate the parasite. The overall productivity of a camel herd regarding calves, milk and weight gains is greatly impaired. A lethal outcome is relatively rare although mortality may reach up to 20%.

Diagnosis

The diagnosis of trypanosomiasis is made by demonstration of parasites in blood. However, dromedaries are usually herded far away from laboratory facilities. A tentative diagnosis can be made without microscopy, taking into account the owners' observations and clinical examination of camels in the field.

The herder may report weight loss, weakness, blindness, abortions or changes in the odour of the urine. For the veterinarian the leading symptom is anaemia. The mucus membranes are pale to white in colour, tachycardia occurs, there may or may not be pyrexia, lacrimation, cachexia, enlarged lymph nodes, reduced appetite and oedema, which is first noticed on the underbelly.

On postmortem there are no absolutely typical signs, however, there is often some degree of anaemia; skeletal and heart muscles are pale, there are signs of dehydration, pericardial effusion, enlarged lymph nodes and splenomegaly.

The direct methods of trypanosome detection usually confirm the presence of the parasite: wet blood films, a stained thick drop of blood and a thin blood smear. Concentration techniques can also be employed, such as the haemotocrit centrifuge technique (HTC) (Woo 1969), dark ground illumination-buffy coat technique (DGI) (Murray *et al* 1977), and the miniature anion-exchange centrifugation technique (mAECT) (Lumsden *et al* 1979). Centrifugation of blood, to determine the PCV and to use the buffy coat within the microhaematocrit capillary for concentration techniques (HCT or DGI), plays a vital role in assessing the degree of anaemia and, at the same time, to confirm diagnosis.

A battery-operated minicentrifuge has proved to be extremely valuable, because both these tests are possible in the field (Kelley and Schillinger 1983).

Inoculation of camel blood into laboratory rodents was found to be valuable in detecting sub-patent infections of *T. evansi* in camels (Godfrey and Killick-Kendrick 1962). This was later confirmed by Pegram and Scott (1976) who considered the inoculation of camel blood into laboratory rodents to be the best direct diagnostic method.

For mass screening of dromedary herds, numerous indirect tests have been described. The formol-gel test (Knowles 1924) and the mercuric chloride test (Bennett 1929) only detect high serum globulin levels which are a common feature in camel trypanosomiasis, but are nonspecific. Specific serological tests have been widely applied: the capillary agglutination test (Jatkar *et al* 1977), the passive haemaglutination test (Jatkar and Singh 1971), the immunofluorescent antibody test and the enzyme-linked immunosorbent assay (ELISA) (Luckins *et al* 1979). Recently, Zweygarth *et al* (1986) described a simplified ELISA test for camel trypanosomiasis on the basis of a commercially available protein A-peroxidase conjugate. The serodiagnosis of camel trypanosomiasis with these tests requires a somewhat sophisticated laboratory. Recently, however, a card agglutination test has been introduced for the diagnosis of Gambian sleeping sickness (TestrypR CATT. Smith and Kline) which has been adapted successfully for the serodiagnosis of *T. evansi* in camels (Zweygarth *et al* 1984).

Treatment

Two drugs are available for the treatment of *T. evansi* infections in dromedaries:

- suramin (Naganol, Bayer and Antrypol, ICI) - 12 mg/kg intravenously for curative and prophylactic activity.
- quinapyramine-methyl sulphate (Antrycide Sulphate, ICI; Quintrycide, Gharda Chemicals; Trypacide Sulphate, (RMB/May & Baker); Noroquin, Norbrook Laboratories) - 3-5 mg/kg subcutaneous injection for curative purposes
- quinapyramine pro-salt - chloride/methyl sulphate mixture (Antrycide pro-salt, Quintrycide pro-salt, Trypacide pro-salt, Noroquin pro-salt) - 5-8.3mg/kg subcutaneous injection for curative and prophylactic activity.

Most of the drugs for cattle trypanosomiasis are either not curative such as homidium bromide,

(Ethidium®, Camco) and pyrithidium bromide (Prothidium®, Boots) (Srivastava and Ahluwalia 1973), or are too toxic for camels such as diminazene aceturate (Berenil®, Hoechst) (Leach 1961; Fazil 1977 Homeida *et al* 1981).

Suramin has been in use for almost 60 years. A dose of 12 mg/kg or about 5 g per adult camel, given slowly intravenously, is recommended. Paravenous application can result in phlebitis. The drug is excreted slowly, which results in some prophylactic drug effect for 6-12 weeks, depending on the dosage and the challenge infection. Suramin is tolerated up to 3 times the recommended dose. There are now numerous suramin-resistant strains of *T. evansi.*

Quinapyramine is simpler to dissolve than suramin and its subcutaneous application is easier. Quinapyramine methyl sulphate is used as a curative drug, while a mixture of two salts, quinapyramine methyl sulphate and quinapyramine chloride at a ratio of 3:2, is applied for prophylactic purposes (Pro-salt R.F.). Prophylactic cover results for about 4-6 months. Severe overdose causes salivation, muscle tremors, stiffness and collapse or death following "curare-like" symptoms while moderate overdoses are predominantly nephrotoxic (Davey 1957). Also numerous strains have developed resistance against quinapyramine, and many *T. evansi* strains with dual resistance to suramin and quinapyramine have been described (Mahmoud & Osman 1979; Schillinger *et al* 1984).

Isometamidium chloride (Samorin, May & Baker; Trypamidium, SPECIA) has only a moderate effect against *T. evansi* and has been used in camels as an emergency measure where dual-resistance against suramin and quinapyramine exist. When given intramuscularly isometamidium produces severe local reactions. In camels, 0.5mg/kg isometamidium given intravenously as a 2% solution is well-tolerated (Balis 1977; Balis and Richard 1977). This route of application is curative in acute cases but fails when parasites have already entered extra vascular sites.

Trypanosoma evansi may enter body compartments other than the vascular system. The available trypanocides with the exception of the arsenicals, do not cross the blood brain barrier efficiently.

Melarsoprol (SPECIA) has been tested using mice infected with *T. evansi* strains with single or dual resistance. All were fully sensitive to the drug, which not only overcomes resistance, but also offers a cure in the later stages when trypanosomes have entered the central nervous system and are inaccessible to other drugs. Melarsoprol is curative, but has considerable disadvantages. It causes severe local reactions and should be given intravenously. It has a narrow therapeutic index and treatment depends on accurate body weight and dosage determination. A dosage of 3.6 mg/kg is tolerated but should not be exceeded (Schillinger and Rottcher unpublished results).

Prevention

Prevention should aim at the vector to break the transmission cycle. The application of synthetic pyrethroids for the control of *Tabanidae* and *Muscidae* has been highly effective in temperate climates. In dromedaries this technique would most likely provide effective protection. Ear tags containing pyrethroids (Flectron, Shell; Wellcare Earclip, Coopers) provide a whole body protection of cattle against biting flies for 3 - 5 months after application. The active ingredients are distributed in the grease throughout the haircoat and kill the insects quickly. It remains to be seen whether similar results can be obtained with camels to control tabanids. Ear tags, however, are not suitable for camels and a different form of application is required.

Tabanid challenge for sedentary camel herds can be reduced by trapping large numbers of flies, using Manitoba traps (Molyneux and Ashford 1983).

Because most transmissions occur within a herd, regular veterinary examination of all camels and correct treatment of those which are trypanosomiasis-positive are the most important measures to reduce new infections.

One should bear in mind that sheep and goats, which are very often kept close to camels, act as asymptomatic carriers of *T. evansi* from which transmission to camels can take place. In the Sudan, Boid *et al* (1981) demonstrated antibodies against *T. evansi* in sheep and goats, but they were unable to demonstrate the parasite.

Tsetse-transmitted trypanosomiasis

Glossina spp. transmit the classical trypanosomes of domestic livestock: *T. brucei, T. vivax, T. simiae* and *T. congolense*, however, there are virtually no

camels living in tsetse areas. *Trypanosoma brucei* produces a disease syndrome in camels which is rather similar to that caused by *T. evansi*. The course of the two infections, the pathological changes and the drug responses are also similar.

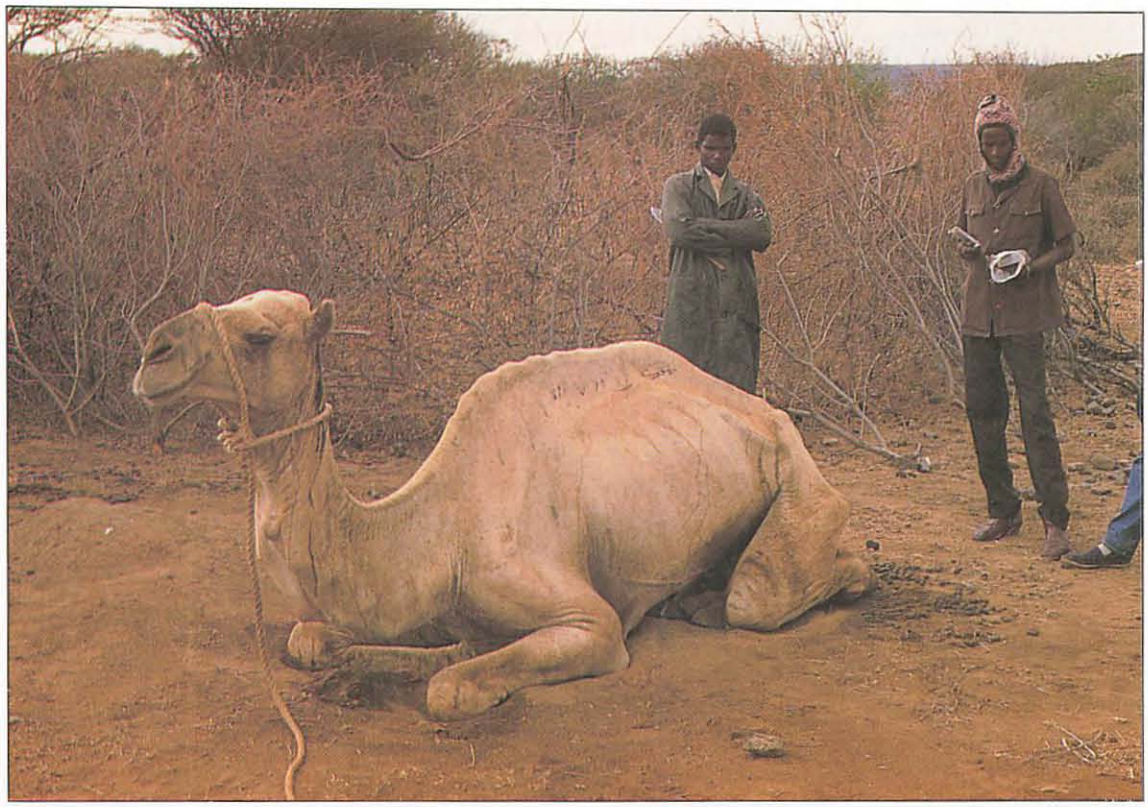
Artificial *T. vivax* infection causes a relatively mild disease with low mortality and a high percentage of self-cures (Bennett 1933, Pellegrini 1950). Isolates of *T. vivax* from cattle have been reported to be unable to infect camels (Harter *et al* 1985). *Trypanosoma simiae* is said to result in high mortality (Pellegrini 1948), however, our attempts to infect camels with *T. simiae* have failed (Zweygarth *et al* 1986).

The tsetse-transmitted trypanosome (*T. congolense)* has a devastating effect on dromedaries whenever they enter endemic areas. It causes a highly acute disease which ends fatally, within one month, if untreated (Leese 1927: Bennett 1933; Harter *et al* 1985). After a prepatent period of 10-15 days, the infected dromedaries have intermittent fever, high parasitaemia, a moderate anaemia and severe weakness. The vascular system soon becomes permeable and there is a marked effusion of plasma into body cavities, connective tissue, pericardium and lungs. The affected camel dies within days of the onset of symptoms. The most striking postmortem finding is a cardiac tamponade with litres of fluid in the pericardial sac and some degree of pulmonary oedema.

Suramin has little effect on *T. congolense* while quinapyramine methyl sulphate is an effective drug, provided it is applied in the early stages of the disease, before pathological changes become severe.

Plate 7.1.1: Camel suffering from Trypanosomiasis on left. Healthy camel on right. (Chris Field)

Plate 7.1.2: Camel showing typical signs of Trypanosomiasis. (Chris Field)



CHAPTER 7.2

Skin diseases of camels

by Dr Set Bornstein

Introduction

Skin diseases of various aetiologies are often seen in camels. Sarcoptic mange is said to be the commonest disease of camels after trypanosomiasis and/or camel pox, another common skin disease. Some common micro-organisms, bacteria and fungi often cause skin lesions in camels as primary or secondary invaders. Many of the skin pathogens are zoonotic i.e. they can also affect other animals and man. As in the case with other diseases of camels our knowledge of the skin diseases is premature and unsatisfactory.

True camel pox

The true camel pox is a highly contagious virus disease particularly affecting young camels. It often takes a mild course, but can be severe and fatal with mortalities in over 10% of cases.

Aetiology

The virus causing true camel pox is *Orthopox virus cameli* (genus: *Orthopoxvirus;* family: *Poxviridae*) is highly host specific. It is prevalent in all countries where camels are found, in Asia as well as in Africa. The disease is regarded to be of increasing economic importance.

Clinical signs

Many camels are found to have encountered the infection, which spreads rapidly through a herd particularly affecting the young stock. The incubation period is 10-15 days.

The clinical manifestations of the disease can take several forms. In a mild (benign) form the first symptoms are a low grade fever followed by diffuse oedema around the lips. Papules develop on the labial mucosa (mouth) and around the lips. The papules turn into vesicles, which eventually rupture. The raw lesions may become secondary infected and brown crusts usually develop over the ruptured vesicles. The animals can find eating painful and thus lose condition. The eruptions of papules and vesicles are accompanied by pruritus.

The sub-maxillary lymph nodes may be enlarged. The lesions heal within three weeks, often leaving scars. Other areas of the body can be affected i.e. the thigh and inguinal regions.

In a more severe form of the disease the "pock" lesions will erupt all over the body following high fever. In some cases the head is oedematous and swollen showing lesions around the lips and eyes.

Conjunctivitis and keratitis can follow. Affected animals may die following diarrhoea, dehydration, secondary infections and emaciation. Animals that recover develop lasting immunity.

Diagnosis

Camel herdsmen readily recognise the disease. However, to confirm suspect cases specimens (vesicles) should be taken to a laboratory for virus isolation and/or for histopathological or electron microscopical investigations.

Treatment and control

Traditional treatments are known, i.e. crude vaccinations using the scabs of infected animals. In the USSR vaccines are used. No vaccines are available in Africa. No treatment or prophylaxis are practised outside the USSR - but to let the disease run its course. To avoid the spreading of an infected herd isolation (quarantine) should be enforced. The virus is easily spread by fomites.

Differential diagnosis

1. Contagious echtyma particularly the generalised form.
2. Sarcoptic mange.
3. Ringworm.

Camel contagious echtyma (eczema)

Contagious echtyma in camels is a benign (mild) disease caused by a parapoxvirus. It is characterised by localised poxlike skin lesions with high morbidity and no mortality. There are only few reports of the disease (from the USSR, Mongolia, Kenya and Somalia).

Clinical signs

The symptoms can sometimes be confused with camel pox. Poxlike lesions develop, normally localised but sometimes generalised. Pustules and scabs can be seen on the head particularly around the lips and nostrils. In some generalised cases the head is oedematous (swollen) and so are the mandibular and cervical lymph nodes.

Infection often seems to occur during the rainy seasons and is mostly seen in young animals, 6 months - 2 years old. Recovered animals do not get the disease again.

Diagnosis

Confirmation of the diagnosis is by finding the parapox virions by electron microscopy.

Differential diagnosis

True camel pox.

Camel papillomatosis

Wartlike skin lesions are often seen in abundance around the lips and nostrils in young animal (6-18 months). In older animals warts can be found in other areas of the body e.g. on the teats. The warts are caused by a papilloma virus.

Diagnosis

In electron microscopic examinations papilloma virions are seen in sections of the warts. Histopathological sections will confirm the diagnosis of the warts.

Differential diagnosis

Mixed infections of warts and contagious echtyma are reported. Other wartlike lesions of other aetiology.

Ringworm

Ringworm belongs to the dermatomycotic diseases i.e. infections of keratin-bearing tissues (hair, skin and nails) caused by fungi, (dermatophytes).

Aetiology

In camels ringworm is caused by Trichophyton species, most often by *T. verrucosum*. Although camels of all ages may be affected the disease is most commonly found in calves and young animals (up to 3 years).

Clinical signs

The infection is characterised by a local oedematous lesion developing into alopecia (hair loss) and a thick scaly encrustation, often greyish-black coloured. The lesions often occur at sites where the skin comes in contact with other infected animals or contaminated objects (e.g. saddles, blankets, harnesses) - notably the head, neck, shoulders, hump, flanks and front legs. The spores are tough and can survive for months in the environment outside the body .

Diagnosis

The diagnosis can be confirmed by identification of the fungus found on the affected hairs. Specimens (hairs and scrapings taken from the periphery of the lesion) for microscopical examination should be cleaned in 10% potassium hydroxide. Chains of spherical (4-6µ) spores are seen surrounding the shaft of the hairs.

A more effective means of securing a diagnosis is to culture the organisms. This is done on Sabouraud agar plates. It can take 1-4 weeks before colonies of the fungus have developed.

Treatment

Thick crusts should first be removed with a brush and mild soap. Daily applications of a mixture of equal parts of iodine and glycerine have been effective. Other topical, specifically anti-mycotic agents might be tried. However, griseofulvin applied parenterally at doses of 2.5 - 5.0g daily is not

recommended. It has been observed to produce side-effects in camels. Vaccines are successfully used in the USSR.

Differential diagnosis

1. Sarcoptic mange.
2. Note mixed infections with other skin pathogens.
3. Unspecific dermatitis.

Ectoparasitic arthropods

Mites (ticks), flies, fleas, lice, etc., cause a great diversity of animal health problems. Their infestations alone can give rise to severe irritation, debility (anaemia, arthritis) and trauma, and thus to substantial economic losses from reduced milk production, lowered weight gains, and damage to hides, etc.

Some arthropods act as vectors of disease. Many of the known vectors transmitting infection to cattle and smallstock are not incriminated as vectors in regard to camels. Below are some arthropods of particular importance.

Sarcoptic mange

Sarcoptic mange or scabies (the name applied to the disease in man) is a highly pruritic and contagious disease caused by a mite, *Sarcoptes scabiei*, which is reported to be able to infect and cause skin disease in 40 different mammalian species, including man.

In camels the variant of this pathogenic mite is called *Sarcoptic scabiei var cameli*, which is morphologically indistinguishable from other variants found in other susceptible animal species.

The adult mite can barely be seen by the naked eye. The male is about two thirds the size of the female, which is roughly 0.3-0.5mm long and 0.2-0.4mm wide. The mites are whitish-opaque in colour and resemble a tortoise with small, barely visible legs tucked under the body (Figure 7.2.1). The nymphs and adults have four pairs of legs; and the larvae three pairs of legs.

Life-cycle

The mites dig into the upper layers of the skin (epidermis) making tunnels in which the fertilised female lays her eggs, 2-3 per day. The eggs hatch within a few days. The development from egg - via larva, proto- and trito-nymph - takes about two weeks.

Transmission

All the life-stages (instars), of the mite frequently leave the burrows in the epidermis and wander on the skin and thus may infect other animals directly or indirectly by being dislodged from the host (when scratching) onto other objects in the environment.

Survival off the host is dependant on ambient temperature and relative humidity (RH). Lower temperature and higher RH, which reduce the risk of desiccation of the mites, are favourable for survival. Female mites survive only a few hours at 45°C and 25-45% RH, but can survive one week at 10°C and 25% RH, and about two weeks at 10°C and 97% RH. If exposed to 50°C the mites will die after 10-15 minutes.

Host specificity

S. scabiei var cameli has been shown experimentally to infect sheep and goats and *S. scabiei varians* on sheep and goats have likewise successfully infected camels (Nayel and Abu-Samra 1986).

Symptoms

The incubation period is believed to be around 2-3 weeks at a primary infection. Presumably the incubation period will be much shorter if re-infection occurs after recovery from the previous infection. The first symptom to appear is pruritus, which gradually increases during the acute stage of the infection. The intense itching is usually accompanied, or soon followed, by erythema (skin rash) and papule formation, which are signs of hypersensitivity (immune) reactions. The itching and rubbing causes the hairs to fall off (alopecia) and excoriation to occur. A localised exudative inflammation can develop.

The lesions are often localised during the first few weeks and usually confined to one or several of the following areas of the body: the head and neck, medial aspect of the flank, inguinal regions, udder, shoulder and hump. Scabs and crusts are seen a few weeks after the first clinical signs have appeared and are soon followed by thickening of the skin, which becomes rough, wrinkled with fissures and discoloured greyish-black (hyperkeratosis).

Affected animals can become seriously disturbed by the intense itching (pruritus) particularly during the acute phase of the disease. Feeding behaviour can be so affected that the animal loses condition due to reduced food-intake (malnutrition). In the more chronic phase the pruritus is usually significantly less.

All age groups of camels can be affected although the infection is most prevalent in the younger age groups (<2 years).

Immunity

No protective immunity to the infection is known to occur in the camel. In sarcoptic mange of dogs, pigs, guinea pigs and red foxes humoral non-protective antibodies have been detected from the second to fifth week following infection (Bornstein, personal comment).

Diagnosis

Apart from the characteristic signs - pruritus, alopecia and hyperkeratosis - identification of the mite is necessary to confirm the diagnosis. This is done by taking skin scrapings from several areas of the animal. The skin lesions at the border to normal skin and/or of the hyperkeratic lesions should be scraped with a sharp knife, scalpel or razor blade, until slight bleeding occurs.

The scrapings can be looked at through a stereo microscope in search for living mites. If no moving mites are seen the scrapings should be placed in a centrifuge tube and a few ml of 10% potassium hydroxide added. This can be left at room temperature or in a water bath (37°C) for 3-6 hours until the dried skin particles, scabs, etc. have disintegrated (partly digested). After centrifugation, at 3,000 rpm, and after the supernatant has been discarded, 1-2 drops of glycerine can be added to the sediment. This can then be stored in a fridge, for a few weeks if necessary, before being investigated under low power light microscopy in search for mites and their eggs.

There are mites other than *Sarcoptes scabiei*, both pathogenic (i.e. *Demodex spp*) and non-pathogenic, which can readily by seen in this type of preparation.

Serological diagnosis of sarcoptic mange is not yet developed for camels. An ELISA (detecting antibodies) is being used in Sarcoptic mange diagnosis in dogs and red foxes in Sweden. The diagnosis of Sarcoptic mange can only be confirmed as yet in camels by identifying the *Sarcoptes scabiei* mite. A tentative diagnosis is often done by trying treatment against the disease.

Treatment

A strict protocol is needed for effectively treating and controlling the disease. The proper use of acaricides (i.e. organochlorines and organophosphorous compounds) following the manufacturers recommendations for the control of sarcoptic mange is essential.

It is necessary to apply the acaricides over the whole body (spraying) at least three times, at 7 day intervals. Sometimes there is a need to apply the acaricides up to 5 times. Local topical application over circumscribed skin lesions is not enough. Mites can wander about on the skin and burrow into other areas of the skin which look completely healthy. Remember the incubation period.

In chronic mange it might be necessary, before applying the acaricide, to soften and reduce the thick scurvy hyperkeratotic parts by brushing (scrubbing) the area with soap-water.

An effective injectable drug against Sarcoptic mange in most animals, ivermectin (Ivomec Merck), has successfully been proven on camels. Two subcutaneous injections of 1 ml/50kg BW, 10 days apart are close to 100% effective. One injection can often be enough.

Differential Diagnosis

1. Camel pox - particularly the papules and scab formation stages.
2. Ringworm - note that mixed infection can occur.
3. Contagious skin necrosis.
4. Other agents of mange, i.e. *Demodex spp*, which has been isolated from camels in Kenya.
5. Streptothricosis - have been isolated from "mangy" camels in Kenya.
6. Dermatitis
7. Hypersensitivity reaction (allergies)
8. Mixed infection of above.

Ticks

Camels harbour several species of ticks, which are often found in large numbers. Deaths are attributed to infestations by them. More than 100 ticks of *Hyalomma spp* per 2.5cm^2 have been recorded (Steward 1950). In some herds of camels in Kenya, calf mortalities of over 20% have been reported

due to "tick-anaemia". It has been established that there is a loss of 1-3 ml blood for every tick completing its life cycle on an animal.

Mechanical injuries caused by tick bites, although minute, can attract flies, which in turn can cause myiasis and/or bacterial infections. Ticks are commonly found in and around the ears, eyes, lips, toes, and in the perineal, inguinal and axillary regions. There is a species predisposition for these attachment sites. The irritation from ticks around the eyes is said to cause conjunctivitis and perhaps even keratitis.

In the literature there are a few reports of ticks acting as transmitters of disease pathogens: *Amblyomma lepidum* has been suggested to be a vector of *Cowdria ruminantia* (heart water) in camels in Sudan; and there has been inconclusive suggestions of *Hyalomma dromedarii* transmitting *Theileria cumelensis.* However, the evidence for the above is inconclusive . One of the commonest ticks found on camels, *Hyalomma truncatum* has been incriminated in causing toxicosis (posterior paralysis) in camels.

Control

The same procedures that are recommended for controlling ticks on other livestock (e.g. cattle) can be applied to camels. No routine prophylaxis specifically against ticks is practised on camels, because no serious camel diseases have been associated with the presence of ticks. Treatment against Sarcoptic mange also kills ticks. Predilection sites for tick attachment could be treated topically e.g. with an acaricidal grease. Ivermectin (see under Sarcoptic mange) is known to effectively reduce tick infestation. The modern 'Pour ons' are worth trying.

A list of tick species found on camels at various sites in Kenya is given below. This list was compiled using data from Dolan et al (1982) and the Yorkshire Schools Expedition Society (unpub), and Schwartz and Dioli (1993).

Amblyomma gemma
A. lepidum
A. variegatum
Boophilus decoloratus
Hyalomma dromedarii
H. impeltatum
H. marginatum
H. rufipes
H. truncatum
Rhipicephalus camicasi
R. evertsi
R. pravus
R. pulchellus
R. sanguinous
R. simus

Other insect pests

Several insect species can cause damage to animals

1. by just pestering them through their numbers and their bites;
2. through causing them pain and pruritis;
3. by transmitting disease i.e. trypanosomiasis;
4. by causing myiasis;
5. by causing secondary infections, dermatitis.

Flies causing cutaneous myiasis

Larvae of 6 fly species are know to cause myiasis in camels. (Five of these belong to the family of *Calliphoridae* and one to the *Oestridae* family). Some of these cause cutaneous myiasis, subcutaneous and deeper-situated tissue myiasis.

Wohlfahrtia magnifica is thought to be the most important of the myiasis causing flies affecting camels. It is particularly prevalent in Asia and around the Mediterranean.

Wohlfahrtia nuba present in several countries in Africa, and in Sudan is known to infect wounds on both camels and man.

Lucilia cuprina called the "Green bottle fly" or "Copper/Bottle fly" is widely found in Africa and in Asia and is known to attack camels as well as other livestock. It is the major fly causing blow-fly strike of sheep in Australia and in South Africa. The adult female usually deposits her eggs in bodies of dead animals, but it is also attracted to infected wounds, or hair soiled by sores or other discharges. The eggs in the wounds hatch after one to two days. The larvae feed on epidermal cells, lymph and necrotic tissue. Thus wounds can become quite large, 10-15cm in diameter, if untreated. The ideal sites for the ovipositing flies are skin folds, particularly in the perineal region which is contaminated by urine and faeces.

Chrysomia bezziana, the Old World screw-worm fly, is common in Africa and southern Asia. It oviposits only in living tissue and is attracted by discharges from wounds, which can be as small as tick bite and needle injection sites.

The female flies deposit clusters of up to 500 eggs at the edge of a wound. The eggs hatch in a day and the larvae mature in about 3-6 days, after which they leave to pupate in the ground. This can take from one to several weeks (Soulsby 1968). Preferred sites of attack by the flies are under the tail and around the ears (Higgins 1986).

Treatment

Infested wounds should be clipped, cleaned and the larvae removed manually. This procedure may necessitate the sedation of the animal. When dressing the lesions it is necessary to use a suitable insecticide. Negasunt (Bayer) can be recommended because in addition to the larvacides (comophos and propoxur) it contains 5% sulphanilamide, which is important in controlling secondary bacteriological infections. Parenteral antibacterial therapy is also recommended e.g. Terramycin LA (Pfeizer) and Tribrissen 48% (Wellcome).

Flies Causing Distress

There are several species of insects which pester camels. Some of these are a threat to the animals both by their direct effect (bites causing pains and attracting other insects) and by the risk of them transmitting infections.

The mere presence of flies around a camel can cause considerable distress and irritation to the animal. This can distract the animal from feeding adequately. Some biting flies pose particular risk to camels by being mechanical vectors of *Trypanosoma evansi* e.g. tabanids (or horse flies). The tabanids are particularly vicious insects. Often after their attacks they leave small amounts of blood on the skin, which will attract other flies.

Mosquitoes, biting midges, etc., will certainly attack and feed on camels if they are in the vicinity (breeding grounds). Some mosquitoes are vectors of *Dipetalonema evansi* and *Onchocerca fasciata*, both common parasites of camels.

Prevention and control

It is fairly practical to even contemplate enforcing adequate fly control programmes in areas where camels are reared. Herders are often well aware of insect problems and will do much to avoid or prevent them pestering their animals e.g. by using smoky fires and avoiding places where the pests are abundant. Modern fly repellents and insecticide formulations can be used and applied externally on the animals.

Bacteriological skin infections

Contagious Skin Necrosis

A disease characterised by necrosis, abscess formation and enlarged local lymph nodes, has been rightly or wrongly associated with lack of salt in the feed to camels ever since 1938 (Peck). This disease of camels was common during the colonial days when the military employed camel corps. The animals were closely accommodated, often zero grazed and under hard work regimes. Leese (1927), rated the disease second only to Sarcoptic mange. Today the disease is only found sporadically amongst camel herds. Paling et al (1988) reported the disease to be present in 10 per cent of the camels in one herd on a ranch in Kenya.

Clinical signs

A firm swelling develops which bursts after 5-10 days leaving a discharging sinus, which might readily resolve or continue discharging pus intermittently for months. These flat cutaneous abscesses 2-5cm in diameter often leave an ulceration. Regional lymph nodes are sometimes involved (enlarged).

The lesions can be seen on any part of the body although they are most common in the neck, shoulders, flanks and hind quarters (legs). Sometimes single - lesion (sinuses) are found, sometimes numerous.

Aetiology

Several bacteria species have been isolated from the lesion: *Streptococcus spp* (some belonging to the Lancefield group B), *S. agalactiae, Staphylococcus aureus* (coagulase positive) *Corynnebacterium spp* (including *C. pseudo tuberculosis* and *C. pyogenes,* and mixed infections of some of the above. *Dermatophilus sp* has been isolated from skin lesions resembling "contagious skin necrosis".

Treatment

Cleaning and application of adequate antibiotic ointments locally and, if there are multiple lesions, parenterally (i.e. intra muscular injections of antibiotics). Various other treatments are used: Iodine: glycerine 50:50, Sulphur paste and "foot rot spray" (Evans, personal comment).

Differential Diagnosis

Any localised purulent dermatitic lesion.

Note
Wounds from thorns etc. are common, and sometimes occur on the feet (especially on the sole etc.). Such lesions can become secondary infected and purulent deep infections can develop. Affected animals often become lame and are not fit for any work. Wounds from badly fitted or balanced saddles or loads can give bruises, "saddle sores" and burns. Such "blisters" can also become secondary infected. Utmost care must be taken when saddling or loading an animal to avoid saddle-sores. It is important to treat such lesions and animals should not be put to work unless the lesions are healed.

Abscesses of the skin and external lymph nodes

Lymphadenitis

Similar groups of pathogenic bacteria that have been isolated from contagious skin necrosis, are also isolated from the very prevalent abscesses of external and regional lymph nodes of camels. Some authors suggest that these conditions are only second to Trypanosomiasis, the most prevalent disease of camels.

These conditions are clinically manifested in different forms:

1a. Abscesses, often several, are commonly found at the base of the neck and between the front legs (fig 7.2.1) of calves <4 months of age. The abscesses are often big - often the size of an orange or even larger. They are warm ("hot") and painful. The pus from the abscesses is yellow and creamy. Affected animals are disturbed by the lesions and some can lose condition and even die from it. The disease is commonly seen simultaneously in several of the calves in a herd.

1b. In adults (at least 4-5 year olds) one finds single abscesses, which are often localised in the lower cervical lymph node (1 n). In some camels the abscesses can be found in the preparotid and retromaxillary lymph nodes. These abscesses are large and can be either cold or warm. The pus is of the same consistency as those of the calves. Abscesses seen externally are sometimes said to be associated with internal abscesses.

Aetiology
In the abscesses of the calves *Streptococcus spp* and *Staphylococcus spp* have been isolated. *Corynebacterium pseudo tuberculosis* and *C. pyogenes* are often isolated from the abscesses of the adults.

Treatment
Parenteral therapy of antibiotics (penicillin and/or tetracyclines) are recommended for the calves.

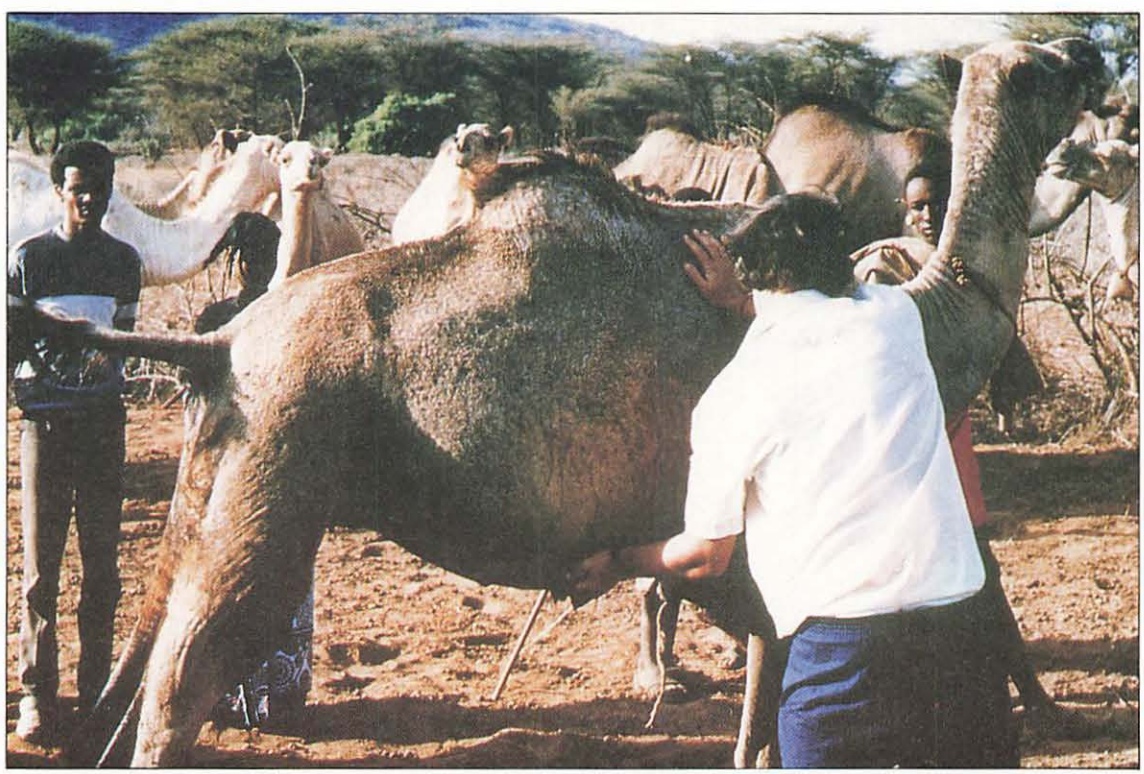
The abscesses fo the adults should be incised, the pus washed away, and the abscess cavity rinsed and dressed with any antispectic (a solution of 0.2-0.3% H_2O_2 has been used with good effect).

2. Another typical form of Lymphadenitis are the smaller abscesses usually found on three different locations (fig 3); at the shoulder (the prescapularis (1 n), at the base of the neck (the cervicalis inferioris 1 n), and at the back of the knee (the popliteus 1 n).

These abscesses often open spontaneously, discharging a pus of varying consistency often mixed with blood. Affected animals are often between 1.5-2 years of age. *Streptococcus spp* and *Staphylococcus spp* are isolated from these abscesses.

Plate 7.2.1: Camel suffering from sarcoptic mange. (Chris Field)

Plate 7.2.2: Hand-washing with acaracides as a treatment for mange.



CHAPTER 7.3

Gastrointestinal helminths of camels: an overview

by Dr E J Mukhwana

The camel is a creature of the arid and semi-arid areas, a habitat generally considered not to be conducive to the development and transmission of helminth parasites. However several researchers have found a surprisingly large and diverse fauna of helminths comprising representatives of all classes of these metazoan parasites (El Bihari 1985, Wilson 1988b).

In camels, helminthiasis is a chronic problem which occurs with an infection rate as high as 90% in natural conditions. However, some cases of mixed nematode infections have been reported to precipitate acute conditions (Arzoun et. al. 1984a).

Gastrointestinal nematodes (Roundworms)

Nematodes are the most important internal parasites of camels (Steward 1950, Malek 1959, Graber et al 1967, Wilson 1988a). Nematodiasis in camels is characterised by diarrhoea, general debility, reduced growth rates and milk yields, increased calving intervals, inappetance, anaemia, and consumption of large amounts of sand (pica) (Arzoun et al 1984b). Wilson (1988a) has reported that common camel nematodes belong to the following genera: *Trichuris, Nematodirus, Strongyloides, Haemonchus* and *Trichostrongylus.* Camels are infected with these parasites when they graze on infested pasture. But, *Strongyloides spp.* are reported to infect camels by skin penetration.

Several surveys indicate that camel nematodiasis occurs with varying prevalence in different countries and even within countries. Richard (1976) found that 92% of all camels examined in Ethiopia had internal parasites of which 80% were *Strongyles,* 10% *Strongyloides spp* and 16% *Trichuris spp.* Wilson et al (1984) reported a similar level of infestation in Kenya. They revealed that in Kenya *Haemonchus contortus,* the stomach worm of sheep was the most common *strongyle* nematode in adult camels and that *Strongyloides spp* was common in all ages, but *Ascaris spp* was uncommon. Table 7.3.1. shows the helminth parasites as identified by Mukhwana (1993) during a recent survey in Kenya. The results of this survey show that *Haemonchus spp* was by far the most common strongyle nematode present. *Trichostrongylus spp* was also very common while *Cooperia spp* and *Bunostomum spp* occurred at relatively low levels in a fair proportion of the herds. *Oesophagostomum spp, Strongyloides spp* and *Ostertagia spp* were the least encountered.

Table 7.3.1 Nematode larvae recovered during the survey period in Kenya as a percentage of the total (Mukhwana 1993).

PARASITE	NO. OF FARMS WHERE IT WAS IDENTIFIED	% OF THE TOTAL PARASITES IDENTIFIED
Haemonchus spp.	14	48.62
Trichostrongylus spp.	10	32.14
Cooperia spp	7	9.78
Bunostomum spp	5	5.29
Oesophagostomum spp	3	2.61
Strongyloides spp	3	0.91
Ostertagia spp	1	0.65

Reports from most camel-keeping areas however, indicate that *Haemonchus longistipes* is the commonest and most pathogenic internal parasite of the camel (Steward 1950, Malek 1959, Graber et al 1967, El Bihari and Kawasmeh 1980, Arzoun et al 1984a, Tager-Kagan 1984, Onyali and Onwuliri 1989, Tembely et al 1992). According to several researchers, *Haemonchus longistipes* usually occurs as a mixed nematode infection mostly with

Trichostrongylus spp. However, Arzoun et al (1984a) found on post-mortem examination that apart from ruminal amphistomes, *Haemonchus longistipes* was the only helminth found in the gastrointestinal tracts of the camels examined.

Haemonchus longistipes is reported to be a serious blood sucker and causes high mortality rates in tropical Africa (Onyali and Onwuliri 1989). This parasite is responsible for 72% of all deaths caused by helminths in Chad (Onyali and Onwuliri 1989).

While working with camels in Iraq and Kuwait (Altaif 1974, Abdul-Salam and Farah 1988) it was found that *Trichostrongylus probolurus* was the most prevalent helminth parasite present in all camels that they examined. They further demonstrated that the parasite was more common in calves and was associated with emaciation and diarrhoea. This parasite has been reported to cause considerable pathogenicity in camels (Steward 1950, Tembely et al 1992).

Table 7.3.2 shows the major gastrointestinal helminths of the camel and their location within the body.

Table 7.3.2: Common gastrointestinal helminths of camels (Modified from El Bihari 1985)

PARASITE	LOCATION
Haemonchus longistipes	Abomasum
Camelostrongylus mentulatus	Abomasum
Trichostrongylus probolurus	Duodenum
Trichostrongylus colubriformis	Duodenum and abomasum
Trichostrongylus vitrinus	Intestines and abomasum
Trichuris ovis	Caecum and colon
Trichuris globulosa	Caecum and colon
Trichuris cameli	Caecum and colon
Strongyloides papillosus	Duodenum
Oesophagostomum spp	Large intestine
Bunostomum spp	Small intestine
Nematodirus spp	Small intestine
Haemonchus contortus	Abomasum
Ostertagia spp	Abomasum
Cooperia spp	Small intestine
Monieza expansa	Small intestine
Stilezia vittata	Small intestine
Fasciola hepatica	Bile ducts, rarely ectopic
Fasciola gigantica	in lungs

Gastrointestinal cestodes (Tapeworms)

According to Altaif (1974) and Abdulrahman and Bornstein (1991) intestinal tapeworms are universally present in camels. Camels are reported to be susceptible to infections of both the adult and larval stages of cestodes. Gastrointestinal cestodes reported to occur in camels include *Moniezia expansa, Stilezia vittata* and *Avitellina spp* (Richard 1976, Tager-Kagan 1984, Wilson 1988b).

Stilezia vittata is very common in the intestines especially in the Arabian camel, although no pathogenic effects have so far been attributed to it (El Bihari 1985). *Moniezia expansa* is said to be fairly common and its presence is usually detected at post-mortem or when segments are passed out in faeces. Its occurrence has been reported in Ethiopian camels by Wosene (1991) and in Somalia by Abdulrahman and Bornstein (1991). In Kenya this tapeworm is common (Wilson et al 1984, Mukhwana 1993) although it is not known to be pathogenic (Rutagwenda 1985). However the parasite might obstruct the gastrointestinal tract and cause death in young animals (Blood and Radostitis 1980, Soulsby 1986).

Gastrointestinal trematodes (Liver Flukes)

Although the environment in which camels live does not seem to favour high prevalence of liver flukes, they seem to occur in a fair proportion of camels. Magzoub and Kassim (1978) reported infestations of *Fasciola gigantica* and *Fasciola hepatica* in camels of Saudi Arabia. Al-Khalidi et al (1990) on examining faecal samples from 283 camels in Iraq using the sedimentation method, found a high infection rate of *Fasciola spp* especially during the summer period.

Fascioliasis is generally associated with high rainfall and irrigation schemes that provide conducive environments in which land snails, the intermediate hosts, survive and transmit infections to camels. Thus, in Saudi Arabia, camels from the east of the country on the Persian Gulf have a higher incidence of fascioliasis than those from other areas. It has been noted in the Sudan that camels around the River Nile and its major tributaries (where irrigation schemes are common) have a higher incidence of fascioliasis. Fascioliasis has recently been reported in camels in Kenya (Mukhwana 1993).

The only pathological change which has been noted in camels having fasciola infection is the thickening of the bile ducts which may result in partial or total condemnation of the affected livers at meat inspection (El Bihari 1985).

Diagnosis of camel gastrointestinal helminths

Arzoun et al (1984) enumerated and described the clinical signs of helminthiasis in experimentally infected camels. However, these signs are seldom seen under natural conditions, and hence a definitive diagnosis is required as it forms an integral part in the helminthiasis control programme. This involves taking faecal samples from suspected camels and determining the number of eggs per gram of faeces (E.P.G.) (Soulsby 1986). This is a quantitative index that is used to score the intensity of infection in animals. Five hundred eggs per gram is normally taken to be the pathogenic threshold in camels (Rutagwenda 1985). In addition, direct microscopic examination of faeces is useful as it may reveal whole worms and proglottids of tapeworms.

Nematodirus spp, when present in large numbers are passed out attached on the outside of the faeces held by strands of mucus. In most mixed infections, mere detection of eggs is not enough and larval culture and identification should always be attempted. Diagnosis of *Fasciola spp* and whip worms infections should be carried out using techniques established for sheep and cattle (Great Britain Ministry of Agriculture, Fisheries and Food 1986). Post mortem worm identification is also an important diagnostic tool.

Epidemiology of camel gastrointestinal helminths

The epidemiological picture of camel helminthiasis is probably similar to that of the better studied helminthiasis of other ruminants. Although the conditions in which the camels are usually kept throughout the world are not favourable for helminth parasite transmission, more than 60 different species of helminths are known to occur in these areas (El Bihari 1985).

The reasons for occurrence of economically significant helminthiasis in camels may be multiple and interactive. Many factors such as stocking density, immune status of hosts, environmental temperature, humidity and soil structure, vegetation type, drainage, nutritional status of hosts, concurrent diseases, mineral deficiencies, age and sex of hosts which may singly or in association with others determine or influence the occurrence of helminthiasis (Brundson 1980).

Depending on the type of management, it has been found that there is some degree of interchange of helminth parasites between camels, sheep, goats and probably wild animals. This is of particular relevance to transhumant communities whose camels are usually herded together with goats and sheep and are often kept in the same enclosures ("bomas") at night (El Bihari 1985).

Onyali and Onwuliri (1989) attributed the high prevalence of camel *Trichostrongylus colubriformis, Cooperia pectinata, Oesophagostomum columbianum* and *Strongyloides papillosus* which are common nematodes of sheep, cattle and goats in Nigeria to transmission from these animals to camels. This finding was reinforced by the observation that camels occasionally grazed alongside other animals in the areas of study.

Experimentally , *Haemonchus longistipes* has been successfully adapted to goats and less successfully to sheep (Arzoun et al. 1983). In both cases overt infections were reported and adult worms recovered.

Baitursinov and Berkinbaev (1989) in an ecological study of camel parasites in south eastern Kazakh (USSR) found that there was inter-transmission of helminth parasites between camels and sheep. They also recorded five species of camel parasites for the first time in this area. These included *Moniezia benedeni, Chabertia ovina, Nematodirus dromedarii, Nematodirus oiratianum* and *Nematodirella longissimespiculata.* Out of the 32 parasites that they isolated, 22 were nematodes, 3 eimeria, 4 trematodes and 3 cestodes.

The low stocking rates of the camel in its traditional habitat and the long intervals between waterings reduce the frequency of close contact with other animals. This in turn minimises the occurrence of several helminth parasites which are shared between camels and other animals. This reduced inter-transfer of helminthiasis is further augmented by the fact that camels usually graze and browse in a radius of 50 km around the watering-point while cattle, sheep and goats graze within 20 km from the nearest water point (Bremaud 1969, cited by Richard 1984).

A one year study of trichostrongyloid egg output in camels in Saudi Arabia (El Bihari and Kawasmeh 1980) found that egg production peaked at the start of the short winter rains. This period also coincided with peak infection of camels. These researchers suggested that routine

Figure 7.3.1: Mean strongyle egg counts of camels in relation to total rainfall (mm) in Lorroki Division, Samburu District. (Mukhwana 1993).

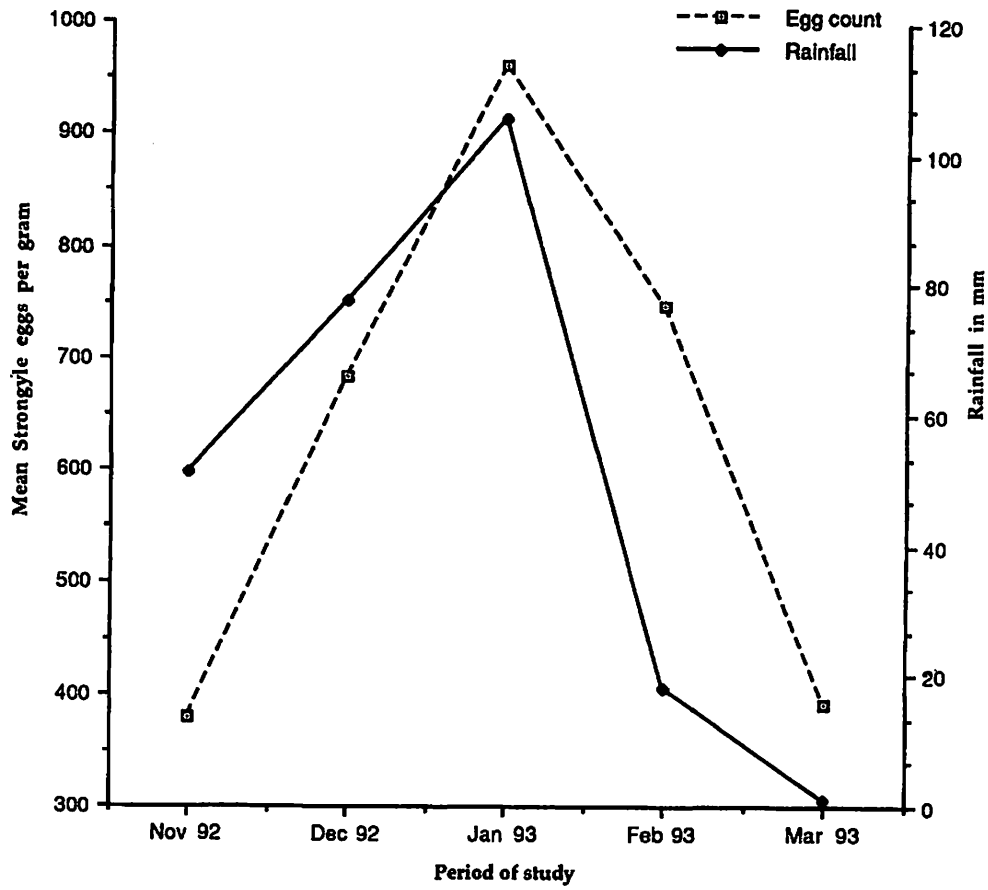
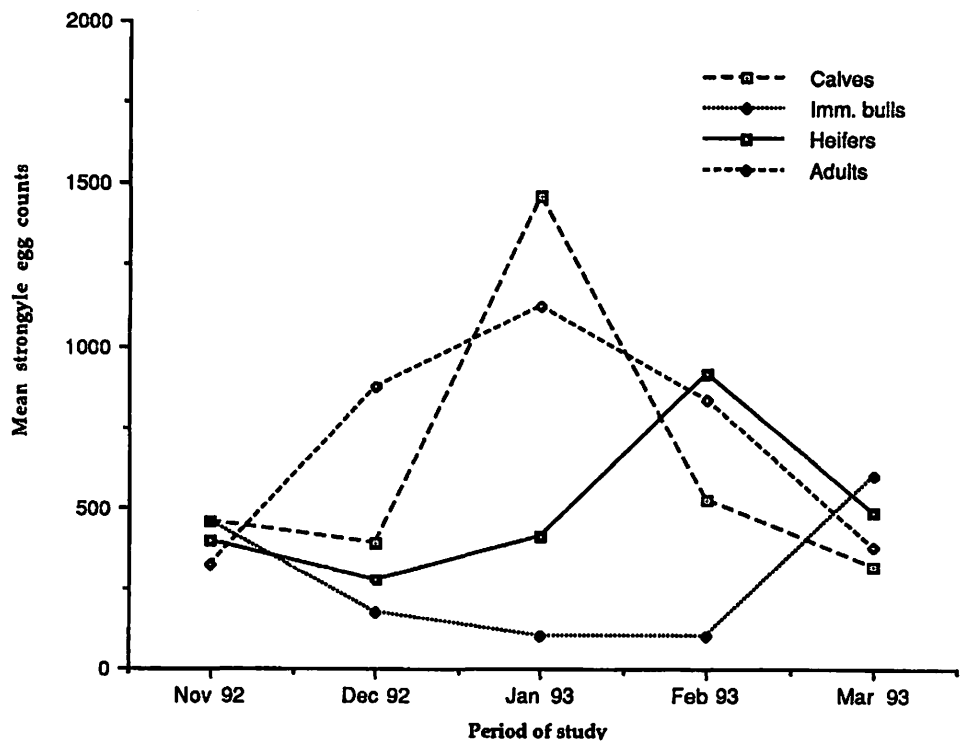


Figure 7.3.2. Mean strongyle egg counts for the different age groups of camels over the study period (Mukhwana 1993).



dosing with anthelmintics may be done just before the start of the short rains. In Kenya (Njanja 1991, Mukhwana 1993) demonstrated that high E.P.G. levels in camels occurred during the wet and early dry seasons. The E.P.G. values decreased progressively during the late dry season only to begin rising again at the onset of the rains. Figure 7.3.1 illustrates the relationship between rainfall and mean strongyle egg counts in a division of Samburu District, Kenya.

Control and treatment of camel helminthiasis

Eradication of most helminth infections is not practical and most regimes aim at controlling parasites to levels compatible with economic production. In Sub-Saharan Africa, control strategies are often "protective" in nature and are based on haphazard and random use of anthelmintics. Effective parasite control programmes can only be achieved by integrating grazing management, use of anthelmintics and dependence on acquisition of immunity. However, interactions of many factors in the arid and semi-arid areas limit the successful application of these three approaches. This is because an integrated control programme requires an understanding of the inter-relationships that exist between the various sources of pasture contamination, the availability of infective larvae, and the knowledge of seasonal fluctuations of helminthiasis (Brundson 1980).

It is difficult to recommend a universal regime for administration of anthelmintics. This is because the value of any anthelmintic in a helminth control programme is determined after one has understood the management system (of animals) in question, climatic conditions, economics of production, susceptibility of animals after infestation and other epidemiological data. Because of the ever escalating costs of anthelmintics, it has become necessary for one to strategically use the most cost-effective treatment.

In Kenya several anthelmintics are available for treating and controlling camel helminthiasis. Some are simple compounds such as levamisole (Nilverm™, Cooper; Wormicid™, Cosmos), albendazole (Valbazen™, Ciba Geigy), oxyfendazole (Systamex™ Cooper), thiophanate (Nemafax™ Rhone Poulenc) etc. Others are mixtures of two or more compounds; these include Wormicid plus™ (Cosmos) which contains levamisole and bithionol sulfoxide, and Nilzan™ (Cooper) which contains levamisole and oxyclosanide.

Different anthelmintics are designed to kill specific types of worms and readers are referred to labels accompanying each product. Furthermore some products also kill parasite eggs and larvae while some do not.

A wide range of research has been done regarding the relative efficacy of different anthelmintics in camels all over the world. In one such study in Kenya (Mukhwana 1993) it was found that thiophanate (Nemafax™, Rhone Poulenc) 20%w/v at a dose of 15 ml per 50kg body weight was a good drug for treating camel helminthiasis. Albendazole 10% w/v (at a dose of 10 mg/kg) was also found to be useful. However, levamisole (Nilverm™, Cooper) at the recommended dose was found to be ineffective and sometimes inconsistent in its actions. Some workers have even found this drug to be toxic to camels at the recommended therapeutic dose. More research is recommended in this area.

Hypobiosis, a process whereby there is inhibition of larval development, has been reported to occur in camels. Retardation of growth by *Haemonchus longistipes* in the abomasum of camels during the dry season (Arzoun et al 1984a) has been observed.

The high prevalence of tapeworm infections in camels is thought to be due to lack of toilets among most pastoral communities, while fascioliasis is more common in areas with high amounts of rainfall, near irrigation schemes, rivers and dams (Magzoub and Kassim 1978)

Camel owners in Kenya hardly ever attempt deworming, although they know that helminthiasis is a problem. The latter coupled with communal use of grazing fields and watering points in traditional camel keeping areas, increases the chances and rate of re infection even when deworming is done by some few farmers. There is also evidence that wildlife could be acting as carriers of helminths for domestic animals in the lower part of Samburu District, Kenya.

In the arid and semi-arid environment in which camels are kept in Kenya, there is a complex interaction between parasitism and nutritional stress, the two are often difficult to separate (Njanja 1991). Figure 7.3.2 shows the relative susceptibilities of different age groups and sexes of camels to helminthiasis in Kenya.

CHAPTER 7.4

Xylazine-anaesthesia and antagonisation in dromedaries

by K H Bonath

Introduction

In order to improve the veterinary care of camels, immobilisation techniques and anaesthesia are essential. These should take into consideration the physiological peculiarities of the species, their veterinary requirements and the local climate conditions.

Preparation and aftercare

The animal should be starved for at least 12 hours before anaesthesia. For injection it is made to sit down in the shade and tied in such a manner that it cannot rise. To prevent damage, the camel's head should be haltered and held by a person until an optimal stage of anaesthesia is attained. The rumen can be relieved if the animal is restrained in a sitting or right-sided recumbency. To prevent aspiration of rumen contents, the head always should be brought into a lowered position.

During recovery, the camel is brought into a sitting position. Its head is carefully held down, until it can be held upright on its own. Uncontrolled head and neck movements can be dangerous for men and animals alike. Ties are not loosened until the head can be held upright without any help and the animal is ready to rise. In the standing position, the swaying and reeling camel has to be supported by the haltered head and tail.

Xylazine-anaesthesia

Currently Xylazine (Rompun®) is the most widely used drug for producing recumbency in camels. It has sedative, analgesic and muscle relaxant properties and, according to several authors, has a wide therapeutic index (Bolbol *et al.* 1980; Peshin *et al.* 1980).

The exclusive use of Xylazine is associated with side-effects such as circulatory depression (bradicardia, hypotonia, reduced cardiac output, increased peripheral resistance) and respiratory depression (bradypnoea, decreased respiratory volume, respiratory acidosis). The combination of the long duration of recumbency with climatic stress (notably the high ambient temperatures in arid zones) may occasionally lead to death in camels.

To prevent complications as described, the dosage of Xylazine can be reduced by combining it with Ketamine hydrochloride (50 mg Xylazine + 20 mg Ketamine*/100 kg b.w., i.m.)

On Ol Maisor Farm, Rumuruti, Kenya, we successfully elaborated the following method (Bonath *et al.*, 1988). 50 mg Xylazine/100 kg b.w. are injected i.v. in the upper third of the jugular vein and cause an anaesthetic stage of III/1 through III/2. To counteract circulatory and respiratory depressions especially at the end of the painful treatment, Xylazine anaesthesia can be antagonised with an i.v. injection of 40-60 mg Tolazoline*/100 kg b.w. 5.2 ±2.5 minutes after Tolazoline injection, the animals are able to sit upright and stand spontaneously 12 ±6 minutes after antagonisation. In comparison, the duration of anaesthesia in non-antagonised animals lasts 65 ±23 minutes. Sometimes when its effect is used up and the animal collapses again, the i.v. injection of the antagonist has to be repeated. A direct influence of the i.v. injected antagonist on bradicardia, hypotonia and bradypnoea induced by Xylazine cannot be determined (Table 7.4.1). These parameters normalise only after the animals have risen. Even at higher doses of Tolazoline,

no changes are observed and the recovery phase is shortened.

We anaesthetised 39 dromedaries (*Camelus dromedarius)* of both sexes and various ages under field conditions. Indications for anaesthesia have been cryptochordism, vasectomy, castration of males, tooth fistulation, teeth extraction, therapy of abscesses, phlegmon, mastitis, wounds and others.

Table 7.4.1: Influence of Xylazine-anaesthesia and Xylazine-antagonisation by Tolazoline on heart rate (HR), systolic, diastolic and mean arterial blood pressure (p syst, p diast. p mean), respiratory rate (RR) and body temperature (temp) in dromedaries (mean ± standard deviation). n = number of anaesthetised animals

	Before Anaesthesia (n=39)	**Xylazine** (n=7)	**2 min after Tolazoline injection** (n=39)	**12 ± 6 min after Tolazoline injection** (n=39)
HR	71 ± 17	35 ± 10	46 ± 10	55 ± 13
P syst	172 ± 11	135 ± 24	129 ± 14	128 ± 17
P diast	101 ± 17	81 ± 20	74 ± 16	57 ± 20
P mean	123 ± 18	100 ± 23	92 ± 12	84 ± 18
RR	16 ± 5	16 ± 4	16 ± 4	16 ± 3
Temp	37.3 ± 0.7	37.0 ± 0.9		36.8 ± 0.3

(Editors Note:- We notice considerable variations in dosage rates of Xylazine by different authors for the anaesthesia of camels. We have personally observed many successful administrations using the lowest dosage rate of 0.25mg/Kg as recommended by Dr. H. Cran. This of course is cheaper and perhaps safer. Should it prove ineffective an additional injection can always be given, but this should never be greater than the first dose.)

CHAPTER 7.5

Castration of camels

by Dr H R Cran

Introduction

Although not practised in all countries in which camels are found, castration has certain advantages such as obviating the effects of musth, involving as it does extra trouble in handling, fighting and injuries. Castrated males and females may be worked together. Although geldings are not as strong as entires and are unable to carry such a heavy load, they are more tractable. In addition, being lighter in build geldings may be more suitable as riding camels.

Drugs used

The camel is economically important in several of the less developed countries and a cheap, effective and unsophisticated method of anaesthesia is desirable bearing in mind the conditions and location where camel handling operations are likely to take place. Drugs suitable for use in camels include the following:

1 chloroform
2. etorphine with acepromazine (Immobilon) and the antagonist diprenorphine (Revivon LA) 0.5 ml per cwt
3. chloral hydrate and sodium citrate 1% solution i/v
4. xylazine (Rompun) 2% 0.25 mg per kg
5. chloral hydrate/magnesium sulphate

Taking costs of drugs, adverse side-effects and the skill of available personnel, in my opinion Rompun (xylazine), used in conjunction with local anaesthetic, is the drug of choice. The drug is well tolerated, highly effective and easily administered.

Although the use of the bloodless castration has been advocated in the past, the anatomy of the camel does not render it a suitable subject as the spermatic cords are short and almost horizontal and difficult to grasp and failures are common.

Methods

Camels intended for baggage work should not be castrated under the age of four years. Camels should be starved if possible for 24 hours before castration.

When one has a number of camels to be castrated, e.g. up to a dozen, I have found it convenient to get the camel men to couch their camels, hobble one fore-leg and then given Rompun 2% at a dosage rate (ml) of 0.25 mg per kilogram/20 by intra muscular injection in the gluteal muscles to all the camels to be operated on. After about twenty minutes one can start work on the most sedated animals and by the time one has finished with one or two, the remainder should be adequately sedated.

The animal is rolled onto is right flank and the fore and hind legs well secured with rope, with the hind legs well drawn up. Protect the underneath eye with a piece of sacking. Local anaesthetic procaine hydrochloride with adrenaline approximately 20 ml. is injected into each testicle and spermatic cord, i.e. 40 ml per animal. One testicle is incised fairly close to the median raphe, withdrawn through the incision and the spermatic cord crushed fairly high up with a horse emasculator. I ligate the cord with no. 3 or 4 catgut and have had no cases of bleeding or swelling. The second testicle is removed through the same incision and the wound sprayed with an antibiotic/gentian violet aerosol spray and left open. I

then give an antibiotic and tetanus antitoxin by intramuscular injection. Drugs used have been:

- ampicillin trihydrate BP (3000 mg. ampicillin) 20 ml.
- 20 ml. penicillin/streptomycin (5000 mg. dihydrostreptomycin as the sulphate and 4 mega units of penicillin G. procaine) by intramuscular injection to average weight camels.
- other antibiotics such as oxytetracycline may also be used.

The ropes are then untied, always hind legs first, the camel is rolled onto its brisket, and generally rises to its feet and moves off to graze.

The use of this method has been very satisfactory with no cases of haemorrhage or swelling, no fatalities and no apparent loss of condition.

$$\text{Rompun Dose Rate (ml)} = \frac{0.25 \text{ mg} \times \text{BW (kg)}}{20}$$

(Editors Note:- We notice considerable variations in dosage rates of Xylazine by different authors for the anaesthesia of camels. We have personally observed many successful administrations using the lowest dosage rate of 0.25 mg/Kg as recommended by Dr. H. Cran. This of course is cheaper and perhaps safer. Should it prove ineffective an additional injection can always be given, but this should never be greater than the first dose.)

Plate 7.5.1 Castration of camel by open incision and use of emasculator

CHAPTER 7.6

Camel calf care

by Dr R Kamber

Assistance during birth

Calving in camels is usually no problem. The narrow body of the calf makes it easy to slip out, so assistance is not very often needed. The calf coming out backwards is very rare in camels.

Most assistance done by humans result from impatience during birth and is mostly not needed, and in some cases even dangerous.

First breathing

As soon as the umbilical cord is disconnected, the calf starts breathing in order to supply the body with oxygen and clear the blood of carbon dioxide. The first breath must be strong enough to unfold the lung which up to this point does not contain any air. Different measures may be taken to assist the calf start breathing:

- Cold water poured over the chest and head has the effect of a shock and makes the calf raise and shake its head.
- Massaging with two fingers from the eyes towards the nostrils clears out the mucous.
- Irritation of the nostrils with a straw makes the calf sneeze and thus also expels the mucous.
- Turn the calf upside-down with its head towards the ground and massage the chest moving down towards the head.

A respiratory stimulant (Respirot®) may be placed in both nostrils, or in severe cases 2 ml of Doxapram Hydrochloride (Dopram®) given intravenously.

NOTE: Don't reach into the mouth with your fingers! It can cause an infection and diarrhoea!

Umbilical cord

The umbilical cord has a predetermined place where it is most likely to be disconnected, about 10 cm from the body. Blood vessels, veins and arteries, are part of the umbilical cord. Soon after birth, these vessels will shrink and break. Dipping the cord in a disinfectant solution will prevent germs entering the vessels and spreading through the body producing local infection resulting in an abscess. A practice very often seen is the tying up of the cord with a little string close to the body. However it has never been proved that this practice reduces the incidence of umbilical infections. Moreover, a string used for this purpose, which is not sterile, might even be the cause for the infection.

Milk/Colostrum

The new-born calf will soon try to stand up but only succeeds after a few hours. Instinctively, it will search for the mother's udder and start suckling.

Right after birth, the calf has almost no reserves of energy, but a lot of energy is required to cope with the stress of the first days of life. There are many reasons that can lead to a calf not obtaining enough milk. Inexperienced young camels may refuse the calf. A lot of patience is needed to calm the mother down and make her accept the calf. In severe cases, a slight sedation with Rompun® might help.

Mastitis can make suckling very painful for the mother. Check the udder for swellings and heat.

If the mother does not seem to have any or enough milk, massaging the udder can help. An injection of oxytocin (10-20 I.E., i.v.) increases the milk flow within minutes. After treatment with oxytocin, the udder should be milked out completely, in order to prevent mastitis.

There is another, even more important reason why the calf should suckle as soon as possible. Most animal's placenta, unlike humans, will not allow the passage of antibodies from the mother's

blood system into the calf's blood during gestation. The new-born therefore has no protection against diseases. Its own immune system will develop only a few weeks after birth.

The colostrum, the first milk produced by the mother, has a very high concentration of antibodies. This concentration however will decrease very soon after birth. Moreover, antibodies are proteins, and the intestine is incapable of absorbing proteins as a whole molecule except within the first 24 hours of life.

NOTE: It is vital for the calf to suckle as soon as possible and as much as possible.

A calf that fails to suckle within 6 hours after birth should be forced to do so. Helping it to stand up and leading it to the mother's udder should be sufficient in most cases. If the calf is not able to stand by itself, milk the mother and feed the calf with bottle and teat. If no colostrum is available from the mother, drench the calf with 1-2l of blood from the mother, which will provide it with at least some antibodies.

Colostrum from a camel whose calf has died right after birth can be collected and deep-frozen. Thus, colostrum is always available for other calves.

If all this fails, the calf should be protected during the first few days of life by injecting it with antibiotics (e.g. Clamoxyl[R]).

Pastoralists very often tell us that colostrum is the cause of diarrhoea in calves and therefore, they will not let the calf have the colostrum, or will not let it suckle enough colostrum. However, the calf suckles several times during the day, each time only imbibing a small quantity. The theory put forward by pastoralists is wrong. Diarrhoea in calves has many reasons - too much colostrum isn't one of them.

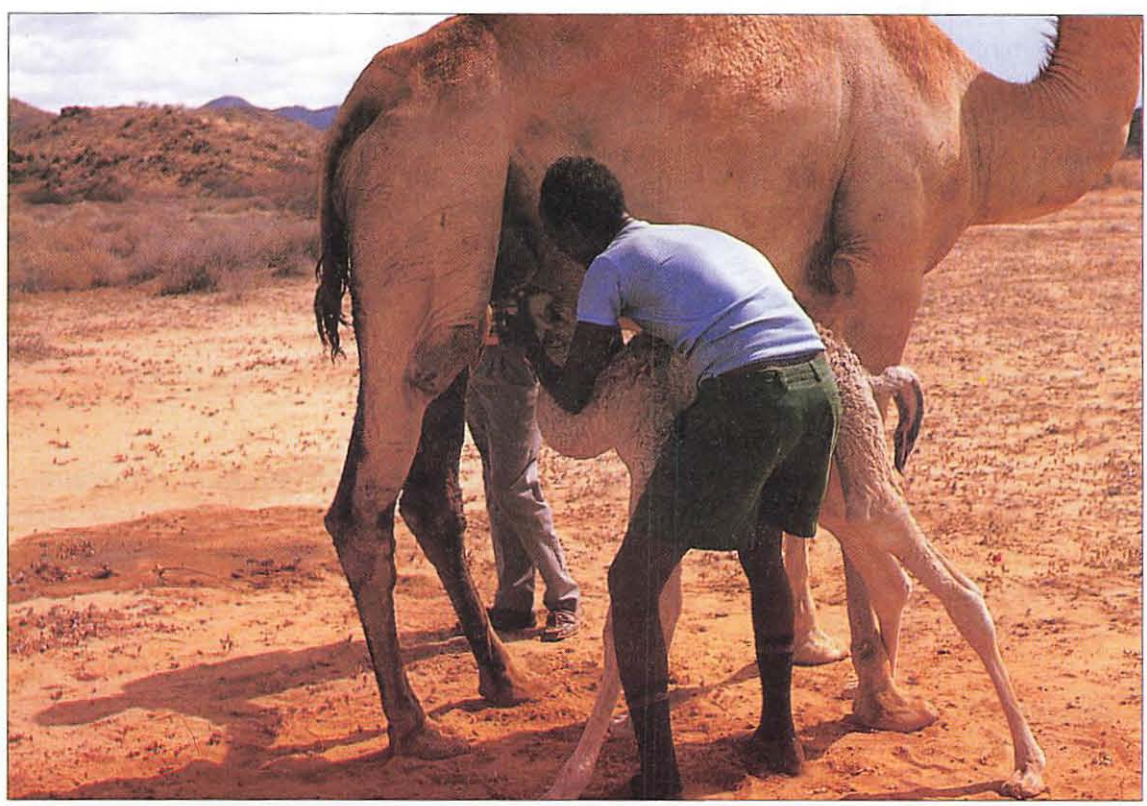
Meconium

Meconium is the foetal faeces. It has a smeary, pasty consistence and is mostly of dark brown colour. The meconium will be discharged after suckling colostrum, as the colostrum has a relaxing effect on the intestines.

If discharge of meconium does not occur within 24 hours, this may cause obstruction and can be lethal. An enema of liquid paraffin, dissolved in warm water, given with a 20cc syringe and tender massage with a finger in the rectum, should be repeated until no more meconium comes out.

NOTE: The rectum mucosa is very weak and can be perforated if roughly treated.

Plate 7.6.1: It is vital that calves should obtain colostrum within 6 hours of birth. Assisting the calf to stand and suckle improves the chances of survival. (Chris Field)



CHAPTER 7.7

Miscellaneous veterinary notes

by J O Evans and Dr R Kamber

Abortion

Abortion has as many reasons as there are infections. Any disease that goes along with high fever can cause abortion. However there are some very special germs (bacteriological and viral) which are responsible for abortion by infecting the placenta or foetus. In most cases it will not be possible to differentiate between these infections by clinical examination. Serum samples, parts of the placenta or even the whole foetus, should be sent to the laboratory for analyses. Nevertheless, only about 30% of all cases can be tracked down to one specific germ being responsible for the abortion.

Afterbirth retention

Occurs after abortion, birth of an immature foal or sometimes even after normal delivery. Don't pull the afterbirth! If the calf is alive, suckling will help (release of Oxytocin by the mother). In case of abortion, Tetracycline intra-uterine or i.v., and Oxytocin i.v. are suggested. Roots of *Salvadora persica* given as a drench are also effective.

Anaemia

Anaemia is a symptom and therefore has many causes. In camels, the main reason for anaemia is Trypanosomiasis. Great loss of blood through external injuries or intestinal bleeding after infections or parasites may also cause anaemia. If possible treat the causative disease. Blood transfusion from another camel is possible.

Anaesthesia

See K.H. Bonath in this manual.

Anaesthetic, local

Inject a sedative, such as a low dose of 'Rompun'. After 10-15 minutes infiltrate subcutaneously around wound or operating site with local anaesthetic such as 'Hostacaine' or 'Xylacaine' (2% Lignocaine). Wait for 10-15 minutes for anaesthetic to take effect.

Anthrax (*Bacillus anthracis*)

Prevent by vaccination. Use anthrax spore vaccine or 'Blanthrax' vaccine. Anthrax is dangerous to humans. Carcasses must never be opened and should be completely buried or best destroyed along with all contaminated material. It is a very quick killer but on rare occasions immediate treatment with Penicillin may be effective. An animal that has died of anthrax quickly distends and bleeds at mouth, nose and anus.

Arthritis

Causes are probably various and are uncertain, but some suspect that there is an infectious agent which would warrant separation of sufferers. Treatment with Dexaforte or Butazolidone may be beneficial.

Berenil

This must **NOT** be used for camels.

Blackquarter (*Clostridium chauvaei*)

Prevent by vaccination with 'Blanthrax' vaccine. Carcass destruction and treatment as for anthrax.

Bloat

Uncommon in camels. Use kerosene or cooking oil as a drench. Use 1/5 bottle, fill up with milk (or water if no milk is available), shake well and drench.

Blood in urine

Boil some of the urine and if it coagulates it indicates damage or infection of the urinary tract. Inspect for mechanical damage to the penis and treat infection with Ampicillin ('Penbritin'), the drug of choice as it is excreted through the urinary tract.

If blood in the urine does not coagulate it indicates excessive destruction of blood cells within the body. Seek cause of the disease, probably trypanosomiasis, and treat accordingly.

Botulism (*Clostridium botulinum*)

This is usually contracted by the animal eating infected bones. Therefore if adequate Phosphorous and Calcium are fed to the animals it should deter them from chewing bones. (See Chapter 2.1.) A dead animal could contaminate a waterhole.

If it is contracted, drench with a bottle of sour milk: the toxin created by the Clostridium is neutralised by the lactic acid. (see Bayer's 'Handbook for Farmers'). This organism can be responsible for serious food poisoning in humans.

Brucellosis

Brucella abortus and *B. melitensis* are both reported in camels, but it does not seem to be a widespread complaint. Pastoralists consider fresh camel milk as safe to drink, whereas other milk, particularly goat milk, is treated with suspicion. (See 'The camel in Health and Disease', Higgins 1986)

Brushing elbows

For brushing elbows that become sore, apply grease or Kimbo before walking. Do not apply before resting as sand and grit may adhere and make the abrasion worse. Camels with this fault should not be used for breeding.

Caesarean section

This is a rare necessity. The operation is described by Higgins (1986) 'The camel in Health and Disease', and Rathore (1985) in 'Camels and their management'. The former advocates opening the left flank and the latter the right flank. We suggest that slinging the animal might facilitate the operation by lessening the pressure of the rumen and intestines on the uterus. The operator may need a table to stand on.

Camel flies (*Hippobosca camelina*)

These flies apparently do not transmit disease, although some people suspect they may be capable of mechanically carrying trypanosomes from an infected camel to other camels. They do however suck blood and are very irritating to the animal. Spray the flies and the animal with insecticide. Hoechst 'Neguvon' is very effective.

Camel pox (*Orthopoxvirus cameli*)

See Bornstein on 'Skin diseases of camels' Chapter 7.2. in this manual. Treatment of the sores and scabs to ease pain and prevent other infections may be done with Iodine, Gentian Violet, Withania solution, Salt solution, Healing oil etc. Feed soft food if possible. There is cross-immunity between camel pox and Smallpox. (See 'The camel in Health and Disease', Higgins 1986; 'A study of camel pox in Somalia' by B. Kriz, 1982).

Castration

See Chapter 7.5.

Clostridium

A genus of bacteria with many species and types producing lethal toxins etc. They include Blackquarter, Tetanus, Enterotoxaemia, Botulism and Clostridial Enteritis. See under each heading.

Colostrum

Colostrum is the first milk produced by the mother after giving birth. This is vital to the new-born calf. It contains antibodies and vitamins which help the calf to withstand infections and gain strength. Antibodies created by vaccination of the mother may be passed on to the calf in the colostrum. The calf should have the colostrum within 6 hours of birth since the gut does not absorb the antibodies after that time. The colostrum also acts as a laxative and helps the calf expel the meconium. If the mother has no milk, 1 litre of her blood should be taken and the calf drenched with it within 6 hours of birth as an alternative to her colostrum.

Constipation

Drench with one or two bottles of molasses mixed with an equal amount of water. Alternatively (although it is not as good) 1/2lb of Epsom salt (Magnesium sulphate) in copious water. For calves which have not expelled the meconium, give 20cc of liquid paraffin or cooking oil, (NOT castor oil) as an enema. "Novalgin" is an intestinal relaxant for acute constipation.

Contagious Echtyma

See 'Orf'

Contagious skin necrosis

See Chapter 7.2. Skin necrosis is also known as *'Jhooling'*.

Diarrhoea

Drench with Kaolin in water (say 2" in a big bottle for a big camel, or 2" in a soda bottle for a small camel). If persistent use Sulpha drugs (see Drug Treatment below). Prolonged treatment may destroy the rumen flora. These may be re-established by drenching with some of the mother's cud which may be mixed with kaolin. Kaolin forms a slurry in the intestines which alleviates irritation. Rehydration fluid (see below) and vitamins are a big help. Worms and Liver fluke can cause diarrhoea which should be treated accordingly. The cooled liquor of *Acacia* bark (particularly *A. nilotica* and *A. nubica*) boiled in water can be a help.

Drug Treatment

Drug treatments should never be given at less than recommended dosage rates. This is the prime cause of disease resistance rendering the drugs ineffective. This eventually affects everybody. Alternatives (if any) will invariably be more expensive. Overdosing may be dangerous and is unnecessarily expensive. Before treatment, manufacturers instructions must be carefully read and understood regarding method, site of application and quantity. Formulations and strengths vary. (See 'Weight calculation' in this manual). Before buying drugs check their expiry date.

Sulpha drugs, Tetracycline and Penicillin type drugs should not be used at the same time. Their systems of combating disease are different and may be counter-effective. It can be noted that not many drugs have been specifically tested on camels, so one can only assume that their effect is similar to that of other ruminants. Where no dose rates for camels are given, the dose rate is usually calculated using the recommended rates for cattle.

In Israel (pers. comm. Prof. Yagil) they have found that in camels injected drugs are not effective unless the camel is fully hydrated. They suggest drenching the animal to be treated with 50 litres of 2% salt solution to ensure good circulation of the drug within the body.

Syringes and needles must be spotlessly clean and sterile. New or well boiled (20 minutes) syringes and needles should be used for each animal. Old blood is particularly dangerous as it is a natural breeding ground for microbes. Needles, like biting insects, may transmit disease from one animal to another if the same one is used on different animals.

Note: The formula for calculating the weight of a camel is found in Chapter 8.1.

Ears

Suppuration in the ear may be caused by *Rhabditis boris*, a nematode. A squirt of aerosol insecticide, such as "It" or "Doom" into the ear usually cures this. Otherwise insecticide or acaricide in paraffin should work. Water solution runs off the wax in the ear and is not effective.

Enterotoxaemia

Clostridium perfringens is reported in camels. A vaccine has been produced. Could this be cause of deaths in young calves? Further investigation is required.

Exhaustion

Feed (drench if necessary) gruel made from maize-meal, oatmeal, pollards, dairy meal, bran, etc. Addition of molasses also helps. In debilitated animals injection with 'Dexafort'. 'Catasol' or 'Tonophosfan' can also help. Vitamins are also useful. Cut green feed for the animal.

If the animal lies on its side it must be turned over frequently and encouraged to sit upright. After a day's rest, if the animal cannot or will not stand up it should be lifted to its feet. Slap the leg muscles to help the circulation. This may have to be done for several days. If possible, sling the animal for a few hours at a time to encourage it to use its legs. (see Fig. 7.7.3)

Eyes

For conjunctivitis apply Chloramphenicol, Tetracycline or Penicillin eye ointment. Intra-mammary ointment will do. A lotion of Withania is also useful (see below). Tetracortril or ointments containing cortisone should not be used on physically-damaged eyes.

Corneal ulcers or damaged eyes can be treated by injecting 1cc of Penicillin, Combiotic, Penstrep or Chloramphenicol into the conjunctiva with a thin needle parallel to the eyelid or deep above the eyeball. It is important to cure an infected eye because the infection may travel down the nerve to the opposite eye and may cause blindness in that eye also. If the 'white' of a calf's eye is seen to be deep red, it may denote an infection of the body, and the animal should be treated, or at least watched carefully for signs of sickness.

Feet

Broken toe-nails should be trimmed so they do not catch on obstructions. Overgrown toe-nails should be cut level with the pad and trimmed. Wounded pads must be cleaned, and thorns, pebbles, etc. removed. If the wound is extensive the pad should be protected after treatment with a boot. A goat skin or several layers of sack may be used by cutting a circular piece 3 times the diameter of the foot. Make holes around the edge and thread a cord through them. Pull up and tie above the fetlock, leaving no gaps for dirt to enter. The boot must be removed, cleaned and treated frequently, especially when wet. Feet should be kept free of ticks as they can cause abscesses. Abscesses should be lanced and treated when ripe, but care must be taken not to damage tendons in the foot.

Haemorrhagic septicaemia

Haemorrhagic septicaemia is caused by *Pasteurella multocida*. Vaccination every six months is effective. Treatment after contracting the disease usually fails. Symptoms include swollen throat, affected lungs and haemorrhages in the guts, but symptoms are numerous and varied. Diagnosis is difficult and the disease is probably more prevalent than suspected.

Hydatids (*Echinococcus granulosis*)

A potentially dangerous type of tapeworm. Dogs, jackals, hyenas etc. eat the discarded offal containing cysts from slaughtered or dead animals. These cysts become tapeworms in the carnivore which shed eggs in the host's faeces. The eggs are ingested by other animals or man, which hatch, migrate in the body and become cysts. Household dogs are the usual agent for infection of man. The cysts cause mechanical damage to the organs of the body and may be lethal. They can only be removed by surgery, if diagnosed. It is therefore imperative to destroy the hydatid cysts from any carcass before they can be eaten by dogs etc. The cysts look like small ping-pong balls and are usually found in the liver, but may also be found in other parts of the body. Regular six monthly treatments of dogs with 'Droncit' will break the cycle. This tapeworm is not killed by normal tapeworm treatments.

Intestinal parasites

Healthy adult camels live in balance with a moderate number of intestinal parasites and should not need regular dosing. Camels under stress, or chronically ill, and young camels at weaning benefit from drenching with anthelmintics. Tapeworms and liver flukes are not killed by normal anthelmintics and need specific treatment.

Joint ill

This is caused by Pasteurella, Salmonella and many other organisms entering the body through the fresh umbilical cord of newly born calves. It is very difficult to cure. Chloramphenicol may help. Every new-born calf should have the umbilical cord dressed with tincture of Iodine and tied very close to the body with string soaked in the same to prevent entry of germs.

Leptospirosis

There are many types of *Leptospira* affecting mammals, including man. Symptoms include jaundice and discoloured urine and milk. Transmission is generally through urine. Leptospirosis is not well recorded in camels but awareness is required.

Lifting sick or stuck animals

Sick or debilitated animals will often walk if they can be stood upon their feet. Once standing it helps to restore circulation by slapping or massaging the leg muscles. Camels that refuse or are unable to remain standing, or have broken limbs,

may be slung to give relief from constant sitting. This encourages using the limbs or saves using a damaged limb. (See Figures 7.7.1 - 7.7.3.)

Liver Fluke (*Fasciola hepatica & Fasciola gigantica*)

Snails are the intermediate host. Emaciation and diarrhoea may be symptoms. There are many preparations for drenching to kill flukes in the animal. The snails should be controlled by treating the water with Copper Sulphate or the pounded fruit of *Balanites aegyptica*.

Local Anaesthesia

See "Anaesthetic, local"

Mange

See Chapter 7.2. Dr. W. Forse reports that in Ethiopia a strong infusion of *Castor Oil* leaves is used successfully to cure Mange in goats and should be tried on camels.

Meconium

It is important that Meconium, the calf's first faecal discharge, is voided soon after birth. If it is not done the calf must be made to drink the mothers colostrum or fresh milk, and some spoonfuls of cooking oil or liquid paraffin (not Castor oil) may help. (Traditionally, a solution made from chewing tobacco is given) At the same time give an enema of 50% warm water and oil or liquid paraffin.

Nasal Bots (*Cephalopina titillator*)

The adult is a fly which deposits its eggs in the nostrils of the camel. The larvae inhabit the nasal passages, sometimes in large numbers, causing distress. This species is specific to camels. Drenching with "Ranide" or "Neguvon" eliminates the bots.

"Orf"

(Camel Contagious Echtyma), Pustular Dermititis. See Chapter 7.2. Sheep Orf Vaccine made by Vet. Labs. Kabete has given protection on Ol Maisor, Rumuruti. Treatment of lesions as for Camel Pox.

Papilloma

See Chapter 7.2

Parapox

See "Orf".

Pasteurella

See "Haemorrhagic Septicaemia" and "Joint Ill"

Poisonous Plants

Capparis tomentosa, particularly the fruit, and *Sarcostemma andongenese* are known to be poisonous to camels. Traditional treatment is to drench with melted sheep's fat. Vitamin B is also a help. Bread yeast contains Vitamin B and this may be brewed up with sugar and water and given as a drench. *Sarcostemma* poisoning causes paralysis and sometimes contortion of the neck looking as though it was broken. Animals may not be able to stand for several days and should be fed and watered. (See "The Camel" by Leese, p. 358 and "Camels and their Management" by Rathore, p. 191)

Prolapsed Vagina

This may occur either before or after calving. If successfully restored the condition seems to recur again with the next calf and so perhaps the animal should be culled. Clean gently with "Savlon". Sprinkle all over with a handful of sugar and push the whole extrusion back into place with your fist. If after a few days the treatment is not successful the vulva must be stitched in several places to hold it in. Use thick string or pieces of bandage so that the vulva does not tear. "Purse-string" suture through the skin surrounding the vulva is best as this does not damage the mucous membrane of the vulva. The stitches must be removed in due course, particularly if the animal is near to calving. Sometimes a pad, wooden block or piece of basket-work, held in place with a harness, is used instead of stitches, but this system tends to become messy and the harness is a nuisance.

Rabies

Camels with Rabies may become belligerent and try to bite people and other camels. Any unusual behaviour for the animal concerned (not to be confused with a bull in rut) and particularly if there

Figure 7.7.1: Pulling and lifting a camel forward. Note the rope behind the knees for pulling forward, and another rope fastened around the body providing handholds for many people.

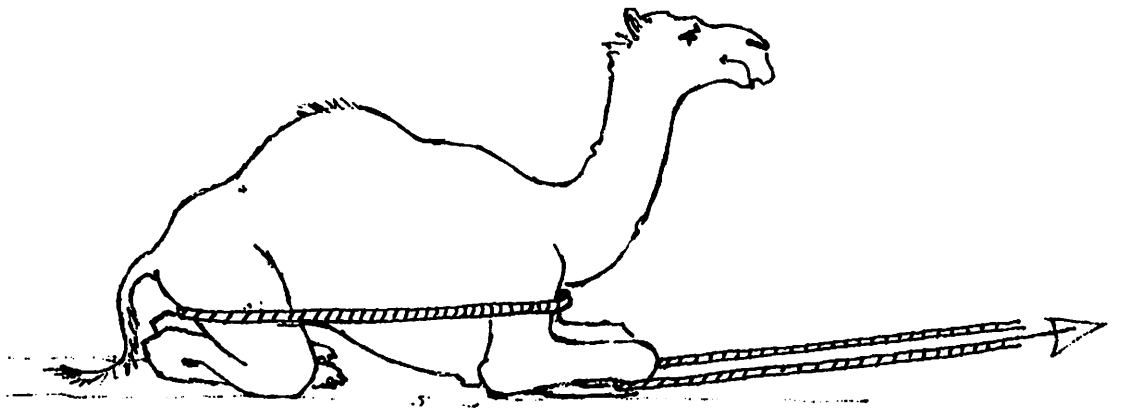


Figure 7.7.2: Moving a foundered camel. Rope threaded under the animal between the poles makes a stretcher.

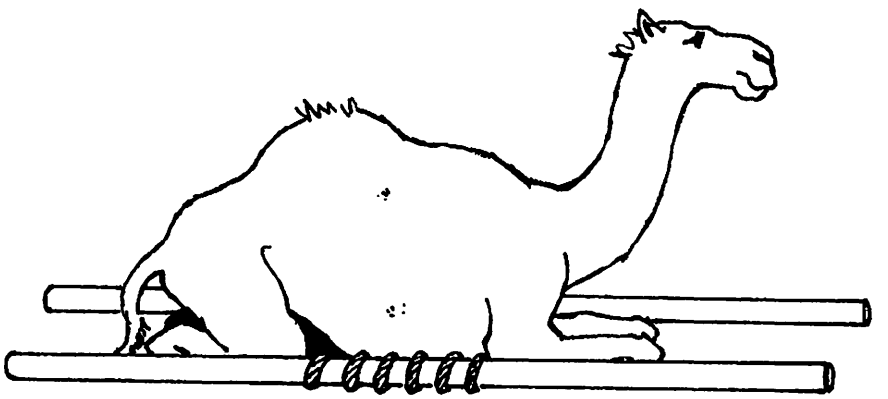
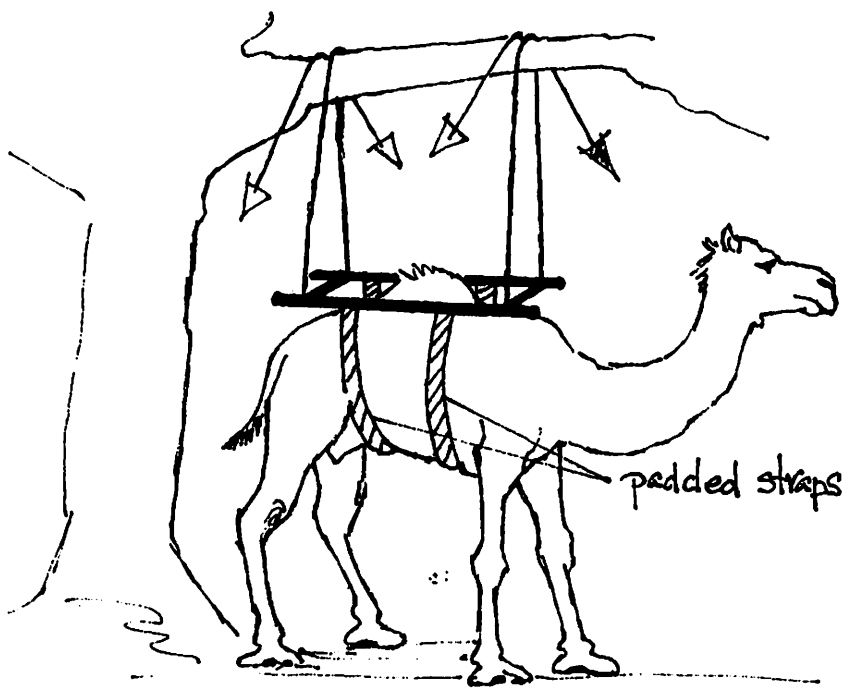


Figure 7.7.3: Lifting or Slinging a camel. The main weight should be taken under the breast pad. The slings may be kept apart by spreaders to ease constriction of the body. The sling should allow an inch or two of slack when the animal is standing.



is any record of being bitten at any time, makes one suspect rabies.

Incubation of the disease may be up to one year. The disease progresses from the excitable stage to paralysis in the hind legs to death within five days. The animal must be killed. The head should be taken to a laboratory for examination. Take precautions not to have contact with the saliva, blood or other body fluids. People having been in contact with a rabid animal should have Rabies vaccination. Try to find and destroy carriers such as dogs and jackals. Rabies is incurable, fatal and an unpleasant death affecting humans and all warm-blooded animals.

Rehydration Formula

Sick animals often become very dehydrated and must be helped. A water solution containing the following is advantageous: Salt 10 gms, Sugar 90 gms (or Glucose or Dextrose), Potassium Chloride 7 gms per lt. as a drench. Prof. Yagil advocates drenching a full-grown camel with 50 litres of 2% salt solution when undergoing injection treatment to help circulate the drug.

Rift Valley Fever

Rift Valley Fever has been reported in camels (Scott et al 1963, Davies 1984 and others). This is caused by a virus carried by *Culicoides* and perhaps other biting insects associated with damp conditions. Abortions, and sometimes death, following a high fever can be the result. Preventative vaccination should be possible.

Ringworm

See Chapter 7.2.

Rubbing Post

A post, or tree, in the night boma draped with a sack regularly soaked with old engine oil mixed with some acaracide "dip" helps to control mange and ticks, as camels will rub against it when they have skin irritations. It should be remembered that undressed rubbing places may spread mange, necrosis, etc. from one camel to another.

Slinging

See "Lifting".

Streptothricosis

Similar to "lumpy wool" in sheep. This usually appears in wet weather along the top of the ribs and rump. The hair comes away leaving scurfy skin. "Anabac" 15 cc. in 1 Lt of water is effective (Dr. U. Rottcher, pers. com.). 5% Copper Sulphate solution also helps.

Snake Bite

Inject serum specific to the type of snake, or multivalent serum. Slow intravenous or intramuscular injection, or preferably 2/3 intravenous and 1/3 at site of the bite. Otherwise use an electric cattle-prod (See Chapter 7.8). Spark plug lead from a motor car has the same effect but if possible earth the body near the treatment site.

For adder bites, said to be effective, inject a solution of Epsom Salt (Magnesium Sulphate): 1 oz. in 1 pint of water injected in and around the bite. Otherwise lance through the fang holes quite deeply, being sure not to cut any ligament or tendon, and press in Potassium Permanganate crystals. The electric cattle prod treatment is also effective for Scorpion and Hornet stings, and probably bee stings in humans.

Tetanus

Tetanus has been reported in camels, but appears to be of minor importance. It is contracted from infected soil or dirty surgical instruments, entering deep anaerobic wounds. Deep wounds should be irrigated with an oxidising agent such as Hydrogen peroxide or Potassium permanganate. Symptoms of Tetanus are violent spasmodic muscular contractions, terminating in death.

Ticks

Ticks do not appear to transmit any diseases to camels. Paralysis may be induced, mainly in young camels, by a toxin introduced by *Hyalomma* ticks. If the offending ticks are removed the animal should recover (See Chapter 7.2).

Tick-Bird Wounds

Tick birds feed on blood from open wounds which they do not allow to heal. Such wounds should be covered with something like Stockholm Tar, juice from *Aloe* leaves, or perhaps *Tephrosia* leaves.

Trypanosomiasis

See "Trypanosomiasis" (Chapter 7.6).

Tuberculosis

Tuberculosis is rare in camels in range conditions. It may be transmitted from man to animals or animals to man through droplets in breath or infected milk.

Ulcerative Lymphangitis

This is caused by *Corynebacterium* forming lumps full of pus. Sometimes very large, becoming fibrous which may be amputated with difficulty. When the ulcer is ripe it should be lanced and cleaned and dressed as for other wounds. A local treatment that appears to be effective is to cauterise the open ulcer with latex from the "**Bobong**" tree (*Euphorbia kibweziensis*). Probably very painful.

Umbilical Cord

All new-born calves should have the umbilical cord treated with Tincture of Iodine and be tied very close with string soaked in the same to prevent the entry of infection (See "Joint III").

Urea Poisoning

Drench with mixture of 1 cup of vinegar, 1 cup of sugar and 1 pint of water.

Weak New-born Calves

If a calf does not start breathing immediately after birth, apply artificial respiration or, if available, administer "Respirot". An intravenous injection 9 gms salt, 50 gms glucose, 10 gms sodium bicarbonate, in 1 lt. of water will strengthen a weak calf.

A calf must have colostrum, preferably within 6 hours of birth, to absorb its mother's antibodies. If the calf is unable to suckle, the mother should be milked and the colostrum fed to the calf. If the mother has no milk take 1 to 2 lts. of blood from her (or another camel) and drench the calf with the blood within 6 hours of birth.

A calf that has not acquired antibodies from its mother has to produce its own in response to any challenge from disease, and is therefore at risk.

Wounds

Fresh wounds should be dressed with mild antiseptic: "Savlon" or "Dettol" solutions, Tincture of Iodine, Gentian Violet or Tetracycline spray. If bleeding is profuse the juice or flesh of *aloe* leaves is a good styptic, or 10% solution of Alum. If this is insufficient apply a pad of cotton wool gauze or absorbent toilet paper as well.

Suppurating wounds should be cleaned with 2% solution of Hydrogen peroxide (usually sold as "20 Vol." which is 6% and therefore needs diluting with 2 parts of water). If Hydrogen peroxide is not available the wound should be thoroughly cleaned with a mild solution of antiseptic. The wound must be allowed to drain which may require a slot cut out of the skin. The wound must then be dressed: Tetracycline spray, Antibiotic creams, Sulphanilamide powder or "Negusunt" powder. The latter is very good as it is also insecticidal and prevents infestation of maggots. Deep wounds may be injected with intramammary mastitis ointments.

If a wound has to be stitched, a drainage hole must always be left. For drawing an abscess: apply a paste of fine Magnesium sulphate (Epsom Salt) mixed with Glycerine or a paste of fine sugar mixed with Tincture of Iodine. For swollen limbs: soak in hot water with Epsom salt or common salt added.

(Editors Note: We notice considerable variations in dosage rates of Xylazine by different authors for the anaesthesia of camels. We have personally observed many successful administrations using the lowest dosage rate of 0.25mg/Kg as recommended by Dr. H. Cran in chapter 7.5 "Castration". This of course is cheaper and perhaps safer. Should it prove ineffective an additional injection can always be given, but this should never be greater than the first dose.)

Table 7.7.1: Physiological data for healthy Livestock (from Field 1993)

ANIMAL	SHEEP	GOAT	COW - ADULT	COW - CALF	CAMEL
Temperature (°C)	38.5-40	38.5-40.5	37.5-39.5	38.5-40.5	35-42*
Heart rate (per min)	60-80	70-90	40-60	60-80	30-50
Breathing rate (per min)	10-20	10-20	12-30	40-60	5-12
Onset of heat (in months)	8-12	4-8	8-18		24
Length of heat	30-36 hours	2-3 days	<12 hours**		3-6 days
Length of heat cycle (days)	16-21	18-21	21		20-25***
Gestation period (days)	145-150	145-155	275-290		375-390

** Temperature is lower in the morning and higher at night*
*** Often occurs at night. 'Silent heats' are common*
**** It is doubtful whether camels exhibit a normal heat cycle*

Normal parameters given are for adult animals except where noted. The temperatures, heart rate and breathing rate for young animals will normally be higher. Care should be taken not to misinterpret readings of young animals. The stress of restraint and handling may raise the temperature, heart rate and breathing rate of a healthy animal - these readings should be interpreted carefully.

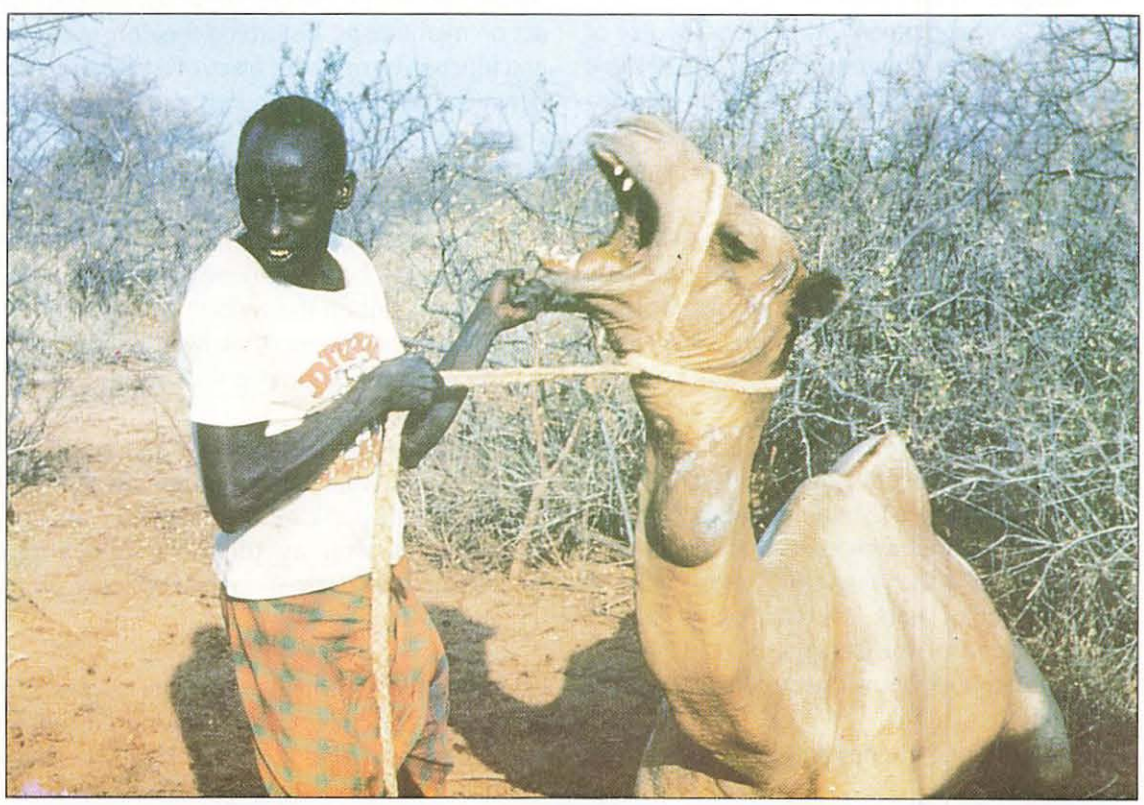
Locations for taking heart rate

- Sheep/goat - the heart or inside the hind leg.
- Camel - the tail or inside the hind leg.
- Cow - the tail

Plate 7.7.1: Protective boot made of leather to protect wound on pad. (Chris Field)

Plate 7.7.2: Larvae of the nasal bot fly (Cephalopina titillator). *(Chris Field)*

Plate 7.7.3: Ulcerative lymphangitis. (Chris Field)



CHAPTER 7.8

High voltage shock treatment for snakebite

by R Kamber

Editors note: This article by Dr. R. Kamber is adapted from articles and letters published in The Lancet, July 26th 1986 under the following headings: *High Voltage Shock Treatment for Snake Bite* by R.H. Guderian, C.D. Mackenzi, J.F. Williams, *Biological Basis for High-Voltage Shock Treatment for Snake Bite* by C.Kroegal and K.H. Afeyer zum Boschenfeld, *Scorpion Stings* by J.G. Den Hartog MD

The mainstay of treatment of a person or animal bitten by a venomous insect or reptile is to give anti-venom as soon as possible. However, the serum needed may not be available in remote areas of the world. So, an alternative to this kind of treatment is needed and was found in the High Voltage Shock Treatment.

The results from this treatment, reported in various articles all over the world, have been very encouraging. The treatment is easy, practicable and needs no equipment other than a source of high voltage, low amperage current (20-25 kV, < 1mA), such as an automobile spark plug wire or a portable cattle-prod.

With a cattle prod, the current is applied directly. When using the current from an automobile, the bitten area (usually a limb) is electrically grounded as close to the bite as possible. The electrical current is applied (via an insulated probe) to the site of the bite for 1-2 seconds. Repeating the treatment 4-5 times at intervals of 5-10 seconds is sufficient.

It is reported, that, if treated soon enough (within 30 minutes after being bitten), all pain disappears within 10-15 minutes due to this treatment. All the known symptoms that appear after an untreated bite, such as swelling, serosanguinous bullae, bleeding, shock and renal failure, did not develop. None of the patients died or needed further treatment for the classic complications of snake bites.

This technique has not only been successfully used for snake bites but also for ant bites, and scorpion or bee stings. The same positive results are achieved each time.

The biological basis of this treatment is not yet completely known. However, several effects may be involved:

- A shut down of local vessels by electrospasms preventing the venom from spreading through the body.
- Direct influence on the venom affecting its activity.

Snake venoms contain a complex mixture of enzymes, nuclear and metal ions, as well as a group of proteins and polypeptides characterised by an overall net positive charge. These last compounds act on membranes, disturbing their organisation and function by means of electrostatic interaction between the basic compounds and the negative charged surface of the membrane. This is presumed to be essential to their cytotoxic action on various cells of the body.

It is concluded, that three different mechanisms seem to be responsible for the effect of electrical current on the venom:

1) The current influences the hydrogen bonds of the enzymes destroying their secondary and tertiary structure.
2) The current reduces metal ions, which are mandatory cofactors for different enzymes.
3) The electric particles interfere with the membrane as well as the positive-charged polypeptides decreasing their cytotoxic properties.

Whatever the mechanism, this technique is a practicable and potentially life-saving procedure for humans as well as livestock.

CHAPTER 7.9

Plants found in camel rearing areas that have some medicinal properties for both livestock and/or people

by J O Evans and S P Simpkin

This list is by no means exhaustive, and comprises the plants that have actually been used by, or in the presence of, the authors, and have been seen to be effective.

Medicinal Plants

Acacia nilotica - infusion from the bark used to stop diarrhoea.

Acacia nubica - infusion from the bark used to stop diarrhoea, and cure headache.

Albizia anthelmintica - roots and bark infusions are given as a drench which acts as a purgative and expels some intestinal parasites.

Aloe spp. - used as a styptic to stop bleeding, soothe burns and treat wounds.

Azadirachta indica - Neem tree - leaves have insecticidal properties, and an infusion of leaves acts as a worm drench, effective against certain worms.

Balanites aegyptica - pulverised fruit can be put into water to kill snails that carry liver fluke and bilharzia. It may also be effective against leeches.

Commiphora spp. - the gum is used to treat wounds and abscesses, and it may have an effect on ticks.

Euphorbia kibweziensis (***Ipopong***) Bobong - sap used for cauterising ulcers and abscesses.

Myrsine africana - widely used as a tonic by many tribes in Kenya. Seeds boiled in water (or tea) are given as a drench, sometimes with soup or fat. Its actual effectiveness has never been tested by the authors.

Papaya - latex from the unripe fruit is good for cleaning suppurating wounds.

Salvadora persica - the roots are boiled up with water, and after cooling given as a drench to animals suffering from retained afterbirth.

Spilanthes mauritania - a local anaesthetic. Used to reduce pain, local anaesthetic for toothache. Chew the yellow flower head.

Tephrosia villosa and *T. vogelii* - Insect repellent. Leaves crunched up and rubbed on a wound keeps flies away.

Withanya somnifera - infusion of the roots used to clean wounds, and given as eye medicine

Yeast (Vitamin B) - used to cure wry neck, and counter the effects of *Sarcostemma spp* poisoning.

Chewing tobacco can be boiled in water to produce a liquid with acaracidal properties.

Poisonous Plants

Capparis tomentosa - leaves and flowers can be poisonous to camels, and fruit is poisonous to people. Traditionally, boiled sheep's fat is given as an antidote. Some camels in S. Horr and environs have developed some immunity to the poison.

Sarcostemma andongencse - highly poisonous to livestock.

CHAPTER 7.10

Obtaining veterinary samples for diagnosis

by Dr R Kamber

In order to make sure that a diagnosis from clinical examination or a postmortem is right, you want to send samples to a laboratory for examination. For this purpose it is important to know what kind of samples must be taken, how they should be taken, and, most importantly how they have to be treated in order to stay fresh until they are examined in the lab.

Ensure that every sample has a tag with the date and the number and owner of the animal; also send a description of the disease and the treatment - it gives the lab a clue what to look for!!

Blood samples

Blood samples are used to detect viral and bacteriological infections, mineral deficiencies, nutritional status, poisoning, failure of different organs, etc.

Take blood from the jugular vein. If the blood is taken from an artery, indicate accordingly on the label. To do a haematological examination (blood cells count) the blood needs to have an anticoagulant (e.g.. EDTA, Heparin) added. There are special tubes available already prepared with anticoagulant. For most blood chemistry analyses (minerals, enzymes, etc.), and examination for antibodies (bacterial or viral infections) blood serum is required. For this purpose, take blood in a plain tube and let it stand, or centrifuge it until blood cells and serum have separated. Pour the serum into another tube and put it immediately into the fridge or freezer.

Blood slides are taken for detection of blood parasites and changes in blood patterns.

For detection of trypanosomes the "buffy coat" is best. This is the layer between the red blood cells and the plasma when the blood has been centrifuged or allowed to separate by standing the tube for a few hours. The slide should be prepared by placing a drop of "buffy coat" on a slide, covering it with a second slide, pressing the two gently together and sliding the second slide to spread the sample. Slides of whole blood should be prepared by placing a very small drop of blood at the end of one slide and, with a second slide held at 45∞ touch the blood drop with the end to spread the blood along the edge, then push the glass the length of the lower slide to make a very thin smear. Allow the smear to dry uncovered. This is then in a state suitable for lab staining and examination.

Urine samples

Urine samples can detect kidney or bladder infections, renal failure, metabolic deficiency, etc.

If the sample is unlikely to be examined within 4 hours of the sample being taken, freeze it as soon as possible after collection.

Faecal samples

Faecal samples are used to detect and identify parasites in the intestines.

Faecal samples should be taken if there is a suspicion of worm infestation. The sample should be kept in an airtight tube.

Bacteriological samples

Samples for further examination from postmortems, abscesses, nasal discharge, etc.

If possible take samples of parts, or whole organs. Keep them in the fridge and keep them cool even whilst in transit.

Swab samples for bacteriological examination must be stored in a suitable media, and then sent to a lab, otherwise bacteriological overgrowth will make an examination impossible. In order to stop growth, keep the samples at a low temperature in the fridge. Take the sample from inside of an organ, not the surface.

SECTION 8

DATA COLLECTION AND HERD MONITORING

CHAPTER 8.1

Data collection and herd monitoring

by S P Simpkin

Introduction

A good stock owner inspects his herd at least daily — once in the morning and again in the evening when stock return from pasture. Any animals requiring attention or treatment should be attended to as soon as possible. If the owner is unable to personally supervise his stock, he should ensure that he has good herdsmen. Any signs of sickness should be reported immediately, and again animals should be counted in and out of the boma each day.

Record Cards

Every camel in the herd should have a unique ID number and its own record card. Calves should be recorded on the same card as their mothers until they are weaned, when they should be branded and a separate record card kept.

Record cards should include space at the top for:

- Name/Number
- Sex
- Breed/type
- Date of birth/date of purchase
- Mother's number (or previous owner if bought)
- Sire's number (or place of origin if bought)
- Distinguishing marks (brands, earnotches, colour, etc.)

There should then be columns for:

- Date
- State
- Dentition
- Condition
- Body measurements - Shoulder height (SH), Thoracic Girth (TG) and Abdominal Girth (AG)
- Weight
- Comment/Treatments

In the case of female camels the cards should include extra columns for:

- Calf weight
- Combined weight
- Mean monthly milk yield
- Date mated
- Sire No.

Examples of record cards are given below.

Figure 8.1.1: Example of record card for female camels.

Name/No.	Sex	Breed/Type	Date of birth/purchase
Mothers No.	Sires No.	Previous owner	Place of origin
Distinguishing marks:			

Date	State	Dentition	Condition	SH	TG	AG	Live weight	Calf weight	Combined weight	Milk yield	Comments	Mated	
												Date	Sire No.

Figure 8.1.2: Example of record card for male camel.

Name/No.	Sex	Breed/Type	Date of birth/purchase
Mothers No.	Sires No.	Previous owner	Place of origin
Distinguishing marks:			

Date	State	Dentition	Condition	SH	TG	AG	Live weight	Comments

General notes

Observations on health, condition and any treatments given should be written down straight away; if the details are not written down, confusion of dates, ID numbers etc. may lead to a serious loss of production and hence income.

Any births, deaths, matings, abortions, sales or buy-ins should be recorded accordingly. This is best done in the evening each day, after the herd have come in from pasture, and the herdsmen can be questioned on the day's activities.

ID numbers, either brands or ear-tags, should be kept legible and clear. Hair brands need to be repeated periodically as they become difficult to read after the hair has grown.

The condition of the camels should be noted monthly. Most camel farmers and researchers classify their animals as either in Good (G), Fair (F) or Poor (P) condition. It is a very subjective classification and will vary according to the individual monitoring the herd and his/her experience and knowledge of the camels in the herd.

The age and breeding status of each camel should be noted monthly. Ageing is normally estimated by eruption of the incisor teeth, and it is useful to include this on each ID card. (See Tooth eruption/ageing by Wilson, Chapter 6.1.)

Suggested abbreviations and categories for breeding status include:

Males
A — Active stud bull
I — Inactive stud bull
C — Castrated male
W — Weaner male
S — Suckling calf

Females
P — Pregnant female
L — Lactating female
PL — Pregnant and lactating
D — Dry adult female
PH — Pregnant heifer
NH — Non pregnant heifer
W— Weaner
S — Suckling calf

Weights

Calf birthweight should be recorded within 24 hours of calving. Subsequent body weights should be recorded monthly. A camel platform weigh-scale is best, and camels soon get used to being weighed. Alternatively the live weight can be calculated from body measurements. Individual body measurements should be included on the record card so that if a mistake is made in the measurements it can be compared to the previous month and the necessary corrections made.

The general formula used is: Liveweight = Shoulder Height (SH) x Thoracic Girth (TG) x Abdominal Girth (AG) x 50 (See Figure 8.1.3). This provides an estimate of Live weight in kilograms. All body measurements are made in metres.

Some researchers have found different formulae are more accurate for different age groups. Atkins (unpub) finds that for younger animals the measurements should be multiplied by 48 instead of 50.

Milk yields

Milk yields should be recorded weekly if possible. Both morning and evening yields should be measured. Recording should include the number of teats milked and which side of the udder is milked. The time the calf last suckled, or was separated, or the time the mother was last milked should all be recorded. There are considerable differences in milking techniques, and this has led to considerable confusion as to estimating total milk yields. Ideally each milk measurement should be recorded after a separation time of at least three

hours; before separation the udder should be emptied by hand after the calf has had its fill.

Any major deviation in the milking technique and frequency is itself going to affect milk yields, therefore measurements should be carried out with the least interruption to the normal milking/ suckling regime. Since strength of the milk ejection reflex and "milk let-down" is of importance in milking camels, it is recommended that the calf suckles two teats, whilst the yield from the other two teats is recorded.

Milk yields should be measured either by volume in a measuring jug, or by weighing, and the results presented either in litres or kilograms.

When reporting it is important to state whether the yield is the actual yield available to the herdsmen, or whether it is an estimated total daily yield including the estimated amount consumed by the calf.

Treatments/Comments

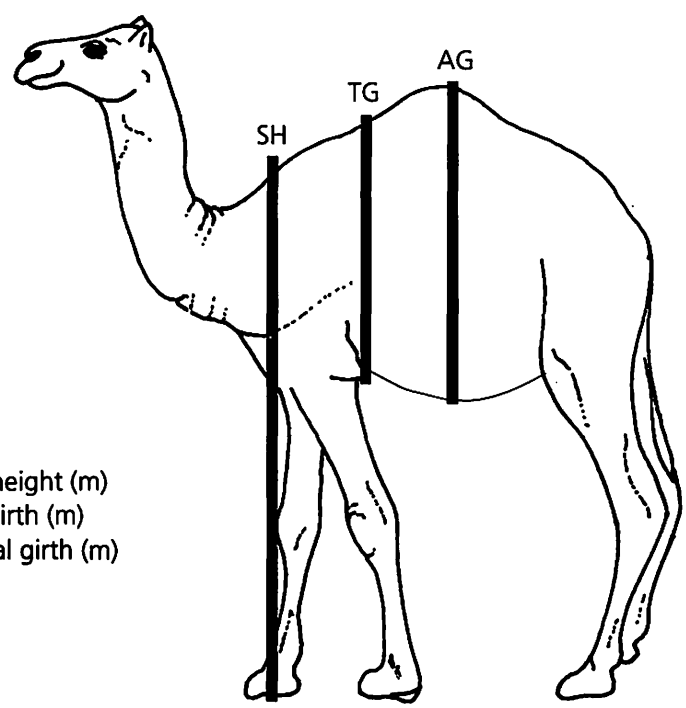
Any treatments or health conditions should be noted. The name of the drug used, and the dose rate given should be included.

Conclusions

Data are only useful if recorded accurately and routinely. Long-term and accurate data on camel production are in short supply, and therefore what little is known about camels tends to be based on only a few observations or studies. Monitoring and data collection are important in the upkeep and improvement of a herd, and in increasing the knowledge about the potential of camel production.

Data collection does need to be planned and organised. It is more important to collect a reasonable quantity of accurate long-term records than to try and collect too much data in a haphazard and disjointed manner.

Figure 8.1.3: Body measurements for estimating liveweights of camels.



SH = Shoulder height (m)
TG = Thoracic girth (m)
AG = Abdominal girth (m)

Estimated liveweight (Kg) = SH x TG x AG x 50

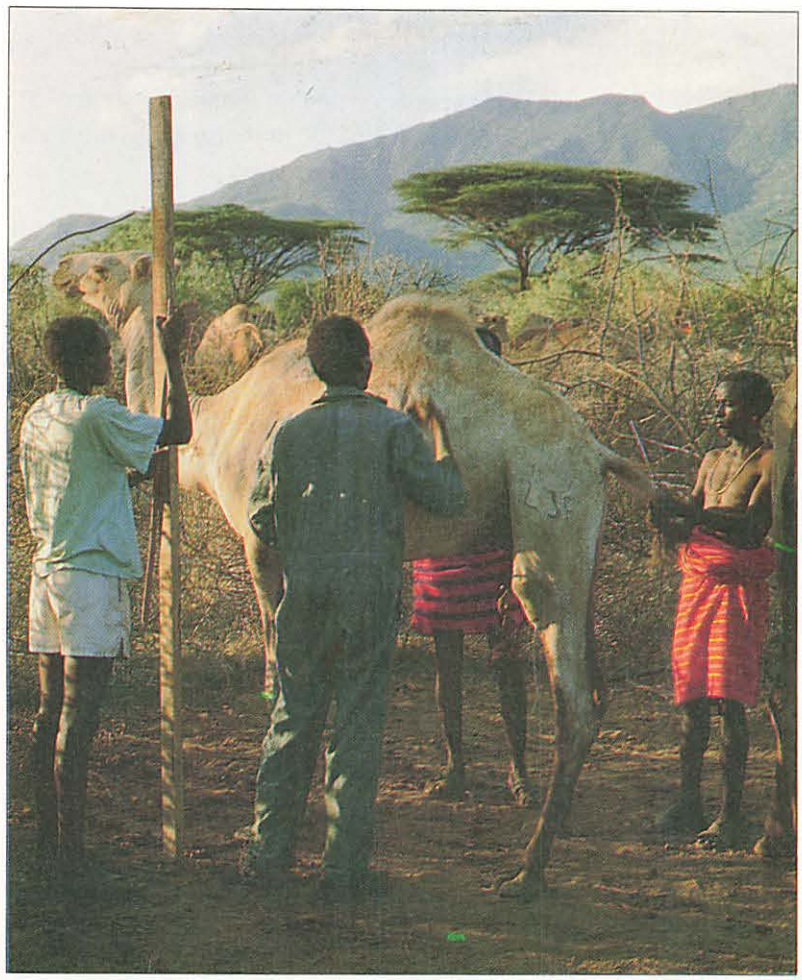
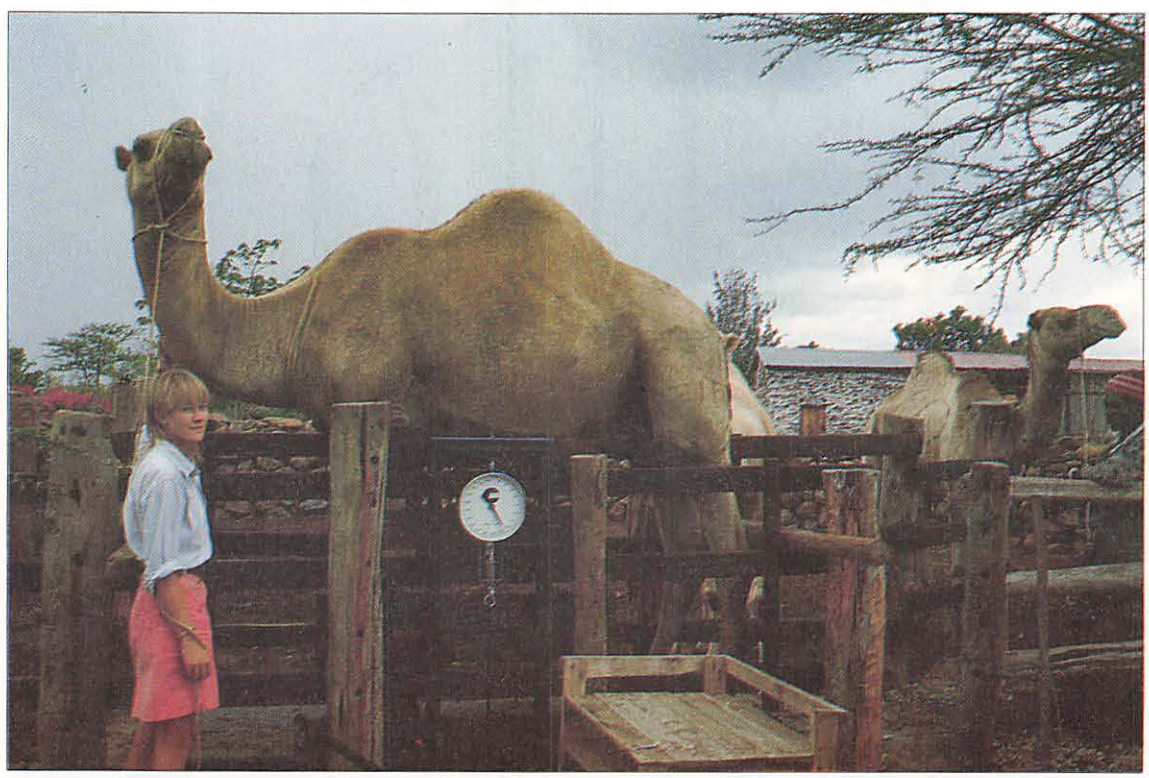


Plate 8.1.1: Calculating liveweight by recording body measurements (Chris Field).

Plate 8.1.2: Weighing a camel on a platform scale (Jasper Evans).



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APPENDIX 1

Camel distribution in Kenya

Compiled from 3 aerial surveys by the Kenya Rangeland Ecological Monitoring Unit (KREMU) in 1970's and 1980's, and presented in lecture notes by Dr. C.R. Field.

DISTRICT	ARIDITY INDEX	CAMEL POPULATION	HUMAN POPULATION DENSITY PEOPLE/KM²	RATIO OF CAMELS:COWS
Wajir	6	160 000	3	1:1.2
Garissa	7	46 000	3	1:7
Mandera	7	111 000	4	1:0.3
Marsabit	7	90 000	1	1:1.5
Samburu	6	11 000	4	1:12
Isiolo	7	97 000	2	1:1.4
Turkana	7	76 000	2	1:3
Baringo	5	2 000	21	1:54
Narok	4	<100	13	1:5100
Kajiado	5	<100	8	1:4100
Lamu	5	44	7	1:475
Kilifi	5	<500	35	1:196
Kitui	6	<1000	16	1:380
Tana River	7	34 000	2	1:6
Laikipia	5	750	14	1:320

The natural southern distribution of camels has been determined by the presence of the Tsetse fly, but pockets of camels do now exist in Tsetse areas. The slow but steady southerly spread of the camel has been accelerated in recent times by the involvement of government and NGO's looking for methods of delaying the spread of deserts.

APPENDIX 2

Vernacular names of common camel food plants

Camels are documented to have a very wide and varied diet. In the following table a number of plants and their vernacular names are listed. These plants are not exclusive to the camel diet, and there are probably more plants omitted from this list than are included.

The vernacular names given to plants are not always relevant to the same classification applied by botanists or range scientists. As a result many plants of quite different families may all have the same vernacular name. Names for plants may also vary from area to area, and indeed with the size or stage of growth of the plant, and individuals used for identifying the plant may use different names for the same plant from other people in the community.

The sources from which these plants have been obtained all listed degrees of palatability or preference in the camel diet. These ratings have been omitted from this table because preference and palatability vary considerably from place to place, as well as from season to season, stage of plant growth, and even as to what the individual camel itself is accustomed.

This table should only be considered as a rough guide aimed to help in the field identification of plants. It is not presented as a definitive paper on camel food plants or rangeland vegetation.

FAMILY	PLANT	TYPE	SOMALI	GABBRA/ BORAN	RENDILLE	TURKANA	SAMBURU	POKOT	SOURCE
Acanthaceae	Duosperma eremophilum	DS	sarem sarim	sarim	dyewah liebah	edurkunyato	ldurukunyanto		2, 3 4
"	Barleria proxima	DS	gamaadiis odarol	maadek	sucha		sucha	kelklyan	1, 5
"	Barleria acanthoides	DS		shiisha kelteppe	sotya sucha		sucha		4
"	Blepharis ciliaris	H		baaraata					4
"	Blepharis linariifolia	H	quarda yumarook	kutumbule baraata	harja lemaruk		lmarak	tarkwon	2 4
"	Justicia spp.					lopora	siget		
Aizoaceae	Gisekia pharmaceoides	H					lekulupani loldonyo		2
"	Trianthema salsoides	H		kantala					4
"	Zaleya penandra	H		laamisho					2 4
Amaranthacaea	Sericocomopsis hildebrantii	DS		garbitch jilbeete	gilb	akabonyo?	lturkan		2 4
"	Digera muricata	H		gelgedaana					2
"	Dasyphaera prostrata	H		jilbete			lopitara		2
"	Pupalia lappaceae	H		mat'anne		etanago	lorepirepi		4
Anacardiaceae	Rhus natalensis/ quartiniana	S		daboobesa			lmisigiyoi		4
Apocynaceae	Carissa edulis	S	dagams	dagams			lamuriai		

FAMILY	PLANT	TYPE	SOMALI	GABBRA/ BORAN	RENDILLE	TURKANA	SAMBURU	POKOT	SOURCE
Balanitaceae	Balanites aegyptica	T	kullen kidthi	badan baddana	kulum	eroronyit	lbulei	tunywo	2 4
"	Balanites orbicularis	T	kullen	baddan baddana		ebei	sarai	lomyon	2 4
Boraginaceae	Cordia sinensis	T/S	mared mareer	mader	gaer kohh	edome	lgweita kweita	adomeyon	2
"	Cordia ovalis	S		mader modera marer-gom	gaer		seki		
"	Cordia cronata	S					lmanture		
"	Cordia gharaf	T/S		madeera			silapani		4
"	Heliotropium subulatum	H		dubarraara					4
"	Heliotropium albohispidum	H		kokoomisha			lekulupani	chemoroin	2 4
Burseraceae	Commiphora spp	T	ayned dirinder dengelle garbaad gestow gosi	chalaka dakkidah jalanga amess-dirra sanga-igu hamess waraab reeb	rumwe ramo hagar gadayan geiborbor dawahad-ado	ekadeli	loishimi lailepai lcheninyiro	mindarotwo katagh	2
"	Commiphora africana	T/S	dabaunun dibo	ammeesa			loishimi lcheninyiro		4
"	Commiphora boiviniana	T/S	dibrik takdaha	dakd'a dakadaha			layamai		4
"	Commiphora madagascariensis	T		c'allanka			lemarasin		4

FAMILY	PLANT	TYPE	SOMALI	GABBRA/ BORAN	RENDILLE	TURKANA	SAMBURU	POKOT	SOURCE
"	Commiphora erythrea	T	hagar	agarsu					4
"	Commiphora candululla	T/S		waara			samanderi lokees		4
Burseraceae	Boswellia hildebrantii	T	mudufur	dak'ara		edweite	silalei		4
Caesalpin iodeae	Delonix elata	T	lebi	sukella		ekuchanoit	lawai		
Capparaceae	Cadaba ruspolii	T	qadhu				rasia		2
"	Cadaba farinosa	S		khaddi tutch haggarinyap deekuku	geikuku	ereng	larasoro	arerenyon	
"	Cadaba gillettii	S		k'adu					4
"	Cadaba mirabilis	S	gadu	afuursa					
"	Capparis tormentosa	T/S	goryafun gumbor	gora			laturdei	kankodowua	
"	Maerua crassifolia	S	dume	galgacha umacho kalkaj- domaio d'umasho		ereng	lumi ldumei	tuwa	2 4
"	Maerua angolensis	T		k'alk'ac'a			ldumei loitarkini lamalogi		4
"	Maeru spp.	T/S	afuursa						4
	Boscia augustifolia	T		galgacha hareh			lororoi		2

FAMILY	PLANT	TYPE	SOMALI	GABBRA/ BORAN	RENDILLE	TURKANA	SAMBURU	POKOT	SOURCE
"	Boscia coriacea	T	kalkatch		nyaror ioror lyoror		serichoi		2
"	Plectranthus ignarius	DS	dalol				saali		
Chenopod iaceae	Sueda monoica	T		durte			lduruchoi		2 4
"	Sueda hortensis	DS							1
Combretaceae	Combretum spp	T	edeshebell	kaleda rukhes c'anc'ali	hikho		lemawol lparasiani		2 4
"	Combretum molle	T		rukeesa			lkerepei		4
"	Terminalia polycarpa	T		k'orobo					
"	Terminalia spp	T	bisiq gogon	bisig gambe		bisirkh	ilbugoi naiteteyiai		
Commelin aceae	Commelina latifolia	H		k'aayyu					4
Compositae	Kleinia kleinoides						longaaloi		2
"	Leucas pododoiskos								2
"	Aspilia mossambicencis	H		adha		loyiapasoi			4
Convolvulaceae	Ipomoea kotschyana	S				lakitengi			2
"	Seddera hirsuta	H		gurbi		leturot			
Cucurbitaceae	Kedrostis gijef	V		gaalle	sarkhudum	sakurdumi ntujuu			2 4

FAMILY	PLANT	TYPE	SOMALI	GABBRA/ BORAN	RENDILLE	TURKANA	SAMBURU	POKOT	SOURCE
"	Cucumis prophetarum	V		baraambarro			nkalamoi		4
Ebenaceae	Euclea sp.						nginyei		
Euphorbiaceae	Euphorbia tirucalli	Sc/ S		anno		elila	loile		
"	Euphorbia cuneata	S	dumaale	(h) idaa	andikha		Itilimani		4
Graminaceae	Aristida adscensionis	G	bila ramot	buuyo biila	khos		Italakwani		4
"	Aristida mutabilis	G	bila				Italakwani		2
"	Cenchrus ciliaris	G	ahs guduud	diilaleesa			lorokwe		4
"	Cenchrus pennisetiformis	G		k'onc'orro			lorokwe		4
"	Cenchrus setigerus	G	ahs garbaab	buuyyo harre			Ikawa		4
"	Chrysopogon plumulosus	G	ahs danaan	alala					4
"	Cynodon dactylon	G	dalad				lamuruai		
"	Dactyloctenium bogdanii	G	jarba	maa			laburan		4
"	Digitaria velutina	G		biila			lanana		4
"	Echinochloa haploclada	G	kalankal	geddi			nkujita		4
"	Leptothrium senegalense	G	garole	ilmogora			lonoro		4

FAMILY	PLANT	TYPE	SOMALI	GABBRA/ BORAN	RENDILLE	TURKANA	SAMBURU	POKOT	SOURCE
"	Panicum coloratum	G		laabbesa			laraa		4
"	Paspalidium desertorum	G	seir				nkujit		4
"	Pennisetum mezianum	G		ogonno			lkurume		4
"	Setaria verticillata	G	dadiga	hank'arre			lorroturoto		4
"	Sporobolus ioclados	G		buuyyo fiinc'o					4
"	Sporobolus spicatus	G		harfug			loopi		4
"	Themeda triandra	G		buuyo diimtu			lperesiwuas		4
Legum: Mimoisideae	Acacia drepanolobium	T					luai rangau		2
"	Acacia nilotica	T	bilil madow	burquqe		ekalapelimet	ilkiloriti		2 4
"	Acacia etbaica	T		alqabes		eluwo	ljakwai		2 4
"	Acacia goetzei	T		burraa					
"	Acacia reficiens	T	Khamsa	sigirso	khassa	eregai	ljurai		2 4
"	Acacia senegal	T	adad	sabanso-dima iddado	idado	ekunoit	lkerdedi	chemanga	2 4
"	Acacia tortilis	T	abuk abaq	dadach d'addac'a	dhar	ewoli etir	ltepes	ses sess	2 4

FAMILY	PLANT	TYPE	SOMALI	GABBRA/ BORAN	RENDILLE	TURKANA	SAMBURU	POKOT	SOURCE
"	Acacia brevispica	T	gorgor	ameresa			lgirigiri		
"	Acacia gerardii	T					rankau		
"	Acacia mellifera	T	bilil	sabansa gurach	bilhil	ebenyo		iti	4
"	Acacia elatior	T	bura	bura		esanyanait	sesia	atat	
"	Acacia nubica	S	gumar	waanga	dahar	epetetet	ldebe		4
"	Acacia paoli	S	gumar	c'aac'anne	gomor		lmarti		4
Malvaceae	Pavonia zeylanica	H		ilk'abat					
Menispermaceae	Cocculus pendulus	V		marma					
Nyctaginaceae	Commicarpus helenae	H		aratho			lekweitia		4
Legum: Papilionoidaea	Indigofera spinosa	DS	rufile maratel	k'ilt'ip'e korate gala	khoro	emakwi	lkitagesi	amekunyaan	1 4
"	Indigofera diffordiana	DS	dirkba	(h) agaggaro			imiim		2 4
"	Crotolaria spp. C. spinosa	H		(h) asura			lmejerai		4
"	Rhynchosia minima	H		uube			idakat		4
"	Vatovaea psuedolablab	V		gaabbe			lanyoi		4
"	Vigna frutescens	H		c'iimp'a					4

FAMILY	PLANT	TYPE	SOMALI	GABBRA/ BORAN	RENDILLE	TURKANA	SAMBURU	POKOT	SOURCE
Rhamnaceae	Ziziphus abyssinica	T/S		kurk'uura			sanangurii		
"	Ziziphus mauritania		gob	gob			lderendei		
"	Scutia myrtina	T/S							
Salvadoraceae	Salvadora persica	T	adde athei	adhe	hayayay haich	esekon	sokotei	aschokonyon	2 4
"	Dobera glabra	T	garas	garse		edapal	serii	kreschion	
Solanaceae	Lycium europaeum	S		fursa					2
"	Solanum dubium	H	idi	ree (h) iddi					
Tiliaceae	Grewia spp Grewia bicolor	S	depi damak kubbish deka beret	hororessa deka sarkam ogumti	dabach	epat ekali engomo lgogomi epong emaleger	siteti irri lngongomi najipouwis	sitet toronwo	
"	Grewia tenax	S	deka	d'eeka dexa	mulehenyu mulehanyu	lngongomi beteti			4
"	Grewia trichocarpa	S		arooresa					4
"	Grewia villosa	S	kamash	ogomdi			lopopoi lpupoi		4
"	Triumfetta flavescens	S		hanch'abbi					4
Zygophyllaceae	Tribulus cistoides	H		mogoree					4
"	Leptothrium senegalense		kaeowle	karowle					2

Category/Type

T = Tree
T/S = Tree/Shrub
S = Shrub
DS = Dwarf Shrub
H = Herb
V = Vine
Sc = Succulent

Source

1= Field 1979a
2 = Field1979b
3 = Maloiy 1972
4 = Stiles and Kassam 1991

APPENDIX 3

Vernacular names of camel diseases and conditions

DISEASE/ CONDITION	SOMALI	GABBRA/ BORAN	RENDILLE	SAMBURU	TURKANA	POKOT
Abortion	D'ess L'ess	Iralii		Nkiboroto	Akiyechun Akiecium	Touno
Abscesses	Mala Mall Arno	Mala Garfat ?	Malah Mala	Imongoi	Ngubuthien Abus Adjumei	
Anthrax	Kud Khut	Chirrmalle		Lokuchum	Lokuchum	
Arthritis	Gudan Chechupsa	Lukusutowa		Ngilai		
Backstrain or paralysis after calving	Chachafsa	Chachafsa			Loborin	
Blackquarter	Khut	Lkumur	Khadit	Loduseddi	Ngwaat Lokichum	
Calf Diarrhoea	Dab Adeya	Albahti Lbartey Albata		Ngiriata Nkorotit Kepi-Ngocheki	Loleo Colera Lolei'a Ekuruton	
Camel fly	Dakar Ketan	Ketan	Dakar	Ledine	Longoku Lelongokori Elingakori	
Camel Pox	Afrur Furruk	Aftara Baga ? Irgo Abdarra	Afturro	Afturro Abituro	Ngiborwok Ettune	Mokoyon
Capparis poisoning	Gora	Gora Galla		Laturdei	Ekorokonoit	
Contagious hepatitis				Ndiss	Lonyang	
Contagious skin necrosis	Dalleham Garfat Ma'ah Maha	Dula Kharfat	Garfat Kharfat	Ngamanyeni Lomgoi	Lelebunai	
Corynobacterium	Kurri			Mongoi	Etunoi ?	

DISEASE/ CONDITION	SOMALI	GABBRA/ BORAN	RENDILLE	SAMBURU	TURKANA	POKOT
Dermatomycosis	Robi	Ropi		Ngammyeni	Akiserit	
Elbow brushing	Haggagaito Sakirr	Rigo			Ekipianow	
Fleas/lice	Injit	Tuffi Njiraa		Loisusu	Ngilach Ilachit Lonyenji	
Gastro-intestinal diarrhoea	Har Hardik	Albati	Harr Diggheharr		Colera Loleo	
Haemorrhagic septicaemia	Kud Garir	Khando Khandich	Khanid	Nolgoso ? Nangarangar	Lobolio Lorarrurei Lobolibolio	
Hydatid cyst					Labusiyon	
Joint Ill	Lugira Lo'uk	Hilaliit Garfat		Nguratet	Abus	
Maggots				Lkurri	Ukurr	
Mange	Addo Chitto Addha	Chitto	Haddo	Lpepedo	Emitina Ametina	
Mosquito				Lajingani	Ethuru	
Nasal Bots	Sangali Senghel	Jirrid Yirrid Rhamu	Senghelel	Marsomwa	Ekurrut	
Orf	Ambarrur ? Mburur	Humbururu Mburur		Non-kutukie Lopedo	Ngiborwok Mburuwok	Ngirimen
Paralysis/ Brain disease/ Madness	Shimbr Shimpir	Sirigo Busama		Sirigo		
Plant poisoning	Sunu	Bosoke Bobia		Lekochem	Epoison	
Pneumonia Coughing	Dugato Kharid	Furri ? Duguo? Kufasa ?	Dahassi	LbusLbus Lchama Loroget	Loukoi Lotai Erukum	
Pneumonia influenza	Dugub Erghib	Kufa'	Yahar	Nkorroget	Loukoi	
Pus				Ngimek	Abulon	
Rabies	Aidurr			Nkwang	Arthim	
Retained afterbirth	Maderr	Gillu		Lmodong	Edungat - hep nakok	
Ringworm	Ambarr	Robbi		Ngamunyeni	Epara Ekithariit	
Shoulder sprain	Garabaido	Imbuka				
Swollen glnads (often caused by	Kurri	Kando Kandich	Khanid	Nolgaringari	Longarrue Elukunoit	

DISEASE/ CONDITION	SOMALI	GABBRA/ BORAN	RENDILLE	SAMBURU	TURKANA	POKOT
Haemorraghic septicaemia)		Kandicha				
Spiderweb poisoning	Har'ar			Lderepenya	Akiya'-alimakok	
Tabanus fly	Bal Dug Gindi	Baltagi Dug Sorangees		anampur	Ekalich	
Tick infestation	Shillin Yakhal-nymphs	Chillmi Yagala[3] Yagar[3] Shelem Shini	Chillim Turdach-nymph	Lmanjeri	Emadang	
Trypanosomiasis	Aino Attech Dukan[1] Gandi[2] Gudho Salaf Korbarar[4]	Dukan Ghandi Kando	Omar	Saar	Tikana Lokipi	Lokurucho
Worms (Helm) (Tape)	Bahala			Kinyoot LtumaLtumai Ndumai	Ngirtan Nyiritan	

1 Chronic form
2 Acute form of T. evansi
3 Nymphs or larvae stage
4 T. congolense

This list is a preliminary list from observations I have made and from talking and interviewing many camel owners.
It also includes information from:-
Iles (1991)
Mares (1954)
Simpkin (1985)
Dioli, McGovern, Simpkin and Guturo, (this manual)
Schwartz and Dioli (1992)

APPENDIX 4

Some vernacular terms for camels of varying age and sex categories

Category	Somali	Somali-Gare	Gabbra/ Boran	Rendille	Samburu	Turkana	Pokot
MALES							
Stud Bull	Ratii Bargub	Korm	Koram	Oor	Laigoni Laingwen	Ekala-etapan	Kiruk
Entire male trained	Wali Rakub	Rocho Orofaile (coll)	Oro	Recoub (riding) ?	Laur	Ekala-etapan	
Entire male not trained	Barkab		Lufukab		Laur Ldupaan	Ekala-etapan	
Castrate trained	Karran Koran	Qubl	Lufaa Roycho-fahile	Hal	Laur Ldupaan Lmongo		
Castrate not trained	Karran	Qubl	Lufaa	Dufan Folas	Laur Ldupaan Lmongo		Tirgel
Fat castrate	Gol Gool Gawl		Lufaa Dufal	Folas	Laur Ldupaan Lmongo	Ekala-ludungu	
Immature male	Walyk Gorbaa		Gurborr Gurbo		Laur	Ekala-nyungtu	
Male calf	Niriga Gorbaa	Irman - newborn Chonole- one year	Ogori Hirman Chonole	Nyirigi	Lnyirig (sitima)	Tan'gan' nyikidi	Waura
FEMALES							
Adult female	Hal galob		Howiit		Ntames ntawo	akal-nowiganon	Adonge
Pregnant adult female	Krimii Hamir		Remaa		Ntames keti rugum	akal-nowiganon	
Lactating' adult female	Liss Adol Irman- (coll)		Gal anani	Irbaan	Ntames keti nkule (nelepo)	akal-nyideli	
Barren female	Galoof Galof						
Fattened female	Gol Gool						

Category	Somali	Somali-Gare	Gabbra/ Boran	Rendille	Samburu	Turkana	Pokot
Pregnant heifer	Ubuk Balin Kailin		Goroms		Ntawo e Ntames	akal-natak	
Non pregnant heifer	Kalin Dida gil		Goroms Orge-yabota		Ntawo e Ntames	Tangal nyarokit	
Immature female		Kalmah	Gusot Orge		Ntawo e Ntames	Tangal	
Female calf	Nirok	Irman-newborn Chonole-one year	Orgi Hirman Chonole	Nyirigi	Lnyirig (lepong)	Tangal	
Camel	Gel		Gal Galla	Gal	Ntames	Ntamish Ngaala	Tamas (s) Tamasae (pl)

Partially compiled from Iles (1991), Mares (1954)

APPENDIX 5

Weights, measures, conversion factors

Weights and Measures

Mass - Metric

ppm = parts per million = 1 gram per tonne

mg = Milligram = $^1/_{1000}$ of a gram = 0.015 grains

gr = gram = $^1/_{1000}$ of a kilogram = 15.432 grains (1 gram = the weight of 1cc of pure water)

Kg = 1,000 grams = $^1/_{1000}$ of a tonne = 2.204 lbs

Tonne = 1,000 kilograms = 2,204 lbs or short ton

Mass - Imperial

Grn = Grain = 437.5 grains to 1 oz. = 64.8mg 7000 grns = 1 lb. (Origin = 1 grain of wheat)

Oz = Ounce = $^1/_{16}$ of a pound = 28.352 gms

lb = (origin Latin "libra") pound = 0.4536 Kg (as also £ originally 1lb weight of silver)

cwt = Hundred weight = 112 pounds = 50.80 Kg

Ton = 2,240 lbs or 20 cwts = 1,016.06 Kg

Capacity - Metric

Ml = millilitre = $^1/_{1000}$ of a litre

cc = cubic centimetre = $^1/_{100}$ of a litre = .0352 fl. oz (1cc of pure water weighs 1 gram)

Lt = Litre = 1,000 ml (weighs 1 Kg of pure water) = 1.76 pints

Capacity - Imperial

Fl.oz = fluid ounce = $^1/_{20}$ of a pint = 28.4 ml

Pint = 20 fl. oz or $^1/_8$ gallon = 0.568 Lt

Gallon = 8 pints or 160 fl. oz (weighs 10 lbs) = 4.536 Lt
Volume of 1 gallon = 277.274 cubic inches
NB. 1 U.S. gallon = 3.78 Lt or 231 cubic inches

Length - Metric

μ = micron = $^1/_{1000}$ of a millimetre

Mm = millimetre = $^1/_{1000}$ of a mt. = 0.0393 in.

Cm = centimetre = $^1/_{100}$ of a mt. = 0.393 in.

Mt = metre = 39.37" or 3.28 ft' or 1.0936 yards

Km = kilometre = 1,000 mts = 1,093.6 yards or 0.621 miles

Length - Imperial

in " = inch is $^1/_{12}$ of a foot = 2.54 cm

ft ' = foot is $^1/_3$ of a yard = 12" in = 0.3048 mt

yd = yard is 3 feet = .914 mt

chain = 22 yards (length of cricket pitch) = 20.117 mts

furlong = $^1/_8$ mile, 10 chains or 220 yds = 201.167 mts
mile = 80 chains, 1760 yds or 5280 ft = 1.6093 km

Tanks

Tank 4'x4'x4' contains 400 galls, weighs 4,000 lbs.

Tank 1m x 1m x 1m contains 1,000 lts, weighs 1,000 kg. and = 1 cubic meter

1 cubic ft water contains 6.25 gallons, weighs 62.5 lbs

Circular tank capacity = $\pi r^2 h$ x 6.25 = gallons π = 3.142, r = radius in ft, h = height in ft)

(or) (Cooper's Pocket Guide) d^2 x 4.9 gallons per ft (d = diameter in ft)

(or) d^2 x 78.2 = Lts per Mt (d = diameter in mts)

Land Measure

1 Hectare = 100 mts x 100 mts = 10,000 sq. mts = 2.4711 acres

1 acre = 4840 sq. yds (22 yds x 220 yds or approx 70 yds x 70 yds) = 0.40458 Hectares

1 sq. mile contains 640 acres, or 259 ha, or 2.59 sq. km.

1 sq. kilometer = 100 hectares = 247 acres.

Approximate conversions

Metres to feet: multiply by 3 $^1/_4$, or (x 3.281)

Feet to metres: multiply by 3 & divide by 10 (or) multiply by 0.3048

Metres to yards: d $^1/_{10}$ or multiply by 1.094

Yards to metres: deduct $^1/_{10}$ or multiply by 0.9144

Kilometres to miles: multiply by 5, divide by 8 or multiply by 0.6214

Miles to kilometres: add $^{5}/_{8}$ of the number or multiply by 1.609

Sq. metres to sq. yards: add $^{1}/_{5}$ or multiply by 1.196

Sq. yards to sq. metres : deduct $^{1}/_{5}$ or multiply by 0.835

Sq. kilometres to sq. miles: multiply by 2, divide by 5 or multiply by 0.3861

Sq. miles to sq. kilometres: multiply by 2.6

Cubic metres to cubic yards: add $^{1}/_{3}$ or multiply by 1.308

Cubic yards to cubic metres: deduct $^{1}/_{3}$ or multiply by 0.7646

Kilogrammes to pounds: multiply by 2 and add $^{1}/_{10}$ or multiply by 2.205

Pounds to kilogrammes: deduct $^{1}/_{10}$ and divide by 2 or multiply by 0.4536

Litres to pints: add $^{3}/_{4}$

Pints to litres: multiply by 3, divide by 5 or multiply by 0.5682

Gallons to litres: multiply by 4.546

Litres to gallons: multiply by 0.22

In the absence of measuring equipment the following are useful:-

- 1 tablespoon = 2 desert spoons = approx $^{3}/_{4}$ fl.oz or 20ml
- 1 desert spoon = 2 tea spoons = approx $^{3}/_{8}$ fl.oz or 10ml
- 1 Tea spoon = approx $^{3}/_{16}$ fl.oz or 5ml
- "Soda" bottles usually have the capacity printed on the bottle.
- Standard wine and spirit bottles contain 750ml or $^{1}/_{6}$ of a gallon.
- A "treetop" bottle contains 700ml.
- A beer bottle contains 500ml.
- A small beer bottle (Export) contains 300ml.
- A normal "soda" bottle contains 300ml.
- A small "soda" bottle contains 200ml.
- 6 spirit or wine bottles approximates 1 gallon.

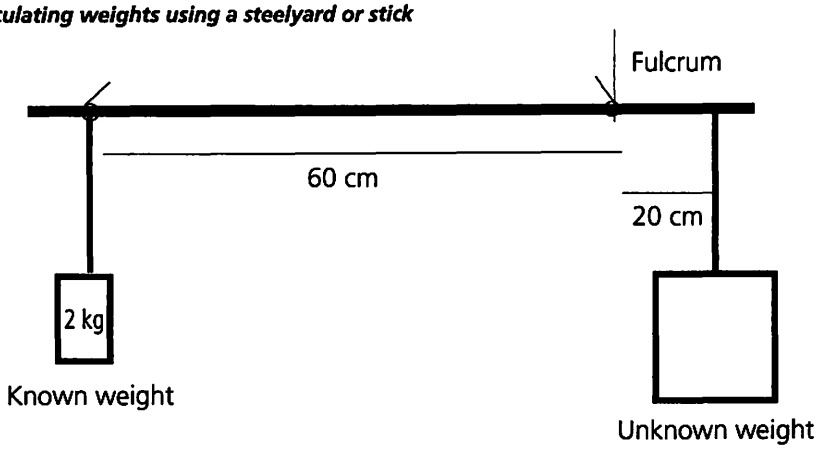
Measured amounts of water may be used for weighing (counterbalance the weight of the container).

- 1 litre = 1 kg.
- 500ml = 500g.
- 1 gallon = 10 lbs

A 'steelyard' or stick may be used to weigh an object if you have another object of known weight:

1) Suspend a stick and balance it.
2) Hang the object to be weighed on one end.
3) Slide your known weight along the stick until they balance.
4) Measure the distance from the fulcrum to the known weight and multiply the two together.
5) Measure the distance from the fulcrum to the unknown weight and divide that into the figure found from 4), which gives you the weight of the object being weighed.

Figure 1: Calculating weights using a steelyard or stick



60 cm x 2 kg = 120 ⟶ 120 divided by 20 cm = 6 kg

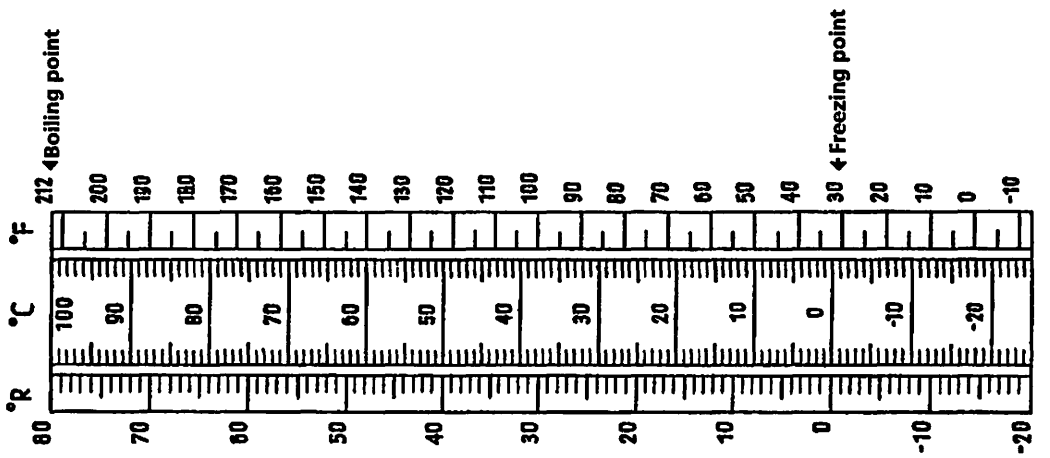
Temperature

	Centigrade	Fahrenheit
Pure water (at sea level) boils at	100°	212°
Pure water (at sea level) freezes at	0°	32°

To convert to Fahrenheit : °Cent + 32° x 9/5 or (°C x 1.8) + 32

To convert to Centigrade : °Fahr - 32° x 5/9 or (°F - 32) x 0.5555

Figure 2: Temperature scale



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