
PART ONE INTRODUCTION



DESCENT AND DOMESTICATION OF GOATS AND SHEEP

Goats and sheep both belong to the tribe Caprini of the family Bovidae in the sub-order Ruminantia of the order Artiodactyla (Zeuner, 1963; Epstein, 1971; Corbet, 1978; Corbet & Hill, 1980; Ryder, 1984). They are typical cloven-hoofed ruminants of relatively small size.

The tribe Caprini is comprised of five genera. Two of these genera, *Capra* and *Hemitragus*, are true goats; one genus, *Ovis*, is the sheep; and there are two genera -- *Ammotragus* and *Pseudois* -- of goat-like sheep or sheep-like goats.

The Barbary sheep or aoudad, *Ammotragus lervia* (Figure 1), is confined to the Sahara and the bharal or blue sheep, *Pseudois nayaur*, to the Himalayas: neither of these have been domesticated and neither will hybridize with true sheep of the genus *Ovis*. Fertile offspring by male Barbary sheep out of female domestic goats are known, however.

According to latest taxonomic opinion the two genera of true goats are divided into three species of *Hemitragus* or tahrs, and six of *Capra*. All the tahrs have the same chromosome number ($2n=48$). Most of the *Capra* species are interfertile although for some pairs no crosses are recorded: all the species examined (bezoar, ibex and markhor) have the same number of chromosomes ($2n=60$).

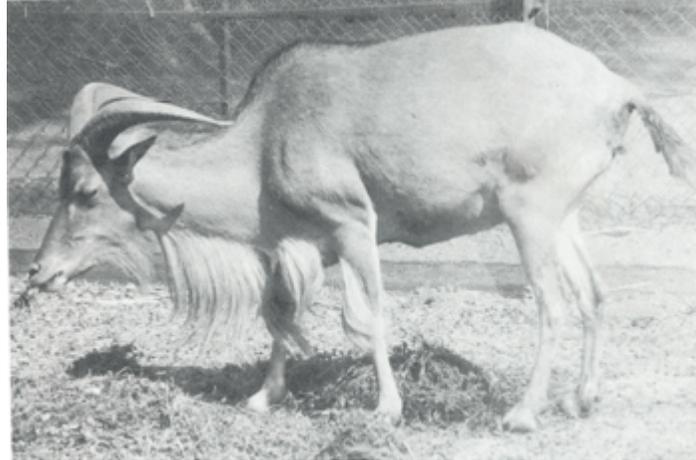


Figure 1 A female Barbary sheep *Ammotragus lervia* at Khartoum zoo
Hemitragus jayakari: Arabian tahr, found now only in Oman and in danger of extinction;

Hemitragus jemlahicus: Himalaya tahr;

Hemitragus hylocrius: Nilgiri tahr of southern India;

Capra aegagrus: Bezoar or wild goat with five sub-species: the domestic variant is classed as *Capra hircus*;

Capra ibex: Ibex, with four sub-species in the Alps; in central Asia; in the Near East, Egypt and Sudan (*C.i.nubian*) (Figure 2); and in the Simen Mountains of Ethiopia, this last being *C.i.walie*;

Capra caucasica: West Caucasian tur or kuban which until recently was considered as a sub-species of the ibex named *C.i.severtzovi*;

Capra cylindricornis: East Caucasian tur which was earlier called *C.caucasica*;

Capra pyrenaica: Spanish ibex or wild goat with two sub-species;

Capra falconeri: Markhor of Afghanistan and Pakistan with six or seven sub-species.

The nomenclature of the genus *Ovis* is confused but latest opinion tends to favour six wild species.

Ovis orientalis: Mouflon, with one sub-species in Asia (*O.o.laristanica*) and one in Europe (*O.o.musimon*);

Ovis ammon: Argal, with nine sub-species;

Ovis vignei: Urial, with thirteen sub-species. *Ovis orientalis* is some-times considered synonymous with *O.vignei*;



Figure 2 Nubian ibex *Capra ibex nuniana* in captivity at Khartoum zoo

Ovis canadensis: Bighorn, with eight sub-species in Canada and the United States of America;

Ovis nivicola: Snow sheep of Siberia with three sub-species;

Ovis dalli: Thinhorn of Alaska also with three sub-species;

All these "species" of *Ovis* are fully interfertile and might therefore be considered to be monotypic. To distinguish them from the wild types, all domesticated sheep are now classed as *Ovis aries*. The mouflon has the same number of chromosomes as the domestic sheep ($2n=54$) while the urial ($2n=58$) and the argal ($2n=56$) differ.

Of the six species of *Capra*, it is most likely that only *C.aegagrus* blood is present in the modern domestic goat although a slim possibility still remains that the markhor, *C.falconeri*, may have been involved in the ancestry of some Indian breeds.

The bighorn, *O.canadensis*, and the thinhorn, *O.dalli*, are excluded, on geographical considerations alone, from the ancestry of domestic sheep. Some authorities, on the grounds of chromosome number, consider the mouflon to be the sole ancestor of the domestic sheep. Both the argal and the urial, however, freely interbreed with, and produce fully fertile offspring from, the domestic sheep and therefore cannot be excluded from its ancestry.

Domestic goats and sheep, because of the divergence in chromosome numbers, do not usually interbreed (Gray, 1972). Experimental chimaera are known (Fehilly, Willadsen & Tucker, 1984; Meinecke-Tillman & Meinecke, 1984) and one of these, back-crossed to a ram, is reported to have produced twin offspring (Bunch, Foote & Spillet, 1976).

The most simple and effective visual way of separating goats from sheep is the carriage of the tail -- in all domestic forms, goats' tails are erect while those of sheep are pendent. There are, however, a considerable number of additional morphological differences between the two species. Goats have beard and caudal (i.e. at the tail) scent glands in the male. Sheep have suborbital (under the eye) tear glands and lachrymal (tear) pits in the skull and also possess foot glands: goats may, however, have glands in the

forefeet. Both species differ from cattle in normally having only two nipples instead of four.

Goats were almost certainly the first ruminants to be domesticated and were possibly only the second species to be taken into the human fold after the dog. South-west Asia (Iran and Iraq) is the most likely origin of the domestic species, the bezoar, *C.aegagrus*, being present there. Domestication occurred gradually over a period centred about 9000 years Before Present (Mason, 1984). Domestication of sheep possibly followed closely upon that of the goat and took place in the same area. Both goats and sheep appeared in tomb and cave paintings in Egypt by about 7000 years BP. Goats moved into sub-Saharan Africa by at least 5500 years BP and a dwarf type has been recorded from that period near Khartoum in Sudan. Sheep probably entered Africa with cattle, at some time in the period 6000-5000 BP, possibly slightly later than goats.

SMALL RUMINANT PRODUCTION SYSTEMS IN TROPICAL AFRICA

Tropical Africa contains one-third of all the world's goats and one-sixth of its sheep. On average there is one goat or sheep on *every* 10 ha of tropical Africa and there are 1.1 head of goats and sheep per person employed in the agricultural sector. Goats and sheep are equivalent, in weight terms, to about 17 per cent of the total domestic ruminant biomass (DRB) of tropical Africa.

Total meat production from African goats and sheep combined is estimated (FAO, 1985) at 1.15 million tonnes, equivalent to about 16 per cent of total world output from these species. Milk from small ruminants is 1.99 million tonnes, about 14 per cent of world production. Small ruminant skins from Africa, estimated at 258 000 tonnes, represent about 16 per cent of world production, the proportion from goats (25 per cent) being much greater than that from sheep. African wool production, of about 228 000 tonnes, is equivalent to less than 8 per cent of world output and most of this wool is produced in South Africa and Africa north of the Sahara. Goats in tropical Africa are much more important than sheep as milk producers and she-goats (does) are estimated to produce about three times as much milk in total as are ewes.

DISTRIBUTION AND IMPORTANCE OF GOATS AND SHEEP

The major criteria adopted for assessing the distribution and importance of goats and sheep are: the ratios of goats to sheep; the density per unit area of both species combined; the ratio of goats and sheep to the human population involved in agricultural activities; and the contribution of goats and sheep to the total domestic ruminant biomass.

Ratios of goats to sheep

In tropical Africa as a whole, goats outnumber sheep in the ratio 1.16:1.00. There does not appear to be any overall pattern in the relative importance of goats and sheep related to the major ecological zones or to the major production systems, at least at the country level (Figure 3).

Goats are dominant and exceed sheep by a ratio of 4:1 in widely disparate countries. The highest ratios of more than 11:1 are found in the Central African Republic and in Zambia. Both countries have low densities of small ruminants, low ratios to the human population and a low contribution of small ruminants to total ruminant biomass. Swaziland has a ratio of goats to sheep exceeding 8:1. The ratio of goats to sheep in Botswana approaches 5:1, this country in general being much drier than the others where high ratios are found and also having a largely pastoral vocation.

Countries in which goats remain dominant over sheep in ratios varying from 2:1 to 4:1 also appear to have few factors in common, either in terms of agro-ecology or of principal production systems. They include the mainly pastoral Niger (2.1:1.0) and neighbouring Nigeria (2.0:1.0). They also include the largely agricultural countries of Zaire (3.8:1.0) and Mozambique (3.1:1.0) as well as some countries with mixed agricultural-livestock economies such as Angola (3.8:1), Zimbabwe (3.4:1.0) and Madagascar (2.5:1.0). The two small central African highland republics of Rwanda (2.9:1.0) and Burundi (2.2:1.0) also fall within this group.

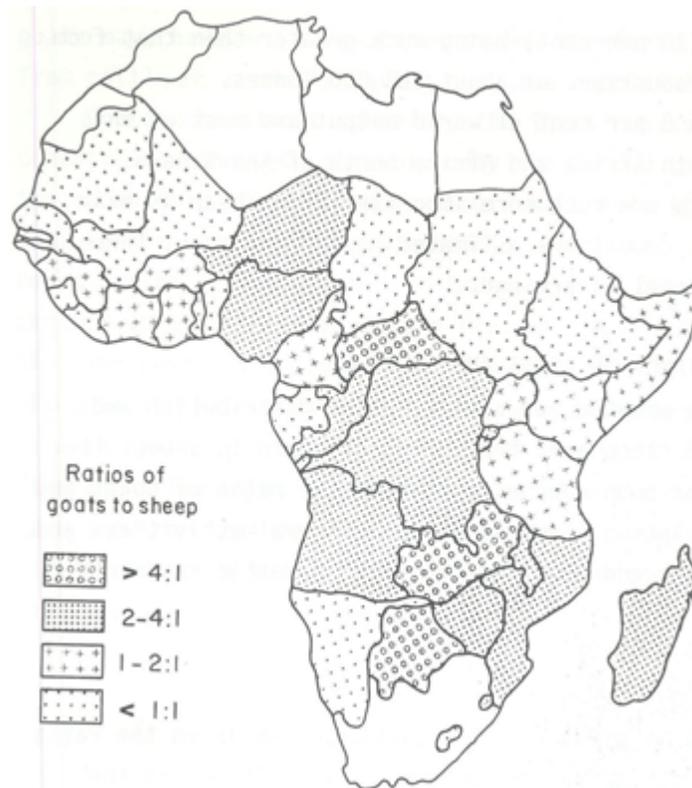


Figure 3 Ratios of goats to sheep in tropical Africa

Sheep assume more importance but are still fewer in number than goats in the major East African countries and in some of the Gulf of Guinea states in West Africa. Somalia has a ratio of goats to sheep of 1.6:1.0, Djibouti of 1.3:1.0, Kenya of 1.2:1.0, Uganda of 1.7:1.0 and Tanzania of 1.6:1.0. In West Africa the ratio varies from 1.3:1.0 in Burkina Faso to about parity in Guinea, Côte d'Ivoire and Ghana.

Goats are less numerous than sheep across much of the Sahel. In Senegal there is only one goat for every two sheep and in Mauritania there are two goats for three sheep. In Sudan and Ethiopia (and also in Gabon and Lesotho) the proportion of goats to sheep is about 0.7:1.0 while in Chad it is about 0.9:1.0. Sheep are more important than goats in Namibia, largely because of the pelt industry, and outnumber them in the ratio of 1.0:0.4.

Density

Small ruminants achieve their highest densities in two distinct areas (Figure 4). More than 35 goats and sheep per square kilometre are found in the Horn of Africa in Somalia and Djibouti where people are traditionally pastoralists. Very high densities are also found in Ethiopia where much of the northern, eastern and southern lowlands also have a pastoral vocation. An additional factor in the high densities in Ethiopia is that the highlands have heavy concentrations of people, the case being similar in the small central African highland republics of Burundi and Rwanda. On a finer scale, the eastern Zaire province of Kivu would also show high densities. Large numbers of small ruminants are also found in Nigeria due to the same

combination of a pastoral vocation (in the north) and large numbers of people (in the centre and south) as in Ethiopia.



Figure 4 Densities of small ruminants per unit area in tropical Africa

Medium densities (18-35 head/km²) of small ruminants are found in countries where there is relatively heavy human population pressure and where they can be integrated with crop farming in mixed smallholder systems. Examples are Togo and Benin in West Africa (countries which are less humid than their immediate neighbours in the Gulf of Guinea) and Uganda and Kenya in East Africa (although Kenya is also largely pastoral in the north and north-east).

Lower densities (7-18 head/km²) are found in all the West African Sahel countries and in Sudan. On a regional basis, densities would probably be in the highest class in the southern areas of this group of countries but large tracts of desert in the north are sparsely populated. Low to extremely low densities are also found in the coastal Gulf of Guinea states mainly because the people are principally agriculturalists but possibly also because of tsetse fly infestation and other humid-associated disease problems.

Very low densities (< 7 goats and sheep/km²) are found from Chad (which is very sparsely populated), through central Africa and into the southern states of Botswana and Zimbabwe. With the exception of the two last named, agriculture is the main preoccupation of the human population and trypanosomiasis is also a problem. Zimbabwe has many more cattle than small ruminants, mainly for socio-cultural reasons, and Botswana, like Chad, is very sparsely populated. Madagascar also falls into the lowest density class.

There are three major exceptions to the general rules governing density of small ruminants. Tanzania has a low human population in relation to its resource potential. Namibia is very thinly populated and has developed an important industry based on pelt production from Karakul sheep. Lesotho is in the highest density class for reasons similar to Namibia in that it has

developed specialist production of mohair from Angora goats and fine wool from Merino sheep.

Numbers of goats and sheep per person

Highest ratios of goats and sheep to humans ($> 2.5:1.0$) are found in the principally pastoral countries (Figure 5). These include, again, Somalia and Djibouti but also Mauritania. Namibia has by far the highest ratio of small ruminants to humans ($13.5:1.0$), almost twice as great as in Mauritania (7.6) and Somalia (7.4).



Figure 5 Relationships of total numbers of goats and sheep to the numbers of people in tropical Africa

Intermediate ratios ($1.3-2.5$ head per person) are found in countries where large segments of the population in the drier areas are pastoralists. These include Mali, Niger and Sudan in the north and Botswana in the south. Small, mountainous Lesotho also appears in this intermediate class because, whilst having the highest density (78.9 head/ km^2) of goats and sheep of all African countries, it also has a large human population in relation to its area.

Low ($0.7-1.3$ head/person) and very low (< 0.7 head/person) ratios prevail in the remainder of Africa. In Ethiopia the highland, mainly agricultural, areas have a population of farmers which greatly outnumbers the pastoral peoples of the lowlands and the situation is similar in Kenya. Togo and Benin, as well as Burundi and Rwanda, which are in the high density classes for small ruminants, also have large human populations, this leading to low numbers of goats and sheep per person. Large numbers of people in the south and centre of Nigeria also impose a low ratio in this country.

Most of the central belt of the continent, from the Atlantic Ocean to the Indian, has very low ratios of small ruminants to people in addition to low densities.

Small ruminants as a proportion of all domestic ruminants

The contribution of goats and sheep to total DRB (Figure 6) has been calculated on the basis of the mean population weight (MPW) of each species. The MPW is the average weight of each animal in the herd or flock and is obtained from weights at specific ages and for different sexes. Although there are obviously some regional differences, MPWs have been standardized at 307 kg for camels, 206 kg for cattle, 30 kg for sheep and 18 kg for goats.

The distribution of the highest proportions (> 25 per cent) of small ruminants in DRB is rather surprising at first sight as it coincides mainly with the humid Gulf of Guinea and central Atlantic coast countries. The reasons for this might be related to the better tolerance, compared to cattle, of goats and sheep to trypanosomiasis. It is also possible that the mainly agricultural peoples of these areas can handle small ruminants more easily than they can cattle. It should, however, be borne in mind that overall animal numbers in these countries are few. Mauritania is the only pastoral country where goats and sheep fall into the highest proportional class although Namibia with a "modern" pastoral economy also has a high relative biomass of small ruminants.

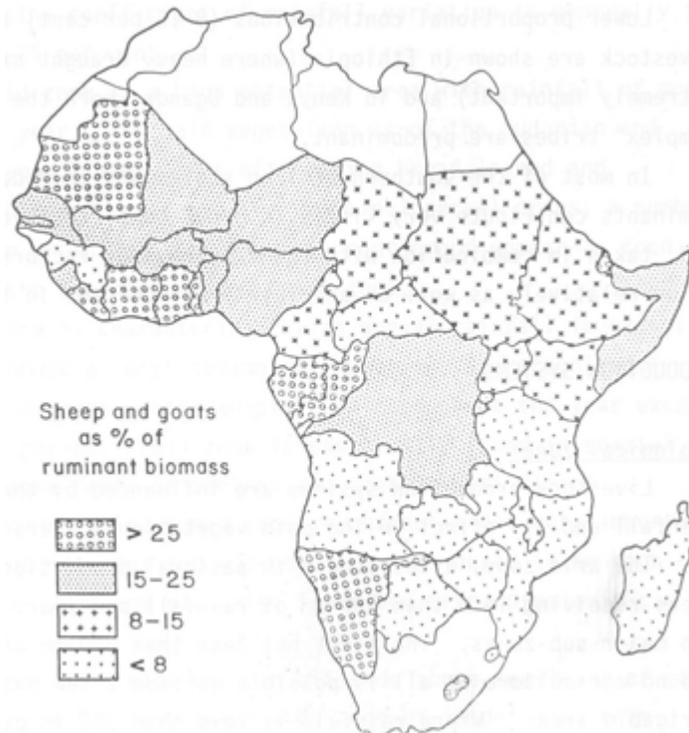


Figure 6 The contribution of small ruminants to total domestic ruminant biomass in tropical Africa

Small ruminants are of considerable (15-25 per cent of DRB) importance in the total livestock mix in most of the remaining pastoral or principally pastoral countries. Of the two such countries that are not in this class,

Sudan does have 14 per cent of DRB as goats and sheep. Small, intensively cultivated countries with high goat and sheep densities also fall into this grouping.

Lower proportional contributions (8-15 per cent) to total livestock are shown in Ethiopia (where heavy draught oxen are extremely important) and in Kenya and Uganda where the "cattle complex" tribes are predominant. In most of the southern African states and in Madagascar, small ruminants contribute very little (< 8 per cent) to livestock biomass and, taken in combination with the two previous factors, can be seen to be relatively as well as absolutely unimportant in this region.