PART B

SCIENCE OF CAMELIDS

General Biology and Evolution

Taxonomy

The systematic classification of Old World camels has never been open to debate. The one-humped camel (dromedary) is named *Camelus dromedarius* and the two-humped camel (Bactrian), *Camelus bactrianus*. The classification of the South American Camelids (SACs) has been more debatable, and one of the factors that has contributed to this confusion is the commonly held belief that crosses between the four species either do not occur or that, when they do, the offspring are sterile.

Linnaeus placed the *llama, alpaca,* and Old World camels in a single genus, *Camelus*, in 1758. Other taxonomists proposed a separate genus status for SACs in the early nineteenth century, but none of this work was accepted by the International Commission on Zoological Nomenclature. The genus name, *Auchenia*, was proposed by Illiger for SACs in 1811 and is frequently seen in print, even today, in world literature. However, *Auchenia* had been applied earlier to a genus of insects and thus was not a valid name for any other animal. In 1827, Lesson published an acceptable paper classifying the New World camelidae in the genus *Lama*. In 1924, Miller assigned the *vicuna* to a separate genus, *Vicugna vicugna*.

One system classifies the *guanaco*, *llama*, and *alpaca* within the genus *Lama* and the *vicuna* as a single species in the genus *Vicugna;* and this is based on its open-rooted incisors, which have enamel in the labial face. Another system classifies all SACs within the genus *Lama*. Others classify the *llama* and *alpaca* as subspecies of *L.guanicoe guanicoe*. In this paper the terms *llama* (*Lama glama*), *alpaca* (*Lama pacos*), *guanaco* (*Lama guanicoe*), and *vicuna* (*Lama vicugna*) will be used.

Collectively, SACs are known as "lamoids" or New World Camelids, although the term *Auquenidae* is often found in older literature. Both camels and SACs are included in the term camelid. The zoological classification for SACs is listed in Table 3.

Table 3: SAC Classification

Class	-	*Mammalia*
Order	-	*Artiodactyla*
Sub-order	-	*Tylopoda*
Family	-	*Camelidae*
Genus	-	*Lama*
Species		
		L.glama, llama
		L.pacos, alpaca
		L.guanicoe, guanaco
		L.vicugna, vicuna

The *alpaca* and *llama* exist only as domestic species. The *guanaco* and *vicuna* are wild animals.

Evolution

Camelid evolution began in North America 40 to 50 million years ago in the early Eocene epoch. (Geological and palaeontological time scales are estimated and are subject to revision.) The evolution of Pleistocene camelids published by Webb suggested three major tribes, separated as early as the Eocene epoch. This family tree, with insufficient fossil records to trace lines accurately, is formed by the tribes *Camelopini* (*Camelops*) and *Camelini* (*Camelus*), that evolved in North America west of the Mississipi River. The tribe *Lamini* (*Lamas*) was also found in Florida.

The Pleistocene epoch was characterised by a series of periods of extreme cold and glaciation in northern North America and Europe. The last glacial retreat occurred about 10,000 years ago, marking the beginning of the recent epoch in which lamoids and camels flourished. Many genera in the family *Camelidae* became extinct, for unknown reasons, before the recent epoch.

The first lamoids migrated to South America at the beginning of the Pleistocene epoch, approximately 3 million years ago, when an open land connection between North and South America developed. The major early lamoid genus appearing in South America was *Hemiauchenia* (*Tanupoloma*) which radiated throughout the flatter regions east of the Andes. During the mid-Pleistocene epoch, the genera *Paleolama* and *Lama* developed from the long-limbed, flatland-adapted *Hemiauchenia*. These genera had shorter limbs, thus were more adapted to the mountainous Andes. Various species of *Paleolama* migrated back to North America. Fossils have been found along the Gulf Coast and Florida in association with North American *Hemiauchenia*.

Domestication

Presently available archaeological evidence indicates that *llamas* and *alpacas* were domesticated in the Andean highlands, probably around Lake Titicaca or elsewhere, perhaps in the *puna* of Junin (Telermachay), Peru (elevation 4,000 to 4,900masl), by 4000 B.C. (for further information on the domestication process, see Part A).

Some of the most complete information yet available on *llama* and *alpaca* domestication has come from the reconstruction of prehistoric animal exploitation strategies at archaeological sites by Elizabeth Wing, on the basis of cranial morphology and incisor analysis, from sites located at lower elevations in Peru.

By the end of the Preceramic period around 2000 B.C., domestic camelids had spread along the highland drainage systems into elevations below 4,000m, as for example the Ayacucho Valley (2,850m), Huacaloma in northern Peru (2,700m), and Puripica near the Salar de Atacama in northern Chile (3,000m). The evidence for the first spread of domestic camelids to the coast comes from Trujillo, around 1500-1100 B.C. On the coast of southern Peru and northern Chile, *llama* feet and woollen textiles are frequently found in burial mounds dating from 500 B.C. State-owned herds of *llama* were maintained on the coast by the Incas until the time of the Spanish conquest. Some historians (Rostworowski) have argued that the coastal region was home to local varieties which disappeared soon after the conquest.

On the basis of cranial morphology, a German zooarchaeologist, suggested that the *guanaco* is the common ancestor of the *llama* and *alpaca*. Another concurs with the first on the *llama* but hypothesises, principally on the basis of behavioural traits, that the *alpaca* resulted from crossing domestic *llama* with *vicuna*, while a third one, also on the basis of behaviour, maintains that the *alpaca* is a domestic *vicuna*. Much more archaeological, palaeontological, and biological research is needed, however, before this problem can be resolved.

General Characteristics

Even though the four species of SAC possess some common characteristics, such as body shape, they differ markedly in other ways, such as colour pattern, body size, and usefulness to man.

All camelids have 37 pairs of chromosomes; the similarity of karyotypes probably explains the fecundity of the offspring produced by all possible crosses, of both pure and hybrid parents. Their haemoglobin has a very high oxygen affinity, advantageous at high altitudes.

Camelids have a complex, three-compartmentalised stomach. Gastric digestion is similar to, but not analogous with, ruminant digestion. The two sub-orders separated from each other 30 to 40 million years ago when primordial species were simple-stomached. Both groups utilised fibrous forage and developed similar foregut fermentation systems by parallel evolution. Camelids regurgitate and rechew ingested forage, as do ruminants, but they are more efficient than ruminants in extracting protein and energy from poor-quality forages.

They defaecate and urinate in relatively confined areas ("latrines") even when they have access to the whole of the pasture. This behaviour has both social and environmental significance. For the wild species, *guanaco* and *vicuna*, it has a short-term primary function of marking territories, especially for intragroup orientation. In the long term it has a secondary side effect of causing greater soil development on heavily vegetated strips as a result of long-term deposition and subsequent downhill washing of the manure by rain. The fertilising effects of the manure and urine are especially noticeable downhill from dung piles at the beginning of the rainy season in the summer. This behaviour is of great importance, since by defaecating only in regularly used dung piles, lamoids have a significantly lower risk of infestation by parasites, and thus parasitic cycles are interrupted. They also make common use of some areas of the pasture for rolling. Here they form pits that become bare on account of continuous use: this behaviour can transmit external parasites, particularly sarcoptic mange.

They have a foot adaptation rather like a cushion that is very sensitive and delicate. This enables them to avoid soil compactation and travel over dangerously steep areas on the mountains with ease.

They demonstrate great curiosity for anything that is new (people, animals, or things) and will often advance fearlessly to discover the object of their curiosity.

Herding with dogs is not possible, because SACs attack members of the dog family by "group moving", much like the treatment dogs receive from the North American elk (*Cervus canadensis*). When frightened, they are apt to spit and kick.

Ovulation is induced by mating and the embryo is implanted in the left uterine horn. The gestation period is around 345 days. They tend to regulate birth to the sunny days only and during full daylight when the temperature is favourable for the young. Daylight parturition is probably an adaptation to avoid giving birth during the freezing night-time temperatures of high altitude regions.

They have split upper lips that enable them to select leaves from the horny parts of forages and they also have very sharp incisor teeth on the lower jaw which continue growing and permit them to eat very short and lignine-rich forages.

The colour of the skin and fibre of the wild members, *guanaco* and *vicuna*, is invariably golden-brown, which permits very good camouflage on both rocks and in the mountain basin pastures.

The *guanaco* and *vicuna* have a well-defined social structure, living in family groups made up of one male and his harem of six to seven females. Remnants of this behaviour can be seen in *alpaca* or *llama* herds.